

v20.1 ClickHouse مستندات

ClickHouse چیست؟

ClickHouse یک مدیریت دیتابیس (DBMS) ستون گرا برای پردازش تحلیلی آنلاین (OLAP) می باشد.

در یک مدیریت دیتابیس ردیف گرا، داده ها به فرم زیر ذخیره سازی می شوند:

EventTime	GoodEvent	Title	JavaEnable	WatchID	Row
05:19:20 2016-05-18	1	Investor Relations	1	5385521489354350662	#0
08:10:20 2016-05-18	1	Contact us	0	5385521490329509958	#1
07:38:00 2016-05-18	1	Mission	1	5385521489953706054	#2
...	N#

به این صورت، تمام مقادیر مربوط به یک سطر (رکورد) به صورت فیزیکی و در کنار یکدیگر ذخیره سازی می شوند.

دیتابیس های MySQL و MS SQL Server، Postgres از انواع دیتابیس های ردیف گرا می باشند.

در یک دیتابیس ستون گرا، داده ها به شکل زیر ذخیره سازی می شوند:

N#	#2	#1	#0	:Row
...	5385521489953706054	5385521490329509958	5385521489354350662	:WatchID
...	1	0	1	:JavaEnable
...	Mission	Contact us	Investor Relations	:Title
...	1	1	1	:GoodEvent
...	07:38:00 2016-05-18	08:10:20 2016-05-18	05:19:20 2016-05-18	:EventTime

این مثال ها تنها نشان می دهند که داده ها منظم شده اند. مقادیر ستون های مختلف به صورت جدا، و داده های مربوط به یک ستون در کنار یکدیگر ذخیره می شوند.

مثال های از دیتابیس های ستون گرا: Vertica, Paraccel (Actian Matrix, Amazon Redshift), Sybase IQ, Exasol, Infobright, +InfiniDB, MonetDB (VectorWise, Actian Vector), LucidDB, SAP HANA, Google Dremel, Google PowerDrill, Druid, kdb

ترتیب های مختلف برای ذخیره سازی داده ها، مناسب سناریو های مختلف هستند. سناریو دسترسی به داده اشاره دارد به، چه هایی ساخته شده اند، چند وقت به چند وقت، در چه مقداری، چقدر داده در هنگام اجرای query خوانده می شود، چند رکورد، چند ستون و چند بایت؛ رابطه های بین خوانده و نوشتن داده؛ سایز دیتاسی فعل مورد استفاده و نحوه ای استفاده آن به صورت محلی؛ آیا از تراکنش استفاده می شود؛ چگونه داده ها جدا می شوند؛ نیازمندی ها برای replication داده ها و یکپارچگی منطقی داده ها؛ نیازمندی ها برای latency و throughput برای هر نوع از query، و...

مهمتر از بالا بودن لود سیستم، سفارشی کردن سیستم مطابق با نیازمندی های سناریو می باشد، و این سفارشی سازی در ادامه دقیق تر می شود. هیچ سیستمی وجود ندارد که مناسب انجام سناریو های متفاوت (بسیار متفاوت) باشد. اگر یک سیستم برای اجرای سناریو

های مختلف آدابته شده باشد، در زمان بالا بودن لود، سیستم تمام سناریوها را به صورت ضعیف handle می کند.

ویژگی های کلیدی یک سناریو OLAP

- اکثریت درخواست های برای خواندن می باشد.
- داده ها به صورت batch های بزرگ (> 1000 رکورد) وارد می شوند، نه به صورت تکی؛ یا اینکه اصلاً بروز نمی شوند.
- داده ها به دیتابیس اضافه می شوند و تغییر پیدا نمی کنند.
- برای خواندن، تعداد زیادی از رکورد ها از دیتابیس استخراج می شوند، اما فقط چند ستون از رکورد ها.
- جداول "wide" هستند، به این معنی تعداد زیادی ستون دارند.
- query ها نسبتاً کم هستند (معمولاً صدها query در ثانیه به ازای هر سرور یا کمتر)
- برای query های ساده، زمان تأخیر 50 میلی ثانیه مجاز باشد.
- مقادیر ستون ها کوچک باشد: اعداد و رشته های کوتاه (برای مثال 60 بایت به ازای هر url)
- نیازمند throughput بالا در هنگام اجرای یک query (بالای یک میلیارد رکورد در هر ثانیه به ازای هر سرور)
- تراکنش واجب نیست.
- نیازمندی کم برای consistency بودن داده ها.
- فقط یک جدول بزرگ به ازای هر query وجود دارد. تمام جداول کوچک هستند، به جز یکی.
- نتیجه query به طول قابل توجهی کوچکتر از source داده ها می باشد. به عبارتی دیگر در یک query، داده ها فیلتر یا تجمع می شوند، پس نتایج در RAM یک سرور فیت می شوند.

خوب خیلی ساده می توان دید که سناریو های OLAP خیلی متفاوت تر از دیگر سناریو های محبوب هستند (مثل Key-Value یا OLTP). پس اگر میخواهید performance مناسب داشته باشید، استفاده از دیتابیس های OLTP یا Key-Value یا OLAP query برای اجرای های OLAP معنی ندارد. برای مثال، اگر شما از دیتابیس MongoDB یا Redis برای آنالیز استفاده کنید، قطعاً performance بسیار ضعیف تری نسبت به دیتابیس های OLAP خواهد داشت.

دلایل برتری دیتابیس های ستون گرا برای سناریو های OLAP

دیتابیس های ستون گرا مناسب سناریو های OLAP هستند (حداقل 100 برابر در بیشتر query ها سرعت پردازش آنها بهتر است). دلایل این برتری در پایین شرح داده شده است، اما آسانترش این هست که به صورت visually این تفاوت را بینیم:

ردیف گرا



ستون گرا



تفاوت را دیدید؟ بیشتر بخوانید تا یاد بگیرید چرا این اتفاق رخ میدهد.

Input/output

1. برای query های تحلیلی، تنها چند ستون از تمام ستون های جدول نیاز به خواندن دارد. در یک دیتابیس ستون گرا، شما فقط داده های مورد نیاز را می خوانید. برای مثال، اگر شما نیاز به 5 ستون از 100 ستون را دارید، شما می توانید انتظار 20 برابر کاهش I/O را داشته باشید.
2. از آنجایی که داده در بسته ها خوانده می شوند، فشرده سازی ساده می باشد. همچنین داده های ستون ها برای فشرده سازی ساده می باشند. این باعث کاهش نرخ I/O در ادامه می شود.
3. با توجه به کاهش I/O، داده های بیشتری در system cache قرار می گیرند.

برای مثال، "تعداد رکوردها به ازای هر بستر نیازمند" نیازمند خواندن ستون "آیدی بستر آگهی"، که 1 بایت بدون فشرده طول می کشد، خواهد بود. اگر بیشتر ترافیک مربوط به بسترهای نیازمندی نبود، شما می توانید انتظار حداقل 10 برابر فشرده سازی این ستون را داشته باشید. زمانی که از الگوریتم فشرده سازی quick استفاده می کنید، عملیات decompression داده ها با سرعت حداقل چندین گیگابایت در ثانیه اجام می شود. به عبارت دیگر، این query توپانایی پردازش تقریباً چندین میلیارد رکورد در ثانیه به ازای یک سرور را دارد. این سرعت در عمل واقعی و دست یافتنی است.

```
$ clickhouse-client
ClickHouse client version 0.0.52053.
Connecting to localhost:9000.
Connected to ClickHouse server version 0.0.52053.

:) SELECT CounterID, count() FROM hits GROUP BY CounterID ORDER BY count() DESC LIMIT 20

SELECT
    CounterID,
    count()
FROM hits
GROUP BY CounterID
ORDER BY count() DESC
LIMIT 20



| CounterID | count()  |
|-----------|----------|
| 114208    | 56057344 |
| 115080    | 51619590 |
| 3228      | 44658301 |
| 38230     | 42045932 |
| 145263    | 42042158 |
| 91244     | 38297270 |
| 154139    | 26647572 |
| 150748    | 24112755 |
| 242232    | 21302571 |
| 338158    | 13507087 |
| 62180     | 12229491 |
| 82264     | 12187441 |
| 232261    | 12148031 |
| 146272    | 11438516 |
| 168777    | 11403636 |
| 4120072   | 11227824 |
| 10938808  | 10519739 |
| 74088     | 9047015  |
| 115079    | 8837972  |
| 337234    | 8205961  |



20 rows in set. Elapsed: 0.153 sec. Processed 1.00 billion rows, 4.00 GB (6.53 billion rows/s., 26.10
GB/s.)

:)
```

CPU

از آنجایی که اجرای یک query نیازمند پردازش تعداد زیادی سطر می باشد، این کمک می کند تا تمام عملیات ها به جای ارسال به سطرهای جداگانه، برای کل بردار ارسال شود، یا برای ترکیب query engine به طوری که هیچ هزینه ای ارسالی وجود ندارد. اگر این کار رو نکنید، با هر half-decent disk subsystem تفسیرگر query ناگزیر است که CPU را متوقف کند. این منطقی است که در صورت امکان هر دو کار ذخیره سازی داده در ستون ها و پردازش ستون ها با هم انجام شود.

دو راه برای انجام این کار وجود دارد:

1. یک موتور بردار. تمام عملیات ها به جای مقادیر جداگانه، برای بردارها نوشته شوند. این به این معنیست که شما خیلی از موقع نیازی به صدا کردن عملیات ها ندارید، و هزینه انتقال ناچیز است. کد عملیاتی شامل یک چرخه داخلی بهینه شده است.
2. Code generation. کد تولید شده برای query دارای تماس های غیرمستقیم در آن است.

این در یک دیتابیس نرم افزاری انجام نمی شود، چرا که برای اجرای query های ساده این کارها منطقی نیست. هرچند، استثناهایی هم وجود دارد. برای مثال، MemSQL از code generation برای کاهش latency در هنگام پردازش query های SQL استفاده می کند. (برای مقایسه، مدیریت دیتابیس های آنالیزی نیازمند بهینه سازی توان عملیاتی (throughput) latency هستند نه).

توجه کنید که برای کارایی query language CPU، SQL یا MDX باشد، یا حداقل یک بردار (K, L) باشد. query برای بهینه سازی باید فقط دارای حلقه های implicit باشد.

ویژگی های برجسته ClickHouse

مدیریت دیتابیس ستون گرای واقعی

در یک مدیریت دیتابیس ستون گرای واقعی، هیچ مقداری فضای اضافی برای ذخیره سازی ندارد. برای مثال، این به این معنیست که برای مقادیر constant-length باید پشتیبانی شوند تا از ذخیره سازی طول مقدار به عنوان یه عدد integer کنار مقدار جلوگیری شود. در این مورد، یک میلیارد مقدار UInt8 باید در واقع در حالت غیرفشرده 1 گیگابایت فضا اشغال کند، در غیراین صورت به شدت بر عملکرد CPU تاثیر میگذارد. این خیلی مهم هست که داده ها به صورت compact ذخیره سازی شوند حتی زمانی که compressed هستند، از آنجا که سرعت سرعت CPU Usage (CPU Usage) عمدها به حجم داده های decompress (decompress) بستگی دارد.

این بسیار قابل توجه است چون سیستم هایی وجود دارند که توانایی ذخیره سازی مقادیر ستون ها را به صورت جداگانه دارند، اما به دلیل بهینه سازی آنها برای دیگر سناریوهای، نمیتوانند به طور موثر پردازش های تحلیلی انجام دهند. برای مثال، HBase، BigTable، Cassandra و HyperTable. در این سیستم ها، شما توان عملیاتی حدود صدها هزار سطر در ثانیه را دارید، اما نه صدها میلیون سطر در ثانیه.

همچنین توجه داشته باشید که ClickHouse یک مدیریت دیتابیس است نه فقط یک دیتابیس. اجازه میدهد که در رمان اجراء اقدام به ساخت جدول، دیتابیس کنید، داده load کنید و query های خود را بدون restart و یا reconfigure مجدد سرور، اجرا کنید.

فشرده سازی داده ها

بعضی دیتابیس های ستون گرا (MonetDB CE یا InfiniDB CE) از فشرده سازی داده ها استفاده نمی کنند. با این حال، فشرده سازی داده ها برای رسیدن به عملکرد عالی ضروری است.

Disk storage of data

خیلی از مدیریت دیتابیس های ستون گرا (Google PowerDrill و SAP HANA مثل) فقط داخل RAM کار می کنند. این رویکرد منجر به تخصیص بودجه سخت افزاری بالا برای تحقق آنالیز های real-time ClickHouse برای کار بر روی هارد دیسک های معمولی طراحی شده است، که هزینه های برای هر گیگابایت داده را تضمین می کند، اما اگر SSD و RAM موجود باشد به طور کامل مورد استفاده قرار می گیرد.

پردازش موازی روی چندین هسته

query های بزرگ به طور طبیعی با استفاده از تمام منابع موجود در روی سرور فعلی، موازی سازی می شوند.

پردازش توزیع شده بر روی چندین سرور

تقریبا هیچ کدام از DBMS هایی که بالاتر ذکر شد، از اجرای query ها به صورت توزیع شده پشتیبانی نمی کنند. در ClickHouse ها می توان در shard های مختلف مستقر شوند. هر shard میتوانند گروهی از replica ها برای بالا بردن تحمل پذیری در برابر خطا (fault tolerance) را داشته باشد. یک query به صورت موازی بر روی تمامی shard های اجرا می شود. این برای کاربر شفاف است.

پشتیبانی SQL

اگر شما با SQL آشنا باشید، ما واقعاً نمیتوانیم در مورد پشتیبانی از SQL صحبت کنیم. تمام توابع اسم های مختلفی دارند. با این حال، این یک زبان بر پایه SQL هست که نمیتواند در بسیاری از موارد با SQL متفاوت باشد. JOIN ها پشتیبانی می شود. ها در JOIN و JOIN FROM، IN FROM، IN JOIN پشتیبانی می شود. Dependent subquery ها پشتیبانی می شود.

زبان بر پایه SQL ClickHouse است که در بسیاری از موارد از استاندارد SQL پیروی می کند. scalar window function ها در JOIN، IN و JOIN پشتیبانی می شود. subquery های مرتبه و subquery ها پشتیبانی نمی شود.

موتور بردار

داده ها نه فقط براساس ستون ها ذخیره می شوند، بلکه با استفاده از برداردها (بخشی از ستون ها) پردازش می شوند. این قابلیت

بروزرسانی داده ها به صورت Real-Time

از جداول دارای Primary Key پشتیبانی می کند. به منظور اجرای query های range بر روی Primary Key، داده ها به صورت افزایشی (مرتب شده) با استفاده از merge tree ذخیره سازی می شوند. با توجه به این، داده ها می توانند به طور پیوسته به جدول اضافه شوند. هیچ نوع lock در هنگام مصرف داده ها وجود ندارد.

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داشتن داده ها به صورت فیزیکی و مرتب شده براساس Primary Key این قابلیت را می دهد که استخراج کردن داده برای مقدار خاص و یا مقادیر range با کمترین latency، یعنی کمتر از چند هزار میلی ثانیه ممکن شود.

مناسب برای query های آنلاین

پایین به این معنی است که query ها بتوانند بدون delay و بدون تلاش برای رسیدن به پیش پاسخ (از قبل محاسبه شده) دقیقا در همان لحظه که کاربر در حال load صفحه است پردازش شوند. به عبارتی دیگر، آنلاین

پشتیبانی از محاسبات تقریبی

روش های مختلفی برای کسب دقیق performance ارائه می دهد:

1. توابع Aggregate برای محاسبات تقریبی تعداد مقادیر متمایز (distinct)، median و quantity ها
2. اجرای یک query برای بخشی از داده ها (داده ی sample) و دریافت خروجی تقریبی. در این مورد داده ی نسبتاً کمتری از دیسک بازیابی می شود.
3. اجرای یک Aggregation برای تعداد محدودی از کلید های تصادفی، به جای تمام کلید ها. در شرایط خاص برای توزیع کلید در داده ها، این روش کمک می کند به نتایج منطقی برسیم با استفاده از منابع کمتر.

Replication داده ها و integrity

از روش ClickHouse asynchronous multimaster replication استفاده می کند. بعد از نوشتن داده در یکی از replica های موجود، داده به صورت توزیع شده به بقیه replica ها منتقل می شود. این سیستم داده های مشابه را در replica های مختلف نگه داری می کند. در اکثر موارد که سیستم fail می شوند، داده ها به صورت اتوماتیک restore می شوند و یا در موارد پیچیده به صورت نیمه اتوماتیک restore می شوند.

برای اطلاعات بیشتر، به بخش replication داده ها مراجعه کنید.

ویژگی های از ClickHouse که می توانند معایبی باشد.

1. بدون پشتیبانی کامل از تراکنش
2. عدم توانایی برای تغییر و یا حذف داده های در حال حاضر وارد شده با سرعت بالا و تأخیر کم. برای پاک کردن و یا اصلاح داده ها، به عنوان مثال برای پیروی از GDPR دسته ای پاک و به روزرسانی وجود دارد. حال توسعه می باشد.
3. باعث می شود ClickHouse چندان مناسب اجرای پرسمان های point query برای دریافت یک ردیف از داده ها با استفاده از کلید آنها نباشد.

Performance

با توجه به نتایج تست های Yandex، ClickHouse بهترین عملکرد را برای سناریوهای عملیاتی قابل مقایسه با دیگر سیستم های در کلاس خود را از خود نشان داد. این تست ها شامل بالاترین توان عملیاتی برای query های طولانی، و کمترین latency برای query های کوتاه بود. نتایج این تست های در صفحه جدا موجود است.

benchmark های زیادی وجود دارند که این نتایج را تایید می کنند. میتوانید این نتایج را جستجو کنید و یا [این لینک های benchmark](#) مستقل را ببینید.

توان عملیاتی برای یک query بزرگ

توان عملیاتی می تواند به صورت تعداد سطر در ثانیه و یا تعداد مگابایت در ثانیه اندازه گیری شود. اگر داده ها در page cache داشته باشند، یک query برای اجرا شدن بر روی سخت افزارهای مدرن چندان پیچیده نخواهد بود و با سرعت تقریبا 2 تا 10 گیگابایت در ثانیه برای داده های غیرفشرده و در یک سرور پردازش خواهد شد (برای ساده ترین موارد، سرعت ممکن است به 30 گیگابایت در ثانیه برسد). اگر داده ها در page cache قرار نداشته باشند، سرعت محدود به دیسک و همچنین چگونگی فشرده سازی داده ها بر روی دیسک می باشد. برای مثال اگر یک دیسک اجازه خواندن داده ها با سرعت 400 مگابایت در ثانیه را بدهد، و داده ها با نرخ 3 فشرده سازی شده باشند، سرعت در حدود 1.2 گیگابایت در ثانیه خواهد بود. برای گرفتن تعداد رکورد در ثانیه، سرعت بایت در ثانیه را تقسیم بر کل سایز ستون ها مورد استفاده در query می کنیم. برای مثال اگر 10 بایت از ستون ها استخراج می شود، سرعت در حدود 100 تا 200 میلیون سطر در ثانیه می باشد.

سرعت پردازش در سرویس توزیع شده تقریبا به صورت خطی افزایش پیدا می کند، اما فقط وقتی که نتایج سطرهای به دست آمده از aggeration یا مرتب سازی زیاد بزرگ نباشند.

Latency در زمان پردازش query های کوتاه

اگر یک Primary Key query از استفاده نکند و تعداد زیادی از سطر ها را برای پردازش select نکند (صدها هزار)، و از تعداد زیادی ستون استفاده نکند، اگر داده ها در page cache قرار داشته باشند، ما میتوانیم انتظار latency کمتر از 50 میلی ثانیه را داشته باشیم. در غیر این صورت محاسبه زمان براساس تعداد seek ها انجام خواهد گرفت. اگر شما از هارد های دیسکی استفاده می کنید، برای سیستمی که overload محسوب می شود، محاسبه تقریبی latency با استفاده از این فرمول ممکن است: زمان (10 ms) * تعداد ستون های مورد نیاز در query * تعداد قطعات داده

توان عملیاتی در هنگام پردازش تعداد زیادی از query های کوتاه

تحت شرایط مشابه ClickHouse، توانایی رسیدگی به چند صد query در ثانیه به ازای یک سرور را دارد (بالای چند هزار در ثانیه در بهترین مورد). از آنجایی که این سناریو در مدیریت دیتابیس های آنالیزی معمول نیست، بهتر است نهايانا انتظار چند صد latency در ثانیه را داشته باشید.

Performance در هنگام درج داده ها

پیشنهاد می کنیم درج داده ها را به صورت دسته ای و حداکثر 100 سطر در هر دسته انجام دهید و یا بیش از یک درخواست در ثانیه را نداشته باشید. در هنگام درج داده در جدول MergeTree از یک dump جدا شده با tab، سرعت درج داده از 50 تا 200 مگابایت در ثانیه می باشد. اگر سطر های درج شده حدود 1 کیلوبایت باشند، سرعت حدود 50 هزار تا 200 هزار سطر در ثانیه می باشد. اگر سطر ها کوچک باشند بازدهی بالایی در تعداد سطر در ثانیه خواهیم داشت. در Banner System Data -> 500 data Graphite 1 -> میلیون سطر در ثانیه. برای بهبود کارایی، شما می توانید چندین insert را به صورت موازی اجرا کنید، که در این حالت کارایی سیستم به صورت خطی افزایش می یابد.

ClickHouse هچخیرات

در ابتدا برای قدرت به Yandex.Metrica دومین بستر آنالیز وب در دنیا توسعه داده شد، و همچنان جز اصلی آن است. ClickHouse اجازه می دهد که با بیش از 13 تریلیون رکورد در دیتابیس و بیش از 20 میلیارد event در روز، گزارش های مستقیم (On the fly) از داده های non-aggregate تهیه کنیم. این مقاله پیشنهیه تاریخی در ارتباط با اهداف اصلی ClickHouse قبل از آنکه به یک محصول open source تبدیل شود، می دهد.

Yandex.Metrica تولید گزارش های برایه بازدید و session ها به صورت on the fly و با استفاده از بخش های دلخواه و دوره های زمانی که توسط کاربر انتخاب می شود را انجام می دهد. aggregate های پیچیده معمولاً مورد نیاز هستند، مانند تعداد بازدیدکنندگان unique داده های جدید برای تهیه گزارش گیری به صورت real-time می رساند.

از آوریل 2014، Yandex.Metrica 12 میلیارد event view و click شامل event در روز دریافت کرد. تمام این event ها باید به ترتیب برای ساخت گزارش های سفارشی ذخیره سازی می شدند. یک query ممکن است نیاز به اسکن کردن میلیون ها سطر با زمان کمتر از چند صد میلی ثانیه، یا چند صد میلیون سطر در عرض چند ثانیه داشته باشد.

استفاده در Yandex.Metrica و دیگر سرویس های Yandex

با چندین اهداف در ClickHouse استفاده می شود. وظیفه اصلی آن ساخت گزارش های آنلاین از داده های non-aggregate می باشد. ClickHouse در یک کلاستر با سایز 374 سرور، که بیش از 20.3 تریلیون سطر در دیتابیس را دارد مورد استفاده قرار می گیرد. اندازه فشرده داده ها، بدون شمارش داده های تکراری و replication، حدود 2 پتایت می باشد. اندازه ی غیرفسرده داده ها (در فرمت TSV) حدوداً 17 پتایت می باشد.

همچنین در موارد زیر استفاده می شود:

- ذخیره سازی داده ها برای Session replay از Yandex.Metrica
- پردازش داده های Intermediate
- ساخت گزارش های سراسری از آنالیز ها
- اجرای query ها برای debug کردن موتور Yandex.Metrica
- آنالیز لگ های به دست آمده از API ها و user interface

search verticals، Market، Direct، Business Yandex ClickHouse نصب شده است: در سطح این سرویس های شخصی و Analytics، Mobile Development، AdFox

داده های Aggregate ، Non-Aggregate

یک دیدگاه محبوب وجود دارد که شما باید، داده های خود را به منظور کاهش اندازه داده ها Aggregate کنید.

اما به دلیل زیر، کردن داده ها راه حل بسیار محدودی است:

- شما باید لیست گزارش های از قبیل تعریف شده توسط کاربر که نیاز به تهیه گزارش آنها را دارید، داشته باشید.
- کاربر نمیتواند گزارش های سفارشی تهیه کند.
- در هنگام aggregate کردن تعداد بسیار زیاد key، اندازه ی داده ها کم نمی شود و aggregate بی فایده است.
- برای تعداد زیادی از گزارش ها، aggregate های متعدد و تغییریزیز زیادی وجود دارد. (انفجار ترکیبی).
- هنگام aggregate کردن key ها با cardinality بالا (مثل URL ها)، اندازه داده ها به اندازه کافی کاهش پیدا نمی کند (کمتر از دو برابر).
- به این دلیل اندازه ی داده ها با aggregate کردن ممکن است به جای شکستن، رشد هم بکند.
- کاربر تمام گزارش هایی که ما تولید کردیم را نگاه نمی کند. بخش بزرگی از محاسبات بی فایده است.
- یکپارچگی منطقی داده ها ممکن است برای aggregate های مختلف نقض شود.

اگر ما هیچ چیزی را aggregate نکنیم و با داده های non-aggregate کار کنیم، در واقع این ممکن است باعث کاهش اندازه ی محاسبات شود.

با این حال، با aggregate کردن، بخش قابل توجهی از کار به صورت آفلاین انجام می شود و نسبتاً آرام به پایان می رسد. در مقابل، محاسبات آنلاین به دلیل اینکه کاربر منتظر نمایش نتایج می باشد، نیازمند محاسبه سریع تا جایی که ممکن است می باشد.

دارای یک سیستم تخصصی برای aggregate کردن داده ها به اسم Metrage می باشد، که برای اکثریت گزارش های Yandex.Metrica مورد استفاده قرار می گیرد. شروع سال 2009، Yandex.Metrica همچنین از یک دیتابیس تخصصی OLAP برای داده های non-OLAP Server به نام OLAPServer، که قبلاً برای ساخت گزارش ها استفاده می شد، استفاده می کرد. OLAPServer به خوبی روی داده های Non-Aggregate کار می کرد، اما محدودیت های بسیار زیادی داشت که اجازه ی استفاده در تمام گزارش های دلخواه را نمی داد. مواردی از قبیل عدم پشتیبانی از data type ها (فقط عدد)، و عدم توانایی در بروزرسانی افزایشی داده ها به صورت real-time (این کار فقط به rewrite کردن داده ها به صورت روزانه امکام پذیر بود). یک مدیریت دیتابیس نبود اما یک دیتابیس تخصصی بود.

برای حذف محدودیت های OLAPServer و حل مشکلات کار با داده های Non-Aggregate برای تمام گزارش ها، ما مدیریت دیتابیس ClicHouse را توسعه دادیم..

ندش ورش

قیرط زا دیا، مهمه زا لوا، دینک ساسحا ار ن آ در کلمه دیهالو خیم و دیتسهه دراو هزاتب صنل حاره. دینک باختنا ار بریزی ااه منیزگ زا می کي
دینلوته می من آزا سس:

- دینک ی طار ملصفم ش زوماً
 - دینک ش یامزا هنومزیاهه ھداد ابر

یزادزا هار و بصدز

نیازمندی های سیستم

ClickHouse میں کوئی لامپرے CPU میں SSE 4.2 ایسا ناپیشی ممکن نہیں۔ اس کے لئے ایسا مدد ممکن ہے جس کی مدد میں ClickHouse کو اپنے میکینیکی سرور پر بچالا کر سکتے ہیں۔

```
grep -q sse4_2 /proc/cpuinfo && echo "SSE 4.2 supported" || echo "SSE 4.2 not supported"
```

دیا، دنراد، PowerPC64LE ای AArch64 ای رامعم ای دننکی مزی نابیتیشی SSE 4.2 زا که ClickHouse دینک داجیا عبانم زا ار بسانم تامیظة ای

دوجوم برصے اہ هنیزگ

نصب از طریق پکیج های Debian/Ubuntu

در فایل `etc/apt/sources.list` (یا در یک فایل جدا `etc/apt/sources.list.d/clickhouse.list`), Repo زیر را اضافه کنید:

```
deb http://repo.yandex.ru/clickhouse/deb/stable/ main/
```

اگر شما میخواهید جدیدترین نسخه‌ی تست را استفاده کنید، 'stable' را به 'testing' تغییر بدهید.

سیس دستورات زیر را اجرا کنید:

```
sudo apt-get install dirmngr      # optional  
sudo apt-key adv --keyserver hkp://keyserver.ubuntu.com:80 --recv E0C56BD4      # optional  
sudo apt-get update  
sudo apt-get install clickhouse-client clickhouse-server
```

شما همچنین می توانید از طریق لینک زیر پکیج ClickHouse را به صورت دستی دانلود و نصب کنید:
<https://repo.yandex.ru/clickhouse/deb/stable/main>

ClickHouse دارای تنظیمات محدودیت دسترسی ('config.xml') است که در فایل 'users.xml' (کنار 'users.xml') می‌باشد. به صورت پیش‌فرض دسترسی برای کاربر 'default' از همه جا بدون نیاز به پسورد وجود دارد. برای مشاهده کنید، بروی اطلاعات پیشتر قسمت "تنظیمات فایل‌ها" را مشاهده کنید.

راهنماهی RPM

لذکی م مخصوص rpm کوئنڈل ری نتدم یا هع زوت ری ساس و CentOS , RedHat

دینک هفاضا اریمسر نزخم دیار ادترا:

```
sudo yum install yum-utils  
sudo rpm --import https://repo.yandex.ru/clickhouse/CLICKHOUSE-KEY.GPG  
sudo yum-config-manager --add-repo https://repo.yandex.ru/clickhouse/rpm/stable/x86_64
```

(دوشیم مخصوصاً مشابه آنرا طیم می‌دانیم) "تست" اب ار "رادیاپ"

دینک بمنز ار آه متسبع قاو رد سات دینک ارجا ار تاروتسد نیا سپس:

```
sudo yum install clickhouse-server clickhouse-client
```

دینک بمنز ار آه متسبع قاو رد سات دینک ارجا ار تاروتسد نیا سپس: https://repo.yandex.ru/clickhouse/rpm/stable/x86_64

Docker Image را ###

دینکیم هدافتسا لخاد رد "deb" ممسنی اه متسبع زا برواصتن یا دینک لایند ار (ht/)

نصب از طریق Source

برای Compile، دستورالعمل های فایل build.md را دنبال کنید:

شما میتوانید پکیج را compile و نصب کنید. شما همچنین می توانید بدون نصب پکیج از برنامه ها استفاده کنید.

```
Client: dbms/programs/clickhouse-client  
Server: dbms/programs/clickhouse-server
```

برای سرور، یک کاتالوگ با دیتا بسازید، مانند

```
/opt/clickhouse/data/default/  
/opt/clickhouse/metadata/default/
```

(قابل تنظیم در تنظیمات سرور). 'chown' را برای کاربر دلخواه اجرا کنید.

به مسیر لگ ها در تنظیمات سرور توجه کنید ([src/dbms/programs/config.xml](#)).

روش های دیگر نصب

/Docker image: <https://hub.docker.com/r/yandex/clickhouse-server>

RHEL: <https://github.com/Altinity/clickhouse-rpm-install> یا CentOS پکیج RPM برای

Gentoo: emerge clickhouse

راه اندازی

برای استارت سرور (به صورت daemon)، دستور زیر را اجرا کنید:

```
sudo service clickhouse-server start
```

لگ های دایرکتوری var/log/clickhouse-server/ directory را مشاهده کنید.

اگر سرور استارت نشد، فایل تنظیمات را بررسی کنید ([etc/clickhouse-server/config.xml](#)).

شما همچنین می توانید سرور را از طریق کنسول راه اندازی کنید:

```
clickhouse-server --config-file=/etc/clickhouse-server/config.xml
```

در این مورد که مناسب زمان توسعه می باشد، لگ ها در کنسول پرینت می شوند. اگر فایل تنظیمات در دایرکتوری جاری باشد، نیازی

به مشخص کردن 'config-file--' نمی باشد. به صورت پیش فرض از 'config.xml/. استفاده می شود.

شما می توانید از کلاینت command-line برای اتصال به سرور استفاده کنید:

```
clickhouse-client
```

پارامترهای پیش فرض، نشان از اتصال به localhost:9000 از طرف کاربر 'default' بدون پسورد را می دهد. از کلاینت میتوان برای اتصال به یک سرور remote استفاده کرد. مثال:

```
clickhouse-client --host=example.com
```

برای اطلاعات بیشتر، بخش "کلاینت Command-line" را مشاهده کنید.

چک کردن سیستم:

```
milovidov@hostname:~/work/metrica/src/dbms/src/Client$ ./clickhouse-client
ClickHouse client version 0.0.18749.
Connecting to localhost:9000.
Connected to ClickHouse server version 0.0.18749.

:) SELECT 1

SELECT 1
1
1 rows in set. Elapsed: 0.003 sec.

:)
```

تبریک میگم، سیستم کار می کنه!

برای ادامه آزمایشات، شما میتوانید دیتاباس های تستی را دریافت و امتحان کنید.

ClickHouse Tutorial

?What to Expect from This Tutorial

By going through this tutorial you'll learn how to set up basic ClickHouse cluster, it'll be small, but fault tolerant and scalable. We will use one of example datasets to fill it with data and execute some demo queries

Single Node Setup

To postpone complexities of distributed environment, we'll start with deploying ClickHouse on a single server or virtual machine. ClickHouse is usually installed from **deb** or **rpm** packages, but there are **alternatives** for the operating systems that do not support them

:For example, you have chosen **deb** packages and executed

```
sudo apt-get install dirmngr
sudo apt-key adv --keyserver hkp://keyserver.ubuntu.com:80 --recv E0C56BD4

echo "deb http://repo.yandex.ru/clickhouse/deb/stable/ main/" | sudo tee
/etc/apt/sources.list.d/clickhouse.list
sudo apt-get update

sudo apt-get install -y clickhouse-server clickhouse-client
```

:What do we have in the packages that got installed

- . clickhouse-client package contains **clickhouse-client** application, interactive ClickHouse console client •
- . clickhouse-common package contains a ClickHouse executable file •
- . clickhouse-server package contains configuration files to run ClickHouse as a server •

Server config files are located in `/etc/clickhouse-server/` . Before going further please notice the `<path>` element in `config.xml` . Path determines the location for data storage, so it should be located on volume with large disk capacity, the default value is `/var/lib/clickhouse/` . If you want to adjust the configuration it's not really handy to directly edit `config.xml` file, considering it might get rewritten on future package updates. Recommended way to override the config elements is to create **files in config.d directory** which serve as "patches" to `config.xml`

As you might have noticed, `clickhouse-server` is not launched automatically after package installation. It won't be automatically restarted after updates either. The way you start the server depends on your init system, usually it's

```
sudo service clickhouse-server start
```

or

```
sudo /etc/init.d/clickhouse-server start
```

The default location for server logs is `/var/log/clickhouse-server/` . Server will be ready to handle client connections once `. Ready for connections` message was logged

Once the `clickhouse-server` is up and running, we can use `clickhouse-client` to connect to the server and run some test queries like `SELECT "Hello, world`

Quick tips for clickhouse-client

- :Interactive mode
- clickhouse-client
clickhouse-client --host=... --port=... --user=... --password=...
:Enable multiline queries
- clickhouse-client -m
clickhouse-client --multiline
:Run queries in batch-mode
- clickhouse-client --query='SELECT 1'
echo 'SELECT 1' | clickhouse-client
clickhouse-client <<< 'SELECT 1'
:Insert data from a file in specified format
- clickhouse-client --query='INSERT INTO table VALUES' < data.txt
clickhouse-client --query='INSERT INTO table FORMAT TabSeparated' < data.tsv

Import Sample Dataset

Now it's time to fill our ClickHouse server with some sample data. In this tutorial we'll use anonymized data of Yandex.Metrica, the first service that run ClickHouse in production way before it became open-source (more on that in [history section](#)). There are **multiple ways to import Yandex.Metrica dataset** and for the sake of the tutorial we'll go with the most realistic one

```
curl https://clickhouse-datasets.s3.yandex.net/hits/tsv/hits_v1.tsv.xz | unxz --threads=`nproc` > hits_v1.tsv
curl https://clickhouse-datasets.s3.yandex.net/visits/tsv/visits_v1.tsv.xz | unxz --threads=`nproc` > visits_v1.tsv
```

.The extracted files are about 10GB in size

Create Tables

:Tables are logically grouped into "databases". There's a default database, but we'll create a new one named `tutorial`

```
clickhouse-client --query "CREATE DATABASE IF NOT EXISTS tutorial"
```

Syntax for creating tables is way more complicated compared to databases (see [reference](#)). In general `CREATE TABLE` statement has to specify three key things

.Name of table to create .1

.Table schema, i.e. list of columns and their [data types](#) .2

.[Table engine](#) and it's settings, which determines all the details on how queries to this table will be physically executed .3

Yandex.Metrica is a web analytics service and sample dataset doesn't cover it's full functionality, so there are only two :tables to create

- . `hits` is a table with each action done by all users on all websites covered by the service •

- . `visits` is a table that contains pre-built sessions instead of individual actions •

:Let's see and execute the real create table queries for these tables

```
CREATE TABLE tutorial.hits_v1
(
    `WatchID` UInt64,
    `JavaEnable` UInt8,
    `Title` String,
    `GoodEvent` Int16,
    `EventTime` DateTime,
    `EventDate` Date,
    `CounterID` UInt32,
    `ClientIP` UInt32,
    `ClientIP6` FixedString(16),
    `RegionID` UInt32,
    `UserID` UInt64,
    `CounterClass` Int8,
    `OS` UInt8,
    `UserAgent` UInt8,
    `URL` String,
    `Referer` String,
    `URLDomain` String,
    `RefererDomain` String,
    `Refresh` UInt8,
    `IsRobot` UInt8,
    `RefererCategories` Array(UInt16),
    `URLCategories` Array(UInt16),
    `URLRegions` Array(UInt32),
    `RefererRegions` Array(UInt32),
    `ResolutionWidth` UInt16,
    `ResolutionHeight` UInt16,
    `ResolutionDepth` UInt8,
    `FlashMajor` UInt8,
    `FlashMinor` UInt8,
    `FlashMinor2` String,
    `NetMajor` UInt8,
    `NetMinor` UInt8,
    `UserAgentMajor` UInt16
```

```
 userAgentMajor` UInt8,
`UserAgentMinor` FixedString(2),
`CookieEnable` UInt8,
`JavascriptEnable` UInt8,
`IsMobile` UInt8,
`MobilePhone` UInt8,
`MobilePhoneModel` String,
`Params` String,
`IPNetworkID` UInt32,
`TraficSourceID` Int8,
`SearchEngineID` UInt16,
`SearchPhrase` String,
`AdvEngineID` UInt8,
`IsArtifical` UInt8,
`WindowClientWidth` UInt16,
`WindowClientHeight` UInt16,
`ClientTimeZone` Int16,
`ClientEventTime` DateTime,
`SilverlightVersion1` UInt8,
`SilverlightVersion2` UInt8,
`SilverlightVersion3` UInt32,
`SilverlightVersion4` UInt16,
`PageCharset` String,
`CodeVersion` UInt32,
`IsLink` UInt8,
`IsDownload` UInt8,
`IsNotBounce` UInt8,
`FUniqID` UInt64,
`HID` UInt32,
`IsOldCounter` UInt8,
`IsEvent` UInt8,
`IsParameter` UInt8,
`DontCountHits` UInt8,
`WithHash` UInt8,
`HitColor` FixedString(1),
`UTCEventTime` DateTime,
`Age` UInt8,
`Sex` UInt8,
`Income` UInt8,
`Interests` UInt16,
`Robotness` UInt8,
`GeneralInterests` Array(UInt16),
`RemoteIP` UInt32,
`RemoteIP6` FixedString(16),
`WindowName` Int32,
`OpenerName` Int32,
`HistoryLength` Int16,
`BrowserLanguage` FixedString(2),
`BrowserCountry` FixedString(2),
`SocialNetwork` String,
`SocialAction` String,
`HTTPError` UInt16,
`SendTiming` Int32,
`DNSTiming` Int32,
`ConnectTiming` Int32,
`ResponseStartTiming` Int32,
`ResponseEndTiming` Int32,
`FetchTiming` Int32,
`RedirectTiming` Int32,
`DOMInteractiveTiming` Int32,
`DOMContentLoadedTiming` Int32,
`DOMCompleteTiming` Int32,
`LoadEventStartTiming` Int32,
`LoadEventEndTiming` Int32,
`NSToDOMContentLoadedTiming` Int32,
`FirstPaintTiming` Int32,
`RedirectCount` Int8,
`SocialSourceNetworkID` UInt8,
`SocialSourcePage` String,
`ParamPrice` Int64,
`ParamOrderID` String,
`ParamCurrency` FixedString(3),
`ParamCurrencyID` UInt16,
```

```

`GoalsReached` Array(UInt32),
`OpenstatServiceName` String,
`OpenstatCampaignID` String,
`OpenstatAdID` String,
`OpenstatSourceID` String,
`UTMSource` String,
`UTMMedium` String,
`UTMCampaign` String,
`UTMContent` String,
`UTMTerm` String,
`FromTag` String,
`HasGCLID` UInt8,
`RefererHash` UInt64,
`URLHash` UInt64,
`CLID` UInt32,
`YCLID` UInt64,
`ShareService` String,
`ShareURL` String,
`ShareTitle` String,
`ParsedParams` Nested(
    Key1 String,
    Key2 String,
    Key3 String,
    Key4 String,
    Key5 String,
    ValueDouble Float64),
`IslandID` FixedString(16),
`RequestNum` UInt32,
`RequestTry` UInt8
)
ENGINE = MergeTree()
PARTITION BY toYYYYMM(EventDate)
ORDER BY (CounterID, EventDate, intHash32(UserID))
SAMPLE BY intHash32(UserID)
SETTINGS index_granularity = 8192

```

```

CREATE TABLE tutorial.visits_v1
(
    `CounterID` UInt32,
    `StartDate` Date,
    `Sign` Int8,
    `IsNew` UInt8,
    `VisitID` UInt64,
    `UserID` UInt64,
    `StartTime` DateTime,
    `Duration` UInt32,
    `UTCStartTime` DateTime,
    `PageViews` Int32,
    `Hits` Int32,
    `IsBounce` UInt8,
    `Referer` String,
    `StartURL` String,
    `RefererDomain` String,
    `StartURLDomain` String,
    `EndURL` String,
    `LinkURL` String,
    `IsDownload` UInt8,
    `TraficSourceID` Int8,
    `SearchEngineID` UInt16,
    `SearchPhrase` String,
    `AdvEngineID` UInt8,
    `PlaceID` Int32,
    `RefererCategories` Array(UInt16),
    `URLCategories` Array(UInt16),
    `URLRegions` Array(UInt32),
    `RefererRegions` Array(UInt32),
    `IsYandex` UInt8,
    `GoalReachesDepth` Int32,
    `GoalReachesURL` Int32,
    `GoalReachesAny` Int32,
    `SocialSourceNetworkID` UInt8,
    `SocialSourcePage` String,

```

```
    `MobilePhoneModel` String,
    `ClientEventTime` DateTime,
    `RegionID` UInt32,
    `ClientIP` UInt32,
    `ClientIP6` FixedString(16),
    `RemoteIP` UInt32,
    `RemoteIP6` FixedString(16),
    `IPNetworkID` UInt32,
    `SilverlightVersion3` UInt32,
    `CodeVersion` UInt32,
    `ResolutionWidth` UInt16,
    `ResolutionHeight` UInt16,
    `UserAgentMajor` UInt16,
    `UserAgentMinor` UInt16,
    `WindowClientWidth` UInt16,
    `WindowClientHeight` UInt16,
    `SilverlightVersion2` UInt8,
    `SilverlightVersion4` UInt16,
    `FlashVersion3` UInt16,
    `FlashVersion4` UInt16,
    `ClientTimeZone` Int16,
    `OS` UInt8,
    `UserAgent` UInt8,
    `ResolutionDepth` UInt8,
    `FlashMajor` UInt8,
    `FlashMinor` UInt8,
    `NetMajor` UInt8,
    `NetMinor` UInt8,
    `MobilePhone` UInt8,
    `SilverlightVersion1` UInt8,
    `Age` UInt8,
    `Sex` UInt8,
    `Income` UInt8,
    `JavaEnable` UInt8,
    `CookieEnable` UInt8,
    `JavascriptEnable` UInt8,
    `IsMobile` UInt8,
    `BrowserLanguage` UInt16,
    `BrowserCountry` UInt16,
    `Interests` UInt16,
    `Robotness` UInt8,
    `GeneralInterests` Array(UInt16),
    `Params` Array(String),
    `Goals` Nested(
        ID UInt32,
        Serial UInt32,
        EventTime DateTime,
        Price Int64,
        OrderID String,
        CurrencyID UInt32),
    `WatchIDs` Array(UInt64),
    `ParamSumPrice` Int64,
    `ParamCurrency` FixedString(3),
    `ParamCurrencyID` UInt16,
    `ClickLogID` UInt64,
    `ClickEventID` Int32,
    `ClickGoodEvent` Int32,
    `ClickEventTime` DateTime,
    `ClickPriorityID` Int32,
    `ClickPhraseID` Int32,
    `ClickPageID` Int32,
    `ClickPlaceID` Int32,
    `ClickTypeID` Int32,
    `ClickResourceID` Int32,
    `ClickCost` UInt32,
    `ClickClientIP` UInt32,
    `ClickDomainID` UInt32,
    `ClickURL` String,
    `ClickAttempt` UInt8,
    `ClickOrderID` UInt32,
    `ClickBannerID` UInt32,
    `ClickMarketCategoryID` UInt32,
    `ClickMarketID` UInt32
```

```
 `ClickMarketPP` UInt32,
 `ClickMarketCategoryName` String,
 `ClickMarketPPName` String,
 `ClickAWAPSCampaignName` String,
 `ClickPageName` String,
 `ClickTargetType` UInt16,
 `ClickTargetPhraseID` UInt64,
 `ClickContextType` UInt8,
 `ClickSelectType` Int8,
 `ClickOptions` String,
 `ClickGroupBannerID` Int32,
 `OpenstatServiceName` String,
 `OpenstatCampaignID` String,
 `OpenstatAdID` String,
 `OpenstatSourceID` String,
 `UTMSource` String,
 `UTMMedium` String,
 `UTMCampaign` String,
 `UTMContent` String,
 `UTMTerm` String,
 `FromTag` String,
 `HasGCLID` UInt8,
 `FirstVisit` DateTime,
 `PredLastVisit` Date,
 `LastVisit` Date,
 `TotalVisits` UInt32,
 `TraficSource` Nested(
    ID Int8,
    SearchEngineID UInt16,
    AdvEngineID UInt8,
    PlaceID UInt16,
    SocialSourceNetworkID UInt8,
    Domain String,
    SearchPhrase String,
    SocialSourcePage String),
 `Attendance` FixedString(16),
 `CLID` UInt32,
 `YCLID` UInt64,
 `NormalizedRefererHash` UInt64,
 `SearchPhraseHash` UInt64,
 `RefererDomainHash` UInt64,
 `NormalizedStartURLHash` UInt64,
 `StartURLDomainHash` UInt64,
 `NormalizedEndURLHash` UInt64,
 `TopLevelDomain` UInt64,
 `URLScheme` UInt64,
 `OpenstatServiceNameHash` UInt64,
 `OpenstatCampaignIDHash` UInt64,
 `OpenstatAdIDHash` UInt64,
 `OpenstatSourceIDHash` UInt64,
 `UTMSourceHash` UInt64,
 `UTMMediumHash` UInt64,
 `UTMCampaignHash` UInt64,
 `UTMContentHash` UInt64,
 `UTMTermHash` UInt64,
 `FromHash` UInt64,
 `WebVisorEnabled` UInt8,
 `WebVisorActivity` UInt32,
 `ParsedParams` Nested(
    Key1 String,
    Key2 String,
    Key3 String,
    Key4 String,
    Key5 String,
    ValueDouble Float64),
 `Market` Nested(
    Type UInt8,
    GoalID UInt32,
    OrderID String,
    OrderPrice Int64,
    PP UInt32,
    DirectPlaceID UInt32,
    DirectOrderID UInt32,
```

```

    DirectBannerID UInt32,
    GoodID String,
    GoodName String,
    GoodQuantity Int32,
    GoodPrice Int64),
    `IslandID` FixedString(16)
)
ENGINE = CollapsingMergeTree(Sign)
PARTITION BY toYYYYMM(StartDate)
ORDER BY (CounterID, StartDate, intHash32(UserID), VisitID)
SAMPLE BY intHash32(UserID)
SETTINGS index_granularity = 8192

```

You can execute those queries using interactive mode of clickhouse-client (just launch it in terminal without specifying a .query in advance) or try some [alternative interface](#) if you want

:As we can see, hits_v1 uses the [basic MergeTree engine](#), while the visits_v1 uses the [Collapsing](#) variant

Import Data

Data import to ClickHouse is done via [INSERT INTO](#) query like in many other SQL databases. However data is usually .(provided in one of the [supported formats](#) instead of `VALUES` clause (which is also supported

:The files we downloaded earlier are in tab-separated format, so here's how to import them via console client

```

clickhouse-client --query "INSERT INTO tutorial.hits_v1 FORMAT TSV" --max_insert_block_size=100000 <
hits_v1.tsv
clickhouse-client --query "INSERT INTO tutorial.visits_v1 FORMAT TSV" --max_insert_block_size=100000 <
visits_v1.tsv

```

ClickHouse has a lot of [settings to tune](#) and one way to specify them in console client is via arguments, as we can see with `--max_insert_block_size` . The easiest way to figure out what settings are available, what do they mean and what the :defaults are is to query the `system.settings` table

```

SELECT name, value, changed, description
FROM system.settings
WHERE name LIKE '%max_insert_b%'
FORMAT TSV

max_insert_block_size    1048576    0    "The maximum block size for insertion, if we control the creation
of blocks for insertion."

```

Optionally you can [OPTIMIZE](#) the tables after import. Tables that are configured with MergeTree-family engine always do merges of data parts in background to optimize data storage (or at least check if it makes sense). These queries will just :force table engine to do storage optimization right now instead of some time later

```

clickhouse-client --query "OPTIMIZE TABLE tutorial.hits_v1 FINAL"
clickhouse-client --query "OPTIMIZE TABLE tutorial.visits_v1 FINAL"

```

This is I/O and CPU intensive operation so if the table constantly receives new data it's better to leave it alone and let .merges run in background

:Now we can check that the tables are successfully imported

```

clickhouse-client --query "SELECT COUNT(*) FROM tutorial.hits_v1"
clickhouse-client --query "SELECT COUNT(*) FROM tutorial.visits_v1"

```

Example Queries

```

SELECT
    StartURL AS URL,
    AVG(Duration) AS AvgDuration
FROM tutorial.visits_v1
WHERE StartDate BETWEEN '2014-03-23' AND '2014-03-30'
GROUP BY URL
ORDER BY AvgDuration DESC
LIMIT 10

```

```

SELECT
    sum(Sign) AS visits,
    sumIf(Sign, has(Goals.ID, 1105530)) AS goal_visits,
    (100. * goal_visits) / visits AS goal_percent
FROM tutorial.visits_v1
WHERE (CounterID = 912887) AND (toYYYYMM(StartDate) = 201403) AND (domain(StartURL) = 'yandex.ru')

```

Cluster Deployment

:ClickHouse cluster is a homogenous cluster. Steps to set up

Install ClickHouse server on all machines of the cluster .1

Set up cluster configs in configuration files .2

Create local tables on each instance .3

Create a **Distributed table** .4

Distributed table is actually a kind of "view" to local tables of ClickHouse cluster. SELECT query from a distributed table will be executed using resources of all cluster's shards. You may specify configs for multiple clusters and create multiple .distributed tables providing views to different clusters

:Example config for cluster with three shards, one replica each

```

<remote_servers>
    <perftest_3shards_1replicas>
        <shard>
            <replica>
                <host>example-perftest01j.yandex.ru</host>
                <port>9000</port>
            </replica>
        </shard>
        <shard>
            <replica>
                <host>example-perftest02j.yandex.ru</host>
                <port>9000</port>
            </replica>
        </shard>
        <shard>
            <replica>
                <host>example-perftest03j.yandex.ru</host>
                <port>9000</port>
            </replica>
        </shard>
    </perftest_3shards_1replicas>
</remote_servers>

```

For further demonstration let's create new local table with exactly the same CREATE TABLE query that we used for : hits_v1 , but different table name

```
CREATE TABLE tutorial.hits_local (...) ENGINE = MergeTree() ...
```

:Creating a distributed table providing a view into local tables of the cluster

```
CREATE TABLE tutorial.hits_all AS tutorial.hits_local  
ENGINE = Distributed(perftest_3shards_1replicas, tutorial, hits_local, rand());
```

Common practice is to create similar Distributed tables on all machines of the cluster. This would allow to run distributed queries on any machine of the cluster. Also there's an alternative option to create temporary distributed table for a given .SELECT query using **remote** table function

.Let's run **INSERT SELECT** into Distributed table to spread the table to multiple servers

```
INSERT INTO tutorial.hits_all SELECT * FROM tutorial.hits_v1;
```

Notice

.This approach is not suitable for sharding of large tables. There's a separate tool [clickhouse-copyer](#) that can re-shard arbitrary large tables

As you could expect computationally heavy queries are executed N times faster being launched on 3 servers instead of .one

.In this case we have used a cluster with 3 shards each contains a single replica

To provide resilience in production environment we recommend that each shard should contain 2-3 replicas distributed .between multiple data-centers. Note that ClickHouse supports unlimited number of replicas

:Example config for cluster of one shard containing three replicas

```
<remote_servers>  
...  
<perftest_1shards_3replicas>  
  <shard>  
    <replica>  
      <host>example-perftest01j.yandex.ru</host>  
      <port>9000</port>  
    </replica>  
    <replica>  
      <host>example-perftest02j.yandex.ru</host>  
      <port>9000</port>  
    </replica>  
    <replica>  
      <host>example-perftest03j.yandex.ru</host>  
      <port>9000</port>  
    </replica>  
  </shard>  
</perftest_1shards_3replicas>  
</remote_servers>
```

To enable native replication **ZooKeeper** is required. ClickHouse will take care of data consistency on all replicas and run .restore procedure after failure automatically. It's recommended to deploy ZooKeeper cluster to separate servers

ZooKeeper is not a strict requirement: in some simple cases you can duplicate the data by writing it into all the replicas from your application code. This approach is not recommended, in this case ClickHouse won't be able to guarantee data .consistency on all replicas. This remains the responsibility of your application

:ZooKeeper locations need to be specified in configuration file

```

<zookeeper-servers>
  <node>
    <host>zoo01.yandex.ru</host>
    <port>2181</port>
  </node>
  <node>
    <host>zoo02.yandex.ru</host>
    <port>2181</port>
  </node>
  <node>
    <host>zoo03.yandex.ru</host>
    <port>2181</port>
  </node>
</zookeeper-servers>

```

:Also we need to set macros for identifying each shard and replica, it will be used on table creation

```

<macros>
  <shard>01</shard>
  <replica>01</replica>
</macros>

```

If there are no replicas at the moment on replicated table creation, a new first replica will be instantiated. If there are already live replicas, new replica will clone the data from existing ones. You have an option to create all replicated tables .first and that insert data to it. Another option is to create some replicas and add the others after or during data insertion

```

CREATE TABLE tutorial.hits_replica (...)

ENGINE = ReplicatedMergeTree(
    '/clickhouse_perftest/tables/{shard}/hits',
    '{replica}'
)
...

```

Here we use **ReplicatedMergeTree** table engine. In parameters we specify ZooKeeper path containing shard and replica .identifiers

```
INSERT INTO tutorial.hits_replica SELECT * FROM tutorial.hits_local;
```

Replication operates in multi-master mode. Data can be loaded into any replica and it will be synced with other instances automatically. Replication is asynchronous so at a given moment of time not all replicas may contain recently inserted data. To allow data insertion at least one replica should be up. Others will sync up data and repair consistency once they .will become active again. Please notice that such approach allows for the low possibility of loss of just appended data

OnTime

دانلود داده ها:

```

for s in `seq 1987 2018` 
do
for m in `seq 1 12` 
do
wget
https://transtats.bts.gov/PREZIP/On_Time_Reportng_Carrier_On_Time_Performance_1987_present_${s}_${m}.zip
done
done

```

(<https://github.com/Percona-Lab/ontime-airline-performance/blob/master/download.sh> از)

ساخت جدول:

```
CREATE TABLE `ontime` (
```

```
`Year` UInt16,
`Quarter` UInt8,
`Month` UInt8,
`DayofMonth` UInt8,
`DayOfWeek` UInt8,
`FlightDate` Date,
`UniqueCarrier` FixedString(7),
`AirlineID` Int32,
`Carrier` FixedString(2),
`TailNum` String,
`FlightNum` String,
`OriginAirportID` Int32,
`OriginAirportSeqID` Int32,
`OriginCityMarketID` Int32,
`Origin` FixedString(5),
`OriginCityName` String,
`OriginState` FixedString(2),
`OriginStateFips` String,
`OriginStateName` String,
`OriginWac` Int32,
`DestAirportID` Int32,
`DestAirportSeqID` Int32,
`DestCityMarketID` Int32,
`Dest` FixedString(5),
`DestCityName` String,
`DestState` FixedString(2),
`DestStateFips` String,
`DestStateName` String,
`DestWac` Int32,
`CRSDepTime` Int32,
`DepTime` Int32,
`DepDelay` Int32,
`DepDelayMinutes` Int32,
`DepDel15` Int32,
`DepartureDelayGroups` String,
`DepTimeBlk` String,
`TaxiOut` Int32,
`WheelsOff` Int32,
`WheelsOn` Int32,
`TaxiIn` Int32,
`CRSArrTime` Int32,
`ArrTime` Int32,
`ArrDelay` Int32,
`ArrDelayMinutes` Int32,
`ArrDel15` Int32,
`ArrivalDelayGroups` Int32,
`ArrTimeBlk` String,
`Cancelled` UInt8,
`CancellationCode` FixedString(1),
`Diverted` UInt8,
`CRSElapsedTime` Int32,
`ActualElapsedTime` Int32,
`AirTime` Int32,
`Flights` Int32,
`Distance` Int32,
`DistanceGroup` UInt8,
`CarrierDelay` Int32,
`WeatherDelay` Int32,
`NASDelay` Int32,
`SecurityDelay` Int32,
`LateAircraftDelay` Int32,
`FirstDepTime` String,
`TotalAddGTime` String,
`LongestAddGTime` String,
`DivAirportLandings` String,
`DivReachedDest` String,
`DivActualElapsedTime` String,
`DivArrDelay` String,
`DivDistance` String,
`Div1Airport` String,
`Div1AirportID` Int32,
`Div1AirportSeqID` Int32,
`Div1WheelsOn` String
```

```

`Div1WheelsOn` String,
`Div1TotalGTime` String,
`Div1LongestGTime` String,
`Div1WheelsOff` String,
`Div1TailNum` String,
`Div2Airport` String,
`Div2AirportID` Int32,
`Div2AirportSeqID` Int32,
`Div2WheelsOn` String,
`Div2TotalGTime` String,
`Div2LongestGTime` String,
`Div2WheelsOff` String,
`Div2TailNum` String,
`Div3Airport` String,
`Div3AirportID` Int32,
`Div3AirportSeqID` Int32,
`Div3WheelsOn` String,
`Div3TotalGTime` String,
`Div3LongestGTime` String,
`Div3WheelsOff` String,
`Div3TailNum` String,
`Div4Airport` String,
`Div4AirportID` Int32,
`Div4AirportSeqID` Int32,
`Div4WheelsOn` String,
`Div4TotalGTime` String,
`Div4LongestGTime` String,
`Div4WheelsOff` String,
`Div4TailNum` String,
`Div5Airport` String,
`Div5AirportID` Int32,
`Div5AirportSeqID` Int32,
`Div5WheelsOn` String,
`Div5TotalGTime` String,
`Div5LongestGTime` String,
`Div5WheelsOff` String,
`Div5TailNum` String
) ENGINE = MergeTree(FlightDate, (Year, FlightDate), 8192)

```

:داده ها Load

```
for i in *.zip; do echo $i; unzip -cq $i '*.csv' | sed 's/\.\.00//g' | clickhouse-client --host=example-perf-test01j --query="INSERT INTO ontione FORMAT CSVWithNames"; done
```

:لها query

.Q0

```
select avg(c1) from (select Year, Month, count(*) as c1 from ontione group by Year, Month);
```

Q1. تعداد پروازهای به تفکیک روز از تاریخ 2000 تا 2008

```
SELECT DayOfWeek, count(*) AS c FROM ontione WHERE Year >= 2000 AND Year <= 2008 GROUP BY DayOfWeek ORDER BY c DESC;
```

Q2. تعداد پروازهای بیش از 10 دقیقه تاخیر خورده، گروه بندی براساس روزهای هفته از سال 2000 تا 2008

```
SELECT DayOfWeek, count(*) AS c FROM ontione WHERE DepDelay>10 AND Year >= 2000 AND Year <= 2008 GROUP BY DayOfWeek ORDER BY c DESC
```

Q3. تعداد تاخیرها براساس airport از سال 2008 تا 2000

```
SELECT Origin, count(*) AS c FROM ontione WHERE DepDelay>10 AND Year >= 2000 AND Year <= 2008 GROUP BY Origin ORDER BY c DESC LIMIT 10
```

78. تعداد تاخيرها براساس carrier در سال Q4

```
SELECT Carrier, count(*) FROM ontime WHERE DepDelay>10 AND Year = 2007 GROUP BY Carrier ORDER BY count(*) DESC
```

2007. درصد تاخير ها براساس carrier در سال Q5

```
SELECT Carrier, c, c2, c*100/c2 as c3
FROM
(
    SELECT
        Carrier,
        count(*) AS c
    FROM ontime
    WHERE DepDelay>10
        AND Year=2007
    GROUP BY Carrier
)
ANY INNER JOIN
(
    SELECT
        Carrier,
        count(*) AS c2
    FROM ontime
    WHERE Year=2007
    GROUP BY Carrier
) USING Carrier
ORDER BY c3 DESC;
```

نسخه ی بهتر query

```
SELECT Carrier, avg(DepDelay > 10) * 100 AS c3 FROM ontime WHERE Year = 2007 GROUP BY Carrier ORDER BY Carrier
```

2008. مانند اما برای طیف وسیعی از سال های 2000 تا 2008 Q6

```
SELECT Carrier, c, c2, c*100/c2 as c3
FROM
(
    SELECT
        Carrier,
        count(*) AS c
    FROM ontime
    WHERE DepDelay>10
        AND Year >= 2000 AND Year <= 2008
    GROUP BY Carrier
)
ANY INNER JOIN
(
    SELECT
        Carrier,
        count(*) AS c2
    FROM ontime
    WHERE Year >= 2000 AND Year <= 2008
    GROUP BY Carrier
) USING Carrier
ORDER BY c3 DESC;
```

نسخه ی بهتر query

```
SELECT Carrier, avg(DepDelay > 10) * 100 AS c3 FROM ontime WHERE Year >= 2000 AND Year <= 2008 GROUP BY Carrier ORDER BY Carrier
```

Q7. درصد تاخير بیش از 10 دقیقه پروازها به تفکیک سال

```

SELECT Year, c1/c2
FROM
(
    select
        Year,
        count(*)*100 as c1
    from ontime
    WHERE DepDelay>10
    GROUP BY Year
)
ANY INNER JOIN
(
    select
        Year,
        count(*) as c2
    from ontime
    GROUP BY Year
) USING (Year)
ORDER BY Year

```

نسخه ی بهتر query

```
SELECT Year, avg(DepDelay > 10) FROM ontime GROUP BY Year ORDER BY Year
```

Q8. مقصد های پر طرفدار بر اساس تعداد اتصال های مستقیم شهرها برای سال 2000 تا 2010

```
SELECT DestCityName, uniqExact(OriginCityName) AS u FROM ontime WHERE Year >= 2000 and Year <= 2010 GROUP BY DestCityName ORDER BY u DESC LIMIT 10;
```

.Q9

```
select Year, count(*) as c1 from ontime group by Year;
```

.Q10

```

select
    min(Year), max(Year), Carrier, count(*) as cnt,
    sum(ArrDelayMinutes>30) as flights_delayed,
    round(sum(ArrDelayMinutes>30)/count(*),2) as rate
FROM ontime
WHERE
    DayOfWeek not in (6,7) and OriginState not in ('AK', 'HI', 'PR', 'VI')
    and DestState not in ('AK', 'HI', 'PR', 'VI')
    and FlightDate < '2010-01-01'
GROUP by Carrier
HAVING cnt > 100000 and max(Year) > 1990
ORDER by rate DESC
LIMIT 1000;

```

query های بیشتر:

```

SELECT avg(cnt) FROM (SELECT Year,Month,count(*) AS cnt FROM ontime WHERE DepDel15=1 GROUP BY Year,Month)

select avg(c1) from (select Year,Month,count(*) as c1 from ontime group by Year,Month)

SELECT DestCityName, uniqExact(OriginCityName) AS u FROM ontime GROUP BY DestCityName ORDER BY u DESC LIMIT 10;

SELECT OriginCityName, DestCityName, count() AS c FROM ontime GROUP BY OriginCityName, DestCityName ORDER BY c DESC LIMIT 10;

SELECT OriginCityName, count() AS c FROM ontime GROUP BY OriginCityName ORDER BY c DESC LIMIT 10;

```

این تست های توسط Vadim Tkachenko انجام شده است. برای اطلاعات بیشتر به لینک های زیر مراجعه کنید:

- [/https://www.percona.com/blog/2009/10/02/analyzing-air-traffic-performance-with-infobright-and-monetdb](https://www.percona.com/blog/2009/10/02/analyzing-air-traffic-performance-with-infobright-and-monetdb)
- [/https://www.percona.com/blog/2009/10/26/air-traffic-queries-in-luciddb](https://www.percona.com/blog/2009/10/26/air-traffic-queries-in-luciddb)
- [/https://www.percona.com/blog/2009/11/02/air-traffic-queries-in-infinidb-early-alpha](https://www.percona.com/blog/2009/11/02/air-traffic-queries-in-infinidb-early-alpha)
- [/https://www.percona.com/blog/2014/04/21/using-apache-hadoop-and-impala-together-with-mysql-for-data-analysis](https://www.percona.com/blog/2014/04/21/using-apache-hadoop-and-impala-together-with-mysql-for-data-analysis)
- [/https://www.percona.com/blog/2016/01/07/apache-spark-with-air-ontime-performance-data](https://www.percona.com/blog/2016/01/07/apache-spark-with-air-ontime-performance-data)
- <http://nickmakos.blogspot.ru/2012/08/analyzing-air-traffic-performance-with.html>

داده های تاکسی New York

چطور داده های raw را import کنیم

برای توضیحات بیشتر در ارتباط با دیتاست و موارد مربوط به دانلود به دو لینک <https://github.com/toddwschneider/nyc-taxi-data> و <http://tech.marksblogg.com/billion-nyc-taxi-rides-redshift.html> مراجعه کنید.

دانلود فایل ها حدود 277 گیگابایت داده ی غیرفسرده در قالب فایل های CSV می باشد. دانلود با استفاده از بیش از یک کانکشن 1 Gbit نزدیک 1 ساعت طول می کشد (دانلود موازی از s3.amazonaws.com حداقل نصف کانال 1 Gbit روبران می کند). بعضی از فایل ها ممکن است به طول کامل دانلود نشوند. اندازه فایل ها را بررسی کنید و اگر فایلی مشکوک بود، مجددا دانلود کنید.

بعضی از فایل ها ممکن است دارای سطرهای نامعتبر باشند. با اجرای دستورات زیر این موارد برطرف می شود:

```
sed -E '/^(.*,){{18,}}/d' data/yellow_tripdata_2010-02.csv > data/yellow_tripdata_2010-02.csv_
sed -E '/^(.*,){{18,}}/d' data/yellow_tripdata_2010-03.csv > data/yellow_tripdata_2010-03.csv_
mv data/yellow_tripdata_2010-02.csv_ data/yellow_tripdata_2010-02.csv
mv data/yellow_tripdata_2010-03.csv_ data/yellow_tripdata_2010-03.csv
```

سیس داده ها باید در PostgreSQL پیش پردازش شوند. این کار نقاط انتخابی چند ضلعی را ایجاد می کند (برای مطابقت با نقاط بر روی نقشه با مناطق شهر نیویورک) و تمام داده ها را با استفاده از JOIN در یک جدول flat و denormal ترکیب می کند. برای این کار شما نیاز به نصب PostgreSQL با پشتیبانی از PostGIS دارید.

در هنگام اجرای initialize_database.sh مراقب باشید و به صورت دستی مجددا تمام جداول را چک کنید.

PostgreSQL تقریبا 20 تا 30 دقیقه برای پردازش هر ماه زمان نیاز میگیرد، در مجموع حدود 48 ساعت این عملیات طول می کشد.

از طریق دستور زیر شما می توانید تعداد سطرهای دانلود شده را دریافت کنید:

```
time psql nyc-taxi-data -c "SELECT count(*) FROM trips;"
```

```
###      count
1298979494
(1 row)

real    7m9.164s
```

(در یکی از پست های مقالات Mark Litwintschik این کمی بیشتر از 1.1 میلیارد سطر گزارش شده است.)

حجم داده ها در PostgreSQL 370 گیگابایت می باشد.

:PostgreSQL Export گیری داده ها از

```

COPY
(
    SELECT trips.id,
        trips.vendor_id,
        trips.pickup_datetime,
        trips.dropoff_datetime,
        trips.store_and_fwd_flag,
        trips.rate_code_id,
        trips.pickup_longitude,
        trips.pickup_latitude,
        trips.dropoff_longitude,
        trips.dropoff_latitude,
        trips.passenger_count,
        trips.trip_distance,
        trips.fare_amount,
        trips.extra,
        trips.mta_tax,
        trips.tip_amount,
        trips.tolls_amount,
        trips.ehail_fee,
        trips.improvement_surcharge,
        trips.total_amount,
        trips.payment_type,
        trips.trip_type,
        trips.pickup,
        trips.dropoff,
        cab_types.type cab_type,
        weather.precipitation_tenths_of_mm rain,
        weather.snow_depth_mm,
        weather.snowfall_mm,
        weather.max_temperature_tenths_degrees_celsius max_temp,
        weather.min_temperature_tenths_degrees_celsius min_temp,
        weather.average_wind_speed_tenths_of_meters_per_second wind,
        pick_up.gid pickup_nyct2010_gid,
        pick_up.ctlabel pickup_ctlabel,
        pick_up.borocode pickup_borocode,
        pick_up.boroname pickup_boroname,
        pick_up.ct2010 pickup_ct2010,
        pick_up.boroct2010 pickup_boroct2010,
        pick_up.cdeligibil pickup_cdeligibil,
        pick_up.ntacode pickup_ntacode,
        pick_up.ntaname pickup_ntaname,
        pick_up.puma pickup_puma,
        drop_off.gid dropoff_nyct2010_gid,
        drop_off.ctlabel dropoff_ctlabel,
        drop_off.borocode dropoff_borocode,
        drop_off.boroname dropoff_boroname,
        drop_off.ct2010 dropoff_ct2010,
        drop_off.boroct2010 dropoff_boroct2010,
        drop_off.cdeligibil dropoff_cdeligibil,
        drop_off.ntacode dropoff_ntacode,
        drop_off.ntaname dropoff_ntaname,
        drop_off.puma dropoff_puma
    FROM trips
    LEFT JOIN cab_types
        ON trips.cab_type_id = cab_types.id
    LEFT JOIN central_park_weather_observations_raw weather
        ON weather.date = trips.pickup_datetime::date
    LEFT JOIN nyct2010 pick_up
        ON pick_up.gid = trips.pickup_nyct2010_gid
    LEFT JOIN nyct2010 drop_off
        ON drop_off.gid = trips.dropoff_nyct2010_gid
) TO '/opt/milovidov/nyc-taxi-data/trips.tsv';

```

از داده ها با سرعت 50 مگابایت در ثانیه انجام می شود. در هنگام ایجاد snapshot PostgreSQL داده ها را با سرعت 28 مگابایت در ثانیه از روی می خواند. این کار حدود 5 ساعت زمان میبرد. نتیجه کار فایل TSV با حجم 590612904969 بایت می باشد.

```

CREATE TABLE trips
(
    trip_id                UInt32,
    vendor_id               String,
    pickup_datetime         DateTime,
    dropoff_datetime        Nullable(DateTime),
    store_and_fwd_flag     Nullable(FixedString(1)),
    rate_code_id            Nullable(UInt8),
    pickup_longitude        Nullable(Float64),
    pickup_latitude          Nullable(Float64),
    dropoff_longitude       Nullable(Float64),
    dropoff_latitude         Nullable(Float64),
    passenger_count         Nullable(UInt8),
    trip_distance            Nullable(Float64),
    fare_amount              Nullable(Float32),
    extra                    Nullable(Float32),
    mta_tax                  Nullable(Float32),
    tip_amount                Nullable(Float32),
    tolls_amount              Nullable(Float32),
    ehail_fee                 Nullable(Float32),
    improvement_surcharge   Nullable(Float32),
    total_amount              Nullable(Float32),
    payment_type              Nullable(String),
    trip_type                 Nullable(UInt8),
    pickup                    Nullable(String),
    dropoff                   Nullable(String),
    cab_type                  Nullable(String),
    precipitation             Nullable(UInt8),
    snow_depth                 Nullable(UInt8),
    snowfall                   Nullable(UInt8),
    max_temperature           Nullable(UInt8),
    min_temperature           Nullable(UInt8),
    average_wind_speed        Nullable(UInt8),
    pickup_nyct2010_gid      Nullable(UInt8),
    pickup_ctlabel            Nullable(String),
    pickup_borocode           Nullable(UInt8),
    pickup_boroname            Nullable(String),
    pickup_ct2010              Nullable(String),
    pickup_boroc2010           Nullable(String),
    pickup_cdeligibil        Nullable(FixedString(1)),
    pickup_ntacode             Nullable(String),
    pickup_ntaname              Nullable(String),
    pickup_puma                 Nullable(String),
    dropoff_nyct2010_gid      Nullable(UInt8),
    dropoff_ctlabel            Nullable(String),
    dropoff_borocode           Nullable(UInt8),
    dropoff_boroname            Nullable(String),
    dropoff_ct2010              Nullable(String),
    dropoff_boroc2010           Nullable(String),
    dropoff_cdeligibil        Nullable(String),
    dropoff_ntacode             Nullable(String),
    dropoff_ntaname              Nullable(String),
    dropoff_puma                 Nullable(String)
) ENGINE = Log;

```

برای تبدیل فیلد ها به data type های صحیح تر و در صورت امکان، حذف NULL ها لازم است.

```

time clickhouse-client --query="INSERT INTO trips FORMAT TabSeparated" < trips.tsv
real    75m56.214s

```

داده ها با سرعت 112 تا 140 مگابیت در ثایله خوانده می شوند. load کردن داده ها در جدول Log Type در یک Stream، 76 دقیقه زمان کشید. این داده ها در این جدول 142 گیگابایت فضای اشغال می کنند.

import) کردن داده ها به صورت مستقیم از Postgres با استفاده از COPY ... TO PROGRAM هم امکان پذیر است.

متاسفانه، تمام فیلدهای مرتبط با آب و هوا (precipitation...average_wind_speed) Null با پر شدند. به خاطر همین، ما از دیتا است نهایی اینها را حذف کردیم.

برای شروع، ما یک جدول در یک سرور ایجاد کردیم. بعدها ما یک جدول توزیع شده می‌سازیم.

یک جدول خلاصه ایجاد و پر کنید:

```
CREATE TABLE trips_mergetree
ENGINE = MergeTree(pickup_date, pickup_datetime, 8192)
AS SELECT
    trip_id,
    CAST(vendor_id AS Enum8('1' = 1, '2' = 2, 'CMT' = 3, 'VTS' = 4, 'DDS' = 5, 'B02512' = 10, 'B02598' = 11,
    'B02617' = 12, 'B02682' = 13, 'B02764' = 14)) AS vendor_id,
    toDate(pickup_datetime) AS pickup_date,
    ifNull(pickup_datetime, toDate(0)) AS pickup_datetime,
    toDate(dropoff_datetime) AS dropoff_date,
    ifNull(dropoff_datetime, toDate(0)) AS dropoff_datetime,
    assumeNotNull(store_and_fwd_flag) IN ('Y', '1', '2') AS store_and_fwd_flag,
    assumeNotNull(rate_code_id) AS rate_code_id,
    assumeNotNull(pickup_longitude) AS pickup_longitude,
    assumeNotNull(pickup_latitude) AS pickup_latitude,
    assumeNotNull(dropoff_longitude) AS dropoff_longitude,
    assumeNotNull(dropoff_latitude) AS dropoff_latitude,
    assumeNotNull(passenger_count) AS passenger_count,
    assumeNotNull(trip_distance) AS trip_distance,
    assumeNotNull(fare_amount) AS fare_amount,
    assumeNotNull(extra) AS extra,
    assumeNotNull(mta_tax) AS mta_tax,
    assumeNotNull(tip_amount) AS tip_amount,
    assumeNotNull(tolls_amount) AS tolls_amount,
    assumeNotNull(ehail_fee) AS ehail_fee,
    assumeNotNull(improvement_surcharge) AS improvement_surcharge,
    assumeNotNull(total_amount) AS total_amount,
    CAST((assumeNotNull(payment_type) AS pt) IN ('CSH', 'CASH', 'Cash', 'CAS', 'Cas', '1') ? 'CSH' : (pt IN
    ('CRD', 'Credit', 'Cre', 'CRE', 'CREDIT', '2') ? 'CRE' : (pt IN ('NOC', 'No Charge', 'No', '3') ? 'NOC' :
    (pt IN ('DIS', 'Dispute', 'Dis', '4') ? 'DIS' : 'UNK'))) AS Enum8('CSH' = 1, 'CRE' = 2, 'UNK' = 0, 'NOC' =
    3, 'DIS' = 4)) AS payment_type_,
    assumeNotNull(trip_type) AS trip_type,
    ifNull(toFixedString(unhex(pickup), 25), toFixedString('', 25)) AS pickup,
    ifNull(toFixedString(unhex(dropoff), 25), toFixedString('', 25)) AS dropoff,
    CAST(assumeNotNull(cab_type) AS Enum8('yellow' = 1, 'green' = 2, 'uber' = 3)) AS cab_type,
    assumeNotNull(pickup_nyct2010_gid) AS pickup_nyct2010_gid,
   toFloat32(ifNull(pickup_ctlabel, '0')) AS pickup_ctlabel,
    assumeNotNull(pickup_borocode) AS pickup_borocode,
    CAST(assumeNotNull(pickup_boroname) AS Enum8('Manhattan' = 1, 'Queens' = 4, 'Brooklyn' = 3, '' = 0, 'Bronx' =
    2, 'Staten Island' = 5)) AS pickup_boroname,
    toFixedString(ifNull(pickup_ct2010, '000000'), 6) AS pickup_ct2010,
    toFixedString(ifNull(pickup_boroct2010, '0000000'), 7) AS pickup_boroct2010,
    CAST(assumeNotNull(ifNull(pickup_cdeligibil, ' ')) AS Enum8(' ' = 0, 'E' = 1, 'I' = 2)) AS
    pickup_cdeligibil,
    toFixedString(ifNull(pickup_ntacode, '0000'), 4) AS pickup_ntacode,
    CAST(assumeNotNull(pickup_ntaname) AS Enum16(' ' = 0, 'Airport' = 1, 'Allerton-Pelham Gardens' = 2,
    'Annadale-Huguenot-Prince\''s Bay-Eltingville' = 3, 'Arden Heights' = 4, 'Astoria' = 5, 'Auburndale' = 6,
    'Baisley Park' = 7, 'Bath Beach' = 8, 'Battery Park City-Lower Manhattan' = 9, 'Bay Ridge' = 10, 'Bayside-
    Bayside Hills' = 11, 'Bedford' = 12, 'Bedford Park-Fordham North' = 13, 'Bellerose' = 14, 'Belmont' = 15,
    'Bensonhurst East' = 16, 'Bensonhurst West' = 17, 'Borough Park' = 18, 'Breezy Point-Belle Harbor-Rockaway
    Park-Broad Channel' = 19, 'Briarwood-Jamaica Hills' = 20, 'Brighton Beach' = 21, 'Bronxdale' = 22,
    'Brooklyn Heights-Cobble Hill' = 23, 'Brownsville' = 24, 'Bushwick North' = 25, 'Bushwick South' = 26,
    'Cambria Heights' = 27, 'Canarsie' = 28, 'Carroll Gardens-Columbia Street-Red Hook' = 29, 'Central Harlem
    North-Polo Grounds' = 30, 'Central Harlem South' = 31, 'Charleston-Richmond Valley-Tottenville' = 32,
    'Chinatown' = 33, 'Clarendon-Bathgate' = 34, 'Clinton' = 35, 'Clinton Hill' = 36, 'Co-op City' = 37,
    'College Point' = 38, 'Corona' = 39, 'Crotona Park East' = 40, 'Crown Heights North' = 41, 'Crown Heights
    South' = 42, 'Cypress Hills-City Line' = 43, 'DUMBO-Vinegar Hill-Downtown Brooklyn-Boerum Hill' = 44,
    'Douglas Manor-Douglaslaston-Little Neck' = 45, 'Dyker Heights' = 46, 'East Concourse-Concourse Village' = 47,
    'East Elmhurst' = 48, 'East Flatbush-Farragut' = 49, 'East Flushing' = 50, 'East Harlem North' = 51, 'East
    Harlem South' = 52, 'East New York' = 53, 'East New York (Pennsylvania Ave)' = 54, 'East Tremont' = 55,
    'East Village' = 56, 'East Williamsburg' = 57, 'Eastchester-Edenwald-Baychester' = 58, 'Elmhurst' = 59,
    'Elmhurst-Maspeth' = 60, 'Erasmus' = 61, 'Far Rockaway-Bayswater' = 62, 'Flatbush' = 63, 'Flatlands' = 64,
```

'Flushing' = 65, 'Fordham South' = 66, 'Forest Hills' = 67, 'Fort Greene' = 68, 'Fresh Meadows-Utopia' = 69, 'Ft. Totten-Bay Terrace-Clearview' = 70, 'Georgetown-Marine Park-Bergen Beach-Mill Basin' = 71, 'Glen Oaks-Floral Park-New Hyde Park' = 72, 'Glendale' = 73, 'Gramercy' = 74, 'Grasmere-Arrochar-Ft. Wadsworth' = 75, 'Gravesend' = 76, 'Great Kills' = 77, 'Greenpoint' = 78, 'Grymes Hill-Clifton-Fox Hills' = 79, 'Hamilton Heights' = 80, 'Hammels-Arverne-Edgemere' = 81, 'Highbridge' = 82, 'Hollis' = 83, 'Homecrest' = 84, 'Hudson Yards-Chelsea-Flatiron-Union Square' = 85, 'Hunters Point-Sunnyside-West Maspeth' = 86, 'Hunts Point' = 87, 'Jackson Heights' = 88, 'Jamaica' = 89, 'Jamaica Estates-Holliswood' = 90, 'Kensington-Ocean Parkway' = 91, 'Kew Gardens' = 92, 'Kew Gardens Hills' = 93, 'Kingsbridge Heights' = 94, 'Laurelton' = 95, 'Lenox Hill-Roosevelt Island' = 96, 'Lincoln Square' = 97, 'Lindenwood-Howard Beach' = 98, 'Longwood' = 99, 'Lower East Side' = 100, 'Madison' = 101, 'Manhattanville' = 102, 'Marble Hill-Inwood' = 103, 'Mariner\'s Harbor-Arlington-Port Ivory-Graniteville' = 104, 'Maspeth' = 105, 'Melrose South-Mott Haven North' = 106, 'Middle Village' = 107, 'Midtown-Midtown South' = 108, 'Midwood' = 109, 'Morningside Heights' = 110, 'Morrisania-Melrose' = 111, 'Mott Haven-Port Morris' = 112, 'Mount Hope' = 113, 'Murray Hill' = 114, 'Murray Hill-Kips Bay' = 115, 'New Brighton-Silver Lake' = 116, 'New Dorp-Midland Beach' = 117, 'New Springville-Bloomfield-Travis' = 118, 'North Corona' = 119, 'North Riverdale-Fieldston-Riverdale' = 120, 'North Side-South Side' = 121, 'Norwood' = 122, 'Oakland Gardens' = 123, 'Oakwood-Oakwood Beach' = 124, 'Ocean Hill' = 125, 'Ocean Parkway South' = 126, 'Old Astoria' = 127, 'Old Town-Dongan Hills-South Beach' = 128, 'Ozone Park' = 129, 'Park Slope-Gowanus' = 130, 'Parkchester' = 131, 'Pelham Bay-Country Club-City Island' = 132, 'Pelham Parkway' = 133, 'Pomonok-Flushing Heights-Hillcrest' = 134, 'Port Richmond' = 135, 'Prospect Heights' = 136, 'Prospect Lefferts Gardens-Wingate' = 137, 'Queens Village' = 138, 'Queensboro Hill' = 139, 'Queensbridge-Ravenswood-Long Island City' = 140, 'Rego Park' = 141, 'Richmond Hill' = 142, 'Ridgewood' = 143, 'Rikers Island' = 144, 'Rosedale' = 145, 'Rossville-Woodrow' = 146, 'Rugby-Remsen Village' = 147, 'Schuylerville-Throgs Neck-Edgewater Park' = 148, 'Seagate-Coney Island' = 149, 'Sheepshead Bay-Gerritsen Beach-Manhattan Beach' = 150, 'SoHo-TriBeCa-Civic Center-Little Italy' = 151, 'Soundview-Bruckner' = 152, 'Soundview-Castle Hill-Clason Point-Harding Park' = 153, 'South Jamaical' = 154, 'South Ozone Park' = 155, 'Springfield Gardens North' = 156, 'Springfield Gardens South-Brooklyn' = 157, 'Spuyten Duyvil-Kingsbridge' = 158, 'St. Albans' = 159, 'Stapleton-Rosebank' = 160, 'Starrett City' = 161, 'Steinway' = 162, 'Stuyvesant Heights' = 163, 'Stuyvesant Town-Cooper Village' = 164, 'Sunset Park East' = 165, 'Sunset Park West' = 166, 'Todt Hill-Emerson Hill-Heartland Village-Lighthouse Hill' = 167, 'Turtle Bay-East Midtown' = 168, 'University Heights-Morris Heights' = 169, 'Upper East Side-Carnegie Hill' = 170, 'Upper West Side' = 171, 'Van Cortlandt Village' = 172, 'Van Nest-Morris Park-Westchester Square' = 173, 'Washington Heights North' = 174, 'Washington Heights South' = 175, 'West Brighton' = 176, 'West Concourse' = 177, 'West Farms-Bronx River' = 178, 'West New Brighton-New Brighton-St. George' = 179, 'West Village' = 180, 'Westchester-Unionport' = 181, 'Westerleigh' = 182, 'Whitestone' = 183, 'Williamsbridge-Olinville' = 184, 'Williamsburg' = 185, 'Windsor Terrace' = 186, 'Woodhaven' = 187, 'Woodlawn-Wakefield' = 188, 'Woodside' = 189, 'Yorkville' = 190, 'park-cemetery-etc-Bronx' = 191, 'park-cemetery-etc-Brooklyn' = 192, 'park-cemetery-etc-Manhattan' = 193, 'park-cemetery-etc-Queens' = 194, 'park-cemetery-etc-Staten Island' = 195) AS pickup_ntaname,

toUInt16(ifNull(pickup_puma, '0')) AS pickup_puma,

assumeNotNull(dropoff_nyct2010_gid) AS dropoff_nyct2010_gid,
toFloat32(ifNull(dropoff_ctlabel, '0')) AS dropoff_ctlabel,
assumeNotNull(dropoff_borocode) AS dropoff_borocode,
CAST(assumeNotNull(dropoff_boroname) AS Enum8('Manhattan' = 1, 'Queens' = 4, 'Brooklyn' = 3, '' = 0, 'Bronx' = 2, 'Staten Island' = 5)) AS dropoff_boroname,
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toFixedString(ifNull(dropoff_boroc2010, '0000000'), 7) AS dropoff_boroc2010,
CAST(assumeNotNull(ifNull(dropoff_cdeligibil, ' ')) AS Enum8(' ' = 0, 'E' = 1, 'I' = 2)) AS dropoff_cdeligibil,
toFixedString(ifNull(dropoff_ntacode, '0000'), 4) AS dropoff_ntacode,

CAST(assumeNotNull(dropoff_ntaname) AS Enum16(' ' = 0, 'Airport' = 1, 'Allerton-Pelham Gardens' = 2, 'Annadale-Huguenot-Prince\'s Bay-Eltingville' = 3, 'Arden Heights' = 4, 'Astoria' = 5, 'Auburndale' = 6, 'Baisley Park' = 7, 'Bath Beach' = 8, 'Battery Park City-Lower Manhattan' = 9, 'Bay Ridge' = 10, 'Bayside-Bayside Hills' = 11, 'Bedford' = 12, 'Bedford Park-Fordham North' = 13, 'Bellerose' = 14, 'Belmont' = 15, 'Bensonhurst East' = 16, 'Bensonhurst West' = 17, 'Borough Park' = 18, 'Breezy Point-Belle Harbor-Rockaway Park-Broad Channel' = 19, 'Briarwood-Jamaica Hills' = 20, 'Brighton Beach' = 21, 'Bronxdale' = 22, 'Brooklyn Heights-Cobble Hill' = 23, 'Brownsville' = 24, 'Bushwick North' = 25, 'Bushwick South' = 26, 'Cambria Heights' = 27, 'Canarsie' = 28, 'Carroll Gardens-Columbia Street-Red Hook' = 29, 'Central Harlem North-Polo Grounds' = 30, 'Central Harlem South' = 31, 'Charleston-Richmond Valley-Tottenville' = 32, 'Chinatown' = 33, 'Claremont-Bathgate' = 34, 'Clinton' = 35, 'Clinton Hill' = 36, 'Co-op City' = 37, 'College Point' = 38, 'Corona' = 39, 'Crotona Park East' = 40, 'Crown Heights North' = 41, 'Crown Heights South' = 42, 'Cypress Hills-City Line' = 43, 'DUMBO-Vinegar Hill-Downtown Brooklyn-Boerum Hill' = 44, 'Douglas Manor-Douglaslaston-Little Neck' = 45, 'Dyker Heights' = 46, 'East Concourse-Concourse Village' = 47, 'East Elmhurst' = 48, 'East Flatbush-Farragut' = 49, 'East Flushing' = 50, 'East Harlem North' = 51, 'East Harlem South' = 52, 'East New York' = 53, 'East New York (Pennsylvania Ave)' = 54, 'East Tremont' = 55, 'East Village' = 56, 'East Williamsburg' = 57, 'Eastchester-Edenwald-Baychester' = 58, 'Elmhurst' = 59, 'Elmhurst-Maspeth' = 60, 'Erasmus' = 61, 'Far Rockaway-Bayswater' = 62, 'Flatbush' = 63, 'Flatlands' = 64, 'Flushing' = 65, 'Fordham South' = 66, 'Forest Hills' = 67, 'Fort Greene' = 68, 'Fresh Meadows-Utopia' = 69, 'Ft. Totten-Bay Terrace-Clearview' = 70, 'Georgetown-Marine Park-Bergen Beach-Mill Basin' = 71, 'Glen Oaks-Floral Park-New Hyde Park' = 72, 'Glendale' = 73, 'Gramercy' = 74, 'Grasmere-Arrochar-Ft. Wadsworth' = 75, 'Gravesend' = 76, 'Great Kills' = 77, 'Greenpoint' = 78, 'Grymes Hill-Clifton-Fox Hills' = 79.

'Co., Graveston' = 70, 'Great Kills' = 71, 'Great Neck-Point Lookout' = 72, 'Great Neck-Sixty-Nine Miles' = 73, 'Hamilton Heights' = 80, 'Hammels-Arverne-Edgemere' = 81, 'Highbridge' = 82, 'Hollis' = 83, 'Homecrest' = 84, 'Hudson Yards-Chelsea-Flatiron-Union Square' = 85, 'Hunters Point-Sunnyside-West Maspeth' = 86, 'Hunts Point' = 87, 'Jackson Heights' = 88, 'Jamaica' = 89, 'Jamaica Estates-Holliswood' = 90, 'Kensington-Ocean Parkway' = 91, 'Kew Gardens' = 92, 'Kew Gardens Hills' = 93, 'Kingsbridge Heights' = 94, 'Laurelton' = 95, 'Lenox Hill-Roosevelt Island' = 96, 'Lincoln Square' = 97, 'Lindenwood-Howard Beach' = 98, 'Longwood' = 99, 'Lower East Side' = 100, 'Madison' = 101, 'Manhattanville' = 102, 'Marble Hill-Inwood' = 103, 'Mariner's Harbor-Arlington-Port Ivory-Graniteville' = 104, 'Maspeth' = 105, 'Melrose South-Mott Haven North' = 106, 'Middle Village' = 107, 'Midtown-Midtown South' = 108, 'Midwood' = 109, 'Morningside Heights' = 110, 'Morrisania-Melrose' = 111, 'Mott Haven-Port Morris' = 112, 'Mount Hope' = 113, 'Murray Hill' = 114, 'Murray Hill-Kips Bay' = 115, 'New Brighton-Silver Lake' = 116, 'New Dorp-Midland Beach' = 117, 'New Springville-Bloomfield-Travis' = 118, 'North Corona' = 119, 'North Riverdale-Fieldston-Riverdale' = 120, 'North Side-South Side' = 121, 'Norwood' = 122, 'Oakland Gardens' = 123, 'Oakwood-Oakwood Beach' = 124, 'Ocean Hill' = 125, 'Ocean Parkway South' = 126, 'Old Astoria' = 127, 'Old Town-Dongan Hills-South Beach' = 128, 'Ozone Park' = 129, 'Park Slope-Gowanus' = 130, 'Parkchester' = 131, 'Pelham Bay-Country Club-City Island' = 132, 'Pelham Parkway' = 133, 'Pomonok-Flushing Heights-Hillcrest' = 134, 'Port Richmond' = 135, 'Prospect Heights' = 136, 'Prospect Lefferts Gardens-Wingate' = 137, 'Queens Village' = 138, 'Queensboro Hill' = 139, 'Queensbridge-Ravenswood-Long Island City' = 140, 'Rego Park' = 141, 'Richmond Hill' = 142, 'Ridgewood' = 143, 'Rikers Island' = 144, 'Rosedale' = 145, 'Rossville-Woodrow' = 146, 'Rugby-Remsen Village' = 147, 'Schuylerville-Throgs Neck-Edgewater Park' = 148, 'Seagate-Coney Island' = 149, 'Sheepshead Bay-Gerritsen Beach-Manhattan Beach' = 150, 'SoHo-TriBeCa-Civic Center-Little Italy' = 151, 'Soundview-Bruckner' = 152, 'Soundview-Castle Hill-Clason Point-Harding Park' = 153, 'South Jamaica' = 154, 'South Ozone Park' = 155, 'Springfield Gardens North' = 156, 'Springfield Gardens South-Brookville' = 157, 'Spuyten Duyvil-Kingsbridge' = 158, 'St. Albans' = 159, 'Stapleton-Rosebank' = 160, 'Starrett City' = 161, 'Steinway' = 162, 'Stuyvesant Heights' = 163, 'Stuyvesant Town-Cooper Village' = 164, 'Sunset Park East' = 165, 'Sunset Park West' = 166, 'Todt Hill-Emerson Hill-Heartland Village-Lighthouse Hill' = 167, 'Turtle Bay-East Midtown' = 168, 'University Heights-Morris Heights' = 169, 'Upper East Side-Carnegie Hill' = 170, 'Upper West Side' = 171, 'Van Cortlandt Village' = 172, 'Van Nest-Morris Park-Westchester Square' = 173, 'Washington Heights North' = 174, 'Washington Heights South' = 175, 'West Brighton' = 176, 'West Concourse' = 177, 'West Farms-Bronx River' = 178, 'West New Brighton-New Brighton-St. George' = 179, 'West Village' = 180, 'Westchester-Unionport' = 181, 'Westerleigh' = 182, 'Whitestone' = 183, 'Williamsbridge-Olinville' = 184, 'Williamsburg' = 185, 'Windsor Terrace' = 186, 'Woodhaven' = 187, 'Woodlawn-Wakefield' = 188, 'Woodside' = 189, 'Yorkville' = 190, 'park-cemetery-etc-Bronx' = 191, 'park-cemetery-etc-Brooklyn' = 192, 'park-cemetery-etc-Manhattan' = 193, 'park-cemetery-etc-Queens' = 194, 'park-cemetery-etc-Staten Island' = 195)) AS dropoff_ntaname,

این کار با سرعت 428 هزار رکورد در ثانیه و 3030 ثانیه طول خواهد کشید. برای load سریعتر، شما می‌توانید یک جدول با موتور Log به جای MergeTree بسازید. در این مورد، دانلود سریعتر از 200 ثانیه کار می‌کند.

این جدول 126 گیابایت فضای بر روی دیسک اشغال می کند.

```
:) SELECT formatReadableSize(sum(bytes)) FROM system.parts WHERE table = 'trips_mergetree' AND active  
  
SELECT formatReadableSize(sum(bytes))  
FROM system.parts  
WHERE (table = 'trips_mergetree') AND active  
  
└─formatReadableSize(sum(bytes))─  
| 126.18 GiB |
```

در میان چیزهای دیگر، شما می‌توانید از دستور OPTIMIZE بر روی MergeTree استفاده کنید. اما از آنجایی که بدون این دستور همه چیز خوب است، اجرای این دستور ضروری نیست.

نتایج بر روی یک سرور

:Q1

```
SELECT cab_type, count(*) FROM trips_mergetree GROUP BY cab_type
```

.seconds 0.490

:Q2

```
SELECT passenger_count, avg(total_amount) FROM trips_mergetree GROUP BY passenger_count
```

.seconds 1.224

:Q3

```
SELECT passenger_count, toYear(pickup_date) AS year, count(*) FROM trips_mergetree GROUP BY passenger_count, year
```

.seconds 2.104

:Q4

```
SELECT passenger_count, toYear(pickup_date) AS year, round(trip_distance) AS distance, count(*) FROM trips_mergetree GROUP BY passenger_count, year, distance ORDER BY year, count(*) DESC
```

.seconds 3.593

کانفیگ سرور به این صورت بود:

Two Intel(R) Xeon(R) CPU E5-2650 v2 @ 2.60GHz, 16 physical kernels total, 128 GiB RAM, 8x6 TB HD on hardware RAID-5

زمان اجرا query ها از زمان دومین اجرا بهتر می شود، چون query ها داده ها را از فایل system cache می خوانند. در ادامه دیگری رخ نمیدهد: داده ها در هر اجرا خوانده و پردازش شده اند.

ساخت جداول در در سه سرور:

در هر سرور دستور زیر را اجرا کنید:

```
CREATE TABLE default.trips_mergetree_third ( trip_id UInt32, vendor_id Enum8('1' = 1, '2' = 2, 'CMT' = 3, 'VTS' = 4, 'DDS' = 5, 'B02512' = 10, 'B02598' = 11, 'B02617' = 12, 'B02682' = 13, 'B02764' = 14), pickup_date Date, pickup_datetime DateTime, dropoff_date Date, dropoff_datetime DateTime, store_and_fwd_flag UInt8, rate_code_id UInt8, pickup_longitude Float64, pickup_latitude Float64, dropoff_longitude Float64, dropoff_latitude Float64, passenger_count UInt8, trip_distance Float64, fare_amount Float32, extra Float32, mta_tax Float32, tip_amount Float32, tolls_amount Float32, ehail_fee Float32, improvement_surcharge Float32, total_amount Float32, payment_type_ Enum8('UNK' = 0, 'CSH' = 1, 'CRE' = 2, 'NOC' = 3, 'DIS' = 4), trip_type UInt8, pickup FixedString(25), dropoff FixedString(25), cab_type Enum8('yellow' = 1, 'green' = 2, 'uber' = 3), pickup_nyct2010_gid UInt8, pickup_ctlabel Float32, pickup_borocode UInt8, pickup_boroname Enum8('' = 0, 'Manhattan' = 1, 'Bronx' = 2, 'Brooklyn' = 3, 'Queens' = 4, 'Staten Island' = 5), pickup_ct2010 FixedString(6), pickup_boroct2010 FixedString(7), pickup_cdeligibil Enum8('' = 0, 'E' = 1, 'I' = 2), pickup_ntacode FixedString(4), pickup_ntaname Enum16('' = 0, 'Airport' = 1, 'Allerton-Pelham Gardens' = 2, 'Annadale-Huguenot-Prince's Bay-Eltingville' = 3, 'Arden Heights' = 4, 'Astoria' = 5, 'Auburndale' = 6, 'Baisley Park' = 7, 'Bath Beach' = 8, 'Battery Park City-Lower Manhattan' = 9, 'Bay Ridge' = 10, 'Bayside-Bayside Hills' = 11, 'Bedford' = 12, 'Bedford Park-Fordham North' = 13, 'Belleroose' = 14, 'Belmont' = 15, 'Bensonhurst East' = 16, 'Bensonhurst West' = 17, 'Borough Park' = 18, 'Breezy Point-Belle Harbor-Rockaway Park-Broad Channel' = 19, 'Briarwood-Jamaica Hills' = 20, 'Brighton Beach' = 21, 'Bronxdale' = 22, 'Brooklyn Heights-Cobble Hill' = 23, 'Brownsville' = 24, 'Bushwick North' = 25, 'Bushwick South' = 26, 'Cambria Heights' = 27, 'Canarsie' = 28, 'Carroll Gardens-Columbia Street-Red Hook' = 29, 'Central Harlem North-Polo Grounds' = 30, 'Central Harlem South' = 31, 'Charleston-Richmond Valley-Tottenville' = 32, 'Chinatown' = 33, 'Clarendon-Bathgate' = 34, 'Clinton' = 35, 'Clinton Hill' = 36, 'Co-op City' = 37, 'College Point' = 38, 'Corona' = 39, 'Crotona Park East' = 40, 'Crown Heights North' = 41, 'Crown Heights South' = 42, 'Cypress Hills-City Line' = 43, 'DUMBO-Vinegar Hill-Downtown Brooklyn-Boerum Hill' = 44, 'Douglas Manor-Douglaston-Little Neck' = 45, 'Dyker Heights' = 46, 'East Concourse-Concourse Village' = 47, 'East Elmhurst' = 48, 'East Flatbush-Farragut' = 49, 'East Flushing' = 50, 'East Harlem North' = 51, 'East Harlem South' = 52, 'East New York' = 53, 'East New York (Pennsylvania Ave)' = 54, 'East Tremont' = 55, 'East Village' = 56, 'East Williamsburg' = 57, 'Eastchester-Edenwald-Baychester' = 58, 'Elmhurst' = 59, 'Elmhurst-Maspeth' = 60, 'Erasmus' = 61, 'Far Rockaway-Bayswater' = 62, 'Flatbush' = 63, 'Flatlands' = 64, 'Flushing' = 65, 'Fordham South' = 66, 'Forest Hills' = 67, 'Fort Greene' = 68, 'Fresh Meadows-Utopia' = 69, 'Ft. Totten-Bay Terrace-Clearview' = 70, 'Georgetown-Marine Park-Bergen Beach-Mill Basin' = 71, 'Glen Oaks-Floral Park-New Hyde Park' = 72, 'Glendale' = 73, 'Kingsbridge' = 74, 'Lefferts-Gowanus-Brownsville' = 75, 'Lowell' = 76, 'Long Island City' = 77, 'Longwood'
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'Gramercy' = 74, 'Grasmere-Arrochar-Ft. Wadsworth' = 75, 'Gravesend' = 76, 'Great Kills' = 77, 'Greenpoint' = 78, 'Grymes Hill-Clifton-Fox Hills' = 79, 'Hamilton Heights' = 80, 'Hammels-Arverne-Edgemere' = 81, 'Highbridge' = 82, 'Hollis' = 83, 'Homecrest' = 84, 'Hudson Yards-Chelsea-Flatiron-Union Square' = 85, 'Hunters Point-Sunnyside-West Maspeth' = 86, 'Hunts Point' = 87, 'Jackson Heights' = 88, 'Jamaica' = 89, 'Jamaica Estates-Holliswood' = 90, 'Kensington-Ocean Parkway' = 91, 'Kew Gardens' = 92, 'Kew Gardens Hills' = 93, 'Kingsbridge Heights' = 94, 'Laurelton' = 95, 'Lenox Hill-Roosevelt Island' = 96, 'Lincoln Square' = 97, 'Lindenwood-Howard Beach' = 98, 'Longwood' = 99, 'Lower East Side' = 100, 'Madison' = 101, 'Manhattanville' = 102, 'Marble Hill-Inwood' = 103, 'Mariner's Harbor-Arlington-Port Ivory-Graniteville' = 104, 'Maspeth' = 105, 'Melrose South-Mott Haven North' = 106, 'Middle Village' = 107, 'Midtown-Midtown South' = 108, 'Midwood' = 109, 'Morningside Heights' = 110, 'Morrisania-Melrose' = 111, 'Mott Haven-Port Morris' = 112, 'Mount Hope' = 113, 'Murray Hill' = 114, 'Murray Hill-Kips Bay' = 115, 'New Brighton-Silver Lake' = 116, 'New Dorp-Midland Beach' = 117, 'New Springville-Bloomfield-Travis' = 118, 'North Corona' = 119, 'North Riverdale-Fieldston-Riverdale' = 120, 'North Side-South Side' = 121, 'Norwood' = 122, 'Oakland Gardens' = 123, 'Oakwood-Oakwood Beach' = 124, 'Ocean Hill' = 125, 'Ocean Parkway South' = 126, 'Old Astoria' = 127, 'Old Town-Dongan Hills-South Beach' = 128, 'Ozone Park' = 129, 'Park Slope-Gowanus' = 130, 'Parkchester' = 131, 'Pelham Bay-Country Club-City Island' = 132, 'Pelham Parkway' = 133, 'Pomonok-Flushing Heights-Hillcrest' = 134, 'Port Richmond' = 135, 'Prospect Heights' = 136, 'Prospect Lefferts Gardens-Wingate' = 137, 'Queens Village' = 138, 'Queensboro Hill' = 139, 'Queensbridge-Ravenswood-Long Island City' = 140, 'Rego Park' = 141, 'Richmond Hill' = 142, 'Ridgewood' = 143, 'Rikers Island' = 144, 'Rosedale' = 145, 'Rossville-Woodrow' = 146, 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'Washington Heights South' = 175, 'West Brighton' = 176, 'West Concourse' = 177, 'West Farms-Bronx River' = 178, 'West New Brighton-New Brighton-St. George' = 179, 'West Village' = 180, 'Westchester-Unionport' = 181, 'Westerleigh' = 182, 'Whitestone' = 183, 'Williamsbridge-Olinville' = 184, 'Williamsburg' = 185, 'Windsor Terrace' = 186, 'Woodhaven' = 187, 'Woodlawn-Wakefield' = 188, 'Woodside' = 189, 'Yorkville' = 190, 'park-cemetery-etc-Bronx' = 191, 'park-cemetery-etc-Brooklyn' = 192, 'park-cemetery-etc-Manhattan' = 193, 'park-cemetery-etc-Queens' = 194, 'park-cemetery-etc-Staten Island' = 195), pickup_puma UInt16, dropoff_nyct2010_gid UInt8, dropoff_ctlabel Float32, dropoff_borocode UInt8, dropoff_boroname Enum8('' = 0, 'Manhattan' = 1, 'Bronx' = 2, 'Brooklyn' = 3, 'Queens' = 4, 'Staten Island' = 5), dropoff_ct2010 FixedString(6), dropoff_boroct2010 FixedString(7), dropoff_cdeligibil Enum8('' = 0, 'E' = 1, 'I' = 2), dropoff_ntacode FixedString(4), dropoff_ntaname Enum16('' = 0, 'Airport' = 1, 'Allerton-Pelham Gardens' = 2, 'Annadale-Huguenot-Prince's Bay-Eltingville' = 3, 'Arden Heights' = 4, 'Astoria' = 5, 'Auburndale' = 6, 'Baisley Park' = 7, 'Bath Beach' = 8, 'Battery Park City-Lower Manhattan' = 9, 'Bay Ridge' = 10, 'Bayside-Bayside Hills' = 11, 'Bedford' = 12, 'Bedford Park-Fordham North' = 13, 'Bellerose' = 14, 'Belmont' = 15, 'Bensonhurst East' = 16, 'Bensonhurst West' = 17, 'Borough Park' = 18, 'Breezy Point-Belle Harbor-Rockaway Park-Broad Channel' = 19, 'Briarwood-Jamaica Hills' = 20, 'Brighton Beach' = 21, 'Bronxdale' = 22, 'Brooklyn Heights-Cobble Hill' = 23, 'Brownsville' = 24, 'Bushwick North' = 25, 'Bushwick South' = 26, 'Cambria Heights' = 27, 'Canarsie' = 28, 'Carroll Gardens-Columbia Street-Red Hook' = 29, 'Central Harlem North-Polo Grounds' = 30, 'Central Harlem South' = 31, 'Charleston-Richmond Valley-Tottenville' = 32, 'Chinatown' = 33, 'Clarendon-Bathgate' = 34, 'Clinton' = 35, 'Clinton Hill' = 36, 'Co-op City' = 37, 'College Point' = 38, 'Corona' = 39, 'Crotona Park East' = 40, 'Crown Heights North' = 41, 'Crown Heights South' = 42, 'Cypress Hills-City Line' = 43, 'DUMBO-Vinegar Hill-Downtown Brooklyn-Boerum Hill' = 44, 'Douglas Manor-Douglaslaston-Little Neck' = 45, 'Dyker Heights' = 46, 'East Concourse-Concourse Village' = 47, 'East Elmhurst' = 48, 'East Flatbush-Farragut' = 49, 'East Flushing' = 50, 'East Harlem North' = 51, 'East Harlem South' = 52, 'East New York' = 53, 'East New York (Pennsylvania Ave)' = 54, 'East Tremont' = 55, 'East Village' = 56, 'East Williamsburg' = 57, 'Eastchester-Edenwald-Baychester' = 58, 'Elmhurst' = 59, 'Elmhurst-Maspeth' = 60, 'Erasmus' = 61, 'Far Rockaway-Bayswater' = 62, 'Flatbush' = 63, 'Flatlands' = 64, 'Flushing' = 65, 'Fordham South' = 66, 'Forest Hills' = 67, 'Fort Greene' = 68, 'Fresh Meadows-Utopia' = 69, 'Ft. Totten-Bay Terrace-Clearview' = 70, 'Georgetown-Marine Park-Bergen Beach-Mill Basin' = 71, 'Glen Oaks-Floral Park-New Hyde Park' = 72, 'Glendale' = 73, 'Gramercy' = 74, 'Grasmere-Arrochar-Ft. Wadsworth' = 75, 'Gravesend' = 76, 'Great Kills' = 77, 'Greenpoint' = 78, 'Grymes Hill-Clifton-Fox Hills' = 79, 'Hamilton Heights' = 80, 'Hammels-Arverne-Edgemere' = 81, 'Highbridge' = 82, 'Hollis' = 83, 'Homecrest' = 84, 'Hudson Yards-Chelsea-Flatiron-Union Square' = 85, 'Hunters Point-Sunnyside-West Maspeth' = 86, 'Hunts Point' = 87, 'Jackson Heights' = 88, 'Jamaica' = 89, 'Jamaica Estates-Holliswood' = 90, 'Kensington-Ocean Parkway' = 91, 'Kew Gardens' = 92, 'Kew Gardens Hills' = 93, 'Kingsbridge Heights' = 94, 'Laurelton' = 95, 'Lenox Hill-Roosevelt Island' = 96, 'Lincoln Square' = 97, 'Lindenwood-Howard Beach' = 98, 'Longwood' = 99, 'Lower East Side' = 100, 'Madison' = 101, 'Manhattanville' = 102, 'Marble Hill-Inwood' = 103, 'Mariner's Harbor-Arlington-Port Ivory-Graniteville' = 104, 'Maspeth' = 105, 'Melrose South-Mott Haven North' = 106, 'Middle Village' = 107, 'Midtown-Midtown South' = 108, 'Midwood' = 109, 'Morningside Heights' = 110, 'Morrisania-Melrose' = 111, 'Mott Haven-Port Morris' = 112, 'Mount Hope' = 113, 'Murray Hill' = 114, 'Murray Hill-Kips Bay' = 115, 'New Brighton-Silver Lake' = 116, 'New Dorp-Midland Beach' = 117, 'New Springville-Bloomfield-Travis' = 118, 'North Corona' = 119, 'North Riverdale-Fieldston-Riverdale' = 120, 'North Side-South Side' = 121, 'Norwood' = 122, 'Oakland Gardens' = 123, 'Oakwood-Oakwood Beach' = 124, 'Ocean Hill' = 125, 'Ocean Parkway South' = 126, 'Old Astoria' = 127, 'Old Town-Dongan Hills-South Beach' = 128, 'Ozone Park' = 129, 'Park Slope-Gowanus' = 130, 'Parkchester' =

```

131, 'Pelham Bay-Country Club-City Island' = 132, 'Pelham Parkway' = 133, 'Pomonok-Flushing Heights-Hillcrest' = 134, 'Port Richmond' = 135, 'Prospect Heights' = 136, 'Prospect Lefferts Gardens-Wingate' = 137, 'Queens Village' = 138, 'Queensboro Hill' = 139, 'Queensbridge-Ravenswood-Long Island City' = 140, 'Rego Park' = 141, 'Richmond Hill' = 142, 'Ridgewood' = 143, 'Rikers Island' = 144, 'Rosedale' = 145, 'Rossville-Woodrow' = 146, 'Rugby-Remsen Village' = 147, 'Schuylerville-Throgs Neck-Edgewater Park' = 148, 'Seagate-Coney Island' = 149, 'Sheepshead Bay-Gerritsen Beach-Manhattan Beach' = 150, 'SoHo-TriBeCa-Civic Center-Little Italy' = 151, 'Soundview-Bruckner' = 152, 'Soundview-Castle Hill-Clason Point-Harding Park' = 153, 'South Jamaica' = 154, 'South Ozone Park' = 155, 'Springfield Gardens North' = 156, 'Springfield Gardens South-Brookville' = 157, 'Spuyten Duyvil-Kingsbridge' = 158, 'St. Albans' = 159, 'Stapleton-Rosebank' = 160, 'Starrett City' = 161, 'Steinway' = 162, 'Stuyvesant Heights' = 163, 'Stuyvesant Town-Cooper Village' = 164, 'Sunset Park East' = 165, 'Sunset Park West' = 166, 'Todt Hill-Emerson Hill-Heartland Village-Lighthouse Hill' = 167, 'Turtle Bay-East Midtown' = 168, 'University Heights-Morris Heights' = 169, 'Upper East Side-Carnegie Hill' = 170, 'Upper West Side' = 171, 'Van Cortlandt Village' = 172, 'Van Nest-Morris Park-Westchester Square' = 173, 'Washington Heights North' = 174, 'Washington Heights South' = 175, 'West Brighton' = 176, 'West Concourse' = 177, 'West Farms-Bronx River' = 178, 'West New Brighton-New Brighton-St. George' = 179, 'West Village' = 180, 'Westchester-Unionport' = 181, 'Westerleigh' = 182, 'Whitestone' = 183, 'Williamsbridge-Olinville' = 184, 'Williamsburg' = 185, 'Windsor Terrace' = 186, 'Woodhaven' = 187, 'Woodlawn-Wakefield' = 188, 'Woodside' = 189, 'Yorkville' = 190, 'park-cemetery-etc-Bronx' = 191, 'park-cemetery-etc-Brooklyn' = 192, 'park-cemetery-etc-Manhattan' = 193, 'park-cemetery-etc-Queens' = 194, 'park-cemetery-etc-Staten Island' = 195), dropoff_puma UInt16) ENGINE = MergeTree(pickup_date, pickup_datETIME, 8192)

```

بر روی سرور source دستور زیر را وارد کنید:

```
CREATE TABLE trips_mergetree_x3 AS trips_mergetree_third ENGINE = Distributed(perftest, default,
trips_mergetree_third, rand())
```

زیر دادها را توزیع مجدد می کند:

```
INSERT INTO trips_mergetree_x3 SELECT * FROM trips_mergetree
```

این query 2454 ثانیه زمان میبرد.

در سه سرور:

Q1: 0.212 ثانیه. Q2: 0.438 ثانیه. Q3: 0.733 ثانیه. Q4: 1.241 ثانیه.

از آنجایی که query ها به صورت خطی scale شده اند، از نتایج به دست آمده شگفتی وجود ندارد.

ما همچنین نتایج زیر را از اجرای این query در کلاستر 140 سرور دریافت کردیم:

Q1: 0.028 ثانیه. Q2: 0.043 ثانیه. Q3: 0.051 ثانیه. Q4: 0.072 ثانیه.

در این مورد، زمان پردازش query براساس latency شبکه مشخص می شود. ما این query ها را با استفاده از یک مشتری واقع در دیتابسenter Yandex در فنلاند در یک کلاستر روسیه دریافت کردیم، که latency آن حدود 20 میلی ثانیه به نتایج اضافه کرد.

نتایج

نودها	Q1	Q2	Q3	Q4
1	0.490	1.224	2.104	3.593
3	0.212	0.438	0.733	1.241
140	0.028	0.043	0.051	0.072

بنچمارک AMPLab Big Data

[/https://amplab.cs.berkeley.edu/benchmark](https://amplab.cs.berkeley.edu/benchmark) بینید

با یک اکانت مجانی در <https://aws.amazon.com> ثبت نام کنید. شما نیاز به ایمیل، شماره تلفن و credit card دارید. یک Access key ثبت نام کنید. دریافت کنید https://console.aws.amazon.com/iam/home?nc2=h_m_sc#security_credential دریافت کنید.

در کنسول این دستورات را وارد کنید:

```
sudo apt-get install s3cmd
mkdir tiny; cd tiny;
s3cmd sync s3://big-data-benchmark/pavlo/text-deflate/tiny/ .
cd ..
mkdir 1node; cd 1node;
s3cmd sync s3://big-data-benchmark/pavlo/text-deflate/1node/ .
cd ..
mkdir 5nodes; cd 5nodes;
s3cmd sync s3://big-data-benchmark/pavlo/text-deflate/5nodes/ .
cd ..
```

این های ClickHouse query را اجرا کنید:

```

CREATE TABLE rankings_tiny
(
    pageURL String,
    pageRank UInt32,
    avgDuration UInt32
) ENGINE = Log;

CREATE TABLE uservisits_tiny
(
    sourceIP String,
    destinationURL String,
    visitDate Date,
    adRevenue Float32,
    UserAgent String,
    cCode FixedString(3),
    lCode FixedString(6),
    searchWord String,
    duration UInt32
) ENGINE = MergeTree(visitDate, visitDate, 8192);

CREATE TABLE rankings_1node
(
    pageURL String,
    pageRank UInt32,
    avgDuration UInt32
) ENGINE = Log;

CREATE TABLE uservisits_1node
(
    sourceIP String,
    destinationURL String,
    visitDate Date,
    adRevenue Float32,
    UserAgent String,
    cCode FixedString(3),
    lCode FixedString(6),
    searchWord String,
    duration UInt32
) ENGINE = MergeTree(visitDate, visitDate, 8192);

CREATE TABLE rankings_5nodes_on_single
(
    pageURL String,
    pageRank UInt32,
    avgDuration UInt32
) ENGINE = Log;

CREATE TABLE uservisits_5nodes_on_single
(
    sourceIP String,
    destinationURL String,
    visitDate Date,
    adRevenue Float32,
    UserAgent String,
    cCode FixedString(3),
    lCode FixedString(6),
    searchWord String,
    duration UInt32
) ENGINE = MergeTree(visitDate, visitDate, 8192);

```

به کنسول برگردید و دستورات زیر را مجددا اجرا کنید:

```

for i in tiny/rankings/*.deflate; do echo $i; zlib-flate -uncompress < $i | clickhouse-client --host=example-perftest01j --query="INSERT INTO rankings_tiny FORMAT CSV"; done
for i in tiny/uservisits/*.deflate; do echo $i; zlib-flate -uncompress < $i | clickhouse-client --host=example-perftest01j --query="INSERT INTO uservisits_tiny FORMAT CSV"; done
for i in 1node/rankings/*.deflate; do echo $i; zlib-flate -uncompress < $i | clickhouse-client --host=example-perftest01j --query="INSERT INTO rankings_1node FORMAT CSV"; done
for i in 1node/uservisits/*.deflate; do echo $i; zlib-flate -uncompress < $i | clickhouse-client --host=example-perftest01j --query="INSERT INTO uservisits_1node FORMAT CSV"; done
for i in 5nodes/rankings/*.deflate; do echo $i; zlib-flate -uncompress < $i | clickhouse-client --host=example-perftest01j --query="INSERT INTO rankings_5nodes_on_single FORMAT CSV"; done
for i in 5nodes/uservisits/*.deflate; do echo $i; zlib-flate -uncompress < $i | clickhouse-client --host=example-perftest01j --query="INSERT INTO uservisits_5nodes_on_single FORMAT CSV"; done

```

گرفتن های query data sample

```

SELECT pageURL, pageRank FROM rankings_1node WHERE pageRank > 1000

SELECT substring(sourceIP, 1, 8), sum(adRevenue) FROM uservisits_1node GROUP BY substring(sourceIP, 1, 8)

SELECT
    sourceIP,
    sum(adRevenue) AS totalRevenue,
    avg(pageRank) AS pageRank
FROM rankings_1node ALL INNER JOIN
(
    SELECT
        sourceIP,
        destinationURL AS pageURL,
        adRevenue
    FROM uservisits_1node
    WHERE (visitDate > '1980-01-01') AND (visitDate < '1980-04-01')
) USING pageURL
GROUP BY sourceIP
ORDER BY totalRevenue DESC
LIMIT 1

```

WikiStat

<http://dumps.wikimedia.org/other/pagecounts-raw>: بینید

ساخت جدول:

```

CREATE TABLE wikistat
(
    date Date,
    time DateTime,
    project String,
    subproject String,
    path String,
    hits UInt64,
    size UInt64
) ENGINE = MergeTree(date, (path, time), 8192);

```

load دتا

```

for i in {2007..2016}; do for j in {01..12}; do echo $i-$j >&2; curl -sSL "http://dumps.wikimedia.org/other/pagecounts-raw/$i/$i-$j/" | grep -oE 'pagecounts-[0-9]+-[0-9]+\.\gz'; done; done | sort | uniq | tee links.txt
cat links.txt | while read link; do wget http://dumps.wikimedia.org/other/pagecounts-raw/$(echo $link | sed -r 's/pagecounts-([0-9]{4})([0-9]{2})[0-9]{2}-[0-9]+\.\gz/\1/')/$(echo $link | sed -r 's/pagecounts-([0-9]{4})([0-9]{2})[0-9]{2}-[0-9]+\.\gz/\1-\2/'); done
ls -1 /opt/wikistat/ | grep gz | while read i; do echo $i; gzip -cd /opt/wikistat/$i | ./wikistat-loader -time="$(echo -n $i | sed -r 's/pagecounts-([0-9]{4})([0-9]{2})([0-9]{2})-[0-9]{2}(([0-9]{2})([0-9]{2}))\.\gz/\1-\2-\3 \4-00-00/')" | clickhouse-client --query="INSERT INTO wikistat FORMAT TabSeparated"; done

```

ترابایت از لگ های کلیک از سرویس Criteo

داده ها را از <http://labs.criteo.com/downloads/download-terabyte-click-logs> دانلود کنید.

جدول را برای لگ ها ایجاد کنید:

```
CREATE TABLE criteo_log (date Date, clicked UInt8, int1 Int32, int2 Int32, int3 Int32, int4 Int32, int5 Int32, int6 Int32, int7 Int32, int8 Int32, int9 Int32, int10 Int32, int11 Int32, int12 Int32, int13 Int32, cat1 String, cat2 String, cat3 String, cat4 String, cat5 String, cat6 String, cat7 String, cat8 String, cat9 String, cat10 String, cat11 String, cat12 String, cat13 String, cat14 String, cat15 String, cat16 String, cat17 String, cat18 String, cat19 String, cat20 String, cat21 String, cat22 String, cat23 String, cat24 String, cat25 String, cat26 String) ENGINE = Log
```

داده ها را دانلود کنید:

```
for i in {00..23}; do echo $i; zcat datasets/criteo/day_${i#0}.gz | sed -r 's/^2000-01-${i/00/24}'\t/' | clickhouse-client --host=example-perftest01j --query="INSERT INTO criteo_log FORMAT TabSeparated"; done
```

یک جدول برای داده های تبدیل شده ایجاد کنید:

```
CREATE TABLE criteo
(
    date Date,
    clicked UInt8,
    int1 Int32,
    int2 Int32,
    int3 Int32,
    int4 Int32,
    int5 Int32,
    int6 Int32,
    int7 Int32,
    int8 Int32,
    int9 Int32,
    int10 Int32,
    int11 Int32,
    int12 Int32,
    int13 Int32,
    icat1 UInt32,
    icat2 UInt32,
    icat3 UInt32,
    icat4 UInt32,
    icat5 UInt32,
    icat6 UInt32,
    icat7 UInt32,
    icat8 UInt32,
    icat9 UInt32,
    icat10 UInt32,
    icat11 UInt32,
    icat12 UInt32,
    icat13 UInt32,
    icat14 UInt32,
    icat15 UInt32,
    icat16 UInt32,
    icat17 UInt32,
    icat18 UInt32,
    icat19 UInt32,
    icat20 UInt32,
    icat21 UInt32,
    icat22 UInt32,
    icat23 UInt32,
    icat24 UInt32,
    icat25 UInt32,
    icat26 UInt32
) ENGINE = MergeTree(date, intHash32(icat1), (date, intHash32(icat1)), 8192)
```

داده ها را از لگ raw انتقال و به جدول دوم وارد کنید:

```

INSERT INTO criteo SELECT date, clicked, int1, int2, int3, int4, int5, int6, int7, int8, int9, int10,
int11, int12, int13, reinterpretAsUInt32(unhex(cat1)) AS icat1, reinterpretAsUInt32(unhex(cat2)) AS icat2,
reinterpretAsUInt32(unhex(cat3)) AS icat3, reinterpretAsUInt32(unhex(cat4)) AS icat4,
reinterpretAsUInt32(unhex(cat5)) AS icat5, reinterpretAsUInt32(unhex(cat6)) AS icat6,
reinterpretAsUInt32(unhex(cat7)) AS icat7, reinterpretAsUInt32(unhex(cat8)) AS icat8,
reinterpretAsUInt32(unhex(cat9)) AS icat9, reinterpretAsUInt32(unhex(cat10)) AS icat10,
reinterpretAsUInt32(unhex(cat11)) AS icat11, reinterpretAsUInt32(unhex(cat12)) AS icat12,
reinterpretAsUInt32(unhex(cat13)) AS icat13, reinterpretAsUInt32(unhex(cat14)) AS icat14,
reinterpretAsUInt32(unhex(cat15)) AS icat15, reinterpretAsUInt32(unhex(cat16)) AS icat16,
reinterpretAsUInt32(unhex(cat17)) AS icat17, reinterpretAsUInt32(unhex(cat18)) AS icat18,
reinterpretAsUInt32(unhex(cat19)) AS icat19, reinterpretAsUInt32(unhex(cat20)) AS icat20,
reinterpretAsUInt32(unhex(cat21)) AS icat21, reinterpretAsUInt32(unhex(cat22)) AS icat22,
reinterpretAsUInt32(unhex(cat23)) AS icat23, reinterpretAsUInt32(unhex(cat24)) AS icat24,
reinterpretAsUInt32(unhex(cat25)) AS icat25, reinterpretAsUInt32(unhex(cat26)) AS icat26 FROM criteo_log;

DROP TABLE criteo_log;

```

بنچمارک Star Schema

از لینک روبرو dbgen رو کامپایل کنید.
<https://github.com/vadimtk/ssb-dbggen>

```

git clone git@github.com:vadimtk/ssb-dbggen.git
cd ssb-dbggen
make

```

در هنگام پردازش چند warnings نمایش داده می شود که مشکلی نیست و طبیعی است.

800 گیگابایت فضای حالی دیسک قرار دهید.

تولید داده ها:

```

./dbgen -s 1000 -T c
./dbgen -s 1000 -T l

```

ساخت جداول در ClickHouse

```

CREATE TABLE lineorder (
    LO_ORDERKEY          UInt32,
    LO_LINENUMBER        UInt8,
    LO_CUSTKEY           UInt32,
    LO_PARTKEY           UInt32,
    LO_SUPPKEY           UInt32,
    LO_ORDERDATE         Date,
    LO_ORDERPRIORITY     String,
    LO_SHIPPRIORITY      UInt8,
    LO_QUANTITY          UInt8,
    LO_EXTENDEDPRICE    UInt32,
    LO_ORDTOTALPRICE    UInt32,
    LO_DISCOUNT          UInt8,
    LO_REVENUE           UInt32,
    LO_SUPPLYCOST        UInt32,
    LO_TAX                UInt8,
    LO_COMMITDATE        Date,
    LO_SHIPMODE           String
)Engine=MergeTree(LO_ORDERDATE, (LO_ORDERKEY, LO_LINENUMBER, LO_ORDERDATE), 8192);

CREATE TABLE customer (
    C_CUSTKEY            UInt32,
    C_NAME                String,
    C_ADDRESS              String,
    C_CITY                String,
    C_NATION               String,
    C_REGION               String,
    C_PHONE                String,
    C_MKTSEGMENT          String,
    C_FAKEDEATE           Date
)Engine=MergeTree(C_FAKEDEATE, (C_CUSTKEY, C_FAKEDEATE), 8192);

CREATE TABLE part (
    P_PARTKEY            UInt32,
    P_NAME                String,
    P_MFGR                String,
    P_CATEGORY             String,
    P_BRAND               String,
    P_COLOR                String,
    P_TYPE                String,
    P_SIZE                UInt8,
    P_CONTAINER             String,
    P_FAKEDEATE           Date
)Engine=MergeTree(P_FAKEDEATE, (P_PARTKEY, P_FAKEDEATE), 8192);

CREATE TABLE lineorderd AS lineorder ENGINE = Distributed(perftest_3shards_1replicas, default, lineorder, rand());
CREATE TABLE customerd AS customer ENGINE = Distributed(perftest_3shards_1replicas, default, customer, rand());
CREATE TABLE partd AS part ENGINE = Distributed(perftest_3shards_1replicas, default, part, rand());

```

برای تست بر روی یک سرور، فقط از جداول MergeTree استفاده کنید. برای تست توزیع شده، شما نیاز به کانفیگ در فایل کانفیگ را دارید. در ادامه جداول MergeTree را در هر سرور ایجاد کنید و موارد بالا را توزیع کنید.

دانلود داده ها (تغییر customerd به customer در نسخه ی توزیع شده):

```

cat customer.tbl | sed 's/$/2000-01-01/' | clickhouse-client --query "INSERT INTO customer FORMAT CSV"
cat lineorder.tbl | clickhouse-client --query "INSERT INTO lineorder FORMAT CSV"

```

Anonymized Yandex.Metrica Data

Dataset consists of two tables containing anonymized data about hits (hits_v1) and visits (visits_v1) of Yandex.Metrica. You can read more about Yandex.Metrica in [ClickHouse history](#) section

The dataset consists of two tables, either of them can be downloaded as a compressed `tsv.xz` file or as prepared partitions. In addition to that, an extended version of the `hits` table containing 100 million rows is available as TSV at

https://clickhouse-datasets.s3.yandex.net/hits/tsv/hits_100m_obfuscated_v1.tsv.xz and as prepared partitions at https://clickhouse-datasets.s3.yandex.net/hits/partitions/hits_100m_obfuscated_v1.tar.xz

Obtaining Tables from Prepared Partitions

:Download and import hits table

```
curl -O https://clickhouse-datasets.s3.yandex.net/hits/partitions/hits_v1.tar
tar xvf hits_v1.tar -C /var/lib/clickhouse # path to ClickHouse data directory
## check permissions on unpacked data, fix if required
sudo service clickhouse-server restart
clickhouse-client --query "SELECT COUNT(*) FROM datasets.hits_v1"
```

:Download and import visits

```
curl -O https://clickhouse-datasets.s3.yandex.net/visits/partitions/visits_v1.tar
tar xvf visits_v1.tar -C /var/lib/clickhouse # path to ClickHouse data directory
## check permissions on unpacked data, fix if required
sudo service clickhouse-server restart
clickhouse-client --query "SELECT COUNT(*) FROM datasets.visits_v1"
```

Obtaining Tables from Compressed TSV File

:Download and import hits from compressed TSV file

```
curl https://clickhouse-datasets.s3.yandex.net/hits/tsv/hits_v1.tsv.xz | unxz --threads=`nproc` >
hits_v1.tsv
## now create table
clickhouse-client --query "CREATE DATABASE IF NOT EXISTS datasets"
clickhouse-client --query "CREATE TABLE datasets.hits_v1 ( WatchID UInt64, JavaEnable UInt8, Title
String, GoodEvent Int16, EventTime DateTime, EventDate Date, CounterID UInt32, ClientIP UInt32,
ClientIP6 FixedString(16), RegionID UInt32, UserID UInt64, CounterClass Int8, OS UInt8, UserAgent
UInt8, URL String, Referer String, URLDomain String, RefererDomain String, Refresh UInt8, IsRobot
UInt8, RefererCategories Array(UInt16), URLCategories Array(UInt16), URLRegions Array(UInt32),
RefererRegions Array(UInt32), ResolutionWidth UInt16, ResolutionHeight UInt16, ResolutionDepth UInt8,
FlashMajor UInt8, FlashMinor UInt8, FlashMinor2 String, NetMajor UInt8, NetMinor UInt8, UserAgentMajor
UInt16, UserAgentMinor FixedString(2), CookieEnable UInt8, JavascriptEnable UInt8, IsMobile UInt8,
MobilePhone UInt8, MobilePhoneModel String, Params String, IPNetworkID UInt32, TraficSourceID Int8,
SearchEngineID UInt16, SearchPhrase String, AdvEngineID UInt8, IsArtifical UInt8, WindowClientWidth
UInt16, WindowClientHeight UInt16, ClientTimeZone Int16, ClientEventTime DateTime, SilverlightVersion1
UInt8, SilverlightVersion2 UInt8, SilverlightVersion3 UInt32, SilverlightVersion4 UInt16, PageCharset
String, CodeVersion UInt32, IsLink UInt8, IsDownload UInt8, IsNotBounce UInt8, FUniqID UInt64, HID
UInt32, IsOldCounter UInt8, IsEvent UInt8, IsParameter UInt8, DontCountHits UInt8, WithHash UInt8,
HitColor FixedString(1), UTCEventTime DateTime, Age UInt8, Sex UInt8, Income UInt8, Interests UInt16,
Robotness UInt8, GeneralInterests Array(UInt16), RemoteIP UInt32, RemoteIP6 FixedString(16), WindowName
Int32, OpenerName Int32, HistoryLength Int16, BrowserLanguage FixedString(2), BrowserCountry
FixedString(2), SocialNetwork String, SocialAction String, HTTPError UInt16, SendTiming Int32,
DNSTiming Int32, ConnectTiming Int32, ResponseStartTiming Int32, ResponseEndTiming Int32, FetchTiming
Int32, RedirectTiming Int32, DOMInteractiveTiming Int32, DOMContentLoadedTiming Int32, DOMCompleteTiming
Int32, LoadEventStartTiming Int32, LoadEventEndTiming Int32, NSToDOMContentLoadedTiming Int32,
FirstPaintTiming Int32, RedirectCount Int8, SocialSourceNetworkID UInt8, SocialSourcePage String,
ParamPrice Int64, ParamOrderID String, ParamCurrency FixedString(3), ParamCurrencyID UInt16, GoalsReached
Array(UInt32), OpenstatServiceName String, OpenstatCampaignID String, OpenstatAdID String,
OpenstatSourceID String, UTMSource String, UTMMedium String, UTMCampaign String, UTMContent String,
UTMTerm String, FromTag String, HasGCLID UInt8, RefererHash UInt64, URLHash UInt64, CLID UInt32, YCLID
UInt64, ShareService String, ShareURL String, ShareTitle String, ParsedParams Nested(Key1 String, Key2
String, Key3 String, Key4 String, Key5 String, ValueDouble Float64), IslandID FixedString(16),
RequestNum UInt32, RequestTry UInt8) ENGINE = MergeTree() PARTITION BY toYYYYMM(EventDate) ORDER BY
(CounterID, EventDate, intHash32(UserID)) SAMPLE BY intHash32(UserID) SETTINGS index_granularity = 8192"
## import data
cat hits_v1.tsv | clickhouse-client --query "INSERT INTO datasets.hits_v1 FORMAT TSV" --
max_insert_block_size=100000
## optionally you can optimize table
clickhouse-client --query "OPTIMIZE TABLE datasets.hits_v1 FINAL"
clickhouse-client --query "SELECT COUNT(*) FROM datasets.hits_v1"
```

:Download and import visits from compressed tsv-file

```
curl https://clickhouse-datasets.s3.yandex.net/visits/tsv/visits_v1.tsv.xz | unxz --threads=`nproc` > visits_v1.tsv
## now create table
clickhouse-client --query "CREATE DATABASE IF NOT EXISTS datasets"
clickhouse-client --query "CREATE TABLE datasets.visits_v1 ( CounterID UInt32, StartDate Date, Sign Int8, IsNew UInt8, VisitID UInt64, UserID UInt64, StartTime DateTime, Duration UInt32, UTCStartTime DateTime, PageViews Int32, Hits Int32, IsBounce UInt8, Referer String, StartURL String, RefererDomain String, StartURLDomain String, EndURL String, LinkURL String, IsDownload UInt8, TraficSourceID Int8, SearchEngineID UInt16, SearchPhrase String, AdvEngineID UInt8, PlaceID Int32, RefererCategories Array(UInt16), URLCategories Array(UInt16), URLRegions Array(UInt32), RefererRegions Array(UInt32), IsYandex UInt8, GoalReachesDepth Int32, GoalReachesURL Int32, GoalReachesAny Int32, SocialSourceNetworkID UInt8, SocialSourcePage String, MobilePhoneModel String, ClientEventTime DateTime, RegionID UInt32, ClientIP UInt32, ClientIP6 FixedString(16), RemoteIP UInt32, RemoteIP6 FixedString(16), IPNetworkID UInt32, SilverlightVersion3 UInt32, CodeVersion UInt32, ResolutionWidth UInt16, ResolutionHeight UInt16, UserAgentMajor UInt16, UserAgentMinor UInt16, WindowClientWidth UInt16, WindowClientHeight UInt16, SilverlightVersion2 UInt8, SilverlightVersion4 UInt16, FlashVersion3 UInt16, FlashVersion4 UInt16, ClientTimeZone Int16, OS UInt8, UserAgent UInt8, ResolutionDepth UInt8, FlashMajor UInt8, FlashMinor UInt8, NetMajor UInt8, NetMinor UInt8, MobilePhone UInt8, SilverlightVersion1 UInt8, Age UInt8, Income UInt8, JavaEnable UInt8, CookieEnable UInt8, JavascriptEnable UInt8, IsMobile UInt8, BrowserLanguage UInt16, BrowserCountry UInt16, Interests UInt16, Robotness UInt8, GeneralInterests Array(UInt16), Params Array(String), Goals Nested(ID UInt32, Serial UInt32, EventTime DateTime, Price Int64, OrderID String, CurrencyID UInt32), WatchIDs Array(UInt64), ParamSumPrice Int64, ParamCurrency FixedString(3), ParamCurrencyID UInt16, ClickLogID UInt64, ClickEventID Int32, ClickGoodEvent Int32, ClickEventTime DateTime, ClickPriorityID Int32, ClickPhraseID Int32, ClickPageID Int32, ClickPlaceID Int32, ClickTypeID Int32, ClickResourceID Int32, ClickCost UInt32, ClickClientIP UInt32, ClickDomainID UInt32, ClickURL String, ClickAttempt UInt8, ClickOrderID UInt32, ClickBannerID UInt32, ClickMarketCategoryID UInt32, ClickMarketPP UInt32, ClickMarketCategoryName String, ClickMarketPPName String, ClickAWAPSCampaignName String, ClickPageName String, ClickTargetType UInt16, ClickTargetPhraseID UInt64, ClickContextType UInt8, ClickSelectType Int8, ClickOptions String, ClickGroupBannerID Int32, OpenstatServiceName String, OpenstatCampaignID String, OpenstatAdID String, OpenstatSourceID String, UTMSource String, UTMMedium String, UTMCampaign String, UTMContent String, UTMTerm String, FromTag String, HasGCLID UInt8, FirstVisit DateTime, PredLastVisit Date, LastVisit Date, TotalVisits UInt32, TraficSource Nested(ID Int8, SearchEngineID UInt16, AdvEngineID UInt8, PlaceID UInt16, SocialSourceNetworkID UInt8, Domain String, SearchPhrase String, SocialSourcePage String), Attendance FixedString(16), CLID UInt32, YCLID UInt64, NormalizedRefererHash UInt64, SearchPhraseHash UInt64, RefererDomainHash UInt64, NormalizedStartURLHash UInt64, StartURLDomainHash UInt64, NormalizedEndURLHash UInt64, TopLevelDomain UInt64, URLscheme UInt64, OpenstatServiceNameHash UInt64, OpenstatCampaignIDHash UInt64, OpenstatAdIDHash UInt64, OpenstatSourceIDHash UInt64, UTMSourceHash UInt64, UTMMediumHash UInt64, UTMCampaignHash UInt64, UTMCContentHash UInt64, UTMTermHash UInt64, FromHash UInt64, WebVisorEnabled UInt8, WebVisorActivity UInt32, ParsedParams Nested(Key1 String, Key2 String, Key3 String, Key4 String, Key5 String, ValueDouble Float64), Market Nested(Type UInt8, GoalID UInt32, OrderID String, OrderPrice Int64, PP UInt32, DirectPlaceID UInt32, DirectOrderID UInt32, DirectBannerID UInt32, GoodID String, GoodName String, GoodQuantity Int32, GoodPrice Int64), IslandID FixedString(16)) ENGINE = CollapsingMergeTree(StartDate, intHash32(UserID), (CounterID, StartDate, intHash32(UserID), VisitID), 8192, Sign)"
## import data
cat visits_v1.tsv | clickhouse-client --query "INSERT INTO datasets.visits_v1 FORMAT TSV" --
max_insert_block_size=100000
## optionally you can optimize table
clickhouse-client --query "OPTIMIZE TABLE datasets.visits_v1 FINAL"
clickhouse-client --query "SELECT COUNT(*) FROM datasets.visits_v1"
```

Example Queries

ClickHouse tutorial is based on Yandex.Metrica dataset and the recommended way to get started with this dataset is to just go through tutorial

Additional examples of queries to these tables can be found among stateful tests of ClickHouse (they are named test.hists .(and test.visits there

رابط ها

دو اینترفیس شبکه را فراهم می کند (هر دو می توانند به صورت اختیاری در TLS برای امنیت اضافی پیچیده شوند):

- **HTTP**, که مستند شده و به راحتی به طور مستقیم استفاده می شود.
- **TCP**, که دارای سریار کمتر است.

اگرچه در بیشتر موارد توصیه می شود از ابزار یا کتابخانه مناسب استفاده کنید تا به طور مستقیم با آن ها ارتباط برقرار نکنید. به طور رسمی توسط یانداکس پشتیبانی می شوند عبارتند از: **خط فرمان خط رانده JDBC** **ODBC** **++ کتابخانه مشتری**

همچنین برای کار با ClickHouse طیف گسترده ای از کتابخانه های شخص ثالث وجود دارد: **کتابخانه های مشتری ادغام * رابط های بصری**

کلاینت Command-line

برای کار از طریق محیط ترمینال میتوانید از دستور `clickhouse-client` استفاده کنید

```
$ clickhouse-client
ClickHouse client version 0.0.26176.
Connecting to localhost:9000.
Connected to ClickHouse server version 0.0.26176.

:)
```

کلاینت از آپشن های command-line و فایل های کانفیگ پشتیبانی می کند. برای اطلاعات بیشتر بخش "پیکربندی" را مشاهده کنید.

استفاده

کلاینت می تواند به دو صورت non-interactive (batch) و interactive (batch) استفاده قرار گیرد. برای استفاده از حالت `batch`, پارامتر `query` را مشخص کنید، و یا داده ها ره به `stdin` ارسال کنید (کلاینت تایید می کند که `stdin` ترمینال نیست) و یا از هر 2 استفاده کنید. مشابه HTTP interface، هنگامی که از پارامتر `query` و ارسال داده ها به `stdin` استفاده می کنید، درخواست، ترکیبی از پارامتر `query`، و داده ها در `stdin` است. این کار برای های بزرگ `INSERT` مناسب است.

مثالی از استفاده کلاینت برای اجرای دستور `INSERT` داده

```
echo -ne "1, 'some text', '2016-08-14 00:00:00'\n2, 'some more text', '2016-08-14 00:00:01'" | clickhouse-client --database=test --query="INSERT INTO test FORMAT CSV";

cat <<_EOF | clickhouse-client --database=test --query="INSERT INTO test FORMAT CSV";
3, 'some text', '2016-08-14 00:00:00'
4, 'some more text', '2016-08-14 00:00:01'
_EOF

cat file.csv | clickhouse-client --database=test --query="INSERT INTO test FORMAT CSV";
```

در حالت Batch، فرمت داده ها به صورت پیش فرض به صورت TabSeparated می باشد. شما میتوانید فرمت داده ها رو در هنگام اجرای `query` و با استفاده از شرط `FORMAT` مشخص کنید.

به طور پیش فرض شما فقط می توانید یک `query` را در حالت `batch` اجرا کنید. برای ساخت چندین `query` از یک "اسکریپت"، از پارامتر `multิquery` استفاده کنید. این روش برای تمام `query` ها به جز `INSERT` کار می کند. نتایج `query` ها به صورت متوالی و بدون `separator` اضافه تولید می شوند. به طور مشابه برای پردازش تعداد زیادی از `query` ها می توانید از 'clickhouse-client' برای هر `query` استفاده کنید. دقیقاً کمک است حدود 10 میلی ثانیه تا زمان راه اندازی برنامه 'clickhouse-client' زمان گرفته شود.

در حالت `interactive`، شما یک `command line` برای درج `query` های خود دریافت می کنید.

اگر 'multiline' مشخص نشده باشد (به صورت پیش فرض): برای اجرای یک `query`، دکمه `Enter` را بزنید. سیمی کالن در انتهای `query` اجباری نیست. برای درج یک `query` چند خطی (multiline)، دکمه `یک اسلش \` را قبل از `line feed` فشار دهید. بعد از فشردن `Enter`، از شما برای درج خط بعدی `query` درخواست خواهد شد.

اگر چند خطی (multiline) مشخص شده باشد: برای اجرای `query`، در انتهای سیمی کالن را وارد کنید و سپس `Enter` بزنید. اگر سیمی کالن از انتهای خط حذف می شد، از شما برای درج خط جدید `query` درخواست می شد.

نها یک query اجرا می شود. پس همه چیز بعد از سیمی کالن ignore می شود.

شما میتوانید از `G\` به جای سیمی کالن یا بعد از سیمی کالن استفاده کنید. این علامت، فرمت Vertical را نشان می دهد. در این فرمت، هر مقدار در یک خط جدا چاپ می شود که برای جداول عریض مناسب است. این ویژگی غیرمعمول برای سازگاری با MySQL CLI اضافه شد.

برای پایه command line 'readline' (و 'history' یا 'libedit') یا بدون کتابخانه بسته به (build) می باشد. به عبارت دیگر، این محیط از `shortcuts` های آشنا استفاده می کند و history دستورات را نگه می دارد. history ها در فایل `~/clickhouse-client-history` نوشته می شوند.

به صورت پیش فرض فرمت خروجی PrettyCompact می باشد. شما میتوانید از طریق دستور `FORMAT` در یک query، یا با مشخص کردن `G\` در انتهای query، استفاده از آرگومان های `format` یا `vertical` یا از کانفیگ فایل کلاینت، فرمت خروجی را مشخص کنید.

برای خروج از کلاینت، `Ctrl+C` (یا `Ctrl-D`) را فشار دهید؛ یا یکی از دستورات زیر را به جای اجرای query اجرا کنید:

```
""logout", "exit;", "quit;", "logout;", "q", "Q", ":q
```

در هنگام اجرای یک query، کلاینت موارد زیر را نمایش می دهد:

1. `Progress`، که بیش از 10 بار در ثانیه بروز نخواهد شد (به صورت پیش فرض). برای query های سریع، `progress` ممکن است زمانی برای نمایش پیدا نکند.

2. فرمت کردن query بعد از عملیات پارس کردن، به منظور دیباگ کردن query.

3. نمایش خروجی با توجه به نوع فرمت.

4. تعداد لاین های خروجی، زمان پاس شدن query، و میانگیم سرعت پردازش query.

شما میتوانید query های طولانی را با فشردن `Ctrl-C` کنسل کنید. هر چند، بعد از این کار همچنان نیاز به انتظار چند ثانیه ای برای قطع کردن درخواست توسط سرور می باشد. امکان کنسل کردن یک query در مراحل خاص وجود ندارد. اگر شما صبر نکنید و برای بار دوم `Ctrl+C` را وارد کنید از client خارج می شوید.

کلاینت اجازه ی پاس دادن داده های external (جداول موقت) را برای query ها می دهد. برای اطلاعات بیشتر به بخش "داده های External" برای پردازش "query" مراجعه کنید.

پیکربندی

شما میتوانید، پارامتر ها را به `clickhouse-client` (تمام پارامترها دارای مقدار پیش فرض هستند) از دو روش زیر پاس بدید:

- از طریق Command Line

گزینه های Command-line مقادیر پیش فرض در سینیگ و کانفیگ فایل را نادیده میگیرد.

- کانفیگ فایل ها.

سینیگ های داخل کانفیگ فایل، مقادیر پیش فرض را نادیده میگرد.

گزینه های Command line

- `-h--host` – نام سرور، به صورت پیش فرض 'localhost' است. شما میتوانید یکی از موارد نام و یا IPv4 و یا IPv6 را در این گزینه مشخص کنید.

- `-port--port` – پورت اتصال به ClickHouse. مقدار پیش فرض: 9000. دقت کنید که پرت اینترفیس HTTP و اینترفیس native متفاوت است.

- `-user--default` – نام کاربری جهت اتصال. پیش فرض: `default`.

- `-password--password` – پسورد جهت اتصال. پیش فرض: خالی

- `-non-interactive--query` – مشخص کردن query برای پردازش در هنگام استفاده از حالت non-interactive.

- `-database--d` – انتخاب دیتابیس در بدو ورود به کلاینت. مقدار پیش فرض: دیتابیس مشخص شده در تنظیمات سرور (پیش فرض `'default'`)

- اگر مشخص شود، یعنی اجازه‌ی نوشتن query‌های چند خطی را بده. (بعد از Enter، query را ارسال نکن). `multiline, -m--`
- اگر مشخص شود، اجازه‌ی اجرای چندین query که از طریق جمع و حلقه‌ها جدا شده‌اند را می‌دهد. فقط در حالت non-interactive کار می‌کند. `multiquery, -n--`
- مشخص کردن نوع فرمت خروجی `format, -f--`
- اگر مشخص شود، از فرمت Vertical برای نمایش خروجی استفاده می‌شود. این گزینه مشابه `'format=Vertical'` می‌باشد. در این فرمت، هر مقدار در یک خط جدید چاپ می‌شود، که در هنگام نمایش جداول عربی مفید است. `vertical, -E--`
- اگر مشخص شود، در حالت non-interactive زمان اجرای query در `'stderr'` چاپ می‌شود. `time, -t--`
- اگر مشخص شود stack trace مربوط به اجرای query در هنگام رخدادن یک exception در `'stacktrace--'`
- نام فایل پیکربندی. `config-file--`

فایل‌های پیکربندی

clickhouse-client به ترتیب اولویت زیر از اولین فایل موجود برای سمت کردن تنظیمات استفاده می‌کند:

- مشخص شده در پارامتر config-file--
- `clickhouse-client.xml/.~\`
- `clickhouse-client/config.xml./~\`
- `etc/clickhouse-client/config.xml/`

مثالی از یک کانفیگ فایل

```
<config>
  <user>username</user>
  <password>password</password>
</config>
```

رابط بومی (TCP)

پروتکل بومی در [خط فرمان خط] (cli.md)، برای برقراری ارتباط بین سرور در طی پردازش پرس و جو توزیع شده، و همچنین در سایر برنامه‌های C++ استفاده می‌شود. متأسفانه، پروتکل ClickHouse بومی هنوز مشخصات رسمی ندارد، اما می‌توان آن را از کد منبع (شروع از اینجا) و / یا با رهگیری و تجزیه و تحلیل ترافیک ClickHouse TCP.

HTTP interface

به شما امکان استفاده از ClickHouse در هر پلتفرم با هر زمان برنامه نویسی را می‌دهد. ما از این Interface برای زبان‌های Java و Perl به مانند shell استفاده می‌کنیم. در دیگر دپارتمان‌ها، Python، Go و HTTP interface در اینجا محدود‌تر از native interface می‌باشد، اما سازگاری بهتری دارد.

به صورت پیش‌فرض، clickhouse-server به پرت 8123 در HTTP گوش می‌دهد. (میتوانه در کانفیگ فایل تغییر پیدا کنه). اگر شما یک درخواست GET / بدون پارامتر بسازید، رشته‌ی "Ok". را دریافت می‌کنید (به همراه line feed در انتهای آن). شما می‌توانید از این درخواست برای اسکریپت‌های health-check استفاده کنید.

```
$ curl 'http://localhost:8123/'
```

درخواست‌های خود را پارامتر 'query'، یا با متدهای POST، یا با متدهای query را در پارامتر 'query' ارسال کنید، و بقیه را در POST (بعداً توضیح خواهیم داد که چرا این کار ضروری است). سایت URL محدود به 16 کیلوبایت است، پس هنگام ارسال query‌های بزرگ، اینها به حافظه داشته باشید

اگر درخواست موفق آمیز باشد، استاتوس کد 200 را دریافت می‌کنید و نتایج در بدنه response می‌باشد. اگر اروری رخداد، استاتوس کد 500 را دریافت می‌کنید و توضیحات ارور در بدنه response قرار می‌گیرد.

در هنگام استفاده از متد 'GET', 'readonly' است می شود. به عبارت دیگر، برای query هایی که قصد تغییر دیتا را دارند، شما فقط از طریق متد POST می توانید این تغییرات را انجام دهید. شما میتوانید query را در بدن میتوانید POST یا به عنوان پارامتر های URL ارسال کنید.

مثال:

```
$ curl 'http://localhost:8123/?query=SELECT%201'
1

$ wget -O- -q 'http://localhost:8123/?query=SELECT 1'
1

$ echo -ne 'GET /?query=SELECT%201 HTTP/1.0\r\n\r\n' | nc localhost 8123
HTTP/1.0 200 OK
Connection: Close
Date: Fri, 16 Nov 2012 19:21:50 GMT

1
```

همانطور که می بینید، curl is somewhat inconvenient in that spaces must be URL escaped. هر چند wget همه چیز را خودش escape می کنه، ما توصیه به استفاده از اون رو نمی کنیم، چون wget به خوبی با HTTP 1.1 keep-alive را از هدر های Transfer-Encoding: chunked و

```
$ echo 'SELECT 1' | curl 'http://localhost:8123/' --data-binary @-
1

$ echo 'SELECT 1' | curl 'http://localhost:8123/?query=' --data-binary @-
1

$ echo '1' | curl 'http://localhost:8123/?query=SELECT' --data-binary @-
1
```

اگر بخشی از query در پارامتر ارسال شود، و بخش دیگر در POST، یک line feed بین دو بخش وارد می شود. مثال (این کار نمی کند):

```
$ echo 'ECT 1' | curl 'http://localhost:8123/?query=SEL' --data-binary @-
Code: 59, e.displayText() = DB::Exception: Syntax error: failed at position 0: SEL
ECT 1
, expected One of: SHOW TABLES, SHOW DATABASES, SELECT, INSERT, CREATE, ATTACH, RENAME, DROP, DETACH, USE,
SET, OPTIMIZE., e.what() = DB::Exception
```

به صورت پیش فرض، داده ها با فرمت TabSeparated بر میگردند. (برای اطلاعات بیشتر بخش "فرمت" را مشاهده کنید). شما میتوانید از دستور FORMAT در query خود برای ساخت فرمتی دیگر استفاده کنید.

```
$ echo 'SELECT 1 FORMAT Pretty' | curl 'http://localhost:8123/?' --data-binary @-
1
1
```

برای query های INSERT متد POST ضروری است. در این مورد، شما می توانید ابتدای query خود را در URL parameter بنویسید، و از POST برای پاس داده داده ها برای درج می تواند، برای درج می تواند، برای مثال یک دامپ tab-separated شده از MySQL باشد. به این ترتیب، query INSERT جایگزین LOAD DATA LOCAL INFILE از MySQL می شود.

مثال: ساخت جدول

```
echo 'CREATE TABLE t (a UInt8) ENGINE = Memory' | curl 'http://localhost:8123/' --data-binary @-
```

استفاده از query INSERT برای درج داده:

```
echo 'INSERT INTO t VALUES (1),(2),(3)' | curl 'http://localhost:8123/' --data-binary @-
```

داده ها میتوانند جدا از پارامتر query ارسال شوند:

```
echo '(4),(5),(6)' | curl 'http://localhost:8123/?query=INSERT%20INTO%20t%20VALUES' --data-binary @-
```

شما می توانید هر نوع فرمت دینایی مشخص کنید. فرمت 'Values' دقیقا مشابه زمانی است که شما INSERT INTO t VALUES را می نویسید:

```
echo '(7),(8),(9)' | curl 'http://localhost:8123/?query=INSERT%20INTO%20t%20FORMAT%20Values' --data-binary @-
```

برای درج داده ها از یک دامپ tab-separate، فرمت مشخص زیر را وارد کنید:

```
echo -ne '10\n11\n12\n' | curl 'http://localhost:8123/?query=INSERT%20INTO%20t%20FORMAT%20TabSeparated' --data-binary @-
```

به دلیل پردازش موازی، نتایج query با ترتیب رندوم چاپ می شود:

```
$ curl 'http://localhost:8123/?query=SELECT%20a%20FROM%20t'  
7  
8  
9  
10  
11  
12  
1  
2  
3  
4  
5  
6
```

حذف جدول:

```
echo 'DROP TABLE t' | curl 'http://localhost:8123/' --data-binary @-
```

برای درخواست هایی موفقی که داده ای از جدول بر نمیگردد، بدن response خالی است.

شما می توانید از فرمت فشرده سازی داخلی ClickHouse در هنگان انتقال داده ها استفاده کنید. این فشرده سازی داده، یک فرمت غیراستاندارد است، و شما باید از برنامه مخصوص فشرده سازی ClickHouse برای استفاده از آن استفاده کنید. (این برنامه در هنگام نصب پکیج clickhouse-client نصب شده است)

اگر شما در URL پارامتر 'compress=1' را قرار دهید، سرور داده های ارسالی به شما را فشرده سازی می کند. اگر شما پارامتر 'decompress=1' را در URL ست کنید، سرور داده های ارسالی توسط متده POST را decompress می کند.

همچنین استفاده از فشرده سازی استاندارد gzip در HTTP ممکن است. برای ارسال درخواست POST و فشرده سازی آن به صورت gzip، هدر Content-Encoding: gzip را به request خود اضافه کنید. برای اینکه ClickHouse، response فشرده شده به صورت gzip برای شما ارسال کند، ابتدا باید ClickHouse را در تنظیمات enable_http_compression فعال کنید و در ادامه هدر Accept-Encoding: gzip را به درخواست خود اضافه کنید.

شما می توانید از این کار برای کاهش ترافیک شبکه هنگام ارسال مقدار زیادی از داده ها یا برای ایجاد dump هایی که بلا فاصله فشرده می شوند، استفاده کنید.

شما می توانید از پارامتر 'database' در URL برای مشخص کردن دیتابیس پیش فرض استفاده کنید.

```
$ echo 'SELECT number FROM numbers LIMIT 10' | curl 'http://localhost:8123/?database=system' --data-binary @-
0
1
2
3
4
5
6
7
8
9
```

به صورت پیش فرض، دیتابیس ثبت شده در تنظیمات سرور به عنوان دیتابیس پیش فرض مورد استفاده قرار می گیرد، این دیتابیس 'default' نامیده می شود. از سوی دیگر، شما می توانید همیشه نام دیتابیس را با دات و قبل از اسم جدول مشخص کنید.

نام کاربری و پسورد می توانند به یکی از دو روش زیر سمت شوند:

1. استفاده از HTTP Basic Authentication مثال:

```
echo 'SELECT 1' | curl 'http://user:password@localhost:8123/' -d @-
```

1. با دو پارامتر 'user' و 'password' در URL مثال:

```
echo 'SELECT 1' | curl 'http://localhost:8123/?user=user&password=password' -d @-
```

اگر نام کاربری مشخص نشود، نام کاربری 'default' استفاده می شود. اگر پسورد مشخص نشود، پسورد خالی استفاده می شود. شما همچنین می توانید از پارامتر های URL برای مشخص کردن هر تنظیمی برای اجرای یک query استفاده کنید. مثال:

```
http://localhost:8123/?profile=web&max_rows_to_read=1000000000&query=SELECT+1
```

برای اطلاعات بیشتر بخش "تنظیمات" را مشاهده کنید.

```
$ echo 'SELECT number FROM system.numbers LIMIT 10' | curl 'http://localhost:8123/?' --data-binary @-
0
1
2
3
4
5
6
7
8
9
```

برای اطلاعات بیشتر در مورد دیگر پارامترها، بخش "SET" را بینید.

به طور مشابه، شما می توانید از ClickHouse Session در HTTP استفاده کنید. برای این کار، شما نیاز به سمت کردن پارامتر session_id برای درخواست را دارید. شما میتوانید از هر رشته ای برای سمت کردن Session ID استفاده کنید. به صورت پیش فرض، یک session بعد از 60 ثانیه از اجرای آخرین درخواست نابود می شود. برای تغییر زمان timeout، باید default_session_timeout را در تنظیمات سرور تغییر دهید و یا پارامتر session_timeout در هنگام درخواست سمت کنید. برای بررسی وضعیت status از پارامتر session_check=1 استفاده کنید. با یک session query تنها یک query در لحظه می توان اجرا کرد.

گزینه ای برای دریافت اطلاعات progress اجرای query وجود دارد. این گزینه هدر X-ClickHouse-Progress می باشد. برای این کار تنظیم send_progress_in_http_headers در کانفیگ فایل فعال کنید.

درخواست در حال اجرا، در صورت لاست شدن کانکشن HTTP به صورت اتوماتیک متوقف نمی شود. پارس کردن و فرمات کردن داده ها در سمت سرور صورت می گیرد، و استفاده از شبکه ممکن است ناکارآمد باشد. پارامتر 'query_id' می تونه به عنوان id query پاس داده شود (هر رشته ای قابل قبول است). برای اطلاعات بیشتر بخش "تنظیمات" را مشاهده کنید.

پارامتر 'quofo_key' می تواند به عنوان quofo key پاس داده شود (هر رشته ای قابل قبول است). برای اطلاعات بیشتر بخش "Quotas" را مشاهده کنید.

اجازه‌ی پاس دادن داده‌های external (جداول موقت query) به برای اطلاعات بیشتر، بخش "داده‌های External برای پردازش query را مشاهده کنید.

بافرینگ Response

شما می‌توانید در سمت سرور قابلی بافرینگ response را فعال کنید. پارامترهای `buffer_size` و `wait_end_of_query` در URL برای این هدف ارائه شده‌اند.

تعیین کننده‌ی اندازه‌ی نتیجه (بایت) برای بافر شدن در حافظه سرور است. اگر بدنی نتیجه بیش بزرگتر از این `buffer_size` باشد، بافر بر روی HTTP channel نوشته می‌شود و باقی مانده‌ی دینا به صورت مستقیم به HTTP Channel ارسال می‌شود.

برای اینکه مطمئن بشید که کل response بافر شده است، `wait_end_of_query=1` را سمت کنید. در این مورد، داده‌های که در حافظه ذخیره نمی‌شوند، در یک فایل موقت سمت سرور بافر می‌شوند.

مثال:

```
curl -sS 'http://localhost:8123/?max_result_bytes=4000000&buffer_size=3000000&wait_end_of_query=1' -d  
'SELECT toUInt8(number) FROM system.numbers LIMIT 9000000 FORMAT RowBinary'
```

از بافرینگ به منظور اجتناب از شرایطی که یک خطای پردازش query رخ داده بعد از response کد و هدرهای ارسال شده به کلاینت استفاده کنید. در این شرایط، پیغام خطا در انتهای بندе response نوشته می‌شود، و در سمت کلاینت، پیغام خطا فقط از طریق مرحله پارس کردن قابل شناسایی است.

فرمت‌های Input و Output

فرمت تعیین می‌کند که چگونه داده‌ها پس از اجرای SELECT (چگونه نوشته شده و چگونه توسط سرور فرمت شده) به شما بر می‌گردد، و چگونه آن برای INSERT‌ها پذیرفته شده (چگونه آن توسط سرور پارس و خوانده می‌شود).

جدول زیر لیست فرمت‌های پشتیبانی شده برای هر نوع از query‌ها را نمایش می‌دهد.

SELECT	INSERT	Format
✓	✓	TabSeparated
✓	✗	TabSeparatedRaw
✓	✓	TabSeparatedWithNames
✓	✓	TabSeparatedWithNamesAndTypes
✓	✓	Template
✗	✓	TemplateIgnoreSpaces
✓	✓	CSV
✓	✓	CSVWithNames
✓	✓	Values
✓	✗	Vertical
✓	✗	VerticalRaw
✓	✗	JSON
✓	✗	JSONCompact
✓	✓	JSONEachRow
✓	✓	TSKV
✓	✗	Pretty
✓	✗	PrettyCompact
✓	✗	PrettyCompactMonoBlock
✓	✗	PrettyNoEscapes
✓	✗	PrettySpace
✓	✓	RowBinary
✓	✓	Native
✓	✗	Null
✓	✗	XML
✓	✓	CapnProto

TabSeparated

در فرمت TabSeparated، داده ها به صورت سطر نوشته می شوند. هر سطر شامل مقادیر جدا شده با tab می باشد. هر مقدار با یک دنبال می شود، به جز آخرین مقدار یک سطر، که با line feed unix در همه جا مورد تسافده قرار می

گیرد. آخرین سطر از خروجی هم باید شامل `line feed` باشد. مقادیر در فرمت متى بدون `enclose` با کوتیشن، و یا `escape` با کاراکترهای ویژه، نوشته می شوند.

اعداد `Integer` با فرم `decimal` نوشته می شوند. اعداد می توانند شامل کاراکتر اضافه "+" در ابتدای خود باشند. (در هنگام پارس کردن نادیده گرفته می شوند، و در هنگام فرمت کردن، ثبت نمی شوند). اعداد غیر منفی نمیتوانند شامل علامت منفی باشند. در هنگام خواندن، اجازه داده می شود که رشته خالی را به عنوان صفر، پارس کرد، یا (برای تایپ های sign) یک رشته که شامل فقط یک علامت منفی است به عنوان صفر پارس کرد. اعدادی که در `data type` مربوطه فیت نشوند ممکن است به عددی متفاوت تبدیل شوند و پیغام خطایی هم نمایش ندهند.

اعداد `Floating-point` به فرم `decimal` نوشته می شوند. از دات به عنوان جدا کننده `decimal` استفاده می شود. نوشته های نمایشی مثل "'nan'", "'inf'", '+inf', '-inf' پشتیبانی می شوند. ورودی اعداد `floating-point` می تواند با یه نقطه اعشار شروع یا پایان باید. در هنگام فرمت، دقت اعداد `floating-point` ممکن است گم شوند. در هنگام پارس کردن، دقیقا نیازی به خواندن نزدیکترین عدد-machine-representable نیست.

Dates با فرمت `YYYY-MM-DD` نوشته می شوند و به همین حالت پارس می شوند، اما با هر کاراکتری به عنوان جدا کننده. Dates همراه زمان با فرمت `YYYY-MM-DD hh:mm:ss` نوشته می شوند و با همین فرمت پارس می شوند، اما با هر کاراکتری به عنوان جدا کننده. این در منطقه زمان سیستم در زمانی که کلاینت یا سرور شروع می شود (بسته به اینکه کدام یک از داده ها را تشکیل می دهد) رخ می دهد. برای تاریخ همراه با زمان DST مشخص نمی شود. پس اگر یک دامپ دارای زمان DST باشد، دامپ، داده ها را به طور غیرمستقیم مطابقت نمی دهد و پارسینگ، یکی از دو ساعت را انتخاب خواهد کرد. در طول عملیات خواندن، تاریخ ها و تاریخ و ساعت های نادرست می توانند به صورت `null` و یا `natural overflow` پارس شوند، بدون اینکه پیغام خطایی نمایش دهنند.

به عنوان یک استثنا، پارس کردن تاریخ به همراه ساعت، اگر مقدار دقیقا شامل 10 عدد `decimal` باشد، به عنوان فرمت `unix timestamp` پشتیبانی خواهد کرد. خروجی وابسته به `time-zone` نمی باشد. فرمت های `mm: ss` یا `YYYY-MM-DD hh: mm: ss` به صورت خودکار تمایز می یابند.

رشته های دارای کاراکتر های ویژه `backslash-escaped` های در ادامه برای خروجی استفاده می شوند: \b, \t, \n, \r, \f, \v, \l, \a, \w, \xHH (hex escape) و هر \e پشتیبانی می کند. بدین ترتیب خواندن داده ها از فرمت `line feed` که می تواند به صورت \n یا \v نوشته شود پشتیبانی می کند. برای مثال، رشته `Hello world` به همراه `line feed` بین کلمات به جای `space` می تواند به هر یک از حالات زیر پارس شود:::

```
Hello\nworld
Hello\
world
```

نوع دوم به دلیل پشتیبانی MySQL در هنگام نوشتن دامپ به صورت `tab-separate`, `tab`, پشتیبانی می شود.

حداقل مجموعه از کاراکترهایی که در هنگام پاس دادن داده در فرمت `TabSeparate` نیاز به آن دارید: (LF, tab, line feed) یک اسلش.

فقط مجموعه ای کمی از نماد ها `escape` می شوند. شما به راحتی می توانید بر روی مقدار رشته که در ترمینال شما در خروجی نمایش داده می شود حرکت کنید.

آرایه ها به صورت لیستی از مقادیر که به `comma` از هم جدا شده اند و در داخل برآکت قرار گرفته اند نوشته می شوند. آیتم های عددی در آرای به صورت نرمال فرمت می شوند، اما تاریخ و تاریخ با ساعت و رشته ها در داخل تک کوتیشن به همراه قوانین `escape` که بالا اشاره شد، نوشته می شوند.

فرمت `TabSeparate` برای پردازش داده ها با استفاده از برنامه های شخصی سازی شده و اسکریپت ها مناسب است. به صورت پیش فرض در `HTTP interface` و در حالت `batch` کلاینت `command-line` مورد استفاده قرار می گیرد. همچنین این فرمت اجازه ای انتقال داده ها بین DBMS های مختلف را می دهد. برای مثال، شما می توانید از MySQL با این روش دامپ بگیرید و آن را در vice versa آپلود کنید یا ClickHouse

فرمت `TabSeparated` از خروجی `total values` (هنگام استفاده از `TOTALS`) و `'extreme values'` (در هنگامی که 'extreme' با 1 است) پشتیبانی می کند. در این موارد، `extreme` و `total value` بعد از داده های اصلی در خروجی می آیند. نتایج اصلی، `total` و `extreme` همگی با یک `empty line` از هم جدا می شوند. مثال:

```
SELECT EventDate, count() AS c FROM test.hits GROUP BY EventDate WITH TOTALS ORDER BY EventDate FORMAT  
TabSeparated``
```

2014-03-17	1406958
2014-03-18	1383658
2014-03-19	1405797
2014-03-20	1353623
2014-03-21	1245779
2014-03-22	1031592
2014-03-23	1046491
0000-00-00	8873898
2014-03-17	1031592
2014-03-23	1406958

این فرمت نیز تحت نام TSV موجود است.

TabSeparatedRaw

تفاوت آن با TabSeparated در این است که در این فرمت سطرها بدون escape نوشته می شوند. این فرمت فقط مناسب خروجی نتایج query ها می باشد، نه برای پارس کردن (دریافت داده ها و درج آن در جدول).

همچنین این فرمت تحت عنوان TSVRaw وجود دارد.

TabSeparatedWithNames

تفاوت آن با فرمت TabSeparated در این است که، در این فرمت نام ستون ها در سطر اول قرار می گیرد. در طول پارس کردن، سطر اول به طور کامل نادیده گرفته می شود. شما نمی توانید نام ستون ها را برای تعیین موقعیت آنها یا بررسی صحت آنها استفاده کنید. (پشتیبانی از پارس کردن سطر header ممکن است در آینده اضافه شود).

همچنین این فرمت تحت عنوان TSVWithNames وجود دارد.

TabSeparatedWithNamesAndTypes

تفاوت آن با TabSeparated در این است که در این فرمت نام ستون ها در سطر اول نوشته می شود، و type ستون ها در سطر دوم نوشته می شود. در طی پارسینگ، سطر اول و دوم به طور کامل نادیده گرفته می شوند.

همچنین این فرمت تحت عنوان TSVWithNamesAndTypes وجود دارد.

Template

This format allows to specify a custom format string with placeholders for values with specified escaping rule

It uses settings `format_schema` , `format_schema_rows` , `format_schema_rows_between_delimiter` and some settings of other formats (e.g. `output_format_json_quote_64bit_integers` when using `JSON` escaping, see further

:Format string `format_schema_rows` specifies rows format with the following syntax

, delimiter_1\${column_1:serializeAs_1}delimiter_2\${column_2:serializeAs_2} ... delimiter_N

where `delimiter_i` is a delimiter between values (\$ symbol can be escaped as \$\$), `column_j` is a name of a column whose values are to be selected or inserted (if empty, then column will be skipped), `serializeAs_j` is an escaping rule for the column values. The following escaping rules are supported

(CSV , JSON , XML (similarly to the formats of the same names •

(Escaped (similarly to TSV •

(Quoted (similarly to Values •

(Raw (without escaping, similarly to TSVRaw •

(None (no escaping rule, see further •

.If escaping rule is omitted, then `None` will be used. `XML` and `Raw` are suitable only for output

:So, for the following format string

```
`Search phrase: ${SearchPhrase:Quoted}, count: ${c:Escaped}, ad price: ${${price:JSON}};`
```

the values of `SearchPhrase`, `c` and `price` columns, which are escaped as `Quoted`, `Escaped` and `JSON` will be printed (for select) or will be expected (for insert) between `Search phrase:`, `,`, `count:`, `,`, `ad price:$` and `;` delimiters respectively. For :example

```
;Search phrase: 'bathroom interior design', count: 2166, ad price: $3
```

The `format_schema_rows_between_delimiter` setting specifies delimiter between rows, which is printed (or expected) after (every row except the last one (`\n` by default

Format string `format_schema` has the same syntax as `format_schema_rows` and allows to specify a prefix, a suffix and a :way to print some additional information. It contains the following placeholders instead of column names

`data` is the rows with data in `format_schema_rows` format, separated by `format_schema_rows_between_delimiter`. This •
.placeholder must be the first placeholder in the format string

(`totals` is the row with total values in `format_schema_rows` format (when using `WITH TOTALS`) •

(`min` is the row with minimum values in `format_schema_rows` format (when extremes is set to 1) •

(`max` is the row with maximum values in `format_schema_rows` format (when extremes is set to 1) •

`rows` is the total number of output rows •

`rows_before_limit` is the minimal number of rows there would have been without `LIMIT`. Output only if the query •
contains `LIMIT`. If the query contains `GROUP BY`, `rows_before_limit_at_least` is the exact number of rows there would
.have been without a `LIMIT`

`time` is the request execution time in seconds •

`rows_read` is the number of rows have been read •

`bytes_read` is the number of bytes (uncompressed) have been read •

The placeholders `data`, `totals`, `min` and `max` must not have escaping rule specified (or `None` must be specified explicitly).
The remaining placeholders may have any escaping rule specified. If the `format_schema` setting is an empty string, `${data}`
is used as default value. For insert queries format allows to skip some columns or some fields if prefix or suffix (see
.example

: Select example

```

SELECT SearchPhrase, count() AS c FROM test.hits GROUP BY SearchPhrase ORDER BY c DESC LIMIT 5
FORMAT Template
SETTINGS format_schema = '<!DOCTYPE HTML>
<html> <head> <title>Search phrases</title> </head>
<body>
<table border="1"> <caption>Search phrases</caption>
  <tr> <th>Search phrase</th> <th>Count</th> </tr>
  ${data}
</table>
<table border="1"> <caption>Max</caption>
  ${max}
</table>
<b>Processed ${rows_read:XML} rows in ${time:XML} sec</b>
</body>
</html>',
format_schema_rows = '<tr> <td>${SearchPhrase:XML}</td> <td>${c:XML}</td> </tr>',
format_schema_rows_between_delimiter = '\n  '

```

```

<!DOCTYPE HTML>
<html> <head> <title>Search phrases</title> </head>
<body>
<table border="1"> <caption>Search phrases</caption>
  <tr> <th>Search phrase</th> <th>Count</th> </tr>
  <tr> <td></td> <td>8267016</td> </tr>
  <tr> <td>bathroom interior design</td> <td>2166</td> </tr>
  <tr> <td>yandex</td> <td>1655</td> </tr>
  <tr> <td>spring 2014 fashion</td> <td>1549</td> </tr>
  <tr> <td>freeform photos</td> <td>1480</td> </tr>
</table>
<table border="1"> <caption>Max</caption>
  <tr> <td></td> <td>8873898</td> </tr>
</table>
<b>Processed 3095973 rows in 0.1569913 sec</b>
</body>
</html>

```

: Insert example

```

Some header
Page views: 5, User id: 4324182021466249494, Useless field: hello, Duration: 146, Sign: -1
Page views: 6, User id: 4324182021466249494, Useless field: world, Duration: 185, Sign: 1
Total rows: 2

```

```

INSERT INTO UserActivity FORMAT Template SETTINGS
format_schema = 'Some header\n${data}\nTotal rows: ${:CSV}\n',
format_schema_rows = 'Page views: ${PageViews:CSV}, User id: ${UserID:CSV}, Useless field: ${:CSV},
Duration: ${Duration:CSV}, Sign: ${Sign:CSV}'

```

PageViews , UserID , Duration and Sign inside placeholders are names of columns in the table. Values after Useless field in rows and after \nTotal rows: in suffix will be ignored. All delimiters in the input data must be strictly equal to delimiters in .specified format strings

TemplateIgnoreSpaces

This format is suitable only for input. Similar to Template , but skips whitespace characters between delimiters and values in the input stream. However, if format strings contain whitespace characters, these characters will be expected in the input stream. Also allows to specify empty placeholders (\${} or \${:None}) to split some delimiter into separate parts to ignore spaces between them. Such placeholders are used only for skipping whitespace characters. It's possible to read JSON using this format, if values of columns have the same order in all rows. For example, the following request can be used for inserting data from output example of format JSON

```

INSERT INTO table_name FORMAT TemplateIgnoreSpaces SETTINGS
format_schema = '{${}"meta"${{}:${}:JSON},${{}"data"${{}:${}:JSON}
[${}data]}${{}:${}:"totals"${{}:${}:JSON},${{}"extremes"${{}:${}:JSON},${{}"rows"${{}:${}:JSON},${{}"rows_before_limit_at_
format_schema_rows = '${{}"SearchPhrase"${{}:${}:JSON}${{}:${}:phrase:JSON}${{}:${}:"c"${{}:${}:cnt:JSON}${{}:${}:}}',
format_schema_rows_between_delimiter = ', '

```

TSKV

مشابه فرمت TabSeparated، اما خروجی به صورت name=value می باشد. نام ها مشابه روش TabSeparated، escape می شوند و همچنین escape هم symbol می شود.

```

SearchPhrase= count()=8267016
SearchPhrase=bathroom interior design count()=2166
SearchPhrase=yandex count()=1655
SearchPhrase=spring 2014 fashion count()=1549
SearchPhrase=freeform photos count()=1480
SearchPhrase=angelina jolia count()=1245
SearchPhrase=omsk count()=1112
SearchPhrase=photos of dog breeds count()=1091
SearchPhrase=curtain design count()=1064
SearchPhrase=baku count()=1000

```

وقتی تعداد زیادی از ستون ها وجود دارد، این فرمت بی فایده است، و در حالت کلی دلیلی بر استفاده از این فرمت در این موقع وجود ندارد. این فرمت در بعضی از دیارتمان های Yandex استفاده می شد.

خروجی داده ها و پارس کردن هر دو در این فرمت پشتیبانی می شوند. برای پارس کردن، هر ترتیبی برای مقادیر ستون های مختلف پشتیبانی می شود. حذف بعضی از مقادیر قابل قبول است. این مقادیر با مقادیر پیش فرض خود برابر هستند. در این مورد، صفر و سطر خالی، توسط مقادیر پیش فرض پر می شوند. مقادیر پیچیده ای که می توانند در جدول مشخص شود به عنوان پیش فرض در این فرمت پشتیبانی نمی شوند.

پارس کردن، اجازه می دهد که فیلد اضافه `i` بدون علامت و مقدار وجود داشته باشد. این فیلد نادیده گرفته می شود.

CSV

.(Comma Separated Values format ([RFC](#)

زمانی که از این روش برای فرمت استفاده می شود، سطر ها با دابل کوتیشن داخل یک رشته خروجی آن به صورت دو دابل کوتیشن در یک سطر است. قانون دیگری برای escape کردن کاراکترها وجود ندارد. تاریخ و تاریخ ساعت در دابل کوتیشن ها `enclosed` می شوند. اعداد بدون دابل کوتیشن در خروجی می آیند. مقادیر با جدا کننده * مشخص می شوند. سطر ها با استفاده از (LF) (line feed) جدا می شوند. آرایه ها در csv به این صورت می شوند: ابتدا آرایه به یک رشته با فرمت TabSeparate سریالایز می شوند، و سپس رشته i حاصل در دابل کوتیشن برای csv ارسال می شود. Tuple ها در فرمت CSV در ستون های جدا سریالایز می شوند (به این ترتیب، nest ها در table از دست می روند)

```
clickhouse-client --format_csv_delimiter="|" --query="INSERT INTO test.csv FORMAT CSV" < data.csv
```

* به صورت پیش فرض — . برای اطلاعات بیشتر [format_csv_delimiter](#) را بینید.

در هنگام پارس کردن، تمامی مقادیر می توانند با کوتیشن یا بدون کوتیشن پارس شوند. تک کوتیشن و دابل کوتیشن پشتیبانی می شود. سطر ها می توانند بدون کوتیشن تنظیم شوند. در این مورد سطر ها، جدا کننده ها با (LF) یا (CR) پارس می شوند. در موارد نقض RFC در هنگام پارس کردن سطر ها بدون کوتیشن، فضاهای tab های پیشین نادید گرفته می شوند. برای `line feed`، یونیکس از (LF)، ویدنوو از (CR LF) و Mac OS (CR LF) کلاسیک (CR LF) پشتیبانی می کند.

فرمت CSV خروجی total و extreme را همانند TabSeparated پشتیبانی می کند.

CSVWithNames

همچنین header را چاپ می کند، شبیه به .TabSeparatedWithNames

JSON

خروجی داده ها با فرمت JSON. در کنال داده های جداول، خروجی JSON اسم ستون ها و type آنها به همراه اطلاعات بیشتر تولید می کند: تعداد سطر های خروجی، و همچنین تعداد رکورد های کل بدون در نظر گرفتن دستور LIMIT. مثال:

```
SELECT SearchPhrase, count() AS c FROM test.hits GROUP BY SearchPhrase WITH TOTALS ORDER BY c DESC LIMIT 5
FORMAT JSON
```

```

{
  "meta": [
    {
      "name": "SearchPhrase",
      "type": "String"
    },
    {
      "name": "c",
      "type": "UInt64"
    }
  ],
  "data": [
    {
      "SearchPhrase": "",
      "c": "8267016"
    },
    {
      "SearchPhrase": "bathroom interior design",
      "c": "2166"
    },
    {
      "SearchPhrase": "yandex",
      "c": "1655"
    },
    {
      "SearchPhrase": "spring 2014 fashion",
      "c": "1549"
    },
    {
      "SearchPhrase": "freeform photos",
      "c": "1480"
    }
  ],
  "totals": [
    {
      "SearchPhrase": "",
      "c": "8873898"
    }
  ],
  "extremes": [
    {
      "min": {
        "SearchPhrase": "",
        "c": "1480"
      },
      "max": {
        "SearchPhrase": "",
        "c": "8267016"
      }
    }
  ],
  "rows": 5,
  "rows_before_limit_at_least": 141137
}

```

JSON با جاوااسکریپت سازگار است. برای اطمینان از این، بعضی از کاراکتر ها escape های اضافه دارند: اسلش / به صورت \ می شود؛ line break جایگزین یعنی U+2028 و U+2029 که باعث break می شود، به شکل \uXXXX\ escape می شوند. کاراکتر های کنترلی ASCII هم escape می شوند: carriage return، form feed، line feed، horizontal tab به ترتیب با \r، \n، \f، \t، \b، \a جایگزین می شوند. همچنین بایت های باقی مانده در محدوده 00 تا 1F با استفاده از \uXXXX\ جایگزین می شوند. کاراکتر های بی اعتبار UTF-8 با \u202A جایگزین می شوند، پس خروجی JSON شامل موارد معتبر UTF-8 می باشد. برای سازگاری با جاوااسکریپت، اعداد Int64 و Uint64 به صورت پیش فرض، با استفاده از دابل کوتیشن enclose می شوند. برای حذف کوتیشن، شما باید پارامتر output_format_json_quote_64bit_integers را برابر با 0 قرار دهید.

rows – تعداد سطر های خروجی

rows حداقل تعداد سطر ها در هنگام عدم استفاده از LIMIT. فقط در هنگامی که دارای query است rows_before_limit_at_least خروجی دارد. اگر query شامل GROUP BY باشد، مقدار rows_before_limit_at_least دقیقا با زمانی که از LIMIT استفاده نمی شود یکی است.

totals – مقدار TOTAL (زمانی که از WITH TOTALS استفاده می شود).

extreme – مقدار Extreme (در هنگامی که برابر با 1 است).

این فرمت فقط مناسب خروجی query های می باشد، به این معنی که برای عملیات پارس کردن (دستیابی داده برای insert در جدول) نیست. همچنین فرمت JSONEachRow را ببینید.

JSONCompact

فقط در جاهایی که داده ها به جای array در object در هستند خروجی آنها متفاوت است.

مثال:

```
{  
  "meta":  
  [  
    {  
      "name": "SearchPhrase",  
      "type": "String"  
    },  
    {  
      "name": "c",  
      "type": "UInt64"  
    }  
  ],  
  
  "data":  
  [  
    [ "", "8267016"],  
    [ "bathroom interior design", "2166"],  
    [ "yandex", "1655"],  
    [ "spring 2014 fashion", "1549"],  
    [ "freeform photos", "1480"]  
  ],  
  
  "totals": [ "", "8873898"],  
  
  "extremes":  
  {  
    "min": [ "", "1480"],  
    "max": [ "", "8267016"]  
  },  
  
  "rows": 5,  
  
  "rows_before_limit_at_least": 141137  
}
```

این فرمت فقط مناسب خروجی query های می باشد، به این معنی که برای عملیات پارس کردن (دستیابی داده برای insert در جدول) نیست. همچنین فرمت JSONEachRow را ببینید.

JSONEachRow

هر سطر برای خود JSON Object جدا دارد. (با استفاده از newline, JSON تعريف می شوند.)

```

{"SearchPhrase": "", "count()": "8267016"}
 {"SearchPhrase": "bathroom interior design", "count()": "2166"}
 {"SearchPhrase": "yandex", "count()": "1655"}
 {"SearchPhrase": "spring 2014 fashion", "count()": "1549"}
 {"SearchPhrase": "freeform photo", "count()": "1480"}
 {"SearchPhrase": "angelina jolie", "count()": "1245"}
 {"SearchPhrase": "omsk", "count()": "1112"}
 {"SearchPhrase": "photos of dog breeds", "count()": "1091"}
 {"SearchPhrase": "curtain design", "count()": "1064"}
 {"SearchPhrase": "baku", "count()": "1000"}

```

برخلاف فرمت JSON، هیچ جایگزینی برای کاراکتر های بی اعتبار UTF-8 وجود ندارد. هر مجموعه ای از بایت های می تواند داخل سطر در خروجی باشند. پس داده ها بدون از دست دادن هیچ اطلاعاتی فرمت می شوند. مقادیر شبیه به escape JSON می شوند.

برای پارس کردن، هر ترتیبی برای مقادیر ستون های مختلف پشتیبانی می شود. حذف شدن بعضی مقادیر قابل قبول است، آنها با مقادیر پیش فرض خود برابر هستند. در این مورد، صفر و سطر های خالی به عنوان مقادیر پیش فرض قرار می گیرند. مقادیر پیچیده که می توانند در جدول مشخص شوند، به عنوان مقادیر پیش فرض پشتیبانی نمی شوند. Whitespace element بین داده ها نادیده گرفته می شوند. اگر کاما بعد از object ها قرار گیرند، نادیده گرفته می شوند. object ها نیازی به جداسازی با استفاده از new line را ندارند.

Usage of Nested Structures

If you have a table with the **Nested** data type columns, you can insert JSON data having the same structure. Enable this functionality with the `input_format_import_nested_json` setting

:For example, consider the following table

```
CREATE TABLE json_each_row_nested (n Nested (s String, i Int32) ) ENGINE = Memory
```

As you can find in the `Nested` data type description, ClickHouse treats each component of the nested structure as a separate column, `n.s` and `n.i` for our table. So you can insert the data the following way

```
INSERT INTO json_each_row_nested FORMAT JSONEachRow {"n.s": ["abc", "def"], "n.i": [1, 23]}
```

.To insert data as hierarchical JSON object set `input_format_import_nested_json=1`

```
{
  "n": {
    "s": ["abc", "def"],
    "i": [1, 23]
  }
}
```

.Without this setting ClickHouse throws the exception

```
SELECT name, value FROM system.settings WHERE name = 'input_format_import_nested_json'
```

name	value
input_format_import_nested_json	0

```
INSERT INTO json_each_row_nested FORMAT JSONEachRow {"n": {"s": ["abc", "def"], "i": [1, 23]}}
```

Code: 117. DB::Exception: Unknown field found while parsing JSONEachRow format: n: (at row 1)

```
SET input_format_import_nested_json=1
INSERT INTO json_each_row_nested FORMAT JSONEachRow {"n": {"s": ["abc", "def"], "i": [1, 23]}}
SELECT * FROM json_each_row_nested
```

n.s	n.i
['abc', 'def']	[1,23]

Native

کارآمدترین فرمت. داده ها تو سط بلاک ها و در فرمت با این نو شته و خوانده می شوند. برای هر بلاک، تعداد سط ها، تعداد ستون ها، نام ستون ها و آنها، و بخش هایی از ستون ها در این بلاک یکی پس از دیگر ثبت می شوند. به عبارت دیگر، این فرمت "columnar" است - این فرمت ستون ها را به سطر تبدیل نمی کند. این فرمت در حالت native interface و بین سرور و محیط ترمینال همچنین کلاینت C++ استفاده می شود.

شما می توانید از این فرمت برای تهیه دامپ سریع که فقط تو سط مدیریت دیتابیس ClickHouse قابل خواندن است استفاده کنید. برای استفاده از این فرمت برای خودتان منطقی نیست.

Null

هیچی در خروجی نمایش داده نمی شود. با این حال، query پردازش می شود، و زمانی که از کلایت command-line استفاده می کنید، داده ها برای کلاینت ارسال می شوند. از این برای تست، شامل تست بهره وری استفاده می شود. به طور مشخص، این فرمت فقط برای خروجی مناسب است نه برای پارس کردن.

Pretty

خروجی داده ها به صورت جداول Unicode-art ANSI-escape برای تنظیم رنگ های ترمینال. یک جدول کامل کشیده می شود، و هر سطر دو خط از ترمینال را اشغال می کند. هر بلاک نتیجه، به عنوان یک جدول جدا چاپ می شود. پس بلاک ها می توانند بدون بافر کردن نتایج چاپ شوند (با فرینگ برای pre-calculate تمام مقادیر قابل مشاهده ضروری است). برای جلوگیری از دامپ زیاد داده ها در ترمینال، 10 هزار سطر اول چاپ می شوند. اگر تعداد سط های بزرگتر مساوی 10 هزار باشد، پیغام "10 هزار اول نمایش داده شد" چاپ می شود. این فرمت فقط مناسب خروجی نتایج query ها می باشد، نه برای پارس کردن (دریافت داده ها و درج آن در جدول).

فرمت Pretty از total values (هنگام استفاده از WITH TOTALS) و extreme values (هنگام که 'extremes' برابر با 1 است) برای خروجی پشتیبانی می کند. در این موارد، بعد از نمایش داده های اصلی در جداول جدا، چاپ می شوند. مثال (برای فرمت PrettyCompact نمایش داده شده است):

```
SELECT EventDate, count() AS c FROM test.hits GROUP BY EventDate WITH TOTALS ORDER BY EventDate FORMAT PrettyCompact
```

EventDate	c
2014-03-17	1406958
2014-03-18	1383658
2014-03-19	1405797
2014-03-20	1353623
2014-03-21	1245779
2014-03-22	1031592
2014-03-23	1046491

Totals:

EventDate	c
0000-00-00	8873898

Extremes:

EventDate	c
2014-03-17	1031592
2014-03-23	1406958

PrettyCompact

تفاوت آن با Pretty در این است که grid های کشیده شده بین سطرها و خروجی فشرده تر است. این فرمت به صورت پیش فرض در محیط کلاینت در حالت interactive مورد استفاده قرار می گیرد.

PrettyCompactMonoBlock

تفاوت آن با PrettyCompact در این است که 10 هزار سطر خروجی بافر می شوند، و سپس در یک جدول چاپ می شوند. نه به صورت بلاک.

PrettyNoEscapes

تفاوت آن با Pretty در این است که از ANSI-escape استفاده نمی کند. این برای نمایش این فرمت در مرورگر ضروری است، و همچنین برای استفاده از دستور 'watch' ضروری است.

مثال:

```
watch -n1 "clickhouse-client --query='SELECT event, value FROM system.events FORMAT PrettyCompactNoEscapes'"
```

شما می توانید برای نمایش در مرورگر از interface HTTP استفاده کنید.

PrettyCompactNoEscapes

همانند تنظیم قبلی می باشد.

PrettySpaceNoEscapes

همانند تنظیم قبلی می باشد..

PrettySpace

تفاوت آن با PrettyCompact در این است که از whitespace (کاراکتر های space) به جای grid استفاده می کند.

RowBinary

فرمت ها و پارس کردن داده ها، براساس سطر در فرمت باینری است. سطرها و مقادیر به صورت پیوسته و بدون جدا کننده لیست می شوند. این فرمت کم کارآمد تر از فرمت native است، از آنجایی که ردیف گرا است.

اعداد Integers از fixed-length استفاده می کنند. برای مثال UInt64 از 8 بایت استفاده می کند. DateTime از UInt32 که شامل مقدار Unix Timestamp است استفاده می کند. Date از UInt16 که شامل تعداد روز از تاریخ 1-1-1970 است استفاده می کند. String به عنوان variant length نشان داده می شود (unsigned LEB128)، که دنباله ای از بایت های یک رشته هستند. FixedString به سادگی به عنوان توالی از بایت ها نمایش داده می شود.

آرایه به عنوان variant length نشان داده می شود (unsigned LEB128)، دنباله ای از عناصر پیوسته آرایه

Values

هر سطر داخل براکت چاپ می شود. سطرها توسط comma جدا می شوند. برای آخرین سطر comma وجود ندارد. مقادیر داخل براکت همچنین توسط comma جدا می شوند. اعداد با فرمت decimal و بدون کوتیشن چاپ می شوند. آرایه ها در براکت ها چاپ می شوند. رشته ها، تاریخ و تاریخ با ساعت داخل کوتیشن قرار می گیرند. قوانین escape و پارس کردن شبیه به فرمت TabSeparated انجام می شود. در طول فرمت، extra spaces در نمی شوند، اما در هنگام پارس کردن، آنها مجاز و skip می شوند. (به جز space های داخل مقادیر آرایه، که مجاز نیستند).

حداقل کاراکترهای که شما در هنگام پاس داده ها برای escape نیاز دارید: تک کوتیشن و بک اسلش.

این فرمت برای دستور `... INSERT INTO t VALUES` مورد استفاده قرار می‌گیرد، اما همچنین شما می‌توانید برای فرمت نتایج query استفاده کنید.

Vertical

مقدار هر ستون به همراه نام ستون در سطر جداگانه چاپ می‌شود. اگر هر سطر شامل تعداد زیادی ستون است، این فرمت جهت چاپ چند سطر مناسب است. این فرمت فقط مناسب خروجی نتایج query ها می‌باشد، نه برای پارس کردن (دریافت داده‌ها و درج آن در جدول).

VerticalRaw

تفاوت آن با `Vertical` در این است که سطرها escape نمی‌شوند. این فرمت فقط مناسب خروجی نتایج query ها می‌باشد، نه برای پارس کردن (دریافت داده‌ها و درج آن در جدول).

مثال:

```
:) SHOW CREATE TABLE geonames FORMAT VerticalRaw;
Row 1:
_____
statement: CREATE TABLE default.geonames ( geonameid UInt32, date Date DEFAULT CAST('2017-12-08' AS Date))
ENGINE = MergeTree(date, geonameid, 8192)

:) SELECT 'string with \'quotes\' and \t with some special \n characters' AS test FORMAT VerticalRaw;
Row 1:
_____
test: string with 'quotes' and   with some special
characters
```

در مقایسه با فرمت `Vertical`

```
:) SELECT 'string with \'quotes\' and \t with some special \n characters' AS test FORMAT Vertical;
Row 1:
_____
test: string with \"quotes\" and \t with some special \n characters
```

XML

فرمت XML فقط برای خروجی مناسب است، نه برای پارس کردن. مثال:

```

<?xml version='1.0' encoding='UTF-8' ?>
<result>
    <meta>
        <columns>
            <column>
                <name>SearchPhrase</name>
                <type>String</type>
            </column>
            <column>
                <name>count()</name>
                <type>UInt64</type>
            </column>
        </columns>
    </meta>
    <data>
        <row>
            <SearchPhrase></SearchPhrase>
            <field>8267016</field>
        </row>
        <row>
            <SearchPhrase>bathroom interior design</SearchPhrase>
            <field>2166</field>
        </row>
        <row>
            <SearchPhrase>yandex</SearchPhrase>
            <field>1655</field>
        </row>
        <row>
            <SearchPhrase>spring 2014 fashion</SearchPhrase>
            <field>1549</field>
        </row>
        <row>
            <SearchPhrase>freeform photos</SearchPhrase>
            <field>1480</field>
        </row>
        <row>
            <SearchPhrase>angelina jolie</SearchPhrase>
            <field>1245</field>
        </row>
        <row>
            <SearchPhrase>omsk</SearchPhrase>
            <field>1112</field>
        </row>
        <row>
            <SearchPhrase>photos of dog breeds</SearchPhrase>
            <field>1091</field>
        </row>
        <row>
            <SearchPhrase>curtain design</SearchPhrase>
            <field>1064</field>
        </row>
        <row>
            <SearchPhrase>baku</SearchPhrase>
            <field>1000</field>
        </row>
    </data>
    <rows>10</rows>
    <rows_before_limit_at_least>141137</rows_before_limit_at_least>
</result>

```

اگر نام فیلد، فرمت قابل قبولی نداشته باشد، اسم 'field' به عنوان نام عنصر استفاده می شود. به طور کلی، ساختار XML مشابه ساختار JSON می باشد. فقط در JSON، موارد بی اعتبار UTF-8 تبدیل به کاراکتر ♦ می شوند که منجر به خروجی معنیز ۸ می شود.

در مقادیر رشته ای، کاراکتر های < و & به صورت < و & escape می شوند.

آرایه ها به شکل tuple<elem>Hello</elem>> و array<elem>Hello</elem><elem>World</elem>...</array> ها به صورت <> در خروجی می آیند.

یک فرمت پیام باینری شبیه به Protocol Buffer و Thrift می باشد، اما شبیه به MessagePack یا JSON نیست. بیگانه های Cap'n Proto به صورت self-describing نیستند، به این معنی که آنها نیاز دارند که به صورت external schema آنها شرح داده شود. schema به صورت on the fly اضافه می شود و برای هر query, cache می شود.

```
SELECT SearchPhrase, count() AS c FROM test.hits
GROUP BY SearchPhrase FORMAT CapnProto SETTINGS schema = 'schema:Message'
```

جایی که schema.capnp شبیه این است:

```
struct Message {
    SearchPhrase @0 :Text;
    c @1 :Uint64;
}
```

فایل های Schema در فایلی قرار دارند که این فایل در دایرکتوری مشخص شده کانفیگ format_schema_path قرار گرفته اند. عملیات Deserialization موثر است و معمولاً لود سیستم را افزایش نمی دهد.

درایور JDBC

درایور رسمی JDBC برای ClickHouse وجود دارد. برای اطلاعات بیشتر [اینجا](#) را بینید.

درایور JDBC توسط سازمان های دیگر اجرا می شوند.

[ClickHouse-Native-JDBC](#) •

درایور ODBC

درایور رسمی ODBC برای ClickHouse وجود دارد. برای اطلاعات بیشتر [اینجا](#) را بینید.

C++ Client Library

.See README at [clickhouse-cpp](#) repository

کتابخانه های مشتری شخص ثالث

سلب مسئولیت

Yandex نه حفظ کتابخانه ها در زیر ذکر شده و نشده انجام هر آزمایش های گستردگی برای اطمینان از کیفیت آنها.

[Python](#) •

[infi.clickhouse_orm](#) •

[clickhouse-driver](#) •

[clickhouse-client](#) •

[PHP](#) •

[phpClickHouse](#) •

[clickhouse-php-client](#) •

- [clickhouse-client](#) •
- [PhpClickHouseClient](#) •
- Go •
- [clickhouse](#) •
- [go-clickhouse](#) •
- [mailru-go-clickhouse](#) •
- [golang-clickhouse](#) •
- NodeJS •
- ([clickhouse \(NodeJS\)](#) •
- [node-clickhouse](#) •
- Perl •
- [perl-DBD-ClickHouse](#) •
- [HTTP-ClickHouse](#) •
- [AnyEvent-ClickHouse](#) •
- Ruby •
- ([ClickHouse \(Ruby\)](#) •
- R •
- [clickhouse-r](#) •
- [RClickhouse](#) •
- Java •
- [clickhouse-client-java](#) •
- Scala •
- [clickhouse-scala-client](#) •
- Kotlin •
- [AORM](#) •
- #C •
- [ClickHouse.Ado](#) •
- [ClickHouse.Net](#) •
- [ClickHouse.Client](#) •
- Elixir •
- [clickhouseex](#) •
- Nim •
- [nim-clickhouse](#) •

ما این کتابخانه ها را تست نکردیم. آنها به صورت تصادفی انتخاب شده اند.

کتابخانه ادغام ثالث

سلب مسئولیت 

Yandex نه حفظ کتابخانه ها در زیر ذکر شده و نشده انجام هر آزمایش های گسترشده ای برای اطمینان از کیفیت آنها.

محصولات زیربنایی

• سیستم های مدیریت پایگاه داده رابطه ای

MySQL •

ProxySQL •

clickhouse-mysql-data-reader •

horgh-replicator •

PostgreSQL •

clickhousedb_fdw •

(infi.clickhouse_orm) استفاده می کند infi.clickhouse_fdw •

pg2ch •

MSSQL •

ClickHouseMigrator •

صف پیام •

Kafka •

(Go client) استفاده می کند clickhouse_sinker •

فروشگاه شی •

S3 •

clickhouse-backup •

ارکیتراسیون کانتینر •

Kubernetes •

clickhouse-operator •

مدیریت تنظیمات •

puppet •

innogames/clickhouse •

mfedotov/clickhouse •

ناظارت بر •

Graphite •

graphouse •

+ carbon-clickhouse •

graphite-clickhouse •

graphite-ch-optimizer - optimizes stale partitions in *GraphiteMergeTree if rules from rollup configuration could be applied •

Grafana •

clickhouse-grafana •

Prometheus •

clickhouse_exporter •

PromHouse •

Nagios •

check_clickhouse •

Zabbix •
clickhouse-zabbix-template •
Semantext •
ادغام clickhouse •
ثبت نام •
rsyslog •
omclickhouse •
fluentd •
(Kubernetes برای) loghouse •
logagent •
logagent output-plugin-clickhouse •
جغرافیایی •
MaxMind •
clickhouse-maxmind-geoip •

اکوسیستم زبان برنامه نویسی

Python •
SQLAlchemy •
(infi.clickhouse_orm استفاده می کند sqlalchemy-clickhouse •
pandas •
pandahouse •
R •
dplyr •
(clickhouse-cpp استفاده می کند RClickhouse •
Java •
Hadoop •
(JDBC استفاده می کند clickhouse-hdfs-loader •
Scala •
Akka •
clickhouse-scala-client •
#C •
ADO.NET •
ClickHouse.Ado •
ClickHouse.Net •
ClickHouse.Net.Migrations •
Elixir •
Ecto •
clickhouse_ecto •

third-party visual interface های توسعه دهنگان

متن باز

Tabix

ClickHouse در پروژه Tabix تحت وب برای interface

ویژگی ها:

- کار با ClickHouse به صورت مستقیم و از طریق مرورگر، بدون نیاز به نرم افزار اضافی.
- ادیتور query به همراه syntax highlighting.
- ویژگی Auto-completion برای دستورات.
- ابزارهایی برای آنالیز گرافیکی اجرای query.
- گزینه های Color scheme.

مستندات Tabix

HouseOps

نرم افزار Desktop برای سیستم عامل های Windows و OSX و Linux می باشد..

ویژگی ها:

- ابزار Query builder به همراه syntax highlighting.
- خروجی نتایج به صورت JSON Object و CSV.
- نمایش Processes List ها به همراه توضیحات، ویژگی حالت record و kill کردن ها.
- نمودار دیتابیس به همراه تمام جداول و ستون ها به همراه اطلاعات اضافی.
- نمایش آسان سایز ستون ها.
- تنظیمات سرور.
- مدیریت دیتابیس (بزودی);
- مدیریت کاربران (بزودی);
- آنالیز داده ها به صورت Real-Time (بزودی);
- مانیتورینگ کلستر/برساخت (بزودی);
- مدیریت کلستر (بزودی);
- مانیتورینگ کافکا و جداول replicate (بزودی);
- و بسیاری از ویژگی های دیگر برای شما.

LightHouse

رابط کاربری سیک وزن برای ClickHouse است.

امکانات:

- لیست جدول با فیلتر کردن و ابرداده.
- پیش نمایش جدول با فیلتر کردن و مرتب سازی.
- اعداد نمایش داده شده فقط خواندنی

DBeaver

ClickHouse - مشتری دسکتاپ دسکتاپ با پشتیبانی

امکانات:

- توسعه پرس و جو با برجسته نحو
- پیش نمایش جدول
- تکمیل خودکار

clickhouse-cli

یک مشتری خط فرمان برای ClickHouse است که در پایتون 3 نوشته شده است.

امکانات: - تکمیل خودکار - نحو برجسته برای نمایش داده ها و خروجی داده ها. - پشتیبانی از Pager برای خروجی داده. - دستورات پست سفارشی مانند PostgreSQL.

clickhouse-flamegraph

.flamegraph یک ابزار تخصصی برای تجسم است system.trace_log مانند clickhouse-flamegraph

تجاری

DataGrip

پایگاه داده از JetBrains DataGrip IDE با پشتیبانی اختصاصی برای ClickHouse است. این ابزار همچنین به سایر ابزارهای مبتنی بر IntelliJ تعبیه شده است: PyCharm, IntelliJ IDEA, GoLand, PhpStorm و دیگران.

امکانات:

- تکمیل کد بسیار سریع
- نحو برجسته ClickHouse
- پشتیبانی از ویژگی های خاص برای ClickHouse، برای مثال ستون های تویی، موتورهای جدول.
- ویرایشگر داده.
- .Refactorings
- جستجو و ناوبری

سرورهای پروکسی از توسعه دهندگان شخص ثالث

، یک پراکسی HTTP و تعادل بار برای پایگاه داده ClickHouse است. chproxy

امکانات

- مسیریابی و پاسخ دهنده کاربر به کاربر.
- محدودیت انعطاف پذیر
- تمدید SSL certificate به صورت خودکار.

اجرا شده در برو

KittenHouse

طراحی شده است که یک پروکسی محلی بین ClickHouse و سرور برنامه باشد در صورتی که غیر ممکن است یا ناخواهایند بافر کردن اطلاعات INSERT در قسمت درخواست شما.

امکانات:

- بافر حافظه در حافظه و درایو.

- مسیریابی در جدول
- تعادل بار و بررسی سلامت.

اجرا شده در برو

ClickHouse-Bulk

یک ClickHouse جمع کننده ساده است.

امکانات:

- درخواست گروهی و ارسال توسط آستانه یا فاصله.
- چند سرور از راه دور
- احراز هویت پایه

اجرا شده در برو

Data types

قابلیت ذخیره سازی انواع type های مختلف برای ذخیره داده ها در جداول را دارا می باشد. این بخش انواع data type های قابل پشتیبانی در ClickHouse را شرح می دهد، همچنین ملاحظات آنها در هنگام استفاده آنها را شرح می دهد.

UInt8, UInt16, UInt32, UInt64, Int8, Int16, Int32, Int64

اعداد با طول مشخص (Fixed-length) با یا بدون sign

محدوده ای Int

- [Int8 - [-128 : 127 •
- [Int16 - [-32768 : 32767 •
- [Int32 - [-2147483648 : 2147483647 •
- [Int64 - [-9223372036854775808 : 9223372036854775807 •

محدوده ای UInt

- [UInt8 - [0 : 255 •
- [UInt16 - [0 : 65535 •
- [UInt32 - [0 : 4294967295 •
- [UInt64 - [0 : 18446744073709551615 •

Float32, Float64

اعداد .Float

float های در ClickHouse مشابه C می باشد:

- Float32 - float

توصیه می کنیم که داده ها را هر زمان که امکان پذیره است به جای float به صورت int ذخیره کنید. برای مثال: تبدیل دقت اعداد به یک مقدار int، مثل سرعت page load در قالب میلی ثانیه.

استفاده از اعداد Float

- محاسبات با اعداد با float ممکن است خطای round شدن را ایجاد کنند.

```
SELECT 1 - 0.9
```

```
minus(1, 0.9)
0.0999999999999998
```

- نتایج محاسبات بسته به متد محاسباتی می باشد (نوع processor و معماری سیستم).
- محاسبات اسن نتایجی مثل "inf" (Not-a-number) و "NaN" (infinity) داشته باشد. این در هنگام پردازش نتایج محاسبات باید مورد توجه قرار گیرد.
- هنگام خواندن اعداد float از سطر ها، نتایج ممکن است نزدیک به اعداد machine-representable باشد.

Inf و NaN

در مقابل استاندارد SQL، ClickHouse پشتیبانی می کند:

. Inf – Infinity •

```
SELECT 0.5 / 0
```

```
divide(0.5, 0)
      inf |
```

. Inf – Negative infinity- •

```
SELECT -0.5 / 0
```

```
divide(-0.5, 0)
      -inf |
```

. NaN – Not a number •

```
SELECT 0 / 0
```

```
divide(0, 0)
      nan |
```

قوانين مربوط به مرتب سازی NaN را در بخش ORDER BY clause ببینید.

(Decimal(P, S), Decimal32(S), Decimal64(S), Decimal128(S)

Signed fixed point numbers that keep precision during add, subtract and multiply operations. For division least significant digits are discarded (not rounded)

Parameters

- .(P - precision. Valid range: [1 : 38]. Determines how many decimal digits number can have (including fraction • .S - scale. Valid range: [0 : P]. Determines how many decimal digits fraction can have •

Depending on P parameter value Decimal(P, S) is a synonym for: - P from [1 : 9] - for Decimal32(S) - P from [10 : 18] - (for Decimal64(S) - P from [19 : 38] - for Decimal128(S

Decimal value ranges

- ((Decimal32(S) - (-1 * 10^(9 - S), 1 * 10^(9 - S • ((Decimal64(S) - (-1 * 10^(18 - S), 1 * 10^(18 - S • ((Decimal128(S) - (-1 * 10^(38 - S), 1 * 10^(38 - S •

.For example, Decimal32(4) can contain numbers from -99999.9999 to 99999.9999 with 0.0001 step

Internal representation

Internally data is represented as normal signed integers with respective bit width. Real value ranges that can be stored in .memory are a bit larger than specified above, which are checked only on conversion from string

Because modern CPU's do not support 128 bit integers natively, operations on Decimal128 are emulated. Because of this .Decimal128 works significantly slower than Decimal32/Decimal64

Operations and result type

.(Binary operations on Decimal result in wider result type (with any order of arguments

- (Decimal64(S1) Decimal32(S2) -> Decimal64(S • (Decimal128(S1) Decimal32(S2) -> Decimal128(S • (Decimal128(S1) Decimal64(S2) -> Decimal128(S •

:Rules for scale

- .(add, subtract: S = max(S1, S2 • .multiply: S = S1 + S2 • .divide: S = S1 •

.For similar operations between Decimal and integers, the result is Decimal of the same size as argument

Operations between Decimal and Float32/Float64 are not defined. If you really need them, you can explicitly cast one of argument using toDecimal32, toDecimal64, toDecimal128 or toFloat32, toFloat64 builtins. Keep in mind that the result will .lose precision and type conversion is computationally expensive operation

Some functions on Decimal return result as Float64 (for example, var or stddev). Intermediate calculations might still be .performed in Decimal, which might lead to different results between Float64 and Decimal inputs with same values

Overflow checks

During calculations on Decimal, integer overflows might happen. Excessive digits in fraction are discarded (not rounded). .Excessive digits in integer part will lead to exception

```
SELECT toDecimal32(2, 4) AS x, x / 3
```

x	divide(toDecimal32(2, 4), 3)
2.0000	0.6666

```
SELECT toDecimal32(4.2, 8) AS x, x * x
```

DB::Exception: Scale is out of bounds.

```
SELECT toDecimal32(4.2, 8) AS x, 6 * x
```

DB::Exception: Decimal math overflow.

Overflow checks lead to operations slowdown. If it is known that overflows are not possible, it makes sense to disable checks using `decimal_check_overflow` setting. When checks are disabled and overflow happens, the result will be incorrect

```
SET decimal_check_overflow = 0;
SELECT toDecimal32(4.2, 8) AS x, 6 * x
```

x	multiply(6, toDecimal32(4.2, 8))
4.20000000	-17.74967296

:Overflow checks happen not only on arithmetic operations, but also on value comparison

```
SELECT toDecimal32(1, 8) < 100
```

DB::Exception: Can't compare.

Boolean مقادیر

type مخصوص مقادیر boolean وجود ندارد. از Uint8 و محدود شده به 0 و 1 می توان استفاده کرد.

String

یک type برای قرار دادن رشته با طول دلخواه می باشد. این طول محدود نمی باشد. این مقدار می تواند شامل مجموعه ای دلخواه از بایت ها، از جمله null byte باشد. VARCHAR, BLOB, CLOB String type جایگزین ... دیگر DBMS ها می باشد.

Encodings

encoding مفهومی به نام String ها می توانند شامل مجموعه ای بایت ها باشند که با همان شکل که نوشته می شوند به همان شکل هم در خروجی دیده شوند. اگر شما نیاز به ذخیره سازی متن دارید، توصیه می کنیم از UTF-8 استفاده کنید. حداقل اگر ترمینال شما از UTF-8 (پیشنهاد شده)، استفاده می کند، شما می توانید به راحتی مقادیر خود را نوشته و بخوانید. به طور مشابه توابع خاصی برای کار با رشته های متنوع وجود دارند که تخلی این فرضیه عمل می کنند که رشته شامل مجموعه ای از بایت ها می باشند که نماینده ای متن های UTF-8 هستند. برای مثال تابع 'length' برای محاسبه طول رشته براساس بایت است، در حالی که تابع 'lengthUTF8' برای محاسبه طول رشته بر اساس UNICODE می باشد.

(FixedString(N

یک رشته با طول ثابت N بایت (fixed-length) (نه تعداد کاراکتر یا N) باید یک عدد طبیعی مثبت باشد. هنگامی که سرور رشته ای با اندازه N کمتر از N میخواند (مثل زمان پارس کردن برای INSERT داده ها)، سمت راست رشته به اندازه فضای خالی باقی مانده به بایت null درج می شود. زمانی که سرور رشته ای بزرگتر از N میخواند، پیغام خطأ بر میگردد. زمانی که سرور یک رشته با طول ثابت را می نویسد (مثلا در زمانی که خروجی یک SELECT را بر میگرداند)، بایت های null از انتهای رشته حذف نمی شوند، و در خروجی می آیند. توجه داشته باشید که این رفتار متفاوت از رفتار MySQL برای Char می باشد (زمانی که رشته با space پر می شود و در خروجی space ها حذف می شود).

توابع کمتری نسبت به String برای FixedString(N) وجود دارد، و برای استفاده کمتر مناسب است.

UUID

A universally unique identifier (UUID) is a 16-byte number used to identify records. For detailed information about the .UUID, see [Wikipedia](#)

:The example of UUID type value is represented below

```
61f0c404-5cb3-11e7-907b-a6006ad3dba0
```

:If you do not specify the UUID column value when inserting a new record, the UUID value is filled with zero

```
00000000-0000-0000-0000-000000000000
```

How to generate

.To generate the UUID value, ClickHouse provides the [generateUUIDv4](#) function

Usage example

Example 1

.This example demonstrates creating a table with the UUID type column and inserting a value into the table

```
CREATE TABLE t_uuid (x UUID, y String) ENGINE=TinyLog
```

```
INSERT INTO t_uuid SELECT generateUUIDv4(), 'Example 1'
```

```
SELECT * FROM t_uuid
```

x	y
417ddc5d-e556-4d27-95dd-a34d84e46a50	Example 1

Example 2

.In this example, the UUID column value is not specified when inserting a new record

```
INSERT INTO t_uuid (y) VALUES ('Example 2')
```

```
SELECT * FROM t_uuid
```

x	y
417ddc5d-e556-4d27-95dd-a34d84e46a50	Example 1
00000000-0000-0000-0000-000000000000	Example 2

Restrictions

.(The UUID data type only supports functions which String data type also supports (for example, `min`, `max`, and `count`

The UUID data type is not supported by arithmetic operations (for example, `abs`) or aggregate functions, such as `sum` and `.avg`

Date

دو بایت به ازای هر تاریخ که به صورت عددی و از تاریخ 01-01-1970 می باشد ذخیره می کند (unsigned). این type به شما اجازه ذخیره سازی تاریخ های از ابتدای Unix Epoch تا بالاترین مقدار قابل پشتیبانی توسط این استاندارد را می دهد (در حال حاضر بالاترین مقدار این روش سال 2106 می باشد، اما سال آخری که به طور کامل پشتیبانی می شود سال 2105 است). کمترین مقدار این در خروجی 00-00-0000 می باشد.

بدون time zone Date ذخیره می شود.

DateTime

تاریخ با ساعت 4 بایت به صورت Unix timestamp ذخیره می کند (unsigned). به شما اجازه ذخیره سازی در محدوده تایپ Date را می دهد. حداقل مقدار در خروجی 00-00-0000 00:00:00 می باشد. زمان با دقت تا یک ثانیه ذخیره می شود.

Time zones

این type از text به باینری تبدیل می شود، و در هنگام برگشت با توجه به time zone سرور، در زمانی که کلاینت یا سرور شروع به کار می کند تبدیل می شود. در فرمات text، اطلاعات DST از دست می رود.

به صورت پیش فرض زمانی که کلاینت به سرور کانکت می شود، آن به تنظیم سرور تغییر می کند. شما می توانید این رفتار را با فعال سازی گزینه `--use_client_time_zone` در محیط command-line تغییر دهید.

بس در هنگام کار با تاریخ متنی (برای مثال زمانی که دامپ text می گیرید)، به خاطر داشته باشید که ممکن است به دلیل تغییرات DST، نتایج مبهمی در خروجی بینید، و ممکن است در صورت تغییر time zone مشکلی با مطابقت خروجی با داده ها وجود داشته باشد.

Enum

به شما اجازه ذخیره سازی مجموعه ای محدود از رشته ها را می دهد که کارآمدتر از String می باشد.

مثال:

```
Enum8('hello' = 1, 'world' = 2)
```

- مقدار داخل این ستون می تواند یکی از دو مقدار 'hello' یا 'world' باشد.

هر کدام از مقادیر یک عدد در محدوده 128- ... 127 برای Enum8 و در محدوده 32768- ... 32767 برای Enum16 می باشد. تمام رشته ها و اعداد باید متفاوت باشند. رشته های خالی مجاز است. اگر این type مشخص شده باشد (در تعریف جدول)، اعداد می توانند به صورت دلخواه مرتب شوند. با این حال، ترتیب در اینجا مهم نیست.

در RAM، این type مشابه Int8 یا Int16 ذخیره می شود. هنگام خواندن در فرم متنی، ClickHouse مقدار را به صورت String پارس

می کند و رشته‌ی مربوطه را در مقادیر Enum جستجو می کند. اگر رشته را پیدا کند یک exception پرتاب می شود. در هنگام خواندن در فرمت text، رشته خواند می شود و مقدار عددی مربوطه مورد بررسی قرار می گیرد. اگر مقدار پیدا نشود exception پرتاب می شود. هنگام نوشتمن، مقدار با رشته‌ی مربوط نوشته می شود. اگر داده‌ی ستون دارای garbage باشد، (اعدادی که از مجموعه‌ی معتبر نیستند)، یک exception پرتاب می شود. هنگام خواندن و نوشتمن به صورت باینری، این type شبیه به Int8 و Int16 کار می کند.

.The implicit default value is the value with the lowest number

در جین ORDER BY ، GROUP BY ، IN ، DISTINCT در صورت عددی اینها رو مرتب می کند. اپراتور های مقایسه‌ای و مساوی عمل مشابهی در Enums دارند.

مقادیرEnum نمیتوانند با اعداد مقایسه شوند. مقادیرEnum را می توان با رشته‌ی ثابت مقایسه کرد. اگر رشته‌ی مقایسه، مقدار معتبری برای مقایسی به IN نداشته باشد، یک exception رخ می دهد. اپراتور IN درEnum پشتیبانی می شود؛ به این صورت که ستون enum در سمت چپ و مجموعه از رشته‌ها در سمت راست قرار می گیرند. رشته‌ها مقادیر مربوط بهEnum هستند.

خیلی از اپراتورهای عددی و رشته‌ای برای مقادیرEnum تعریف نشده‌اند. برای مثال جمع یک عدد باEnum یا کانکت کردن یک رشته با این حالEnum دارای تابعی به نام toString برای برگشت داده به صورت رشته می باشد.

همچنین مقادیرEnum با استفاده از تابع toT قابل تبدیل به type های عددی هستند. جایی که T یک type عددی است. زمانی که T به نوع عددیEnum مربوط می شود، این تبدیل هیچ هزینه‌ای ندارد. اگر فقط مجموعه از مقادیر تغییر کند،Enum بدون هیچ هزینه‌ای می تواند ALTER شود. اضافه یا حذف کردن عضوهایEnum با استفاده از Alter ممکن است (حذف یک عضو به شرطی که تا الان در جدول از آن استفاده نشده باشد امن است). به عنوان یک محافظت، تغییر مقدار عددی که قبل از توسعه اعضایEnum تعریف شده است منجر به exception می شود.

استفاده از ALTER برای تبدیلEnum8 یا برعکس، ممکن است، دقیقاً شبیه به Int8 به Int16.

(Array(T

آرایه‌ای از عناصر با تایپ T. تایپ T می تواند هر Type باشد، از جمله یک آرایه. ما توصیه به استفاده از آرایه‌های multidimensional نمی کنیم، چون آنها به خوبی پشتیبانی نمی شوند (برای مثال، شما نمی توانید در جداولی که موتور آنها MergeTree است، آرایه‌های multidimensional ذخیره سازی کنید).

(...AggregateFunction(name, types_of_arguments

حالت متوسط از توابع aggregate. برای دریافت آن، از توابع aggregate به همراه پسوند 'State' استفاده کنید. برای اطلاعات بیشتر قسمت "AggregatingMergeTree" را ببینید.

(..., Tuple(T1, T2

Tuple ها نمیتوانند در جدول نوشته شوند (به غیر جداول Memory). آنها برای گروه بندی موقت ستون‌ها مورد استفاده قرار می گیرند. ستون‌های می توانند گروه بندی شوند اگر از عبارت In در استفاده کنیم، و برای تعیین فرمت پارامترهای خاصی از توابع لامبدا. برای اطلاعات بیشتر "اپراتور IN" ، "توابع Higher order" را ببینید.

Tuple می توانند در خروجی نتیجه query در حال اجرا باشند. در این مورد، برای فرمت‌های text به غیر از JSON*، مقادیر به صورت comma-separate داخل برآکت قرار میگیرند. در فرمت‌های JSON* مقادیر tuple به صورت آرایه در خروجی می آیند.

(Nullable(TypeName

Allows to store special marker (**NULL**) that denotes "missing value" alongside normal values allowed by TypeName . For example, a Nullable(Int8) type column can store Int8 type values, and the rows that don't have a value will store NULL

For a TypeName , you can't use composite data types **Array** and **Tuple**. Composite data types can contain Nullable type . ((values, such as Array(Nullable(Int8

.A Nullable type field can't be included in table indexes

.NULL is the default value for any Nullable type, unless specified otherwise in the ClickHouse server configuration

Storage features

To store Nullable type values in table column, ClickHouse uses a separate file with NULL masks in addition to normal file with values. Entries in masks file allow ClickHouse to distinguish between NULL and default value of corresponding data type for each table row. Because of additional file, Nullable column consumes additional storage space compared to .similar normal one

Note 

.Using Nullable almost always negatively affects performance, keep this in mind when designing your databases

Usage example

```
CREATE TABLE t_null(x Int8, y Nullable(Int8)) ENGINE TinyLog
```

```
INSERT INTO t_null VALUES (1, NULL), (2, 3)
```

```
SELECT x + y FROM t_null
```

plus(x, y)
NULL
5

Nested data structures

(..., Nested(Name1 Type1, Name2 Type2

ساختار داده‌ی nested می‌باشد. بارامترهای ساختار داده nested، نام ستون‌ها و type‌های آنها مشابه دستور CREATE، مشخص می‌شود. هر سطر از جدول می‌تواند به هر تعداد سطر در ساختار داده nested مربوط شود.

:مثال

```

CREATE TABLE test.visits
(
    CounterID UInt32,
    StartDate Date,
    Sign Int8,
    IsNew UInt8,
    VisitID UInt64,
    UserID UInt64,
    ...
    Goals Nested
    (
        ID UInt32,
        Serial UInt32,
        EventTime DateTime,
        Price Int64,
        OrderID String,
        CurrencyID UInt32
    ),
    ...
) ENGINE = CollapsingMergeTree(StartDate, intHash32(UserID), (CounterID, StartDate, intHash32(UserID),
VisitID), 8192, Sign)

```

این مثال Goals را به عنوان یک ساختار داده nested تعریف می کند، که می تواند شامل داده های مربوط به conversion (اهداف رسیده) باشد. هر سطر در جدول visit می تواند با صفر یا چند conversion ارتباط داشته باشد.

فقط تا یک لول از nested پشتیبانی می شود. ستون های nested دارای آرایه، با آرایه های multidimensional یکسان هستند، پس محدودیت در پشتیبانی دارند (جداول با موتور MergeTree از ستون های multidimensional پشتیبانی نمی کنند).

در بیشتر موارد، هنگام کار با ساختار داده i nested، ستون های آن مشخص شده اند. برای این کار، نام ستون ها با استفاده از دات جدا می شوند. این ستون ها آرایه ای از انواع type دهند. تمام آرایه های یک ساختار داده i nested دارای طول ثابت هستند.

مثال:

```

SELECT
    Goals.ID,
    Goals.EventTime
FROM test.visits
WHERE CounterID = 101500 AND length(Goals.ID) < 5
LIMIT 10

```

Goals.ID	Goals.EventTime
[1073752, 591325, 591325]	['2014-03-17 16:38:10', '2014-03-17 16:38:48', '2014-03-17 16:42:27']
[1073752]	['2014-03-17 00:28:25']
[1073752]	['2014-03-17 10:46:20']
[1073752, 591325, 591325, 591325]	['2014-03-17 13:59:20', '2014-03-17 22:17:55', '2014-03-17 22:18:07', '2014-03-17 22:18:51']
[]	[]
[1073752, 591325, 591325]	['2014-03-17 11:37:06', '2014-03-17 14:07:47', '2014-03-17 14:36:21']
[]	[]
[]	[]
[591325, 1073752]	['2014-03-17 00:46:05', '2014-03-17 00:46:05']
[1073752, 591325, 591325, 591325]	['2014-03-17 13:28:33', '2014-03-17 13:30:26', '2014-03-17 18:51:21', '2014-03-17 18:51:45']

ساده ترین راه برای فکر کردن به یک ساختار داده nested این است که، یک مجموعه ای از آرایه های چند ستونی با طول ثابت است.

تنهای جایی که یک دستور SELECT می تواند کل ساختار داده ای nested را به جای مشخص کردن ستون های آن قرار دهد، عبارت است. برای اطلاعات بیشتر "ARRAY JOIN clause" را ببینید. مثال:

```
SELECT
    Goal.ID,
    Goal.EventTime
FROM test.visits
ARRAY JOIN Goals AS Goal
WHERE CounterID = 101500 AND length(Goals.ID) < 5
LIMIT 10
```

Goal.ID	Goal.EventTime
1073752	2014-03-17 16:38:10
591325	2014-03-17 16:38:48
591325	2014-03-17 16:42:27
1073752	2014-03-17 00:28:25
1073752	2014-03-17 10:46:20
1073752	2014-03-17 13:59:20
591325	2014-03-17 22:17:55
591325	2014-03-17 22:18:07
591325	2014-03-17 22:18:51
1073752	2014-03-17 11:37:06

شما نمیتوانید در قسمت SELECT تمام ساختار داده ای nested را قرار دهید. شما فقط می توانید ستون های فردی که هر کدام بخشی از این ساختار داده هستند را لیست کنید.

برای INSERT، شما باید تمام ستون های nested را به صورت جدا پاس بدهید. در حین درج، سیستم بررسی می کند که تمام آنها طول یکسانی داشته باشند.

برای دستور DESCRIBE، ستون های داخل nested، به صورت جدا ستون می شوند.

دستور ALTER برای عناصر داخل nested بسیار محدود است.

Special data types

مقادیر نوع داده special، نمیتوانند در در جدول ذخیره و یا در نتایج خروجی قرار بگیرند، اما در نتایج متوسط (intermediate) یک query میتوانند در در جدول ذخیره و یا در نتایج خروجی قرار بگیرند، اما در نتایج متوسط (intermediate) یک query میتوانند در در حال اجرا استفاده می شوند.

Expression

برای نشان دادن توابع لامبда در توابع high-order استفاده می شود.

Set

برای نصف سمت راست IN استفاده می شود.

Nothing

The only purpose of this data type is to represent cases where value is not expected. So you can't create a Nothing type .value

.For example, literal **NULL** has type of Nullable(Nothing) . See more about **Nullable**

:The `Nothing` type can also used to denote empty arrays

```
SELECT toTypeName(array())
```

```
toTypeName(array())
Array(Nothing)
```

Interval

.The family of data types representing time and date intervals. The resulting types of the `INTERVAL` operator

Warning

.You can't use `Interval` data types for storing values in tables

:Structure

- .Time interval as an unsigned integer value •
- .Type of an interval •

:Supported interval types

- SECOND •
- MINUTE •
- HOUR •
- DAY •
- WEEK •
- MONTH •
- QUARTER •
- YEAR •

For each interval type, there is a separate data type. For example, the `DAY` interval is expressed as the `IntervalDay` data type

```
SELECT toTypeName(INTERVAL 4 DAY)
```

```
toTypeName(toIntervalDay(4))
IntervalDay
```

Usage Remarks

You can use `Interval`-type values in arithmetical operations with `Date` and `DateTime`-type values. For example, you can add 4 days to the current time

```
SELECT now() as current_date_time, current_date_time + INTERVAL 4 DAY
```

```
current_date_time plus(now(), toIntervalDay(4))
2019-10-23 10:58:45 | 2019-10-27 10:58:45
```

Intervals with different types can't be combined. You can't use intervals like `4 DAY 1 HOUR`. Express intervals in units that are smaller or equal to the smallest unit of the interval, for example, the interval `1 day` and an hour interval can be expressed as `25 HOUR` or `90000 SECOND`.

You can't perform arithmetical operations with `Interval`-type values, but you can add intervals of different types consequently to values in `Date` or `DateTime` data types. For example

```
SELECT now() AS current_date_time, current_date_time + INTERVAL 4 DAY + INTERVAL 3 HOUR
```

current_date_time	plus(plus(now(), toIntervalDay(4)), toIntervalHour(3))
2019-10-23 11:16:28	2019-10-27 14:16:28

:The following query causes an exception

```
select now() AS current_date_time, current_date_time + (INTERVAL 4 DAY + INTERVAL 3 HOUR)
```

Received exception from server (version 19.14.1):

Code: 43. DB::Exception: Received from localhost:9000. DB::Exception: Wrong argument types for function plus: if one argument is Interval, then another must be Date or DateTime..

See Also

- [INTERVAL operator](#) •
- [toInterval type conversion functions](#) •

Domains

Domains are special-purpose types, that add some extra features atop of existing base type, leaving on-wire and on-disc format of underlying table intact. At the moment, ClickHouse does not support user-defined domains

:You can use domains anywhere corresponding base type can be used

- [Create a column of domain type](#) •
- [Read/write values from/to domain column](#) •
- [Use it as index if base type can be used as index](#) •
- [Call functions with values of domain column](#) •
- [.etc](#) •

Extra Features of Domains

- [Explicit column type name in SHOW CREATE TABLE or DESCRIBE TABLE](#) •
- [\(...\)Input from human-friendly format with INSERT INTO domain_table\(domain_column\) VALUES](#) •
- [Output to human-friendly format for SELECT domain_column FROM domain_table](#) •
- [... Loading data from external source in human-friendly format:INSERT INTO domain_table FORMAT CSV](#) •

Limitations

- [Can't convert index column of base type to domain type via ALTER TABLE](#) •
- [Can't implicitly convert string values into domain values when inserting data from another column or table](#) •
- [Domain adds no constraints on stored values](#) •

IPv4 is a domain based on UInt32 type and serves as typed replacement for storing IPv4 values. It provides compact storage with human-friendly input-output format, and column type information on inspection

Basic Usage

```
CREATE TABLE hits (url String, from IPv4) ENGINE = MergeTree() ORDER BY url;
DESCRIBE TABLE hits;
```

name	type	default_type	default_expression	comment	codec_expression
url	String				
from	IPv4				

:OR you can use IPv4 domain as a key

```
CREATE TABLE hits (url String, from IPv4) ENGINE = MergeTree() ORDER BY from;
```

:IPv4 domain supports custom input format as IPv4-strings

```
INSERT INTO hits (url, from) VALUES ('https://wikipedia.org', '116.253.40.133')
('https://clickhouse.yandex', '183.247.232.58')('https://clickhouse.yandex/docs/en/', '116.106.34.242');
SELECT * FROM hits;
```

url	from
https://clickhouse.yandex/docs/en/	116.106.34.242
https://wikipedia.org	116.253.40.133
https://clickhouse.yandex	183.247.232.58

:Values are stored in compact binary form

```
SELECT toTypeName(from), hex(from) FROM hits LIMIT 1;
```

toTypeName(from)	hex(from)
IPv4	B7F7E83A

Domain values are not implicitly convertible to types other than UInt32 . If you want to convert IPv4 value to a string, you have to do that explicitly with IPv4NumToString() function

```
SELECT toTypeName(s), IPv4NumToString(from) as s FROM hits LIMIT 1;
```

toTypeName(IPv4NumToString(from))	s
String	183.247.232.58

:Or cast to a UInt32 value

```
SELECT toTypeName(i), CAST(from as UInt32) as i FROM hits LIMIT 1;
```

toTypeName(CAST(from, 'UInt32'))	i
UInt32	3086477370

IPv6

IPv6 is a domain based on `FixedString(16)` type and serves as typed replacement for storing IPv6 values. It provides compact storage with human-friendly input-output format, and column type information on inspection

Basic Usage

```
CREATE TABLE hits (url String, from IPv6) ENGINE = MergeTree() ORDER BY url;  
DESCRIBE TABLE hits;
```

name	type	default_type	default_expression	comment	codec_expression
url	String				
from	IPv6				

:OR you can use `IPv6` domain as a key

```
CREATE TABLE hits (url String, from IPv6) ENGINE = MergeTree() ORDER BY from;
```

: IPv6 domain supports custom input as IPv6-strings

```
INSERT INTO hits (url, from) VALUES ('https://wikipedia.org', '2a02:aa08:e000:3100::2')  
( 'https://clickhouse.yandex', '2001:44c8:129:2632:33:0:252:2')('https://clickhouse.yandex/docs/en/','  
'2a02:e980:1e::1');
```

```
SELECT * FROM hits;
```

url	from
https://clickhouse.yandex	2001:44c8:129:2632:33:0:252:2
https://clickhouse.yandex/docs/en/	2a02:e980:1e::1
https://wikipedia.org	2a02:aa08:e000:3100::2

:Values are stored in compact binary form

```
SELECT toTypeName(from), hex(from) FROM hits LIMIT 1;
```

toTypeName(from)	hex(from)
IPv6	200144C8012926320033000002520002

Domain values are not implicitly convertible to types other than `FixedString(16)`. If you want to convert `IPv6` value to a `String`, you have to do that explicitly with `IPv6NumToString()` function

```
SELECT toTypeName(s), IPv6NumToString(from) as s FROM hits LIMIT 1;
```

toTypeName(IPv6NumToString(from))	s
String	2001:44c8:129:2632:33:0:252:2

:Or cast to a `FixedString(16)` value

```
SELECT toTypeName(i), CAST(from as FixedString(16)) as i FROM hits LIMIT 1;
```

```
└─toTypeName(CAST(from, 'FixedString(16)'))─i─  
| FixedString(16) | 000 |
```

Database Engines

Database engines allow you to work with tables

By default, ClickHouse uses its native database engine, which provides configurable **table engines** and an **SQL dialect**

You can also use the following database engines

- MySQL •
- Lazy •

MySQL

Allows to connect to databases on a remote MySQL server and perform `INSERT` and `SELECT` queries with tables to exchange data between ClickHouse and MySQL

The MySQL database engine translates queries to the MySQL server so you can perform operations such as `SHOW TABLES` or `SHOW CREATE TABLE`

You cannot perform the following queries

- RENAME •
- CREATE TABLE •
- ALTER •

Creating a Database

```
CREATE DATABASE [IF NOT EXISTS] db_name [ON CLUSTER cluster]  
ENGINE = MySQL('host:port', 'database', 'user', 'password')
```

Engine Parameters

- . host:port — MySQL server address •
- . database — Remote database name •
- . user — MySQL user •
- . password — User password •

Data Types Support

ClickHouse	MySQL
UInt8	UNSIGNED TINYINT
Int8	TINYINT
UInt16	UNSIGNED SMALLINT
Int16	SMALLINT
UInt32	UNSIGNED INT, UNSIGNED MEDIUMINT
Int32	INT, MEDIUMINT
UInt64	UNSIGNED BIGINT
Int64	BIGINT
Float32	FLOAT
Float64	DOUBLE
Date	DATE
DateTime	DATETIME, TIMESTAMP
FixedString	BINARY

.All other MySQL data types are converted into [String](#)

[Nullable](#) is supported

Examples of Use

:Table in MySQL

```
mysql> USE test;
Database changed

mysql> CREATE TABLE `mysql_table` (
    ->   `int_id` INT NOT NULL AUTO_INCREMENT,
    ->   `float` FLOAT NOT NULL,
    ->   PRIMARY KEY (`int_id`));
Query OK, 0 rows affected (0,09 sec)

mysql> insert into mysql_table (`int_id`, `float`) VALUES (1,2);
Query OK, 1 row affected (0,00 sec)

mysql> select * from mysql_table;
+-----+-----+
| int_id | value |
+-----+-----+
|      1 |     2 |
+-----+-----+
1 row in set (0,00 sec)
```

:Database in ClickHouse, exchanging data with the MySQL server

```
CREATE DATABASE mysql_db ENGINE = MySQL('localhost:3306', 'test', 'my_user', 'user_password')
```

```
SHOW DATABASES
```

name
default
mysql_db
system

```
SHOW TABLES FROM mysql_db
```

name
mysql_table

```
SELECT * FROM mysql_db.mysql_table
```

int_id	value
1	2

```
INSERT INTO mysql_db.mysql_table VALUES (3,4)
```

```
SELECT * FROM mysql_db.mysql_table
```

int_id	value
1	2
3	4

Lazy

Works like Ordinary , but keeps tables in RAM only expiration_time_in_seconds seconds after last access. Can be used only .with *Log tables

.It's optimized for storing many small *Log tables, for which there is a long time interval between accesses

Creating a Database

```
CREATE DATABASE testlazy ENGINE = Lazy(expiration_time_in_seconds);
```

Table engines

:The table engine (type of table) determines

- .How and where data is stored, where to write it to, and where to read it from •
- .Which queries are supported, and how •
- .Concurrent data access •
- .Use of indexes, if present •
- .Whether multithreaded request execution is possible •
- .Data replication parameters •

Engine Families

MergeTree

The most universal and functional table engines for high-load tasks. The property shared by these engines is quick data insertion with subsequent background data processing. MergeTree family engines support data replication (with .Replicated* versions of engines), partitioning, and other features not supported in other engines

:Engines in the family

- MergeTree •
- ReplacingMergeTree •
- SummingMergeTree •
- AggregatingMergeTree •
- CollapsingMergeTree •
- VersionedCollapsingMergeTree •
- GraphiteMergeTree •

Log

Lightweight engines with minimum functionality. They're the most effective when you need to quickly write many small .tables (up to approximately 1 million rows) and read them later as a whole

:Engines in the family

- TinyLog •
- StripeLog •
- Log •

Intergation engines

.Engines for communicating with other data storage and processing systems

:Engines in the family

- Kafka •
- MySQL •
- ODBC •
- JDBC •
- HDFS •

Special engines

:Engines in the family

- Distributed •
- MaterializedView •
- Dictionary •
- Merge •
- File •
- Null •

[Set](#) •
[Join](#) •
[URL](#) •
[View](#) •
[Memory](#) •
[Buffer](#) •

Virtual columns

.Virtual column is an integral table engine attribute that is defined in the engine source code

You shouldn't specify virtual columns in the `CREATE TABLE` query and you can't see them in `SHOW CREATE TABLE` and
. `DESCRIBE TABLE` query results. Virtual columns are also read-only, so you can't insert data into virtual columns

To select data from a virtual column, you must specify its name in the `SELECT` query. `SELECT *` doesn't return values
.from virtual columns

If you create a table with a column that has the same name as one of the table virtual columns, the virtual column
becomes inaccessible. We don't recommend doing this. To help avoid conflicts, virtual column names are usually prefixed
.with an underscore

MergeTree

.The `MergeTree` engine and other engines of this family (`*MergeTree`) are the most robust ClickHouse table engines

Engines in the `MergeTree` family are designed for inserting a very large amount of data into a table. The data is quickly
written to the table part by part, then rules are applied for merging the parts in the background. This method is much more
.efficient than continually rewriting the data in storage during insert

:Main features

.Stores data sorted by primary key •

.This allows you to create a small sparse index that helps find data faster

.Partitions can be used if the [partitioning key](#) is specified •

ClickHouse supports certain operations with partitions that are more effective than general operations on the same
data with the same result. ClickHouse also automatically cuts off the partition data where the partitioning key is
.specified in the query. This also improves query performance

.Data replication support •

.The family of `ReplicatedMergeTree` tables provides data replication. For more information, see [Data replication](#)

.Data sampling support •

.If necessary, you can set the data sampling method in the table

Info 

.The [Merge](#) engine does not belong to the `*MergeTree` family

Creating a Table

```

CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
    name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1] [TTL expr1],
    name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2] [TTL expr2],
    ...
    INDEX index_name1 expr1 TYPE type1(...) GRANULARITY value1,
    INDEX index_name2 expr2 TYPE type2(...) GRANULARITY value2
) ENGINE = MergeTree()
[PARTITION BY expr]
[ORDER BY expr]
[PRIMARY KEY expr]
[SAMPLE BY expr]
[TTL expr [DELETE|TO DISK 'xxx'|TO VOLUME 'xxx'], ...]
[SETTINGS name=value, ...]

```

.For a description of parameters, see the [CREATE query description](#)

Note

. INDEX is an experimental feature, see [Data Skipping Indexes](#)

Query Clauses

ENGINE — Name and parameters of the engine. `ENGINE = MergeTree()` . The `MergeTree` engine does not have •
.parameters
. **PARTITION BY** — The [partitioning key](#) •

For partitioning by month, use the `toYYYYMM(date_column)` expression, where `date_column` is a column with a date of
.the type [Date](#). The partition names here have the "YYYYMM" format

. **ORDER BY** — The sorting key •
. (A tuple of columns or arbitrary expressions. Example:`ORDER BY (CounterID, EventDate`
. **PRIMARY KEY** — The primary key if it[differs from the sorting key](#) •

By default the primary key is the same as the sorting key (which is specified by the**ORDER BY** clause). Thus in most
.cases it is unnecessary to specify a separate `PRIMARY KEY` clause

. **SAMPLE BY** — An expression for sampling •

If a sampling expression is used, the primary key must contain it. Example:`SAMPLE BY intHash32(UserID) ORDER BY`
.(((`CounterID, EventDate, intHash32(UserID`

TTL — A list of rules specifying storage duration of rows and defining logic of automatic parts movementbetween •
.disks and volumes

Expression must have one `Date` or `DateTime` column as a result. Example: `TTL date + INTERVAL 1 DAY`

Type of the rule `DELETE|TO DISK 'xxx'|TO VOLUME 'xxx'` specifies an action to be done with the part if the expression is satisfied (reaches current time): removal of expired rows, moving a part (if expression is satisfied for all rows in a part) to specified disk (`TO DISK 'xxx'`) or to volume (`TO VOLUME 'xxx'`). Default type of the rule is removal (`DELETE`). List of
.multiple rules can specified, but there should be no more than one `DELETE` rule

For more details, see [TTL for columns and tables](#)

: **SETTINGS** — Additional parameters that control the behavior of the `MergeTree` •

index_granularity — Maximum number of data rows between the marks of an index. Default value: 8192. See[Data Storage](#) •
.Storage

index_granularity_bytes — Maximum size of data granules in bytes. Default value: 10Mb. To restrict the granule •
.size only by number of rows, set to 0 (not recommended). See [Data Storage](#)

enable_mixed_granularity_parts — Enables or disables transitioning to control the granule size with the •
`index_granularity_bytes` setting. Before version 19.11, there was only the `index_granularity` setting for restricting

granule size. The `index_granularity_bytes` setting improves ClickHouse performance when selecting data from tables with big rows (tens and hundreds of megabytes). If you have tables with big rows, you can enable this setting for the tables to improve the efficiency of `SELECT` queries.

`use_minimalistic_part_header_in_zookeeper` — Storage method of the data parts headers in ZooKeeper. If `use_minimalistic_part_header_in_zookeeper=1`, then ZooKeeper stores less data. For more information, see the ["setting description](#) in "Server configuration parameters".

`min_merge_bytes_to_use_direct_io` — The minimum data volume for merge operation that is required for using direct I/O access to the storage disk. When merging data parts, ClickHouse calculates the total storage volume of all the data to be merged. If the volume exceeds `min_merge_bytes_to_use_direct_io` bytes, ClickHouse reads and writes the data to the storage disk using the direct I/O interface (`O_DIRECT` option). If `min_merge_bytes_to_use_direct_io = 0`, then direct I/O is disabled. Default value: `10 * 1024 * 1024 * 1024` bytes.

`merge_with_ttl_timeout` — Minimum delay in seconds before repeating a merge with TTL. Default value: `86400` (1 day).

`write_final_mark` — Enables or disables writing the final index mark at the end of data part. Default value: 1. Don't turn it off.

`storage_policy` — Storage policy. See [Using Multiple Block Devices for Data Storage](#).

Example of Sections Setting

```
ENGINE MergeTree() PARTITION BY toYYYYMM(EventDate) ORDER BY (CounterID, EventDate, intHash32(UserID))
SAMPLE BY intHash32(UserID) SETTINGS index_granularity=8192
```

In the example, we set partitioning by month.

We also set an expression for sampling as a hash by the user ID. This allows you to pseudorandomize the data in the table for each `CounterID` and `EventDate`. If you define a `SAMPLE` clause when selecting the data, ClickHouse will return an evenly pseudorandom data sample for a subset of users.

The `index_granularity` setting can be omitted because 8192 is the default value.

Attention

.Do not use this method in new projects. If possible, switch old projects to the method described above

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
    name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1],
    name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2],
    ...
) ENGINE [=] MergeTree(date-column [, sampling_expression], (primary, key), index_granularity)
```

MergeTree() Parameters

`date-column` — The name of a column of the `Date` type. ClickHouse automatically creates partitions by month based on this column. The •
.partition names are in the "YYYYMM" format

.`sampling_expression` — An expression for sampling •
(`primary, key`) — Primary key. Type: `Tuple` •

`index_granularity` — The granularity of an index. The number of data rows between the "marks" of an index. The value 8192 is appropriate for •
.most tasks

Example

```
MergeTree(EventDate, intHash32(UserID), (CounterID, EventDate, intHash32(UserID)), 8192)
```

.The `MergeTree` engine is configured in the same way as in the example above for the main engine configuration method

Data Storage

.A table consists of data parts sorted by primary key

When data is inserted in a table, separate data parts are created and each of them is lexicographically sorted by primary key. For example, if the primary key is `(CounterID, Date)`, the data in the part is sorted by `CounterID`, and within each .`CounterID`, it is ordered by `Date`

Data belonging to different partitions are separated into different parts. In the background, ClickHouse merges data parts for more efficient storage. Parts belonging to different partitions are not merged. The merge mechanism does not .guarantee that all rows with the same primary key will be in the same data part

Each data part is logically divided into granules. A granule is the smallest indivisible data set that ClickHouse reads when selecting data. ClickHouse doesn't split rows or values, so each granule always contains an integer number of rows. The first row of a granule is marked with the value of the primary key for the row. For each data part, ClickHouse creates an index file that stores the marks. For each column, whether it's in the primary key or not, ClickHouse also stores the same .marks. These marks let you find data directly in column files

The granule size is restricted by the `index_granularity` and `index_granularity_bytes` settings of the table engine. The number of rows in a granule lies in the `[1, index_granularity]` range, depending on the size of the rows. The size of a granule can exceed `index_granularity_bytes` if the size of a single row is greater than the value of the setting. In this case, the size of the .granule equals the size of the row

Primary Keys and Indexes in Queries

:Take the `(CounterID, Date)` primary key as an example. In this case, the sorting and index can be illustrated as follows

Whole data:	[-----]
CounterID:	[aaaaaaaaaaaaaaaaaaaaabbbbcdfffffffggggggggghhhhhhhhhiiiiiiik11111111]
Date:	[111111122222233312332111122222332111111212222223111122231112233]
Marks:	a,1 a,2 a,3 b,3 e,2 e,3 g,1 h,2 i,1 i,3 l,3
Marks numbers:	0 1 2 3 4 5 6 7 8 9 10

:If the data query specifies

- . (CounterID in ('a', 'h') , the server reads the data in the ranges of marks[0, 3) and [6, 8] •
- . (CounterID IN ('a', 'h') AND Date = 3 , the server reads the data in the ranges of marks[1, 3) and [7, 8] •
- . [Date = 3 , the server reads the data in the range of marks[1, 10] •

.The examples above show that it is always more effective to use an index than a full scan

A sparse index allows extra data to be read. When reading a single range of the primary key, up to `index_granularity * 2` extra rows in each data block can be read

Sparse indexes allow you to work with a very large number of table rows, because in most cases, such indexes fit in the computer's RAM

.ClickHouse does not require a unique primary key. You can insert multiple rows with the same primary key

Selecting the Primary Key

The number of columns in the primary key is not explicitly limited. Depending on the data structure, you can include more or fewer columns in the primary key. This may

.Improve the performance of an index •

If the primary key is (a, b) , then adding another column c will improve the performance if the following conditions are met

.There are queries with a condition on column c •

Long data ranges (several times longer than the `index_granularity`) with identical values for (a, b) are common. In other words, when adding another column allows you to skip quite long data ranges

.Improve data compression •

.ClickHouse sorts data by primary key, so the higher the consistency, the better the compression

.Provide additional logic when merging data parts in the [CollapsingMergeTree](#) and [SummingMergeTree](#) engines •

.In this case it makes sense to specify the `sorting key` that is different from the primary key

A long primary key will negatively affect the insert performance and memory consumption, but extra columns in the primary key do not affect ClickHouse performance during `SELECT` queries

Choosing a Primary Key that Differs from the Sorting Key

It is possible to specify a primary key (an expression with values that are written in the index file for each mark) that is different from the sorting key (an expression for sorting the rows in data parts). In this case the primary key expression tuple must be a prefix of the sorting key expression tuple

This feature is helpful when using the [SummingMergeTree](#) and [AggregatingMergeTree](#) table engines. In a common case when using these engines, the table has two types of columns: *dimensions* and *measures*. Typical queries aggregate values of measure columns with arbitrary `GROUP BY` and filtering by dimensions. Because [SummingMergeTree](#) and [AggregatingMergeTree](#) aggregate rows with the same value of the sorting key, it is natural to add all dimensions to it. As a result, the key expression consists of a long list of columns and this list must be frequently updated with newly added dimensions

In this case it makes sense to leave only a few columns in the primary key that will provide efficient range scans and add .the remaining dimension columns to the sorting key tuple

ALTER of the sorting key is a lightweight operation because when a new column is simultaneously added to the table and to the sorting key, existing data parts don't need to be changed. Since the old sorting key is a prefix of the new sorting key and there is no data in the newly added column, the data is sorted by both the old and new sorting keys at the moment of .table modification

Use of Indexes and Partitions in Queries

For `SELECT` queries, ClickHouse analyzes whether an index can be used. An index can be used if the `WHERE/PREWHERE` clause has an expression (as one of the conjunction elements, or entirely) that represents an equality or inequality comparison operation, or if it has `IN` or `LIKE` with a fixed prefix on columns or expressions that are in the primary key or partitioning key, or on certain partially repetitive functions of these columns, or logical relationships of .these expressions

Thus, it is possible to quickly run queries on one or many ranges of the primary key. In this example, queries will be fast when run for a specific tracking tag, for a specific tag and date range, for a specific tag and date, for multiple tags with a .date range, and so on

:Let's look at the engine configured as follows

```
ENGINE MergeTree() PARTITION BY toYYYYMM(EventDate) ORDER BY (CounterID, EventDate) SETTINGS  
index_granularity=8192
```

:In this case, in queries

```
SELECT count() FROM table WHERE EventDate = toDate(now()) AND CounterID = 34  
SELECT count() FROM table WHERE EventDate = toDate(now()) AND (CounterID = 34 OR CounterID = 42)  
SELECT count() FROM table WHERE ((EventDate >= toDate('2014-01-01') AND EventDate <= toDate('2014-01-31'))  
OR EventDate = toDate('2014-05-01')) AND CounterID IN (101500, 731962, 160656) AND (CounterID = 101500 OR  
EventDate != toDate('2014-05-01'))
```

ClickHouse will use the primary key index to trim improper data and the monthly partitioning key to trim partitions that are .in improper date ranges

The queries above show that the index is used even for complex expressions. Reading from the table is organized so that .using the index can't be slower than a full scan .In the example below, the index can't be used

```
SELECT count() FROM table WHERE CounterID = 34 OR URL LIKE '%upyachka%'
```

To check whether ClickHouse can use the index when running a query, use the settings `force_index_by_date` and .`force_primary_key`

The key for partitioning by month allows reading only those data blocks which contain dates from the proper range. In this case, the data block may contain data for many dates (up to an entire month). Within a block, data is sorted by primary key, which might not contain the date as the first column. Because of this, using a query with only a date condition that .does not specify the primary key prefix will cause more data to be read than for a single date

Use of Index for Partially-Monotonic Primary Keys

Consider, for example, the days of the month. They form a **monotonic sequence** for one month, but not monotonic for more extended periods. This is a partially-monotonic sequence. If a user creates the table with partially-monotonic primary key, ClickHouse creates a sparse index as usual. When a user selects data from this kind of table, ClickHouse analyzes the query conditions. If the user wants to get data between two marks of the index and both these marks fall within one month, ClickHouse can use the index in this particular case because it can calculate the distance between the parameters

.of a query and index marks

ClickHouse cannot use an index if the values of the primary key in the query parameter range don't represent a monotonic sequence. In this case, ClickHouse uses the full scan method

ClickHouse uses this logic not only for days of the month sequences, but for any primary key that represents a partially-monotonic sequence

(Data Skipping Indexes (Experimental))

You need to set `allow_experimental_data_skipping_indices` to 1 to use indices. (run `SET allow_experimental_data_skipping_indices = 1`)

The index declaration is in the columns section of the `CREATE` query

```
INDEX index_name expr TYPE type(...) GRANULARITY granularity_value
```

.For tables from the `*MergeTree` family, data skipping indices can be specified

These indices aggregate some information about the specified expression on blocks, which consist of `granularity_value` granules (the size of the granule is specified using the `index_granularity` setting in the table engine). Then these aggregates are used in `SELECT` queries for reducing the amount of data to read from the disk by skipping big blocks of .data where the `where` query cannot be satisfied

Example

```
CREATE TABLE table_name
(
    u64 UInt64,
    i32 Int32,
    s String,
    ...
    INDEX a (u64 * i32, s) TYPE minmax GRANULARITY 3,
    INDEX b (u64 * length(s)) TYPE set(1000) GRANULARITY 4
) ENGINE = MergeTree()
...
```

Indices from the example can be used by ClickHouse to reduce the amount of data to read from disk in the following :queries

```
SELECT count() FROM table WHERE s < 'z'
SELECT count() FROM table WHERE u64 * i32 == 10 AND u64 * length(s) >= 1234
```

AVAILABLE TYPES OF INDICES

minmax •

Stores extremes of the specified expression (if the expression is `tuple`, then it stores extremes for each element of .`tuple`), uses stored info for skipping blocks of data like the primary key

(`set(max_rows` •

Stores unique values of the specified expression (no more than `max_rows` rows, `max_rows=0` means "no limits"). .Uses the values to check if the `WHERE` expression is not satisfiable on a block of data

(`ngrambf_v1(n, size_of_bloom_filter_in_bytes, number_of_hash_functions, random_seed` •

Stores a **Bloom filter** that contains all ngrams from a block of data. Works only with strings. Can be used for .optimization of `equals`, `like` and `in` expressions

, `n` — ngram size •

`size_of_bloom_filter_in_bytes` — Bloom filter size in bytes (you can use large values here, for example, 256 or 512, •

.(because it can be compressed well

- . number_of_hash_functions — The number of hash functions used in the Bloom filter •
- . random_seed — The seed for Bloom filter hash functions •

(tokenbf_v1(size_of_bloom_filter_in_bytes, number_of_hash_functions, random_seed) •

The same as ngrambf_v1 , but stores tokens instead of ngrams. Tokens are sequences separated by non-alphanumeric characters

- . bloom_filter([false_positive]) — Stores a **Bloom filter** for the specified columns •

The optional false_positive parameter is the probability of receiving a false positive response from the filter. Possible values: (0, 1). Default value: 0.025

.Supported data types: Int* , UInt* , Float* , Enum , Date , DateTime , String , FixedString , Array , LowCardinality , Nullable .The following functions can use it: equals, notEquals, in, notIn, has

```
INDEX sample_index (u64 * length(s)) TYPE minmax GRANULARITY 4
INDEX sample_index2 (u64 * length(str), i32 + f64 * 100, date, str) TYPE set(100) GRANULARITY 4
INDEX sample_index3 (lower(str), str) TYPE ngrambf_v1(3, 256, 2, 0) GRANULARITY 4
```

FUNCTIONS SUPPORT

Conditions in the WHERE clause contains calls of the functions that operate with columns. If the column is a part of an index, ClickHouse tries to use this index when performing the functions. ClickHouse supports different subsets of functions for using indexes

.The set index can be used with all functions. Function subsets for other indexes are shown in the table below

bloom_filter	tokenbf_v1	ngrambf_v1	minmax	primary key	Function (operator) / Index
✓	✓	✓	✓	✓	(==,=) equals
✓	✓	✓	✓	✓	(<>,!=) notEquals
✗	✗	✓	✓	✓	like
✗	✓	✓	✓	✓	notLike
✗	✓	✓	✓	✓	startsWith
✗	✓	✓	✗	✗	endsWith
✗	✓	✓	✗	✗	multiSearchAny
✓	✓	✓	✓	✓	in
✓	✓	✓	✓	✓	notin
✗	✗	✗	✓	✓	(>) less
✗	✗	✗	✓	✓	(<) greater
✗	✗	✗	✓	✓	(=>) lessOrEquals
✗	✗	✗	✓	✓	(=<) greaterOrEquals
✗	✗	✗	✓	✓	empty
✗	✗	✗	✓	✓	notEmpty
✗	✓	✗	✗	✗	hasToken

.Functions with a constant argument that is less than ngram size can't be used by ngrambf_v1 for query optimization

Bloom filters can have false positive matches, so the ngrambf_v1 , tokenbf_v1 , and bloom_filter indexes can't be used for optimizing queries where the result of a function is expected to be false, for example

:Can be optimized •

'%s LIKE '%test •

'%NOT s NOT LIKE '%test •

s = 1 •

NOT s != 1 •

('startsWith(s, 'test •

:Can't be optimized •

'%NOT s LIKE '%test •

'%s NOT LIKE '%test •

NOT s = 1 •

s != 1 •

('NOT startsWith(s, 'test •

Concurrent Data Access

For concurrent table access, we use multi-versioning. In other words, when a table is simultaneously read and updated, data is read from a set of parts that is current at the time of the query. There are no lengthy locks. Inserts do not get in the way of read operations

.Reading from a table is automatically parallelized

TTL for Columns and Tables

.Determines the lifetime of values

The `TTL` clause can be set for the whole table and for each individual column. Table-level TTL can also specify logic of
.automatic move of data between disks and volumes

.Expressions must evaluate to `Date` or `DateTime` data type

:Example

```
TTL time_column  
TTL time_column + interval
```

.To define `interval`, use `time interval` operators

```
TTL date_time + INTERVAL 1 MONTH  
TTL date_time + INTERVAL 15 HOUR
```

Column TTL

When the values in the column expire, ClickHouse replaces them with the default values for the column data type. If all
.the column values in the data part expire, ClickHouse deletes this column from the data part in a filesystem

.The `TTL` clause can't be used for key columns

:Examples

Creating a table with TTL

```
CREATE TABLE example_table  
(  
    d DateTime,  
    a Int TTL d + INTERVAL 1 MONTH,  
    b Int TTL d + INTERVAL 1 MONTH,  
    c String  
)  
ENGINE = MergeTree  
PARTITION BY toYYYYMM(d)  
ORDER BY d;
```

Adding TTL to a column of an existing table

```
ALTER TABLE example_table  
MODIFY COLUMN  
c String TTL d + INTERVAL 1 DAY;
```

Altering TTL of the column

```
ALTER TABLE example_table
    MODIFY COLUMN
        c String TTL d + INTERVAL 1 MONTH;
```

Table TTL

Table can have an expression for removal of expired rows, and multiple expressions for automatic move of parts between **disks or volumes**. When rows in the table expire, ClickHouse deletes all corresponding rows. For parts moving feature, all .rows of a part must satisfy the movement expression criteria

```
TTL expr [DELETE|TO DISK 'aaa'|TO VOLUME 'bbb'], ...
```

Type of TTL rule may follow each TTL expression. It affects an action which is to be done once the expression is satisfied :((reaches current time

- ; (DELETE - delete expired rows (default action •
- ; TO DISK 'aaa' - move part to the disk aaa •
- . TO VOLUME 'bbb' - move part to the disk bbb •

:Examples

Creating a table with TTL

```
CREATE TABLE example_table
(
    d DateTime,
    a Int
)
ENGINE = MergeTree
PARTITION BY toYYYYMM(d)
ORDER BY d
TTL d + INTERVAL 1 MONTH [DELETE],
    d + INTERVAL 1 WEEK TO VOLUME 'aaa',
    d + INTERVAL 2 WEEK TO DISK 'bbb';
```

Altering TTL of the table

```
ALTER TABLE example_table
    MODIFY TTL d + INTERVAL 1 DAY;
```

Removing Data

.Data with an expired TTL is removed when ClickHouse merges data parts

When ClickHouse see that data is expired, it performs an off-schedule merge. To control the frequency of such merges, you can set **merge_with_ttl_timeout**. If the value is too low, it will perform many off-schedule merges that may consume a .lot of resources

If you perform the `SELECT` query between merges, you may get expired data. To avoid it, use the **OPTIMIZE** query .before `SELECT`

Using Multiple Block Devices for Data Storage

Introduction

MergeTree family table engines can store data on multiple block devices. For example, it can be useful when the data of a certain table are implicitly split into "hot" and "cold". The most recent data is regularly requested but requires only a small amount of space. On the contrary, the fat-tailed historical data is requested rarely. If several disks are available, the "hot"

data may be located on fast disks (for example, NVMe SSDs or in memory), while the "cold" data - on relatively slow ones .((for example, HDD

Data part is the minimum movable unit for MergeTree -engine tables. The data belonging to one part are stored on one disk. Data parts can be moved between disks in the background (according to user settings) as well as by means of the .**ALTER** queries

Terms

- .Disk — Block device mounted to the filesystem •
- .Default disk — Disk that stores the path specified in the **path** server setting •
- .(Volume — Ordered set of equal disks (similar to **JBOD**) •
- .Storage policy — Set of volumes and the rules for moving data between them •

The names given to the described entities can be found in the system tables **system.storage_policies** and **system.disks**.

To apply one of the configured storage policies for a table, use the **storage_policy** setting of MergeTree -engine family .**tables**

Configuration

Disks, volumes and storage policies should be declared inside the **<storage_configuration>** tag either in the main file .**config.xml** or in a distinct file in the **config.d** directory :Configuration structure

```
<storage_configuration>
  <disks>
    <disk_name_1> <!-- disk name -->
      <path>/mnt/fast_ssd/clickhouse</path>
    </disk_name_1>
    <disk_name_2>
      <path>/mnt/hdd1/clickhouse</path>
      <keep_free_space_bytes>10485760</keep_free_space_bytes>
    </disk_name_2>
    <disk_name_3>
      <path>/mnt/hdd2/clickhouse</path>
      <keep_free_space_bytes>10485760</keep_free_space_bytes>
    </disk_name_3>

    ...
  </disks>

  ...
</storage_configuration>
```

:Tags

- . **disk_name_N** — Disk name. Names must be different for all disks •
 - .**/' path** — path under which a server will store data (**data** and **shadow** folders), should be terminated with •
 - . **keep_free_space_bytes** — the amount of free disk space to be reserved •
- .The order of the disk definition is not important

:Storage policies configuration markup

```

<storage_configuration>
...
<policies>
    <policy_name_1>
        <volumes>
            <volume_name_1>
                <disk>disk_name_from_disks_configuration</disk>
                <max_data_part_size_bytes>1073741824</max_data_part_size_bytes>
            </volume_name_1>
            <volume_name_2>
                <!-- configuration -->
            </volume_name_2>
            <!-- more volumes -->
        </volumes>
        <move_factor>0.2</move_factor>
    </policy_name_1>
    <policy_name_2>
        <!-- configuration -->
    </policy_name_2>

    <!-- more policies -->
</policies>
...
</storage_configuration>

```

:Tags

- . `policy_name_N` — Policy name. Policy names must be unique •
- . `volume_name_N` — Volume name. Volume names must be unique •
- . `disk` — a disk within a volume •
- . `max_data_part_size_bytes` — the maximum size of a part that can be stored on any of the volume's disks •
- `move_factor` — when the amount of available space gets lower than this factor, data automatically start to move on •
. (the next volume if any (by default, 0.1

:Configuration examples

```

<storage_configuration>
...
<policies>
    <hdd_in_order> <!-- policy name -->
        <volumes>
            <single> <!-- volume name -->
                <disk>disk1</disk>
                <disk>disk2</disk>
            </single>
        </volumes>
    </hdd_in_order>

    <moving_from_ssd_to_hdd>
        <volumes>
            <hot>
                <disk>fast(ssd)</disk>
                <max_data_part_size_bytes>1073741824</max_data_part_size_bytes>
            </hot>
            <cold>
                <disk>disk1</disk>
            </cold>
        </volumes>
        <move_factor>0.2</move_factor>
    </moving_from_ssd_to_hdd>
</policies>
...
</storage_configuration>

```

In given example, the `hdd_in_order` policy implements the **round-robin** approach. Thus this policy defines only one volume

(`single`), the data parts are stored on all its disks in circular order. Such policy can be quite useful if there are several similar disks mounted to the system, but RAID is not configured. Keep in mind that each individual disk drive is not reliable and you might want to compensate it with replication factor of 3 or more.

If there are different kinds of disks available in the system, `moving_from_ss_to_hdd` policy can be used instead. The volume `hot` consists of an SSD disk (`fast_ss`), and the maximum size of a part that can be stored on this volume is 1GB. All the parts with the size larger than 1GB will be stored directly on the `cold` volume, which contains an HDD disk `disk1`. Also, once the disk `fast_ss` gets filled by more than 80%, data will be transferred to the `disk1` by a background process.

The order of volume enumeration within a storage policy is important. Once a volume is overfilled, data are moved to the next one. The order of disk enumeration is important as well because data are stored on them in turns.

:When creating a table, one can apply one of the configured storage policies to it

```
CREATE TABLE table_with_non_default_policy (
    EventDate Date,
    OrderID UInt64,
    BannerID UInt64,
    SearchPhrase String
) ENGINE = MergeTree
ORDER BY (OrderID, BannerID)
PARTITION BY toYYYYMM(EventDate)
SETTINGS storage_policy = 'moving_from_ss_to_hdd'
```

The `default` storage policy implies using only one volume, which consists of only one disk given in `<path>`. Once a table is created, its storage policy cannot be changed.

Details

:In the case of `MergeTree` tables, data is getting to disk in different ways

- .(As a result of an insert (`INSERT` query
- .During background merges and `mutations`
- .When downloading from another replica
- .As a result of partition freezing `ALTER TABLE ... FREEZE PARTITION`

In all these cases except for mutations and partition freezing, a part is stored on a volume and a disk according to the given storage policy

The first volume (in the order of definition) that has enough disk space for storing a part (`unreserved_space > current_part_size`) and allows for storing parts of a given size (`max_data_part_size_bytes > current_part_size`) is chosen.

Within this volume, that disk is chosen that follows the one, which was used for storing the previous chunk of data, .
.(and that has free space more than the part size (`unreserved_space - keep_free_space_bytes > current_part_size`))

Under the hood, mutations and partition freezing make use of **hard links**. Hard links between different disks are not supported, therefore in such cases the resulting parts are stored on the same disks as the initial ones.

In the background, parts are moved between volumes on the basis of the amount of free space (`move_factor` parameter) according to the order the volumes are declared in the configuration file. Data is never transferred from the last one and into the first one. One may use system tables `system.part_log` (field `type = MOVE_PART`) and `system.parts` (fields `path` and `disk`) to monitor background moves. Also, the detailed information can be found in server logs.

User can force moving a part or a partition from one volume to another using the query `ALTER TABLE ... MOVE PART|PARTITION ... TO VOLUME|DISK ...`, all the restrictions for background operations are taken into account. The query initiates a move on its own and does not wait for background operations to be completed. User will get an error message if not enough free space is available or if any of the required conditions are not met.

Moving data does not interfere with data replication. Therefore, different storage policies can be specified for the same table on different replicas

After the completion of background merges and mutations, old parts are removed only after a certain amount of time (`old_parts_lifetime`). During this time, they are not moved to other volumes or disks. Therefore, until the parts are finally removed, they are still taken into account for evaluation of the occupied disk space

Data Replication

:Replication is only supported for tables in the MergeTree family

- ReplicatedMergeTree •
- ReplicatedSummingMergeTree •
- ReplicatedReplacingMergeTree •
- ReplicatedAggregatingMergeTree •
- ReplicatedCollapsingMergeTree •
- ReplicatedVersionedCollapsingMergeTree •
- ReplicatedGraphiteMergeTree •

Replication works at the level of an individual table, not the entire server. A server can store both replicated and non-replicated tables at the same time

.Replication does not depend on sharding. Each shard has its own independent replication

.(Compressed data for `INSERT` and `ALTER` queries is replicated (for more information, see the documentation for [ALTER](#) :`CREATE` , `DROP` , `ATTACH` , `DETACH` and `RENAME` queries are executed on a single server and are not replicated

The `CREATE TABLE` query creates a new replicatable table on the server where the query is run. If this table already exists on other servers, it adds a new replica

.The `DROP TABLE` query deletes the replica located on the server where the query is run

The `RENAME` query renames the table on one of the replicas. In other words, replicated tables can have different names on different replicas

.ClickHouse uses [Apache ZooKeeper](#) for storing replicas meta information. Use ZooKeeper version 3.4.5 or newer

.To use replication, set parameters in the [zookeeper](#) server configuration section

Attention

.Don't neglect the security setting. ClickHouse supports the digest [ACL scheme](#) of the ZooKeeper security subsystem

:Example of setting the addresses of the ZooKeeper cluster

```

<zookeeper>
  <node index="1">
    <host>example1</host>
    <port>2181</port>
  </node>
  <node index="2">
    <host>example2</host>
    <port>2181</port>
  </node>
  <node index="3">
    <host>example3</host>
    <port>2181</port>
  </node>
</zookeeper>

```

You can specify any existing ZooKeeper cluster and the system will use a directory on it for its own data (the directory is .(specified when creating a replicatable table

If ZooKeeper isn't set in the config file, you can't create replicated tables, and any existing replicated tables will be read-only

ZooKeeper is not used in `SELECT` queries because replication does not affect the performance of `SELECT` and queries run just as fast as they do for non-replicated tables. When querying distributed replicated tables, ClickHouse behavior is controlled by the settings `max_replica_delay_for_distributed_queries` and `.fallback_to_stale_replicas_for_distributed_queries`

For each `INSERT` query, approximately ten entries are added to ZooKeeper through several transactions. (To be more precise, this is for each inserted block of data; an `INSERT` query contains one block or one block per `max_insert_block_size = 1048576 rows`.) This leads to slightly longer latencies for `INSERT` compared to non-replicated tables. But if you follow the recommendations to insert data in batches of no more than one `INSERT` per second, it doesn't create any problems. The entire ClickHouse cluster used for coordinating one ZooKeeper cluster has a total of several hundred `INSERTs` per second. The throughput on data inserts (the number of rows per second) is just as high as for non-replicated data

For very large clusters, you can use different ZooKeeper clusters for different shards. However, this hasn't proven .(necessary on the Yandex.Metrica cluster (approximately 300 servers

Replication is asynchronous and multi-master. `INSERT` queries (as well as `ALTER`) can be sent to any available server. Data is inserted on the server where the query is run, and then it is copied to the other servers. Because it is asynchronous, recently inserted data appears on the other replicas with some latency. If part of the replicas are not available, the data is written when they become available. If a replica is available, the latency is the amount of time it .takes to transfer the block of compressed data over the network

By default, an `INSERT` query waits for confirmation of writing the data from only one replica. If the data was successfully written to only one replica and the server with this replica ceases to exist, the stored data will be lost. To enable getting .confirmation of data writes from multiple replicas, use the `insert_quorum` option

Each block of data is written atomically. The `INSERT` query is divided into blocks up to `max_insert_block_size = 1048576 rows`. In other words, if the `INSERT` query has less than 1048576 rows, it is made atomically

Data blocks are deduplicated. For multiple writes of the same data block (data blocks of the same size containing the same rows in the same order), the block is only written once. The reason for this is in case of network failures when the client application doesn't know if the data was written to the DB, so the `INSERT` query can simply be repeated. It doesn't matter which replica `INSERTs` were sent to with identical data. `INSERTs` are idempotent. Deduplication parameters are .controlled by `merge_tree` server settings

During replication, only the source data to insert is transferred over the network. Further data transformation (merging) is coordinated and performed on all the replicas in the same way. This minimizes network usage, which means that replication works well when replicas reside in different datacenters. (Note that duplicating data in different datacenters is .the main goal of replication

You can have any number of replicas of the same data. Yandex.Metrica uses double replication in production. Each server uses RAID-5 or RAID-6, and RAID-10 in some cases. This is a relatively reliable and convenient solution

The system monitors data synchronicity on replicas and is able to recover after a failure. Failover is automatic (for small differences in data) or semi-automatic (when data differs too much, which may indicate a configuration error

Creating Replicated Tables

.The `Replicated` prefix is added to the table engine name. For example:

`Replicated*MergeTree` parameters

- `.zoo_path` — The path to the table in ZooKeeper •
- `.replica_name` — The replica name in ZooKeeper •

:Example

```
CREATE TABLE table_name
(
    EventDate DateTime,
    CounterID UInt32,
    UserID UInt32
) ENGINE = ReplicatedMergeTree('/clickhouse/tables/{layer}-{shard}/table_name', '{replica}')
PARTITION BY toYYYYMM(EventDate)
ORDER BY (CounterID, EventDate, intHash32(UserID))
SAMPLE BY intHash32(UserID)
```

Example in deprecated syntax

```
CREATE TABLE table_name
(
    EventDate DateTime,
    CounterID UInt32,
    UserID UInt32
) ENGINE = ReplicatedMergeTree('/clickhouse/tables/{layer}-{shard}/table_name', '{replica}', EventDate,
intHash32(UserID), (CounterID, EventDate, intHash32(UserID), EventTime), 8192)
```

As the example shows, these parameters can contain substitutions in curly brackets. The substituted values are taken from the 'macros' section of the configuration file. Example

```
<macros>
    <layer>05</layer>
    <shard>02</shard>
    <replica>example05-02-1.yandex.ru</replica>
</macros>
```

The path to the table in ZooKeeper should be unique for each replicated table. Tables on different shards should have different paths. In this case, the path consists of the following parts

.`clickhouse/tables/` is the common prefix. We recommend using exactly this one/

`{layer}-{shard}` is the shard identifier. In this example it consists of two parts, since the Yandex.Metrica cluster uses bi-level sharding. For most tasks, you can leave just the `{shard}` substitution, which will be expanded to the shard identifier

`table_name` is the name of the node for the table in ZooKeeper. It is a good idea to make it the same as the table name. It is defined explicitly, because in contrast to the table name, it doesn't change after a `RENAME` query

HINT: you could add a database name in front of `table_name` as well. E.g. `db_name.table_name`

The replica name identifies different replicas of the same table. You can use the server name for this, as in the example.

.The name only needs to be unique within each shard

You can define the parameters explicitly instead of using substitutions. This might be convenient for testing and for .configuring small clusters. However, you can't use distributed DDL queries (ON CLUSTER) in this case

.When working with large clusters, we recommend using substitutions because they reduce the probability of error

Run the CREATE TABLE query on each replica. This query creates a new replicated table, or adds a new replica to an .existing one

If you add a new replica after the table already contains some data on other replicas, the data will be copied from the .other replicas to the new one after running the query. In other words, the new replica syncs itself with the others

To delete a replica, run DROP TABLE . However, only one replica is deleted – the one that resides on the server where you .run the query

Recovery After Failures

If ZooKeeper is unavailable when a server starts, replicated tables switch to read-only mode. The system periodically .attempts to connect to ZooKeeper

If ZooKeeper is unavailable during an INSERT , or an error occurs when interacting with ZooKeeper, an exception is .thrown

After connecting to ZooKeeper, the system checks whether the set of data in the local file system matches the expected set of data (ZooKeeper stores this information). If there are minor inconsistencies, the system resolves them by syncing .data with the replicas

If the system detects broken data parts (with the wrong size of files) or unrecognized parts (parts written to the file system but not recorded in ZooKeeper), it moves them to the detached subdirectory (they are not deleted). Any missing parts are .copied from the replicas

.Note that ClickHouse does not perform any destructive actions such as automatically deleting a large amount of data

When the server starts (or establishes a new session with ZooKeeper), it only checks the quantity and sizes of all files. If the file sizes match but bytes have been changed somewhere in the middle, this is not detected immediately, but only when attempting to read the data for a SELECT query. The query throws an exception about a non-matching checksum or size of a compressed block. In this case, data parts are added to the verification queue and copied from the replicas if .necessary

If the local set of data differs too much from the expected one, a safety mechanism is triggered. The server enters this in the log and refuses to launch. The reason for this is that this case may indicate a configuration error, such as if a replica on a shard was accidentally configured like a replica on a different shard. However, the thresholds for this mechanism are set fairly low, and this situation might occur during normal failure recovery. In this case, data is restored semi-.automatically - by "pushing a button

To start recovery, create the node /path_to_table/replica_name flags/force_restore_data in ZooKeeper with any content, or run :the command to restore all replicated tables

```
sudo -u clickhouse touch /var/lib/clickhouse/flags/force_restore_data
```

.Then restart the server. On start, the server deletes these flags and starts recovery

Recovery After Complete Data Loss

:If all data and metadata disappeared from one of the servers, follow these steps for recovery

Install ClickHouse on the server. Define substitutions correctly in the config file that contains the shard identifier and .1
.replicas, if you use them

If you had unreplicated tables that must be manually duplicated on the servers, copy their data from a replica (in the .2
.(/directory /var/lib/clickhouse/data/db_name/table_name

Copy table definitions located in /var/lib/clickhouse/metadata/ from a replica. If a shard or replica identifier is defined .3
explicitly in the table definitions, correct it so that it corresponds to this replica. (Alternatively, start the server and
(./make all the ATTACH TABLE queries that should have been in the .sql files in /var/lib/clickhouse/metadata

To start recovery, create the ZooKeeper node /path_to_table/replica_name flags/force_restore_data with any content, or .4
run the command to restore all replicated tables: sudo -u clickhouse touch /var/lib/clickhouse flags/force_restore_data

.Then start the server (restart, if it is already running). Data will be downloaded from replicas

An alternative recovery option is to delete information about the lost replica from ZooKeeper (/path_to_table/replica_name),
.then create the replica again as described in "[Creating replicated tables](#)

.There is no restriction on network bandwidth during recovery. Keep this in mind if you are restoring many replicas at once

Converting from MergeTree to ReplicatedMergeTree

.We use the term MergeTree to refer to all table engines in the MergeTree family , the same as for ReplicatedMergeTree

If you had a MergeTree table that was manually replicated, you can convert it to a replicated table. You might need to do
.this if you have already collected a large amount of data in a MergeTree table and now you want to enable replication

.If the data differs on various replicas, first sync it, or delete this data on all the replicas except one

Rename the existing MergeTree table, then create a ReplicatedMergeTree table with the old name. Move the data from the
old table to the detached subdirectory inside the directory with the new table data
(/var/lib/clickhouse/data/db_name/table_name/). Then run ALTER TABLE ATTACH PARTITION on one of the replicas to add
.these data parts to the working set

Converting from ReplicatedMergeTree to MergeTree

Create a MergeTree table with a different name. Move all the data from the directory with theReplicatedMergeTree table
.data to the new table's data directory. Then delete the ReplicatedMergeTree table and restart the server

:If you want to get rid of a ReplicatedMergeTree table without launching the server

.(/Delete the corresponding .sql file in the metadata directory /var/lib/clickhouse/metadata •
. (Delete the corresponding path in ZooKeeper (/path_to_table/replica_name •

.After this, you can launch the server, create a MergeTree table, move the data to its directory, and then restart the server

Recovery When Metadata in The ZooKeeper Cluster is Lost or Damaged

If the data in ZooKeeper was lost or damaged, you can save data by moving it to an unreplicated table as described
.above

Custom Partitioning Key

Partitioning is available for the MergeTree family tables (including replicated tables). Materialized views based on
.MergeTree tables support partitioning, as well

A partition is a logical combination of records in a table by a specified criterion. You can set a partition by an arbitrary criterion, such as by month, by day, or by event type. Each partition is stored separately in order to simplify manipulations of this data. When accessing the data, ClickHouse uses the smallest subset of partitions possible

The partition is specified in the PARTITION BY expr clause when [creating a table](#). The partition key can be any expression (from the table columns. For example, to specify partitioning by month, use the expression toYYYYMM(date_column)

```
CREATE TABLE visits
(
    VisitDate Date,
    Hour UInt8,
    ClientID UUID
)
ENGINE = MergeTree()
PARTITION BY toYYYYMM(VisitDate)
ORDER BY Hour;
```

:The partition key can also be a tuple of expressions (similar to the [primary key](#)). For example

```
ENGINE = ReplicatedCollapsingMergeTree('/clickhouse/tables/name', 'replica1', Sign)
PARTITION BY (toMonday(StartDate), EventType)
ORDER BY (CounterID, StartDate, intHash32(UserID));
```

.In this example, we set partitioning by the event types that occurred during the current week

When inserting new data to a table, this data is stored as a separate part (chunk) sorted by the primary key. In 10-15 minutes after inserting, the parts of the same partition are merged into the entire part

Info 

A merge only works for data parts that have the same value for the partitioning expression. This means you shouldn't make overly granular partitions (more than about a thousand partitions). Otherwise, the `SELECT` query performs poorly because of an unreasonably large number of .files in the file system and open file descriptors

Use the `system.parts` table to view the table parts and partitions. For example, let's assume that we have a `visits` table with partitioning by month. Let's perform the `SELECT` query for the `system.parts` table

```
SELECT
    partition,
    name,
    active
FROM system.parts
WHERE table = 'visits'
```

partition	name	active
201901	201901_1_3_1	0
201901	201901_1_9_2	1
201901	201901_8_8_0	0
201901	201901_9_9_0	0
201902	201902_4_6_1	1
201902	201902_10_10_0	1
201902	201902_11_11_0	1

The `partition` column contains the names of the partitions. There are two partitions in this example: 201901 and 201902 . You can use this column value to specify the partition name in [ALTER ... PARTITION](#) queries

The `name` column contains the names of the partition data parts. You can use this column to specify the name of the part .in the [ALTER ATTACH PART](#) query

:Let's break down the name of the first part: 201901_1_3_1

- .is the partition name 201901
- .is the minimum number of the data block 1
- .is the maximum number of the data block 3
- .(is the chunk level (the depth of the merge tree it is formed from 1

Info ⓘ

The parts of old-type tables have the name: 20190117_20190123_2_2_0 (minimum date - maximum date - minimum block number - maximum block .(number - level

The `active` column shows the status of the part. 1 is active; 0 is inactive. The inactive parts are, for example, source .parts remaining after merging to a larger part. The corrupted data parts are also indicated as inactive

As you can see in the example, there are several separated parts of the same partition (for example, 201901_1_3_1 and 201901_1_9_2). This means that these parts are not merged yet. ClickHouse merges the inserted parts of data periodically, approximately 15 minutes after inserting. In addition, you can perform a non-scheduled merge using the :OPTIMIZE query. Example

```
OPTIMIZE TABLE visits PARTITION 201902;
```

partition	name	active
201901	201901_1_3_1	0
201901	201901_1_9_2	1
201901	201901_8_8_0	0
201901	201901_9_9_0	0
201902	201902_4_6_1	0
201902	201902_4_11_2	1
201902	201902_10_10_0	0
201902	201902_11_11_0	0

.Inactive parts will be deleted approximately 10 minutes after merging

Another way to view a set of parts and partitions is to go into the directory of the table: :/var/lib/clickhouse/data/<database>/<table>/. For example

```
/var/lib/clickhouse/data/default/visits$ ls -l
total 40
drwxr-xr-x 2 clickhouse clickhouse 4096 Feb  1 16:48 201901_1_3_1
drwxr-xr-x 2 clickhouse clickhouse 4096 Feb  5 16:17 201901_1_9_2
drwxr-xr-x 2 clickhouse clickhouse 4096 Feb  5 15:52 201901_8_8_0
drwxr-xr-x 2 clickhouse clickhouse 4096 Feb  5 15:52 201901_9_9_0
drwxr-xr-x 2 clickhouse clickhouse 4096 Feb  5 16:17 201902_10_10_0
drwxr-xr-x 2 clickhouse clickhouse 4096 Feb  5 16:17 201902_11_11_0
drwxr-xr-x 2 clickhouse clickhouse 4096 Feb  5 16:19 201902_4_11_2
drwxr-xr-x 2 clickhouse clickhouse 4096 Feb  5 12:09 201902_4_6_1
drwxr-xr-x 2 clickhouse clickhouse 4096 Feb  1 16:48 detached
```

The folders '201901_1_1_0', '201901_1_7_1' and so on are the directories of the parts. Each part relates to a .(corresponding partition and contains data just for a certain month (the table in this example has partitioning by month

The `detached` directory contains parts that were detached from the table using the DETACH query. The corrupted parts are also moved to this directory, instead of being deleted. The server does not use the parts from the `detached` directory. You can add, delete, or modify the data in this directory at any time – the server will not know about this until you run the ATTACH query

Note that on the operating server, you cannot manually change the set of parts or their data on the file system, since the server will not know about it. For non-replicated tables, you can do this when the server is stopped, but it isn't

.recommended. For replicated tables, the set of parts cannot be changed in any case ClickHouse allows you to perform operations with the partitions: delete them, copy from one table to another, or create a .backup. See the list of all operations in the section [Manipulations With Partitions and Parts](#)

ReplacingMergeTree

The engine differs from [MergeTree](#) in that it removes duplicate entries with the same primary key value (or more .accurately, with the same [sorting key](#) value

Data deduplication occurs only during a merge. Merging occurs in the background at an unknown time, so you can't plan for it. Some of the data may remain unprocessed. Although you can run an unscheduled merge using the [OPTIMIZE](#) .query, don't count on using it, because the [OPTIMIZE](#) query will read and write a large amount of data

Thus, `ReplacingMergeTree` is suitable for clearing out duplicate data in the background in order to save space, but it .doesn't guarantee the absence of duplicates

Creating a Table

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
    name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1],
    name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2],
    ...
) ENGINE = ReplacingMergeTree([ver])
[PARTITION BY expr]
[ORDER BY expr]
[PRIMARY KEY expr]
[SAMPLE BY expr]
[SETTINGS name=value, ...]
```

.For a description of request parameters, see[request description](#)

ReplacingMergeTree Parameters

.`ver` — column with version. Type `UInt*`, `Date` or `DateTime` . Optional parameter •

When merging, `ReplacingMergeTree` from all the rows with the same primary key leaves only one: - Last in the .selection, if `ver` not set. - With the maximum version, if `ver` specified

Query clauses

.When creating a `ReplacingMergeTree` table the same [clauses](#) are required, as when creating a `MergeTree` table

Attention !

.Do not use this method in new projects and, if possible, switch the old projects to the method described above

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
    name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1],
    name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2],
    ...
) ENGINE [=] ReplacingMergeTree(date-column [, sampling_expression], (primary, key), index_granularity,
[ver])
```

.All of the parameters excepting ver have the same meaning as in MergeTree

.ver - column with the version. Optional parameter. For a description, see the text above •

SummingMergeTree

The engine inherits from [MergeTree](#). The difference is that when merging data parts for SummingMergeTree tables ClickHouse replaces all the rows with the same primary key (or more accurately, with the same [sorting key](#)) with one row which contains summarized values for the columns with the numeric data type. If the sorting key is composed in a way that a single key value corresponds to large number of rows, this significantly reduces storage volume and speeds up data selection

We recommend to use the engine together with MergeTree . Store complete data in MergeTree table, and use SummingMergeTree for aggregated data storing, for example, when preparing reports. Such an approach will prevent you from losing valuable data due to an incorrectly composed primary key

Creating a Table

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
    name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1],
    name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2],
    ...
) ENGINE = SummingMergeTree([columns])
[PARTITION BY expr]
[ORDER BY expr]
[SAMPLE BY expr]
[SETTINGS name=value, ...]
```

.For a description of request parameters, see[request description](#)

Parameters of SummingMergeTree

columns - a tuple with the names of columns where values will be summarized. Optional parameter. The columns • must be of a numeric type and must not be in the primary key

If columns not specified, ClickHouse summarizes the values in all columns with a numeric data type that are not in the primary key

Query clauses

.When creating a SummingMergeTree table the same [clauses](#) are required, as when creating a MergeTree table

Attention

.Do not use this method in new projects and, if possible, switch the old projects to the method described above

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
    name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1],
    name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2],
    ...
) ENGINE [=] SummingMergeTree(date-column [, sampling_expression], (primary, key), index_granularity,
[columns])
```

.All of the parameters excepting columns have the same meaning as in MergeTree

.columns — tuple with names of columns values of which will be summarized. Optional parameter. For a description, see the text above •

Usage Example

:Consider the following table

```
CREATE TABLE summtt
(
    key UInt32,
    value UInt32
)
ENGINE = SummingMergeTree()
ORDER BY key
```

:Insert data to it

```
INSERT INTO summtt Values(1,1),(1,2),(2,1)
```

ClickHouse may sum all the rows not completely ([see below](#)), so we use an aggregate function sum and GROUP BY .clause in the query

```
SELECT key, sum(value) FROM summtt GROUP BY key
```

key	sum(value)
2	1
1	3

Data Processing

When data are inserted into a table, they are saved as-is. Clickhouse merges the inserted parts of data periodically and .this is when rows with the same primary key are summed and replaced with one for each resulting part of data

ClickHouse can merge the data parts so that different resulting parts of data cat consist rows with the same primary key, i.e. the summation will be incomplete. Therefore (SELECT) an aggregate function sum() and GROUP BY clause should be .used in a query as described in the example above

Common rules for summation

The values in the columns with the numeric data type are summarized. The set of columns is defined by the parameter . columns

.If the values were 0 in all of the columns for summation, the row is deleted

.If column is not in the primary key and is not summarized, an arbitrary value is selected from the existing ones

.The values are not summarized for columns in the primary key

The Summation in the AggregateFunction Columns

For columns of **AggregateFunction** type ClickHouse behaves as **AggregatingMergeTree** engine aggregating according to

.the function

Nested Structures

.Table can have nested data structures that are processed in a special way

:If the name of a nested table ends with **Map** and it contains at least two columns that meet the following criteria

,the first column is numeric (*Int*, Date, DateTime) , let's call it **key** •

, (...the other columns are arithmetic (*Int*, Float32/64) , let's call it **(values** •

then this nested table is interpreted as a mapping of **key => (values...)** , and when merging its rows, the elements of two

. (...data sets are merged by **key** with a summation of the corresponding **(values**

:Examples

```
[(1, 100)] + [(2, 150)] -> [(1, 100), (2, 150)]
[(1, 100)] + [(1, 150)] -> [(1, 250)]
[(1, 100)] + [(1, 150), (2, 150)] -> [(1, 250), (2, 150)]
[(1, 100), (2, 150)] + [(1, -100)] -> [(2, 150)]
```

.When requesting data, use the **sumMap(key, value)** function for aggregation of **Map**

.For nested data structure, you do not need to specify its columns in the tuple of columns for summation

AggregatingMergeTree

The engine inherits from **MergeTree**, altering the logic for data parts merging. ClickHouse replaces all rows with the same primary key (or more accurately, with the same **sorting key**) with a single row (within a one data part) that stores a .combination of states of aggregate functions

.You can use **AggregatingMergeTree** tables for incremental data aggregation, including for aggregated materialized views

.The engine processes all columns with **AggregateFunction** type

.It is appropriate to use **AggregatingMergeTree** if it reduces the number of rows by orders

Creating a Table

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
    name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1],
    name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2],
    ...
) ENGINE = AggregatingMergeTree()
[PARTITION BY expr]
[ORDER BY expr]
[SAMPLE BY expr]
[TTL expr]
[SETTINGS name=value, ...]
```

.For a description of request parameters, see [request description](#)

Query clauses

.When creating a `AggregatingMergeTree` table the same [clauses](#) are required, as when creating a `MergeTree` table

Deprecated Method for Creating a Table

Attention 

.Do not use this method in new projects and, if possible, switch the old projects to the method described above

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
    name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1],
    name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2],
    ...
) ENGINE [=] AggregatingMergeTree(date-column [, sampling_expression], (primary, key),
index_granularity)
```

.All of the parameters have the same meaning as in `MergeTree`

SELECT and INSERT

To insert data, use [INSERT SELECT](#) query with aggregate -State- functions. When selecting data from `AggregatingMergeTree` table, use `GROUP BY` clause and the same aggregate functions as when inserting data, but using `.Merge` suffix

In the results of `SELECT` query the values of `AggregateFunction` type have implementation-specific binary representation for all of the ClickHouse output formats. If dump data into, for example, `TabSeparated` format with `SELECT` query then this `.dump` can be loaded back using `INSERT` query

Example of an Aggregated Materialized View

: `AggregatingMergeTree` materialized view that watches the `test.visits` table

```
CREATE MATERIALIZED VIEW test.basic
ENGINE = AggregatingMergeTree() PARTITION BY toYYYYMM(StartDate) ORDER BY (CounterID, StartDate)
AS SELECT
    CounterID,
    StartDate,
    sumState(Sign) AS Visits,
    uniqState(UserID) AS Users
FROM test.visits
GROUP BY CounterID, StartDate;
```

.Inserting of data into the `test.visits` table

```
INSERT INTO test.visits ...
```

.The data are inserted in both the table and view `test.basic` that will perform the aggregation

: To get the aggregated data, we need to execute a query such as `SELECT ... GROUP BY ...` from the view `test.basic`

```
SELECT
    StartDate,
    sumMerge(Visits) AS Visits,
    uniqMerge/Users) AS Users
FROM test.basic
GROUP BY StartDate
ORDER BY StartDate;
```

CollapsingMergeTree

.The engine inherits from [MergeTree](#) and adds the logic of rows collapsing to data parts merge algorithm

`CollapsingMergeTree` asynchronously deletes (collapses) pairs of rows if all of the fields in a sorting key (`ORDER BY`) are equivalent excepting the particular field `Sign` which can have `1` and `-1` values. Rows without a pair are kept. For more details see the [Collapsing](#) section of the document

.The engine may significantly reduce the volume of storage and increase efficiency of `SELECT` query as a consequence

Creating a Table

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
    name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1],
    name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2],
    ...
) ENGINE = CollapsingMergeTree(sign)
[PARTITION BY expr]
[ORDER BY expr]
[SAMPLE BY expr]
[SETTINGS name=value, ...]
```

.For a description of query parameters, see[query description](#)

CollapsingMergeTree Parameters

. `sign` — Name of the column with the type of row:`1` is a "state" row, `-1` is a "cancel" row •

.Column data type — `Int8`

Query clauses

.When creating a `CollapsingMergeTree` table, the same[query clauses](#) are required, as when creating a `MergeTree` table

Attention

.Do not use this method in new projects and, if possible, switch the old projects to the method described above

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
    name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1],
    name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2],
    ...
) ENGINE [=] CollapsingMergeTree(date-column [, sampling_expression], (primary, key),
index_granularity, sign)
```

.All of the parameters excepting sign have the same meaning as in MergeTree

.sign — Name of the column with the type of row: 1 — "state" row, -1 — "cancel" row •

.Column Data Type — Int8

Collapsing**Data**

Consider the situation where you need to save continually changing data for some object. It sounds logical to have one row for an object and update it at any change, but update operation is expensive and slow for DBMS because it requires rewriting of the data in the storage. If you need to write data quickly, update not acceptable, but you can write the changes .of an object sequentially as follows

Use the particular column Sign . If Sign = 1 it means that the row is a state of an object, let's call it "state" row. If Sign = -1 .it means the cancellation of the state of an object with the same attributes, let's call it "cancel" row

For example, we want to calculate how much pages users checked at some site and how long they were there. At some :moment of time we write the following row with the state of user activity

UserID	PageViews	Duration	Sign
4324182021466249494	5	146	1

.At some moment later we register the change of user activity and write it with the following two rows

UserID	PageViews	Duration	Sign
4324182021466249494	5	146	-1
4324182021466249494	6	185	1

The first row cancels the previous state of the object (user). It should copy the sorting key fields of the canceled state .excluding Sign

.The second row contains the current state

As we need only the last state of user activity, the rows

UserID	PageViews	Duration	Sign
4324182021466249494	5	146	1
4324182021466249494	5	146	-1

can be deleted collapsing the invalid (old) state of an object. CollapsingMergeTree does this while merging of the data .parts

.Why we need 2 rows for each change read in the **Algorithm** paragraph

Peculiar properties of such approach

The program that writes the data should remember the state of an object to be able to cancel it. "Cancel" string .1 should contain copies of the sorting key fields of the "state" string and the opposite `Sign`. It increases the initial size of .storage but allows to write the data quickly

Long growing arrays in columns reduce the efficiency of the engine due to load for writing. The more straightforward .2 .data, the higher efficiency

The `SELECT` results depend strongly on the consistency of object changes history. Be accurate when preparing data .3 for inserting. You can get unpredictable results in inconsistent data, for example, negative values for non-negative .metrics such as session depth

Algorithm

When ClickHouse merges data parts, each group of consecutive rows with the same sorting key (`ORDER BY`) is reduced to not more than two rows, one with `Sign = 1` ("state" row) and another with `Sign = -1` ("cancel" row). In other words, .entries collapse

:For each resulting data part ClickHouse saves

.The first "cancel" and the last "state" rows, if the number of "state" and "cancel" rows matches .1

.The last "state" row, if there is one more "state" row than "cancel" rows .2

.The first "cancel" row, if there is one more "cancel" row than "state" rows .3

.None of the rows, in all other cases .4

The merge continues, but ClickHouse treats this situation as a logical error and records it in the server log. This error .can occur if the same data were inserted more than once

Thus, collapsing should not change the results of calculating statistics. Changes gradually collapsed so that in the end .only the last state of almost every object left

The `Sign` is required because the merging algorithm doesn't guarantee that all of the rows with the same sorting key will be in the same resulting data part and even on the same physical server. ClickHouse process `SELECT` queries with multiple threads, and it can not predict the order of rows in the result. The aggregation is required if there is a need to get .completely "collapsed" data from `CollapsingMergeTree` table

To finalize collapsing, write a query with `GROUP BY` clause and aggregate functions that account for the sign. For example, to calculate quantity, use `sum(Sign)` instead of `count()`. To calculate the sum of something, use `sum(Sign * x)` .instead of `sum(x)`, and so on, and also add `HAVING sum(Sign) > 0`

The aggregates `count`, `sum` and `avg` could be calculated this way. The aggregate `uniq` could be calculated if an object has at least one state not collapsed. The aggregates `min` and `max` could not be calculated because `CollapsingMergeTree` .does not save values history of the collapsed states

If you need to extract data without aggregation (for example, to check whether rows are present whose newest values match certain conditions), you can use the `FINAL` modifier for the `FROM` clause. This approach is significantly less .efficient

Example of use

:Example data

UserID	PageViews	Duration	Sign
4324182021466249494	5	146	1
4324182021466249494	5	146	-1
4324182021466249494	6	185	1

:Creation of the table

```
CREATE TABLE UAct
(
    UserID UInt64,
    PageViews UInt8,
    Duration UInt8,
    Sign Int8
)
ENGINE = CollapsingMergeTree(Sign)
ORDER BY UserID
```

:Insertion of the data

```
INSERT INTO UAct VALUES (4324182021466249494, 5, 146, 1)
```

```
INSERT INTO UAct VALUES (4324182021466249494, 5, 146, -1), (4324182021466249494, 6, 185, 1)
```

We use two `INSERT` queries to create two different data parts. If we insert the data with one query ClickHouse creates .one data part and will not perform any merge ever

:Getting the data

```
SELECT * FROM UAct
```

UserID	PageViews	Duration	Sign
4324182021466249494	5	146	-1
4324182021466249494	6	185	1

UserID	PageViews	Duration	Sign
4324182021466249494	5	146	1

?What do we see and where is collapsing

With two `INSERT` queries, we created 2 data parts. The `SELECT` query was performed in 2 threads, and we got a random order of rows. Collapsing not occurred because there was no merge of the data parts yet. ClickHouse merges data part in .an unknown moment of time which we can not predict

:Thus we need aggregation

```
SELECT
    UserID,
    sum(PageViews * Sign) AS PageViews,
    sum(Duration * Sign) AS Duration
FROM UAct
GROUP BY UserID
HAVING sum(Sign) > 0
```

UserID	PageViews	Duration
4324182021466249494	6	185

.If we do not need aggregation and want to force collapsing, we can use `FINAL` modifier for `FROM` clause

```
SELECT * FROM UAct FINAL
```

UserID	PageViews	Duration	Sign
4324182021466249494	6	185	1

. This way of selecting the data is very inefficient. Don't use it for big tables

Example of another approach

:Example data

UserID	PageViews	Duration	Sign
4324182021466249494	5	146	1
4324182021466249494	-5	-146	-1
4324182021466249494	6	185	1

The idea is that merges take into account only key fields. And in the "Cancel" line we can specify negative values that equalize the previous version of the row when summing without using the Sign column. For this approach, it is necessary .to change the data type PageViews , Duration to store negative values of UInt8 -> Int16

```
CREATE TABLE UAct
(
    UserID UInt64,
    PageViews Int16,
    Duration Int16,
    Sign Int8
)
ENGINE = CollapsingMergeTree(Sign)
ORDER BY UserID
```

:Let's test the approach

```
insert into UAct values(4324182021466249494, 5, 146, 1);
insert into UAct values(4324182021466249494, -5, -146, -1);
insert into UAct values(4324182021466249494, 6, 185, 1);

select * from UAct final; // avoid using final in production (just for a test or small tables)
```

UserID	PageViews	Duration	Sign
4324182021466249494	6	185	1

```
SELECT
    UserID,
    sum(PageViews) AS PageViews,
    sum(Duration) AS Duration
FROM UAct
GROUP BY UserID
```text
```

UserID	PageViews	Duration
4324182021466249494	6	185

```
select count() FROM UAct
```

count()
3

```
optimize table UAct final;
select * FROM UAct
```

UserID	PageViews	Duration	Sign
4324182021466249494	6	185	1

## VersionedCollapsingMergeTree

:This engine

- .Allows quick writing of object states that are continually changing •
- .Deletes old object states in the background. This significantly reduces the volume of storage •
- .See the section [Collapsing](#) for details

The engine inherits from [MergeTree](#) and adds the logic for collapsing rows to the algorithm for merging data parts. `VersionedCollapsingMergeTree` serves the same purpose as [CollapsingMergeTree](#) but uses a different collapsing algorithm that allows inserting the data in any order with multiple threads. In particular, the `Version` column helps to collapse the rows properly even if they are inserted in the wrong order. In contrast, [CollapsingMergeTree](#) allows only strictly consecutive insertion

## Creating a Table

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
 name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1],
 name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2],
 ...
) ENGINE = VersionedCollapsingMergeTree(sign, version)
[PARTITION BY expr]
[ORDER BY expr]
[SAMPLE BY expr]
[SETTINGS name=value, ...]
```

.For a description of query parameters, see the[query description](#)

### Engine Parameters

```
VersionedCollapsingMergeTree(sign, version)
```

- . `sign` — Name of the column with the type of row:`1` is a "state" row, `-1` is a "cancel" row •  
.The column data type should be `Int8`
- . `version` — Name of the column with the version of the object state •  
.The column data type should be `UInt`

### Query Clauses

.When creating a `VersionedCollapsingMergeTree` table, the same [clauses](#) are required as when creating a [MergeTree](#) table

## Attention !

.Do not use this method in new projects. If possible, switch the old projects to the method described above

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
 name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1],
 name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2],
 ...
) ENGINE [=] VersionedCollapsingMergeTree(date-column [, sampling_expression], (primary, key),
index_granularity, sign, version)
```

.All of the parameters except `sign` and `version` have the same meaning as in `MergeTree`

- .`sign` — Name of the column with the type of row: `1` is a "state" row, `-1` is a "cancel" row •

- .Column Data Type — `Int8`

- .`version` — Name of the column with the version of the object state •

- . \*The column data type should be `UInt`

## Collapsing

## Data

Consider a situation where you need to save continually changing data for some object. It is reasonable to have one row for an object and update the row whenever there are changes. However, the update operation is expensive and slow for a DBMS because it requires rewriting the data in the storage. Update is not acceptable if you need to write data quickly, but

.you can write the changes to an object sequentially as follows

Use the `Sign` column when writing the row. If `Sign = 1` it means that the row is a state of an object (let's call it the "state" row). If `Sign = -1` it indicates the cancellation of the state of an object with the same attributes (let's call it the "cancel" row). Also use the `Version` column, which should identify each state of an object with a separate number

For example, we want to calculate how many pages users visited on some site and how long they were there. At some point in time we write the following row with the state of user activity

UserID	PageViews	Duration	Sign	Version
4324182021466249494	5	146	1	1

.At some point later we register the change of user activity and write it with the following two rows

UserID	PageViews	Duration	Sign	Version
4324182021466249494	5	146	-1	1
4324182021466249494	6	185	1	2

The first row cancels the previous state of the object (user). It should copy all of the fields of the canceled state except .`Sign`

.The second row contains the current state

Because we need only the last state of user activity, the rows

User ID	Page Views	Duration	Sign	Version
4324182021466249494	5	146	1	1
4324182021466249494	5	146	-1	1

can be deleted, collapsing the invalid (old) state of the object. `VersionedCollapsingMergeTree` does this while merging the .data parts

.To find out why we need two rows for each change, see [Algorithm](#)

## Notes on Usage

The program that writes the data should remember the state of an object in order to cancel it. The "cancel" string .1 should be a copy of the "state" string with the opposite `Sign` . This increases the initial size of storage but allows to .write the data quickly

Long growing arrays in columns reduce the efficiency of the engine due to the load for writing. The more .2 .straightforward the data, the better the efficiency

`SELECT` results depend strongly on the consistency of the history of object changes. Be accurate when preparing .3 data for inserting. You can get unpredictable results with inconsistent data, such as negative values for non-negative .metrics like session depth

## Algorithm

When ClickHouse merges data parts, it deletes each pair of rows that have the same primary key and version and .different `Sign` . The order of rows does not matter

When ClickHouse inserts data, it orders rows by the primary key. If the `Version` column is not in the primary key, .ClickHouse adds it to the primary key implicitly as the last field and uses it for ordering

## Selecting Data

ClickHouse doesn't guarantee that all of the rows with the same primary key will be in the same resulting data part or even on the same physical server. This is true both for writing the data and for subsequent merging of the data parts. In addition, ClickHouse processes `SELECT` queries with multiple threads, and it cannot predict the order of rows in the result.

This means that aggregation is required if there is a need to get completely "collapsed" data from a . `VersionedCollapsingMergeTree` table

To finalize collapsing, write a query with a `GROUP BY` clause and aggregate functions that account for the sign. For example, to calculate quantity, use `sum(Sign)` instead of `count()` . To calculate the sum of something, use `sum(Sign * x)` .instead of `sum(x)` , and add `HAVING sum(Sign) > 0`

The aggregates `count` , `sum` and `avg` can be calculated this way. The aggregate `uniq` can be calculated if an object has at least one non-collapsed state. The aggregates `min` and `max` can't be calculated because `VersionedCollapsingMergeTree` .does not save the history of values of collapsed states

If you need to extract the data with "collapsing" but without aggregation (for example, to check whether rows are present whose newest values match certain conditions), you can use the `FINAL` modifier for the `FROM` clause. This approach is .inefficient and should not be used with large tables

## Example of Use

:Example data

UserID	PageViews	Duration	Sign	Version
4324182021466249494	5	146	1	1
4324182021466249494	5	146	-1	1
4324182021466249494	6	185	1	2

:Creating the table

```
CREATE TABLE UAct
(
 UserID UInt64,
 PageViews UInt8,
 Duration UInt8,
 Sign Int8,
 Version UInt8
)
ENGINE = VersionedCollapsingMergeTree(Sign, Version)
ORDER BY UserID
```

:Inserting the data

```
INSERT INTO UAct VALUES (4324182021466249494, 5, 146, 1, 1)
```

```
INSERT INTO UAct VALUES (4324182021466249494, 5, 146, -1, 1), (4324182021466249494, 6, 185, 1, 2)
```

We use two `INSERT` queries to create two different data parts. If we insert the data with a single query, ClickHouse creates one data part and will never perform any merge

:Getting the data

```
SELECT * FROM UAct
```

UserID	PageViews	Duration	Sign	Version
4324182021466249494	5	146	1	1
4324182021466249494	5	146	-1	1
4324182021466249494	6	185	1	2

What do we see here and where are the collapsed parts? We created two data parts using two `INSERT` queries. The `SELECT` query was performed in two threads, and the result is a random order of rows. Collapsing did not occur because the data parts have not been merged yet. ClickHouse merges data parts at an unknown point in time which we cannot predict

:This is why we need aggregation

```
SELECT
 UserID,
 sum(PageViews * Sign) AS PageViews,
 sum(Duration * Sign) AS Duration,
 Version
FROM UAct
GROUP BY UserID, Version
HAVING sum(Sign) > 0
```

UserID	PageViews	Duration	Version
4324182021466249494	6	185	2

If we don't need aggregation and want to force collapsing, we can use the `FINAL` modifier for the `FROM` clause

```
SELECT * FROM UAct FINAL
```

UserID	PageViews	Duration	Sign	Version
4324182021466249494	6	185	1	2

. This is a very inefficient way to select data. Don't use it for large tables

## GraphiteMergeTree

This engine is designed for thinning and aggregating/averaging (rollup) [Graphite](#) data. It may be helpful to developers who  
. want to use ClickHouse as a data store for Graphite

You can use any ClickHouse table engine to store the Graphite data if you don't need rollup, but if you need a rollup use  
. `GraphiteMergeTree` . The engine reduces the volume of storage and increases the efficiency of queries from Graphite  
. The engine inherits properties from [MergeTree](#)

## Creating a Table

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
 Path String,
 Time DateTime,
 Value <Numeric_type>,
 Version <Numeric_type>
 ...
) ENGINE = GraphiteMergeTree(config_section)
[PARTITION BY expr]
[ORDER BY expr]
[SAMPLE BY expr]
[SETTINGS name=value, ...]
```

. See a detailed description of the [CREATE TABLE](#) query

: A table for the Graphite data should have the following columns for the following data

- . Metric name (Graphite sensor). Data type: `String` •
- . Time of measuring the metric. Data type: `DateTime` •
- . Value of the metric. Data type: any numeric •
- . Version of the metric. Data type: any numeric •

ClickHouse saves the rows with the highest version or the last written if versions are the same. Other rows are  
. deleted during the merge of data parts

. The names of these columns should be set in the rollup configuration

GraphiteMergeTree parameters

. `config_section` — Name of the section in the configuration file, where are the rules of rollup set •

Query clauses

. When creating a `GraphiteMergeTree` table, the same [clauses](#) are required, as when creating a `MergeTree` table

## Attention !

.Do not use this method in new projects and, if possible, switch the old projects to the method described above

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
 EventDate Date,
 Path String,
 Time DateTime,
 Value <Numeric_type>,
 Version <Numeric_type>
 ...
) ENGINE [=] GraphiteMergeTree(date-column [, sampling_expression], (primary, key), index_granularity,
config_section)
```

All the parameters excepting config section have the same meaning as in MergeTree

`.config section` — Name of the section in the configuration file, where are the rules of rollup set •

## Rollup configuration

The settings for rollup are defined by the `graphite_rollup` parameter in the server configuration. The name of the `.parameter` could be any. You can create several configurations and use them for different tables.

:Rollup configuration structure

## required-columns patterns

## Required Columns

- .path\_column\_name — The name of the column storing the metric name (Graphite sensor). Default value: Path
- .time\_column\_name — The name of the column storing the time of measuring the metric. Default value: Time
- value\_column\_name — The name of the column storing the value of the metric at the time set intime\_column\_name .  
.Default value: Value
- .version\_column\_name — The name of the column storing the version of the metric. Default value: Timestamp

## Patterns

### Structure of the patterns section

```
pattern
 regexp
 function
pattern
 regexp
 age + precision
...
pattern
 regexp
 function
 age + precision
...
pattern
 ...
default
 function
 age + precision
```

:Patterns must be strictly ordered

- .Patterns without function or retention .1
- .Patterns with both function and retention .2
- .Pattern default .3

When processing a row, ClickHouse checks the rules in the `pattern` sections. Each of `pattern` (including `default`) sections can contain `function` parameter for aggregation, `retention` parameters or both. If the metric name matches the `regexp`, the `.rules` from the `pattern` section (or sections) are applied; otherwise, the rules from the `default` section are used

:Fields for `pattern` and `default` sections

- . `regexp` – A pattern for the metric name •
- . `age` – The minimum age of the data in seconds •
- .`( precision` – How precisely to define the age of the data in seconds. Should be a divisor for 86400 (seconds in a day) •
- `function` – The name of the aggregating function to apply to data whose age falls within the range `age, age + [precision]` •

## Configuration Example

```
<graphite_rollup>
<version_column_name>Version</version_column_name>
<pattern>
 <regexp>click_cost</regexp>
 <function>any</function>
 <retention>
 <age>0</age>
 <precision>5</precision>
 </retention>
 <retention>
 <age>86400</age>
 <precision>60</precision>
 </retention>
</pattern>
<default>
 <function>max</function>
 <retention>
 <age>0</age>
 <precision>60</precision>
 </retention>
 <retention>
 <age>3600</age>
 <precision>300</precision>
 </retention>
 <retention>
 <age>86400</age>
 <precision>3600</precision>
 </retention>
</default>
</graphite_rollup>
```

## Log Engine Family

These engines were developed for scenarios when you need to quickly write many small tables (up to about 1 million `.rows`) and read them later as a whole

:Engines of the family

- StripeLog** •

## Common properties

:Engines

- .Store data on a disk •
- .Append data to the end of file when writing •
- .Support locks for concurrent data access •

During `INSERT` queries, the table is locked, and other queries for reading and writing data both wait for the table to .unlock. If there are no data writing queries, any number of data reading queries can be performed concurrently

- .Do not support **mutation** operations •
  - .Do not support indexes •
- .This means that `SELECT` queries for ranges of data are not efficient
- .Do not write data atomically •

You can get a table with corrupted data if something breaks the write operation, for example, abnormal server .shutdown

## Differences

The `TinyLog` engine is the simplest in the family and provides the poorest functionality and lowest efficiency. The `TinyLog` engine doesn't support parallel data reading by several threads. It reads data slower than other engines in the family that support parallel reading and it uses almost as many descriptors as the `Log` engine because it stores each column in a .separate file. Use it in simple low-load scenarios

The `Log` and `StripeLog` engines support parallel data reading. When reading data, ClickHouse uses multiple threads.

Each thread processes a separate data block. The `Log` engine uses a separate file for each column of the table. `StripeLog` stores all the data in one file. As a result, the `StripeLog` engine uses fewer descriptors in the operating system, .but the `Log` engine provides higher efficiency when reading data

## StripeLog

This engine belongs to the family of log engines. See the common properties of log engines and their differences in the .[Log Engine Family](#) article

.(Use this engine in scenarios when you need to write many tables with a small amount of data (less than 1 million rows

## Creating a Table

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
 column1_name [type1] [DEFAULT|MATERIALIZED|ALIAS expr1],
 column2_name [type2] [DEFAULT|MATERIALIZED|ALIAS expr2],
 ...
) ENGINE = StripeLog
```

.See the detailed description of the [CREATE TABLE](#) query

## Writing the Data

The StripeLog engine stores all the columns in one file. For each `INSERT` query, ClickHouse appends the data block to the end of a table file, writing columns one by one

:For each table ClickHouse writes the files

.`data.bin` — Data file •

.`index.mrk` — File with marks. Marks contain offsets for each column of each data block inserted •

.The StripeLog engine does not support the `ALTER UPDATE` and `ALTER DELETE` operations

## Reading the Data

The file with marks allows ClickHouse to parallelize the reading of data. This means that a `SELECT` query returns rows in an unpredictable order. Use the `ORDER BY` clause to sort rows

## Example of Use

:Creating a table

```
CREATE TABLE stripe_log_table
(
 timestamp DateTime,
 message_type String,
 message String
)
ENGINE = StripeLog
```

:Inserting data

```
INSERT INTO stripe_log_table VALUES (now(), 'REGULAR', 'The first regular message')
INSERT INTO stripe_log_table VALUES (now(), 'REGULAR', 'The second regular message'),(now(), 'WARNING', 'The
first warning message')
```

.We used two `INSERT` queries to create two data blocks inside the `data.bin` file

ClickHouse uses multiple threads when selecting data. Each thread reads a separate data block and returns resulting rows independently as it finishes. As a result, the order of blocks of rows in the output does not match the order of the same blocks in the input in most cases. For example

```
SELECT * FROM stripe_log_table
```

timestamp	message_type	message
2019-01-18 14:27:32	REGULAR	The second regular message
2019-01-18 14:34:53	WARNING	The first warning message

timestamp	message_type	message
2019-01-18 14:23:43	REGULAR	The first regular message

:(Sorting the results (ascending order by default

```
SELECT * FROM stripe_log_table ORDER BY timestamp
```

timestamp	message_type	message
2019-01-18 14:23:43	REGULAR	The first regular message
2019-01-18 14:27:32	REGULAR	The second regular message
2019-01-18 14:34:53	WARNING	The first warning message

## Log

Engine belongs to the family of log engines. See the common properties of log engines and their differences in the [Log Engine Family](#) article

Log differs from [TinyLog](#) in that a small file of "marks" resides with the column files. These marks are written on every data block and contain offsets that indicate where to start reading the file in order to skip the specified number of rows.

This makes it possible to read table data in multiple threads. For concurrent data access, the read operations can be performed simultaneously, while write operations block reads and each other. The Log engine does not support indexes. Similarly, if writing to a table failed, the table is broken, and reading from it returns an error. The Log engine is appropriate for temporary data, write-once tables, and for testing or demonstration purposes

## TinyLog

The engine belongs to the log engine family. See [Log Engine Family](#) for common properties of log engines and their differences

This table engine is typically used with the write-once method: write data one time, then read it as many times as necessary. For example, you can use `TinyLog`-type tables for intermediary data that is processed in small batches. Note that storing data in a large number of small tables is inefficient

Queries are executed in a single stream. In other words, this engine is intended for relatively small tables (up to about 1,000,000 rows). It makes sense to use this table engine if you have many small tables, since it's simpler than the [Log](#) engine (fewer files need to be opened

## Kafka

This engine works with [Apache Kafka](#)

:Kafka lets you

- Publish or subscribe to data flows
- Organize fault-tolerant storage
- Process streams as they become available

## Creating a Table

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
 name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1],
 name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2],
 ...
) ENGINE = Kafka()
SETTINGS
 kafka_broker_list = 'host:port',
 kafka_topic_list = 'topic1,topic2,...',
 kafka_group_name = 'group_name',
 kafka_format = 'data_format'[,]
 [kafka_row_delimiter = 'delimiter_symbol',]
 [kafka_schema = '' ,]
 [kafka_num_consumers = N,]
 [kafka_skip_broken_messages = N]
```

:Required parameters

.( `kafka_broker_list` – A comma-separated list of brokers (for example, `localhost:9092`) •  
                   `kafka_topic_list` – A list of Kafka topics •  
`kafka_group_name` – A group of Kafka consumers. Reading margins are tracked for each group separately. If you don't •  
                   .want messages to be duplicated in the cluster, use the same group name everywhere  
`kafka_format` – Message format. Uses the same notation as the SQL `FORMAT` function, such as `JSONEachRow`. For •  
                   .more information, see the [Formats](#) section  
:Optional parameters

`kafka_row_delimiter` – Delimiter character, which ends the message •  
`kafka_schema` – Parameter that must be used if the format requires a schema definition. For example, [Cap'n Proto](#) •  
                   .requires the path to the schema file and the name of the root `schema.capnp:Message` object  
`kafka_num_consumers` – The number of consumers per table. Default: `1`. Specify more consumers if the throughput of •  
                   one consumer is insufficient. The total number of consumers should not exceed the number of partitions in the topic,  
                   .since only one consumer can be assigned per partition  
`kafka_skip_broken_messages` – Kafka message parser tolerance to schema-incompatible messages per block. Default: •  
                   `0`. If `kafka_skip_broken_messages = N` then the engine skips `N` Kafka messages that cannot be parsed (a message  
                   >equals a row of data

#### :Examples

```

CREATE TABLE queue (
 timestamp UInt64,
 level String,
 message String
) ENGINE = Kafka('localhost:9092', 'topic', 'group1', 'JSONEachRow');

SELECT * FROM queue LIMIT 5;

CREATE TABLE queue2 (
 timestamp UInt64,
 level String,
 message String
) ENGINE = Kafka SETTINGS kafka_broker_list = 'localhost:9092',
 kafka_topic_list = 'topic',
 kafka_group_name = 'group1',
 kafka_format = 'JSONEachRow',
 kafka_num_consumers = 4;

CREATE TABLE queue2 (
 timestamp UInt64,
 level String,
 message String
) ENGINE = Kafka('localhost:9092', 'topic', 'group1')
 SETTINGS kafka_format = 'JSONEachRow',
 kafka_num_consumers = 4;

```

Deprecated Method for Creating a Table ✎

Attention ⚠

.Do not use this method in new projects. If possible, switch old projects to the method described above

```
Kafka(kafka_broker_list, kafka_topic_list, kafka_group_name, kafka_format
 [, kafka_row_delimiter, kafka_schema, kafka_num_consumers, kafka_skip_broken_messages])
```

#### Description

The delivered messages are tracked automatically, so each message in a group is only counted once. If you want to get .the data twice, then create a copy of the table with another group name

Groups are flexible and synced on the cluster. For instance, if you have 10 topics and 5 copies of a table in a cluster, then each copy gets 2 topics. If the number of copies changes, the topics are redistributed across the copies automatically. .Read more about this at <http://kafka.apache.org/intro>

SELECT is not particularly useful for reading messages (except for debugging), because each message can be read only :once. It is more practical to create real-time threads using materialized views. To do this

.Use the engine to create a Kafka consumer and consider it a data stream .1

.Create a table with the desired structure .2

.Create a materialized view that converts data from the engine and puts it into a previously created table .3

When the MATERIALIZED VIEW joins the engine, it starts collecting data in the background. This allows you to continually receive messages from Kafka and convert them to the required format using SELECT . One kafka table can have as many materialized views as you like, they do not read data from the kafka table directly, but receive new records (in blocks), this .(way you can write to several tables with different detail level (with grouping - aggregation and without

:Example

```
CREATE TABLE queue (
 timestamp UInt64,
 level String,
 message String
) ENGINE = Kafka('localhost:9092', 'topic', 'group1', 'JSONEachRow');

CREATE TABLE daily (
 day Date,
 level String,
 total UInt64
) ENGINE = SummingMergeTree(day, (day, level), 8192);

CREATE MATERIALIZED VIEW consumer TO daily
 AS SELECT toDate(toDateTime(timestamp)) AS day, level, count() as total
 FROM queue GROUP BY day, level;

SELECT level, sum(total) FROM daily GROUP BY level;
```

To improve performance, received messages are grouped into blocks the size of `max_insert_block_size`. If the block wasn't formed within `stream_flush_interval_ms` milliseconds, the data will be flushed to the table regardless of the .completeness of the block

:To stop receiving topic data or to change the conversion logic, detach the materialized view

```
DETACH TABLE consumer;
ATTACH MATERIALIZED VIEW consumer;
```

If you want to change the target table by using ALTER , we recommend disabling the material view to avoid discrepancies .between the target table and the data from the view

## Configuration

Similar to GraphiteMergeTree, the Kafka engine supports extended configuration using the ClickHouse config file. There are two configuration keys that you can use: global ( kafka ) and topic-level ( kafka\_\* ). The global configuration is applied .(first, and then the topic-level configuration is applied (if it exists

```

<!-- Global configuration options for all tables of Kafka engine type -->
<kafka>
 <debug>cgrp</debug>
 <auto_offset_reset>smallest</auto_offset_reset>
</kafka>

<!-- Configuration specific for topic "logs" -->
<kafka_logs>
 <retry_backoff_ms>250</retry_backoff_ms>
 <fetch_min_bytes>100000</fetch_min_bytes>
</kafka_logs>

```

For a list of possible configuration options, see the [librdkafka configuration reference](#). Use the underscore (`_`) instead of a `.` `<dot` in the ClickHouse configuration. For example, `check.crcs=true` will be `<check_crcs>true</check_crcs`

## Virtual Columns

- .topic — Kafka topic\_ •
- .key — Key of the message\_ •
- .offset — Offset of the message\_ •
- .timestamp — Timestamp of the message\_ •
- .partition — Partition of Kafka topic\_ •

See Also

[Virtual columns](#) •

## MySQL

The MySQL engine allows you to perform `SELECT` queries on data that is stored on a remote MySQL server

### Creating a Table

```

CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
 name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1] [TTL expr1],
 name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2] [TTL expr2],
 ...
) ENGINE = MySQL('host:port', 'database', 'table', 'user', 'password'[, replace_query,
'on_duplicate_clause']);

```

See a detailed description of the [CREATE TABLE](#) query

The table structure can differ from the original MySQL table structure

Column names should be the same as in the original MySQL table, but you can use just some of these columns and •  
•.in any order

Column types may differ from those in the original MySQL table. ClickHouse tries to **cast** values to the ClickHouse •  
•.data types

### Engine Parameters

- .host:port — MySQL server address •
- .database — Remote database name •
- .table — Remote table name •

. user — MySQL user •  
 . password — User password •  
 replace\_query — Flag that converts `INSERT INTO` queries to `REPLACE INTO`. If `replace_query=1`, the query is •  
 .substituted  
`.on_duplicate_clause` — The `ON DUPLICATE KEY on_duplicate_clause` expression that is added to the `INSERT` query •  
 Example: `INSERT INTO t (c1,c2) VALUES ('a', 2) ON DUPLICATE KEY UPDATE c2 = c2 + 1`, where `on_duplicate_clause` is  
`UPDATE c2 = c2 + 1`. See the [MySQL documentation](#) to find which `on_duplicate_clause` you can use with the `ON DUPLICATE KEY` clause  
 To specify `on_duplicate_clause` you need to pass `0` to the `replace_query` parameter. If you simultaneously pass  
`.replace_query = 1` and `on_duplicate_clause`, ClickHouse generates an exception  
`.Simple WHERE clauses such as =, !=, >, >=, <, <= are executed on the MySQL server`

The rest of the conditions and the `LIMIT` sampling constraint are executed in ClickHouse only after the query to MySQL  
`.finishes`

## Usage Example

:Table in MySQL

```
mysql> CREATE TABLE `test`.`test` (
-> `int_id` INT NOT NULL AUTO_INCREMENT,
-> `int_nullable` INT NULL DEFAULT NULL,
-> `float` FLOAT NOT NULL,
-> `float_nullable` FLOAT NULL DEFAULT NULL,
-> PRIMARY KEY (`int_id`));
Query OK, 0 rows affected (0,09 sec)

mysql> insert into test (`int_id`, `float`) VALUES (1,2);
Query OK, 1 row affected (0,00 sec)

mysql> select * from test;
+-----+-----+-----+
| int_id | int_nullable | float | float_nullable |
+-----+-----+-----+
| 1 | NULL | 2 | NULL |
+-----+-----+-----+
1 row in set (0,00 sec)
```

:Table in ClickHouse, retrieving data from the MySQL table created above

```
CREATE TABLE mysql_table
(
 `float_nullable` Nullable(Float32),
 `int_id` Int32
)
ENGINE = MySQL('localhost:3306', 'test', 'test', 'bayonet', '123')
```

```
SELECT * FROM mysql_table
```

float_nullable	int_id
NULL	1

See Also

[The 'mysql' table function](#) •

## JDBC

.Allows ClickHouse to connect to external databases via JDBC

To implement the JDBC connection, ClickHouse uses the separate program [clickhouse-jdbc-bridge](#) that should run as a .daemon

.This engine supports the [Nullable](#) data type

### Creating a Table

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name
(
 columns list...
)
ENGINE = JDBC(dbms_uri, external_database, external_table)
```

#### Engine Parameters

. dbms\_uri — URI of an external DBMS •

Format: jdbc:<driver\_name>://<host\_name>:<port>/?user=<username>&password=<password> . Example for MySQL:

. jdbc:mysql://localhost:3306/?user=root&password=root

. external\_database — Database in an external DBMS •

. external\_table — Name of the table in external\_database •

### Usage Example

:Creating a table in MySQL server by connecting directly with it's console client

```
mysql> CREATE TABLE `test`.`test` (
-> `int_id` INT NOT NULL AUTO_INCREMENT,
-> `int_nullable` INT NULL DEFAULT NULL,
-> `float` FLOAT NOT NULL,
-> `float_nullable` FLOAT NULL DEFAULT NULL,
-> PRIMARY KEY (`int_id`));
Query OK, 0 rows affected (0,09 sec)

mysql> insert into test (`int_id`, `float`) VALUES (1,2);
Query OK, 1 row affected (0,00 sec)

mysql> select * from test;
+-----+-----+-----+-----+
| int_id | int_nullable | float | float_nullable |
+-----+-----+-----+-----+
| 1 | NULL | 2 | NULL |
+-----+-----+-----+-----+
1 row in set (0,00 sec)
```

:Creating a table in ClickHouse server and selecting data from it

```
CREATE TABLE jdbc_table ENGINE JDBC('jdbc:mysql://localhost:3306/?user=root&password=root', 'test', 'test')
```

```
DESCRIBE TABLE jdbc_table
```

name	type	default_type	default_expression
int_id	Int32		
int_nullable	Nullable(Int32)		
float	Float32		
float_nullable	Nullable(Float32)		

```
SELECT *
FROM jdbc_table
```

int_id	int_nullable	float	float_nullable
1	NULL	2	NULL

## See Also

[.JDBC table function](#) •

## ODBC

.Allows ClickHouse to connect to external databases via[ODBC](#)

To safely implement ODBC connections, ClickHouse uses a separate program `clickhouse-odbc-bridge`. If the ODBC driver is loaded directly from `clickhouse-server`, driver problems can crash the ClickHouse server. ClickHouse automatically starts `clickhouse-odbc-bridge` when it is required. The ODBC bridge program is installed from the same package as the `clickhouse-server`.

.This engine supports the [Nullable](#) data type

## Creating a Table

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
 name1 [type1],
 name2 [type2],
 ...
)
ENGINE = ODBC(connection_settings, external_database, external_table)
```

.See a detailed description of the[CREATE TABLE](#) query

:The table structure can differ from the source table structure

Column names should be the same as in the source table, but you can use just some of these columns and in any order

.Column types may differ from those in the source table. ClickHouse tries to[cast](#) values to the ClickHouse data types

## Engine Parameters

. `connection_settings` — Name of the section with connection settings in the `odbc.ini` file

. `external_database` — Name of a database in an external DBMS

. `external_table` — Name of a table in the `external_database`

## Usage Example

Retrieving data from the local MySQL installation via ODBC

. This example is checked for Ubuntu Linux 18.04 and MySQL server 5.7

. Ensure that unixODBC and MySQL Connector are installed

By default (if installed from packages), ClickHouse starts as user clickhouse . Thus, you need to create and configure this .user in the MySQL server

```
$ sudo mysql
```

```
mysql> CREATE USER 'clickhouse'@'localhost' IDENTIFIED BY 'clickhouse';
mysql> GRANT ALL PRIVILEGES ON *.* TO 'clickhouse'@'clickhouse' WITH GRANT OPTION;
```

. Then configure the connection in /etc/odbc.ini

```
$ cat /etc/odbc.ini
[mysqlconn]
DRIVER = /usr/local/lib/libmyodbc5w.so
SERVER = 127.0.0.1
PORT = 3306
DATABASE = test
USERNAME = clickhouse
PASSWORD = clickhouse
```

. You can check the connection using the isql utility from the unixODBC installation

```
$ isql -v mysqlconn
+-----+
| Connected! |
| |
...
```

:Table in MySQL

```
mysql> CREATE TABLE `test`.`test` (
 -> `int_id` INT NOT NULL AUTO_INCREMENT,
 -> `int_nullable` INT NULL DEFAULT NULL,
 -> `float` FLOAT NOT NULL,
 -> `float_nullable` FLOAT NULL DEFAULT NULL,
 -> PRIMARY KEY (`int_id`));
Query OK, 0 rows affected (0,09 sec)

mysql> insert into test (`int_id`, `float`) VALUES (1,2);
Query OK, 1 row affected (0,00 sec)

mysql> select * from test;
+-----+-----+-----+
| int_id | int_nullable | float | float_nullable |
+-----+-----+-----+
| 1 | NULL | 2 | NULL |
+-----+-----+-----+
1 row in set (0,00 sec)
```

:Table in ClickHouse, retrieving data from the MySQL table

```
CREATE TABLE odbc_t
(
 `int_id` Int32,
 `float_nullable` Nullable(Float32)
)
ENGINE = ODBC ('DSN=mysqlconn', 'test', 'test')
```

```
SELECT * FROM odbc_t
```

int_id	float_nullable
1	NULL

## See Also

- [ODBC external dictionaries](#) •
- [ODBC table function](#) •

## HDFS

This engine provides integration with [Apache Hadoop](#) ecosystem by allowing to manage data on [HDFS](#) via ClickHouse.  
This engine is similar to the [File](#) and [URL](#) engines, but provides Hadoop-specific features

### Usage

```
ENGINE = HDFS(URI, format)
```

The `URI` parameter is the whole file URI in HDFS. The `format` parameter specifies one of the available file formats. To perform `SELECT` queries, the `format` must be supported for input, and to perform `INSERT` queries -- for output. The available formats are listed in the [Formats](#) section. The path part of `URI` may contain globs. In this case the table would be readonly

:Example

:Set up the `hdfs_engine_table` table .1

```
CREATE TABLE hdfs_engine_table (name String, value UInt32) ENGINE=HDFS('hdfs://hdfs1:9000/other_storage', 'TSV')
```

:Fill file .2

```
INSERT INTO hdfs_engine_table VALUES ('one', 1), ('two', 2), ('three', 3)
```

:Query the data .3

```
SELECT * FROM hdfs_engine_table LIMIT 2
```

name	value
one	1
two	2

### Implementation Details

- Reads and writes can be parallel •
- :Not supported •
- .ALTER and SELECT...SAMPLE operations •
- .Indexes •

Multiple path components can have globs. For being processed file should exists and matches to the whole path pattern.  
 .(Listing of files determines during `SELECT` (not at `CREATE` moment

- .Substitutes any number of any characters except / including empty string — \* •
- .Substitutes any single character — ? •
- .`'some_string,another_string,yet_another_one'` — Substitutes any of strings`'some_string', 'another_string', 'yet_another_one'` •
- .`N..M}` — Substitutes any number in range from N to M including both borders} •
- .Constructions with {} are similar to the `remote` table function

### Example

:Suppose we have several files in TSV format with the following URIs on HDFS .1

```
'hdfs://hdfs1:9000/some_dir/some_file_1' .2
'hdfs://hdfs1:9000/some_dir/some_file_2' .3
'hdfs://hdfs1:9000/some_dir/some_file_3' .4
'hdfs://hdfs1:9000/another_dir/some_file_1' .5
'hdfs://hdfs1:9000/another_dir/some_file_2' .6
'hdfs://hdfs1:9000/another_dir/some_file_3' .7
```

:There are several ways to make a table consisting of all six files .8

```
CREATE TABLE table_with_range (name String, value UInt32) ENGINE =
HDFS('hdfs://hdfs1:9000/{some,another}_dir/some_file_{1..3}', 'TSV')
```

:Another way

```
CREATE TABLE table_with_question_mark (name String, value UInt32) ENGINE =
HDFS('hdfs://hdfs1:9000/{some,another}_dir/some_file_?', 'TSV')
```

:(Table consists of all the files in both directories (all files should satisfy format and schema described in query

```
CREATE TABLE table_with_asterisk (name String, value UInt32) ENGINE =
HDFS('hdfs://hdfs1:9000/{some,another}_dir/*', 'TSV')
```

### Warning

.? If the listing of files contains number ranges with leading zeros, use the construction with braces for each digit separately or use

### Example

:Create table with files named `file000` , `file001` , ... , `file999`

```
CREATE TABLE big_table (name String, value UInt32) ENGINE = HDFS('hdfs://hdfs1:9000/big_dir/file{0..9}
{0..9}{0..9}', 'CSV')
```

### Distributed

The Distributed engine does not store data itself, but allows distributed query processing on multiple servers. Reading is

automatically parallelized. During a read, the table indexes on remote servers are used, if there are any. The Distributed engine accepts parameters: the cluster name in the server's config file, the name of a remote database, the name of a :remote table, and (optionally) a sharding key. Example

```
Distributed(logs, default, hits[, sharding_key])
```

Data will be read from all servers in the 'logs' cluster, from the default.hits table located on every server in the cluster. Data is not only read, but is partially processed on the remote servers (to the extent that this is possible). For example, for a query with GROUP BY, data will be aggregated on remote servers, and the intermediate states of aggregate functions .will be sent to the requestor server. Then data will be further aggregated

.()Instead of the database name, you can use a constant expression that returns a string. For example: currentDatabase

.logs – The cluster name in the server's config file

:Clusters are set like this

```
<remote_servers>
 <logs>
 <shard>
 <!-- Optional. Shard weight when writing data. Default: 1. -->
 <weight>1</weight>
 <!-- Optional. Whether to write data to just one of the replicas. Default: false (write data to all replicas). -->
 <internal_replication>false</internal_replication>
 <replica>
 <host>example01-01-1</host>
 <port>9000</port>
 </replica>
 <replica>
 <host>example01-01-2</host>
 <port>9000</port>
 </replica>
 </shard>
 <shard>
 <weight>2</weight>
 <internal_replication>false</internal_replication>
 <replica>
 <host>example01-02-1</host>
 <port>9000</port>
 </replica>
 <replica>
 <host>example01-02-2</host>
 <secure>1</secure>
 <port>9440</port>
 </replica>
 </shard>
 </logs>
</remote_servers>
```

Here a cluster is defined with the name 'logs' that consists of two shards, each of which contains two replicas. Shards refer to the servers that contain different parts of the data (in order to read all the data, you must access all the shards).

.(Replicas are duplicating servers (in order to read all the data, you can access the data on any one of the replicas

.Cluster names must not contain dots

:The parameters host , port , and optionally user , password , secure , compression are specified for each server

host – The address of the remote server. You can use either the domain or the IPv4 or IPv6 address. If you • specify the domain, the server makes a DNS request when it starts, and the result is stored as long as the server .is running. If the DNS request fails, the server doesn't start. If you change the DNS record, restart the server

port – The TCP port for messenger activity ('tcp\_port' in the config, usually set to 9000). Do not confuse it with • .http\_port

`user` – Name of the user for connecting to a remote server. Default value: `default`. This user must have access to connect to the specified server. Access is configured in the `users.xml` file. For more information, see the section

[Access rights](#)

`.password` – The password for connecting to a remote server (not masked). Default value: empty string

`secure` - Use `ssl` for connection, usually you also should define `port = 9440`. Server should listen on `9440` and have correct certificates

`.compression` - Use data compression. Default value: `true`

When specifying replicas, one of the available replicas will be selected for each of the shards when reading. You can configure the algorithm for load balancing (the preference for which replica to access) – see the [load\\_balancing](#) setting. If the connection with the server is not established, there will be an attempt to connect with a short timeout. If the connection failed, the next replica will be selected, and so on for all the replicas. If the connection attempt failed for all the replicas, the attempt will be repeated the same way, several times. This works in favor of resiliency, but does not provide complete fault tolerance: a remote server might accept the connection, but might not work, or work poorly

You can specify just one of the shards (in this case, query processing should be called remote, rather than distributed) or up to any number of shards. In each shard, you can specify from one to any number of replicas. You can specify a different number of replicas for each shard

.You can specify as many clusters as you wish in the configuration

.To view your clusters, use the '`system.clusters`' table

The Distributed engine allows working with a cluster like a local server. However, the cluster is inextensible: you must write its configuration in the server config file (even better, for all the cluster's servers

There is no support for Distributed tables that look at other Distributed tables (except in cases when a Distributed table only has one shard). As an alternative, make the Distributed table look at the "final" tables

The Distributed engine requires writing clusters to the config file. Clusters from the config file are updated on the fly, without restarting the server. If you need to send a query to an unknown set of shards and replicas each time, you don't need to create a Distributed table – use the 'remote' table function instead. See the section [Table functions](#)

:There are two methods for writing data to a cluster

First, you can define which servers to write which data to and perform the write directly on each shard. In other words, perform `INSERT` in the tables that the distributed table "looks at". This is the most flexible solution as you can use any sharding scheme, which could be non-trivial due to the requirements of the subject area. This is also the most optimal solution, since data can be written to different shards completely independently

Second, you can perform `INSERT` in a Distributed table. In this case, the table will distribute the inserted data across servers itself. In order to write to a Distributed table, it must have a sharding key set (the last parameter). In addition, if there is only one shard, the write operation works without specifying the sharding key, since it doesn't mean anything in this case

Each shard can have a weight defined in the config file. By default, the weight is equal to one. Data is distributed across shards in the amount proportional to the shard weight. For example, if there are two shards and the first has a weight of 9 while the second has a weight of 10, the first will be sent  $9 / 19$  parts of the rows, and the second will be sent  $10 / 19$

.Each shard can have the '`internal_replication`' parameter defined in the config file

If this parameter is set to 'true', the write operation selects the first healthy replica and writes data to it. Use this alternative if the Distributed table "looks at" replicated tables. In other words, if the table where data will be written is going to replicate them itself

If it is set to 'false' (the default), data is written to all replicas. In essence, this means that the Distributed table replicates

data itself. This is worse than using replicated tables, because the consistency of replicas is not checked, and over time .they will contain slightly different data

To select the shard that a row of data is sent to, the sharding expression is analyzed, and its remainder is taken from dividing it by the total weight of the shards. The row is sent to the shard that corresponds to the half-interval of the remainders from 'prev\_weight' to 'prev\_weights + weight', where 'prev\_weights' is the total weight of the shards with the smallest number, and 'weight' is the weight of this shard. For example, if there are two shards, and the first has a weight of 9 while the second has a weight of 10, the row will be sent to the first shard for the remainders from the range [0, 9), and .(to the second for the remainders from the range [9, 19

The sharding expression can be any expression from constants and table columns that returns an integer. For example, you can use the expression 'rand()' for random distribution of data, or 'UserID' for distribution by the remainder from dividing the user's ID (then the data of a single user will reside on a single shard, which simplifies running IN and JOIN by .(users). If one of the columns is not distributed evenly enough, you can wrap it in a hash function: intHash64(UserID

A simple remainder from division is a limited solution for sharding and isn't always appropriate. It works for medium and large volumes of data (dozens of servers), but not for very large volumes of data (hundreds of servers or more). In the latter case, use the sharding scheme required by the subject area, rather than using entries in Distributed tables

SELECT queries are sent to all the shards, and work regardless of how data is distributed across the shards (they can be distributed completely randomly). When you add a new shard, you don't have to transfer the old data to it. You can write new data with a heavier weight – the data will be distributed slightly unevenly, but queries will work correctly and .efficiently

:You should be concerned about the sharding scheme in the following cases

Queries are used that require joining data (IN or JOIN) by a specific key. If data is sharded by this key, you can use • .local IN or JOIN instead of GLOBAL IN or GLOBAL JOIN, which is much more efficient

A large number of servers is used (hundreds or more) with a large number of small queries (queries of individual clients - websites, advertisers, or partners). In order for the small queries to not affect the entire cluster, it makes sense to locate data for a single client on a single shard. Alternatively, as we've done in Yandex.Metrica, you can set up bi-level sharding: divide the entire cluster into "layers", where a layer may consist of multiple shards. Data for a single client is located on a single layer, but shards can be added to a layer as necessary, and data is randomly distributed within them. Distributed tables are created for each layer, and a single shared distributed table is created .for global queries

Data is written asynchronously. When inserted in the table, the data block is just written to the local file system. The data is sent to the remote servers in the background as soon as possible. The period for sending data is managed by the [distributed\\_directory\\_monitor\\_sleep\\_time\\_ms](#) and [distributed\\_directory\\_monitor\\_max\\_sleep\\_time\\_ms](#) settings. The Distributed engine sends each file with inserted data separately, but you can enable batch sending of files with the [distributed\\_directory\\_monitor\\_batch\\_inserts](#) setting. This setting improves cluster performance by better utilizing local server and network resources. You should check whether data is sent successfully by checking the list of files (data ./waiting to be sent) in the table directory: /var/lib/clickhouse/data/database/table

If the server ceased to exist or had a rough restart (for example, after a device failure) after an INSERT to a Distributed table, the inserted data might be lost. If a damaged data part is detected in the table directory, it is transferred to the .'broken' subdirectory and no longer used

When the [max\\_parallel\\_replicas](#) option is enabled, query processing is parallelized across all replicas within a single .shard. For more information, see the section [max\\_parallel\\_replicas](#)

## Virtual Columns

. shard\_num — Contains the shard\_num (from system.clusters ). Type: [UInt32](#) •

.Since `remote`/ cluster table functions internally create temporary instance of the same Distributed engine, `_shard_num` is available there too

See Also

[Virtual columns](#) •

## External Data for Query Processing

ClickHouse allows sending a server the data that is needed for processing a query, together with a SELECT query. This data is put in a temporary table (see the section "Temporary tables") and can be used in the query (for example, in IN .(operators

For example, if you have a text file with important user identifiers, you can upload it to the server along with a query that .uses filtration by this list

If you need to run more than one query with a large volume of external data, don't use this feature. It is better to upload .the data to the DB ahead of time

.External data can be uploaded using the command-line client (in non-interactive mode), or using the HTTP interface

In the command-line client, you can specify a parameters section in the format

```
--external --file=... [--name=...] [--format=...] [--types=...|--structure=...]
```

.You may have multiple sections like this, for the number of tables being transmitted  
external – Marks the beginning of a clause.--file – Path to the file with the table dump, or -, which refers to stdin. Only a--single table can be retrieved from stdin

The following parameters are optional:--name– Name of the table. If omitted, `_data` is used.--format – Data format in the .file. If omitted, TabSeparated is used

One of the following parameters is required:-types – A list of comma-separated column types. For example: UInt64,String .  
The columns will be named `_1`, `_2`, ... --structure– The table structure in the format `UserID UInt64 , URL String` . Defines the .column names and types

The files specified in 'file' will be parsed by the format specified in 'format', using the data types specified in 'types' or ."structure'. The table will be uploaded to the server and accessible there as a temporary table with the name in 'name'

:Examples

```
$ echo -ne "1\n2\n3\n" | clickhouse-client --query="SELECT count() FROM test.visits WHERE TraficSourceID IN _data" --external --file=- --types=Int8
849897
$ cat /etc/passwd | sed 's/:/\t/g' | clickhouse-client --query="SELECT shell, count() AS c FROM passwd GROUP BY shell ORDER BY c DESC" --external --file=- --name=passwd --structure='login String, unused String, uid UInt16, gid UInt16, comment String, home String, shell String'
/bin/sh 20
/bin/false 5
/bin/bash 4
/usr/sbin/nologin 1
/bin/sync 1
```

When using the HTTP interface, external data is passed in the multipart/form-data format. Each table is transmitted as a separate file. The table name is taken from the file name. The 'query\_string' is passed the parameters 'name\_format', 'name\_types', and 'name\_structure', where 'name' is the name of the table that these parameters correspond to. The

.meaning of the parameters is the same as when using the command-line client

:Example

```
$ cat /etc/passwd | sed 's/:/\t/g' > passwd.tsv

$ curl -F 'passwd=@passwd.tsv;' 'http://localhost:8123/?query=SELECT+shell,+count())+AS+c+FROM+passwd+GROUP+BY+shell+ORDER+BY+c+DESC&passwd_structure=login+String,+uni

/bin/sh 20
/bin/false 5
/bin/bash 4
/usr/sbin/nologin 1
/bin/sync 1
```

.For distributed query processing, the temporary tables are sent to all the remote servers

## Dictionary

.The `Dictionary` engine displays the `dictionary` data as a ClickHouse table

:As an example, consider a dictionary of products with the following configuration

```
<dictionaries>
<dictionary>
 <name>products</name>
 <source>
 <odbc>
 <table>products</table>
 <connection_string>DSN=some-db-server</connection_string>
 </odbc>
 </source>
 <lifetime>
 <min>300</min>
 <max>360</max>
 </lifetime>
 <layout>
 <flat/>
 </layout>
 <structure>
 <id>
 <name>product_id</name>
 </id>
 <attribute>
 <name>title</name>
 <type>String</type>
 <null_value></null_value>
 </attribute>
 </structure>
</dictionary>
</dictionaries>
```

:Query the dictionary data

```
SELECT
 name,
 type,
 key,
 attribute.names,
 attribute.types,
 bytes_allocated,
 element_count,
 source
FROM system.dictionaries
WHERE name = 'products'
```

name	type	key	attribute.names	attribute.types	bytes_allocated	element_count	source
.products	Flat	UInt64	['title']	['String']	23065376	175032	ODBC:

. You can use the `dictGet*` function to get the dictionary data in this format

This view isn't helpful when you need to get raw data, or when performing a `JOIN` operation. For these cases, you can use the `Dictionary` engine, which displays the dictionary data in a table

:Syntax

```
CREATE TABLE %table_name% (%fields%) engine = Dictionary(%dictionary_name%)`
```

:Usage example

```
create table products (product_id UInt64, title String) Engine = Dictionary(products);
```

Ok

. Take a look at what's in the table

```
select * from products limit 1;
```

product_id	title
152689	Some item

## Merge

The `Merge` engine (not to be confused with `MergeTree`) does not store data itself, but allows reading from any number of other tables simultaneously. Reading is automatically parallelized. Writing to a table is not supported. When reading, the indexes of tables that are actually being read are used, if they exist. The `Merge` engine accepts parameters: the database `.name` and a regular expression for tables

:Example

```
Merge(hits, '^WatchLog')
```

. Data will be read from the tables in the `hits` database that have names that match the regular expression `'^WatchLog'`

. () Instead of the database name, you can use a constant expression that returns a string. For example `currentDatabase`

Regular expressions — `re2` (supports a subset of PCRE), case-sensitive. See the notes about escaping symbols in regular expressions in the "match" section

When selecting tables to read, the `Merge` table itself will not be selected, even if it matches the regex. This is to avoid loops. It is possible to create two `Merge` tables that will endlessly try to read each others' data, but this is not a good idea

. The typical way to use the `Merge` engine is for working with a large number of `TinyLog` tables as if with a single table

:Example 2

Let's say you have an old table (`WatchLog_old`) and decided to change partitioning without moving data to a new table

.(WatchLog\_new) and you need to see data from both tables

```
CREATE TABLE WatchLog_old(date Date, UserId Int64, EventType String, Cnt UInt64)
ENGINE=MergeTree(date, (UserId, EventType), 8192);
INSERT INTO WatchLog_old VALUES ('2018-01-01', 1, 'hit', 3);

CREATE TABLE WatchLog_new(date Date, UserId Int64, EventType String, Cnt UInt64)
ENGINE=MergeTree PARTITION BY date ORDER BY (UserId, EventType) SETTINGS index_granularity=8192;
INSERT INTO WatchLog_new VALUES ('2018-01-02', 2, 'hit', 3);

CREATE TABLE WatchLog as WatchLog_old ENGINE=Merge(currentDatabase(), '^WatchLog');

SELECT *
FROM WatchLog
```

date	UserId	EventType	Cnt
2018-01-01	1	hit	3

date	UserId	EventType	Cnt
2018-01-02	2	hit	3

## Virtual Columns

.table — Contains the name of the table from which data was read. Type[String](#) •

You can set the constant conditions on `_table` in the `WHERE/PREWHERE` clause (for example, `WHERE _table='xyz'`). In this case the read operation is performed only for that tables where the condition on `_table` is satisfied, so the `_table`.column acts as an index

See Also

[Virtual columns](#) •

## File

.(The File table engine keeps the data in a file in one of the supported[file formats](#) (TabSeparated, Native, etc

:Usage examples

.Data export from ClickHouse to file •

.Convert data from one format to another •

.Updating data in ClickHouse via editing a file on a disk •

## Usage in ClickHouse Server

### File(Format)

The `Format` parameter specifies one of the available file formats. To perform `SELECT` queries, the format must be supported for input, and to perform `INSERT` queries -- for output. The available formats are listed in the[Formats](#) section

ClickHouse does not allow to specify filesystem path for `File`. It will use folder defined by `path` setting in server .configuration

When creating table using `File(Format)` it creates empty subdirectory in that folder. When data is written to that table, it's .put into `data.Format` file in that subdirectory

You may manually create this subfolder and file in server filesystem and then[ATTACH](#) it to table information with

.matching name, so you can query data from that file

### Warning

Be careful with this functionality, because ClickHouse does not keep track of external changes to such files. The result of simultaneous writes via ClickHouse and outside of ClickHouse is undefined

:Example

:Set up the `file_engine_table` table .1

```
CREATE TABLE file_engine_table (name String, value UInt32) ENGINE=File(TabSeparated)
```

.By default ClickHouse will create folder `/var/lib/clickhouse/data/default/file_engine_table`

:Manually create `/var/lib/clickhouse/data/default/file_engine_table/data.TabSeparated` containing .2

```
$ cat data.TabSeparated
one 1
two 2
```

:Query the data .3

```
SELECT * FROM file_engine_table
```

name	value
one	1
two	2

## Usage in Clickhouse-local

In **clickhouse-local** File engine accepts file path in addition to Format . Default input/output streams can be specified using :numeric or human-readable names like `0` or `stdin` , `1` or `stdout` . Example

```
$ echo -e "1,2\n3,4" | clickhouse-local -q "CREATE TABLE table (a Int64, b Int64) ENGINE = File(CSV,
stdin); SELECT a, b FROM table; DROP TABLE table"
```

## Details of Implementation

.Multiple `SELECT` queries can be performed concurrently, but `INSERT` queries will wait each other •

.Supported creating new file by `INSERT` query •

.If file exists, `INSERT` would append new values in it •

:Not supported •

ALTER •

SELECT ... SAMPLE •

Indices •

Replication •

## Null

.When writing to a Null table, data is ignored. When reading from a Null table, the response is empty

.However, you can create a materialized view on a Null table. So the data written to the table will end up in the view

## Set

.("A data set that is always in RAM. It is intended for use on the right side of the IN operator (see the section "IN operators

You can use INSERT to insert data in the table. New elements will be added to the data set, while duplicates will be ignored. But you can't perform SELECT from the table. The only way to retrieve data is by using it in the right half of the .IN operator

Data is always located in RAM. For INSERT, the blocks of inserted data are also written to the directory of tables on the .disk. When starting the server, this data is loaded to RAM. In other words, after restarting, the data remains in place

For a rough server restart, the block of data on the disk might be lost or damaged. In the latter case, you may need to .manually delete the file with damaged data

## Join

.Prepared data structure for using in JOIN operations

### Creating a Table

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
 name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1] [TTL expr1],
 name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2] [TTL expr2],
) ENGINE = Join(join_strictness, join_type, k1[, k2, ...])
```

.See the detailed description of the CREATE TABLE query

Engine Parameters

- . join\_strictness – JOIN strictness •
- . join\_type – JOIN type •

. k1[, k2, ...] – Key columns from the USING clause that the JOIN operation is made with •

Enter join\_strictness and join\_type parameters without quotes, for example, Join(ANY, LEFT, col1) . They must match the JOIN operation that the table will be used for. If the parameters don't match, ClickHouse doesn't throw an exception and .may return incorrect data

## Table Usage

### Example

:Creating the left-side table

```
CREATE TABLE id_val(`id` UInt32, `val` UInt32) ENGINE = TinyLog
```

```
INSERT INTO id_val VALUES (1,11)(2,12)(3,13)
```

:Creating the right-side Join table

```
CREATE TABLE id_val_join(`id` UInt32, `val` UInt8) ENGINE = Join(ANY, LEFT, id)
```

```
INSERT INTO id_val_join VALUES (1,21)(1,22)(3,23)
```

:Joining the tables

```
SELECT * FROM id_val ANY LEFT JOIN id_val_join USING (id) SETTINGS join_use_nulls = 1
```

id	val	id_val_join.val
1	11	21
2	12	NULL
3	13	23

:As an alternative, you can retrieve data from the `Join` table, specifying the join key value

```
SELECT joinGet('id_val_join', 'val', toUInt32(1))
```

joinGet('id_val_join', 'val', toUInt32(1))	21
--------------------------------------------	----

## Selecting and Inserting Data

You can use `INSERT` queries to add data to the `Join`-engine tables. If the table was created with the `ANY` strictness, data for duplicate keys are ignored. With the `ALL` strictness, all rows are added

:You cannot perform a `SELECT` query directly from the table. Instead, use one of the following methods

- Place the table to the right side in a `JOIN` clause

- Call the `joinGet` function, which lets you extract data from the table the same way as from a dictionary

## Limitations and Settings

:When creating a table, the following settings are applied

- `join_use_nulls`
- `max_rows_in_join`
- `max_bytes_in_join`
- `join_overflow_mode`
- `join_any_take_last_row`

.The `Join`-engine tables can't be used in `GLOBAL JOIN` operations

## Data Storage

`Join` table data is always located in the RAM. When inserting rows into a table, ClickHouse writes data blocks to the .directory on the disk so that they can be restored when the server restarts

If the server restarts incorrectly, the data block on the disk might get lost or damaged. In this case, you may need to .manually delete the file with damaged data

(URL(URL, Format

.Manages data on a remote HTTP/HTTPS server. This engine is similar to the [File](#) engine

## Using the engine in the ClickHouse server

The `format` must be one that ClickHouse can use in `SELECT` queries and, if necessary, in `INSERTs`. For the full list of supported formats, see [Formats](#)

The `URL` must conform to the structure of a Uniform Resource Locator. The specified URL must point to a server that uses HTTP or HTTPS. This does not require any additional headers for getting a response from the server

`INSERT` and `SELECT` queries are transformed to `POST` and `GET` requests, respectively. For processing `POST` requests, the remote server must support [Chunked transfer encoding](#)

.You can limit the maximum number of HTTP GET redirect hops using the [max\\_http\\_get\\_redirects](#) setting

:Example

: Create a `url_engine_table` table on the server .1

```
CREATE TABLE url_engine_table (word String, value UInt64)
ENGINE=URL('http://127.0.0.1:12345/', CSV)
```

:Create a basic HTTP server using the standard Python 3 tools and start it .2

```
from http.server import BaseHTTPRequestHandler, HTTPServer

class CSVHTTPServer(BaseHTTPRequestHandler):
 def do_GET(self):
 self.send_response(200)
 self.send_header('Content-type', 'text/csv')
 self.end_headers()

 self.wfile.write(bytes('Hello,1\nWorld,2\n', "utf-8"))

if __name__ == "__main__":
 server_address = ('127.0.0.1', 12345)
 HTTPServer(server_address, CSVHTTPServer).serve_forever()
```

```
$ python3 server.py
```

:Request data .3

```
SELECT * FROM url_engine_table
```

word	value
Hello	1
World	2

## Details of Implementation

Reads and writes can be parallel •

:Not supported •

. `ALTER` and `SELECT...SAMPLE` operations •

.Indexes •

.Replication •

## View

Used for implementing views (for more information, see the CREATE VIEW query). It does not store data, but only stores the specified SELECT query. When reading from a table, it runs this query (and deletes all unnecessary columns from the .(query

## MaterializedView

Used for implementing materialized views (for more information, see [CREATE TABLE](#)). For storing data, it uses a different .engine that was specified when creating the view. When reading from a table, it just uses this engine

## Memory

The Memory engine stores data in RAM, in uncompressed form. Data is stored in exactly the same form as it is received when read. In other words, reading from this table is completely free. Concurrent data access is synchronized. Locks are short: read and write operations don't block each other. Indexes are not supported. Reading is parallelized. Maximal productivity (over 10 GB/sec) is reached on simple queries, because there is no reading from the disk, decompressing, or deserializing data. (We should note that in many cases, the productivity of the MergeTree engine is almost as high.) When restarting a server, data disappears from the table and the table becomes empty. Normally, using this table engine is not justified. However, it can be used for tests, and for tasks where maximum speed is required on a relatively small .(number of rows (up to approximately 100,000,000

The Memory engine is used by the system for temporary tables with external query data (see the section "External data .("for processing a query"), and for implementing GLOBAL IN (see the section "IN operators

## Buffer

Buffers the data to write in RAM, periodically flushing it to another table. During the read operation, data is read from the .buffer and the other table simultaneously

```
Buffer(database, table, num_layers, min_time, max_time, min_rows, max_rows, min_bytes, max_bytes)
```

:Engine parameters

. database – Database name. Instead of the database name, you can use a constant expression that returns a string •  
. table – Table to flush data to •  
num\_layers – Parallelism layer. Physically, the table will be represented as num\_layers of independent buffers. •  
.Recommended value: 16  
. min\_time , max\_time , min\_rows , max\_rows , min\_bytes , and max\_bytes – Conditions for flushing data from the buffer •

Data is flushed from the buffer and written to the destination table if all the min\* conditions or at least one max\* condition .are met

. min\_time , max\_time – Condition for the time in seconds from the moment of the first write to the buffer •  
. min\_rows , max\_rows – Condition for the number of rows in the buffer •  
. min\_bytes , max\_bytes – Condition for the number of bytes in the buffer •

During the write operation, data is inserted to a num\_layers number of random buffers. Or, if the data part to insert is large .enough (greater than max\_rows or max\_bytes ), it is written directly to the destination table, omitting the buffer

The conditions for flushing the data are calculated separately for each of the `num_layers` buffers. For example, if  
. `num_layers = 16` and `max_bytes = 100000000`, the maximum RAM consumption is 1.6 GB

:Example

```
CREATE TABLE merge.hits_buffer AS merge.hits ENGINE = Buffer(merge, hits, 16, 10, 100, 10000, 1000000,
10000000, 100000000)
```

Creating a 'merge.hits\_buffer' table with the same structure as 'merge.hits' and using the Buffer engine. When writing to this table, data is buffered in RAM and later written to the 'merge.hits' table. 16 buffers are created. The data in each of them is flushed if either 100 seconds have passed, or one million rows have been written, or 100 MB of data have been written; or if simultaneously 10 seconds have passed and 10,000 rows and 10 MB of data have been written. For example, if just one row has been written, after 100 seconds it will be flushed, no matter what. But if many rows have been written, .the data will be flushed sooner

.When the server is stopped, with `DROP TABLE` or `DETACH TABLE`, buffer data is also flushed to the destination table

You can set empty strings in single quotation marks for the database and table name. This indicates the absence of a destination table. In this case, when the data flush conditions are reached, the buffer is simply cleared. This may be useful .for keeping a window of data in memory

When reading from a Buffer table, data is processed both from the buffer and from the destination table (if there is one). Note that the Buffer tables does not support an index. In other words, data in the buffer is fully scanned, which might be (.slow for large buffers. (For data in a subordinate table, the index that it supports will be used

If the set of columns in the Buffer table doesn't match the set of columns in a subordinate table, a subset of columns that .exist in both tables is inserted

If the types don't match for one of the columns in the Buffer table and a subordinate table, an error message is entered in the server log and the buffer is cleared. The same thing happens if the subordinate table doesn't exist when the buffer is .flushed

If you need to run `ALTER` for a subordinate table and the Buffer table, we recommend first deleting the Buffer table, .running `ALTER` for the subordinate table, then creating the Buffer table again

.If the server is restarted abnormally, the data in the buffer is lost

`FINAL` and `SAMPLE` do not work correctly for Buffer tables. These conditions are passed to the destination table, but are not used for processing data in the buffer. If these features are required we recommend only using the Buffer table for .writing, while reading from the destination table

When adding data to a Buffer, one of the buffers is locked. This causes delays if a read operation is simultaneously being .performed from the table

Data that is inserted to a Buffer table may end up in the subordinate table in a different order and in different blocks. Because of this, a Buffer table is difficult to use for writing to a CollapsingMergeTree correctly. To avoid problems, you can .set '`num_layers`' to 1

If the destination table is replicated, some expected characteristics of replicated tables are lost when writing to a Buffer table. The random changes to the order of rows and sizes of data parts cause data deduplication to quit working, which .means it is not possible to have a reliable 'exactly once' write to replicated tables

.Due to these disadvantages, we can only recommend using a Buffer table in rare cases

A Buffer table is used when too many `INSERT`s are received from a large number of servers over a unit of time and data .can't be buffered before insertion, which means the `INSERT`s can't run fast enough

Note that it doesn't make sense to insert data one row at a time, even for Buffer tables. This will only produce a speed of a

few thousand rows per second, while inserting larger blocks of data can produce over a million rows per second (see the .("section "Performance

## SQL Reference

- [SELECT](#) •
- [INSERT INTO](#) •
- [CREATE](#) •
- [ALTER](#) •
- [Other types of queries](#) •

## SELECT Queries Syntax

. SELECT performs data retrieval

```
[WITH expr_list|(subquery)]
SELECT [DISTINCT] expr_list
[FROM [db.]table | (subquery) | table_function] [FINAL]
[SAMPLE sample_coeff]
[ARRAY JOIN ...]
[GLOBAL] [ANY|ALL] [INNER|LEFT|RIGHT|FULL|CROSS] [OUTER] JOIN (subquery)|table USING columns_list
[PREWHERE expr]
[WHERE expr]
[GROUP BY expr_list] [WITH TOTALS]
[HAVING expr]
[ORDER BY expr_list]
[LIMIT [n,]m]
[UNION ALL ...]
[INTO OUTFILE filename]
[FORMAT format]
[LIMIT [offset_value,]n BY columns]
```

All the clauses are optional, except for the required list of expressions immediately after SELECT. The clauses below are .described in almost the same order as in the query execution conveyor

If the query omits the DISTINCT , GROUP BY and ORDER BY clauses and the IN and JOIN subqueries, the query will be completely stream processed, using O(1) amount of RAM. Otherwise, the query might consume a lot of RAM if the appropriate restrictions are not specified: max\_memory\_usage , max\_rows\_to\_group\_by , max\_rows\_to\_sort , max\_rows\_in\_distinct , max\_bytes\_in\_distinct , max\_rows\_in\_set , max\_bytes\_in\_set , max\_rows\_in\_join , max\_bytes\_in\_join , max\_bytes\_before\_external\_sort , max\_bytes\_before\_external\_group\_by . For more information, see the section "Settings". It is possible to use external sorting (saving temporary tables to a disk) and external aggregation. The system does not have .""merge join

### WITH Clause

This section provides support for Common Table Expressions (CTE), with some limitations: 1. Recursive queries are not supported 2. When subquery is used inside WITH section, it's result should be scalar with exactly one row 3. Expression's .results are not available in subqueries Results of WITH clause expressions can be used inside SELECT clause

"Example 1: Using constant expression as "variable

```

WITH '2019-08-01 15:23:00' as ts_upper_bound
SELECT *
FROM hits
WHERE
 EventDate = toDate(ts_upper_bound) AND
 EventTime <= ts_upper_bound

```

Example 2: Evicting sum(bytes) expression result from SELECT clause column list

```

WITH sum(bytes) as s
SELECT
 formatReadableSize(s),
 table
FROM system.parts
GROUP BY table
ORDER BY s

```

Example 3: Using results of scalar subquery

```

/* this example would return TOP 10 of most huge tables */
WITH
(
 SELECT sum(bytes)
 FROM system.parts
 WHERE active
) AS total_disk_usage
SELECT
 (sum(bytes) / total_disk_usage) * 100 AS table_disk_usage,
 table
FROM system.parts
GROUP BY table
ORDER BY table_disk_usage DESC
LIMIT 10

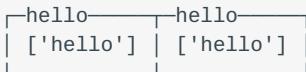
```

Example 4: Re-using expression in subquery As a workaround for current limitation for expression usage in subqueries,  
.you may duplicate it

```

WITH ['hello'] AS hello
SELECT
 hello,
 *
FROM
(
 WITH ['hello'] AS hello
 SELECT hello
)

```



## FROM Clause

If the FROM clause is omitted, data will be read from the system.one table. The system.one table contains exactly one row .((this table fulfills the same purpose as the DUAL table found in other DBMSs

:The FROM clause specifies the source to read data from

Table •

Subquery •

Table function •

.( ARRAY JOIN and the regular JOIN may also be included (see below

Instead of a table, the `SELECT` subquery may be specified in parenthesis. In contrast to standard SQL, a synonym does not need to be specified after a subquery. For compatibility, it is possible to write `AS name` after a subquery, but the specified name isn't used anywhere.

To execute a query, all the columns listed in the query are extracted from the appropriate table. Any columns not needed for the external query are thrown out of the subqueries. If a query does not list any columns (for example, `SELECT count()` `FROM t`), some column is extracted from the table anyway (the smallest one is preferred), in order to calculate the number of rows.

#### FINAL MODIFIER

Applicable when selecting data from tables from the [MergeTree](#)-engine family other than [GraphiteMergeTree](#). When `FINAL` is specified, ClickHouse fully merges the data before returning the result and thus performs all data transformations that happen during merges for the given table engine.

Also supported for: - [Replicated](#) versions of [MergeTree](#) engines. - [View](#), [Buffer](#), [Distributed](#), and [MaterializedView](#) engines that operate over other engines, provided they were created over [MergeTree](#)-engine tables.

:Queries that use `FINAL` are executed not as fast as similar queries that don't, because

- .Query is executed in a single thread and data is merged during query execution

- .Queries with `FINAL` read primary key columns in addition to the columns specified in the query

- .In most cases, avoid using `FINAL`

#### SAMPLE Clause

.The `SAMPLE` clause allows for approximated query processing

When data sampling is enabled, the query is not performed on all the data, but only on a certain fraction of data (sample). For example, if you need to calculate statistics for all the visits, it is enough to execute the query on the 1/10 fraction of all the visits and then multiply the result by 10.

:Approximated query processing can be useful in the following cases

When you have strict timing requirements (like <100ms) but you can't justify the cost of additional hardware resources

- .to meet them

- .When your raw data is not accurate, so approximation doesn't noticeably degrade the quality

Business requirements target approximate results (for cost-effectiveness, or in order to market exact results to

- .(premium users)

#### Note

You can only use sampling with the tables in the [MergeTree](#) family, and only if the sampling expression was specified during table creation (see [\(MergeTree engine\)](#)).

:The features of data sampling are listed below

.Data sampling is a deterministic mechanism. The result of the same `SELECT .. SAMPLE` query is always the same

- .

Sampling works consistently for different tables. For tables with a single sampling key, a sample with the same coefficient always selects the same subset of possible data. For example, a sample of user IDs takes rows with the same subset of all the possible user IDs from different tables. This means that you can use the sample in subqueries

- .in the `IN` clause. Also, you can join samples using the `JOIN` clause

Sampling allows reading less data from a disk. Note that you must specify the sampling key correctly. For more

- .information, see [Creating a MergeTree Table](#)

:For the `SAMPLE` clause the following syntax is supported

	Description	SAMPLE Clause Syntax
The query is executed on <code>k</code> fraction of data. For example, <code>SAMPLE 0.1</code> runs the query on 10% of data. <a href="#">Read more</a>	.Here <code>k</code> is the number from 0 to 1	<code>SAMPLE k</code>
The query is executed on a sample of at least <code>n</code> rows (but not significantly more than this). For example, <code>SAMPLE 10000000</code> runs the query on a minimum of 10,000,000 rows. <a href="#">Read more</a>	.Here <code>n</code> is a sufficiently large integer	<code>SAMPLE n</code>
The query is executed on a sample of <code>k</code> fraction of the data. The data used for the sample is offset by <code>m</code> fraction. <a href="#">Read more</a>	.Here <code>k</code> and <code>m</code> are the numbers from 0 to 1	<code>SAMPLE k OFFSET m</code>

## SAMPLE K

Here `k` is the number from 0 to 1 (both fractional and decimal notations are supported). For example, `SAMPLE 1/2` or  
. `SAMPLE 0.5`

:In a `SAMPLE k` clause, the sample is taken from the `k` fraction of data. The example is shown below

```
SELECT
 Title,
 count() * 10 AS PageViews
FROM hits_distributed
SAMPLE 0.1
WHERE
 CounterID = 34
GROUP BY Title
ORDER BY PageViews DESC LIMIT 1000
```

In this example, the query is executed on a sample from 0.1 (10%) of data. Values of aggregate functions are not corrected automatically, so to get an approximate result, the value `count()` is manually multiplied by 10

## SAMPLE N

.Here `n` is a sufficiently large integer. For example, `SAMPLE 10000000`

In this case, the query is executed on a sample of at least `n` rows (but not significantly more than this). For example,  
. `SAMPLE 10000000` runs the query on a minimum of 10,000,000 rows

Since the minimum unit for data reading is one granule (its size is set by the `index_granularity` setting), it makes sense to  
.set a sample that is much larger than the size of the granule

When using the `SAMPLE n` clause, you don't know which relative percent of data was processed. So you don't know the coefficient the aggregate functions should be multiplied by. Use the `_sample_factor` virtual column to get the approximate  
.result

The `_sample_factor` column contains relative coefficients that are calculated dynamically. This column is created automatically when you `create` a table with the specified sampling key. The usage examples of the `_sample_factor` column  
.are shown below

Let's consider the table `visits`, which contains the statistics about site visits. The first example shows how to calculate the  
:number of page views

```
SELECT sum(PageViews * _sample_factor)
FROM visits
SAMPLE 10000000
```

:The next example shows how to calculate the total number of visits

```
SELECT sum(_sample_factor)
FROM visits
SAMPLE 10000000
```

The example below shows how to calculate the average session duration. Note that you don't need to use the relative coefficient to calculate the average values

```
SELECT avg(Duration)
FROM visits
SAMPLE 10000000
```

SAMPLE K OFFSET M

.Here k and m are numbers from 0 to 1. Examples are shown below

Example 1

```
SAMPLE 1/10
```

:In this example, the sample is 1/10th of all data

[-----+--]

Example 2

```
SAMPLE 1/10 OFFSET 1/2
```

.Here, a sample of 10% is taken from the second half of the data

[-----+-----]

## ARRAY JOIN Clause

Allows executing JOIN with an array or nested data structure. The intent is similar to the **arrayJoin** function, but its functionality is broader

```
SELECT <expr_list>
FROM <left_subquery>
[LEFT] ARRAY JOIN <array>
[WHERE|PREWHERE <expr>]
...
```

.You can specify only a single ARRAY JOIN clause in a query

The query execution order is optimized when running ARRAY JOIN . Although ARRAY JOIN must always be specified before the WHERE/PREWHERE clause, it can be performed either before WHERE/PREWHERE (if the result is needed in this clause), or after completing it (to reduce the volume of calculations). The processing order is controlled by the query optimizer

:Supported types of ARRAY JOIN are listed below

. ARRAY JOIN - In this case, empty arrays are not included in the result of JOIN •

LEFT ARRAY JOIN - The result of JOIN contains rows with empty arrays. The value for an empty array is set to the •  
.default value for the array element type (usually 0, empty string or NULL)

The examples below demonstrate the usage of the ARRAY JOIN and LEFT ARRAY JOIN clauses. Let's create a table with :an Array type column and insert values into it

```

CREATE TABLE arrays_test
(
 s String,
 arr Array(UInt8)
) ENGINE = Memory;

INSERT INTO arrays_test
VALUES ('Hello', [1,2]), ('World', [3,4,5]), ('Goodbye', []);

```

s	arr
Hello	[1,2]
World	[3,4,5]
Goodbye	[]

:The example below uses the `ARRAY JOIN` clause

```

SELECT s, arr
FROM arrays_test
ARRAY JOIN arr;

```

s	arr
Hello	1
Hello	2
World	3
World	4
World	5

:The next example uses the `LEFT ARRAY JOIN` clause

```

SELECT s, arr
FROM arrays_test
LEFT ARRAY JOIN arr;

```

s	arr
Hello	1
Hello	2
World	3
World	4
World	5
Goodbye	0

## USING ALIASES

An alias can be specified for an array in the `ARRAY JOIN` clause. In this case, an array item can be accessed by this alias, but the array itself is accessed by the original name. Example

```

SELECT s, arr, a
FROM arrays_test
ARRAY JOIN arr AS a;

```

s	arr	a
Hello	[1,2]	1
Hello	[1,2]	2
World	[3,4,5]	3
World	[3,4,5]	4
World	[3,4,5]	5

:Using aliases, you can perform `ARRAY JOIN` with an external array. For example

```
SELECT s, arr_external
FROM arrays_test
ARRAY JOIN [1, 2, 3] AS arr_external;
```

s	arr_external
Hello	1
Hello	2
Hello	3
World	1
World	2
World	3
Goodbye	1
Goodbye	2
Goodbye	3

Multiple arrays can be comma-separated in the `ARRAY JOIN` clause. In this case, `JOIN` is performed with them simultaneously (the direct sum, not the cartesian product). Note that all the arrays must have the same size. Example

```
SELECT s, arr, a, num, mapped
FROM arrays_test
ARRAY JOIN arr AS a, arrayEnumerate(arr) AS num, arrayMap(x -> x + 1, arr) AS mapped;
```

s	arr	a	num	mapped
Hello	[1, 2]	1	1	2
Hello	[1, 2]	2	2	3
World	[3, 4, 5]	3	1	4
World	[3, 4, 5]	4	2	5
World	[3, 4, 5]	5	3	6

The example below uses the `arrayEnumerate` function

```
SELECT s, arr, a, num, arrayEnumerate(arr)
FROM arrays_test
ARRAY JOIN arr AS a, arrayEnumerate(arr) AS num;
```

s	arr	a	num	arrayEnumerate(arr)
Hello	[1, 2]	1	1	[1, 2]
Hello	[1, 2]	2	2	[1, 2]
World	[3, 4, 5]	3	1	[1, 2, 3]
World	[3, 4, 5]	4	2	[1, 2, 3]
World	[3, 4, 5]	5	3	[1, 2, 3]

## ARRAY JOIN WITH NESTED DATA STRUCTURE

ARRAY JOIN`` also works with nested data structures. Example

```
CREATE TABLE nested_test
(
 s String,
 nest Nested(
 x UInt8,
 y UInt32)
) ENGINE = Memory;

INSERT INTO nested_test
VALUES ('Hello', [1,2], [10,20]), ('World', [3,4,5], [30,40,50]), ('Goodbye', [], []);
```

s	nest.x	nest.y
Hello	[1,2]	[10,20]
World	[3,4,5]	[30,40,50]
Goodbye	[]	[]

```
SELECT s, `nest.x`, `nest.y`
FROM nested_test
ARRAY JOIN nest;
```

s	nest.x	nest.y
Hello	1	10
Hello	2	20
World	3	30
World	4	40
World	5	50

When specifying names of nested data structures in `ARRAY JOIN`, the meaning is the same as `ARRAY JOIN` with all the `:array` elements that it consists of. Examples are listed below

```
SELECT s, `nest.x`, `nest.y`
FROM nested_test
ARRAY JOIN `nest.x`, `nest.y`;
```

s	nest.x	nest.y
Hello	1	10
Hello	2	20
World	3	30
World	4	40
World	5	50

:This variation also makes sense

```
SELECT s, `nest.x`, `nest.y`
FROM nested_test
ARRAY JOIN `nest.x`;
```

s	nest.x	nest.y
Hello	1	[10,20]
Hello	2	[10,20]
World	3	[30,40,50]
World	4	[30,40,50]
World	5	[30,40,50]

:An alias may be used for a nested data structure, in order to select either the `JOIN` result or the source array. Example

```
SELECT s, `n.x`, `n.y`, `nest.x`, `nest.y`
FROM nested_test
ARRAY JOIN nest AS n;
```

s	n.x	n.y	nest.x	nest.y
Hello	1	10	[1,2]	[10,20]
Hello	2	20	[1,2]	[10,20]
World	3	30	[3,4,5]	[30,40,50]
World	4	40	[3,4,5]	[30,40,50]
World	5	50	[3,4,5]	[30,40,50]

:Example of using the `arrayEnumerate` function

```

SELECT s, `n.x`, `n.y`, `nest.x`, `nest.y`, num
FROM nested_test
ARRAY JOIN nest AS n, arrayEnumerate(`nest.x`) AS num;

```

s	n.x	n.y	nest.x	nest.y	num
Hello	1	10	[1,2]	[10,20]	1
Hello	2	20	[1,2]	[10,20]	2
World	3	30	[3,4,5]	[30,40,50]	1
World	4	40	[3,4,5]	[30,40,50]	2
World	5	50	[3,4,5]	[30,40,50]	3

## JOIN Clause

.Joins the data in the normal [SQL JOIN](#) sense

Note 

.Not related to [ARRAY JOIN](#)

```

SELECT <expr_list>
FROM <left_subquery>
[GLOBAL] [ANY|ALL] [INNER|LEFT|RIGHT|FULL|CROSS] [OUTER] JOIN <right_subquery>
(ON <expr_list>)|(USING <column_list>) ...

```

The table names can be specified instead of `<left_subquery>` and `<right_subquery>`. This is equivalent to the `SELECT * .FROM table` subquery, except in a special case when the table has the [Join](#) engine – an array prepared for joining

### SUPPORTED TYPES OF JOIN

- ( INNER JOIN (or JOIN •
- ( LEFT JOIN (or LEFT OUTER JOIN •
- ( RIGHT JOIN (or RIGHT OUTER JOIN •
- ( FULL JOIN (or FULL OUTER JOIN •
- ( , CROSS JOIN (or •

.See the standard [SQL JOIN](#) description

### MULTIPLE JOIN

Performing queries, ClickHouse rewrites multi-table joins into the sequence of two-table joins. For example, if there are four tables for join ClickHouse joins the first and the second, then joins the result with the third table, and at the last step, it joins the fourth one

If a query contains the `WHERE` clause, ClickHouse tries to pushdown filters from this clause through the intermediate join.  
.If it cannot apply the filter to each intermediate join, ClickHouse applies the filters after all joins are completed

:We recommend the `JOIN ON` or `JOIN USING` syntax for creating queries. For example

```

SELECT * FROM t1 JOIN t2 ON t1.a = t2.a JOIN t3 ON t1.a = t3.a

```

You can use comma-separated lists of tables in the `FROM` clause. This works only with the `:allow_experimental_cross_to_join_conversion = 1` setting. For example

```

SELECT * FROM t1, t2, t3 WHERE t1.a = t2.a AND t1.a = t3.a

```

.Don't mix these syntaxes

ClickHouse doesn't directly support syntax with commas, so we don't recommend using them. The algorithm tries to rewrite the query in terms of `CROSS JOIN` and `INNER JOIN` clauses and then proceeds to query processing. When rewriting the query, ClickHouse tries to optimize performance and memory consumption. By default, ClickHouse treats commas as an `INNER JOIN` clause and converts `INNER JOIN` to `CROSS JOIN` when the algorithm cannot guarantee that `INNER JOIN` returns the required data.

## STRICTNESS

`ALL` — If the right table has several matching rows, ClickHouse creates a **Cartesian product** from matching rows. This is the standard `JOIN` behavior in SQL.

`ANY` — If the right table has several matching rows, only the first one found is joined. If the right table has only one matching row, the results of queries with `ANY` and `ALL` keywords are the same.

`. ASOF` — For joining sequences with a non-exact match. `ASOF JOIN` usage is described below.

## ASOF JOIN Usage

`. ASOF JOIN` is useful when you need to join records that have no exact match.

Tables for `ASOF JOIN` must have an ordered sequence column. This column cannot be alone in a table, and should be one of the data types: `UInt32`, `UInt64`, `Float32`, `Float64`, `Date`, and `DateTime`.

: You can use the following types of syntax

`ASOF JOIN ... ON`

`sql`

`SELECT expressions_list`

`FROM table_1`

`ASOF LEFT JOIN table_2`

`ON equi_cond AND closest_match_cond`

You can use any number of equality conditions and exactly one closest match condition. For example,

```
SELECT count()
FROM A ASOF LEFT JOIN B ON A.a == B.b AND B.t <= A.t . Only table_2.some_col <= table_1.some_col and table_1.some_col
.=! >= table2.some_col condition types are available. You can't apply other conditions like > or
```

`ASOF JOIN ... USING`

`sql`

`SELECT expressions_list`

`FROM table_1`

`ASOF JOIN table_2`

`(USING (equi_column1, ... equi_columnN, asof_column`

`ASOF JOIN` uses `equi_columnX` for joining on equality and `asof_column` for joining on the closest match with the `table_1.asof_column >= table2.asof_column` condition. The `asof_column` column must be the last in the `USING` clause.

: For example, consider the following tables

table_1			table_2		
event	ev_time	user_id	event	ev_time	user_id
event_1_1	12:00	42	event_2_1	11:59	42
...			event_2_2	12:30	42
event_1_2	13:00	42	event_2_3	13:00	42
...			...		

`ASOF JOIN` can take the timestamp of a user event from `table_1` and find an event in `table_2` where the timestamp is closest (equal to or less) to the timestamp of the event from `table_1`. Here, the `user_id` column can be used for joining on

equality and the `ev_time` column can be used for joining on the closest match. In our example, `event_1_1` can be joined with `event_2_1` and `event_1_2` can be joined with `event_2_3`, but `event_2_2` can't be joined

#### Note

. ASOF join is not supported in the `Join` table engine

.To set the default strictness value, use the session configuration parameter[join\\_default\\_strictness](#)

#### GLOBAL JOIN

When using a normal `JOIN`, the query is sent to remote servers. Subqueries are run on each of them in order to make the right table, and the join is performed with this table. In other words, the right table is formed on each server separately

When using `GLOBAL ... JOIN`, first the requestor server runs a subquery to calculate the right table. This temporary table is passed to each remote server, and queries are run on them using the temporary data that was transmitted

.Be careful when using `GLOBAL`. For more information, see the section[Distributed subqueries](#)

#### USAGE RECOMMENDATIONS

When running a `JOIN`, there is no optimization of the order of execution in relation to other stages of the query. The join (a search in the right table) is run before filtering in `WHERE` and before aggregation. In order to explicitly set the processing order, we recommend running a `JOIN` subquery with a subquery

:Example

```
SELECT
 CounterID,
 hits,
 visits
FROM
(
 SELECT
 CounterID,
 count() AS hits
 FROM test.hits
 GROUP BY CounterID
) ANY LEFT JOIN
(
 SELECT
 CounterID,
 sum(Sign) AS visits
 FROM test.visits
 GROUP BY CounterID
) USING CounterID
ORDER BY hits DESC
LIMIT 10
```

CounterID	hits	visits
1143050	523264	13665
731962	475698	102716
722545	337212	108187
722889	252197	10547
2237260	196036	9522
23057320	147211	7689
722818	90109	17847
48221	85379	4652
19762435	77807	7026
722884	77492	11056

Subqueries don't allow you to set names or use them for referencing a column from a specific subquery. The columns specified in `USING` must have the same names in both subqueries, and the other columns must be named differently.

.(You can use aliases to change the names of columns in subqueries (the example uses the aliases `hits` and `visits`

The `USING` clause specifies one or more columns to join, which establishes the equality of these columns. The list of `columns` is set without brackets. More complex join conditions are not supported

.The right table (the subquery result) resides in RAM. If there isn't enough memory, you can't run a `JOIN`

Each time a query is run with the same `JOIN`, the subquery is run again because the result is not cached. To avoid this, `use the special Join table engine, which is a prepared array for joining that is always in RAM`

In some cases, it is more efficient to use `IN` instead of `JOIN`. Among the various types of `JOIN`, the most efficient is `ANY LEFT JOIN`, then `ANY INNER JOIN`. The least efficient are `ALL LEFT JOIN` and `ALL INNER JOIN`

If you need a `JOIN` for joining with dimension tables (these are relatively small tables that contain dimension properties, such as names for advertising campaigns), a `JOIN` might not be very convenient due to the fact that the right table is re-accessed for every query. For such cases, there is an "external dictionaries" feature that you should use instead of `JOIN`.

.For more information, see the section [External dictionaries](#)

## Memory Limitations

ClickHouse uses the `hash join` algorithm. ClickHouse takes the `<right_subquery>` and creates a hash table for it in RAM. If `:you need to restrict join operation memory consumption use the following settings`

- `.max_rows_in_join` — Limits number of rows in the hash table •
- `.max_bytes_in_join` — Limits size of the hash table •

.When any of these limits is reached, ClickHouse acts as the `join_overflow_mode` setting instructs

## PROCESSING OF EMPTY OR NULL CELLS

.While joining tables, the empty cells may appear. The setting `join_use_nulls` define how ClickHouse fills these cells

.If the `JOIN` keys are `Nullable` fields, the rows where at least one of the keys has the value `NULL` are not joined

## SYNTAX LIMITATIONS

:For multiple `JOIN` clauses in a single `SELECT` query

.Taking all the columns via `*` is available only if tables are joined, not subqueries •

.The `PREWHERE` clause is not available •

:For `ON`, `WHERE`, and `GROUP BY` clauses

Arbitrary expressions cannot be used in `ON`, `WHERE`, and `GROUP BY` clauses, but you can define an expression in a •  
. `SELECT` clause and then use it in these clauses via an alias

## WHERE Clause

If there is a `WHERE` clause, it must contain an expression with the `UInt8` type. This is usually an expression with `.comparison` and logical operators. This expression will be used for filtering data before all other transformations

.If indexes are supported by the database table engine, the expression is evaluated on the ability to use indexes

## PREWHERE Clause

This clause has the same meaning as the `WHERE` clause. The difference is in which data is read from the table. When using `PREWHERE`, first only the columns necessary for executing `PREWHERE` are read. Then the other columns are `.read` that are needed for running the query, but only those blocks where the `PREWHERE` expression is true

It makes sense to use `PREWHERE` if there are filtration conditions that are used by a minority of the columns in the query,

.but that provide strong data filtration. This reduces the volume of data to read

For example, it is useful to write PREWHERE for queries that extract a large number of columns, but that only have  
filtration for a few columns

.PREWHERE is only supported by tables from the `*MergeTree` family

.A query may simultaneously specify PREWHERE and WHERE. In this case, PREWHERE precedes WHERE

If the 'optimize\_move\_to\_prewhere' setting is set to 1 and PREWHERE is omitted, the system uses heuristics to  
automatically move parts of expressions from WHERE to PREWHERE

## GROUP BY Clause

.This is one of the most important parts of a column-oriented DBMS

If there is a GROUP BY clause, it must contain a list of expressions. Each expression will be referred to here as a "key".

All the expressions in the SELECT, HAVING, and ORDER BY clauses must be calculated from keys or from aggregate  
.functions. In other words, each column selected from the table must be used either in keys or inside aggregate functions

If a query contains only table columns inside aggregate functions, the GROUP BY clause can be omitted, and aggregation  
.by an empty set of keys is assumed

:Example

```
SELECT
 count(),
 median(FetchTiming > 60 ? 60 : FetchTiming),
 count() - sum(Refresh)
FROM hits
```

However, in contrast to standard SQL, if the table doesn't have any rows (either there aren't any at all, or there aren't any  
after using WHERE to filter), an empty result is returned, and not the result from one of the rows containing the initial  
.values of aggregate functions

As opposed to MySQL (and conforming to standard SQL), you can't get some value of some column that is not in a key or  
aggregate function (except constant expressions). To work around this, you can use the 'any' aggregate function (get the  
.first encountered value) or 'min/max'

:Example

```
SELECT
 domainWithoutWWW(URL) AS domain,
 count(),
 any>Title) AS title -- getting the first occurred page header for each domain.
FROM hits
GROUP BY domain
```

.For every different key value encountered, GROUP BY calculates a set of aggregate function values

.GROUP BY is not supported for array columns

A constant can't be specified as arguments for aggregate functions. Example: sum(1). Instead of this, you can get rid of  
.()the constant. Example: count

## NULL PROCESSING

.For grouping, ClickHouse interprets `NULL` as a value, and `NULL=NULL`

.Here's an example to show what this means

:Assume you have this table

x	y
1	2
2	NULL
3	2
3	3
3	NULL

:The query `SELECT sum(x), y FROM t_null_big GROUP BY y` results in

sum(x)	y
4	2
3	3
5	NULL

. You can see that `GROUP BY` for `y = NULL` summed up `x`, as if `NULL` is this value

If you pass several keys to `GROUP BY`, the result will give you all the combinations of the selection, as if `NULL` were a .specific value

#### WITH TOTALS MODIFIER

If the `WITH TOTALS` modifier is specified, another row will be calculated. This row will have key columns containing default values (zeros or empty lines), and columns of aggregate functions with the values calculated across all the rows .((the "total" values

This extra row is output in `JSON*`, `TabSeparated*`, and `Pretty*` formats, separately from the other rows. In the other .formats, this row is not output

In `JSON*` formats, this row is output as a separate 'totals' field. In `TabSeparated*` formats, the row comes after the main result, preceded by an empty row (after the other data). In `Pretty*` formats, the row is output as a separate table after the .main result

`WITH TOTALS` can be run in different ways when `HAVING` is present. The behavior depends on the 'totals\_mode' setting.

By default, `totals_mode = 'before_having'` . In this case, 'totals' is calculated across all rows, including the ones that don't .pass through `HAVING` and `'max_rows_to_group_by`

The other alternatives include only the rows that pass through `HAVING` in 'totals', and behave differently with the setting

. `'max_rows_to_group_by` and `group_by_overflow_mode = 'any`

`after_having_exclusive` – Don't include rows that didn't pass through `max_rows_to_group_by` . In other words, 'totals' will have .less than or the same number of rows as it would if `max_rows_to_group_by` were omitted

`after_having_inclusive` – Include all the rows that didn't pass through '`max_rows_to_group_by`' in 'totals'. In other words, .'totals' will have more than or the same number of rows as it would if `max_rows_to_group_by` were omitted

`after_having_auto` – Count the number of rows that passed through `HAVING`. If it is more than a certain amount (by default, .50%), include all the rows that didn't pass through '`max_rows_to_group_by`' in 'totals'. Otherwise, do not include them

. `totals_auto_threshold` – By default, 0.5. The coefficient for `after_having_auto`

If `max_rows_to_group_by` and `group_by_overflow_mode = 'any'` are not used, all variations of `after_having` are the same, and .(you can use any of them (for example, `after_having_auto`

You can use `WITH TOTALS` in subqueries, including subqueries in the `JOIN` clause (in this case, the respective total .values are combined

You can enable dumping temporary data to the disk to restrict memory usage during GROUP BY . The max\_bytes\_before\_external\_group\_by setting determines the threshold RAM consumption for dumping GROUP BY temporary data to the file system. If set to 0 (the default), it is disabled

When using max\_bytes\_before\_external\_group\_by , we recommend that you set max\_memory\_usage about twice as high. This is necessary because there are two stages to aggregation: reading the data and forming intermediate data (1) and merging the intermediate data (2). Dumping data to the file system can only occur during stage 1. If the temporary data wasn't dumped, then stage 2 might require up to the same amount of memory as in stage 1

For example, if max\_memory\_usage was set to 100000000000 and you want to use external aggregation, it makes sense to set max\_bytes\_before\_external\_group\_by to 100000000000, and max\_memory\_usage to 20000000000. When external aggregation is triggered (if there was at least one dump of temporary data), maximum consumption of RAM is only slightly more than max\_bytes\_before\_external\_group\_by

With distributed query processing, external aggregation is performed on remote servers. In order for the requester server to use only a small amount of RAM, set distributed\_aggregation\_memory\_efficient to 1

When merging data flushed to the disk, as well as when merging results from remote servers when the distributed\_aggregation\_memory\_efficient setting is enabled, consumes up to 1/256 \* the\_number\_of\_threads from the total amount of RAM

When external aggregation is enabled, if there was less than max\_bytes\_before\_external\_group\_by of data (i.e. data was not flushed), the query runs just as fast as without external aggregation. If any temporary data was flushed, the run time will be several times longer (approximately three times

If you have an ORDER BY with a LIMIT after GROUP BY , then the amount of used RAM depends on the amount of data in LIMIT , not in the whole table. But if the ORDER BY doesn't have LIMIT , don't forget to enable external sorting (( max\_bytes\_before\_external\_sort

## LIMIT BY Clause

A query with the LIMIT n BY expressions clause selects the first n rows for each distinct value of expressions . The key for . LIMIT BY can contain any number of expressions

:ClickHouse supports the following syntax

LIMIT [offset\_value, ]n BY expressions •

LIMIT n OFFSET offset\_value BY expressions •

During query processing, ClickHouse selects data ordered by sorting key. The sorting key is set explicitly using an ORDER BY clause or implicitly as a property of the table engine. Then ClickHouse applies LIMIT n BY expressions and returns the first n rows for each distinct combination of expressions . If OFFSET is specified, then for each data block that belongs to a distinct combination of expressions , ClickHouse skips offset\_value number of rows from the beginning of the block and returns a maximum of n rows as a result. If offset\_value is bigger than the number of rows in the data block, ClickHouse returns zero rows from the block

. LIMIT BY is not related to LIMIT . They can both be used in the same query

## Examples

:Sample table

```
CREATE TABLE limit_by(id Int, val Int) ENGINE = Memory;
INSERT INTO limit_by values(1, 10), (1, 11), (1, 12), (2, 20), (2, 21);
```

:Queries

```
SELECT * FROM limit_by ORDER BY id, val LIMIT 2 BY id
```

id	val
1	10
1	11
2	20
2	21

```
SELECT * FROM limit_by ORDER BY id, val LIMIT 1, 2 BY id
```

id	val
1	11
1	12
2	21

.The `SELECT * FROM limit_by ORDER BY id, val LIMIT 2 OFFSET 1 BY id` query returns the same result

The following query returns the top 5 referrers for each domain, device\_type pair with a maximum of 100 rows in total  
.`(( LIMIT n BY + LIMIT`

```
SELECT
 domainWithoutWWW(URL) AS domain,
 domainWithoutWWW(REFERRER_URL) AS referrer,
 device_type,
 count() cnt
FROM hits
GROUP BY domain, referrer, device_type
ORDER BY cnt DESC
LIMIT 5 BY domain, device_type
LIMIT 100
```

## HAVING Clause

Allows filtering the result received after GROUP BY, similar to the WHERE clause. WHERE and HAVING differ in that WHERE is performed before aggregation (GROUP BY), while HAVING is performed after it. If aggregation is not performed, HAVING can't be used

## ORDER BY Clause

The ORDER BY clause contains a list of expressions, which can each be assigned DESC or ASC (the sorting direction). If the direction is not specified, ASC is assumed. ASC is sorted in ascending order, and DESC in descending order. The sorting direction applies to a single expression, not to the entire list. Example: `ORDER BY Visits DESC, SearchPhrase`

For sorting by String values, you can specify collation (comparison). Example: `ORDER BY SearchPhrase COLLATE 'tr'` - for sorting by keyword in ascending order, using the Turkish alphabet, case insensitive, assuming that strings are UTF-8 encoded. COLLATE can be specified or not for each expression in ORDER BY independently. If ASC or DESC is specified, COLLATE is specified after it. When using COLLATE, sorting is always case-insensitive

We only recommend using COLLATE for final sorting of a small number of rows, since sorting with COLLATE is less efficient than normal sorting by bytes

Rows that have identical values for the list of sorting expressions are output in an arbitrary order, which can also be nondeterministic (different each time). If the ORDER BY clause is omitted, the order of the rows is also undefined, and .may be nondeterministic as well

: NaN and NULL sorting order

.With the modifier `NULLS FIRST` — First NULL , then NaN , then other values •

.With the modifier `NULLS LAST` — First the values, then `NaN`, then `NULL` •

.Default — The same as with the `NULLS LAST` modifier •

:Example

For the table

X	Y
1	NULL
2	2
1	nan
2	2
3	4
5	6
6	nan
7	NULL
6	7
8	9

:Run the query `SELECT * FROM t_null_nan ORDER BY y NULLS FIRST` to get

X	Y
1	NULL
7	NULL
1	nan
6	nan
2	2
2	2
3	4
5	6
6	7
8	9

When floating point numbers are sorted, NaNs are separate from the other values. Regardless of the sorting order, NaNs come at the end. In other words, for ascending sorting they are placed as if they are larger than all the other numbers, .while for descending sorting they are placed as if they are smaller than the rest

Less RAM is used if a small enough `LIMIT` is specified in addition to `ORDER BY`. Otherwise, the amount of memory spent is proportional to the volume of data for sorting. For distributed query processing, if `GROUP BY` is omitted, sorting is partially done on remote servers, and the results are merged on the requestor server. This means that for distributed sorting, the volume of data to sort can be greater than the amount of memory on a single server

If there is not enough RAM, it is possible to perform sorting in external memory (creating temporary files on a disk). Use the setting `max_bytes_before_external_sort` for this purpose. If it is set to 0 (the default), external sorting is disabled. If it is enabled, when the volume of data to sort reaches the specified number of bytes, the collected data is sorted and dumped into a temporary file. After all data is read, all the sorted files are merged and the results are output. Files are written to the `/var/lib/clickhouse/tmp/` directory in the config (by default, but you can use the `'tmp_path'` parameter to change this .(setting

Running a query may use more memory than '`max_bytes_before_external_sort`'. For this reason, this setting must have a value significantly smaller than '`max_memory_usage`'. As an example, if your server has 128 GB of RAM and you need to run a single query, set '`max_memory_usage`' to 100 GB, and '`max_bytes_before_external_sort`' to 80 GB

.External sorting works much less effectively than sorting in RAM

## SELECT Clause

**Expressions** specified in the `SELECT` clause are calculated after all the operations in the clauses described above are finished. These expressions work as if they apply to separate rows in the result. If expressions in the `SELECT` clause

contain aggregate functions, then ClickHouse processes aggregate functions and expressions used as their arguments during the **GROUP BY** aggregation.

If you want to include all columns in the result, use the asterisk (\*) symbol. For example, `SELECT * FROM`. To match some columns in the result with a regular expression, you can use the `COLUMNS` expression

```
COLUMNS('regexp')
```

:For example, consider the table

```
CREATE TABLE default.col_names (aa Int8, ab Int8, bc Int8) ENGINE = TinyLog
```

The following query selects data from all the columns containing the `a` symbol in their name

```
SELECT COLUMNS('a') FROM col_names
```

aa	ab
1	1

The selected columns are returned not in the alphabetical order

You can use multiple `COLUMNS` expressions in a query and apply functions to them

:For example

```
SELECT COLUMNS('a'), COLUMNS('c'), toTypeName(COLUMNS('c')) FROM col_names
```

aa	ab	bc	toTypeName(bc)
1	1	1	Int8

Each column returned by the `COLUMNS` expression is passed to the function as a separate argument. Also you can pass other arguments to the function if it supports them. Be careful when using functions. If a function doesn't support the number of arguments you have passed to it, ClickHouse throws an exception

:For example

```
SELECT COLUMNS('a') + COLUMNS('c') FROM col_names
```

```
Received exception from server (version 19.14.1):
Code: 42. DB::Exception: Received from localhost:9000. DB::Exception: Number of arguments for function plus
doesn't match: passed 3, should be 2.
```

In this example, `COLUMNS('a')` returns two columns: `aa` and `ab`. `COLUMNS('c')` returns the `bc` column. The `+` operator can't apply to 3 arguments, so ClickHouse throws an exception with the relevant message

Columns that matched the `COLUMNS` expression can have different data types. If `COLUMNS` doesn't match any columns and is the only expression in `SELECT`, ClickHouse throws an exception

## DISTINCT Clause

If `DISTINCT` is specified, only a single row will remain out of all the sets of fully matching rows in the result. The result will be the same as if `GROUP BY` were specified across all the fields specified in `SELECT` without aggregate functions. But there are several differences from `GROUP BY`

.DISTINCT can be applied together with GROUP BY •

When ORDER BY is omitted and LIMIT is defined, the query stops running immediately after the required number of •  
.different rows has been read

.Data blocks are output as they are processed, without waiting for the entire query to finish running •

.DISTINCT is not supported if SELECT has at least one array column

DISTINCT works with **NULL** as if **NULL** were a specific value, and **NULL=NULL** . In other words, in the DISTINCT results,  
.different combinations with **NULL** only occur once

ClickHouse supports using the DISTINCT and ORDER BY clauses for different columns in one query. The DISTINCT  
.clause is executed before the ORDER BY clause

:Example table

a	b
2	1
1	2
3	3
2	4

:When selecting data with the `SELECT DISTINCT a FROM t1 ORDER BY b ASC` query, we get the following result

a
2
1
3

:If we change the sorting direction `SELECT DISTINCT a FROM t1 ORDER BY b DESC` , we get the following result

a
3
1
2

.Row 2, 4 was cut before sorting

.Take this implementation specificity into account when programming queries

## LIMIT Clause

. `LIMIT m` allows you to select the first `m` rows from the result

`LIMIT n, m` allows you to select the first `m` rows from the result after skipping the first `n` rows. The `LIMIT m OFFSET n`  
.syntax is also supported

. `n` and `m` must be non-negative integers

.If there isn't an ORDER BY clause that explicitly sorts results, the result may be arbitrary and nondeterministic

## UNION ALL Clause

:You can use UNION ALL to combine any number of queries. Example

```

SELECT CounterID, 1 AS table, toInt64(count()) AS c
 FROM test.hits
 GROUP BY CounterID

UNION ALL

SELECT CounterID, 2 AS table, sum(Sign) AS c
 FROM test.visits
 GROUP BY CounterID
 HAVING c > 0

```

Only UNION ALL is supported. The regular UNION (UNION DISTINCT) is not supported. If you need UNION DISTINCT, you can write SELECT DISTINCT from a subquery containing UNION ALL

.Queries that are parts of UNION ALL can be run simultaneously, and their results can be mixed together

The structure of results (the number and type of columns) must match for the queries. But the column names can differ. In this case, the column names for the final result will be taken from the first query. Type casting is performed for unions. For example, if two queries being combined have the same field with non- Nullable and Nullable types from a compatible type, .the resulting UNION ALL has a Nullable type field

Queries that are parts of UNION ALL can't be enclosed in brackets. ORDER BY and LIMIT are applied to separate queries, not to the final result. If you need to apply a conversion to the final result, you can put all the queries with UNION ALL in a subquery in the FROM clause

### **INTO OUTFILE Clause**

Add the INTO OUTFILE filename clause (where filename is a string literal) to redirect query output to the specified file. In contrast to MySQL, the file is created on the client side. The query will fail if a file with the same filename already exists. .(This functionality is available in the command-line client and clickhouse-local (a query sent via HTTP interface will fail .(The default output format is TabSeparated (the same as in the command-line client batch mode

### **FORMAT Clause**

Specify 'FORMAT format' to get data in any specified format. You can use this for convenience, or for creating dumps. For more information, see the section "Formats". If the FORMAT clause is omitted, the default format is used, which depends on both the settings and the interface used for accessing the DB. For the HTTP interface and the command-line client in batch mode, the default format is TabSeparated. For the command-line client in interactive mode, the default format is .(PrettyCompact (it has attractive and compact tables

When using the command-line client, data is passed to the client in an internal efficient format. The client independently interprets the FORMAT clause of the query and formats the data itself (thus relieving the network and the server from the .(load

### **IN Operators**

.The IN , NOT IN , GLOBAL IN , and GLOBAL NOT IN operators are covered separately, since their functionality is quite rich .The left side of the operator is either a single column or a tuple :Examples

```

SELECT UserID IN (123, 456) FROM ...
SELECT (CounterID, UserID) IN ((34, 123), (101500, 456)) FROM ...

```

If the left side is a single column that is in the index, and the right side is a set of constants, the system uses the index for .processing the query

Don't list too many values explicitly (i.e. millions). If a data set is large, put it in a temporary table (for example, see the

.section "External data for query processing"), then use a subquery

The right side of the operator can be a set of constant expressions, a set of tuples with constant expressions (shown in the examples above), or the name of a database table or SELECT subquery in brackets

If the right side of the operator is the name of a table (for example, `UserID IN users` ), this is equivalent to the subquery `UserID IN (SELECT * FROM users)` . Use this when working with external data that is sent along with the query. For example, the query can be sent together with a set of user IDs loaded to the 'users' temporary table, which should be filtered

If the right side of the operator is a table name that has the Set engine (a prepared data set that is always in RAM), the data set will not be created over again for each query

:The subquery may specify more than one column for filtering tuples. Example

```
SELECT (CounterID, UserID) IN (SELECT CounterID, UserID FROM ...) FROM ...
```

.The columns to the left and right of the IN operator should have the same type

The IN operator and subquery may occur in any part of the query, including in aggregate functions and lambda functions.

:Example

```
SELECT
 EventDate,
 avg(UserID IN
 (
 SELECT UserID
 FROM test.hits
 WHERE EventDate = toDate('2014-03-17')
)) AS ratio
FROM test.hits
GROUP BY EventDate
ORDER BY EventDate ASC
```

EventDate	ratio
2014-03-17	1
2014-03-18	0.807696
2014-03-19	0.755406
2014-03-20	0.723218
2014-03-21	0.697021
2014-03-22	0.647851
2014-03-23	0.648416

For each day after March 17th, count the percentage of pageviews made by users who visited the site on March 17th. A subquery in the IN clause is always run just one time on a single server. There are no dependent subqueries

#### NULL PROCESSING

During request processing, the IN operator assumes that the result of an operation with `NULL` is always equal to 0 , regardless of whether `NULL` is on the right or left side of the operator. `NULL` values are not included in any dataset, do not correspond to each other and cannot be compared

:Here is an example with the `t_null` table

X	Y
1	NULL
2	3

:Running the query `SELECT x FROM t_null WHERE y IN (NULL,3)` gives you the following result

X  
2

You can see that the row in which `y = NULL` is thrown out of the query results. This is because ClickHouse can't decide whether `NULL` is included in the `(NULL,3)` set, returns `0` as the result of the operation, and `SELECT` excludes this row from the final output.

```
SELECT y IN (NULL, 3)
FROM t_null
```

in(y, tuple(NULL, 3))
0
1

## DISTRIBUTED SUBQUERIES

There are two options for IN-s with subqueries (similar to JOINs): normal IN / JOIN and GLOBAL IN / GLOBAL JOIN . They differ in how they are run for distributed query processing

### Attention

.Remember that the algorithms described below may work differently depending on the `settings distributed_product_mode` setting

When using the regular IN, the query is sent to remote servers, and each of them runs the subqueries in the IN or JOIN clause

When using GLOBAL IN / GLOBAL JOINS , first all the subqueries are run for GLOBAL IN / GLOBAL JOINS , and the results are collected in temporary tables. Then the temporary tables are sent to each remote server, where the queries are run using this temporary data

.For a non-distributed query, use the regular IN / JOIN

.Be careful when using subqueries in the IN / JOIN clauses for distributed query processing

Let's look at some examples. Assume that each server in the cluster has a normal local\_table. Each server also has a distributed\_table table with the Distributed type, which looks at all the servers in the cluster

.For a query to the distributed\_table, the query will be sent to all the remote servers and run on them using the local\_table

For example, the query

```
SELECT uniq(UserID) FROM distributed_table
```

will be sent to all remote servers as

```
SELECT uniq(UserID) FROM local_table
```

and run on each of them in parallel, until it reaches the stage where intermediate results can be combined. Then the intermediate results will be returned to the requestor server and merged on it, and the final result will be sent to the client

:Now let's examine a query with IN

```
SELECT uniq(UserID) FROM distributed_table WHERE CounterID = 101500 AND UserID IN (SELECT UserID FROM local_table WHERE CounterID = 34)
```

.Calculation of the intersection of audiences of two sites •

This query will be sent to all remote servers as

```
SELECT uniq(UserID) FROM local_table WHERE CounterID = 101500 AND UserID IN (SELECT UserID FROM local_table WHERE CounterID = 34)
```

In other words, the data set in the IN clause will be collected on each server independently, only across the data that is stored locally on each of the servers

This will work correctly and optimally if you are prepared for this case and have spread data across the cluster servers such that the data for a single UserID resides entirely on a single server. In this case, all the necessary data will be available locally on each server. Otherwise, the result will be inaccurate. We refer to this variation of the query as "local .IN"

To correct how the query works when data is spread randomly across the cluster servers, you could specify :distributed\_table inside a subquery. The query would look like this

```
SELECT uniq(UserID) FROM distributed_table WHERE CounterID = 101500 AND UserID IN (SELECT UserID FROM distributed_table WHERE CounterID = 34)
```

This query will be sent to all remote servers as

```
SELECT uniq(UserID) FROM local_table WHERE CounterID = 101500 AND UserID IN (SELECT UserID FROM distributed_table WHERE CounterID = 34)
```

The subquery will begin running on each remote server. Since the subquery uses a distributed table, the subquery that is on each remote server will be resent to every remote server as

```
SELECT UserID FROM local_table WHERE CounterID = 34
```

For example, if you have a cluster of 100 servers, executing the entire query will require 10,000 elementary requests, which is generally considered unacceptable

In such cases, you should always use GLOBAL IN instead of IN. Let's look at how it works for the query

```
SELECT uniq(UserID) FROM distributed_table WHERE CounterID = 101500 AND UserID GLOBAL IN (SELECT UserID FROM distributed_table WHERE CounterID = 34)
```

The requestor server will run the subquery

```
SELECT UserID FROM distributed_table WHERE CounterID = 34
```

and the result will be put in a temporary table in RAM. Then the request will be sent to each remote server as

```
SELECT uniq(UserID) FROM local_table WHERE CounterID = 101500 AND UserID GLOBAL IN _data1
```

and the temporary table \_data1 will be sent to every remote server with the query (the name of the temporary table is .(implementation-defined

:This is more optimal than using the normal IN. However, keep the following points in mind

When creating a temporary table, data is not made unique. To reduce the volume of data transmitted over the .1 network, specify DISTINCT in the subquery. (You don't need to do this for a normal IN

The temporary table will be sent to all the remote servers. Transmission does not account for network topology. For .2 example, if 10 remote servers reside in a datacenter that is very remote in relation to the requestor server, the data .will be sent 10 times over the channel to the remote datacenter. Try to avoid large data sets when using GLOBAL IN

When transmitting data to remote servers, restrictions on network bandwidth are not configurable. You might overload .3

.the network

.Try to distribute data across servers so that you don't need to use GLOBAL IN on a regular basis .4

If you need to use GLOBAL IN often, plan the location of the ClickHouse cluster so that a single group of replicas .5 resides in no more than one data center with a fast network between them, so that a query can be processed entirely .within a single data center

It also makes sense to specify a local table in the GLOBAL IN clause, in case this local table is only available on the .requestor server and you want to use data from it on remote servers

## Extreme Values

In addition to results, you can also get minimum and maximum values for the results columns. To do this, set the extremes setting to 1. Minimums and maximums are calculated for numeric types, dates, and dates with times. For other .columns, the default values are output

An extra two rows are calculated – the minimums and maximums, respectively. These extra two rows are output in .JSON\*, TabSeparated\*, and Pretty\* **formats**, separate from the other rows. They are not output for other formats

In JSON\* formats, the extreme values are output in a separate 'extremes' field. In TabSeparated\* formats, the row comes after the main result, and after 'totals' if present. It is preceded by an empty row (after the other data). In Pretty\* formats, .the row is output as a separate table after the main result, and after totals if present

Extreme values are calculated for rows before LIMIT, but after LIMIT BY. However, when using LIMIT offset, size, the rows before offset are included in extremes. In stream requests, the result may also include a small number of rows that .passed through LIMIT

## Notes

The GROUP BY and ORDER BY clauses do not support positional arguments. This contradicts MySQL, but conforms to standard SQL. For example, GROUP BY 1, 2 will be interpreted as grouping by constants (i.e. aggregation of all rows into .(one

.You can use synonyms (AS aliases) in any part of a query

You can put an asterisk in any part of a query instead of an expression. When the query is analyzed, the asterisk is expanded to a list of all table columns (excluding the MATERIALIZED and ALIAS columns). There are only a few cases :when using an asterisk is justified

.When creating a table dump •

.For tables containing just a few columns, such as system tables •

For getting information about what columns are in a table. In this case, set LIMIT 1. But it is better to use the DESC • .TABLE query

.When there is strong filtration on a small number of columns using PREWHERE •

.(In subqueries (since columns that aren't needed for the external query are excluded from subqueries •

In all other cases, we don't recommend using the asterisk, since it only gives you the drawbacks of a columnar DBMS .instead of the advantages. In other words using the asterisk is not recommended

## INSERT

.Adding data

:Basic query format

```
INSERT INTO [db.]table [(c1, c2, c3)] VALUES (v11, v12, v13), (v21, v22, v23), ...
```

- :The query can specify a list of columns to insert [(c1, c2, c3)]. In this case, the rest of the columns are filled with
- .The values calculated from the `DEFAULT` expressions specified in the table definition •
  - .Zeros and empty strings, if `DEFAULT` expressions are not defined •
- .If `strict_insert_defaults=1`, columns that do not have `DEFAULT` defined must be listed in the query

Data can be passed to the `INSERT` in any `format` supported by ClickHouse. The format must be specified explicitly in the :query

```
INSERT INTO [db.]table [(c1, c2, c3)] FORMAT format_name data_set
```

:For example, the following query format is identical to the basic version of `INSERT ... VALUES`

```
INSERT INTO [db.]table [(c1, c2, c3)] FORMAT Values (v11, v12, v13), (v21, v22, v23), ...
```

ClickHouse removes all spaces and one line feed (if there is one) before the data. When forming a query, we recommend .(putting the data on a new line after the query operators (this is important if the data begins with spaces

:Example

```
INSERT INTO t FORMAT TabSeparated
11 Hello, world!
22 Qwerty
```

You can insert data separately from the query by using the command-line client or the HTTP interface. For more ."information, see the section "[Interfaces](#)

## Constraints

If table has `constraints`, their expressions will be checked for each row of inserted data. If any of those constraints is not .satisfied — server will raise an exception containing constraint name and expression, the query will be stopped

## Inserting The Results of SELECT

```
INSERT INTO [db.]table [(c1, c2, c3)] SELECT ...
```

Columns are mapped according to their position in the `SELECT` clause. However, their names in the `SELECT` expression .and the table for `INSERT` may differ. If necessary, type casting is performed

None of the data formats except `Values` allow setting values to expressions such as `now()` , `1 + 2` , and so on. The `Values` format allows limited use of expressions, but this is not recommended, because in this case inefficient code is used for .their execution

Other queries for modifying data parts are not supported: `UPDATE` , `DELETE` , `REPLACE` , `MERGE` , `UPSERT` , `INSERT` .`UPDATE` . However, you can delete old data using `ALTER TABLE ... DROP PARTITION`

.() `FORMAT` clause must be specified in the end of query if `SELECT` clause contains table function `input`

## Performance Considerations

`INSERT` sorts the input data by primary key and splits them into partitions by a partition key. If you insert data into several :partitions at once, it can significantly reduce the performance of the `INSERT` query. To avoid this

.Add data in fairly large batches, such as 100,000 rows at a time •

.Group data by a partition key before uploading it to ClickHouse •

:Performance will not decrease if

.Data is added in real time •

.You upload data that is usually sorted by time •

## CREATE Queries

### CREATE DATABASE

.Creates database

```
CREATE DATABASE [IF NOT EXISTS] db_name [ON CLUSTER cluster] [ENGINE = engine(...)]
```

#### Clauses

IF NOT EXISTS •

:If the db\_name database already exists, then ClickHouse doesn't create a new database and

.Doesn't throw an exception if clause is specified •

.Throws an exception if clause isn't specified •

ON CLUSTER •

.ClickHouse creates the db\_name database on all the servers of a specified cluster

ENGINE •

MySQL •

.Allows you to retrieve data from the remote MySQL server

.By default, ClickHouse uses its own **database engine**

## CREATE TABLE

.The CREATE TABLE query can have several forms

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
 name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1] [compression_codec] [TTL expr1],
 name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2] [compression_codec] [TTL expr2],
 ...
) ENGINE = engine
```

Creates a table named 'name' in the 'db' database or the current database if 'db' is not set, with the structure specified in brackets and the 'engine' engine. The structure of the table is a list of column descriptions. If indexes are supported by the .engine, they are indicated as parameters for the table engine

A column description is name type in the simplest case. Example: RegionID UInt32 . Expressions can also be defined for .(default values (see below

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name AS [db2.]name2 [ENGINE = engine]
```

Creates a table with the same structure as another table. You can specify a different engine for the table. If the engine is .not specified, the same engine will be used as for the db2.name2 table

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name AS table_function()
```

.Creates a table with the structure and data returned by a table function

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name ENGINE = engine AS SELECT ...
```

Creates a table with a structure like the result of the SELECT query, with the 'engine' engine, and fills it with data from .SELECT

In all cases, if IF NOT EXISTS is specified, the query won't return an error if the table already exists. In this case, the query .won't do anything

There can be other clauses after the ENGINE clause in the query. See detailed documentation on how to create tables in .the descriptions of table engines

## Default Values

The column description can specify an expression for a default value, in one of the following ways:DEFAULT expr , .( MATERIALIZED expr , ALIAS expr . Example: URLDomain String DEFAULT domain(URL

If an expression for the default value is not defined, the default values will be set to zeros for numbers, empty strings for strings, empty arrays for arrays, and 0000-00-00 for dates or 0000-00-00 00:00:00 for dates with time. NULLs are not .supported

If the default expression is defined, the column type is optional. If there isn't an explicitly defined type, the default expression type is used. Example: EventDate DEFAULT toDate(EventTime) – the 'Date' type will be used for the 'EventDate' .column

If the data type and default expression are defined explicitly, this expression will be cast to the specified type using type .(casting functions. Example: Hits UInt32 DEFAULT 0 means the same thing as Hits UInt32 DEFAULT toUInt32(0

Default expressions may be defined as an arbitrary expression from table constants and columns. When creating and changing the table structure, it checks that expressions don't contain loops. For INSERT, it checks that expressions are .resolvable – that all columns they can be calculated from have been passed

DEFAULT expr

Normal default value. If the INSERT query doesn't specify the corresponding column, it will be filled in by computing the .corresponding expression

MATERIALIZED expr

Materialized expression. Such a column can't be specified for INSERT, because it is always calculated. For an INSERT without a list of columns, these columns are not considered. In addition, this column is not substituted when using an asterisk in a SELECT query. This is to preserve the invariant that the dump obtained using SELECT \* can be inserted .back into the table using INSERT without specifying the list of columns

ALIAS expr

Synonym. Such a column isn't stored in the table at all. Its values can't be inserted in a table, and it is not substituted .when using an asterisk in a SELECT query. It can be used in SELECTs if the alias is expanded during query parsing

When using the ALTER query to add new columns, old data for these columns is not written. Instead, when reading old data that does not have values for the new columns, expressions are computed on the fly by default. However, if running the expressions requires different columns that are not indicated in the query, these columns will additionally be read, but .only for the blocks of data that need it

If you add a new column to a table but later change its default expression, the values used for old data will change (for

data where values were not stored on the disk). Note that when running background merges, data for columns that are missing in one of the merging parts is written to the merged part

.It is not possible to set default values for elements in nested data structures

## Constraints

:Along with columns descriptions constraints could be defined

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
 name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1] [compression_codec] [TTL expr1],
 ...
 CONSTRAINT constraint_name_1 CHECK boolean_expr_1,
 ...
) ENGINE = engine
```

boolean\_expr\_1 could by any boolean expression. If constraints are defined for the table, each of them will be checked for every row in `INSERT` query. If any constraint is not satisfied — server will raise an exception with constraint name and .checking expression

.Adding large amount of constraints can negatively affect performance of big `INSERT` queries

## TTL Expression

Defines storage time for values. Can be specified only for MergeTree-family tables. For the detailed description, see [TTL for columns and tables](#)

## Column Compression Codecs

By default, ClickHouse applies the compression method, defined in [server settings](#), to columns. You can also define the .compression method for each individual column in the `CREATE TABLE` query

```
CREATE TABLE codec_example
(
 dt Date CODEC(ZSTD),
 ts DateTime CODEC(LZ4HC),
 float_value Float32 CODEC(NONE),
 double_value Float64 CODEC(LZ4HC(9))
 value Float32 CODEC(Delta, ZSTD)
)
ENGINE = <Engine>
...
```

If a codec is specified, the default codec doesn't apply. Codecs can be combined in a pipeline, for example, CODEC(Delta, ZSTD) . To select the best codec combination for you project, pass benchmarks similar to described in the Altinity [New Encodings to Improve ClickHouse Efficiency](#) article

### Warning

.You can't decompress ClickHouse database files with external utilities like `lz4` . Instead, use the special [clickhouse-compressor](#) utility

:Compression is supported for the following table engines

[MergeTree family](#) •

[Log family](#) •

[Set](#) •

[Join](#) •

These codecs are designed to make compression more effective by using specific features of data. Some of these codecs don't compress data themselves. Instead, they prepare the data for a common purpose codec, which compresses it better than without this preparation

#### :Specialized codecs

`Delta(delta_bytes)` — Compression approach in which raw values are replaced by the difference of two neighboring values, except for the first value that stays unchanged. Up to `delta_bytes` are used for storing delta values, so `delta_bytes` is the maximum size of raw values. Possible `delta_bytes` values: 1, 2, 4, 8. The default value for `.delta_bytes` is `sizeof(type)` if equal to 1, 2, 4, or 8. In all other cases, it's 1

`DoubleDelta` — Calculates delta of deltas and writes it in compact binary form. Optimal compression rates are achieved for monotonic sequences with a constant stride, such as time series data. Can be used with any fixed-width type. Implements the algorithm used in Gorilla TSDB, extending it to support 64-bit types. Uses 1 extra bit for 32-byte deltas: 5-bit prefixes instead of 4-bit prefixes. For additional information, see Compressing Time Stamps in [Gorilla: A Fast, Scalable, In-Memory Time Series Database](#)

`Gorilla` — Calculates XOR between current and previous value and writes it in compact binary form. Efficient when storing a series of floating point values that change slowly, because the best compression rate is achieved when neighboring values are binary equal. Implements the algorithm used in Gorilla TSDB, extending it to support 64-bit types. For additional information, see Compressing Values in [Gorilla: A Fast, Scalable, In-Memory Time Series Database](#)

`T64` — Compression approach that crops unused high bits of values in integer data types (including `Enum`, `Date` and `DateTime`). At each step of its algorithm, codec takes a block of 64 values, puts them into 64x64 bit matrix, transposes it, crops the unused bits of values and returns the rest as a sequence. Unused bits are the bits, that don't differ between maximum and minimum values in the whole data part for which the compression is used

`DoubleDelta` and `Gorilla` codecs are used in Gorilla TSDB as the components of its compressing algorithm. Gorilla approach is effective in scenarios when there is a sequence of slowly changing values with their timestamps. Timestamps are effectively compressed by the `DoubleDelta` codec, and values are effectively compressed by the `Gorilla` codec. For example, to get an effectively stored table, you can create it in the following configuration

```
CREATE TABLE codec_example
(
 timestamp DateTime CODEC(DoubleDelta),
 slow_values Float32 CODEC(Gorilla)
)
ENGINE = MergeTree()
```

#### :Codecs

- . `NONE` — No compression
- . `LZ4` — Lossless [data compression algorithm](#) used by default. Applies LZ4 fast compression
- `LZ4HC[(level)]` — LZ4 HC (high compression) algorithm with configurable level. Default level: 9. Setting level  $\leq 0$  applies the default level. Possible levels: [1, 12]. Recommended level range: [4, 9]
- `ZSTD[(level)]` — [ZSTD compression algorithm](#) with configurable level. Possible levels: [1, 22]. Default value: 1

High compression levels are useful for asymmetric scenarios, like compress once, decompress repeatedly. Higher levels mean better compression and higher CPU usage

## Temporary Tables

:ClickHouse supports temporary tables which have the following characteristics

- .Temporary tables disappear when the session ends, including if the connection is lost •
- .A temporary table uses the Memory engine only •
- .The DB can't be specified for a temporary table. It is created outside of databases •
- Impossible to create a temporary table with distributed DDL query on all cluster servers (by using ON CLUSTER ): this •  
.table exists only in the current session
- If a temporary table has the same name as another one and a query specifies the table name without specifying the •  
.DB, the temporary table will be used
- .For distributed query processing, temporary tables used in a query are passed to remote servers •  
:To create a temporary table, use the following syntax

```
CREATE TEMPORARY TABLE [IF NOT EXISTS] table_name
(
 name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1],
 name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2],
 ...
)
```

In most cases, temporary tables are not created manually, but when using external data for a query, or for distributed (GLOBAL) IN . For more information, see the appropriate sections

.It's possible to use tables with ENGINE = Memory instead of temporary tables

### (Distributed DDL queries (ON CLUSTER clause

The CREATE , DROP , ALTER , and RENAME queries support distributed execution on a cluster. For example, the following query creates the all\_hits Distributed table on each host in cluster

```
CREATE TABLE IF NOT EXISTS all_hits ON CLUSTER cluster (p Date, i Int32) ENGINE = Distributed(cluster,
default, hits)
```

In order to run these queries correctly, each host must have the same cluster definition (to simplify syncing configs, you can use substitutions from ZooKeeper). They must also connect to the ZooKeeper servers. The local version of the query will eventually be implemented on each host in the cluster, even if some hosts are currently not available. The order for executing queries within a single host is guaranteed

## CREATE VIEW

```
CREATE [MATERIALIZED] VIEW [IF NOT EXISTS] [db.]table_name [TO[db.]name] [ENGINE = engine] [POPULATE] AS
SELECT ...
```

.Creates a view. There are two types of views: normal and MATERIALIZED

Normal views don't store any data, but just perform a read from another table. In other words, a normal view is nothing more than a saved query. When reading from a view, this saved query is used as a subquery in the FROM clause

:As an example, assume you've created a view

```
CREATE VIEW view AS SELECT ...
```

:and written a query

```
SELECT a, b, c FROM view
```

:This query is fully equivalent to using the subquery

```
SELECT a, b, c FROM (SELECT ...)
```

.Materialized views store data transformed by the corresponding SELECT query

.When creating a materialized view, you must specify ENGINE – the table engine for storing data

A materialized view is arranged as follows: when inserting data to the table specified in SELECT, part of the inserted data .is converted by this SELECT query, and the result is inserted in the view

If you specify POPULATE, the existing table data is inserted in the view when creating it, as if making CREATE TABLE ... AS SELECT ... . Otherwise, the query contains only the data inserted in the table after creating the view. We don't .recommend using POPULATE, since data inserted in the table during the view creation will not be inserted in it

A SELECT query can contain DISTINCT , GROUP BY , ORDER BY , LIMIT ... Note that the corresponding conversions are performed independently on each block of inserted data. For example, if GROUP BY is set, data is aggregated during insertion, but only within a single packet of inserted data. The data won't be further aggregated. The exception is when .using an ENGINE that independently performs data aggregation, such as SummingMergeTree

The execution of ALTER queries on materialized views has not been fully developed, so they might be inconvenient. If the materialized view uses the construction TO [db.]name , you can DETACH the view, run ALTER for the target table, and .then ATTACH the previously detached (DETACH) view

.Views look the same as normal tables. For example, they are listed in the result of the SHOW TABLES query

.There isn't a separate query for deleting views. To delete a view, use DROP TABLE

## CREATE DICTIONARY

```
CREATE DICTIONARY [IF NOT EXISTS] [db.]dictionary_name
(
 key1 type1 [DEFAULT|EXPRESSION expr1] [HIERARCHICAL|INJECTIVE|IS_OBJECT_ID],
 key2 type2 [DEFAULT|EXPRESSION expr2] [HIERARCHICAL|INJECTIVE|IS_OBJECT_ID],
 attr1 type2 [DEFAULT|EXPRESSION expr3],
 attr2 type2 [DEFAULT|EXPRESSION expr4]
)
PRIMARY KEY key1, key2
SOURCE(SOURCE_NAME([param1 value1 ... paramN valueN]))
LAYOUT(LAYOUT_NAME([param_name param_value]))
LIFETIME([MIN val1] MAX val2)
```

.Creates external dictionary with given structure, source, layout and lifetime

External dictionary structure consists of attributes. Dictionary attributes are specified similarly to table columns. The only .required attribute property is its type, all other properties may have default values

.Depending on dictionary layout one or more attributes can be specified as dictionary keys

.For more information, see [External Dictionaries](#) section

## ALTER

The ALTER query is only supported for \*MergeTree tables, as well as Merge and Distributed . The query has several

**Column Manipulations**

.Changing the table structure

```
ALTER TABLE [db].name [ON CLUSTER cluster] ADD|DROP|CLEAR|COMMENT|MODIFY COLUMN ...
```

.In the query, specify a list of one or more comma-separated actions. Each action is an operation on a column

:The following actions are supported

- .**ADD COLUMN** — Adds a new column to the table
- .**DROP COLUMN** — Deletes the column
- .**CLEAR COLUMN** — Resets column values
- .**COMMENT COLUMN** — Adds a text comment to the column
- .**MODIFY COLUMN** — Changes column's type and/or default expression

.These actions are described in detail below

**ADD COLUMN**

```
ADD COLUMN [IF NOT EXISTS] name [type] [default_expr] [codec] [AFTER name_after]
```

Adds a new column to the table with the specified `name` , `type` , `codec` and `default_expr` (see the section [Default expressions](#))

If the `IF NOT EXISTS` clause is included, the query won't return an error if the column already exists. If you specify `AFTER name_after` (the name of another column), the column is added after the specified one in the list of table columns. Otherwise, the column is added to the end of the table. Note that there is no way to add a column to the beginning of a table. For a chain of actions, `name_after` can be the name of a column that is added in one of the previous actions

Adding a column just changes the table structure, without performing any actions with data. The data doesn't appear on the disk after `ALTER` . If the data is missing for a column when reading from the table, it is filled in with default values (by performing the default expression if there is one, or using zeros or empty strings). The column appears on the disk after [\(merging data parts \(see MergeTree\)\)](#)

.This approach allows us to complete the `ALTER` query instantly, without increasing the volume of old data

:Example

```
ALTER TABLE visits ADD COLUMN browser String AFTER user_id
```

**DROP COLUMN**

```
DROP COLUMN [IF EXISTS] name
```

Deletes the column with the name `name` . If the `IF EXISTS` clause is specified, the query won't return an error if the column .doesn't exist

.Deletes data from the file system. Since this deletes entire files, the query is completed almost instantly

:Example

```
ALTER TABLE visits DROP COLUMN browser
```

**CLEAR COLUMN**

```
CLEAR COLUMN [IF EXISTS] name IN PARTITION partition_name
```

Resets all data in a column for a specified partition. Read more about setting the partition name in the section [How to specify the partition expression](#)

.If the `IF EXISTS` clause is specified, the query won't return an error if the column doesn't exist

:Example

```
ALTER TABLE visits CLEAR COLUMN browser IN PARTITION tuple()
```

COMMENT COLUMN

```
COMMENT COLUMN [IF EXISTS] name 'comment'
```

Adds a comment to the column. If the `IF EXISTS` clause is specified, the query won't return an error if the column doesn't exist

Each column can have one comment. If a comment already exists for the column, a new comment overwrites the previous comment

.Comments are stored in the `comment_expression` column returned by the [DESCRIBE TABLE](#) query

:Example

```
ALTER TABLE visits COMMENT COLUMN browser 'The table shows the browser used for accessing the site.'
```

MODIFY COLUMN

```
MODIFY COLUMN [IF EXISTS] name [type] [default_expr]
```

This query changes the `name` column's type to `type` and/or the default expression to `default_expr`. If the `IF EXISTS` clause is specified, the query won't return an error if the column doesn't exist

When changing the type, values are converted as if the `toType` functions were applied to them. If only the default expression is changed, the query doesn't do anything complex, and is completed almost instantly

:Example

```
ALTER TABLE visits MODIFY COLUMN browser Array(String)
```

Changing the column type is the only complex action – it changes the contents of files with data. For large tables, this may take a long time

:There are several processing stages

- .Preparing temporary (new) files with modified data •
- .Renaming old files •
- .Renaming the temporary (new) files to the old names •
- .Deleting the old files •

Only the first stage takes time. If there is a failure at this stage, the data is not changed. If there is a failure during one of the successive stages, data can be restored manually. The exception is if the old files were deleted from the file system but the data for the new files did not get written to the disk and was lost

The `ALTER` query for changing columns is replicated. The instructions are saved in ZooKeeper, then each replica applies

them. All `ALTER` queries are run in the same order. The query waits for the appropriate actions to be completed on the other replicas. However, a query to change columns in a replicated table can be interrupted, and all actions will be performed asynchronously.

#### ALTER QUERY LIMITATIONS

The `ALTER` query lets you create and delete separate elements (columns) in nested data structures, but not whole nested data structures. To add a nested data structure, you can add columns with a name like `name.nested_name` and the type `Array(T)`. A nested data structure is equivalent to multiple array columns with a name that has the same prefix before the dot.

There is no support for deleting columns in the primary key or the sampling key (columns that are used in the `ENGINE` expression). Changing the type for columns that are included in the primary key is only possible if this change does not cause the data to be modified (for example, you are allowed to add values to an `Enum` or to change a type from `DateTime` .(to `UInt32`

If the `ALTER` query is not sufficient to make the table changes you need, you can create a new table, copy the data to it using the `INSERT SELECT` query, then switch the tables using the `RENAME` query and delete the old table. You can use .the `clickhouse-copier` as an alternative to the `INSERT SELECT` query

The `ALTER` query blocks all reads and writes for the table. In other words, if a long `SELECT` is running at the time of the `ALTER` query, the `ALTER` query will wait for it to complete. At the same time, all new queries to the same table will wait .while this `ALTER` is running

For tables that don't store data themselves (such as `Merge` and `Distributed`), `ALTER` just changes the table structure, and does not change the structure of subordinate tables. For example, when running `ALTER` for a `Distributed` table, you will .also need to run `ALTER` for the tables on all remote servers

#### Manipulations With Key Expressions

:The following command is supported

```
MODIFY ORDER BY new_expression
```

It only works for tables in the `MergeTree` family (including `replicated` tables). The command changes the `sorting key` of the .table to `new_expression` (an expression or a tuple of expressions). Primary key remains the same

The command is lightweight in a sense that it only changes metadata. To keep the property that data part rows are ordered by the sorting key expression you cannot add expressions containing existing columns to the sorting key (only .(columns added by the `ADD COLUMN` command in the same `ALTER` query

#### Manipulations With Data Skipping Indices

:It only works for tables in the `*MergeTree` family (including `replicated` tables). The following operations are available

```
ALTER TABLE [db].name ADD INDEX name expression TYPE type GRANULARITY value AFTER name [AFTER name2] •
•.index description to tables metadata
```

```
ALTER TABLE [db].name DROP INDEX name - Removes index description from tables metadata and deletes index files •
•.from disk
```

These commands are lightweight in a sense that they only change metadata or remove files. Also, they are replicated .((syncing indices metadata through ZooKeeper

#### Manipulations with constraints

See more on `constraints`

:Constraints could be added or deleted using following syntax

```
ALTER TABLE [db].name ADD CONSTRAINT constraint_name CHECK expression;
ALTER TABLE [db].name DROP CONSTRAINT constraint_name;
```

.Queries will add or remove metadata about constraints from table so they are processed immediately

.Constraint check *will not be executed* on existing data if it was added

.All changes on replicated tables are broadcasting to ZooKeeper so will be applied on other replicas

## Manipulations With Partitions and Parts

:The following operations with **partitions** are available

.**DETACH PARTITION** – Moves a partition to the detached directory and forget it •

.**DROP PARTITION** – Deletes a partition •

.**ATTACH PART|PARTITION** – Adds a part or partition from the detached directory to the table •

.**ATTACH PARTITION FROM** – Copies the data partition from one table to another and adds •

.**REPLACE PARTITION** - Copies the data partition from one table to another and replaces •

.**CLEAR COLUMN IN PARTITION** - Resets the value of a specified column in a partition •

.**CLEAR INDEX IN PARTITION** - Resets the specified secondary index in a partition •

.**FREEZE PARTITION** – Creates a backup of a partition •

.**FETCH PARTITION** – Downloads a partition from another server •

.**MOVE PARTITION|PART** – Move partition/data part to another disk or volume •

### DETACH PARTITION

```
ALTER TABLE table_name DETACH PARTITION partition_expr
```

Moves all data for the specified partition to the detached directory. The server forgets about the detached data partition as .if it does not exist. The server will not know about this data until you make the **ATTACH** query

:Example

```
ALTER TABLE visits DETACH PARTITION 201901
```

.Read about setting the partition expression in a section [How to specify the partition expression](#)

After the query is executed, you can do whatever you want with the data in the detached directory — delete it from the file .system, or just leave it

This query is replicated – it moves the data to the detached directory on all replicas. Note that you can execute this query only on a leader replica. To find out if a replica is a leader, perform the `SELECT` query to the `system.replicas` table. Alternatively, it is easier to make a `DETACH` query on all replicas - all the replicas throw an exception, except the leader .replica

### DROP PARTITION

```
ALTER TABLE table_name DROP PARTITION partition_expr
```

Deletes the specified partition from the table. This query tags the partition as inactive and deletes data completely, .approximately in 10 minutes

.Read about setting the partition expression in a section [How to specify the partition expression](#)

.The query is replicated – it deletes data on all replicas

#### DROP DETACHED PARTITION|PART

```
ALTER TABLE table_name DROP DETACHED PARTITION|PART partition_expr
```

Removes the specified part or all parts of the specified partition from detached . Read more about setting the partition expression in a section [How to specify the partition expression](#)

#### ATTACH PARTITION|PART

```
ALTER TABLE table_name ATTACH PARTITION|PART partition_expr
```

Adds data to the table from the detached directory. It is possible to add data for an entire partition or for a separate part.  
:Examples

```
ALTER TABLE visits ATTACH PARTITION 201901;
ALTER TABLE visits ATTACH PART 201901_2_2_0;
```

.Read more about setting the partition expression in a section [How to specify the partition expression](#)

This query is replicated. The replica-initiator checks whether there is data in the detached directory. If data exists, the query checks its integrity. If everything is correct, the query adds the data to the table. All other replicas download the data from the replica-initiator

So you can put data to the detached directory on one replica, and use the ALTER ... ATTACH query to add it to the table .on all replicas

#### ATTACH PARTITION FROM

```
ALTER TABLE table2 ATTACH PARTITION partition_expr FROM table1
```

This query copies the data partition from the table1 to table2 adds data to existing in the table2 . Note that data won't be deleted from table1

:For the query to run successfully, the following conditions must be met

- Both tables must have the same structure
- Both tables must have the same partition key

#### REPLACE PARTITION

```
ALTER TABLE table2 REPLACE PARTITION partition_expr FROM table1
```

This query copies the data partition from the table1 to table2 and replaces existing partition in the table2 . Note that data .won't be deleted from table1

:For the query to run successfully, the following conditions must be met

- Both tables must have the same structure
- Both tables must have the same partition key

#### CLEAR COLUMN IN PARTITION

```
ALTER TABLE table_name CLEAR COLUMN column_name IN PARTITION partition_expr
```

Resets all values in the specified column in a partition. If the DEFAULT clause was determined when creating a table, this .query sets the column value to a specified default value

```
ALTER TABLE visits CLEAR COLUMN hour IN PARTITION 201902
```

FREEZE PARTITION

```
ALTER TABLE table_name FREEZE [PARTITION partition_expr]
```

This query creates a local backup of a specified partition. If the PARTITION clause is omitted, the query creates the .backup of all partitions at once

**Note**

.The entire backup process is performed without stopping the server

Note that for old-styled tables you can specify the prefix of the partition name (for example, '2019') - then the query creates the backup for all the corresponding partitions. Read about setting the partition expression in a section [How to specify the partition expression](#)

At the time of execution, for a data snapshot, the query creates hardlinks to a table data. Hardlinks are placed in the :directory /var/lib/clickhouse/shadow/N/..., where

- . var/lib/clickhouse/ is the working ClickHouse directory specified in the config/ •
- . N is the incremental number of the backup •

**Note**

If you use [a set of disks for data storage in a table](#), the shadow/N directory appears on every disk, storing data parts that matched by the . PARTITION expression

The same structure of directories is created inside the backup as inside /var/lib/clickhouse/. The query performs 'chmod' for .all files, forbidding writing into them

After creating the backup, you can copy the data from /var/lib/clickhouse/shadow/ to the remote server and then delete it from the local server. Note that the ALTER t FREEZE PARTITION query is not replicated. It creates a local backup only on .the local server

The query creates backup almost instantly (but first it waits for the current queries to the corresponding table to finish .(running

ALTER TABLE t FREEZE PARTITION copies only the data, not table metadata. To make a backup of table metadata, copy the file /var/lib/clickhouse/metadata/database/table.sql

:To restore data from a backup, do the following

.(Create the table if it does not exist. To view the query, use the .sql file (replaceATTACH in it with CREATE .1

Copy the data from the data/database/table/ directory inside the backup to the .2  
. /var/lib/clickhouse/data/database/table/detached/ directory

.Run ALTER TABLE t ATTACH PARTITION queries to add the data to a table .3

.Restoring from a backup doesn't require stopping the server

.For more information about backups and restoring data, see the [Data Backup](#) section

CLEAR INDEX IN PARTITION

```
ALTER TABLE table_name CLEAR INDEX index_name IN PARTITION partition_expr
```

.The query works similar to `CLEAR COLUMN`, but it resets an index instead of a column data  
FETCH PARTITION

```
ALTER TABLE table_name FETCH PARTITION partition_expr FROM 'path-in-zookeeper'
```

.Downloads a partition from another server. This query only works for the replicated tables  
:The query does the following

Downloads the partition from the specified shard. In 'path-in-zookeeper' you must specify a path to the shard in .1  
.ZooKeeper

Then the query puts the downloaded data to the `detached` directory of the `table_name` table. Use the `ATTACH .2`  
`.PARTITION|PART` query to add the data to the table

:For example

```
ALTER TABLE users FETCH PARTITION 201902 FROM '/clickhouse/tables/01-01/visits';
ALTER TABLE users ATTACH PARTITION 201902;
```

:Note that

The `ALTER ... FETCH PARTITION` query isn't replicated. It places the partition to the `detached` directory only on the •  
.local server

The `ALTER TABLE ... ATTACH` query is replicated. It adds the data to all replicas. The data is added to one of the •  
.replicas from the `detached` directory, and to the others - from neighboring replicas

Before downloading, the system checks if the partition exists and the table structure matches. The most appropriate  
.replica is selected automatically from the healthy replicas

Although the query is called `ALTER TABLE`, it does not change the table structure and does not immediately change the  
.data available in the table

MOVE PARTITION|PART

Moves partitions or data parts to another volume or disk for `MergeTree`-engine tables. See [Using Multiple Block Devices](#)  
.for Data Storage

```
ALTER TABLE table_name MOVE PARTITION|PART partition_expr TO DISK|VOLUME 'disk_name'
```

:The `ALTER TABLE t MOVE` query

.Not replicated, because different replicas can have different storage policies •

Returns an error if the specified disk or volume is not configured. Query also returns an error if conditions of data •  
.moving, that specified in the storage policy, can't be applied

Can return an error in the case, when data to be moved is already moved by a background process, concurrent •  
`ALTER TABLE t MOVE` query or as a result of background data merging. A user shouldn't perform any additional  
.actions in this case

:Example

```
ALTER TABLE hits MOVE PART '20190301_14343_16206_438' TO VOLUME 'slow'
ALTER TABLE hits MOVE PARTITION '2019-09-01' TO DISK 'fast_ss'
```

:You can specify the partition expression in `ALTER ... PARTITION` queries in different ways

As a value from the `partition` column of the `system.parts` table. For example, `ALTER TABLE visits DETACH PARTITION .201901`

As the expression from the table column. Constants and constant expressions are supported. For example, `ALTER .((TABLE visits DETACH PARTITION toYYYYMM(toDate('2019-01-25`

Using the partition ID. Partition ID is a string identifier of the partition (human-readable, if possible) that is used as the names of partitions in the file system and in ZooKeeper. The partition ID must be specified in the `PARTITION ID` clause, in a single quotes. For example, `ALTER TABLE visits DETACH PARTITION ID '201901`

In the `ALTER ATTACH PART` and `DROP DETACHED PART` query, to specify the name of a part, use string literal with a value from the `name` column of the `system.detached_parts` table. For example, `ALTER TABLE visits ATTACH .'PART '201901_1_1_0`

Usage of quotes when specifying the partition depends on the type of partition expression. For example, for the `String` type, you have to specify its name in quotes (''). For the `Date` and `Int*` types no quotes are needed

For old-style tables, you can specify the partition either as a number `201901` or a string `'201901'`. The syntax for the new-style tables is stricter with types (similar to the parser for the `VALUES` input format)

All the rules above are also true for the `OPTIMIZE` query. If you need to specify the only partition when optimizing a non-partitioned table, set the expression `PARTITION tuple()`. For example

```
OPTIMIZE TABLE table_not_partitioned PARTITION tuple() FINAL;
```

The examples of `ALTER ... PARTITION` queries are demonstrated in the tests `00502_custom_partitioning_local` and `00502_custom_partitioning_replicated_zookeeper`

## Synchronicity of ALTER Queries

For non-replicable tables, all `ALTER` queries are performed synchronously. For replicable tables, the query just adds instructions for the appropriate actions to `ZooKeeper`, and the actions themselves are performed as soon as possible. However, the query can wait for these actions to be completed on all the replicas

For `ALTER ... ATTACH|DETACH|DROP` queries, you can use the `replication_alter_partitions_sync` setting to set up waiting. Possible values: 0 – do not wait; 1 – only wait for own execution (default); 2 – wait for all

## Mutations

Mutations are an `ALTER` query variant that allows changing or deleting rows in a table. In contrast to standard `UPDATE` and `DELETE` queries that are intended for point data changes, mutations are intended for heavy operations that change a lot of rows in a table. Supported for the `MergeTree` family of table engines including the engines with replication support

Existing tables are ready for mutations as-is (no conversion necessary), but after the first mutation is applied to a table, its metadata format becomes incompatible with previous server versions and falling back to a previous version becomes impossible

:Currently available commands

```
ALTER TABLE [db.]table DELETE WHERE filter_expr
```

The `filter_expr` must be of type `UInt8`. The query deletes rows in the table for which this expression takes a non-zero value

```
ALTER TABLE [db.]table UPDATE column1 = expr1 [, ...] WHERE filter_expr
```

The `filter_expr` must be of type `UInt8`. This query updates values of specified columns to the values of corresponding expressions in rows for which the `filter_expr` takes a non-zero value. Values are casted to the column type using the `.CAST` operator. Updating columns that are used in the calculation of the primary or the partition key is not supported

```
ALTER TABLE [db.]table MATERIALIZE INDEX name IN PARTITION partition_name
```

.The query rebuilds the secondary index `name` in the partition `partition_name`

.One query can contain several commands separated by commas

For \*MergeTree tables mutations execute by rewriting whole data parts. There is no atomicity - parts are substituted for mutated parts as soon as they are ready and a `SELECT` query that started executing during a mutation will see data from .parts that have already been mutated along with data from parts that have not been mutated yet

Mutations are totally ordered by their creation order and are applied to each part in that order. Mutations are also partially ordered with `INSERT`s - data that was inserted into the table before the mutation was submitted will be mutated and data .that was inserted after that will not be mutated. Note that mutations do not block `INSERT`s in any way

A mutation query returns immediately after the mutation entry is added (in case of replicated tables to ZooKeeper, for nonreplicated tables - to the filesystem). The mutation itself executes asynchronously using the system profile settings. To track the progress of mutations you can use the `system.mutations` table. A mutation that was successfully submitted will continue to execute even if ClickHouse servers are restarted. There is no way to roll back the mutation once it is .submitted, but if the mutation is stuck for some reason it can be cancelled with the `KILL MUTATION` query

Entries for finished mutations are not deleted right away (the number of preserved entries is determined by the .`finished_mutations_to_keep` storage engine parameter). Older mutation entries are deleted

## SYSTEM Queries

[RELOAD DICTIONARIES](#) •

[RELOAD DICTIONARY](#) •

[DROP DNS CACHE](#) •

[DROP MARK CACHE](#) •

[FLUSH LOGS](#) •

[RELOAD CONFIG](#) •

[SHUTDOWN](#) •

[KILL](#) •

[STOP DISTRIBUTED SENDS](#) •

[FLUSH DISTRIBUTED](#) •

[START DISTRIBUTED SENDS](#) •

[STOP MERGES](#) •

[START MERGES](#) •

## RELOAD DICTIONARIES

Reloads all dictionaries that have been successfully loaded before. By default, dictionaries are loaded lazily (see `dictionaries_lazy_load`), so instead of being loaded automatically at startup, they are initialized on first access through `dictGet` function or `SELECT` from tables with `ENGINE = Dictionary`. The `SYSTEM RELOAD DICTIONARIES` query reloads .such dictionaries (`LOADED`). Always returns `Ok`, regardless of the result of the dictionary update

## RELOAD DICTIONARY dictionary\_name

Completely reloads a dictionary `dictionary_name`, regardless of the state of the dictionary (LOADED / NOT\_LOADED / FAILED). Always returns `Ok`. regardless of the result of updating the dictionary. The status of the dictionary can be checked by querying the `system.dictionaries` table

```
SELECT name, status FROM system.dictionaries;
```

## DROP DNS CACHE

Resets ClickHouse's internal DNS cache. Sometimes (for old ClickHouse versions) it is necessary to use this command when changing the infrastructure (changing the IP address of another ClickHouse server or the server used by `(dictionaries)`)

For more convenient (automatic) cache management, see `disable_internal_dns_cache`, `dns_cache_update_period` .parameters

## DROP MARK CACHE

.Resets the mark cache. Used in development of ClickHouse and performance tests

## FLUSH LOGS

Flushes buffers of log messages to system tables (e.g. `system.query_log`). Allows you to not wait 7.5 seconds when .debugging

## RELOAD CONFIG

.Reloads ClickHouse configuration. Used when configuration is stored in ZooKeeper

## SHUTDOWN

( {Normally shuts down ClickHouse (like `service clickhouse-server stop` / `kill ${pid_clickhouse-server}`)}

## KILL

( {Aborts ClickHouse process (like `kill -9 ${pid_clickhouse-server}`)}

## Managing Distributed Tables

ClickHouse can manage **distributed** tables. When a user inserts data into these tables, ClickHouse first creates a queue of the data that should be sent to cluster nodes, then asynchronously sends it. You can manage queue processing with the **STOP DISTRIBUTED SENDS**, **FLUSH DISTRIBUTED**, and **START DISTRIBUTED SENDS** queries. You can also .synchronously insert distributed data with the `insert_distributed_sync` setting

## STOP DISTRIBUTED SENDS

.Disables background data distribution when inserting data into distributed tables

```
SYSTEM STOP DISTRIBUTED SENDS [db.]<distributed_table_name>
```

## FLUSH DISTRIBUTED

Forces ClickHouse to send data to cluster nodes synchronously. If any nodes are unavailable, ClickHouse throws an exception and stops query execution. You can retry the query until it succeeds, which will happen when all nodes are back online

```
SYSTEM FLUSH DISTRIBUTED [db.]<distributed_table_name>
```

## START DISTRIBUTED SENDS

:Enables background data distribution when inserting data into distributed tables

```
SYSTEM START DISTRIBUTED SENDS [db.]<distributed_table_name>
```

## STOP MERGES

:Provides possibility to stop background merges for tables in the MergeTree family

```
SYSTEM STOP MERGES [[db.]merge_tree_family_table_name]
```

Note 

. DETACH / ATTACH table will start background merges for the table even in case when merges have been stopped for all MergeTree tables before

## START MERGES

:Provides possibility to start background merges for tables in the MergeTree family

```
SYSTEM START MERGES [[db.]merge_tree_family_table_name]
```

## SHOW Queries

### SHOW CREATE TABLE

```
SHOW CREATE [TEMPORARY] [TABLE|DICTIONARY] [db.]table [INTO OUTFILE filename] [FORMAT format]
```

Returns a single String -type 'statement' column, which contains a single value – the CREATE query used for creating the .specified object

## SHOW DATABASES

```
SHOW DATABASES [INTO OUTFILE filename] [FORMAT format]
```

Prints a list of all databases. This query is identical toSELECT name FROM system.databases [INTO OUTFILE filename] .[[FORMAT format

## SHOW PROCESSLIST

```
SHOW PROCESSLIST [INTO OUTFILE filename] [FORMAT format]
```

Outputs the content of the **system.processes** table, that contains a list of queries that is being processed at the moment, .excepting SHOW PROCESSLIST queries

.The SELECT \* FROM system.processes query returns data about all the current queries

:)(Tip (execute in the console

```
$ watch -n1 "clickhouse-client --query='SHOW PROCESSLIST'"
```

## SHOW TABLES

.Displays a list of tables

```
SHOW [TEMPORARY] TABLES [FROM <db>] [LIKE '<pattern>'] [LIMIT <N>] [INTO OUTFILE <filename>] [FORMAT <format>]
```

.If the `FROM` clause is not specified, the query returns the list of tables from the current database

:You can get the same results as the `SHOW TABLES` query in the following way

```
SELECT name FROM system.tables WHERE database = <db> [AND name LIKE <pattern>] [LIMIT <N>] [INTO OUTFILE <filename>] [FORMAT <format>]
```

### Example

.The following query selects the first two rows from the list of tables in the `system` database, whose names contain co

```
SHOW TABLES FROM system LIKE '%co%' LIMIT 2
```

name
aggregate_function_combinators
collations

## SHOW DICTIONARIES

.Displays a list of [external dictionaries](#)

```
SHOW DICTIONARIES [FROM <db>] [LIKE '<pattern>'] [LIMIT <N>] [INTO OUTFILE <filename>] [FORMAT <format>]
```

.If the `FROM` clause is not specified, the query returns the list of dictionaries from the current database

:You can get the same results as the `SHOW DICTIONARIES` query in the following way

```
SELECT name FROM system.dictionaries WHERE database = <db> [AND name LIKE <pattern>] [LIMIT <N>] [INTO OUTFILE <filename>] [FORMAT <format>]
```

### Example

.The following query selects the first two rows from the list of tables in the `system` database, whose names contain co

```
SHOW DICTIONARIES FROM db LIKE '%reg%' LIMIT 2
```

name
regions
region_names

## Miscellaneous Queries

## ATTACH

This query is exactly the same as CREATE , but

.Instead of the word CREATE it uses the word ATTACH •

The query does not create data on the disk, but assumes that data is already in the appropriate places, and just adds •  
information about the table to the server. After executing an ATTACH query, the server will know about the existence  
.of the table

If the table was previously detached (DETACH ), meaning that its structure is known, you can use shorthand without  
.defining the structure

```
ATTACH TABLE [IF NOT EXISTS] [db.]name [ON CLUSTER cluster]
```

This query is used when starting the server. The server stores table metadata as files withATTACH queries, which it  
.simply runs at launch (with the exception of system tables, which are explicitly created on the server

## CHECK TABLE

.Checks if the data in the table is corrupted

```
CHECK TABLE [db.]name
```

The CHECK TABLE query compares actual file sizes with the expected values which are stored on the server. If the file  
sizes do not match the stored values, it means the data is corrupted. This can be caused, for example, by a system crash  
.during query execution

:The query response contains the result column with a single row. The row has a value of Boolean type

.The data in the table is corrupted - 0 •

.The data maintains integrity - 1 •

:The CHECK TABLE query supports the following table engines

Log •

TinyLog •

StripeLog •

MergeTree family •

.Performed over the tables with another table engines causes an exception

Engines from the \*Log family don't provide automatic data recovery on failure. Use the CHECK TABLE query to track data  
.loss in a timely manner

For MergeTree family engines, the CHECK TABLE query shows a check status for every individual data part of a table on  
.the local server

If the data is corrupted

:If the table is corrupted, you can copy the non-corrupted data to another table. To do this

Create a new table with the same structure as damaged table. To do this execute the queryCREATE TABLE .1  
.<<new\_table\_name> AS <damaged\_table\_name

Set the max\_threads value to 1 to process the next query in a single thread. To do this run the quer)SET max\_threads .2  
.= 1

Execute the query `INSERT INTO <new_table_name> SELECT * FROM <damaged_table_name>`. This request copies the .3 non-corrupted data from the damaged table to another table. Only the data before the corrupted part will be copied

.Restart the `clickhouse-client` to reset the `max_threads` value .4

## DESCRIBE TABLE

```
DESC|DESCRIBE TABLE [db.]table [INTO OUTFILE filename] [FORMAT format]
```

:Returns the following `String` type columns

.`name` — Column name •

.`type` — Column type •

`default_type` — Clause that is used in `default expression` ( `DEFAULT` , `MATERIALIZED` or `ALIAS` ). Column contains an •

.empty string, if the default expression isn't specified

.`default_expression` — Value specified in the `DEFAULT` clause •

.`comment_expression` — Comment text •

.Nested data structures are output in "expanded" format. Each column is shown separately, with the name after a dot

## DETACH

.Deletes information about the 'name' table from the server. The server stops knowing about the table's existence

```
DETACH TABLE [IF EXISTS] [db.]name [ON CLUSTER cluster]
```

This does not delete the table's data or metadata. On the next server launch, the server will read the metadata and find out about the table again. Similarly, a "detached" table can be re-attached using the `ATTACH` query (with the exception of .(system tables, which do not have metadata stored for them

.There is no `DETACH DATABASE` query

## DROP

.This query has two types: `DROP DATABASE` and `DROP TABLE`

```
DROP DATABASE [IF EXISTS] db [ON CLUSTER cluster]
```

Deletes all tables inside the 'db' database, then deletes the 'db' database itself. If `IF EXISTS` is specified, it doesn't return .an error if the database doesn't exist

```
DROP [TEMPORARY] TABLE [IF EXISTS] [db.]name [ON CLUSTER cluster]
```

.Deletes the table. If `IF EXISTS` is specified, it doesn't return an error if the table doesn't exist or the database doesn't exist

```
DROP DICTIONARY [IF EXISTS] [db.]name
```

Deletes the dictionary. If `IF EXISTS` is specified, it doesn't return an error if the table doesn't exist or the database doesn't .exist

## EXISTS

```
EXISTS [TEMPORARY] [TABLE|DICTIONARY] [db.]name [INTO OUTFILE filename] [FORMAT format]
```

Returns a single UInt8 -type column, which contains the single value 0 if the table or database doesn't exist, or 1 if the .table exists in the specified database

## KILL QUERY

```
KILL QUERY [ON CLUSTER cluster]
WHERE <where expression to SELECT FROM system.processes query>
[SYNC|ASYNC|TEST]
[FORMAT format]
```

Attempts to forcibly terminate the currently running queries. The queries to terminate are selected from the .system.processes table using the criteria defined in the WHERE clause of the KILL query

:Examples

```
-- Forcibly terminates all queries with the specified query_id:
KILL QUERY WHERE query_id='2-857d-4a57-9ee0-327da5d60a90'

-- Synchronously terminates all queries run by 'username':
KILL QUERY WHERE user='username' SYNC
```

.Read-only users can only stop their own queries

By default, the asynchronous version of queries is used (ASYNC ), which doesn't wait for confirmation that queries have .stopped

The synchronous version ( SYNC ) waits for all queries to stop and displays information about each process as it stops. :The response contains the kill\_status column, which can take the following values

.finished' – The query was terminated successfully' .1  
.waiting' – Waiting for the query to end after sending it a signal to terminate' .2  
.The other values explain why the query can't be stopped .3

.A test query ( TEST ) only checks the user's rights and displays a list of queries to stop

## KILL MUTATION

```
KILL MUTATION [ON CLUSTER cluster]
WHERE <where expression to SELECT FROM system.mutations query>
[TEST]
[FORMAT format]
```

Tries to cancel and remove mutations that are currently executing. Mutations to cancel are selected from the .system.mutations table using the filter specified by the WHERE clause of the KILL query

.A test query ( TEST ) only checks the user's rights and displays a list of queries to stop

:Examples

```
-- Cancel and remove all mutations of the single table:
KILL MUTATION WHERE database = 'default' AND table = 'table'

-- Cancel the specific mutation:
KILL MUTATION WHERE database = 'default' AND table = 'table' AND mutation_id = 'mutation_3.txt'
```

The query is useful when a mutation is stuck and cannot finish (e.g. if some function in the mutation query throws an exception when applied to the data contained in the table). Changes already made by the mutation are not rolled back.

## OPTIMIZE

```
OPTIMIZE TABLE [db.]name [ON CLUSTER cluster] [PARTITION partition | PARTITION ID 'partition_id'] [FINAL] [DEDUPLICATE]
```

This query tries to initialize an unscheduled merge of data parts for tables with a table engine from the [MergeTree](#) family. Other kinds of table engines aren't supported.

When `OPTIMIZE` is used with the [ReplicatedMergeTree](#) family of table engines, ClickHouse creates a task for merging (and waits for execution on all nodes (if the `replication_alter_partitions_sync` setting is enabled

If `OPTIMIZE` doesn't perform a merge for any reason, it doesn't notify the client. To enable notifications, use the • `.optimize_throw_if_noop` setting

.If you specify a `PARTITION`, only the specified partition is optimized. [How to set partition expression](#) •

.If you specify `FINAL`, optimization is performed even when all the data is already in one part •

If you specify `DEDUPLICATE`, then completely identical rows will be deduplicated (all columns are compared), it • .makes sense only for the [MergeTree](#) engine

### Warning

. `OPTIMIZE` can't fix the "Too many parts" error

## RENAME

. Renames one or more tables

```
RENAME TABLE [db11.]name11 TO [db12.]name12, [db21.]name21 TO [db22.]name22, ... [ON CLUSTER cluster]
```

All tables are renamed under global locking. Renaming tables is a light operation. If you indicated another database after `TO`, the table will be moved to this database. However, the directories with databases must reside in the same file system .((otherwise, an error is returned

## SET

```
SET param = value
```

. Assigns `value` to the `param` `setting` for the current session. You cannot change [server settings](#) this way

. You can also set all the values from the specified settings profile in a single query

```
SET profile = 'profile-name-from-the-settings-file'
```

. For more information, see [Settings](#)

## TRUNCATE

```
TRUNCATE TABLE [IF EXISTS] [db.]name [ON CLUSTER cluster]
```

Removes all data from a table. When the clause `IF EXISTS` is omitted, the query returns an error if the table does not exist.

The `TRUNCATE` query is not supported for `View`, `File`, `URL` and `Null` table engines

## USE

```
USE db
```

Lets you set the current database for the session. The current database is used for searching for tables if the database is not explicitly defined in the query with a dot before the table name. This query can't be made when using the HTTP protocol, since there is no concept of a session

## Functions

There are at least\* two types of functions - regular functions (they are just called "functions") and aggregate functions. These are completely different concepts. Regular functions work as if they are applied to each row separately (for each row, the result of the function doesn't depend on the other rows). Aggregate functions accumulate a set of values from various rows (i.e. they depend on the entire set of rows).

"In this section we discuss regular functions. For aggregate functions, see the section "Aggregate functions

There is a third type of function that the 'arrayJoin' function belongs to; table functions can also be mentioned - \*.separately

## Strong typing

In contrast to standard SQL, ClickHouse has strong typing. In other words, it doesn't make implicit conversions between types. Each function works for a specific set of types. This means that sometimes you need to use type conversion functions

## Common subexpression elimination

All expressions in a query that have the same AST (the same record or same result of syntactic parsing) are considered to have identical values. Such expressions are concatenated and executed once. Identical subqueries are also eliminated this way

## Types of results

All functions return a single return as the result (not several values, and not zero values). The type of result is usually defined only by the types of arguments, not by the values. Exceptions are the `tupleElement` function (the `a.N` operator), and the `toFixedString` function

## Constants

For simplicity, certain functions can only work with constants for some arguments. For example, the right argument of the `LIKE` operator must be a constant. Almost all functions return a constant for constant arguments. The exception is functions that generate random numbers. The 'now' function returns different values for queries that were run at different times, but the result is considered a constant, since constancy is only important within a single query. A constant expression is also considered a constant (for example, the right half of the `LIKE` operator can be constructed from multiple constants)

Functions can be implemented in different ways for constant and non-constant arguments (different code is executed). But the results for a constant and for a true column containing only the same value should match each other

## NULL processing

:Functions have the following behaviors

- .If at least one of the arguments of the function is NULL , the function result is also NULL •

Special behavior that is specified individually in the description of each function. In the ClickHouse source code, these •  
.functions have `UseDefaultImplementationForNulls=false`

## Constancy

Functions can't change the values of their arguments – any changes are returned as the result. Thus, the result of .calculating separate functions does not depend on the order in which the functions are written in the query

## Error handling

Some functions might throw an exception if the data is invalid. In this case, the query is canceled and an error text is returned to the client. For distributed processing, when an exception occurs on one of the servers, the other servers also .attempt to abort the query

## Evaluation of argument expressions

In almost all programming languages, one of the arguments might not be evaluated for certain operators. This is usually the operators `&&` , `||` , and `?:` . But in ClickHouse, arguments of functions (operators) are always evaluated. This is .because entire parts of columns are evaluated at once, instead of calculating each row separately

## Performing functions for distributed query processing

For distributed query processing, as many stages of query processing as possible are performed on remote servers, and .the rest of the stages (merging intermediate results and everything after that) are performed on the requestor server

This means that functions can be performed on different servers. For example, in the query `SELECT f(sum(g(x))) FROM ,(distributed_table GROUP BY h(y`

if a `distributed_table` has at least two shards, the functions 'g' and 'h' are performed on remote servers, and the function •  
. 'f' is performed on the requestor server  
.if a `distributed_table` has only one shard, all the 'f', 'g', and 'h' functions are performed on this shard's server •

The result of a function usually doesn't depend on which server it is performed on. However, sometimes this is important. For example, functions that work with dictionaries use the dictionary that exists on the server they are running on. Another example is the `hostName` function, which returns the name of the server it is running on in order to make `GROUP BY` by .servers in a `SELECT` query

If a function in a query is performed on the requestor server, but you need to perform it on remote servers, you can wrap it .in an 'any' aggregate function or add it to a key in `GROUP BY`

## Arithmetic functions

For all arithmetic functions, the result type is calculated as the smallest number type that the result fits in, if there is such a type. The minimum is taken simultaneously based on the number of bits, whether it is signed, and whether it floats. If there

.are not enough bits, the highest bit type is taken

:Example

```
SELECT toTypeName(0), toTypeName(0 + 0), toTypeName(0 + 0 + 0), toTypeName(0 + 0 + 0 + 0)
```

└─toTypeName(0)─┘	└─toTypeName(plus(0, 0))─┘	└─toTypeName(plus(plus(0, 0), 0))─┘	└─toTypeName(plus(plus(plus(0, 0), 0), 0))─┘
UInt8	UInt16	UInt32	UInt64
<hr/>			

Arithmetic functions work for any pair of types from UInt8, UInt16, UInt32, UInt64, Int8, Int16, Int32, Int64, Float32, or  
.Float64

.++Overflow is produced the same way as in C

### plus(a, b), a + b operator

Calculates the sum of the numbers. You can also add integer numbers with a date or date and time. In the case of a date,  
adding an integer means adding the corresponding number of days. For a date with time, it means adding the  
.corresponding number of seconds

### minus(a, b), a - b operator

.Calculates the difference. The result is always signed

.You can also calculate integer numbers from a date or date with time. The idea is the same – see above for 'plus

### multiply(a, b), a \* b operator

.Calculates the product of the numbers

### divide(a, b), a / b operator

Calculates the quotient of the numbers. The result type is always a floating-point type. It is not integer division. For integer  
.division, use the 'intDiv' function. When dividing by zero you get 'inf', '-inf', or 'nan'

### (intDiv(a, b

Calculates the quotient of the numbers. Divides into integers, rounding down (by the absolute value). An exception is  
.thrown when dividing by zero or when dividing a minimal negative number by minus one

### (intDivOrZero(a, b

.Differs from 'intDiv' in that it returns zero when dividing by zero or when dividing a minimal negative number by minus one

### modulo(a, b), a % b operator

Calculates the remainder after division. If arguments are floating-point numbers, they are pre-converted to integers by  
dropping the decimal portion. The remainder is taken in the same sense as in C++. Truncated division is used for negative  
.numbers. An exception is thrown when dividing by zero or when dividing a minimal negative number by minus one

## **negate(a), -a operator**

.Calculates a number with the reverse sign. The result is always signed

## **(abs(a**

Calculates the absolute value of the number (a). That is, if  $a < 0$ , it returns  $-a$ . For unsigned types it doesn't do anything.

.For signed integer types, it returns an unsigned number

## **(gcd(a, b**

Returns the greatest common divisor of the numbers. An exception is thrown when dividing by zero or when dividing a

.minimal negative number by minus one

## **(lcm(a, b**

Returns the least common multiple of the numbers. An exception is thrown when dividing by zero or when dividing a

.minimal negative number by minus one

## **Comparison functions**

.(Comparison functions always return 0 or 1 (UInt8

:The following types can be compared

numbers •

strings and fixed strings •

dates •

dates with times •

.within each group, but not between different groups

For example, you can't compare a date with a string. You have to use a function to convert the string to a date, or vice

.versa

Strings are compared by bytes. A shorter string is smaller than all strings that start with it and that contain at least one

.more character

Note. Up until version 1.1.54134, signed and unsigned numbers were compared the same way as in C++. In other words,

you could get an incorrect result in cases like `SELECT 9223372036854775807 > -1`. This behavior changed in version

.1.1.54134 and is now mathematically correct

## **equals, a = b and a == b operator**

## **notEquals, a != operator= b and a <> b**

## **less, < operator**

## **greater, > operator**

`lessOrEquals`, `<=` operator

`greaterOrEquals`, `>=` operator

## Logical functions

.Logical functions accept any numeric types, but return a `UInt8` number equal to 0 or 1  
."Zero as an argument is considered "false," while any non-zero value is considered "true

and, AND operator

or, OR operator

not, NOT operator

xor

## Type Conversion Functions

### Common Issues of Numeric Conversions

When you convert a value from one to another data type, you should remember that in common case, it is an unsafe operation that can lead to a data loss. A data loss can occur if you try to fit value from a larger data type to a smaller data type, or if you convert values between different data types

.ClickHouse has the same behavior as C++ programs

`(toInt(8|16|32|64`

:Converts an input value to the `Int` data type. This function family includes

- `.toInt8(expr)` — Results in the `Int8` data type •
- `.toInt16(expr)` — Results in the `Int16` data type •
- `.toInt32(expr)` — Results in the `Int32` data type •
- `.toInt64(expr)` — Results in the `Int64` data type •

Parameters

`expr` — Expression returning a number or a string with the decimal representation of a number. Binary, octal, and •  
.hexadecimal representations of numbers are not supported. Leading zeroes are stripped

Returned value

.Integer value in the `Int8` , `Int16` , `Int32` , or `Int64` data type

.Functions use rounding towards zero, meaning they truncate fractional digits of numbers

The behavior of functions for the `Nan` and `Inf` arguments is undefined. Remember about numeric conversions issues, .when using the functions

## Example

```
SELECT.toInt64(nan), .toInt32(32), .toInt16('16'), .toInt8(8.8)
```

toInt64(nan)	toInt32(32)	toInt16('16')	toInt8(8.8)
-9223372036854775808	32	16	8

## toInt(8|16|32|64)OrZero

.It takes an argument of type String and tries to parse it into Int (8 | 16 | 32 | 64). If failed, returns 0

## Example

```
select.toInt64OrZero('123123'), .toInt8OrZero('123qwe123')
```

toInt64OrZero('123123')	toInt8OrZero('123qwe123')
123123	0

## toInt(8|16|32|64)OrNull

.It takes an argument of type String and tries to parse it into Int (8 | 16 | 32 | 64). If failed, returns NULL

## Example

```
select.toInt64OrNull('123123'), .toInt8OrNull('123qwe123')
```

toInt64OrNull('123123')	toInt8OrNull('123qwe123')
123123	NULL

## (toUInt(8|16|32|64)

:Converts an input value to the UInt data type. This function family includes

- .toUInt8(expr) — Results in the UInt8 data type •
- .toUInt16(expr) — Results in the UInt16 data type •
- .toUInt32(expr) — Results in the UInt32 data type •
- .toUInt64(expr) — Results in the UInt64 data type •

## Parameters

expr — Expression returning a number or a string with the decimal representation of a number. Binary, octal, and •  
.hexadecimal representations of numbers are not supported. Leading zeroes are stripped

## Returned value

.Integer value in the UInt8 , UInt16 , UInt32 , or UInt64 data type

.Functions use rounding towards zero, meaning they truncate fractional digits of numbers

The behavior of functions for negative arguments and for the NaN and Inf arguments is undefined. If you pass a string with a negative number, for example '-32', ClickHouse raises an exception. Remember about numeric conversions issues, .when using the functions

```
SELECT toUInt64(nan), toUInt32(-32), toUInt16('16'), toUInt8(8.8)
```

toUInt64(nan)	toUInt32(-32)	toUInt16('16')	toUInt8(8.8)
9223372036854775808	4294967264	16	8

toUInt(8|16|32|64)OrZero

toUInt(8|16|32|64)OrNull

(toFloat(32|64

toFloat(32|64)OrZero

toFloat(32|64)OrNull

toDate

toDateOrZero

toDateOrNull

toDateTime

toDateTimeOrZero

toDateTimeOrNull

(toDecimal(32|64|128

Converts `value` to the **Decimal** data type with precision of `S`. The `value` can be a number or a string. The `S` (scale) parameter specifies the number of decimal places

(toDecimal32(value, S •

(toDecimal64(value, S •

(toDecimal128(value, S •

toDecimal(32|64|128)OrNull

:Converts an input string to a **Nullable(Decimal(P,S))** data type value. This family of functions include

. toDecimal32OrNull(expr, S) — Results in `Nullable(Decimal32(S))` data type •

. toDecimal64OrNull(expr, S) — Results in `Nullable(Decimal64(S))` data type •

.`toDecimal128OrNull(expr, S)` — Results in `Nullable(Decimal128(S))` data type •

These functions should be used instead of `toDecimal*()` functions, if you prefer to get a `NULL` value instead of an exception in the event of an input value parsing error

#### Parameters

`expr` — [Expression](#), returns a value in the `String` data type. ClickHouse expects the textual representation of the •  
. 'decimal number. For example, '`1.111`

. `S` — Scale, the number of decimal places in the resulting value •

#### Returned value

:A value in the `Nullable(Decimal(P,S))` data type. The value contains

.Number with `S` decimal places, if ClickHouse interprets the input string as a number •

`NULL`, if ClickHouse can't interpret the input string as a number or if the input number contains more than `S` decimal •  
.places

#### Examples

```
SELECT toDecimal320rNull(toString(-1.111), 5) AS val, toTypeName(val)
```

val	toTypeName(toDecimal320rNull(toString(-1.111), 5))
-1.11100	<code>Nullable(Decimal(9, 5))</code>

```
SELECT toDecimal320rNull(toString(-1.111), 2) AS val, toTypeName(val)
```

val	toTypeName(toDecimal320rNull(toString(-1.111), 2))
NULL	<code>Nullable(Decimal(9, 2))</code>

## toDecimal(32|64|128)OrZero

:Converts an input value to the `Decimal(P,S)` data type. This family of functions include

.`toDecimal32OrZero(expr, S)` — Results in `Decimal32(S)` data type •

.`toDecimal64OrZero(expr, S)` — Results in `Decimal64(S)` data type •

.`toDecimal128OrZero(expr, S)` — Results in `Decimal128(S)` data type •

These functions should be used instead of `toDecimal*()` functions, if you prefer to get a `0` value instead of an exception in  
.the event of an input value parsing error

#### Parameters

`expr` — [Expression](#), returns a value in the `String` data type. ClickHouse expects the textual representation of the •  
. 'decimal number. For example, '`1.111`

. `S` — Scale, the number of decimal places in the resulting value •

#### Returned value

:A value in the `Nullable(Decimal(P,S))` data type. The value contains

.Number with `S` decimal places, if ClickHouse interprets the input string as a number •

with `S` decimal places, if ClickHouse can't interpret the input string as a number or if the input number contains 0 •  
.more than `S` decimal places

## Example

```
SELECT toDecimal32OrZero(toString(-1.111), 5) AS val, toTypeName(val)
```

val	toTypeName(toDecimal32OrZero(toString(-1.111), 5))
-1.11100	Decimal(9, 5)

```
SELECT toDecimal32OrZero(toString(-1.111), 2) AS val, toTypeName(val)
```

val	toTypeName(toDecimal32OrZero(toString(-1.111), 2))
0.00	Decimal(9, 2)

## toString

Functions for converting between numbers, strings (but not fixed strings), dates, and dates with times. All these functions  
.accept one argument

When converting to or from a string, the value is formatted or parsed using the same rules as for the TabSeparated format  
.and almost all other text formats). If the string can't be parsed, an exception is thrown and the request is canceled

When converting dates to numbers or vice versa, the date corresponds to the number of days since the beginning of the Unix epoch. When converting dates with times to numbers or vice versa, the date with time corresponds to the number of  
.seconds since the beginning of the Unix epoch

:The date and date-with-time formats for the toDate/toDateTime functions are defined as follows

```
YYYY-MM-DD
YYYY-MM-DD hh:mm:ss
```

As an exception, if converting from UInt32, Int32, UInt64, or Int64 numeric types to Date, and if the number is greater than or equal to 65536, the number is interpreted as a Unix timestamp (and not as the number of days) and is rounded to the date. This allows support for the common occurrence of writing 'toDate(unix\_timestamp)', which otherwise would be an  
.('error and would require writing the more cumbersome 'toDate(toDateTime(unix\_timestamp

.Conversion between a date and date with time is performed the natural way: by adding a null time or dropping the time

.++Conversion between numeric types uses the same rules as assignments between different numeric types in C

Additionally, the `toString` function of the `DateTime` argument can take a second String argument containing the name of  
.the time zone. Example: `Asia/Yekaterinburg` In this case, the time is formatted according to the specified time zone

```
SELECT
now() AS now_local,
toString(now(), 'Asia/Yekaterinburg') AS now_yekat
```

now_local	now_yekat
2016-06-15 00:11:21	2016-06-15 02:11:21

.Also see the `toUnixTimestamp` function

(toFixedString(s, N

Converts a String type argument to a FixedString(N) type (a string with fixed length N). N must be a constant. If the string has fewer bytes than N, it is passed with null bytes to the right. If the string has more bytes than N, an exception is thrown

(toStringCutToZero(s

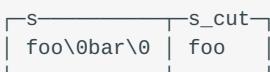
.Accepts a String or FixedString argument. Returns the String with the content truncated at the first zero byte found

:Example

```
SELECT toFixedString('foo', 8) AS s, toStringCutToZero(s) AS s_cut
```



```
SELECT toFixedString('foo\0bar', 8) AS s, toStringCutToZero(s) AS s_cut
```



(reinterpretAsUInt(8|16|32|64

(reinterpretAsInt(8|16|32|64

(reinterpretAsFloat(32|64

reinterpretAsDate

reinterpretAsDateTime

These functions accept a string and interpret the bytes placed at the beginning of the string as a number in host order (little endian). If the string isn't long enough, the functions work as if the string is padded with the necessary number of null bytes. If the string is longer than needed, the extra bytes are ignored. A date is interpreted as the number of days since the beginning of the Unix Epoch, and a date with time is interpreted as the number of seconds since the beginning of the Unix Epoch.

reinterpretAsString

This function accepts a number or date or date with time, and returns a string containing bytes representing the corresponding value in host order (little endian). Null bytes are dropped from the end. For example, a UInt32 type value of .255 is a string that is one byte long

reinterpretAsFixedString

This function accepts a number or date or date with time, and returns a FixedString containing bytes representing the corresponding value in host order (little endian). Null bytes are dropped from the end. For example, a UInt32 type value of .255 is a FixedString that is one byte long

(CAST(x, t

.Converts 'x' to the 't' data type. The syntax CAST(x AS t) is also supported

:Example

```
SELECT
 '2016-06-15 23:00:00' AS timestamp,
 CAST(timestamp AS DateTime) AS datetime,
 CAST(timestamp AS Date) AS date,
 CAST(timestamp, 'String') AS string,
 CAST(timestamp, 'FixedString(22)') AS fixed_string
```

timestamp	datetime	date	string	fixed_string
2016-06-15 23:00:00	2016-06-15 23:00:00	2016-06-15	2016-06-15 23:00:00	2016-06-15 23:00:00\0\0\0

.(Conversion to FixedString(N) only works for arguments of type String or FixedString(N

:Type conversion to **Nullable** and back is supported. Example

```
SELECT toTypeName(x) FROM t_null
```

toTypeName(x)
Int8
Int8

```
SELECT toTypeName(CAST(x, 'Nullable(UInt16)')) FROM t_null
```

toTypeName(CAST(x, 'Nullable(UInt16)'))
Nullable(UInt16)
Nullable(UInt16)

(toInterval(Year|Quarter|Month|Week|Day|Hour|Minute|Second

.Converts a Number type argument to an **Interval** data type

Syntax

```
toIntervalSecond(number)
toIntervalMinute(number)
toIntervalHour(number)
toIntervalDay(number)
toIntervalWeek(number)
toIntervalMonth(number)
toIntervalQuarter(number)
toIntervalYear(number)
```

Parameters

. number — Duration of interval. Positive integer number •

Returned values

.The value in Interval data type •

Example

```
WITH
 toDate('2019-01-01') AS date,
 INTERVAL 1 WEEK AS interval_week,
 toIntervalWeek(1) AS interval_to_week
SELECT
 date + interval_week,
 date + interval_to_week
```

plus(date, interval_week)	plus(date, interval_to_week)
2019-01-08	2019-01-08

## parseDateTimeBestEffort

Parse a number type argument to a Date or DateTime type. different from toDate and toDateTime, parseDateTimeBestEffort can progress more complex date format. For more information, see the link: [Complex Date Format](#)

## parseDateTimeBestEffortOrNull

Same as for [parseDateTimeBestEffort](#) except that it returns null when it encounters a date format that cannot be .processed

## parseDateTimeBestEffortOrZero

Same as for [parseDateTimeBestEffort](#) except that it returns zero date or zero date time when it encounters a date format .that cannot be processed

# Functions for working with dates and times

Support for time zones

All functions for working with the date and time that have a logical use for the time zone can accept a second optional time zone argument. Example: Asia/Yekaterinburg. In this case, they use the specified time zone instead of the local (default) .one

```
SELECT
 toDateTime('2016-06-15 23:00:00') AS time,
 toDate(time) AS date_local,
 toDate(time, 'Asia/Yekaterinburg') AS date_yekat,
 toString(time, 'US/Samoa') AS time_samoa
```

time	date_local	date_yekat	time_samoa
2016-06-15 23:00:00	2016-06-15	2016-06-16	2016-06-15 09:00:00

.Only time zones that differ from UTC by a whole number of hours are supported

## toTimeZone

.Convert time or date and time to the specified time zone

## **toYear**

.(Converts a date or date with time to a UInt16 number containing the year number (AD

## **toQuarter**

.Converts a date or date with time to a UInt8 number containing the quarter number

## **toMonth**

.(Converts a date or date with time to a UInt8 number containing the month number (1-12

## **toDayOfYear**

.(Converts a date or date with time to a UInt16 number containing the number of the day of the year (1-366

## **toDayOfMonth**

.(Converts a date or date with time to a UInt8 number containing the number of the day of the month (1-31

## **toDayOfWeek**

Converts a date or date with time to a UInt8 number containing the number of the day of the week (Monday is 1, and

.(Sunday is 7

## **toHour**

Converts a date with time to a UInt8 number containing the number of the hour in 24-hour time (0-23). This function assumes that if clocks are moved ahead, it is by one hour and occurs at 2 a.m., and if clocks are moved back, it is by one .(hour and occurs at 3 a.m. (which is not always true – even in Moscow the clocks were twice changed at a different time

## **toMinute**

.(Converts a date with time to a UInt8 number containing the number of the minute of the hour (0-59

## **toSecond**

Converts a date with time to a UInt8 number containing the number of the second in the minute (0-59). Leap seconds are .not accounted for

## **toUnixTimestamp**

.Converts a date with time to a unix timestamp

## **toStartOfYear**

.Rounds down a date or date with time to the first day of the year. Returns the date

## **toStartOfISOYear**

.Rounds down a date or date with time to the first day of ISO year. Returns the date

## toStartOfQuarter

Rounds down a date or date with time to the first day of the quarter. The first day of the quarter is either 1 January, 1 April, 1 July, or 1 October. Returns the date

## toStartOfMonth

.Rounds down a date or date with time to the first day of the month. Returns the date

### Attention

.The behavior of parsing incorrect dates is implementation specific. ClickHouse may return zero date, throw an exception or do "natural" overflow

## toMonday

.Rounds down a date or date with time to the nearest Monday. Returns the date

## ([toStartOfWeek(t[,mode

Rounds down a date or date with time to the nearest Sunday or Monday by mode. Returns the date. The mode argument .works exactly like the mode argument to toWeek(). For the single-argument syntax, a mode value of 0 is used

## toStartOfDay

.Rounds down a date with time to the start of the day

## toStartOfHour

.Rounds down a date with time to the start of the hour

## toStartOfMinute

.Rounds down a date with time to the start of the minute

## toStartOfFiveMinute

.Rounds down a date with time to the start of the five-minute interval

## toStartOfTenMinutes

.Rounds down a date with time to the start of the ten-minute interval

## toStartOfFifteenMinutes

.Rounds down the date with time to the start of the fifteen-minute interval

## ([toStartOfInterval(time\_or\_data, INTERVAL x unit [, time\_zone

,This is a generalization of other functions named toStartOf\*. For example

, ( `toStartOfInterval(t, INTERVAL 1 year)` ) returns the same as `toStartOfYear(t)`  
, ( `toStartOfInterval(t, INTERVAL 1 month)` ) returns the same as `toStartOfMonth(t)`  
, ( `toStartOfInterval(t, INTERVAL 1 day)` ) returns the same as `toStartOfDay(t)`  
. `toStartOfInterval(t, INTERVAL 15 minute)` returns the same as `toStartOfFifteenMinutes(t)` etc

## **toTime**

.Converts a date with time to a certain fixed date, while preserving the time

## **toRelativeYearNum**

.Converts a date with time or date to the number of the year, starting from a certain fixed point in the past

## **toRelativeQuarterNum**

.Converts a date with time or date to the number of the quarter, starting from a certain fixed point in the past

## **toRelativeMonthNum**

.Converts a date with time or date to the number of the month, starting from a certain fixed point in the past

## **toRelativeWeekNum**

.Converts a date with time or date to the number of the week, starting from a certain fixed point in the past

## **toRelativeDayNum**

.Converts a date with time or date to the number of the day, starting from a certain fixed point in the past

## **toRelativeHourNum**

.Converts a date with time or date to the number of the hour, starting from a certain fixed point in the past

## **toRelativeMinuteNum**

.Converts a date with time or date to the number of the minute, starting from a certain fixed point in the past

## **toRelativeSecondNum**

.Converts a date with time or date to the number of the second, starting from a certain fixed point in the past

## **toISOYear**

.Converts a date or date with time to a UInt16 number containing the ISO Year number

## **toISOWeek**

.Converts a date or date with time to a UInt8 number containing the ISO Week number

([`toWeek(date)[mode]`

This function returns the week number for date or datetime. The two-argument form of `toWeek()` enables you to specify whether the week starts on Sunday or Monday and whether the return value should be in the range from 0 to 53 or from 1 to 53. If the mode argument is omitted, the default mode is 0. `toISOWeek()` is a compatibility function that is equivalent to `.toWeek(date,3)`. The following table describes how the mode argument works

... Week 1 is the first week	Range	First day of week	Mode
with a Sunday in this year	0-53	Sunday	0
with 4 or more days this year	0-53	Monday	1
with a Sunday in this year	1-53	Sunday	2
with 4 or more days this year	1-53	Monday	3
with 4 or more days this year	0-53	Sunday	4
with a Monday in this year	0-53	Monday	5
with 4 or more days this year	1-53	Sunday	6
with a Monday in this year	1-53	Monday	7
contains January 1	1-53	Sunday	8
contains January 1	1-53	Monday	9

:For mode values with a meaning of “with 4 or more days this year,” weeks are numbered according to ISO 8601:1988

- .If the week containing January 1 has 4 or more days in the new year, it is week 1 •
- .Otherwise, it is the last week of the previous year, and the next week is week 1 •

For mode values with a meaning of “contains January 1”, the week contains January 1 is week 1. It doesn't matter how many days in the new year the week contained, even if it contained only one day

```
toWeek(date, [, mode][, Timezone])
```

#### Parameters

- . `date` – Date or DateTime •
- . `mode` – Optional parameter, Range of values is [0,9], default is 0 •
- . `Timezone` – Optional parameter, it behaves like any other conversion function •

#### Example

```
SELECT toDate('2016-12-27') AS date, toWeek(date) AS week0, toWeek(date,1) AS week1, toWeek(date,9) AS week9;
```

date	week0	week1	week9
2016-12-27	52	52	1

([toYearWeek(date[,mode

Returns year and week for a date. The year in the result may be different from the year in the date argument for the first .and the last week of the year

The mode argument works exactly like the mode argument to toWeek(). For the single-argument syntax, a mode value of .0 is used

. ( toISOYear() is a compatibility function that is equivalent to intDiv(toYearWeek(date,3),100

#### Example

```
SELECT toDate('2016-12-27') AS date, toYearWeek(date) AS yearWeek0, toYearWeek(date,1) AS yearWeek1,
toYearWeek(date,9) AS yearWeek9;
```

date	yearWeek0	yearWeek1	yearWeek9
2016-12-27	201652	201652	201701

now

Accepts zero arguments and returns the current time at one of the moments of request execution. This function returns a .constant, even if the request took a long time to complete

today

Accepts zero arguments and returns the current date at one of the moments of request execution. The same as .'()toDate(now

yesterday

Accepts zero arguments and returns yesterday's date at one of the moments of request execution. The same as 'today() - .1

timeSlot

Rounds the time to the half hour. This function is specific to Yandex.Metrica, since half an hour is the minimum amount of time for breaking a session into two sessions if a tracking tag shows a single user's consecutive pageviews that differ in time by strictly more than this amount. This means that tuples (the tag ID, user ID, and time slot) can be used to search for .pageviews that are included in the corresponding session

toYYYYMM

.(Converts a date or date with time to a UInt32 number containing the year and month number (YYYY \* 100 + MM

toYYYYMMDD

Converts a date or date with time to a UInt32 number containing the year and month number (YYYY \* 10000 + MM \* 100 .(+ DD

toYYYYMMDDhhmmss

Converts a date or date with time to a UInt64 number containing the year and month number (YYYY \* 10000000000 + .(MM \* 1000000000 + DD \* 1000000 + hh \* 10000 + mm \* 100 + ss

`addYears`, `addMonths`, `addWeeks`, `addDays`, `addHours`, `addMinutes`, `addSeconds`, `addQuarters`

:Function adds a Date/DateTime interval to a Date/DateTime and then return the Date/DateTime. For example

```
WITH
 toDate('2018-01-01') AS date,
 toDateTime('2018-01-01 00:00:00') AS date_time
SELECT
 addYears(date, 1) AS add_years_with_date,
 addYears(date_time, 1) AS add_years_with_date_time
```

add_years_with_date	add_years_with_date_time
2019-01-01	2019-01-01 00:00:00

`subtractYears`, `subtractMonths`, `subtractWeeks`, `subtractDays`, `subtractHours`, `subtractMinutes`, `subtractSeconds`, `subtractQuarters`

:Function subtract a Date/DateTime interval to a Date/DateTime and then return the Date/DateTime. For example

```
WITH
 toDate('2019-01-01') AS date,
 toDateTime('2019-01-01 00:00:00') AS date_time
SELECT
 subtractYears(date, 1) AS subtract_years_with_date,
 subtractYears(date_time, 1) AS subtract_years_with_date_time
```

subtract_years_with_date	subtract_years_with_date_time
2018-01-01	2018-01-01 00:00:00

([`dateDiff('unit'`, t1, t2, [timezone]

Return the difference between two times expressed in 'unit' e.g. 'hours'. 't1' and 't2' can be Date or DateTime, If 'timezone' is specified, it applied to both arguments. If not, timezones from datatypes 't1' and 't2' are used. If that timezones are not .the same, the result is unspecified

:Supported unit values

unit
second
minute
hour
day
week
month
quarter
year

([timeSlots(StartTime, Duration[, Size

For a time interval starting at 'StartTime' and continuing for 'Duration' seconds, it returns an array of moments in time, consisting of points from this interval rounded down to the 'Size' in seconds. 'Size' is an optional parameter: a constant UInt32, set to 1800 by default. For example, `timeSlots(toDateTime('2012-01-01 12:20:00'), 600) = [toDateTime('2012-01-01 .12:00:00'), toDateTime('2012-01-01 12:30:00')]`. This is necessary for searching for pageviews in the corresponding session

([formatDateTime(Time, Format[, Timezone

Function formats a Time according given Format string. N.B.: Format is a constant expression, e.g. you can not have  
.multiple formats for single result column

(Supported modifiers for Format: ("Example" column shows formatting result for time 2018-01-02 22:33:44

Example	Description	Modifier
20	(year divided by 100 and truncated to integer (00-99	C%
02	(day of the month, zero-padded (01-31	d%
01/02/18	Short MM/DD/YY date, equivalent to %m/%d/%y	D%
2	(day of the month, space-padded ( 1-31	e%
2018-01-02	short YYYY-MM-DD date, equivalent to %Y-%m-%d	F%
22	(hour in 24h format (00-23	H%
10	(hour in 12h format (01-12	I%
002	(day of the year (001-366	J%
01	(month as a decimal number (01-12	m%
33	(minute (00-59	M%
	('new-line character ('\n	n%
PM	AM or PM designation	p%
22:33	hour HH:MM time, equivalent to %H:%M-24	R%
44	(second (00-59	S%
	('horizontal-tab character ('\t	t%
22:33:44	ISO 8601 time format (HH:MM:SS), equivalent to %H:%M:%S	T%
2	(ISO 8601 weekday as number with Monday as 1 (1-7	u%
01	(ISO 8601 week number (01-53	V%
2	(weekday as a decimal number with Sunday as 0 (0-6	w%
18	(Year, last two digits (00-99	y%
2018	Year	Y%
%	a % sign	%%

## Functions for working with strings

### empty

Returns 1 for an empty string or 0 for a non-empty string. The result type is UInt8. A string is considered non-empty if it .contains at least one byte, even if this is a space or a null byte. The function also works for arrays

### notEmpty

.Returns 0 for an empty string or 1 for a non-empty string. The result type is UInt8. The function also works for arrays

## length

Returns the length of a string in bytes (not in characters, and not in code points). The result type is UInt64. The function .also works for arrays

## lengthUTF8

Returns the length of a string in Unicode code points (not in characters), assuming that the string contains a set of bytes that make up UTF-8 encoded text. If this assumption is not met, it returns some result (it doesn't throw an exception). The .result type is UInt64

## char\_length, CHAR\_LENGTH

Returns the length of a string in Unicode code points (not in characters), assuming that the string contains a set of bytes that make up UTF-8 encoded text. If this assumption is not met, it returns some result (it doesn't throw an exception). The .result type is UInt64

## character\_length, CHARACTER\_LENGTH

Returns the length of a string in Unicode code points (not in characters), assuming that the string contains a set of bytes that make up UTF-8 encoded text. If this assumption is not met, it returns some result (it doesn't throw an exception). The .result type is UInt64

## lower, lcase

.Converts ASCII Latin symbols in a string to lowercase

## upper, ucase

.Converts ASCII Latin symbols in a string to uppercase

## lowerUTF8

Converts a string to lowercase, assuming the string contains a set of bytes that make up a UTF-8 encoded text. It doesn't detect the language. So for Turkish the result might not be exactly correct. If the length of the UTF-8 byte sequence is different for upper and lower case of a code point, the result may be incorrect for this code point. If the string contains a .set of bytes that is not UTF-8, then the behavior is undefined

## upperUTF8

Converts a string to uppercase, assuming the string contains a set of bytes that make up a UTF-8 encoded text. It doesn't detect the language. So for Turkish the result might not be exactly correct. If the length of the UTF-8 byte sequence is different for upper and lower case of a code point, the result may be incorrect for this code point. If the string contains a .set of bytes that is not UTF-8, then the behavior is undefined

## isValidUTF8

.Returns 1, if the set of bytes is valid UTF-8 encoded, otherwise 0

## toValidUTF8

Replaces invalid UTF-8 characters by the  (U+FFFD) character. All running in a row invalid characters are collapsed into the one replacement character

```
toValidUTF8(input_string)
```

:Parameters

.input\_string — Any set of bytes represented as the **String** data type object •

.Returned value: Valid UTF-8 string

### Example

```
SELECT toValidUTF8('\x61\xF0\x80\x80\x80b')
```

```
repeat('a\u0000b')—
a\u0000b
```

repeat

.Repeats a string as many times as specified and concatenates the replicated values as a single string

Syntax

```
repeat(s, n)
```

Parameters

. s — The string to repeat. **String** •

. n — The number of times to repeat the string. **UInt** •

Returned value

.The single string, which contains the string `s` repeated `n` times. If `n < 1`, the function returns empty string

.Type: **String**

### Example

:Query

```
SELECT repeat('abc', 10)
```

:Result

```
repeat('abc', 10)—
abcabcabcabcabcabcabcabcabc
```

reverse

.(Reverses the string (as a sequence of bytes

## reverseUTF8

Reverses a sequence of Unicode code points, assuming that the string contains a set of bytes representing a UTF-8 text.  
.Otherwise, it does something else (it doesn't throw an exception

(... ,format(pattern, s0, s1

Formatting constant pattern with the string listed in the arguments. `pattern` is a simplified Python format pattern. Format string contains "replacement fields" surrounded by curly braces `{}`. Anything that is not contained in braces is considered literal text, which is copied unchanged to the output. If you need to include a brace character in the literal text, it can be escaped by doubling: `\{\{` and `\}}`. Field names can be numbers (starting from zero) or empty (then they are treated as  
.consequence numbers

```
SELECT format('{1} {0} {1}', 'World', 'Hello')
```

```
format('{1} {0} {1}', 'World', 'Hello')
| Hello World Hello
|_____
```

```
SELECT format('{} {}', 'Hello', 'World')
```

```
format('{} {}', 'Hello', 'World')
| Hello World
|_____
```

(... ,concat(s1, s2

.Concatenates the strings listed in the arguments, without a separator

(... ,concatAssumeInjective(s1, s2

Same as `concat`, the difference is that you need to ensure that `concat(s1, s2, s3) -> s4` is injective, it will be used for  
optimization of GROUP BY

(`substring(s, offset, length)`, `mid(s, offset, length)`, `substr(s, offset, length`

Returns a substring starting with the byte from the 'offset' index that is 'length' bytes long. Character indexing starts from  
.one (as in standard SQL). The 'offset' and 'length' arguments must be constants

(`substringUTF8(s, offset, length`

The same as 'substring', but for Unicode code points. Works under the assumption that the string contains a set of bytes  
.representing a UTF-8 encoded text. If this assumption is not met, it returns some result (it doesn't throw an exception

(`appendTrailingCharIfAbsent(s, c`

.If the 's' string is non-empty and does not contain the 'c' character at the end, it appends the 'c' character to the end

(`convertCharset(s, from, to`

.Returns the string 's' that was converted from the encoding in 'from' to the encoding in 'to

(base64Encode(s

Encodes 's' string into base64

(base64Decode(s

.Decode base64-encoded string 's' into original string. In case of failure raises an exception

(tryBase64Decode(s

.Similar to base64Decode, but in case of error an empty string would be returned

(endsWith(s, suffix

Returns whether to end with the specified suffix. Returns 1 if the string ends with the specified suffix, otherwise it returns

.0

(startsWith(str, prefix

.Returns 1 whether string starts with the specified prefix, otherwise it returns 0

```
SELECT startsWith('Spider-Man', 'Spi');
```

Returned values

.if the string starts with the specified prefix ,1 •

.if the string doesn't start with the specified prefix ,0 •

Example

:Query

```
SELECT startsWith('Hello, world!', 'He');
```

:Result

```
startsWith('Hello, world!', 'He')
1
```

trim

Removes all specified characters from the start or end of a string. By default removes all consecutive occurrences of  
.common whitespace (ASCII character 32) from both ends of a string

Syntax

```
trim([[LEADING|TRAILING|BOTH] trim_character FROM] input_string)
```

Parameters

. trim\_character — specified characters for trim. **String** •

. input\_string — string for trim. **String** •

Returned value

.A string without leading and (or) trailing specified characters

.Type: String

Example

:Query

```
SELECT trim(BOTH '()' FROM '(Hello, world!)')
```

:Result

```
trim(BOTH '()' FROM '(Hello, world!)')
| Hello, world!
```

## trimLeft

Removes all consecutive occurrences of common whitespace (ASCII character 32) from the beginning of a string. It  
.doesn't remove other kinds of whitespace characters (tab, no-break space, etc

Syntax

```
trimLeft(input_string)
```

. (Alias: ltrim(input\_string

Parameters

. input\_string — string to trim. **String** •

Returned value

.A string without leading common whitespaces

.Type: String

Example

:Query

```
SELECT trimLeft('Hello, world! ')
```

:Result

```
trimLeft('Hello, world! ')
| Hello, world!
```

## trimRight

Removes all consecutive occurrences of common whitespace (ASCII character 32) from the end of a string. It doesn't  
.remove other kinds of whitespace characters (tab, no-break space, etc

Syntax

```
trimRight(input_string)
```

. (Alias: rtrim(input\_string

Parameters

. input\_string — string to trim. **String** •

Returned value

.A string without trailing common whitespaces

.Type: **String**

Example

:Query

```
SELECT trimRight(' Hello, world! ')
```

:Result

```
trimRight(' Hello, world! ')
| Hello, world!
```

**trimBoth**

Removes all consecutive occurrences of common whitespace (ASCII character 32) from both ends of a string. It doesn't  
.remove other kinds of whitespace characters (tab, no-break space, etc

Syntax

```
trimBoth(input_string)
```

. (Alias: trim(input\_string

Parameters

. input\_string — string to trim. **String** •

Returned value

.A string without leading and trailing common whitespaces

.Type: **String**

Example

:Query

```
SELECT trimBoth(' Hello, world! ')
```

:Result

```
trimBoth(' Hello, world! ')
| Hello, world!
```

## (CRC32(s

Returns the CRC32 checksum of a string, using CRC-32-IEEE 802.3 polynomial and initial value 0xffffffff (zlib  
.(implementation

.The result type is UInt32

## (CRC32IEEE(s

.Returns the CRC32 checksum of a string, using CRC-32-IEEE 802.3 polynomial

.The result type is UInt32

## (CRC64(s

.Returns the CRC64 checksum of a string, using CRC-64-ECMA polynomial

.The result type is UInt64

# Functions for Searching Strings

.The search is case-sensitive by default in all these functions. There are separate variants for case insensitive search

## (position(haystack, needle), locate(haystack, needle

Search for the substring `needle` in the string `haystack` . Returns the position (in bytes) of the found substring, starting from  
.1, or returns 0 if the substring was not found

.For a case-insensitive search, use the function `positionCaseInsensitive`

## (positionUTF8(haystack, needle

The same as `position` , but the position is returned in Unicode code points. Works under the assumption that the string contains a set of bytes representing a UTF-8 encoded text. If this assumption is not met, it returns some result (it doesn't  
.throw an exception

.For a case-insensitive search, use the function `positionCaseInsensitiveUTF8`

## ([multiSearchAllPositions(haystack, [needle<sub>1</sub>, needle<sub>2</sub>, ..., needle<sub>n</sub>

.The same as `position` , but returns `Array` of the positions for all needles

For a case-insensitive search or/and in UTF-8 format use functions `multiSearchAllPositionsCaseInsensitive`,  
`multiSearchAllPositionsUTF8`, `multiSearchAllPositionsCaseInsensitiveUTF8`

## ([multiSearchFirstPosition(haystack, [needle<sub>1</sub>, needle<sub>2</sub>, ..., needle<sub>n</sub>

.The same as `position` but returns the leftmost offset of the string `haystack` that is matched to some of the needles

For a case-insensitive search or/and in UTF-8 format use functions `multiSearchFirstPositionCaseInsensitive`,  
`multiSearchFirstPositionUTF8`, `multiSearchFirstPositionCaseInsensitiveUTF8`

([multiSearchFirstIndex(haystack, [needle<sub>1</sub>, needle<sub>2</sub>, ..., needle<sub>n</sub>

.Returns the index  $i$  (starting from 1) of the leftmost found needle in the string haystack and 0 otherwise

For a case-insensitive search or/and in UTF-8 format use functions multiSearchFirstIndexCaseInsensitive,

.multiSearchFirstIndexUTF8, multiSearchFirstIndexCaseInsensitiveUTF8

([multiSearchAny(haystack, [needle<sub>1</sub>, needle<sub>2</sub>, ..., needle<sub>n</sub>

.Returns 1, if at least one string needle matches the string haystack and 0 otherwise

For a case-insensitive search or/and in UTF-8 format use functions multiSearchAnyCaseInsensitive, multiSearchAnyUTF8,

.multiSearchAnyCaseInsensitiveUTF8

Note 

.In all multiSearch\* functions the number of needles should be less than  $2^8$  because of implementation specification

(match(haystack, pattern

Checks whether the string matches the pattern regular expression. A re2 regular expression. The syntax of the re2 regular expressions is more limited than the syntax of the Perl regular expressions

.Returns 0 if it doesn't match, or 1 if it matches

Note that the backslash symbol (\ ) is used for escaping in the regular expression. The same symbol is used for escaping in string literals. So in order to escape the symbol in a regular expression, you must write two backslashes (\ ) in a string

.literal

The regular expression works with the string as if it is a set of bytes. The regular expression can't contain null bytes. For patterns to search for substrings in a string, it is better to use LIKE or 'position', since they work much faster

([multiMatchAny(haystack, [pattern<sub>1</sub>, pattern<sub>2</sub>, ..., pattern<sub>n</sub>

The same as match , but returns 0 if none of the regular expressions are matched and 1 if any of the patterns matches. It uses hyperscan library. For patterns to search substrings in a string, it is better to use multiSearchAny since it works much faster

Note 

The length of any of the haystack string must be less than  $2^{32}$  bytes otherwise the exception is thrown. This restriction takes place because of .hyperscan API

([multiMatchAnyIndex(haystack, [pattern<sub>1</sub>, pattern<sub>2</sub>, ..., pattern<sub>n</sub>

.The same as multiMatchAny , but returns any index that matches the haystack

([multiMatchAllIndices(haystack, [pattern<sub>1</sub>, pattern<sub>2</sub>, ..., pattern<sub>n</sub>

.The same as multiMatchAny , but returns the array of all indices that match the haystack in any order

([multiFuzzyMatchAny(haystack, distance, [pattern<sub>1</sub>, pattern<sub>2</sub>, ..., pattern<sub>n</sub>

The same as `multiMatchAny`, but returns 1 if any pattern matches the haystack within a constant edit distance. This function is also in an experimental mode and can be extremely slow. For more information see [hyperscan documentation](#)

(`[multiFuzzyMatchAnyIndex(haystack, distance, [pattern1, pattern2, ..., patternn])`

.The same as `multiFuzzyMatchAny`, but returns any index that matches the haystack within a constant edit distance

(`[multiFuzzyMatchAllIndices(haystack, distance, [pattern1, pattern2, ..., patternn])`

The same as `multiFuzzyMatchAny`, but returns the array of all indices in any order that match the haystack within a constant edit distance

Note 

`multiFuzzyMatch*` functions do not support UTF-8 regular expressions, and such expressions are treated as bytes because of hyperscan restriction

Note 

.;To turn off all functions that use hyperscan, use setting `SET allow_hyperscan = 0`

(`extract(haystack, pattern)`

Extracts a fragment of a string using a regular expression. If 'haystack' doesn't match the 'pattern' regex, an empty string is returned. If the regex doesn't contain subpatterns, it takes the fragment that matches the entire regex. Otherwise, it takes the fragment that matches the first subpattern

(`extractAll(haystack, pattern)`

Extracts all the fragments of a string using a regular expression. If 'haystack' doesn't match the 'pattern' regex, an empty string is returned. Returns an array of strings consisting of all matches to the regex. In general, the behavior is the same (as the 'extract' function (it takes the first subpattern, or the entire expression if there isn't a subpattern

`like(haystack, pattern)`, haystack LIKE pattern operator

Checks whether a string matches a simple regular expression. The regular expression can contain the metasymbols % \_ and .(indicates any quantity of any bytes (including zero characters % \_ indicates any one byte \_

.Use the backslash (\ ) for escaping metasymbols. See the note on escaping in the description of the 'match' function

For regular expressions like `%needle%`, the code is more optimal and works as fast as the `position` function. For other regular expressions, the code is the same as for the 'match' function

`notLike(haystack, pattern)`, haystack NOT LIKE pattern operator

.The same thing as 'like', but negative

(`ngramDistance(haystack, needle`

Calculates the 4-gram distance between `haystack` and `needle` : counts the symmetric difference between two multisets of 4-grams and normalizes it by the sum of their cardinalities. Returns float number from 0 to 1 -- the closer to zero, the more strings are similar to each other. If the constant `needle` or `haystack` is more than 32Kb, throws an exception. If some of the non-constant `haystack` or `needle` strings are more than 32Kb, the distance is always one

For case-insensitive search or/and in UTF-8 format use functions `ngramDistanceCaseInsensitive`, `ngramDistanceUTF8`,  
`.ngramDistanceCaseInsensitiveUTF8`

`(ngramSearch(haystack, needle`

Same as `ngramDistance` but calculates the non-symmetric difference between `needle` and `haystack` -- the number of n-grams from `needle` minus the common number of n-grams normalized by the number of `needle` n-grams. The closer to one, the more likely `needle` is in the `haystack` . Can be useful for fuzzy string search

For case-insensitive search or/and in UTF-8 format use functions `ngramSearchCaseInsensitive`, `ngramSearchUTF8`,  
`.ngramSearchCaseInsensitiveUTF8`

Note 

For UTF-8 case we use 3-gram distance. All these are not perfectly fair n-gram distances. We use 2-byte hashes to hash n-grams and then calculate the (non-)symmetric difference between these hash tables -- collisions may occur. With UTF-8 case-insensitive format we do not use `tolower` function -- we zero the 5-th bit (starting from zero) of each codepoint byte and first bit of zeroth byte if bytes more than one -- this works for Latin and mostly for all Cyrillic letters

## Functions for searching and replacing in strings

`(replaceOne(haystack, pattern, replacement`

Replaces the first occurrence, if it exists, of the 'pattern' substring in 'haystack' with the 'replacement' substring. Hereafter, .'pattern' and 'replacement' must be constants

`(replaceAll(haystack, pattern, replacement), replace(haystack, pattern, replacement`

.Replaces all occurrences of the 'pattern' substring in 'haystack' with the 'replacement' substring

`(replaceRegexpOne(haystack, pattern, replacement`

Replacement using the 'pattern' regular expression. A re2 regular expression. Replaces only the first occurrence, if it exists. A pattern can be specified as 'replacement'. This pattern can include substitutions `\0-\9` . The substitution `\0` includes the entire regular expression. Substitutions `\1-\9` correspond to the subpattern numbers. To use the \ character in a template, escape it using `\` . Also keep in mind that a string literal requires an extra escape

:Example 1. Converting the date to American format

```
SELECT DISTINCT
 EventDate,
 replaceRegexpOne(toString(EventDate), '(\d{4})-(\d{2})-(\d{2})', '\2/\3/\1') AS res
FROM test.hits
LIMIT 7
FORMAT TabSeparated
```

2014-03-17	03/17/2014
2014-03-18	03/18/2014
2014-03-19	03/19/2014
2014-03-20	03/20/2014
2014-03-21	03/21/2014
2014-03-22	03/22/2014
2014-03-23	03/23/2014

:Example 2. Copying a string ten times

```
SELECT replaceRegexpOne('Hello, World!', '.', '\\0\\0\\0\\0\\0\\0\\0\\0\\0\\0\\0') AS res
```

res

```
| Hello, World!Hello, World!Hello, World!Hello, World!Hello, World!Hello, World!Hello, World!Hello,
World!Hello, World!Hello, World! |
```

(replaceRegexpAll(haystack, pattern, replacement)

:This does the same thing, but replaces all the occurrences. Example

```
SELECT replaceRegexpAll('Hello, World!', '.', '\\0\\0') AS res
```

res

```
| HHheelllloo,, WWoorrrlldd!! |
```

As an exception, if a regular expression worked on an empty substring, the replacement is not made more than once.

:Example

```
SELECT replaceRegexpAll('Hello, World!', '^', 'here: ') AS res
```

res

```
| here: Hello, World! |
```

(regexpQuoteMeta(s

The function adds a backslash before some predefined characters in the string. Predefined characters: '0', '\', '|', '(', ')', '^', '\$', ':', '[', ']', '?', '\*', '+', '{', '}', '-'. This implementation slightly differs from re2::RE2::QuoteMeta. It escapes zero byte as \0 instead of \x00 and it escapes only required characters. For more information, see the link: [RE2](#)

## Conditional functions

**if** function

(Syntax: `if(cond, then, else`

. Returns `then` if the `cond` is truthy(greater than zero), otherwise returns `else`

- . `cond` must be of type of `UInt8`, and `then` and `else` must have the lowest common type •

- then and else can be `NULL` •

:Example

:Take this LEFT\_RIGHT table

```
SELECT *
FROM LEFT_RIGHT
```

left	right
NULL	4
1	3
2	2
3	1
4	NULL

:The following query compares left and right values

```
SELECT
 left,
 right,
 if(left < right, 'left is smaller than right', 'right is greater or equal than left') AS is_smaller
FROM LEFT_RIGHT
WHERE isNotNull(left) AND isNotNull(right)
```

left	right	is_smaller
1	3	left is smaller than right
2	2	right is greater or equal than left
3	1	right is greater or equal than left

.Note: NULL values are not used in this example, check **NULL values in conditionals** section

## Ternary operator

.It works same as if function

Syntax: cond ? then : else

.Returns then if the cond is truthy(greater than zero), otherwise returns else

- .cond must be of type of UInt8 , and then and else must have the lowest common type •
- then and else can be NULL •

## multilf

.Allows you to write the **CASE** operator more compactly in the query

(Syntax: multilf(cond\_1, then\_1, cond\_2, then\_2, ..., else

:Parameters

- .cond\_N — The condition for the function to return then\_N •
- .then\_N — The result of the function when executed •
- .else — The result of the function if none of the conditions is met •

.The function accepts 2N+1 parameters

Returned values

.The function returns one of the values then\_N or else , depending on the conditions cond\_N

## Example

.Again using LEFT\_RIGHT table

```
SELECT
 left,
 right,
 multiIf(left < right, 'left is smaller', left > right, 'left is greater', left = right, 'Both equal',
'Null value') AS result
FROM LEFT_RIGHT
```

left	right	result
NULL	4	Null value
1	3	left is smaller
2	2	Both equal
3	1	left is greater
4	NULL	Null value

## Using conditional results directly

:Conditionals always result to 0 , 1 or NULL . So you can use conditional results directly like this

```
SELECT left < right AS is_small
FROM LEFT_RIGHT
```

is_small
NULL
1
0
0
NULL

## NULL values in conditionals

.When NULL values are involved in conditionals, the result will also be NULL

```
SELECT
 NULL < 1,
 2 < NULL,
 NULL < NULL,
 NULL = NULL
```

less(NULL, 1)	less(2, NULL)	less(NULL, NULL)	equals(NULL, NULL)
NULL	NULL	NULL	NULL

.So you should construct your queries carefully if the types are Nullable

.The following example demonstrates this by failing to add equals condition to multilif

```

SELECT
 left,
 right,
 multiIf(left < right, 'left is smaller', left > right, 'right is smaller', 'Both equal') AS
faulty_result
FROM LEFT_RIGHT

```

left	right	faulty_result
NULL	4	Both equal
1	3	left is smaller
2	2	Both equal
3	1	right is smaller
4	NULL	Both equal

## Mathematical functions

All the functions return a Float64 number. The accuracy of the result is close to the maximum precision possible, but the .result might not coincide with the machine representable number nearest to the corresponding real number

( $e$ )

.Returns a Float64 number that is close to the number  $e$

( $\pi$ )

.Returns a Float64 number that is close to the number  $\pi$

( $\exp(x)$ )

.Accepts a numeric argument and returns a Float64 number close to the exponent of the argument

( $\log(x)$ ,  $\ln(x)$ )

.Accepts a numeric argument and returns a Float64 number close to the natural logarithm of the argument

( $\exp2(x)$ )

.Accepts a numeric argument and returns a Float64 number close to 2 to the power of  $x$

( $\log2(x)$ )

.Accepts a numeric argument and returns a Float64 number close to the binary logarithm of the argument

( $\exp10(x)$ )

.Accepts a numeric argument and returns a Float64 number close to 10 to the power of  $x$

( $\log10(x)$ )

.Accepts a numeric argument and returns a Float64 number close to the decimal logarithm of the argument

( $\sqrt{x}$ )

.Accepts a numeric argument and returns a Float64 number close to the square root of the argument

(cbrt(x

.Accepts a numeric argument and returns a Float64 number close to the cubic root of the argument

(erf(x

If 'x' is non-negative, then  $\text{erf}(x / \sigma\sqrt{2})$  is the probability that a random variable having a normal distribution with standard deviation ' $\sigma$ ' takes the value that is separated from the expected value by more than 'x

:(Example (three sigma rule

```
SELECT erf(3 / sqrt(2))
```

```
erf(divide(3, sqrt(2)))—
0.9973002039367398 |
```

(erfc(x

Accepts a numeric argument and returns a Float64 number close to  $1 - \text{erf}(x)$ , but without loss of precision for large 'x'.values

(lgamma(x

.The logarithm of the gamma function

(tgamma(x

.Gamma function

(sin(x

.The sine

(cos(x

.The cosine

(tan(x

.The tangent

(asin(x

.The arc sine

(acos(x

.The arc cosine

(atan(x

.The arc tangent

(pow(x, y), power(x, y

.Takes two numeric arguments x and y. Returns a Float64 number close to x to the power of y

intExp2

.Accepts a numeric argument and returns a UInt64 number close to 2 to the power of x

intExp10

.Accepts a numeric argument and returns a UInt64 number close to 10 to the power of x

## Rounding functions

([floor(x[, N

Returns the largest round number that is less than or equal to x . A round number is a multiple of 1/10N, or the nearest number of the appropriate data type if 1 / 10N isn't exact. 'N' is an integer constant, optional parameter. By default it is zero, which means to round to an integer. 'N' may be negative

.Examples: floor(123.45, 1) = 123.4, floor(123.45, -1) = 120

x is any numeric type. The result is a number of the same type. For integer arguments, it makes sense to round with a negative N value (for non-negative N , the function doesn't do anything). If rounding causes overflow (for example, floor(-128, -1)), an implementation-specific result is returned

([ceil(x[, N]), ceiling(x[, N

Returns the smallest round number that is greater than or equal to x . In every other way, it is the same as the floor .(function (see above

([trunc(x[, N]), truncate(x[, N

Returns the round number with largest absolute value that has an absolute value less than or equal to x 's. In every other .(way, it is the same as the 'floor' function (see above

([round(x[, N

.Rounds a value to a specified number of decimal places

The function returns the nearest number of the specified order. In case when given number has equal distance to surrounding numbers, the function uses banker's rounding for float number types and rounds away from zero for the other .number types

```
round(expression [, decimal_places])
```

:Parameters

- .expression — A number to be rounded. Can be any expression returning the numeric data type •
- .decimal-places — An integer value •
- .If decimal-places > 0 then the function rounds the value to the right of the decimal point •
- .If decimal-places < 0 then the function rounds the value to the left of the decimal point •
- .If decimal-places = 0 then the function rounds the value to integer. In this case the argument can be omitted •

:Returned value

.The rounded number of the same type as the input number

## Examples

Example of use

```
SELECT number / 2 AS x, round(x) FROM system.numbers LIMIT 3
```

x	round(divide(number, 2))
0	0
0.5	0
1	1

Examples of rounding

.Rounding to the nearest number

```
round(3.2, 0) = 3
round(4.1267, 2) = 4.13
round(22, -1) = 20
round(467, -2) = 500
round(-467, -2) = -500
```

.Banker's rounding

```
round(3.5) = 4
round(4.5) = 4
round(3.55, 1) = 3.6
round(3.65, 1) = 3.6
```

## (roundToExp2(num

Accepts a number. If the number is less than one, it returns 0. Otherwise, it rounds the number down to the nearest .(whole non-negative) degree of two

## (roundDuration(num

Accepts a number. If the number is less than one, it returns 0. Otherwise, it rounds the number down to numbers from the set: 1, 10, 30, 60, 120, 180, 240, 300, 600, 1200, 1800, 3600, 7200, 18000, 36000. This function is specific to Yandex.Metrica and used for implementing the report on session length

## (roundAge(num

Accepts a number. If the number is less than 18, it returns 0. Otherwise, it rounds the number down to a number from the set: 18, 25, 35, 45, 55. This function is specific to Yandex.Metrica and used for implementing the report on user age

(roundDown(num, arr

Accept a number, round it down to an element in the specified array. If the value is less than the lowest bound, the lowest .bound is returned

([roundBankers(x[, N

.Rounds a value to a specified number of decimal places

The function returns the nearest number of the specified order. In case when given number has equal distance to .(surrounding numbers, the function always return the number having the nearest even digit (banker's rounding

## Functions for working with arrays

empty

.Returns 1 for an empty array, or 0 for a non-empty array. The result type is UInt8. The function also works for strings

notEmpty

.Returns 0 for an empty array, or 1 for a non-empty array. The result type is UInt8. The function also works for strings

length

.Returns the number of items in the array. The result type is UInt64. The function also works for strings

emptyArrayUInt8, emptyArrayUInt16, emptyArrayUInt32, emptyArrayUInt64

emptyArrayInt8, emptyArrayInt16, emptyArrayInt32, emptyArrayInt64

emptyArrayFloat32, emptyArrayFloat64

emptyArrayDate, emptyArrayDateTime

emptyArrayString

.Accepts zero arguments and returns an empty array of the appropriate type

emptyArrayToSingle

.Accepts an empty array and returns a one-element array that is equal to the default value

([range(end), range(start, end [, step

Returns an array of numbers from start to end-1 by step. If the argument start is not specified, defaults to 0. If the argument step is not specified, defaults to 1. It behaviors almost like pythonic range . But the difference is that all the arguments type must be UInt numbers. Just in case, an exception is thrown if arrays with a total length of more than .100,000,000 elements are created in a data block

## [... ,array(x1, ...), operator [x1

Creates an array from the function arguments. The arguments must be constants and have types that have the smallest common type. At least one argument must be passed, because otherwise it isn't clear which type of array to create. That is, you can't use this function to create an empty array (to do that, use the 'emptyArray\*' function described above).

.Returns an 'Array(T)' type result, where 'T' is the smallest common type out of the passed arguments

## arrayConcat

.Combines arrays passed as arguments

```
arrayConcat(arrays)
```

### Parameters

arrays – Arbitrary number of arguments of **Array** type. Example •

```
SELECT arrayConcat([1, 2], [3, 4], [5, 6]) AS res
```

```
res
[1,2,3,4,5,6]
```

## [arrayElement(arr, n), operator arr[n

Get the element with the index `n` from the array `arr`. `n` must be any integer type. Indexes in an array begin from one. Negative indexes are supported. In this case, it selects the corresponding element numbered from the end. For example, `.arr[-1]` is the last item in the array

If the index falls outside of the bounds of an array, it returns some default value (0 for numbers, an empty string for strings, etc.), except for the case with a non-constant array and a constant index 0 (in this case there will be an error `Array .(indices are 1-based`

## (has(arr, elem

.Checks whether the 'arr' array has the 'elem' element. Returns 0 if the the element is not in the array, or 1 if it is

. `NULL` is processed as a value

```
SELECT has([1, 2, NULL], NULL)
```

```
has([1, 2, NULL], NULL)
1
```

## hasAll

.Checks whether one array is a subset of another

```
hasAll(set, subset)
```

### Parameters

. `set` – Array of any type with a set of elements •

.subset – Array of any type with elements that should be tested to be a subset of set •

#### Return values

.if set contains all of the elements from subset , 1 •

.otherwise , 0 •

#### Peculiar properties

.An empty array is a subset of any array •

. Null processed as a value •

.Order of values in both of arrays doesn't matter •

#### Examples

. SELECT hasAll([], []) returns 1

. SELECT hasAll([1, Null], [Null]) returns 1

. SELECT hasAll([1.0, 2, 3, 4], [1, 3]) returns 1

. SELECT hasAll(['a', 'b'], ['a']) returns 1

. SELECT hasAll([1], ['a']) returns 0

. SELECT hasAll([[1, 2], [3, 4]], [[1, 2], [3, 5]]) returns 0

## hasAny

.Checks whether two arrays have intersection by some elements

hasAny(array1, array2)

#### Parameters

. array1 – Array of any type with a set of elements •

. array2 – Array of any type with a set of elements •

#### Return values

.if array1 and array2 have one similar element at least , 1 •

.otherwise , 0 •

#### Peculiar properties

. Null processed as a value •

.Order of values in both of arrays doesn't matter •

#### Examples

. SELECT hasAny([1], []) returns 0

. SELECT hasAny([Null], [Null, 1]) returns 1

. SELECT hasAny([-128, 1., 512], [1]) returns 1

. SELECT hasAny([[1, 2], [3, 4]], ['a', 'c']) returns 0

. SELECT hasAll([[1, 2], [3, 4]], [[1, 2], [1, 2]]) returns 1

### (indexOf(arr, x

. Returns the index of the first 'x' element (starting from 1) if it is in the array, or 0 if it is not

:Example

```
SELECT indexOf([1, 3, NULL, NULL], NULL)
```

```
 indexOf([1, 3, NULL, NULL], NULL)
 3
```

. Elements set to `NULL` are handled as normal values

### (countEqual(arr, x

.(Returns the number of elements in the array equal to x. Equivalent to arrayCount (elem -> elem = x, arr

. `NULL` elements are handled as separate values

:Example

```
SELECT countEqual([1, 2, NULL, NULL], NULL)
```

```
 countEqual([1, 2, NULL, NULL], NULL)
 2
```

### (arrayEnumerate(arr

[ (Returns the array [1, 2, 3, ..., length (arr

This function is normally used with ARRAY JOIN. It allows counting something just once for each array after applying :ARRAY JOIN. Example

```
SELECT
 count() AS Reaches,
 countIf(num = 1) AS Hits
FROM test.hits
ARRAY JOIN
 GoalsReached,
 arrayEnumerate(GoalsReached) AS num
WHERE CounterID = 160656
LIMIT 10
```

```
 Reaches Hits
 95606 | 31406
```

In this example, Reaches is the number of conversions (the strings received after applying ARRAY JOIN), and Hits is the number of pageviews (strings before ARRAY JOIN). In this particular case, you can get the same result in an easier way

```

SELECT
 sum(length(GoalsReached)) AS Reaches,
 count() AS Hits
FROM test.hits
WHERE (CounterID = 160656) AND notEmpty(GoalsReached)

```

Reaches	Hits
95606	31406

This function can also be used in higher-order functions. For example, you can use it to get array indexes for elements that .match a condition

(... ,arrayEnumerateUniq(arr

Returns an array the same size as the source array, indicating for each element what its position is among elements with .[the same value. For example: arrayEnumerateUniq([10, 20, 10, 30]) = [1, 1, 2, 1]

:This function is useful when using ARRAY JOIN and aggregation of array elements. Example

```

SELECT
 Goals.ID AS GoalID,
 sum(Sign) AS Reaches,
 sumIf(Sign, num = 1) AS Visits
FROM test.visits
ARRAY JOIN
 Goals,
 arrayEnumerateUniq(Goals.ID) AS num
WHERE CounterID = 160656
GROUP BY GoalID
ORDER BY Reaches DESC
LIMIT 10

```

GoalID	Reaches	Visits
53225	3214	1097
2825062	3188	1097
56600	2803	488
1989037	2401	365
2830064	2396	910
1113562	2372	373
3270895	2262	812
1084657	2262	345
56599	2260	799
3271094	2256	812

In this example, each goal ID has a calculation of the number of conversions (each element in the Goals nested data structure is a goal that was reached, which we refer to as a conversion) and the number of sessions. Without ARRAY JOIN, we would have counted the number of sessions as sum(Sign). But in this particular case, the rows were multiplied by the nested Goals structure, so in order to count each session one time after this, we apply a condition to the value of .the arrayEnumerateUniq(Goals.ID) function

The arrayEnumerateUniq function can take multiple arrays of the same size as arguments. In this case, uniqueness is .considered for tuples of elements in the same positions in all the arrays

```

SELECT arrayEnumerateUniq([1, 1, 1, 2, 2, 2], [1, 1, 2, 1, 1, 2]) AS res

```

res
[1,2,1,1,2,1]

This is necessary when using ARRAY JOIN with a nested data structure and further aggregation across multiple elements .in this structure

## arrayPopBack

.Removes the last item from the array

```
arrayPopBack(array)
```

Parameters

. array – Array •

Example

```
SELECT arrayPopBack([1, 2, 3]) AS res
```

```
res
[1,2]
```

## arrayPopFront

.Removes the first item from the array

```
arrayPopFront(array)
```

Parameters

. array – Array •

Example

```
SELECT arrayPopFront([1, 2, 3]) AS res
```

```
res
[2,3]
```

## arrayPushBack

.Adds one item to the end of the array

```
arrayPushBack(array, single_value)
```

Parameters

. array – Array •

single\_value – A single value. Only numbers can be added to an array with numbers, and only strings can be added to • an array of strings. When adding numbers, ClickHouse automatically sets the single\_value type for the data type of the array. For more information about the types of data in ClickHouse, see "Data types". Can be NULL . The function .adds a NULL element to an array, and the type of array elements converts to Nullable

Example

```
SELECT arrayPushBack(['a'], 'b') AS res
```

```
res
['a', 'b']
```

## arrayPushFront

.Adds one element to the beginning of the array

```
arrayPushFront(array, single_value)
```

### Parameters

.array — Array •  
single\_value — A single value. Only numbers can be added to an array with numbers, and only strings can be added to an array of strings. When adding numbers, ClickHouse automatically sets the single\_value type for the data type of the array. For more information about the types of data in ClickHouse, see "[Data types](#)". Can be NULL. The function .adds a NULL element to an array, and the type of array elements converts to Nullable

### Example

```
SELECT arrayPushFront(['b'], 'a') AS res
```

```
res
['a', 'b']
```

## arrayResize

.Changes the length of the array

```
arrayResize(array, size[, extender])
```

### :Parameters

.array — Array •  
.size — Required length of the array •  
.If size is less than the original size of the array, the array is truncated from the right •  
If size is larger than the initial size of the array, the array is extended to the right with extender values or default values for the data type of the array items  
.extender — Value for extending an array. Can be NULL •

### :Returned value

.An array of length size

### Examples of calls

```
SELECT arrayResize([1], 3)
```

```
arrayResize([1], 3)
[1,0,0]
```

```
SELECT arrayResize([1], 3, NULL)
```

```
arrayResize([1], 3, NULL)
[1,NULL,NULL]
```

## arraySlice

.Returns a slice of the array

```
arraySlice(array, offset[, length])
```

### Parameters

• . array – Array of data •

• offset – Indent from the edge of the array. A positive value indicates an offset on the left, and a negative value is an .indent on the right. Numbering of the array items begins with 1

• length - The length of the required slice. If you specify a negative value, the function returns an open slice[offset, . [array\_length - length] . If you omit the value, the function returns the slice[offset, the\_end\_of\_array

### Example

```
SELECT arraySlice([1, 2, NULL, 4, 5], 2, 3) AS res
```

```
res
[2,NULL,4]
```

.Array elements set to NULL are handled as normal values

(... ,arraySort([func,] arr

Sorts the elements of the arr array in ascending order. If the func function is specified, sorting order is determined by the result of the func function applied to the elements of the array. If func accepts multiple arguments, the arraySort function is passed several arrays that the arguments of func will correspond to. Detailed examples are shown at the end of . arraySort description

:Example of integer values sorting

```
SELECT arraySort([1, 3, 3, 0]);
```

```
arraySort([1, 3, 3, 0])
[0,1,3,3]
```

:Example of string values sorting

```
SELECT arraySort(['hello', 'world', '!']);
```

```
arraySort(['hello', 'world', '!'])
['!', 'hello', 'world']
```

:Consider the following sorting order for the `NULL` , `NaN` and `Inf` values

```
SELECT arraySort([1, nan, 2, NULL, 3, nan, -4, NULL, inf, -inf]);
```

```
arraySort([1, nan, 2, NULL, 3, nan, -4, NULL, inf, -inf])
[-inf, -4, 1, 2, 3, inf, nan, nan, NULL, NULL]
```

- `Inf` values are first in the array
- `NULL` values are last in the array
- `NaN` values are right before `NULL`
- `Inf` values are right before `NaN`

Note that `arraySort` is a **higher-order function**. You can pass a lambda function to it as the first argument. In this case, .sorting order is determined by the result of the lambda function applied to the elements of the array

:Let's consider the following example

```
SELECT arraySort((x) -> -x, [1, 2, 3]) as res;
```

```
res
[3, 2, 1]
```

For each element of the source array, the lambda function returns the sorting key, that is,  $[1 \rightarrow -1, 2 \rightarrow -2, 3 \rightarrow -3]$ . Since the `arraySort` function sorts the keys in ascending order, the result is  $[3, 2, 1]$ . Thus, the  $(x) \rightarrow -x$  lambda function sets the **descending order** in a sorting

The lambda function can accept multiple arguments. In this case, you need to pass the `arraySort` function several arrays of identical length that the arguments of lambda function will correspond to. The resulting array will consist of elements .from the first input array; elements from the next input array(s) specify the sorting keys. For example

```
SELECT arraySort((x, y) -> y, ['hello', 'world'], [2, 1]) as res;
```

```
res
['world', 'hello']
```

Here, the elements that are passed in the second array ( $[2, 1]$ ) define a sorting key for the corresponding element from the source array ( $['hello', 'world']$ ), that is,  $['hello' \rightarrow 2, 'world' \rightarrow 1]$ . Since the lambda function doesn't use `x`, actual values of the source array don't affect the order in the result. So, 'hello' will be the second element in the result, and 'world' will be .the first

.Other examples are shown below

```
SELECT arraySort((x, y) -> y, [0, 1, 2], ['c', 'b', 'a']) as res;
```

```
res
[2, 1, 0]
```

```
SELECT arraySort((x, y) -> -y, [0, 1, 2], [1, 2, 3]) as res;
```

```
res
[2,1,0]
```

### Note

To improve sorting efficiency, the **Schwartzian transform** is used

(... ,arrayReverseSort([func,] arr

Sorts the elements of the `arr` array in descending order. If the `func` function is specified, `arr` is sorted according to the result of the `func` function applied to the elements of the array, and then the sorted array is reversed. If `func` accepts multiple arguments, the `arrayReverseSort` function is passed several arrays that the arguments of `func` will correspond to.  
Detailed examples are shown at the end of `arrayReverseSort` description

:Example of integer values sorting

```
SELECT arrayReverseSort([1, 3, 3, 0]);
```

```
arrayReverseSort([1, 3, 3, 0])
[3,3,1,0]
```

:Example of string values sorting

```
SELECT arrayReverseSort(['hello', 'world', '!']);
```

```
arrayReverseSort(['hello', 'world', '!'])
['world','hello','!']
```

:Consider the following sorting order for the `NULL` , `NaN` and `Inf` values

```
SELECT arrayReverseSort([1, nan, 2, NULL, 3, nan, -4, NULL, inf, -inf]) as res;
```

```
res
[inf,3,2,1,-4,-inf,nan,nan,NULL,NULL]
```

- . `Inf` values are first in the array •
- . `NULL` values are last in the array •
- . `NaN` values are right before `NULL` •
- . `Inf` values are right before `NaN` - •

Note that the `arrayReverseSort` is a **higher-order function**. You can pass a lambda function to it as the first argument.  
.Example is shown below

```
SELECT arrayReverseSort((x) -> -x, [1, 2, 3]) as res;
```

```
res
[1, 2, 3]
```

:The array is sorted in the following way

At first, the source array ([1, 2, 3]) is sorted according to the result of the lambda function applied to the elements of .1  
.the array. The result is an array [3, 2, 1]

.[Array that is obtained on the previous step, is reversed. So, the final result is [1, 2, 3] .2

The lambda function can accept multiple arguments. In this case, you need to pass the arrayReverseSort function several arrays of identical length that the arguments of lambda function will correspond to. The resulting array will consist of :elements from the first input array; elements from the next input array(s) specify the sorting keys. For example

```
SELECT arrayReverseSort((x, y) -> y, ['hello', 'world'], [2, 1]) AS res;
```

```
res
['hello', 'world']
```

:In this example, the array is sorted in the following way

At first, the source array ('hello', 'world') is sorted according to the result of the lambda function applied to the .1  
elements of the arrays. The elements that are passed in the second array ([2, 1]), define the sorting keys for

.['corresponding elements from the source array. The result is an array ['world', 'hello

.[Array that was sorted on the previous step, is reversed. So, the final result is ['hello', 'world'] .2

.Other examples are shown below

```
SELECT arrayReverseSort((x, y) -> y, [4, 3, 5], ['a', 'b', 'c']) AS res;
```

```
res
[5, 3, 4]
```

```
SELECT arrayReverseSort((x, y) -> -y, [4, 3, 5], [1, 2, 3]) AS res;
```

```
res
[4, 3, 5]
```

(... ,arrayUniq(arr

If one argument is passed, it counts the number of different elements in the array. If multiple arguments are passed, it .counts the number of different tuples of elements at corresponding positions in multiple arrays

.(If you want to get a list of unique items in an array, you can use arrayReduce('groupUniqArray', arr

(arrayJoin(arr

."A special function. See the section "["ArrayJoin function](#)

(arrayDifference(arr

Takes an array, returns an array of differences between adjacent elements. The first element will be 0, the second is the difference between the second and first elements of the original array, etc. The type of elements in the resulting array is determined by the type inference rules for subtraction (e.g. UInt8 - UInt8 = Int16). UInt/Int/Float\* types are supported (type .(Decimal is not supported

:Example

```
SELECT arrayDifference([1, 2, 3, 4])
```

```
arrayDifference([1, 2, 3, 4])
| [0,1,1,1]
```

:Example of the overflow due to result type Int64

```
SELECT arrayDifference([0, 10000000000000000000])
```

```
arrayDifference([0, 10000000000000000000])
| [0,-8446744073709551616]
```

(arrayDistinct(arr

.Takes an array, returns an array containing the distinct elements

:Example

```
SELECT arrayDistinct([1, 2, 2, 3, 1])
```

```
arrayDistinct([1, 2, 2, 3, 1])
| [1,2,3]
```

(arrayEnumerateDense(arr

.Returns an array of the same size as the source array, indicating where each element first appears in the source array

:Example

```
SELECT arrayEnumerateDense([10, 20, 10, 30])
```

```
arrayEnumerateDense([10, 20, 10, 30])
| [1,2,1,3]
```

(arrayIntersect(arr

Takes multiple arrays, returns an array with elements that are present in all source arrays. Elements order in the resulting .array is the same as in the first array

:Example

```
SELECT
arrayIntersect([1, 2], [1, 3], [2, 3]) AS no_intersect,
arrayIntersect([1, 2], [1, 3], [1, 4]) AS intersect
```

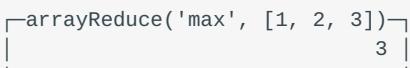


(... ,arrayReduce(agg\_func, arr1

Applies an aggregate function to array elements and returns its result. The name of the aggregation function is passed as a string in single quotes 'max' , 'sum' . When using parametric aggregate functions, the parameter is indicated after the . '(function name in parentheses 'uniqUpTo(6

:Example

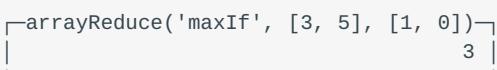
```
SELECT arrayReduce('max', [1, 2, 3])
```



.If an aggregate function takes multiple arguments, then this function must be applied to multiple arrays of the same size

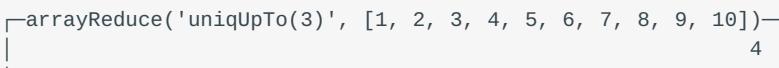
:Example

```
SELECT arrayReduce('maxIf', [3, 5], [1, 0])
```



:Example with a parametric aggregate function

```
SELECT arrayReduce('uniqUpTo(3)', [1, 2, 3, 4, 5, 6, 7, 8, 9, 10])
```



(arrayReverse(arr

.Returns an array of the same size as the original array containing the elements in reverse order

:Example

```
SELECT arrayReverse([1, 2, 3])
```



(reverse(arr

"Synonym for "arrayReverse

arrayFlatten

.Converts an array of arrays to a flat array

:Function

.Applies to any depth of nested arrays •

.Does not change arrays that are already flat •

.The flattened array contains all the elements from all source arrays

Syntax

```
flatten(array_of_arrays)
```

.Alias: flatten

Parameters

. [[ array\_of\_arrays — **Array** of arrays. For example, [[1,2,3], [4,5] •

Examples

```
SELECT flatten([[1], [2], [3]])
```

```
flatten(array(array([1]), array([2], [3])))
[1,2,3]
```

arrayCompact

Removes consecutive duplicate elements from an array. The order of result values is determined by the order in the .source array

Syntax

```
arrayCompact(arr)
```

Parameters

. arr — The **array** to inspect

Returned value

.The array without duplicate

.Type: **Array**

Example

:Query

```
SELECT arrayCompact([1, 1, nan, nan, 2, 3, 3, 3])
```

:Result

```
arrayCompact([1, 1, nan, nan, 2, 3, 3, 3])
[1,nan,nan,2,3]
```

## arrayZip

Combine multiple Array type columns into one Array[Tuple(...)] column

Syntax

```
arrayZip(arr1, arr2, ..., arrN)
```

Parameters

.arr — Any number of array type columns to combine

Returned value

The result of Array[Tuple(...)] type after the combination of these arrays

Example

:Query

```
SELECT arrayZip(['a', 'b', 'c'], ['d', 'e', 'f']);
```

:Result

```
arrayZip(['a', 'b', 'c'], ['d', 'e', 'f'])
| [('a','d'),('b','e'),('c','f')]|
```

## Functions for splitting and merging strings and arrays

(splitByChar(separator, s

Splits a string into substrings separated by 'separator'. 'separator' must be a string constant consisting of exactly one character. Returns an array of selected substrings. Empty substrings may be selected if the separator occurs at the beginning or end of the string, or if there are multiple consecutive separators

(splitByString(separator, s

.The same as above, but it uses a string of multiple characters as the separator. The string must be non-empty

([arrayStringConcat(arr[, separator

Concatenates the strings listed in the array with the separator. 'separator' is an optional parameter: a constant string, set .to an empty string by default. Returns the string

(alphaTokens(s

.Selects substrings of consecutive bytes from the ranges a-z and A-Z. Returns an array of substrings

:Example

```
SELECT alphaTokens('abca1abc')
```

```
[alphaTokens('abca1abc')]
| ['abca', 'abc']
```

## Bit functions

.Bit functions work for any pair of types from UInt8, UInt16, UInt32, UInt64, Int8, Int16, Int32, Int64, Float32, or Float64

The result type is an integer with bits equal to the maximum bits of its arguments. If at least one of the arguments is signed, the result is a signed number. If an argument is a floating-point number, it is cast to Int64

(bitAnd(a, b

(bitOr(a, b

(bitXor(a, b

(bitNot(a

(bitShiftLeft(a, b

(bitShiftRight(a, b

(bitRotateLeft(a, b

(bitRotateRight(a, b

bitTest

Takes any integer and converts it into **binary form**, returns the value of a bit at specified position. The countdown starts .from 0 from the right to the left

Syntax

```
SELECT bitTest(number, index)
```

Parameters

- . number – integer number •
- . index – position of bit •

Returned values

.Returns a value of bit at specified position

.Type: UInt8

Example

.For example, the number 43 in base-2 (binary) numeral system is 101011

:Query

```
SELECT bitTest(43, 1)
```

:Result

```
└─bitTest(43, 1)─
 1 |
```

:Another example

:Query

```
SELECT bitTest(43, 2)
```

:Result

```
└─bitTest(43, 2)─
 0 |
```

## bitTestAll

Returns result of **logical conjunction** (AND operator) of all bits at given positions. The countdown starts from 0 from the right .to the left

:The conjunction for bitwise operations

AND 0 = 0 0 AND 1 = 0 1 AND 0 = 0 1 AND 1 = 1 0

Syntax

```
SELECT bitTestAll(number, index1, index2, index3, index4, ...)
```

Parameters

. number – integer number •  
index1 , index2 , index3 , index4 – positions of bit. For example, for set of positions (index1 , index2 , index3 , index4 ) is •  
. (true if and only if all of its positions are true ( index1  $\wedge$  index2 ,  $\wedge$  index3  $\wedge$  index4

Returned values

. Returns result of logical conjunction

. Type: UInt8

Example

. For example, the number 43 in base-2 (binary) numeral system is 101011

:Query

```
SELECT bitTestAll(43, 0, 1, 3, 5)
```

:Result

```
bitTestAll(43, 0, 1, 3, 5)
 1
```

:Another example

:Query

```
SELECT bitTestAll(43, 0, 1, 3, 5, 2)
```

:Result

```
bitTestAll(43, 0, 1, 3, 5, 2)
 0
```

## bitTestAny

Returns result of **logical disjunction** (OR operator) of all bits at given positions. The countdown starts from 0 from the right .to the left

:The disjunction for bitwise operations

OR 0 = 0 0 OR 1 = 1 1 OR 0 = 1 1 OR 1 = 1 0

Syntax

```
SELECT bitTestAny(number, index1, index2, index3, index4, ...)
```

Parameters

- . number – integer number •
- . index1 , index2 , index3 , index4 – positions of bit •

Returned values

. Returns result of logical disjunction

. Type: UInt8

Example

. For example, the number 43 in base-2 (binary) numeral system is 101011

:Query

```
SELECT bitTestAny(43, 0, 2)
```

:Result

```
bitTestAny(43, 0, 2)
 1
```

:Another example

:Query

```
SELECT bitTestAny(43, 4, 2)
```

:Result

```
bitTestAny(43, 4, 2)
 0
```

## Bitmap functions

Bitmap functions work for two bitmaps Object value calculation, it is to return new bitmap or cardinality while using formula .calculation, such as and, or, xor, and not, etc

There are 2 kinds of construction methods for Bitmap Object. One is to be constructed by aggregation function groupBitmap with -State, the other is to be constructed by Array Object. It is also to convert Bitmap Object to Array .Object

RoaringBitmap is wrapped into a data structure while actual storage of Bitmap objects. When the cardinality is less than or equal to 32, it uses Set objet. When the cardinality is greater than 32, it uses RoaringBitmap object. That is why storage .of low cardinality set is faster

.For more information on RoaringBitmap, see:[CRoaring](#)

### bitmapBuild

.Build a bitmap from unsigned integer array

```
bitmapBuild(array)
```

Parameters

. array – unsigned integer array •

Example

```
SELECT bitmapBuild([1, 2, 3, 4, 5]) AS res, toTypeName(res)
```

```
res toTypeName(bitmapBuild([1, 2, 3, 4, 5]))
 | AggregateFunction(groupBitmap, UInt8) |
```

### bitmapToArray

.Convert bitmap to integer array

```
bitmapToArray(bitmap)
```

Parameters

. bitmap – bitmap object •

Example

```
SELECT bitmapToArray(bitmapBuild([1, 2, 3, 4, 5])) AS res
```

```
res
[1,2,3,4,5]
```

## bitmapSubsetInRange

.(Return subset in specified range (not include the range\_end

```
bitmapSubsetInRange(bitmap, range_start, range_end)
```

### Parameters

- . bitmap – **Bitmap object** •
- . range\_start – range start point. Type: **UInt32** •
- . range\_end – range end point(excluded). Type: **UInt32** •

### Example

```
SELECT
bitmapToArray(bitmapSubsetInRange(bitmapBuild([0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23
toUInt32(30), toUInt32(200))) AS res
```

```
res
[30,31,32,33,100]
```

## bitmapSubsetLimit

.Return subset of the smallest limit values in set which is no less than range\_start

```
bitmapSubsetLimit(bitmap, range_start, limit)
```

### Parameters

- . bitmap – **Bitmap object** •
- . range\_start – range start point. Type: **UInt32** •
- . limit – subset cardinality upper limit. Type: **UInt32** •

### Example

```
SELECT
bitmapToArray(bitmapSubsetLimit(bitmapBuild([0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,
toUInt32(30), toUInt32(200))) AS res
```

```
res
[30,31,32,33,100,200,500]
```

## bitmapContains

.Checks whether the bitmap contains an element

```
bitmapContains(haystack, needle)
```

## Parameters

- . haystack – **Bitmap object**, where the function searches •
- . needle – Value that the function searches. Type: **UInt32** •

## Returned values

- .If haystack doesn't contain needle — 0 •
  - .If haystack contains needle — 1 •
- .Type: **UInt8**

## Example

```
SELECT bitmapContains(bitmapBuild([1,5,7,9]), toUInt32(9)) AS res
```

```
res
1
```

## bitmapHasAny

.Checks whether two bitmaps have intersection by some elements

```
bitmapHasAny(bitmap1, bitmap2)
```

If you are sure that `bitmap2` contains strictly one element, consider using the **bitmapContains** function. It works more .efficiently

## Parameters

- . bitmap\* – bitmap object •

## Return values

- .if `bitmap1` and `bitmap2` have one similar element at least , 1 •
- .otherwise , 0 •

## Example

```
SELECT bitmapHasAny(bitmapBuild([1,2,3]),bitmapBuild([3,4,5])) AS res
```

```
res
1
```

## bitmapHasAll

Analogous to `hasAll(array, array)` returns 1 if the first bitmap contains all the elements of the second one, 0 otherwise. If the .second argument is an empty bitmap then returns 1

```
bitmapHasAll(bitmap,bitmap)
```

## Parameters

- . bitmap – bitmap object •

## Example

```
SELECT bitmapHasAll(bitmapBuild([1,2,3]),bitmapBuild([3,4,5])) AS res
```

```
res
0
```

## bitmapCardinality

.Retrun bitmap cardinality of type UInt64

```
bitmapCardinality(bitmap)
```

### Parameters

. bitmap – bitmap object •

## Example

```
SELECT bitmapCardinality(bitmapBuild([1, 2, 3, 4, 5])) AS res
```

```
res
5
```

## bitmapMin

.Retrun the smallest value of type UInt64 in the set, UINT32\_MAX if the set is empty

```
bitmapMin(bitmap)
```

### Parameters

. bitmap – bitmap object •

## Example

```
SELECT bitmapMin(bitmapBuild([1, 2, 3, 4, 5])) AS res
```

```
res
1
```

## bitmapMax

.Retrun the greatest value of type UInt64 in the set, 0 if the set is empty

```
bitmapMax(bitmap)
```

### Parameters

. bitmap – bitmap object •

## Example

```
SELECT bitmapMax(bitmapBuild([1, 2, 3, 4, 5])) AS res
```

```
└── res
 └── 5
```

## bitmapTransform

.Transform an array of values in a bitmap to another array of values, the result is a new bitmap

```
bitmapTransform(bitmap, from_array, to_array)
```

### Parameters

. bitmap – bitmap object •

from\_array – UInt32 array. For idx in range [0, from\_array.size()), if bitmap contains from\_array[idx], then replace it • with to\_array[idx]. Note that the result depends on array ordering if there are common elements between from\_array .and to\_array

. to\_array – UInt32 array, its size shall be the same to from\_array •

### Example

```
SELECT bitmapToArray(bitmapTransform(bitmapBuild([1, 2, 3, 4, 5, 6, 7, 8, 9, 10]), cast([5, 999, 2] as Array(UInt32)), cast([2, 888, 20] as Array(UInt32)))) AS res
```

```
└── res
 └── [1, 3, 4, 6, 7, 8, 9, 10, 20]
```

## bitmapAnd

.Two bitmap and calculation, the result is a new bitmap

```
bitmapAnd(bitmap,bitmap)
```

### Parameters

. bitmap – bitmap object •

### Example

```
SELECT bitmapToArray(bitmapAnd(bitmapBuild([1,2,3]),bitmapBuild([3,4,5]))) AS res
```

```
└── res
 └── [3]
```

## bitmapOr

.Two bitmap or calculation, the result is a new bitmap

```
bitmapOr(bitmap,bitmap)
```

### Parameters

. bitmap – bitmap object •

## Example

```
SELECT bitmapToArray(bitmapOr(bitmapBuild([1,2,3]),bitmapBuild([3,4,5]))) AS res
```

```
└── res
 └── [1,2,3,4,5]
```

## bitmapXor

.Two bitmap xor calculation, the result is a new bitmap

```
bitmapXor(bitmap,bitmap)
```

## Parameters

. bitmap – bitmap object •

## Example

```
SELECT bitmapToArray(bitmapXor(bitmapBuild([1,2,3]),bitmapBuild([3,4,5]))) AS res
```

```
└── res
 └── [1,2,4,5]
```

## bitmapAndnot

.Two bitmap andnot calculation, the result is a new bitmap

```
bitmapAndnot(bitmap,bitmap)
```

## Parameters

. bitmap – bitmap object •

## Example

```
SELECT bitmapToArray(bitmapAndnot(bitmapBuild([1,2,3]),bitmapBuild([3,4,5]))) AS res
```

```
└── res
 └── [1,2]
```

## bitmapAndCardinality

.Two bitmap and calculation, return cardinality of type UInt64

```
bitmapAndCardinality(bitmap,bitmap)
```

## Parameters

. bitmap – bitmap object •

## Example

```
SELECT bitmapAndCardinality(bitmapBuild([1,2,3]),bitmapBuild([3,4,5])) AS res;
```

```
res
1
```

## bitmapOrCardinality

.Two bitmap or calculation, return cardinality of type UInt64

```
bitmapOrCardinality(bitmap,bitmap)
```

## Parameters

. bitmap – bitmap object •

## Example

```
SELECT bitmapOrCardinality(bitmapBuild([1,2,3]),bitmapBuild([3,4,5])) AS res;
```

```
res
5
```

## bitmapXorCardinality

.Two bitmap xor calculation, return cardinality of type UInt64

```
bitmapXorCardinality(bitmap,bitmap)
```

## Parameters

. bitmap – bitmap object •

## Example

```
SELECT bitmapXorCardinality(bitmapBuild([1,2,3]),bitmapBuild([3,4,5])) AS res;
```

```
res
4
```

## bitmapAndnotCardinality

.Two bitmap andnot calculation, return cardinality of type UInt64

```
bitmapAndnotCardinality(bitmap,bitmap)
```

## Parameters

. bitmap – bitmap object •

## Example

```
SELECT bitmapAndnotCardinality(bitmapBuild([1,2,3]),bitmapBuild([3,4,5])) AS res;
```

res
2

## Hash functions

.Hash functions can be used for the deterministic pseudo-random shuffling of elements

### halfMD5

Interprets all the input parameters as strings and calculates theMD5 hash value for each of them. Then combines hashes, .takes the first 8 bytes of the hash of the resulting string, and interprets them as UInt64 in big-endian byte order

```
halfMD5(par1, ...)
```

The function is relatively slow (5 million short strings per second per processor core). Consider using thesipHash64 .function instead

Parameters

.The function takes a variable number of input parameters. Parameters can be any of thesupported data types

Returned Value

.A UInt64 data type hash value

Example

```
SELECT halfMD5(array('e','x','a'), 'mple', 10, toDateTime('2019-06-15 23:00:00')) AS halfMD5hash,
toTypeName(halfMD5hash) AS type
```

halfMD5hash	type
186182704141653334	UInt64

### MD5

Calculates the MD5 from a string and returns the resulting set of bytes as FixedString(16). If you don't need MD5 in particular, but you need a decent cryptographic 128-bit hash, use the 'sipHash128' function instead. If you want to get the .((same result as output by the md5sum utility, use lower(hex(MD5(s

### sipHash64

.Produces a 64-bit SipHash hash value

```
sipHash64(par1,...)
```

.This is a cryptographic hash function. It works at least three times faster than theMD5 function

Function interprets all the input parameters as strings and calculates the hash value for each of them. Then combines .hashes by the following algorithm

.After hashing all the input parameters, the function gets the array of hashes .1  
.Function takes the first and the second elements and calculates a hash for the array of them .2  
Then the function takes the hash value, calculated at the previous step, and the third element of the initial hash array, .3  
.and calculates a hash for the array of them .4  
.The previous step is repeated for all the remaining elements of the initial hash array .4

Parameters

.The function takes a variable number of input parameters. Parameters can be any of the[supported data types](#)

Returned Value

.A [UInt64](#) data type hash value

Example

```
SELECT sipHash64(array('e','x','a'), 'mple', 10, toDateTime('2019-06-15 23:00:00')) AS SipHash,
toTypeName(SipHash) AS type
```

SipHash	type
13726873534472839665	UInt64

sipHash128

Calculates SipHash from a string. Accepts a String-type argument. Returns FixedString(16). Differs from sipHash64 in that .the final xor-folding state is only done up to 128 bits

cityHash64

.Produces a 64-bit [CityHash](#) hash value

```
cityHash64(par1, ...)
```

This is a fast non-cryptographic hash function. It uses the CityHash algorithm for string parameters and implementation-specific fast non-cryptographic hash function for parameters with other data types. The function uses the CityHash .combinator to get the final results

Parameters

.The function takes a variable number of input parameters. Parameters can be any of the[supported data types](#)

Returned Value

.A [UInt64](#) data type hash value

Examples

:Call example

```
SELECT cityHash64(array('e','x','a'), 'mple', 10, toDateTime('2019-06-15 23:00:00')) AS CityHash,
toTypeName(CityHash) AS type
```

CityHash	type
12072650598913549138	UInt64

:The following example shows how to compute the checksum of the entire table with accuracy up to the row order

```
SELECT groupBitXor(cityHash64(*)) FROM table
```

intHash32

Calculates a 32-bit hash code from any type of integer. This is a relatively fast non-cryptographic hash function of average quality for numbers

intHash64

.Calculates a 64-bit hash code from any type of integer. It works faster than intHash32. Average quality

SHA1

SHA224

SHA256

Calculates SHA-1, SHA-224, or SHA-256 from a string and returns the resulting set of bytes as FixedString(20), FixedString(28), or FixedString(32). The function works fairly slowly (SHA-1 processes about 5 million short strings per second per processor core, while SHA-224 and SHA-256 process about 2.2 million). We recommend using this function only in cases when you need a specific hash function and you can't select it. Even in these cases, we recommend applying the function offline and pre-calculating values when inserting them into the table, instead of applying it in

.SELECTS

([URLHash(url[, N

A fast, decent-quality non-cryptographic hash function for a string obtained from a URL using some type of normalization.

URLHash(s) – Calculates a hash from a string without one of the trailing symbols /, ?, or # at the end, if present.

URLHash(s, N) – Calculates a hash from a string up to the N level in the URL hierarchy, without one of the trailing symbols . /, ?, or # at the end, if present. Levels are the same as in URLHierarchy. This function is specific to Yandex.Metrica

farmHash64

.Produces a 64-bit **FarmHash** hash value

```
farmHash64(par1, ...)
```

.The function uses the Hash64 method from all **available methods**

Parameters

.The function takes a variable number of input parameters. Parameters can be any of the **supported data types**

Returned Value

.A **UInt64** data type hash value

Example

```
SELECT farmHash64(array('e', 'x', 'a'), 'mple', 10, toDateTime('2019-06-15 23:00:00')) AS FarmHash,
toTypeName(FarmHash) AS type
```

FarmHash	type
17790458267262532859	UInt64

## javaHash

Calculates **JavaHash** from a string. This hash function is neither fast nor having a good quality. The only reason to use it is when this algorithm is already used in another system and you have to calculate exactly the same result

Syntax

```
SELECT javaHash('');
```

Returned value

.A Int32 data type hash value

Example

:Query

```
SELECT javaHash('Hello, world!');
```

:Result

javaHash('Hello, world!')	-1880044555
---------------------------	-------------

## javaHashUTF16LE

.Calculates **JavaHash** from a string, assuming it contains bytes representing a string in UTF-16LE encoding

Syntax

```
javaHashUTF16LE(stringUtf16le)
```

Parameters

. stringUtf16le — a string in UTF-16LE encoding •

Returned value

.A Int32 data type hash value

Example

.Correct query with UTF-16LE encoded string

:Query

```
SELECT javaHashUTF16LE(convertCharset('test', 'utf-8', 'utf-16le'))
```

:Result

```
└─javaHashUTF16LE(convertCharset('test', 'utf-8', 'utf-16le'))─
 3556498
```

## hiveHash

.Calculates HiveHash from a string

```
SELECT hiveHash('');
```

This is just **JavaHash** with zeroed out sign bit. This function is used in **Apache Hive** for versions before 3.0. This hash function is neither fast nor having a good quality. The only reason to use it is when this algorithm is already used in another system and you have to calculate exactly the same result

Returned value

.A Int32 data type hash value

.Type: **hiveHash**

Example

:Query

```
SELECT hiveHash('Hello, world!');
```

:Result

```
└─hiveHash('Hello, world!')─
 267439093
```

## metroHash64

.Produces a 64-bit **MetroHash** hash value

```
metroHash64(par1, ...)
```

Parameters

.The function takes a variable number of input parameters. Parameters can be any of the **supported data types**

Returned Value

.A UInt64 data type hash value

Example

```
SELECT metroHash64(array('e', 'x', 'a'), 'mple', 10, toDateTime('2019-06-15 23:00:00')) AS MetroHash,
toTypeName(MetroHash) AS type
```

```
└─MetroHash ─type ─
 14235658766382344533 | UInt64
```

## jumpConsistentHash

Calculates JumpConsistentHash form a UInt64. Accepts two arguments: a UInt64-type key and the number of buckets.  
Returns Int32. For more information, see the link: [JumpConsistentHash](#)

## murmurHash2\_32, murmurHash2\_64

.Produces a [MurmurHash2](#) hash value

```
murmurHash2_32(par1, ...)
murmurHash2_64(par1, ...)
```

### Parameters

.Both functions take a variable number of input parameters. Parameters can be any of the[supported data types](#)

### Returned Value

- .The `murmurHash2_32` function returns hash value having the [UInt32](#) data type •
- .The `murmurHash2_64` function returns hash value having the [UInt64](#) data type •

### Example

```
SELECT murmurHash2_64(array('e', 'x', 'a'), 'mple', 10, toDateTime('2019-06-15 23:00:00')) AS MurmurHash2,
toTypeName(MurmurHash2) AS type
```

MurmurHash2	type
11832096901709403633	UInt64

## murmurHash3\_32, murmurHash3\_64

.Produces a [MurmurHash3](#) hash value

```
murmurHash3_32(par1, ...)
murmurHash3_64(par1, ...)
```

### Parameters

.Both functions take a variable number of input parameters. Parameters can be any of the[supported data types](#)

### Returned Value

- .The `murmurHash3_32` function returns a [UInt32](#) data type hash value •
- .The `murmurHash3_64` function returns a [UInt64](#) data type hash value •

### Example

```
SELECT murmurHash3_32(array('e', 'x', 'a'), 'mple', 10, toDateTime('2019-06-15 23:00:00')) AS MurmurHash3,
toTypeName(MurmurHash3) AS type
```

MurmurHash3	type
2152717	UInt32

## murmurHash3\_128

.Produces a 128-bit [MurmurHash3](#) hash value

```
murmurHash3_128(expr)
```

Parameters

.expr — Expressions returning a String-type value •

Returned Value

.A FixedString(16) data type hash value

Example

```
SELECT murmurHash3_128('example_string') AS MurmurHash3, toTypeName(MurmurHash3) AS type
```

```
+-----+-----+
| MurmurHash3 | type |
+-----+-----+
| 60104"S5KT0~~q | FixedString(16) |
```

xxHash32, xxHash64

.Calculates xxHash from a string. It is proposed in two flavors, 32 and 64 bits

```
SELECT xxHash32('');
```

OR

```
SELECT xxHash64('');
```

Returned value

.A UInt32 or UInt64 data type hash value

.Type: xxHash

Example

:Query

```
SELECT xxHash32('Hello, world!');
```

:Result

```
+-----+
| xxHash32('Hello, world!') |
+-----+
| 834093149 |
```

See Also

.xxHash •

## Functions for generating pseudo-random numbers

.Non-cryptographic generators of pseudo-random numbers are used

All the functions accept zero arguments or one argument. If an argument is passed, it can be any type, and its value is not used for anything. The only purpose of this argument is to prevent common subexpression elimination, so that two different instances of the same function return different columns with different random numbers

## rand

Returns a pseudo-random UInt32 number, evenly distributed among all UInt32-type numbers. Uses a linear congruential generator.

## rand64

Returns a pseudo-random UInt64 number, evenly distributed among all UInt64-type numbers. Uses a linear congruential generator.

## randConstant

.Returns a pseudo-random UInt32 number, The value is one for different blocks

# Encoding functions

## char

Accepts multiple arguments of numeric types. Returns a string with the length as the number of passed arguments and each byte has the value of corresponding argument

## hex

Accepts arguments of types: String , unsigned integer , float , decimal , Date , or DateTime . Returns a string containing the argument's hexadecimal representation. Uses uppercase letters A-F . Does not use 0x prefixes or h suffixes. For strings, all bytes are simply encoded as two hexadecimal numbers. Numbers are converted to big endian ("human readable") format. For numbers, older zeros are trimmed, but only by entire bytes. For example, hex (1) = '01' . Date is encoded as the number of days since the beginning of the Unix epoch. DateTime is encoded as the number of seconds since the beginning of the Unix epoch. float and decimal is encoded as their hexadecimal representation in memory

## (unhex(str

Accepts a string containing any number of hexadecimal digits, and returns a string containing the corresponding bytes. Supports both uppercase and lowercase letters A-F. The number of hexadecimal digits does not have to be even. If it is odd, the last digit is interpreted as the younger half of the 00-0F byte. If the argument string contains anything other than hexadecimal digits, some implementation-defined result is returned (an exception isn't thrown). If you want to convert the result to a number, you can use the 'reverse' and 'reinterpretAsType' functions

## (UUIDStringToNum(str

Accepts a string containing 36 characters in the format 123e4567-e89b-12d3-a456-426655440000 , and returns it as a set of (bytes in a FixedString(16

## (UUIDNumToString(str

.Accepts a FixedString(16) value. Returns a string containing 36 characters in text format

## (bitmaskToList(num

Accepts an integer. Returns a string containing the list of powers of two that total the source number when summed. They

.are comma-separated without spaces in text format, in ascending order

## (bitmaskToArray(num

Accepts an integer. Returns an array of UInt64 numbers containing the list of powers of two that total the source number .when summed. Numbers in the array are in ascending order

# Functions for working with UUID

.The functions for working with UUID are listed below

## generateUUIDv4

.Generates the UUID of **version 4**

```
generateUUIDv4()
```

Returned value

.The UUID type value

Usage example

.This example demonstrates creating a table with the UUID type column and inserting a value into the table

```
CREATE TABLE t_uuid (x UUID) ENGINE=TinyLog
INSERT INTO t_uuid SELECT generateUUIDv4()
SELECT * FROM t_uuid
```

```
f4bf890f-f9dc-4332-ad5c-0c18e73f28e9
```

## (toUUID (x

.Converts String type value to UUID type

```
toUUID(String)
```

Returned value

.The UUID type value

Usage example

```
SELECT toUUID('61f0c404-5cb3-11e7-907b-a6006ad3dba0') AS uuid
```

```
61f0c404-5cb3-11e7-907b-a6006ad3dba0
```

## UUIDStringToNum

Accepts a string containing 36 characters in the format xxxxxxxx-xxxx-xxxx-xxxx-xxxxxxxxxxxx , and returns it as a set of bytes .(in a **FixedString(16)**

**UUIDStringToNum(String)**

Returned value

(**FixedString(16)**

Usage examples

```
SELECT
'612f3c40-5d3b-217e-707b-6a546a3d7b29' AS uuid,
UUIDStringToNum(uuid) AS bytes
```

uuid	bytes
612f3c40-5d3b-217e-707b-6a546a3d7b29	a/<@];!~p{jTj={}

## UUIDNumToString

.Accepts a **FixedString(16)** value, and returns a string containing 36 characters in text format

**UUIDNumToString(FixedString(16))**

Returned value

.**String**

Usage example

```
SELECT
'a/<@];!~p{jTj={}| AS bytes,
UUIDNumToString(toFixedString(bytes, 16)) AS uuid
```

bytes	uuid
a/<@];!~p{jTj={}	612f3c40-5d3b-217e-707b-6a546a3d7b29

See also

[dictGetUUID](#) •

## Functions for working with URLs

All these functions don't follow the RFC. They are maximally simplified for improved performance

### Functions that Extract Parts of a URL

.If the relevant part isn't present in a URL, an empty string is returned

**protocol**

.Extracts the protocol from a URL

...Examples of typical returned values: http, https, ftp, mailto, tel, magnet

## domain

.Extracts the hostname from a URL

```
domain(url)
```

Parameters

.url — URL. Type: **String** •

:The URL can be specified with or without a scheme. Examples

```
svn+ssh://some.svn-hosting.com:80/repo/trunk
some.svn-hosting.com:80/repo/trunk
https://yandex.com/time/
```

:For these examples, the `domain` function returns the following results

```
some.svn-hosting.com
some.svn-hosting.com
yandex.com
```

Returned values

.Host name. If ClickHouse can parse the input string as a URL •

.Empty string. If ClickHouse can't parse the input string as a URL •

.Type: **String**

Example

```
SELECT domain('svn+ssh://some.svn-hosting.com:80/repo/trunk')
```

```
└─domain('svn+ssh://some.svn-hosting.com:80/repo/trunk')─
| some.svn-hosting.com
```

## domainWithoutWWW

.Returns the domain and removes no more than one 'www.' from the beginning of it, if present

## topLevelDomain

.Extracts the the top-level domain from a URL

```
topLevelDomain(url)
```

Parameters

.url — URL. Type: **String** •

:The URL can be specified with or without a scheme. Examples

```
svn+ssh://some.svn-hosting.com:80/repo/trunk
some.svn-hosting.com:80/repo/trunk
https://yandex.com/time/
```

Returned values

- .Domain name. If ClickHouse can parse the input string as a URL
- .Empty string. If ClickHouse cannot parse the input string as a URL

.Type: String

Example

```
SELECT topLevelDomain('svn+ssh://www.some.svn-hosting.com:80/repo/trunk')
```

```
└─topLevelDomain('svn+ssh://www.some.svn-hosting.com:80/repo/trunk')─
 └─com
```

### **firstSignificantSubdomain**

Returns the "first significant subdomain". This is a non-standard concept specific to Yandex.Metrica. The first significant subdomain is a second-level domain if it is 'com', 'net', 'org', or 'co'. Otherwise, it is a third-level domain. For example, `firstSignificantSubdomain ('https://news.yandex.ru/')` = 'yandex', `firstSignificantSubdomain ('https://news.yandex.com.tr/')` = 'yandex'. The list of "insignificant" second-level domains and other implementation details may change in the future

### **cutToFirstSignificantSubdomain**

Returns the part of the domain that includes top-level subdomains up to the "first significant subdomain" (see the .(explanation above

. 'For example, `cutToFirstSignificantSubdomain('https://news.yandex.com.tr/')` = 'yandex.com.tr

### **path**

.Returns the path. Example: /top/news.html The path does not include the query string

### **pathFull**

The same as above, but including query string and fragment. Example: /top/news.html?page=2#comments

### **queryString**

Returns the query string. Example: page=1&lr=213. query-string does not include the initial question mark, as well as # .# and everything after

### **fragment**

.Returns the fragment identifier. fragment does not include the initial hash symbol

### **queryStringAndFragment**

.Returns the query string and fragment identifier. Example: page=1#29390

### **(extractURLParameter(URL, name**

Returns the value of the 'name' parameter in the URL, if present. Otherwise, an empty string. If there are many parameters with this name, it returns the first occurrence. This function works under the assumption that the parameter .name is encoded in the URL exactly the same way as in the passed argument

### **(extractURLParameters(URL**

.Returns an array of name=value strings corresponding to the URL parameters. The values are not decoded in any way

### **(extractURLParameterNames(URL**

Returns an array of name strings corresponding to the names of URL parameters. The values are not decoded in any way

### (URLHierarchy(URL

Returns an array containing the URL, truncated at the end by the symbols /,? in the path and query-string. Consecutive separator characters are counted as one. The cut is made in the position after all the consecutive separator characters

### (URLPathHierarchy(URL

The same as above, but without the protocol and host in the result. The / element (root) is not included. Example: the .function is used to implement tree reports the URL in Yandex. Metric

```
URLPathHierarchy('https://example.com/browse/CONV-6788') =
[
 '/browse/',
 '/browse/CONV-6788'
]
```

### (decodeURLComponent(URL

:Returns the decoded URL. Example

```
SELECT decodeURLComponent('http://127.0.0.1:8123/?query=SELECT%201%3B') AS DecodedURL;
```

```
DecodedURL———
http://127.0.0.1:8123/?query=SELECT 1;
```

## .Functions that remove part of a URL

.If the URL doesn't have anything similar, the URL remains unchanged

### cutWWW

.Removes no more than one 'www.' from the beginning of the URL's domain, if present

### cutQueryString

.Removes query string. The question mark is also removed

### cutFragment

.Removes the fragment identifier. The number sign is also removed

### cutQueryStringAndFragment

.Removes the query string and fragment identifier. The question mark and number sign are also removed

### (cutURLParameter(URL, name

Removes the 'name' URL parameter, if present. This function works under the assumption that the parameter name is encoded in the URL exactly the same way as in the passed argument

## Functions for working with IP addresses

### (IPv4NumToString(num

Takes a UInt32 number. Interprets it as an IPv4 address in big endian. Returns a string containing the corresponding IPv4 .(address in the format A.B.C.d (dot-separated numbers in decimal form

### (IPv4StringToNum(s

.The reverse function of IPv4NumToString. If the IPv4 address has an invalid format, it returns 0

### (IPv4NumToStringClassC(num

.Similar to IPv4NumToString, but using xxx instead of the last octet

:Example

```
SELECT
 IPv4NumToStringClassC(ClientIP) AS k,
 count() AS c
FROM test.hits
GROUP BY k
ORDER BY c DESC
LIMIT 10
```

k	c
83.149.9.xxx	26238
217.118.81.xxx	26074
213.87.129.xxx	25481
83.149.8.xxx	24984
217.118.83.xxx	22797
78.25.120.xxx	22354
213.87.131.xxx	21285
78.25.121.xxx	20887
188.162.65.xxx	19694
83.149.48.xxx	17406

Since using 'xxx' is highly unusual, this may be changed in the future. We recommend that you don't rely on the exact .format of this fragment

### (IPv6NumToString(x

Accepts a FixedString(16) value containing the IPv6 address in binary format. Returns a string containing this address in :text format. IPv6-mapped IPv4 addresses are output in the format ::ffff:111.222.33.44. Examples

```
SELECT IPv6NumToString(toFixedString(unhex('2A0206B800000000000000000000000011'), 16)) AS addr
```

```
addr
2a02:6b8::11
```

```
SELECT
 IPv6NumToString(ClientIP6 AS k),
 count() AS c
FROM hits_all
WHERE EventDate = today() AND substring(ClientIP6, 1, 12) != unhex('0000000000000000FFFF')
GROUP BY k
ORDER BY c DESC
LIMIT 10
```

IPv6ToString(ClientIP6)	c
2a02:2168:aaa:bbbb::2	24695
2a02:2698:abcd:abcd:abcd:8888:5555	22408
2a02:6b8:0:ffff::ff	16389
2a01:4f8:111:6666::2	16016
2a02:2168:888:222::1	15896
2a01:7e00::ffff:ffff:ffff:222	14774
2a02:8109:eee:ee:eeee:eeee:eeee:eeee	14443
2a02:810b:8888:888:8888:8888:8888:8888	14345
2a02:6b8:0:444:4444:4444:4444:4444	14279
2a01:7e00::ffff:ffff:ffff:ffff	13880

```

SELECT
 IPv6ToString(ClientIP6 AS k),
 count() AS c
FROM hits_all
WHERE EventDate = today()
GROUP BY k
ORDER BY c DESC
LIMIT 10

```

IPv6ToString(ClientIP6)	c
::ffff:94.26.111.111	747440
::ffff:37.143.222.4	529483
::ffff:5.166.111.99	317707
::ffff:46.38.11.77	263086
::ffff:79.105.111.111	186611
::ffff:93.92.111.88	176773
::ffff:84.53.111.33	158709
::ffff:217.118.11.22	154004
::ffff:217.118.11.33	148449
::ffff:217.118.11.44	148243

## (IPv6StringToNum(s

The reverse function of IPv6NumToString. If the IPv6 address has an invalid format, it returns a string of null bytes. HEX .can be uppercase or lowercase

## (IPv4ToIPv6(x

Takes a UInt32 number. Interprets it as an IPv4 address in**big endian**. Returns a FixedString(16) value containing the IPv6 :address in binary format. Examples

```
SELECT IPv6ToString(IPv4ToIPv6(IPv4StringToNum('192.168.0.1'))) AS addr
```

addr
::ffff:192.168.0.1

## (cutIPv6(x, bitsToCutForIPv6, bitsToCutForIPv4

Accepts a FixedString(16) value containing the IPv6 address in binary format. Returns a string containing the address of :the specified number of bits removed in text format. For example

```

WITH
 IPv6StringToNum('2001:0DB8:AC10:FE01:FEED:BABE:CAFE:F00D') AS ipv6,
 IPv4ToIPv6(IPv4StringToNum('192.168.0.1')) AS ipv4
SELECT
 cutIPv6(ipv6, 2, 0),
 cutIPv6(ipv4, 0, 2)

```

cutIPv6(ipv6, 2, 0)	cutIPv6(ipv4, 0, 2)
2001:db8:ac10:fe01:feed:babe:cafe:0	::ffff:192.168.0.0

,(IPv4CIDRToRange(ipv4, cidr

Accepts an IPv4 and an UInt8 value containing the **CIDR**. Return a tuple with two IPv4 containing the lower range and the .higher range of the subnet

```
SELECT IPv4CIDRToRange(toIPv4('192.168.5.2'), 16)
```

IPv4CIDRToRange(toIPv4('192.168.5.2'), 16)
('192.168.0.0', '192.168.255.255')

,(IPv6CIDRToRange(ipv6, cidr

Accepts an IPv6 and an UInt8 value containing the CIDR. Return a tuple with two IPv6 containing the lower range and the .higher range of the subnet

```
SELECT IPv6CIDRToRange(toIPv6('2001:0db8:0000:85a3:0000:0000:ac1f:8001'), 32);
```

IPv6CIDRToRange(toIPv6('2001:0db8:0000:85a3:0000:0000:ac1f:8001'), 32)
('2001:db8::', '2001:db8:ffff:ffff:ffff:ffff:ffff:ffff')

(toIPv4(string

An alias to `IPv4StringToNum()` that takes a string form of IPv4 address and returns value of **IPv4** type, which is binary equal .()to value returned by `IPv4StringToNum`

```

WITH
 '171.225.130.45' as IPv4_string
SELECT
 toTypeName(IPv4StringToNum(IPv4_string)),
 toTypeName(toIPv4(IPv4_string))

```

toTypeName(IPv4StringToNum(IPv4_string))	toTypeName(toIPv4(IPv4_string))
UInt32	IPv4

```

WITH
 '171.225.130.45' as IPv4_string
SELECT
 hex(IPv4StringToNum(IPv4_string)),
 hex(toIPv4(IPv4_string))

```

```

└─hex(IPv4StringToNum(IPv4_string)) ── hex(toIPv4(IPv4_string)) ─
 | ABE1822D | ABE1822D

```

(toIPv6(string

An alias to `IPv6StringToNum()` that takes a string form of IPv6 address and returns value of `IPv6` type, which is binary equal  
.(to value returned by `IPv6StringToNum`

```

WITH
 '2001:438:ffff::407d:1bc1' as IPv6_string
SELECT
 typeName(IPv6StringToNum(IPv6_string)),
 typeName(toIPv6(IPv6_string))

```

```

└─typeName(IPv6StringToNum(IPv6_string)) ── typeName(toIPv6(IPv6_string)) ─
 | FixedString(16) | IPv6

```

```

WITH
 '2001:438:ffff::407d:1bc1' as IPv6_string
SELECT
 hex(IPv6StringToNum(IPv6_string)),
 hex(toIPv6(IPv6_string))

```

```

└─hex(IPv6StringToNum(IPv6_string)) ── hex(toIPv6(IPv6_string)) ───────────
 | 20010438FFFF000000000000407D1BC1 | 20010438FFFF000000000000407D1BC1

```

## Functions for working with JSON

In Yandex.Metrica, JSON is transmitted by users as session parameters. There are some special functions for working with this JSON. (Although in most of the cases, the JSONs are additionally pre-processed, and the resulting values are put in separate columns in their processed format.) All these functions are based on strong assumptions about what the .JSON can be, but they try to do as little as possible to get the job done

:The following assumptions are made

.The field name (function argument) must be a constant .1

The field name is somehow canonically encoded in JSON. For example: `visitParamHas('{"abc":"def"}', 'abc')` = 1 , but .2  
`visitParamHas('"\u0061\u0062\u0063":"def"', 'abc')` = 0

Fields are searched for on any nesting level, indiscriminately. If there are multiple matching fields, the first occurrence .3  
.is used

.The JSON doesn't have space characters outside of string literals .4

(`visitParamHas(params, name`

.Checks whether there is a field with the 'name' name

(`visitParamExtractUInt(params, name`

Parses UInt64 from the value of the field named 'name'. If this is a string field, it tries to parse a number from the .beginning of the string. If the field doesn't exist, or it exists but doesn't contain a number, it returns 0

(visitParamExtractInt(params, name

.The same as for Int64

(visitParamExtractFloat(params, name

.The same as for Float64

(visitParamExtractBool(params, name

.Parses a true/false value. The result is UInt8

(visitParamExtractRaw(params, name

.Returns the value of a field, including separators

:Examples

```
visitParamExtractRaw('{"abc": "\n\u0000"}', 'abc') = '\n\u0000'
visitParamExtractRaw('{"abc": {"def": [1, 2, 3]}}', 'abc') = '{"def": [1, 2, 3]}'
```

(visitParamExtractString(params, name

.Parses the string in double quotes. The value is unescaped. If unescaping failed, it returns an empty string

:Examples

```
visitParamExtractString('{"abc": "\n\u0000"}', 'abc') = '\n\u0000'
visitParamExtractString('{"abc": "\u263a"}', 'abc') = '@'
visitParamExtractString('{"abc": "\u2633"}', 'abc') = ''
visitParamExtractString('{"abc": "hello"}', 'abc') = ''
```

There is currently no support for code points in the format \uXXXX\uYYYY that are not from the basic multilingual plane  
.((they are converted to CESU-8 instead of UTF-8

The following functions are based on **simdjson** designed for more complex JSON parsing requirements. The assumption 2  
.mentioned above still applies

(isValidJSON(json

.Checks that passed string is a valid json

:Examples

```
SELECT isValidJSON('{"a": "hello", "b": [-100, 200.0, 300]}') = 1
SELECT isValidJSON('not a json') = 0
```

(...[JSONHas(json[, indices\_or\_keys

.If the value exists in the JSON document, 1 will be returned

.If the value does not exist, 0 will be returned

:Examples

```
SELECT JSONHas('{"a": "hello", "b": [-100, 200.0, 300]}', 'b') = 1
SELECT JSONHas('{"a": "hello", "b": [-100, 200.0, 300]}', 'b', 4) = 0
```

.`indices_or_keys` is a list of zero or more arguments each of them can be either string or integer

.String = access object member by key •

.Positive integer = access the n-th member/key from the beginning •

.Negative integer = access the n-th member/key from the end •

.Minimum index of the element is 1. Thus the element 0 doesn't exist

.You may use integers to access both JSON arrays and JSON objects

:So, for example

```
SELECT JSONExtractKey('{"a": "hello", "b": [-100, 200.0, 300]}', 1) = 'a'
SELECT JSONExtractKey('{"a": "hello", "b": [-100, 200.0, 300]}', 2) = 'b'
SELECT JSONExtractKey('{"a": "hello", "b": [-100, 200.0, 300]}', -1) = 'b'
SELECT JSONExtractKey('{"a": "hello", "b": [-100, 200.0, 300]}', -2) = 'a'
SELECT JSONExtractString('{"a": "hello", "b": [-100, 200.0, 300]}', 1) = 'hello'
```

(...[JSONLength(json[, `indices_or_keys`]

.Return the length of a JSON array or a JSON object

.If the value does not exist or has a wrong type, 0 will be returned

:Examples

```
SELECT JSONLength('{"a": "hello", "b": [-100, 200.0, 300]}', 'b') = 3
SELECT JSONLength('{"a": "hello", "b": [-100, 200.0, 300]}') = 2
```

(...[JSONType(json[, `indices_or_keys`]

.Return the type of a JSON value

.If the value does not exist, Null will be returned

:Examples

```
SELECT JSONType('{"a": "hello", "b": [-100, 200.0, 300]}') = 'Object'
SELECT JSONType('{"a": "hello", "b": [-100, 200.0, 300]}', 'a') = 'String'
SELECT JSONType('{"a": "hello", "b": [-100, 200.0, 300]}', 'b') = 'Array'
```

(...[JSONExtractUInt(json[, `indices_or_keys`]

(...[JSONExtractInt(json[, `indices_or_keys`]

(...[JSONExtractFloat(json[, `indices_or_keys`]

(...[JSONExtractBool(json[, `indices_or_keys`]

.Parses a JSON and extract a value. These functions are similar to visitParam functions

.If the value does not exist or has a wrong type, 0 will be returned

:Examples

```
SELECT JSONExtractInt('{"a": "hello", "b": [-100, 200.0, 300]}', 'b', 1) = -100
SELECT JSONExtractFloat('{"a": "hello", "b": [-100, 200.0, 300]}', 'b', 2) = 200.0
SELECT JSONExtractUInt('{"a": "hello", "b": [-100, 200.0, 300]}', 'b', -1) = 300
```

### (...[JSONExtractString(json[, indices\_or\_keys])]

.Parses a JSON and extract a string. This function is similar to `visitParamExtractString` functions

.If the value does not exist or has a wrong type, an empty string will be returned

.The value is unescaped. If unescaping failed, it returns an empty string

:Examples

```
SELECT JSONExtractString('{"a": "hello", "b": [-100, 200.0, 300]}', 'a') = 'hello'
SELECT JSONExtractString('{"abc": "\n\u0000"}', 'abc') = '\n\0'
SELECT JSONExtractString('{"abc": "\u263a"}', 'abc') = '@'
SELECT JSONExtractString('{"abc": "\u263"}', 'abc') = ''
SELECT JSONExtractString('{"abc": "hello"}', 'abc') = ''
```

### (JSONExtract(json[, indices\_or\_keys...], return\_type)

.Parses a JSON and extract a value of the given ClickHouse data type

This is a generalization of the previous `JSONExtract<type>` functions. This means `JSONExtract(..., 'String')` returns exactly  
. ()the same as `JSONExtractString()`, `JSONExtract(..., 'Float64')` returns exactly the same as `JSONExtractFloat`

:Examples

```
SELECT JSONExtract('{"a": "hello", "b": [-100, 200.0, 300]}', 'Tuple(String, Array(Float64))') = ('hello', [-100, 200, 300])
SELECT JSONExtract('{"a": "hello", "b": [-100, 200.0, 300]}', 'Tuple(b Array(Float64), a String)') =([-100, 200, 300], 'hello')
SELECT JSONExtract('{"a": "hello", "b": [-100, 200.0, 300]}', 'b', 'Array(Nullable(Int8))') = [-100, NULL, NULL]
SELECT JSONExtract('{"a": "hello", "b": [-100, 200.0, 300]}', 'b', 4, 'Nullable(Int64)') = NULL
SELECT JSONExtract('{"passed": true}', 'passed', 'UInt8') = 1
SELECT JSONExtract('{"day": "Thursday"}', 'day', 'Enum8(\n'Sunday'\n = 0, \n'Monday'\n = 1, \n'Tuesday'\n = 2,\n'Wednesday'\n = 3, \n'Thursday'\n = 4, \n'Friday'\n = 5, \n'Saturday'\n = 6)') = 'Thursday'
SELECT JSONExtract('{"day": 5}', 'day', 'Enum8(\n'Sunday'\n = 0, \n'Monday'\n = 1, \n'Tuesday'\n = 2,\n'Wednesday'\n = 3, \n'Thursday'\n = 4, \n'Friday'\n = 5, \n'Saturday'\n = 6)') = 'Friday'
```

### (JSONExtractKeysAndValues(json[, indices\_or\_keys...], value\_type)

.Parse key-value pairs from a JSON where the values are of the given ClickHouse data type

:Example

```
SELECT JSONExtractKeysAndValues('{"x": {"a": 5, "b": 7, "c": 11}}', 'x', 'Int8') = [('a', 5), ('b', 7), ('c', 11)];
```

### (...[JSONExtractRaw(json[, indices\_or\_keys])]

.Returns a part of JSON

.If the part does not exist or has a wrong type, an empty string will be returned

:Example

```
SELECT JSONExtractRaw('{"a": "hello", "b": [-100, 200.0, 300]}', 'b') = '[-100, 200.0, 300]'
```

(...[JSONExtractArrayRaw(json[, indices\_or\_keys

.Returns an array with elements of JSON array, each represented as unparsed string

.If the part does not exist or isn't array, an empty array will be returned

:Example

```
SELECT JSONExtractArrayRaw('{"a": "hello", "b": [-100, 200.0, "hello"]}', 'b') = ['-100', '200.0',
'"hello"]'
```

## Higher-order functions

operator, lambda(params, expr) function <-

Allows describing a lambda function for passing to a higher-order function. The left side of the arrow has a formal parameter, which is any ID, or multiple formal parameters – any IDs in a tuple. The right side of the arrow has an expression that can use these formal parameters, as well as any table columns

.Examples: `x -> 2 * x`, `str -> str != Referer`

.Higher-order functions can only accept lambda functions as their functional argument

A lambda function that accepts multiple arguments can be passed to a higher-order function. In this case, the higher-order function is passed several arrays of identical length that these arguments will correspond to

For some functions, such as `arrayCount` or `arraySum`, the first argument (the lambda function) can be omitted. In this case, identical mapping is assumed

:A lambda function can't be omitted for the following functions

`arrayMap` •

`arrayFilter` •

`arrayFill` •

`arrayReverseFill` •

`arraySplit` •

`arrayReverseSplit` •

`arrayFirst` •

`arrayFirstIndex` •

(..., `arrayMap(func, arr`

.Returns an array obtained from the original application of the `func` function to each element in the `arr` array

:Examples

```
SELECT arrayMap(x -> (x + 2), [1, 2, 3]) as res;
```

```
res
[3,4,5]
```

:The following example shows how to create a tuple of elements from different arrays

```
SELECT arrayMap((x, y) -> (x, y), [1, 2, 3], [4, 5, 6]) AS res
```

```
res
[(1,4),(2,5),(3,6)]
```

.Note that the first argument (lambda function) can't be omitted in the `arrayMap` function

(... ,`arrayFilter(func, arr1`

.Returns an array containing only the elements in `arr1` for which `func` returns something other than 0

:Examples

```
SELECT arrayFilter(x -> x LIKE '%World%', ['Hello', 'abc World']) AS res
```

```
res
['abc World']
```

```
SELECT
arrayFilter(
 (i, x) -> x LIKE '%World%',
 arrayEnumerate(arr),
 ['Hello', 'abc World'] AS arr)
AS res
```

```
res
[2]
```

.Note that the first argument (lambda function) can't be omitted in the `arrayFilter` function

(... ,`arrayFill(func, arr1`

Scan through `arr1` from the first element to the last element and replace `arr1[i]` by `arr1[i - 1]` if `func` returns 0. The first .element of `arr1` will not be replaced

:Examples

```
SELECT arrayFill(x -> notisNull(x), [1, null, 3, 11, 12, null, null, 5, 6, 14, null, null]) AS res
```

```
res
[1,1,3,11,12,12,12,5,6,14,14,14]
```

.Note that the first argument (lambda function) can't be omitted in the `arrayFill` function

(... ,`arrayReverseFill(func, arr1`

Scan through `arr1` from the last element to the first element and replace `arr1[i]` by `arr1[i + 1]` if `func` returns 0. The last .element of `arr1` will not be replaced

:Examples

```
SELECT arrayReverseFill(x -> notisNull(x), [1, null, 3, 11, 12, null, null, 5, 6, 14, null, null]) AS res
```

```
res
[1,3,3,11,12,5,5,5,6,14,NULL,NULL]
```

.Note that the first argument (lambda function) can't be omitted in the `arrayReverseFill` function

(... ,**arraySplit(func, arr1**

Split `arr1` into multiple arrays. When `func` returns something other than 0, the array will be split on the left hand side of .the element. The array will not be split before the first element

:Examples

```
SELECT arraySplit((x, y) -> y, [1, 2, 3, 4, 5], [1, 0, 0, 1, 0]) AS res
```

```
res
[[1,2,3],[4,5]]
```

.Note that the first argument (lambda function) can't be omitted in the `arraySplit` function

(... ,**arrayReverseSplit(func, arr1**

Split `arr1` into multiple arrays. When `func` returns something other than 0, the array will be split on the right hand side of .the element. The array will not be split after the last element

:Examples

```
SELECT arrayReverseSplit((x, y) -> y, [1, 2, 3, 4, 5], [1, 0, 0, 1, 0]) AS res
```

```
res
[[1],[2,3,4],[5]]
```

.Note that the first argument (lambda function) can't be omitted in the `arraySplit` function

(... ,**arrayCount([func,] arr1**

Returns the number of elements in the `arr` array for which `func` returns something other than 0. If 'func' is not specified, it .returns the number of non-zero elements in the array

(... ,**arrayExists([func,] arr1**

.Returns 1 if there is at least one element in 'arr' for which 'func' returns something other than 0. Otherwise, it returns 0

(... ,**arrayAll([func,] arr1**

.Returns 1 if 'func' returns something other than 0 for all the elements in 'arr'. Otherwise, it returns 0

(... ,**arraySum([func,] arr1**

.Returns the sum of the 'func' values. If the function is omitted, it just returns the sum of the array elements

(... ,**arrayFirst(func, arr1**

.Returns the first element in the 'arr1' array for which 'func' returns something other than 0

.Note that the first argument (lambda function) can't be omitted in the `arrayFirst` function

`(... ,arrayFirstIndex(func, arr1`

.Returns the index of the first element in the 'arr1' array for which 'func' returns something other than 0

.Note that the first argument (lambda function) can't be omitted in the `arrayFirstIndex` function

`(... ,arrayCumSum([func,] arr1`

Returns an array of partial sums of elements in the source array (a running sum). If the `func` function is specified, then the .values of the array elements are converted by this function before summing

:Example

```
SELECT arrayCumSum([1, 1, 1, 1]) AS res
```

```
res
[1, 2, 3, 4]
```

`(arrayCumSumNonNegative(arr`

Same as `arrayCumSum`, returns an array of partial sums of elements in the source array (a running sum). Different `arrayCumSum`, when then returned value contains a value less than zero, the value is replace with zero and the :subsequent calculation is performed with zero parameters. For example

```
SELECT arrayCumSumNonNegative([1, 1, -4, 1]) AS res
```

```
res
[1, 2, 0, 1]
```

`(... ,arraySort([func,] arr1`

Returns an array as result of sorting the elements of `arr1` in ascending order. If the `func` function is specified, sorting (order is determined by the result of the function `func` applied to the elements of array (arrays

.The **Schwartzian transform** is used to improve sorting efficiency

:Example

```
SELECT arraySort((x, y) -> y, ['hello', 'world'], [2, 1]);
```

```
res
['world', 'hello']
```

.For more information about the `arraySort` method, see the [Functions for Working With Arrays](#) section

`(... ,arrayReverseSort([func,] arr1`

Returns an array as result of sorting the elements of `arr1` in descending order. If the `func` function is specified, sorting (order is determined by the result of the function `func` applied to the elements of array (arrays

:Example

```
SELECT arrayReverseSort((x, y) -> y, ['hello', 'world'], [2, 1]) as res;
```

```
res
['hello', 'world']
```

.For more information about the `arrayReverseSort` method, see the [Functions for Working With Arrays](#) section

## Functions for Working with External Dictionaries

.For information on connecting and configuring external dictionaries, see [External dictionaries](#)

### dictGet

.Retrieves a value from an external dictionary

```
dictGet('dict_name', 'attr_name', id_expr)
dictGetOrDefault('dict_name', 'attr_name', id_expr, default_value_expr)
```

#### Parameters

- . `dict_name` — Name of the dictionary. [String literal](#) •
- . `attr_name` — Name of the column of the dictionary. [String literal](#) •
- . `id_expr` — Key value. [Expression](#) returning a `UInt64` or `Tuple`-type value depending on the dictionary configuration •
- `default_value_expr` — Value returned if the dictionary doesn't contain a row with the `id_expr` key. [Expression](#) returning •  
the value in the data type configured for the `attr_name` attribute

#### Returned value

- If ClickHouse parses the attribute successfully in the [attribute's data type](#), functions return the value of the dictionary •  
.attribute that corresponds to `id_expr` •  
:If there is no the key, corresponding to `id_expr`, in the dictionary, then •  
. `dictGet` returns the content of the `<null_value>` element specified for the attribute in the dictionary configuration •  
. `dictGetOrDefault` returns the value passed as the `default_value_expr` parameter •

ClickHouse throws an exception if it cannot parse the value of the attribute or the value doesn't match the attribute data  
.type

#### Example

:Create a text file `ext-dict-text.csv` containing the following

```
1,1
2,2
```

.The first column is `id`, the second column is `c1`

:Configure the external dictionary

```

<yandex>
 <dictionary>
 <name>ext-dict-test</name>
 <source>
 <file>
 <path>/path-to/ext-dict-test.csv</path>
 <format>CSV</format>
 </file>
 </source>
 <layout>
 <flat />
 </layout>
 <structure>
 <id>
 <name>id</name>
 </id>
 <attribute>
 <name>c1</name>
 <type>UInt32</type>
 <null_value></null_value>
 </attribute>
 </structure>
 <lifetime>0</lifetime>
 </dictionary>
</yandex>

```

:Perform the query

```

SELECT
 dictGetOrDefault('ext-dict-test', 'c1', number + 1, toUInt32(number * 10)) AS val,
 toTypeName(val) AS type
FROM system.numbers
LIMIT 3

```

val	type
1	UInt32
2	UInt32
20	UInt32

See Also

[External Dictionaries](#) •

## dictHas

.Checks whether a key is present in a dictionary

```
dictHas('dict_name', id_expr)
```

Parameters

- .dict\_name — Name of the dictionary. [String literal](#) •
- .id\_expr — Key value. [Expression](#) returning a UInt64-type value •

Returned value

- .if there is no key ,0 •
  - .if there is a key ,1 •
- .Type: UInt8

## dictGetHierarchy

For the hierarchical dictionary, returns an array of dictionary keys starting from the passed `id_expr` and continuing along the chain of parent elements

```
dictGetHierarchy('dict_name', id_expr)
```

Parameters

- `.dict_name` — Name of the dictionary. [String literal](#) •
- `.id_expr` — Key value. [Expression](#) returning a `UInt64`-type value •

Returned value

- `.Hierarchy of dictionary keys`  
(Type: `Array(UInt64)`)

## dictIsIn

.Checks the ancestor of a key through the whole hierarchical chain in the dictionary

```
dictIsIn('dict_name', child_id_expr, ancestor_id_expr)
```

Parameters

- `.dict_name` — Name of the dictionary. [String literal](#) •
- `.child_id_expr` — Key to be checked. [Expression](#) returning a `UInt64`-type value •
- `.ancestor_id_expr` — Alleged ancestor of the `child_id_expr` key. [Expression](#) returning a `UInt64`-type value •

Returned value

- `.if child_id_expr is not a child of ancestor_id_expr ,0` •
- `.if child_id_expr is a child of ancestor_id_expr or if child_id_expr is an ancestor_id_expr ,1` •

.Type: `UInt8`

## Other functions

ClickHouse supports specialized functions that convert dictionary attribute values to a specific data type regardless of the .dictionary configuration

:Functions

- `dictGetInt8` , `dictGetInt16` , `dictGetInt32` , `dictGetInt64` •
- `dictGetUInt8` , `dictGetUInt16` , `dictGetUInt32` , `dictGetUInt64` •
- `dictGetFloat32` , `dictGetFloat64` •
- `dictGetDate` •
- `dictGetDateTime` •
- `dictGetUUID` •
- `dictGetString` •

.All these functions have the `OrDefault` modification. For example, `dictGetDateOrDefault`

```
dictGet[Type]('dict_name', 'attr_name', id_expr)
dictGet[Type]OrDefault('dict_name', 'attr_name', id_expr, default_value_expr)
```

## Parameters

- . dict\_name — Name of the dictionary. **String literal** •
- . attr\_name — Name of the column of the dictionary. **String literal** •
- . id\_expr — Key value. **Expression** returning a **UInt64**-type value •
- default\_value\_expr — Value which is returned if the dictionary doesn't contain a row with the id\_expr key. **Expression** •  
• returning a value in the data type configured for the attr\_name attribute

## Returned value

If ClickHouse parses the attribute successfully in the **attribute's data type**, functions return the value of the dictionary •  
• .attribute that corresponds to id\_expr  
• :If there is no requested id\_expr in the dictionary then •  
dictGet[Type] returns the content of the <null\_value> element specified for the attribute in the dictionary •  
• .configuration  
• . dictGet[Type]OrDefault returns the value passed as the default\_value\_expr parameter •

ClickHouse throws an exception if it cannot parse the value of the attribute or the value doesn't match the attribute data  
• .type

## Functions for working with Yandex.Metrica dictionaries

In order for the functions below to work, the server config must specify the paths and addresses for getting all the Yandex.Metrica dictionaries. The dictionaries are loaded at the first call of any of these functions. If the reference lists  
• .can't be loaded, an exception is thrown

."For information about creating reference lists, see the section "Dictionaries

### Multiple geobases

ClickHouse supports working with multiple alternative geobases (regional hierarchies) simultaneously, in order to support  
• .various perspectives on which countries certain regions belong to

The 'clickhouse-server' config specifies the file with the regional  
<hierarchy::<path\_to\_regions\_hierarchy\_file>/opt/geo/regions\_hierarchy.txt</path\_to\_regions\_hierarchy\_file

Besides this file, it also searches for files nearby that have the \_ symbol and any suffix appended to the name (before the  
• .file extension). For example, it will also find the file /opt/geo/regions\_hierarchy\_ua.txt , if present  
• . ua is called the dictionary key. For a dictionary without a suffix, the key is an empty string

All the dictionaries are re-loaded in runtime (once every certain number of seconds, as defined in the  
builtin\_dictionaries\_reload\_interval config parameter, or once an hour by default). However, the list of available  
• .dictionaries is defined one time, when the server starts

All functions for working with regions have an optional argument at the end – the dictionary key. It is referred to as the  
• :geobase. Example

```
regionToCountry(RegionID) - Uses the default dictionary: /opt/geo/regions_hierarchy.txt
regionToCountry(RegionID, '') - Uses the default dictionary: /opt/geo/regions_hierarchy.txt
regionToCountry(RegionID, 'ua') - Uses the dictionary for the 'ua' key: /opt/geo/regions_hierarchy_ua.txt
```

### ([regionToCity(id[, geobase

Accepts a UInt32 number – the region ID from the Yandex geobase. If this region is a city or part of a city, it returns the .region ID for the appropriate city. Otherwise, returns 0

### ([regionToArea(id[, geobase

'Converts a region to an area (type 5 in the geobase). In every other way, this function is the same as 'regionToCity

```
SELECT DISTINCT regionToName(regionToArea(toUInt32(number), 'ua'))
FROM system.numbers
LIMIT 15
```

```
regionToName(regionToArea(toUInt32(number), \\'ua\\'))
| Moscow and Moscow region
| St. Petersburg and Leningrad region
| Belgorod region
| Ivanovsk region
| Kaluga region
| Kostroma region
| Kursk region
| Lipetsk region
| Orlov region
| Ryazan region
| Smolensk region
| Tambov region
| Tver region
| Tula region
```

### ([regionToDistrict(id[, geobase

Converts a region to a federal district (type 4 in the geobase). In every other way, this function is the same as ."regionToCity

```
SELECT DISTINCT regionToName(regionToDistrict(toUInt32(number), 'ua'))
FROM system.numbers
LIMIT 15
```

```
regionToName(regionToDistrict(toUInt32(number), \\'ua\\'))
| Central federal district
| Northwest federal district
| South federal district
| North Caucases federal district
| Privilga federal district
| Ural federal district
| Siberian federal district
| Far East federal district
| Scotland
| Faroe Islands
| Flemish region
| Brussels capital region
| Wallonia
| Federation of Bosnia and Herzegovina
```

### ([regionToCountry(id[, geobase

Converts a region to a country. In every other way, this function is the same as 'regionToCity'. Example:  
.([regionToCountry(toUInt32(213)) = 225] converts Moscow (213) to Russia (225

([regionToContinent(id[, geobase

Converts a region to a continent. In every other way, this function is the same as 'regionToCity'. Example:  
.([regionToContinent(toUInt32(213)) = 10001] converts Moscow (213) to Eurasia (10001

([regionToPopulation(id[, geobase

Gets the population for a region. The population can be recorded in files with the geobase. See the section "External dictionaries". If the population is not recorded for the region, it returns 0. In the Yandex geobase, the population might be recorded for child regions, but not for parent regions

([regionIn(lhs, rhs[, geobase

Checks whether a 'lhs' region belongs to a 'rhs' region. Returns a UInt8 number equal to 1 if it belongs, or 0 if it doesn't belong. The relationship is reflexive – any region also belongs to itself

([regionHierarchy(id[, geobase

Accepts a UInt32 number – the region ID from the Yandex geobase. Returns an array of region IDs consisting of the [passed region and all parents along the chain. Example: regionHierarchy(toUInt32(213)) = [213,1,3,225,10001,10000

([regionToName(id[, lang

Accepts a UInt32 number – the region ID from the Yandex geobase. A string with the name of the language can be passed as a second argument. Supported languages are: ru, en, ua, uk, by, kz, tr. If the second argument is omitted, the language 'ru' is used. If the language is not supported, an exception is thrown. Returns a string – the name of the region in the corresponding language. If the region with the specified ID doesn't exist, an empty string is returned  
. ua and uk both mean Ukrainian

## Functions for implementing the IN operator

in, notIn, globalIn, globalNotIn

.See the section **IN operators**

(... ,tuple(x, y, ...), operator (x, y

A function that allows grouping multiple columns. For columns with the types T1, T2, ..., it returns a Tuple(T1, T2, ...) type tuple containing these columns. There is no cost to execute the function. Tuples are normally used as intermediate values for an argument of IN operators, or for creating a list of formal parameters of lambda functions. Tuples can't be written to a .table

tupleElement(tuple, n), operator x.N

A function that allows getting a column from a tuple. 'N' is the column index, starting from 1. N must be a constant. 'N' must be a constant. 'N' must be a strict positive integer no greater than the size of the tuple. There is no cost to execute the .function

## arrayJoin function

.This is a very unusual function

Normal functions don't change a set of rows, but just change the values in each row (map). Aggregate functions compress .(a set of rows (fold or reduce). The 'arrayJoin' function takes each row and generates a set of rows (unfold

This function takes an array as an argument, and propagates the source row to multiple rows for the number of elements in the array. All the values in columns are simply copied, except the values in the column where this function is applied; it .is replaced with the corresponding array value

.A query can use multiple `arrayJoin` functions. In this case, the transformation is performed multiple times

.Note the ARRAY JOIN syntax in the SELECT query, which provides broader possibilities

:Example

```
SELECT arrayJoin([1, 2, 3] AS src) AS dst, 'Hello', src
```

dst	\'Hello\'	src
1	Hello	[1,2,3]
2	Hello	[1,2,3]
3	Hello	[1,2,3]

## Functions for Working with Geographical Coordinates

### greatCircleDistance

.Calculate the distance between two points on the Earth's surface using the great-circle formula

```
greatCircleDistance(lon1Deg, lat1Deg, lon2Deg, lat2Deg)
```

Input parameters

- . [ `lon1Deg` — Longitude of the first point in degrees. Range: $[-180^\circ, 180^\circ]$  •
- . [ `lat1Deg` — Latitude of the first point in degrees. Range: $[-90^\circ, 90^\circ]$  •
- . [ `lon2Deg` — Longitude of the second point in degrees. Range: $[-180^\circ, 180^\circ]$  •
- . [ `lat2Deg` — Latitude of the second point in degrees. Range: $[-90^\circ, 90^\circ]$  •

Positive values correspond to North latitude and East longitude, and negative values correspond to South latitude and .West longitude

Returned value

.The distance between two points on the Earth's surface, in meters

.Generates an exception when the input parameter values fall outside of the range

Example

```
SELECT greatCircleDistance(55.755831, 37.617673, -55.755831, -37.617673)
```

```
greatCircleDistance(55.755831, 37.617673, -55.755831, -37.617673)
14132374.194975413
```

pointInEllipses

Checks whether the point belongs to at least one of the ellipses. Coordinates are geometric in the Cartesian coordinate system

```
pointInEllipses(x, y, x0, y0, a0, b0, ..., xn, yn, an, bn)
```

Input parameters

. x, y — Coordinates of a point on the plane •

. x<sub>i</sub>, y<sub>i</sub> — Coordinates of the center of the i-th ellipsis •

. a<sub>i</sub>, b<sub>i</sub> — Axes of the i-th ellipsis in units of x, y coordinates •

. The input parameters must be 2+4·n, where n is the number of ellipses

Returned values

. if the point is inside at least one of the ellipses; 0 if it is not 1

Example

```
SELECT pointInEllipses(10., 10., 10., 9.1, 1., 0.9999)
```

```
└─pointInEllipses(10., 10., 10., 9.1, 1., 0.9999)─
 └─ 1 ─┘
```

## pointInPolygon

Checks whether the point belongs to the polygon on the plane

```
pointInPolygon((x, y), [(a, b), (c, d) ...], ...)
```

Input values

. x, y — Coordinates of a point on the plane. Data type —**Tuple** — A tuple of two numbers •

a, b), (c, d) ...] — Polygon vertices. Data type —**Array**. Each vertex is represented by a pair of coordinates (a, b). •

Vertices should be specified in a clockwise or counterclockwise order. The minimum number of vertices is 3. The polygon must be constant

The function also supports polygons with holes (cut out sections). In this case, add polygons that define the cut out sections using additional arguments of the function. The function does not support non-simply-connected polygons

Returned values

if the point is inside the polygon, 0 if it is not. If the point is on the polygon boundary, the function may return either 0 or 1

```
SELECT pointInPolygon((3., 3.), [(6, 0), (8, 4), (5, 8), (0, 2)]) AS res
```

```
└─res─
 └─ 1 ─┘
```

Example

## geohashEncode

Encodes latitude and longitude as a geohash-string, please see (<http://geohash.org/>,  
<https://en.wikipedia.org/wiki/Geohash>)

```
geohashEncode(longitude, latitude, [precision])
```

Input values

[longitude - longitude part of the coordinate you want to encode. Floating in range [-180°, 180°] •

[latitude - latitude part of the coordinate you want to encode. Floating in range [-90°, 90°] •

precision - Optional, length of the resulting encoded string, defaults to 12 . Integer in range [1, 12] . Any value less than 1 or greater than 12 is silently converted to 12

Returned values

.(alphanumeric String of encoded coordinate (modified version of the base32-encoding alphabet is used) •

Example

```
SELECT geohashEncode(-5.60302734375, 42.593994140625, 0) AS res
```

```
res
ezs42d000000
```

geohashDecode

.Decodes any geohash-encoded string into longitude and latitude

Input values

.encoded string - geohash-encoded string •

Returned values

.(longitude, latitude) - 2-tuple of Float64 values of longitude and latitude) •

Example

```
SELECT geohashDecode('ezs42') AS res
```

```
res
(-5.60302734375, 42.60498046875)
```

geoToH3

.Returns H3 point index (lon, lat) with specified resolution

H3 is a geographical indexing system where Earth's surface divided into even hexagonal tiles. This system is hierarchical, i. e. each hexagon on the top level can be splitted into seven even but smaller ones and so on

.This index is used primarily for bucketing locations and other geospatial manipulations

Syntax

```
geoToH3(lon, lat, resolution)
```

## Parameters

- .lon — Longitude. Type: `Float64` •
- .lat — Latitude. Type: `Float64` •
- .resolution — Index resolution. Range: [0, 15] . Type: `UInt8` •

## Returned values

- .Hexagon index number •
- .in case of error 0 •

.Type: `UInt64`

## Example

:Query

```
SELECT geoToH3(37.79506683, 55.71290588, 15) as h3Index
```

:Result

```
h3Index
644325524701193974
```

## geohashesInBox

Returns an array of geohash-encoded strings of given precision that fall inside and intersect boundaries of given box,  
.basically a 2D grid flattened into array

## Input values

- [longitude\_min - min longitude, floating value in range[-180°, 180°] •
- [latitude\_min - min latitude, floating value in range[-90°, 90°] •
- [longitude\_max - max longitude, floating value in range[-180°, 180°] •
- [latitude\_max - max latitude, floating value in range[-90°, 90°] •
- [precision - geohash precision, `UInt8` in range [1, 12] •

.Please note that all coordinate parameters should be of the same type: either `Float32` or `Float64`

## Returned values

.array of precision-long strings of geohash-boxes covering provided area, you should not rely on order of items •  
.empty array if *min* values of *latitude* and *longitude* aren't less than corresponding *max* values - [] •

.Please note that function will throw an exception if resulting array is over 10'000'000 items long

## Example

```
SELECT geohashesInBox(24.48, 40.56, 24.785, 40.81, 4) AS thasos
```

```
thasos
['sx1q', 'sx1r', 'sx32', 'sx1w', 'sx1x', 'sx38']
```

## Functions for working with Nullable aggregates

isNull

.Checks whether the argument is **NULL**

```
isNull(x)
```

Parameters

.`x` — A value with a non-compound data type •

Returned value

.if `x` is **NULL** 1 •

.if `x` is not **NULL** 0 •

Example

Input table

x	y
1	NULL
2	3

Query

```
SELECT x FROM t_null WHERE isNull(y)
```

x
1

isNotNull

.Checks whether the argument is **NULL**

```
isNotNull(x)
```

:Parameters

.`x` — A value with a non-compound data type •

Returned value

.if `x` is **NULL** 0 •

.if `x` is not **NULL** 1 •

Example

Input table

x	y
1	NULL
2	3

```
SELECT x FROM t_null WHERE isNotNull(y)
```

x
2

## coalesce

.Checks from left to right whether `NULL` arguments were passed and returns the first non-`NULL` argument

```
coalesce(x, ...)
```

:Parameters

.Any number of parameters of a non-compound type. All parameters must be compatible by data type •

Returned values

.The first non-`NULL` argument •

.`NULL`, if all arguments are `NULL` •

## Example

.Consider a list of contacts that may specify multiple ways to contact a customer

name	mail	phone	icq
client 1	NULL	123-45-67	123
client 2	NULL	NULL	NULL

.The `mail` and `phone` fields are of type `String`, but the `icq` field is `UInt32`, so it needs to be converted to `String`

:Get the first available contact method for the customer from the contact list

```
SELECT coalesce(mail, phone, CAST(icq, 'Nullable(String)')) FROM aBook
```

name	coalesce(mail, phone, CAST(icq, 'Nullable(String)'))
client 1	123-45-67
client 2	NULL

## ifNull

.Returns an alternative value if the main argument is `NULL`

```
ifNull(x, alt)
```

:Parameters

.`x` — The value to check for `NULL` •

.`alt` — The value that the function returns if `x` is `NULL` •

Returned values

.The value `x`, if `x` is not `NULL` •

.The value `alt`, if `x` is `NULL` •

### Example

```
SELECT ifNull('a', 'b')
```

```
ifNull('a', 'b')
| a
```

```
SELECT ifNull(NULL, 'b')
```

```
ifNull(NULL, 'b')
| b
```

## nullIf

.Returns `NULL` if the arguments are equal

```
nullIf(x, y)
```

:Parameters

.`x`, `y` — Values for comparison. They must be compatible types, or ClickHouse will generate an exception

Returned values

. `NULL`, if the arguments are equal •

.The `x` value, if the arguments are not equal •

### Example

```
SELECT nullIf(1, 1)
```

```
nullIf(1, 1)
| NULL
```

```
SELECT nullIf(1, 2)
```

```
nullIf(1, 2)
| 1
```

## assumeNotNull

.Results in a value of type **Nullable** for a non- `Nullable`, if the value is not `NULL`

```
assumeNotNull(x)
```

:Parameters

.`x` — The original value •

Returned values

- .The original value from the non-Nullable type, if it is not NULL •
- .The default value for the non-Nullable type if the original value was NULL •

Example

.Consider the `t_null` table

```
SHOW CREATE TABLE t_null
```

```
--statement
CREATE TABLE default.t_null (x Int8, y Nullable(Int8)) ENGINE = TinyLog
```

x	y
1	NULL
2	3

.Apply the `assumeNotNull` function to the `y` column

```
SELECT assumeNotNull(y) FROM t_null
```

```
--assumeNotNull(y)
0
3
```

```
SELECT toTypeName(assumeNotNull(y)) FROM t_null
```

```
--toTypeName(assumeNotNull(y))
Int8
Int8
```

`toNullable`

.Converts the argument type to Nullable

```
toNullable(x)
```

:Parameters

.`x` — The value of any non-compound type •

Returned value

.The input value with a Nullable type •

Example

```
SELECT toTypeName(10)
```

```
└─toTypeName(10)─
 └─UInt8
```

```
SELECT toTypeName(toNullable(10))
```

```
└─toTypeName(toNullable(10))─
 └─Nullable(UInt8)
```

## Machine learning functions

### (evalMLMethod (prediction

.Prediction using fitted regression models uses `evalMLMethod` function. See link in [linearRegression](#)

#### Stochastic Linear Regression

The [stochasticLinearRegression](#) aggregate function implements stochastic gradient descent method using linear model .and MSE loss function. Uses `evalMLMethod` to predict on new data

#### Stochastic Logistic Regression

The [stochasticLogisticRegression](#) aggregate function implements stochastic gradient descent method for binary .classification problem. Uses `evalMLMethod` to predict on new data

## Introspection Functions

.You can use functions described in this chapter to introspect [ELF](#) and [DWARF](#) for query profiling

### Warning

.These functions are slow and may impose security considerations

:For proper operation of introspection functions

.Install the `clickhouse-common-static-dbg` package •

.Set the [allow\\_introspection\\_functions](#) setting to 1 •

.For security reasons introspection functions are disabled by default

.ClickHouse saves profiler reports to the [trace\\_log](#) system table. Make sure the table and profiler are configured properly

## addressToLine

Converts virtual memory address inside ClickHouse server process to the filename and the line number in ClickHouse .source code

.If you use official ClickHouse packages, you need to install the `clickhouse-common-static-dbg` package

### Syntax

```
addressToLine(address_of_binary_instruction)
```

### Parameters

. address\_of\_binary\_instruction (**UInt64**) — Address of instruction in a running process •

## Returned value

.Source code filename and the line number in this file delimited by colon •

.For example, `/build/obj-x86_64-linux-gnu../dbms/src/Common/ThreadPool.cpp:199`, where 199 is a line number

.Name of a binary, if the function couldn't find the debug information •

.Empty string, if the address is not valid •

.Type: String

#### **:Enabling introspection functions**

```
SET allow_introspection_functions=1
```

:Selecting the first string from the trace\_log system table

```
SELECT * FROM system.trace_log LIMIT 1 \G
```

Row 1:

. The `trace` field contains the stack trace at the moment of sampling

:Getting the source code filename and the line number for a single address

```
SELECT addressToLine(94784076370703) \G
```

Row 1:

addressToLine(94784076370703): /build/obj-x86\_64-linux-gnu/..../dbms/src/Common/ThreadPool.cpp:199

:Applying the function to the whole stack trace

```
SELECT
 arrayStringConcat(arrayMap(x -> addressToLine(x), trace), '\n') AS trace_source_code_lines
FROM system.trace_log
LIMIT 1
\G
```

The `arrayMap` function allows to process each individual element of the trace array by the `addressToLine` function. The result of this processing you see in the `trace source code lines` column of output

Row 1:

```
trace_source_code_lines: /lib/x86_64-linux-gnu/libpthread-2.27.so
/usr/lib/debug/usr/bin/clickhouse
/build/obj-x86_64-linux-gnu/../dbms/src/Common/ThreadPool.cpp:199
/build/obj-x86_64-linux-gnu/../dbms/src/Common/ThreadPool.h:155
/usr/include/c++/9/bits/atomic_base.h:551
/usr/lib/debug/usr/bin/clickhouse
/lib/x86_64-linux-gnu/libpthread-2.27.so
/build/glibc-OTsEL5/glibc-2.27/misc/../sysdeps/unix/sysv/linux/x86_64/clone.S:97
```

## addressToSymbol

.Converts virtual memory address inside ClickHouse server process to the symbol from ClickHouse object files

### Syntax

```
addressToSymbol(address_of_binary_instruction)
```

### Parameters

. address\_of\_binary\_instruction (**UInt64**) — Address of instruction in a running process •

### Returned value

.Symbol from ClickHouse object files •

.Empty string, if the address is not valid •

.Type: **String**

### Example

:Enabling introspection functions

```
SET allow_introspection_functions=1
```

:Selecting the first string from the trace\_log system table

```
SELECT * FROM system.trace_log LIMIT 1 \G
```

Row 1:

```
event_date: 2019-11-20
event_time: 2019-11-20 16:57:59
revision: 54429
timer_type: Real
thread_number: 48
query_id: 724028bf-f550-45aa-910d-2af6212b94ac
trace:
[94138803686098, 94138815010911, 94138815096522, 94138815101224, 94138815102091, 94138814222988, 94138806823642, 941:
```

.The trace field contains the stack trace at the moment of sampling

:Getting a symbol for a single address

```
SELECT addressToSymbol(94138803686098) \G
```

Row 1:

```
addressToSymbol(94138803686098):
_ZNK2DB24IAggregateFunctionHelperINS_20AggregateFunctionSumImmNS_24AggregateFunctionSumDataImEEEEEE19addBatchS:
```

:Applying the function to the whole stack trace

```
SELECT
 arrayStringConcat(arrayMap(x -> addressToSymbol(x), trace), '\n') AS trace_symbols
FROM system.trace_log
LIMIT 1
\G
```

The **arrayMap** function allows to process each individual element of the `trace` array by the `addressToSymbols` function. The result of this processing you see in the `trace_symbols` column of output

Row 1:

```
trace_symbols:
_ZNK2DB24IAggregateFunctionHelperINS_20AggregateFunctionSumImmNS_24AggregateFunctionSumDataImEEEEEE19addBatchS:
_ZNK2DB10Aggregator21executeWithoutKeyImplERPcmPNS0_28AggregateFunctionInstructionEPNS_5ArenaE
_ZN2DB10Aggregator14executeOnBlockEST6vectorIN3COWINS_7IColumnEE13immutable_ptrIS3_EESaIS6_EEmRNS_22Aggregated
_ZN2DB10Aggregator14executeOnBlockERKNS_5BlockERNS_22AggregatedDataVariantsERSt6vectorIPKNS_7IColumnEsaIS9_EE
_ZN2DB10Aggregator7executeERKSt10shared_ptrINS_17IBlockInputStreamEERNS_22AggregatedDataVariantsE
_ZN2DB27AggregatingBlockInputStream8readImplEv
_ZN2DB17IBlockInputStream4readEv
_ZN2DB26ExpressionBlockInputStream8readImplEv
_ZN2DB17IBlockInputStream4readEv
_ZN2DB26ExpressionBlockInputStream8readImplEv
_ZN2DB17IBlockInputStream4readEv
_ZN2DB28AsynchronousBlockInputStream9calculateEv
_ZNST17_Function_handlerIFvvEZN2DB28AsynchronousBlockInputStream4nextEvEUlvE_E9_M_invokeERKSt9_Any_data
_ZN14ThreadpoolImpl20ThreadFromGlobalPoolE6workerEST14_List_iteratorIS0_E
_ZZN20ThreadFromGlobalPoolC4IZN14ThreadpoolImplIS_E12scheduleImplIVET_St8functionIFvvEEiSt8optionalImEEUlvE1_
_ZN14ThreadpoolImpl16threadE6workerEST14_List_iteratorIS0_E
execute_native_thread_routine
start_thread
clone
```

## demangle

.Converts a symbol that you can get using the `addressToSymbol` function to the C++ function name

Syntax

```
demangle(symbol)
```

Parameters

. `symbol` (**String**) — Symbol from an object file •

Returned value

.Name of the C++ function •

.Empty string if a symbol is not valid •

.Type: **String**

## Example

:Enabling introspection functions

```
SET allow_introspection_functions=1
```

:Selecting the first string from the trace\_log system table

```
SELECT * FROM system.trace_log LIMIT 1 \G
```

Row 1:

The `trace` field contains the stack trace at the moment of sampling.

:Getting a function name for a single address

```
SELECT demangle(addressToSymbol(94138803686098)) \G
```

Row 1:

```
demangle(addressToSymbol(94138803686098)): DB::IAggregateFunctionHelper<DB::AggregateFunctionSum<unsigned long, unsigned long, DB::AggregateFunctionSumData<unsigned long> > >::addBatchSinglePlace(unsigned long, char*, DB::IColumn const**, DB::Arena*) const
```

:Applying the function to the whole stack trace

```
SELECT
 arrayStringConcat(arrayMap(x -> demangle(addressToSymbol(x)), trace), '\n') AS trace_functions
FROM system.trace_log
LIMIT 1
\G
```

The `arrayMap` function allows to process each individual element of the `trace` array by the `demangle` function. The result of this processing you see in the `trace` functions `column` of output

Row 1:

```
trace_functions: DB::IAggregateFunctionHelper<DB::AggregateFunctionSum<unsigned long, unsigned long, DB::AggregateFunctionSumData<unsigned long> >::addBatchSinglePlace(unsigned long, char*, DB::IColumn const**, DB::Arena*) const
DB::Aggregator::executeWithoutKeyImpl(char*&, unsigned long, DB::Aggregator::AggregateFunctionInstruction*, DB::Arena*) const
DB::Aggregator::executeOnBlock(std::vector<COW<DB::IColumn>::immutable_ptr<DB::IColumn>, std::allocator<COW<DB::IColumn>::immutable_ptr<DB::IColumn> > >, unsigned long, DB::AggregatedDataVariants&, std::vector<DB::IColumn const*, std::allocator<DB::IColumn const*> >&, std::vector<std::vector<DB::IColumn const*, std::allocator<DB::IColumn const*> >, std::allocator<std::vector<DB::IColumn const*, std::allocator<DB::IColumn const*> >>>&, bool&)
DB::Aggregator::executeOnBlock(DB::Block const&, DB::AggregatedDataVariants&, std::vector<DB::IColumn const*, std::allocator<DB::IColumn const*> >&, std::vector<std::vector<DB::IColumn const*, std::allocator<DB::IColumn const*> >>>&, bool&)
DB::Aggregator::execute(std::shared_ptr<DB::IBlockInputStream> const&, DB::AggregatedDataVariants&)
DB::AggregatingBlockInputStream::readImpl()
DB::IBlockInputStream::read()
DB::ExpressionBlockInputStream::readImpl()
DB::IBlockInputStream::read()
DB::IBlockInputStream::read()
DB::AsynchronousBlockInputStream::calculate()
std::function<void ()> DB::AsynchronousBlockInputStream::next()::
{lambda()#1}>::_M_invoke(std::any const&)
ThreadPoolImpl<ThreadFromGlobalPool>::worker(std::list<ThreadFromGlobalPool>)
ThreadFromGlobalPool::ThreadFromGlobalPool<ThreadPoolImpl<ThreadFromGlobalPool>::scheduleImpl<void>(std::function<void ()>, int, std::optional<unsigned long>::{lambda()#3}>
(ThreadPoolImpl<ThreadFromGlobalPool>::scheduleImpl<void>(std::function<void ()>, int, std::optional<unsigned long>::{lambda()#3}&&){lambda()#1}::operator()() const
ThreadPoolImpl<std::thread>::worker(std::list<std::thread>)
execute_native_thread_routine
start_thread
clone
```

## Other functions

()hostName

Returns a string with the name of the host that this function was performed on. For distributed processing, this is the name .of the remote server host, if the function is performed on a remote server

FQDN

.Returns the fully qualified domain name

Syntax

```
fqdn();
```

.This function is case-insensitive

Returned value

.String with the fully qualified domain name •

.Type: String

Example

:Query

```
SELECT FQDN();
```

:Result

```
+---+
|FQDN()|
+---+
|clickhouse.ru-central1.internal|
```

## basename

Extracts the trailing part of a string after the last slash or backslash. This function is often used to extract the filename from .a path

```
basename(expr)
```

### Parameters

.expr — Expression resulting in a **String** type value. All the backslashes must be escaped in the resulting value •

Returned Value

:A string that contains

.The trailing part of a string after the last slash or backslash •

If the input string contains a path ending with slash or backslash, for example, / or c:\ , the function returns an empty .string

.The original string if there are no slashes or backslashes •

### Example

```
SELECT 'some/long/path/to/file' AS a, basename(a)
```

```
+---+
|a | basename('some\\long\\path\\to\\file')|
+---+
|some\\long\\path\\to\\file | file|
```

```
SELECT 'some\\long\\path\\to\\file' AS a, basename(a)
```

```
+---+
|a | basename('some\\long\\path\\to\\file')|
+---+
|some\\long\\path\\to\\file | file|
```

```
SELECT 'some-file-name' AS a, basename(a)
```

```
+---+
|a | basename('some-file-name')|
+---+
|some-file-name | some-file-name|
```

(visibleWidth(x

Calculates the approximate width when outputting values to the console in text format (tab-separated). This function is .used by the system for implementing Pretty formats

.NULL is represented as a string corresponding to NULL in Pretty formats

```
SELECT visibleWidth(NULL)
```

```
visibleWidth(NULL)
 4
```

### (toTypeName(x

.Returns a string containing the type name of the passed argument

If `NULL` is passed to the function as input, then it returns the `Nullable(Nothing)` type, which corresponds to an internal `.NULL` representation in ClickHouse

### ()blockSize

Gets the size of the block. In ClickHouse, queries are always run on blocks (sets of column parts). This function allows .getting the size of the block that you called it for

### (materialize(x

Turns a constant into a full column containing just one value. In ClickHouse, full columns and constants are represented differently in memory. Functions work differently for constant arguments and normal arguments (different code is .executed), although the result is almost always the same. This function is for debugging this behavior

### (...)ignore

Accepts any arguments, including `NULL` . Always returns 0. However, the argument is still evaluated. This can be used for .benchmarks

### (sleep(seconds

.Sleeps 'seconds' seconds on each data block. You can specify an integer or a floating-point number

### (sleepEachRow(seconds

.Sleeps 'seconds' seconds on each row. You can specify an integer or a floating-point number

### ()currentDatabase

Returns the name of the current database. You can use this function in table engine parameters in a CREATE TABLE .query where you need to specify the database

### ()currentUser

.Returns the login of current user. Login of user, that initiated query, will be returned in case distributed query

```
SELECT currentUser();
```

. ()Alias: `user()` , `USER`

Returned values

.Login of current user •

.Login of user that initiated query in case of distributed query •

.Type: String

Example

:Query

```
SELECT currentUser();
```

:Result

```
└── currentUser()
 └── default
```

(isFinite(x

.Accepts Float32 and Float64 and returns UInt8 equal to 1 if the argument is not infinite and not a NaN, otherwise 0

(isInfinite(x

Accepts Float32 and Float64 and returns UInt8 equal to 1 if the argument is infinite, otherwise 0. Note that 0 is returned  
.for a NaN

(isNaN(x

.Accepts Float32 and Float64 and returns UInt8 equal to 1 if the argument is a NaN, otherwise 0

('hasColumnInTable(['hostname'][, 'username'][, 'password']),] 'database', 'table', 'column

Accepts constant strings: database name, table name, and column name. Returns a UInt8 constant expression equal to 1  
if there is a column, otherwise 0. If the hostname parameter is set, the test will run on a remote server. The function  
throws an exception if the table does not exist. For elements in a nested data structure, the function checks for the  
.existence of a column. For the nested data structure itself, the function returns 0

bar

.Allows building a unicode-art diagram

. bar(x, min, max, width) draws a band with a width proportional to (x - min) and equal to width characters when x = max

:Parameters

. x — Size to display •

. min, max — Integer constants. The value must fit in Int64 •

. width — Constant, positive integer, can be fractional •

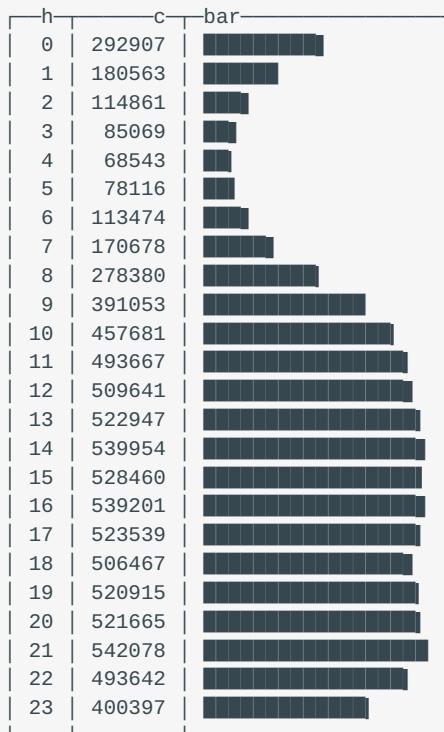
.The band is drawn with accuracy to one eighth of a symbol

:Example

```

SELECT
 toHour(EventTime) AS h,
 count() AS c,
 bar(c, 0, 600000, 20) AS bar
FROM test.hits
GROUP BY h
ORDER BY h ASC

```



## transform

Transforms a value according to the explicitly defined mapping of some elements to other ones. There are two variations of this function

(transform(x, array\_from, array\_to, default .1

.x – What to transform

.array\_from – Constant array of values for converting

.array\_to – Constant array of values to convert the values in 'from' to

.default – Which value to use if 'x' is not equal to any of the values in 'from'

.array\_from and array\_to – Arrays of the same size

:Types

transform(T, Array(T), Array(U), U) -> U

T and U can be numeric, string, or Date or DateTime types. Where the same letter is indicated (T or U), for numeric types these might not be matching types, but types that have a common type. For example, the first argument can have .the Int64 type, while the second has the Array(UInt16) type

If the 'x' value is equal to one of the elements in the 'array\_from' array, it returns the existing element (that is numbered the same) from the 'array\_to' array. Otherwise, it returns 'default'. If there are multiple matching elements in 'array\_from', it .returns one of the matches

:Example

```
SELECT
 transform(SearchEngineID, [2, 3], ['Yandex', 'Google'], 'Other') AS title,
 count() AS c
FROM test.hits
WHERE SearchEngineID != 0
GROUP BY title
ORDER BY c DESC
```

title	c
Yandex	498635
Google	229872
Other	104472

(transform(x, array\_from, array\_to .1

Differs from the first variation in that the 'default' argument is omitted. If the 'x' value is equal to one of the elements in the 'array\_from' array, it returns the matching element (that is numbered the same) from the 'array\_to' array. Otherwise, it . 'returns 'x

:Types

transform(T, Array(T), Array(T)) -> T

:Example

```
SELECT
 transform(domain(Referer), ['yandex.ru', 'google.ru', 'vk.com'], ['www.yandex', 'example.com']) AS s,
 count() AS c
FROM test.hits
GROUP BY domain(Referer)
ORDER BY count() DESC
LIMIT 10
```

s	c
www.yandex	2906259
████████.ru	867767
████████.ru	313599
mail.yandex.ru	107147
████████.ru	100355
████████.ru	65040
news.yandex.ru	64515
████████.net	59141
example.com	57316

(formatReadableSize(x

.Accepts the size (number of bytes). Returns a rounded size with a suffix (KiB, MiB, etc.) as a string

:Example

```
SELECT
 arrayJoin([1, 1024, 1024*1024, 192851925]) AS filesize_bytes,
 formatReadableSize(filesize_bytes) AS filesize
```

filesize_bytes	filesize
1	1.00 B
1024	1.00 KiB
1048576	1.00 MiB
192851925	183.92 MiB

(least(a, b

.Returns the smallest value from a and b

(greatest(a, b

.Returns the largest value of a and b

()uptime

.Returns the server's uptime in seconds

()version

.Returns the version of the server as a string

()timezone

.Returns the timezone of the server

blockNumber

.Returns the sequence number of the data block where the row is located

rowNumberInBlock

.Returns the ordinal number of the row in the data block. Different data blocks are always recalculated

()rowNumberInAllBlocks

.Returns the ordinal number of the row in the data block. This function only considers the affected data blocks

neighbor

The window function that provides access to a row at a specified offset which comes before or after the current row of a given column

Syntax

```
neighbor(column, offset[, default_value])
```

The result of the function depends on the affected data blocks and the order of data in the block. If you make a subquery .with ORDER BY and call the function from outside the subquery, you can get the expected result

Parameters

.column — A column name or scalar expression •  
.offset — The number of rows forwards or backwards from the current row of column . Int64 •  
default\_value — Optional. The value to be returned if offset goes beyond the scope of the block. Type of data blocks •  
.affected

Returned values

.Value for column in offset distance from current row if offset value is not outside block bounds •  
.Default value for column if offset value is outside block bounds. If default\_value is given, then it will be used •  
.Type: type of data blocks affected or default value type

Example

:Query

```
SELECT number, neighbor(number, 2) FROM system.numbers LIMIT 10;
```

:Result

number	neighbor(number, 2)
0	2
1	3
2	4
3	5
4	6
5	7
6	8
7	9
8	0
9	0

:Query

```
SELECT number, neighbor(number, 2, 999) FROM system.numbers LIMIT 10;
```

:Result

number	neighbor(number, 2, 999)
0	2
1	3
2	4
3	5
4	6
5	7
6	8
7	9
8	999
9	999

:This function can be used to compute year-over-year metric value

:Query

```

WITH toDate('2018-01-01') AS start_date
SELECT
 toStartOfMonth(start_date + (number * 32)) AS month,
 toInt32(month) % 100 AS money,
 neighbor(money, -12) AS prev_year,
 round(prev_year / money, 2) AS year_over_year
FROM numbers(16)

```

:Result

month	money	prev_year	year_over_year
2018-01-01	32	0	0
2018-02-01	63	0	0
2018-03-01	91	0	0
2018-04-01	22	0	0
2018-05-01	52	0	0
2018-06-01	83	0	0
2018-07-01	13	0	0
2018-08-01	44	0	0
2018-09-01	75	0	0
2018-10-01	5	0	0
2018-11-01	36	0	0
2018-12-01	66	0	0
2019-01-01	97	32	0.33
2019-02-01	28	63	2.25
2019-03-01	56	91	1.62
2019-04-01	87	22	0.25

(runningDifference(x

Calculates the difference between successive row values in the data block. Returns 0 for the first row and the difference .from the previous row for each subsequent row

The result of the function depends on the affected data blocks and the order of data in the block. If you make a subquery .with ORDER BY and call the function from outside the subquery, you can get the expected result

:Example

```

SELECT
 EventID,
 EventTime,
 runningDifference(EventTime) AS delta
FROM
(
 SELECT
 EventID,
 EventTime
 FROM events
 WHERE EventDate = '2016-11-24'
 ORDER BY EventTime ASC
 LIMIT 5
)

```

EventID	EventTime	delta
1106	2016-11-24 00:00:04	0
1107	2016-11-24 00:00:05	1
1108	2016-11-24 00:00:05	0
1109	2016-11-24 00:00:09	4
1110	2016-11-24 00:00:10	1

.Please note - block size affects the result. With each new block, the runningDifference state is reset

```

SELECT
 number,
 runningDifference(number + 1) AS diff
FROM numbers(100000)
WHERE diff != 1

```

number	diff
0	0

number	diff
65536	0

```
set max_block_size=100000 -- default value is 65536!
```

```

SELECT
 number,
 runningDifference(number + 1) AS diff
FROM numbers(100000)
WHERE diff != 1

```

number	diff
0	0

## runningDifferenceStartingWithFirstValue

Same as for [runningDifference](#), the difference is the value of the first row, returned the value of the first row, and each subsequent row returns the difference from the previous row

## (MACNumToString(num

Accepts a UInt64 number. Interprets it as a MAC address in big endian. Returns a string containing the corresponding .(MAC address in the format AA:BB:CC:DD:EE:FF (colon-separated numbers in hexadecimal form

## (MACStringToNum(s

.The inverse function of MACNumToString. If the MAC address has an invalid format, it returns 0

## (MACStringToOUI(s

Accepts a MAC address in the format AA:BB:CC:DD:EE:FF (colon-separated numbers in hexadecimal form). Returns the .first three octets as a UInt64 number. If the MAC address has an invalid format, it returns 0

## getSizeOfEnumType

.Returns the number of fields in [Enum](#)

```
getSizeOfEnumType(value)
```

:Parameters

. value — Value of type [Enum](#) •

Returned values

- .The number of fields with `Enum` input values •
- .An exception is thrown if the type is not `Enum` •

Example

```
SELECT getSizeOfEnumType(CAST('a' AS Enum8('a' = 1, 'b' = 2))) AS x
```

```
[X]
[2]
```

## toColumnName

.Returns the name of the class that represents the data type of the column in RAM

```
toColumnName(value)
```

:Parameters

- . `value` — Any type of value •

Returned values

.A string with the name of the class that is used for representing the `value` data type in RAM •

Example of the difference between `toTypeName` and `'toColumnName'`

```
SELECT toTypeName(CAST('2018-01-01 01:02:03' AS DateTime))
```

```
[toTypeName(CAST('2018-01-01 01:02:03', 'DateTime'))]
| DateTime
```

```
SELECT toColumnName(CAST('2018-01-01 01:02:03' AS DateTime))
```

```
[toColumnName(CAST('2018-01-01 01:02:03', 'DateTime'))]
| Const(UInt32)
```

. (The example shows that the `DateTime` data type is stored in memory as `Const(UInt32)`

## dumpColumnStructure

Outputs a detailed description of data structures in RAM

```
dumpColumnStructure(value)
```

:Parameters

- . `value` — Any type of value •

Returned values

.A string describing the structure that is used for representing the `value` data type in RAM •

Example

```
SELECT dumpColumnStructure(CAST('2018-01-01 01:02:03', 'DateTime'))
```

```
dumpColumnStructure(CAST('2018-01-01 01:02:03', 'DateTime'))
| DateTime, Const(size = 1, UInt32(size = 1)) |
```

## defaultValueOfArgumentType

.Outputs the default value for the data type

.Does not include default values for custom columns set by the user

```
defaultValueOfArgumentType(expression)
```

:Parameters

. expression — Arbitrary type of value or an expression that results in a value of an arbitrary type •

Returned values

.for numbers 0 •

.Empty string for strings •

. `NULL` for **Nullable** •

Example

```
SELECT defaultValueOfArgumentType(CAST(1 AS Int8))
```

```
defaultValueOfArgumentType(CAST(1, 'Int8'))
| 0 |
```

```
SELECT defaultValueOfArgumentType(CAST(1 AS Nullable(Int8)))
```

```
defaultValueOfArgumentType(CAST(1, 'Nullable(Int8)'))
| NULL |
```

## indexHint

.Outputs data in the range selected by the index without filtering by the expression specified as an argument

The expression passed to the function is not calculated, but ClickHouse applies the index to this expression in the same way as if the expression was in the query without `indexHint`

Returned value

.1 •

Example

.Here is a table with the test data for **ontime**

```
SELECT count() FROM ontime
```

```
count()
4276457
```

. ((The table has indexes for the fields (FlightDate, (Year, FlightDate

:Create a selection by date like this

```
SELECT FlightDate AS k, count() FROM ontime GROUP BY k ORDER BY k
```

k	count()
2017-01-01	13970
2017-01-02	15882
.....	.....
2017-09-28	16411
2017-09-29	16384
2017-09-30	12520

In this selection, the index is not used and ClickHouse processed the entire table (Processed 4.28 million rows ). To apply the :index, select a specific date and run the following query

```
SELECT FlightDate AS k, count() FROM ontime WHERE k = '2017-09-15' GROUP BY k ORDER BY k
```

k	count()
2017-09-15	16428

The last line of output shows that by using the index, ClickHouse processed a significantly smaller number of rows .(( Processed 32.74 thousand rows

:Now pass the expression k = '2017-09-15' to the indexHint function

```
SELECT
 FlightDate AS k,
 count()
FROM ontime
WHERE indexHint(k = '2017-09-15')
GROUP BY k
ORDER BY k ASC
```

k	count()
2017-09-14	7071
2017-09-15	16428
2017-09-16	1077
2017-09-30	8167

The response to the request shows that ClickHouse applied the index in the same way as the previous time(Processed 32.74 thousand rows ). However, the resulting set of rows shows that the expression k = '2017-09-15' was not used when generating the result

Because the index is sparse in ClickHouse, "extra" data ends up in the response when reading a range (in this case, the adjacent dates). Use the indexHint function to see it

replicate

.Creates an array with a single value

.Used for internal implementation of [arrayJoin](#)

```
SELECT replicate(x, arr);
```

:Parameters

- .arr — Original array. ClickHouse creates a new array of the same length as the original and fills it with the value x
- .x — The value that the resulting array will be filled with

Returned value

.An array filled with the value x

.Type: Array

Example

:Query

```
SELECT replicate(1, ['a', 'b', 'c'])
```

:Result

```
replicate(1, ['a', 'b', 'c'])
| [1,1,1]
```

**filesystemAvailable**

Returns the amount of remaining space in the filesystem where the files of the databases located. See the [path](#) server .setting description

```
filesystemAvailable()
```

Returned values

.Amount of remaining space in bytes

.Type: UInt64

Example

```
SELECT filesystemAvailable() AS "Free space", toTypeName(filesystemAvailable()) AS "Type"
```

```
Free space Type
18152624128 | UInt64
```

**filesystemCapacity**

.Returns the capacity information of the disk, in bytes. This information is evaluated using the configured by path

**finalizeAggregation**

.(Takes state of aggregate function. Returns result of aggregation (finalized state

## runningAccumulate

Takes the states of the aggregate function and returns a column with values, are the result of the accumulation of these states for a set of block lines, from the first to the current line. For example, takes state of aggregate function (example runningAccumulate(uniqState(UserID))), and for each row of block, return result of aggregate function on merge of states of all previous rows and current row. So, result of function depends on partition of data to blocks and on order of data in .block

(joinGet('join\_storage\_table\_name', 'get\_column', join\_key

.Gets data from **Join** tables using the specified join key

.Only supports tables created with the `ENGINE = Join(ANY, LEFT, <join_keys>)` statement

(..., modelEvaluate(model\_name

.Evaluate external model. Accepts a model name and model arguments. Returns Float64

([throwIf(x[, custom\_message

Throw an exception if the argument is non zero. `custom_message` - is an optional parameter: a constant string, provides an error message

```
SELECT throwIf(number = 3, 'Too many') FROM numbers(10);
```

```
✓ Progress: 0.00 rows, 0.00 B (0.00 rows/s., 0.00 B/s.) Received exception from server (version 19.14.1):
Code: 395. DB::Exception: Received from localhost:9000. DB::Exception: Too many.
```

()identity

.Returns the same value that was used as its argument

```
SELECT identity(42)
```

```
identity(42)
 42
```

Used for debugging and testing, allows to "break" access by index, and get the result and query performance for a full .scan

## randomPrintableASCII

.Generates a string with a random set of **ASCII** printable characters

Syntax

```
randomPrintableASCII(length)
```

Parameters

.length — Resulting string length. Positive integer •

.If you pass `length < 0`, behavior of the function is undefined

Returned value

.String with a random set of ASCII printable characters •

Type: String

Example

```
SELECT number, randomPrintableASCII(30) as str, length(str) FROM system.numbers LIMIT 3
```

number	str	length(randomPrintableASCII(30))
0	SuiCOSTvC0csfABSw=UcSzp2. `rv8x	30
1	1Ag N1J &RCN: *>HVPg;PE-n0"SUFD	30
2	/"+"<"wUTh:=LjJ Vm!c&hI*m#XTfzz	30

## Aggregate functions

.Aggregate functions work in the normal way as expected by database experts

:ClickHouse also supports

.Parametric aggregate functions, which accept other parameters in addition to columns •

.Combinators, which change the behavior of aggregate functions •

## NULL processing

.During aggregation, all NULLs are skipped

:Examples

:Consider this table

x	y
1	2
2	NULL
3	2
3	3
3	NULL

:Let's say you need to total the values in the y column

```
SELECT sum(y) FROM t_null_big
```

sum(y)
7

The sum function interprets NULL as 0. In particular, this means that if the function receives input of a selection where all the values are NULL, then the result will be 0, not NULL

:Now you can use the groupArray function to create an array from the y column

```
SELECT groupArray(y) FROM t_null_big
```

```
groupArray(y)
| [2, 2, 3]
```

.`groupArray` does not include `NULL` in the resulting array

## Function Reference

### count

.Counts the number of rows or not-`NULL` values

ClickHouse supports the following syntaxes for `count` : - `count(expr)` or `COUNT(DISTINCT expr)` . - `count()` or `COUNT(*)` . The `. count()` syntax is ClickHouse-specific

#### Parameters

:The function can take

.Zero parameters •

.One `expression` •

#### Returned value

.If the function is called without parameters it counts the number of rows •

If the `expression` is passed, then the function counts how many times this expression returned not null. If the expression returns a `Nullable`-type value, then the result of `count` stays not `Nullable` . The function returns 0 if the expression returned `NULL` for all the rows

.In both cases the type of the returned value is `UInt64`

#### Details

ClickHouse supports the `COUNT(DISTINCT ...)` syntax. The behavior of this construction depends on the `count_distinctImplementation` setting. It defines which of the `uniq*` functions is used to perform the operation. The default .is the `uniqExact` function

The `SELECT count() FROM table` query is not optimized, because the number of entries in the table is not stored separately.  
.It chooses a small column from the table and counts the number of values in it

#### Examples

:Example 1

```
SELECT count() FROM t
```

```
count()
| 5
```

:Example 2

```
SELECT name, value FROM system.settings WHERE name = 'count_distinctImplementation'
```

name	value
count_distinctImplementation	uniqExact

```
SELECT count(DISTINCT num) FROM t
```

uniqExact(num)
3

This example shows that `count(DISTINCT num)` is performed by the `uniqExact` function according to the `.count_distinctImplementation` setting value

(any(x

Selects the first encountered value. The query can be executed in any order and even in a different order each time, so the result of this function is indeterminate. To get a determinate result, you can use the 'min' or 'max' function instead of `.any`

In some cases, you can rely on the order of execution. This applies to cases when `SELECT` comes from a subquery that `.uses ORDER BY`

When a `SELECT` query has the `GROUP BY` clause or at least one aggregate function, ClickHouse (in contrast to MySQL) requires that all expressions in the `SELECT`, `HAVING`, and `ORDER BY` clauses be calculated from keys or from aggregate functions. In other words, each column selected from the table must be used either in keys or inside aggregate functions.

To get behavior like in MySQL, you can put the other columns in the `any` aggregate function

(anyHeavy(x

Selects a frequently occurring value using the **heavy hitters** algorithm. If there is a value that occurs more than in half the `.cases` in each of the query's execution threads, this value is returned. Normally, the result is nondeterministic

```
anyHeavy(column)
```

Arguments

`.column` – The column name •

Example

.Take the **OnTime** data set and select any frequently occurring value in the `AirlineID` column

```
SELECT anyHeavy(AirlineID) AS res
FROM ontime
```

res
19690

(anyLast(x

.Selects the last value encountered. The result is just as indeterminate as for the `any` function

groupBitAnd

.Applies bitwise AND for series of numbers

```
groupBitAnd(expr)
```

Parameters

.expr – An expression that results in UInt\* type

Return value

.Value of the UInt\* type

Example

:Test data

```
binary decimal
00101100 = 44
00011100 = 28
00001101 = 13
01010101 = 85
```

:Query

```
SELECT groupBitAnd(num) FROM t
```

.Where num is the column with the test data

:Result

```
binary decimal
00000100 = 4
```

## groupBitOr

.Applies bitwise OR for series of numbers

```
groupBitOr(expr)
```

Parameters

.expr – An expression that results in UInt\* type

Return value

.Value of the UInt\* type

Example

:Test data

```
binary decimal
00101100 = 44
00011100 = 28
00001101 = 13
01010101 = 85
```

:Query

```
SELECT groupBitOr(num) FROM t
```

.Where `num` is the column with the test data

:Result

```
binary decimal
01111101 = 125
```

## groupBitXor

.Applies bitwise XOR for series of numbers

```
groupBitXor(expr)
```

Parameters

.`expr` – An expression that results in `UInt*` type

Return value

.Value of the `UInt*` type

Example

:Test data

```
binary decimal
00101100 = 44
00011100 = 28
00001101 = 13
01010101 = 85
```

:Query

```
SELECT groupBitXor(num) FROM t
```

.Where `num` is the column with the test data

:Result

```
binary decimal
01101000 = 104
```

## groupBitmap

Bitmap or Aggregate calculations from a unsigned integer column, return cardinality of type `UInt64`, if add suffix `-State`, .then return **bitmap object**

```
groupBitmap(expr)
```

Parameters

.`expr` – An expression that results in `UInt*` type

Return value

.Value of the UInt64 type

:Example

:Test data

```
UserID
1
1
2
2
3
```

:Query

```
SELECT groupBitmap(UserID) as num FROM t
```

:Result

```
num
3
```

(min(x

.Calculates the minimum

(max(x

.Calculates the maximum

(argMin(arg, val

Calculates the 'arg' value for a minimal 'val' value. If there are several different values of 'arg' for minimal values of 'val',  
.the first of these values encountered is output

:Example

user	salary
director	5000
manager	3000
worker	1000

```
SELECT argMin(user, salary) FROM salary
```

```
argMin(user, salary)
| worker
```

(argMax(arg, val

Calculates the 'arg' value for a maximum 'val' value. If there are several different values of 'arg' for maximum values of  
'val', the first of these values encountered is output

(sum(x

.Calculates the sum. Only works for numbers

### (sumWithOverflow(x

Computes the sum of the numbers, using the same data type for the result as for the input parameters. If the sum .exceeds the maximum value for this data type, the function returns an error

.Only works for numbers

### (sumMap(key, value

Totals the 'value' array according to the keys specified in the 'key' array. The number of elements in 'key' and 'value' must be the same for each row that is totaled. Returns a tuple of two arrays: keys in sorted order, and values summed for the .corresponding keys

:Example

```
CREATE TABLE sum_map(
 date Date,
 timeslot DateTime,
 statusMap Nested(
 status UInt16,
 requests UInt64
)
) ENGINE = Log;
INSERT INTO sum_map VALUES
('2000-01-01', '2000-01-01 00:00:00', [1, 2, 3], [10, 10, 10]),
('2000-01-01', '2000-01-01 00:00:00', [3, 4, 5], [10, 10, 10]),
('2000-01-01', '2000-01-01 00:01:00', [4, 5, 6], [10, 10, 10]),
('2000-01-01', '2000-01-01 00:01:00', [6, 7, 8], [10, 10, 10]);
SELECT
 timeslot,
 sumMap(statusMap.status, statusMap.requests)
FROM sum_map
GROUP BY timeslot
```

timeslot	sumMap(statusMap.status, statusMap.requests)
2000-01-01 00:00:00	([1,2,3,4,5],[10,10,20,10,10])
2000-01-01 00:01:00	([4,5,6,7,8],[10,10,20,10,10])

### skewPop

.Computes the **skewness** of a sequence

```
skewPop(expr)
```

Parameters

.expr — **Expression** returning a number

Returned value

The skewness of the given distribution. Type — **Float64**

Example

```
SELECT skewPop(value) FROM series_with_value_column
```

## skewSamp

.Computes the **sample skewness** of a sequence

.It represents an unbiased estimate of the skewness of a random variable if passed values form its sample

```
skewSamp(expr)
```

Parameters

.expr — **Expression** returning a number

Returned value

The skewness of the given distribution. Type —**Float64**. If `n <= 1` (`n` is the size of the sample), then the function returns

.nan

Example

```
SELECT skewSamp(value) FROM series_with_value_column
```

## kurtPop

.Computes the **kurtosis** of a sequence

```
kurtPop(expr)
```

Parameters

.expr — **Expression** returning a number

Returned value

The kurtosis of the given distribution. Type —**Float64**

Example

```
SELECT kurtPop(value) FROM series_with_value_column
```

## kurtSamp

.Computes the **sample kurtosis** of a sequence

.It represents an unbiased estimate of the kurtosis of a random variable if passed values form its sample

```
kurtSamp(expr)
```

Parameters

.expr — **Expression** returning a number

Returned value

.The kurtosis of the given distribution. Type —**Float64**. If `n <= 1` (`n` is a size of the sample), then the function returns nan

Example

```
SELECT kurtSamp(value) FROM series_with_value_column
```

(timeSeriesGroupSum(uid, timestamp, value

timeSeriesGroupSum can aggregate different time series that sample timestamp not alignment. It will use linear interpolation between two sample timestamp and then sum time-series together

. uid is the time series unique id, UInt64 •

. timestamp is Int64 type in order to support millisecond or microsecond •

. value is the metric •

.The function returns array of tuples with (timestamp, aggregated\_value) pairs

.Before using this function make sure timestamp is in ascending order

:Example

uid	timestamp	value
1	2	0.2
1	7	0.7
1	12	1.2
1	17	1.7
1	25	2.5
2	3	0.6
2	8	1.6
2	12	2.4
2	18	3.6
2	24	4.8

```
CREATE TABLE time_series(
 uid UInt64,
 timestamp Int64,
 value Float64
) ENGINE = Memory;
INSERT INTO time_series VALUES
(1,2,0.2),(1,7,0.7),(1,12,1.2),(1,17,1.7),(1,25,2.5),
(2,3,0.6),(2,8,1.6),(2,12,2.4),(2,18,3.6),(2,24,4.8);

SELECT timeSeriesGroupSum(uid, timestamp, value)
FROM (
 SELECT * FROM time_series ORDER BY timestamp ASC
);
```

:And the result will be

```
[(2,0.2),(3,0.9),(7,2.1),(8,2.4),(12,3.6),(17,5.1),(18,5.4),(24,7.2),(25,2.5)]
```

(timeSeriesGroupRateSum(uid, ts, val

Similarly timeSeriesGroupRateSum, timeSeriesGroupRateSum will Calculate the rate of time-series and then sum rates together. Also, timestamp should be in ascend order before use this function

:Use this function, the result above case will be

```
[(2,0),(3,0.1),(7,0.3),(8,0.3),(12,0.3),(17,0.3),(18,0.3),(24,0.3),(25,0.1)]
```

(avg(x

.Calculates the average. Only works for numbers. The result is always `Float64`

## uniq

.Calculates the approximate number of different values of the argument

```
uniq(x[, ...])
```

### Parameters

The function takes a variable number of parameters. Parameters can be `Tuple`, `Array`, `Date`, `DateTime`, `String`, or  
.numeric types

### Returned value

.A `UInt64`-type number •

### Implementation details

#### :Function

.Calculates a hash for all parameters in the aggregate, then uses it in calculations •

Uses an adaptive sampling algorithm. For the calculation state, the function uses a sample of element hash values up •  
.to 65536

This algorithm is very accurate and very efficient on the CPU. When the query contains several of these functions,  
.using `uniq` is almost as fast as using other aggregate functions

.(Provides the result deterministically (it doesn't depend on the query processing order •

.We recommend using this function in almost all scenarios

### See Also

[uniqCombined](#) •

[uniqCombined64](#) •

[uniqHLL12](#) •

[uniqExact](#) •

## uniqCombined

.Calculates the approximate number of different argument values

```
uniqCombined(HLL_precision)(x[, ...])
```

.The `uniqCombined` function is a good choice for calculating the number of different values

### Parameters

The function takes a variable number of parameters. Parameters can be `Tuple`, `Array`, `Date`, `DateTime`, `String`, or  
.numeric types

`HLL_precision` is the base-2 logarithm of the number of cells in [HyperLogLog](#). Optional, you can use the function as  
`uniqCombined(x[, ...])`. The default value for `HLL_precision` is 17, which is effectively 96 KiB of space (2^17 cells, 6 bits  
.each

### Returned value

.A number **UInt64**-type number •

Implementation details

:Function

Calculates a hash (64-bit hash for `String` and 32-bit otherwise) for all parameters in the aggregate, then uses it in •  
.calculations

.Uses a combination of three algorithms: array, hash table, and HyperLogLog with an error correction table •

For a small number of distinct elements, an array is used. When the set size is larger, a hash table is used. For a  
.larger number of elements, HyperLogLog is used, which will occupy a fixed amount of memory

.(Provides the result deterministically (it doesn't depend on the query processing order •

#### Note

Since it uses 32-bit hash for non- `String` type, the result will have very high error for cardinalities significantly larger than `UINT_MAX` (error will  
raise quickly after a few tens of billions of distinct values), hence in this case you should use **uniqCombined64**

:Compared to the **uniq** function, the **uniqCombined**

.Consumes several times less memory •

.Calculates with several times higher accuracy •

Usually has slightly lower performance. In some scenarios, **uniqCombined** can perform better than **uniq**, for example,  
.with distributed queries that transmit a large number of aggregation states over the network

See Also

**uniq** •

**uniqCombined64** •

**uniqHLL12** •

**uniqExact** •

## uniqCombined64

.Same as **uniqCombined**, but uses 64-bit hash for all data types

## uniqHLL12

.Calculates the approximate number of different argument values, using the **HyperLogLog** algorithm

`uniqHLL12(x[, ...])`

Parameters

The function takes a variable number of parameters. Parameters can be `Tuple`, `Array`, `Date`, `DateTime`, `String`, or  
.numeric types

Returned value

.A **UInt64**-type number •

Implementation details

:Function

.Calculates a hash for all parameters in the aggregate, then uses it in calculations •  
.Uses the HyperLogLog algorithm to approximate the number of different argument values •  
bit cells are used. The size of the state is slightly more than 2.5 KB. The result is not very accurate (up to 5–212 ~10% error) for small data sets (<10K elements). However, the result is fairly accurate for high-cardinality data sets (10K–100M), with a maximum error of ~1.6%. Starting from 100M, the estimation error increases, and the function will .(return very inaccurate results for data sets with extremely high cardinality (1B+ elements  
.Provides the determinate result (it doesn't depend on the query processing order •

.We don't recommend using this function. In most cases, use the [uniq](#) or [uniqCombined](#) function

See Also

[uniq](#) •

[uniqCombined](#) •

[uniqExact](#) •

## uniqExact

.Calculates the exact number of different argument values

```
uniqExact(x[, ...])
```

.Use the `uniqExact` function if you absolutely need an exact result. Otherwise use the [uniq](#) function

The `uniqExact` function uses more memory than `uniq`, because the size of the state has unbounded growth as the number .of different values increases

Parameters

The function takes a variable number of parameters. Parameters can be `Tuple`, `Array`, `Date`, `DateTime`, `String`, or .numeric types

See Also

[uniq](#) •

[uniqCombined](#) •

[uniqHLL12](#) •

## (groupArray(x), groupArray(max\_size))(x)

.Creates an array of argument values. Values can be added to the array in any (indeterminate) order

The second version (with the `max_size` parameter) limits the size of the resulting array to `max_size` elements. For .[(example, `groupArray(1)(x)` is equivalent to `[any(x`

In some cases, you can still rely on the order of execution. This applies to cases when `SELECT` comes from a subquery .that uses `ORDER BY`

## (groupArrayInsertAt(value, position

.Inserts a value into the array in the specified position

.This function uses zero-based positions, contrary to the conventional one-based positions for SQL arrays

Accepts the value and position as input. If several values are inserted into the same position, any of them might end up in the resulting array (the first one will be used in the case of single-threaded execution). If no value is inserted into a position, the position is assigned the default value

:Optional parameters

- .The default value for substituting in empty positions •

The length of the resulting array. This allows you to receive arrays of the same size for all the aggregate keys. When using this parameter, the default value must be specified

## groupArrayMovingSum

.Calculates the moving sum of input values

```
groupArrayMovingSum(numbers_for_summing)
groupArrayMovingSum(window_size)(numbers_for_summing)
```

The function can take the window size as a parameter. If left unspecified, the function takes the window size equal to the number of rows in the column

### Parameters

- . numbers\_for\_summing — **Expression** resulting in a numeric data type value •
- . window\_size — Size of the calculation window •

### Returned values

- .Array of the same size and type as the input data •

### Example

:The sample table

```
CREATE TABLE t
(
 `int` UInt8,
 `float` Float32,
 `dec` Decimal32(2)
)
ENGINE = TinyLog
```

int	float	dec
1	1.1	1.10
2	2.2	2.20
4	4.4	4.40
7	7.77	7.77

:The queries

```

SELECT
 groupArrayMovingSum(int) AS I,
 groupArrayMovingSum(float) AS F,
 groupArrayMovingSum(dec) AS D
FROM t

```

I	F	D
[1, 3, 7, 14]	[1.1, 3.3000002, 7.7000003, 15.47]	[1.10, 3.30, 7.70, 15.47]

```

SELECT
 groupArrayMovingSum(2)(int) AS I,
 groupArrayMovingSum(2)(float) AS F,
 groupArrayMovingSum(2)(dec) AS D
FROM t

```

I	F	D
[1, 3, 6, 11]	[1.1, 3.3000002, 6.6000004, 12.17]	[1.10, 3.30, 6.60, 12.17]

## groupArrayMovingAvg

.Calculates the moving average of input values

```

groupArrayMovingAvg(numbers_for_summing)
groupArrayMovingAvg(window_size)(numbers_for_summing)

```

The function can take the window size as a parameter. If left unspecified, the function takes the window size equal to the .number of rows in the column

### Parameters

- . numbers\_for\_summing — Expression resulting in a numeric data type value •
- . window\_size — Size of the calculation window •

### Returned values

- .Array of the same size and type as the input data •

.The function uses rounding towards zero. It truncates the decimal places insignificant for the resulting data type

### Example

:The sample table b

```

CREATE TABLE t
(
 `int` UInt8,
 `float` Float32,
 `dec` Decimal32(2)
)
ENGINE = TinyLog

```

int	float	dec
1	1.1	1.10
2	2.2	2.20
4	4.4	4.40
7	7.77	7.77

```
SELECT
 groupArrayMovingAvg(int) AS I,
 groupArrayMovingAvg(float) AS F,
 groupArrayMovingAvg(dec) AS D
FROM t
```

I	F	D
[0,0,1,3]	[0.275,0.82500005,1.9250001,3.8675]	[0.27,0.82,1.92,3.86]

```
SELECT
 groupArrayMovingAvg(2)(int) AS I,
 groupArrayMovingAvg(2)(float) AS F,
 groupArrayMovingAvg(2)(dec) AS D
FROM t
```

I	F	D
[0,1,3,5]	[0.55,1.6500001,3.3000002,6.085]	[0.55,1.65,3.30,6.08]

### (groupUniqArray(x), groupUniqArray(max\_size))(x)

.Creates an array from different argument values. Memory consumption is the same as for the `uniqExact` function

The second version (with the `max_size` parameter) limits the size of the resulting array to `max_size` elements. For  
.[example, `groupUniqArray(1)(x)` is equivalent to `[any(x`

### (quantile(level))(x)

Approximates the `level` quantile. `level` is a constant, a floating-point number from 0 to 1. We recommend using a `level`  
.value in the range of [0.01, 0.99]. Don't use a `level` value equal to 0 or 1 – use the `min` and `max` functions for these cases

In this function, as well as in all functions for calculating quantiles, the `level` parameter can be omitted. In this case, it is  
.assumed to be equal to 0.5 (in other words, the function will calculate the median

Works for numbers, dates, and dates with times. Returns: for numbers – `Float64` ; for dates – a date; for dates with times –  
.a date with time

Uses **reservoir sampling** with a reservoir size up to 8192. If necessary, the result is output with linear approximation from  
the two neighboring values. This algorithm provides very low accuracy. See also: `quantileTiming` , `quantileTDigest` ,  
. `quantileExact`

.The result depends on the order of running the query, and is nondeterministic

When using multiple `quantile` (and similar) functions with different levels in a query, the internal states are not combined  
. (that is, the query works less efficiently than it could). In this case, use the `quantiles` (and similar) functions

### (quantileDeterministic(level))(x, determinator)

Works the same way as the `quantile` function, but the result is deterministic and does not depend on the order of query  
.execution

To achieve this, the function takes a second argument – the "determinator". This is a number whose hash is used instead  
of a random number generator in the reservoir sampling algorithm. For the function to work correctly, the same  
.determinator value should not occur too often. For the determinator, you can use an event ID, user ID, and so on

.Don't use this function for calculating timings. There is a more suitable function for this purpose: `quantileTiming`

## quantileTiming

Computes the quantile of the specified level with determined precision. The function is intended for calculating page loading time quantiles in milliseconds

```
quantileTiming(level)(expr)
```

### Parameters

- .`[level]` — Quantile level. Range: [0, 1]
- `expr` — [Expression](#) returning a `Float*`-type number. The function expects input values in unix timestamp format in milliseconds, but it doesn't validate format
- .If negative values are passed to the function, the behavior is undefined
- .If the value is greater than 30,000 (a page loading time of more than 30 seconds), it is assumed to be 30,000

### Accuracy

- :The calculation is accurate if
  - .Total number of values doesn't exceed 5670
  - .Total number of values exceeds 5670, but the page loading time is less than 1024ms
  - .Otherwise, the result of the calculation is rounded to the nearest multiple of 16 ms

### Note

.For calculating page loading time quantiles, this function is more effective and accurate than [quantile](#)

### Returned value

- .Quantile of the specified level
- .Type: `Float32`

### Note

If no values are passed to the function (when using `quantileTimingIf`), `NaN` is returned. The purpose of this is to differentiate these cases from cases that result in zero. See [ORDER BY clause](#) for notes on sorting `NaN` values

.(The result is deterministic (it doesn't depend on the query processing order

### Example

```
SELECT quantileTiming(0.5)(number / 2) FROM numbers(10)
```

```
└─quantileTiming(0.5)(divide(number, 2))─
 2
```

## (`quantileTimingWeighted(level)(x, weight)`)

Differs from the `quantileTiming` function in that it has a second argument, "weights". Weight is a non-negative integer. The

.result is calculated as if the `x` value were passed `weight` number of times to the `quantileTiming` function

`(quantileExact(level))(x)`

Computes the quantile of 'level' exactly. To do this, all the passed values are combined into an array, which is then partially sorted. Therefore, the function consumes  $O(n)$  memory, where 'n' is the number of values that were passed. However, for a small number of values, the function is very effective

`(quantileExactWeighted(level))(x, weight)`

Computes the quantile of 'level' exactly. In addition, each value is counted with its weight, as if it is present 'weight' times. The arguments of the function can be considered as histograms, where the value 'x' corresponds to a histogram "column" of the height 'weight', and the function itself can be considered as a summation of histograms

A hash table is used as the algorithm. Because of this, if the passed values are frequently repeated, the function consumes less RAM than `quantileExact`. You can use this function instead of `quantileExact` and specify the weight as 1

`(quantileTDigest(level))(x)`

Approximates the quantile level using the **t-digest** algorithm. The maximum error is 1%. Memory consumption by State is proportional to the logarithm of the number of passed values

The performance of the function is lower than for `quantile` or `quantileTiming`. In terms of the ratio of State size to precision, this function is much better than `quantile`

.The result depends on the order of running the query, and is nondeterministic

`(median(x))`

All the quantile functions have corresponding median functions: `median`, `medianDeterministic`, `medianTiming`, `medianTimingWeighted`, `medianExact`, `medianExactWeighted`, `medianTDigest`. They are synonyms and their behavior is identical

`(quantiles(level1, level2, ...))(x)`

All the quantile functions also have corresponding quantiles functions: `quantiles`, `quantilesDeterministic`, `quantilesTiming`, `quantilesTimingWeighted`, `quantilesExact`, `quantilesExactWeighted`, `quantilesTDigest`. These functions calculate all the quantiles of the listed levels in one pass, and return an array of the resulting values

`(varSamp(x))`

.Calculates the amount  $\sum((x - \bar{x})^2) / (n - 1)$ , where `n` is the sample size and  $\bar{x}$  is the average value of `x`

.It represents an unbiased estimate of the variance of a random variable if passed values form its sample

. $\infty+$  Returns `Float64`. When `n <= 1`, returns

`(varPop(x))`

.Calculates the amount  $\sum((x - \bar{x})^2) / n$ , where `n` is the sample size and  $\bar{x}$  is the average value of `x`

.In other words, dispersion for a set of values. Returns `Float64`

(stddevSamp(x

. (The result is equal to the square root of varSamp(x

(stddevPop(x

. (The result is equal to the square root of varPop(x

(topK(N)(column

Returns an array of the most frequent values in the specified column. The resulting array is sorted in descending order of .(frequency of values (not by the values themselves

Implements the **Filtered Space-Saving** algorithm for analyzing TopK, based on the reduce-and-combine algorithm from .Parallel Space Saving

topK(N)(column)

This function doesn't provide a guaranteed result. In certain situations, errors might occur and it might return frequent .values that aren't the most frequent values

.We recommend using the N < 10 value; performance is reduced with large N values. Maximum value of N = 65536

Arguments

.N' is the number of values' •

.x' – The column' •

Example

.Take the **OnTime** data set and select the three most frequently occurring values in the **AirlineID** column

```
SELECT topK(3)(AirlineID) AS res
FROM ontime
```

```
res
[19393,19790,19805]
```

(covarSamp(x, y

. (Calculates the value of  $\sum((x - \bar{x})(y - \bar{y})) / (n - 1$

.∞+ Returns Float64. When n <= 1 , returns

(covarPop(x, y

.Calculates the value of  $\sum((x - \bar{x})(y - \bar{y})) / n$

(corr(x, y

. ((Calculates the Pearson correlation coefficient:  $\sum((x - \bar{x})(y - \bar{y})) / \sqrt{\sum((x - \bar{x})^2) * \sum((y - \bar{y})^2}$

categoricalInformationValue

.Calculates the value of  $(P(\text{tag} = 1) - P(\text{tag} = 0))(\log(P(\text{tag} = 1)) - \log(P(\text{tag} = 0)))$  for each category

```
categoricalInformationValue(category1, category2, ..., tag)
```

The result indicates how a discrete (categorical) feature [category1, category2, ...] contribute to a learning model which predicting the value of tag

## simpleLinearRegression

.Performs simple (unidimensional) linear regression

```
simpleLinearRegression(x, y)
```

:Parameters

.x — Column with dependent variable values •

.y — Column with explanatory variable values •

:Returned values

.Constants (a, b) of the resulting line  $y = a*x + b$

Examples

```
SELECT arrayReduce('simpleLinearRegression', [0, 1, 2, 3], [0, 1, 2, 3])
```

```
arrayReduce('simpleLinearRegression', [0, 1, 2, 3], [0, 1, 2, 3])—
| (1,0) |
```

```
SELECT arrayReduce('simpleLinearRegression', [0, 1, 2, 3], [3, 4, 5, 6])
```

```
arrayReduce('simpleLinearRegression', [0, 1, 2, 3], [3, 4, 5, 6])—
| (1,3) |
```

## stochasticLinearRegression

This function implements stochastic linear regression. It supports custom parameters for learning rate, L2 regularization coefficient, mini-batch size and has few methods for updating weights ([Adam](#) (used by default), [simple SGD](#), [Momentum](#), [\(Nesterov](#)

**Parameters**

There are 4 customizable parameters. They are passed to the function sequentially, but there is no need to pass all four - default values will be used, however good model required some parameter tuning

```
stochasticLinearRegression(1.0, 1.0, 10, 'SGD')
```

`learning rate` is the coefficient on step length, when gradient descent step is performed. Too big learning rate may cause infinite weights of the model. Default is 0.00001

`L2 regularization coefficient` which may help to prevent overfitting. Default is 0.1 .2

`mini-batch size` sets the number of elements, which gradients will be computed and summed to perform one step of .3 gradient descent. Pure stochastic descent uses one element, however having small batches (about 10 elements)

.make gradient steps more stable. Default is 15

method for updating weights , they are: Adam (by default), SGD , Momentum , Nesterov . Momentum and Nesterov require .4 little bit more computations and memory, however they happen to be useful in terms of speed of convergance and .stability of stochastic gradient methods

## Usage

stochasticLinearRegression is used in two steps: fitting the model and predicting on new data. In order to fit the model and save its state for later usage we use -State combinator, which basically saves the state (model weights, etc). To predict .we use function evalMLMethod, which takes a state as an argument as well as features to predict on

Fitting .1

.Such query may be used

```
CREATE TABLE IF NOT EXISTS train_data
(
 param1 Float64,
 param2 Float64,
 target Float64
) ENGINE = Memory;

CREATE TABLE your_model ENGINE = Memory AS SELECT
stochasticLinearRegressionState(0.1, 0.0, 5, 'SGD')(target, param1, param2)
AS state FROM train_data;
```

Here we also need to insert data into train\_data table. The number of parameters is not fixed, it depends only on number of arguments, passed into linearRegressionState . They all must be numeric values. Note that the column with target .value(which we would like to learn to predict) is inserted as the first argument

Predicting .2

After saving a state into the table, we may use it multiple times for prediction, or even merge with other states and create .new even better models

```
WITH (SELECT state FROM your_model) AS model SELECT
evalMLMethod(model, param1, param2) FROM test_data
```

The query will return a column of predicted values. Note that first argument of evalMLMethod is AggregateFunctionState .object, next are columns of features

.test\_data is a table like train\_data but may not contain target value

## Notes

To merge two models user may create such query: sql .1

SELECT state1 + state2 FROM your\_models where your\_models table contains both models. This query will return new .AggregateFunctionState object

User may fetch weights of the created model for its own purposes without saving the model if no -State combinator is .2 used. sql

SELECT stochasticLinearRegression(0.01)(target, param1, param2) FROM train\_data Such query will fit the model and return its weights - first are weights, which correspond to the parameters of the model, the last one is bias. So in the .example above the query will return a column with 3 values

See Also

- [stochasticLogisticRegression](#) •
- [Difference between linear and logistic regressions](#) •

## stochasticLogisticRegression

This function implements stochastic logistic regression. It can be used for binary classification problem, supports the same .custom parameters as stochasticLinearRegression and works the same way

### Parameters

Parameters are exactly the same as in stochasticLinearRegression: learning rate , l2 regularization coefficient , mini-batch size , . method for updating weights . For more information see [parameters](#)

```
stochasticLogisticRegression(1.0, 1.0, 10, 'SGD')
```

Fitting .1

.See the Fitting section in the [stochasticLinearRegression](#) description

.[Predicted labels have to be in [-1, 1]

Predicting .2

.Using saved state we can predict probability of object having label 1

sql

```
WITH (SELECT state FROM your_model) AS model SELECT
 evalMLMethod(model, param1, param2) FROM test_data
```

The query will return a column of probabilities. Note that first argument of evalMLMethod is AggregateFunctionState .object, next are columns of features

.We can also set a bound of probability, which assigns elements to different labels

sql

```
SELECT ans < 1.1 AND ans > 0.5 FROM
 WITH (SELECT state FROM your_model) AS model SELECT
 (evalMLMethod(model, param1, param2)) AS ans FROM test_data
```

.Then the result will be labels

. test\_data is a table like train\_data but may not contain target value

See Also

- [stochasticLinearRegression](#) •
- [Difference between linear and logistic regressions](#) •

## groupBitmapAnd

.Calculations the AND of a bitmap column, return cardinality of type UInt64, if add suffix -State, then return [bitmap object](#)

```
groupBitmapAnd(expr)
```

### Parameters

. expr – An expression that results in AggregateFunction(groupBitmap, UInt\*) type

Return value

.Value of the UInt64 type

Example

```

DROP TABLE IF EXISTS bitmap_column_expr_test2;
CREATE TABLE bitmap_column_expr_test2
(
 tag_id String,
 z AggregateFunction(groupBitmap, UInt32)
)
ENGINE = MergeTree
ORDER BY tag_id;

INSERT INTO bitmap_column_expr_test2 VALUES ('tag1', bitmapBuild(cast([1,2,3,4,5,6,7,8,9,10] as
Array(UInt32))));
INSERT INTO bitmap_column_expr_test2 VALUES ('tag2', bitmapBuild(cast([6,7,8,9,10,11,12,13,14,15] as
Array(UInt32))));
INSERT INTO bitmap_column_expr_test2 VALUES ('tag3', bitmapBuild(cast([2,4,6,8,10,12] as Array(UInt32))));

SELECT groupBitmapAnd(z) FROM bitmap_column_expr_test2 WHERE like(tag_id, 'tag%');

groupBitmapAnd(z)
 3

```

```

SELECT arraySort(bitmapToArray(groupBitmapAndState(z))) FROM bitmap_column_expr_test2 WHERE like(tag_id,
'tag%');
arraySort(bitmapToArray(groupBitmapAndState(z)))
| [6,8,10]

```

## groupBitmapOr

Calculations the OR of a bitmap column, return cardinality of type UInt64, if add suffix -State, then return **bitmap object**.  
 This is equivalent to `groupBitmapMerge`

`groupBitmapOr(expr)`

Parameters

`.expr` – An expression that results in `AggregateFunction(groupBitmap, UInt*)` type

Return value

.Value of the `UInt64` type

Example

```
DROP TABLE IF EXISTS bitmap_column_expr_test2;
CREATE TABLE bitmap_column_expr_test2
(
 tag_id String,
 z AggregateFunction(groupBitmap, UInt32)
)
ENGINE = MergeTree
ORDER BY tag_id;

INSERT INTO bitmap_column_expr_test2 VALUES ('tag1', bitmapBuild(cast([1,2,3,4,5,6,7,8,9,10] as Array(UInt32))));
INSERT INTO bitmap_column_expr_test2 VALUES ('tag2', bitmapBuild(cast([6,7,8,9,10,11,12,13,14,15] as Array(UInt32))));
INSERT INTO bitmap_column_expr_test2 VALUES ('tag3', bitmapBuild(cast([2,4,6,8,10,12] as Array(UInt32))));

SELECT groupBitmapOr(z) FROM bitmap_column_expr_test2 WHERE like(tag_id, 'tag%');
groupBitmapOr(z)
 15

SELECT arraySort(bitmapToArray(groupBitmapOrState(z))) FROM bitmap_column_expr_test2 WHERE like(tag_id, 'tag%');
arraySort(bitmapToArray(groupBitmapOrState(z)))
 [1,2,3,4,5,6,7,8,9,10,11,12,13,14,15]
```

**groupBitmapXor**

.Calculations the XOR of a bitmap column, return cardinality of type UInt64, if add suffix -State, then return bitmap object

`groupBitmapOr(expr)`

## Parameters

.expr – An expression that results in `AggregateFunction(groupBitmap, UInt*)` type

## Return value

.Value of the UInt64 type

## Example

```
DROP TABLE IF EXISTS bitmap_column_expr_test2;
CREATE TABLE bitmap_column_expr_test2
(
 tag_id String,
 z AggregateFunction(groupBitmap, UInt32)
)
ENGINE = MergeTree
ORDER BY tag_id;

INSERT INTO bitmap_column_expr_test2 VALUES ('tag1', bitmapBuild(cast([1,2,3,4,5,6,7,8,9,10] as
Array(UInt32))));

INSERT INTO bitmap_column_expr_test2 VALUES ('tag2', bitmapBuild(cast([6,7,8,9,10,11,12,13,14,15] as
Array(UInt32))));

INSERT INTO bitmap_column_expr_test2 VALUES ('tag3', bitmapBuild(cast([2,4,6,8,10,12] as Array(UInt32))));

SELECT groupBitmapXor(z) FROM bitmap_column_expr_test2 WHERE like(tag_id, 'tag%');
groupBitmapXor(z)
 10

SELECT arraySort(bitmapToArray(groupBitmapXorState(z))) FROM bitmap_column_expr_test2 WHERE like(tag_id,
'tag%');
arraySort(bitmapToArray(groupBitmapXorState(z)))
 [1,3,5,6,8,10,11,13,14,15]
```

## Aggregate function combinators

. The name of an aggregate function can have a suffix appended to it. This changes the way the aggregate function works

If-

The suffix `-If` can be appended to the name of any aggregate function. In this case, the aggregate function accepts an extra argument – a condition (Uint8 type). The aggregate function processes only the rows that trigger the condition. If the condition was not triggered even once, it returns a default value (usually zeros or empty strings).

Examples: `sumIf(column, cond)` , `countIf(cond)` , `avgIf(x, cond)` , `quantilesTimingIf(level1, level2)(x, cond)` , `argMinIf(arg, val, cond)` .and so on

With conditional aggregate functions, you can calculate aggregates for several conditions at once, without using subqueries and JOINs. For example, in Yandex.Metrica, conditional aggregate functions are used to implement the .segment comparison functionality

## Array-

The `-Array` suffix can be appended to any aggregate function. In this case, the aggregate function takes arguments of the `'Array(T)` type (arrays) instead of `'T'` type arguments. If the aggregate function accepts multiple arguments, this must be arrays of equal lengths. When processing arrays, the aggregate function works like the original aggregate function across all array elements.

Example 1: `sumArray(arr)` - Totals all the elements of all 'arr' arrays. In this example, it could have been written more . ((simply: `sum(arraySum(arr`

Example 2: `uniqArray(arr)` – Counts the number of unique elements in all 'arr' arrays. This could be done an easier way: `.uniq(arrayJoin(arr))`, but it's not always possible to add 'arrayJoin' to a query

If and -Array can be combined. However, 'Array' must come first, then 'If'. Examples: `uniqArrayIf(arr, cond)` , -  
`.quantilesTimingArrayIf(level1, level2)(arr, cond)` . Due to this order, the 'cond' argument won't be an array

## State-

If you apply this combinator, the aggregate function doesn't return the resulting value (such as the number of unique values for the `uniq` function), but an intermediate state of the aggregation (for `uniq`, this is the hash table for calculating the number of unique values). This is an `AggregateFunction(...)` that can be used for further processing or stored in a table to .`finish` aggregating later

:To work with these states, use

- `.AggregatingMergeTree` table engine
- `.finalizeAggregation` function
- `.runningAccumulate` function
- `.Merge` combinator
- `.MergeState` combinator

## Merge-

If you apply this combinator, the aggregate function takes the intermediate aggregation state as an argument, combines .the states to finish aggregation, and returns the resulting value

## MergeState-

Merges the intermediate aggregation states in the same way as the `-Merge` combinator. However, it doesn't return the .resulting value, but an intermediate aggregation state, similar to the `-State` combinator

## ForEach-

Converts an aggregate function for tables into an aggregate function for arrays that aggregates the corresponding array items and returns an array of results. For example, `sumForEach` for the arrays `[1, 2]`, `[3, 4, 5]` and `[6, 7]` returns the result .`[10, 13, 5]` after adding together the corresponding array items

## OrDefault-

.Fills the default value of the aggregate function's return type if there is nothing to aggregate

```
SELECT avg(number), avgOrDefault(number) FROM numbers(0)
```

avg(number)	avgOrDefault(number)
nan	0

## OrNull-

.Fills `null` if there is nothing to aggregate. The return column will be nullable

```
SELECT avg(number), avgOrNull(number) FROM numbers(0)
```

avg(number)	avgOrNull(number)
nan	NULL

OrDefault and `-OrNull` can be combined with other combinators. It is useful when the aggregate function does not accept-

.the empty input

```
SELECT avgOrNullIf(x, x > 10)
FROM
(
 SELECT toDecimal32(1.23, 2) AS x
)
```

```
avgOrNullIf(x, greater(x, 10))
 NULL
```

## Resample-

Lets you divide data into groups, and then separately aggregates the data in those groups. Groups are created by splitting  
.the values from one column into intervals

```
<aggFunction>Resample(start, end, step)(<aggFunction_params>, resampling_key)
```

### Parameters

- . start — Starting value of the whole required interval for `resampling_key` values •
- stop — Ending value of the whole required interval for `resampling_key` values. The whole interval doesn't include the •  
. ( stop value [start, stop]
- step — Step for separating the whole interval into subintervals. The `aggFunction` is executed over each of those •  
.subintervals independently
- . `resampling_key` — Column whose values are used for separating data into intervals •
- . `aggFunction_params` — `aggFunction` parameters •

### Returned values

- .Array of `aggFunction` results for each subinterval •

### Example

:Consider the `people` table with the following data

name	age	wage
John	16	10
Alice	30	15
Mary	35	8
Evelyn	48	11.5
David	62	9.9
Brian	60	16

Let's get the names of the people whose age lies in the intervals of [30,60) and [60,75) . Since we use integer  
.representation for age, we get ages in the [30, 59] and [60,74] intervals

To aggregate names in an array, we use the `groupArray` aggregate function. It takes one argument. In our case, it's the  
`name` column. The `groupArrayResample` function should use the `age` column to aggregate names by age. To define the  
.required intervals, we pass the 30, 75, 30 arguments into the `groupArrayResample` function

```
SELECT groupArrayResample(30, 75, 30)(name, age) FROM people
```

```
groupArrayResample(30, 75, 30)(name, age)
| [['Alice', 'Mary', 'Evelyn'], ['David', 'Brian']] |
```

.Consider the results

. John is out of the sample because he's too young. Other people are distributed according to the specified age intervals

.Now let's count the total number of people and their average wage in the specified age intervals

```
SELECT
 countResample(30, 75, 30)(name, age) AS amount,
 avgResample(30, 75, 30)(wage, age) AS avg_wage
FROM people
```

amount	avg_wage
[3, 2]	[11.5, 12.949999809265137]

## Parametric aggregate functions

Some aggregate functions can accept not only argument columns (used for compression), but a set of parameters – constants for initialization. The syntax is two pairs of brackets instead of one. The first is for parameters, and the second is .for arguments

### histogram

.Calculates an adaptive histogram. It doesn't guarantee precise results

```
histogram(number_of_bins)(values)
```

The function uses **A Streaming Parallel Decision Tree Algorithm**. The borders of histogram bins are adjusted as new .data enters a function. In common case, the widths of bins are not equal

#### Parameters

`number_of_bins` — Upper limit for the number of bins in the histogram. The function automatically calculates the number of bins. It tries to reach the specified number of bins, but if it fails, it uses fewer bins. `values` — **Expression** resulting in input .values

#### Returned values

:**Array of Tuples** of the following format •

```
[(lower_1, upper_1, height_1), ... (lower_N, upper_N, height_N)]
```

. `lower` — Lower bound of the bin •

. `upper` — Upper bound of the bin •

. `height` — Calculated height of the bin •

#### Example

```

SELECT histogram(5)(number + 1)
FROM (
 SELECT *
 FROM system.numbers
 LIMIT 20
)

```

```

└─histogram(5)(plus(number, 1))──
| [(1,4.5,4),(4.5,8.5,4),(8.5,12.75,4.125),(12.75,17,4.625),(17,20,3.25)] ┌

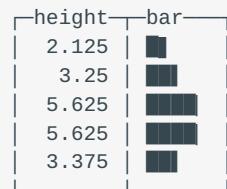
```

:You can visualize a histogram with the **bar** function, for example

```

WITH histogram(5)(rand() % 100) AS hist
SELECT
 arrayJoin(hist).3 AS height,
 bar(height, 0, 6, 5) AS bar
FROM
(
 SELECT *
 FROM system.numbers
 LIMIT 20
)

```



.In this case, you should remember that you don't know the histogram bin borders

**(... ,sequenceMatch(pattern)(timestamp, cond1, cond2**

**.Checks whether the sequence contains an event chain that matches the pattern**

```
sequenceMatch(pattern)(timestamp, cond1, cond2, ...)
```

### Warning

.Events that occur at the same second may lay in the sequence in an undefined order affecting the result

### Parameters

- . pattern** — Pattern string. See [Pattern syntax](#)

- timestamp** — Column considered to contain time data. Typical data types are `Date` and `DateTime`. You can also use `.any` of the supported [UInt](#) data types

- cond1 , cond2** — Conditions that describe the chain of events. Data type: `UInt8`. You can pass up to 32 condition arguments. The function takes only the events described in these conditions into account. If the sequence contains data that isn't described in a condition, the function skips them

### Returned values

- .if the pattern is matched ,1**

- .if the pattern isn't matched ,0**

.Type: UInt8

## Pattern syntax

- N) — Matches the condition argument at position N . Conditions are numbered in the [1, 32] range. For example, ?  
•  
. (?1) matches the argument passed to the cond1 parameter
- .Matches any number of events. You don't need conditional arguments to match this element of the pattern — \*. •
- t operator value) — Sets the time in seconds that should separate two events. For example, pattern (?1)(?t>1800)(?2) ?  
•  
matches events that occur more than 1800 seconds from each other. An arbitrary number of any events can lay  
.between these events. You can use the >= , > , < , <= operators

## Examples

:Consider data in the t table

time	number
1	1
2	3
3	2

:Perform the query

```
SELECT sequenceMatch('(?1)(?2)')(time, number = 1, number = 2) FROM t
```

```
sequenceMatch('(?1)(?2)')(time, equals(number, 1), equals(number, 2))
```

1

The function found the event chain where number 2 follows number 1. It skipped number 3 between them, because the number is not described as an event. If we want to take this number into account when searching for the event chain .given in the example, we should make a condition for it

```
SELECT sequenceMatch('(?1)(?2)')(time, number = 1, number = 2, number = 3) FROM t
```

```
sequenceMatch('(?1)(?2)')(time, equals(number, 1), equals(number, 2), equals(number, 3))
```

0

In this case, the function couldn't find the event chain matching the pattern, because the event for number 3 occurred .between 1 and 2. If in the same case we checked the condition for number 4, the sequence would match the pattern

```
SELECT sequenceMatch('(?1)(?2)')(time, number = 1, number = 2, number = 4) FROM t
```

```
sequenceMatch('(?1)(?2)')(time, equals(number, 1), equals(number, 2), equals(number, 4))
```

1

## See Also

[sequenceCount](#) •

(... ,sequenceCount(pattern)(time, cond1, cond2

Counts the number of event chains that matched the pattern. The function searches event chains that don't overlap. It .starts to search for the next chain after the current chain is matched

.Events that occur at the same second may lay in the sequence in an undefined order affecting the result

```
sequenceCount(pattern)(timestamp, cond1, cond2, ...)
```

#### Parameters

- pattern** — Pattern string. See [Pattern syntax](#)
- timestamp** — Column considered to contain time data. Typical data types are `Date` and `DateTime`. You can also use any of the supported `UInt` data types
- cond1**, **cond2** — Conditions that describe the chain of events. Data type: `UInt8`. You can pass up to 32 condition arguments. The function takes only the events described in these conditions into account. If the sequence contains data that isn't described in a condition, the function skips them

#### Returned values

- .Number of non-overlapping event chains that are matched
- .Type: `UInt64`

#### Example

:Consider data in the `t` table

time	number
1	1
2	3
3	2
4	1
5	3
6	2

:Count how many times the number 2 occurs after the number 1 with any amount of other numbers between them

```
SELECT sequenceCount('(?1).*(?2)')(time, number = 1, number = 2) FROM t
```

```
sequenceCount('(?1).*(?2)')(time, equals(number, 1), equals(number, 2))
```

#### See Also

[sequenceMatch](#)

`(... ,windowFunnel(window, [mode])(timestamp, cond1, cond2, cond3`

Searches for event chains in a sliding time window and calculates the maximum number of events that occurred from the .chain

```
windowFunnel(window, [mode])(timestamp, cond1, cond2, cond3, ...)
```

#### Parameters

- .window — Length of the sliding window in seconds

- . mode - It is an optional argument •
- . strict' - When the 'strict' is set, the windowFunnel() applies conditions only for the unique values' •
- timestamp — Name of the column containing the timestamp. Data types supported: Date , DateTime , and other •
- unsigned integer types (note that even though timestamp supports the UInt64 type, its value can't exceed the Int64 •
- .(maximum, which is  $2^{63} - 1$
- . cond1 , cond2 ... — Conditions or data describing the chain of events. Data type: UInt8 . Values can be 0 or 1 •

## Algorithm

The function searches for data that triggers the first condition in the chain and sets the event counter to 1. This is the •  
.moment when the sliding window starts

If events from the chain occur sequentially within the window, the counter is incremented. If the sequence of events is •  
.disrupted, the counter isn't incremented

If the data has multiple event chains at varying points of completion, the function will only output the size of the •  
.longest chain

## Returned value

Integer. The maximum number of consecutive triggered conditions from the chain within the sliding time window. All •  
.the chains in the selection are analyzed

## Example

.Determine if one hour is enough for the user to select a phone and purchase it in the online store  
:Set the following chain of events

.(The user logged in to their account on the store (eventID=1001 .1  
.('The user searches for a phone (eventID = 1003, product = 'phone .2  
.('The user placed an order (eventID = 1009 .3

:To find out how far the user user\_id could get through the chain in an hour in January of 2017, make the query

```

SELECT
 level,
 count() AS c
FROM
(
 SELECT
 user_id,
 windowFunnel(3600)(timestamp, eventID = 1001, eventID = 1003 AND product = 'phone', eventID =
1009) AS level
 FROM trend_event
 WHERE (event_date >= '2017-01-01') AND (event_date <= '2017-01-31')
 GROUP BY user_id
)
GROUP BY level
ORDER BY level

```

.Simply, the level value could only be 0, 1, 2, 3, it means the maximum event action stage that one user could reach

(... ,retention(cond1, cond2

.Retention refers to the ability of a company or product to retain its customers over some specified periods

cond1 , cond2 ... is from one to 32 arguments of type UInt8 that indicate whether a certain condition was met for the event

:Example

Consider you are doing a website analytics, intend to calculate the retention of customers

This could be easily calculate by retention

```
SELECT
 sum(r[1]) AS r1,
 sum(r[2]) AS r2,
 sum(r[3]) AS r3
FROM
(
 SELECT
 uid,
 retention(date = '2018-08-10', date = '2018-08-11', date = '2018-08-12') AS r
 FROM events
 WHERE date IN ('2018-08-10', '2018-08-11', '2018-08-12')
 GROUP BY uid
)
```

Simply, `r1` means the number of unique visitors who met the `cond1` condition, `r2` means the number of unique visitors who met `cond1` and `cond2` conditions, `r3` means the number of unique visitors who met `cond1` and `cond3` conditions

(`uniqUpTo(N)(x`

Calculates the number of different argument values if it is less than or equal to N. If the number of different argument values is greater than N, it returns N + 1

.Recommended for use with small Ns, up to 10. The maximum value of N is 100

For the state of an aggregate function, it uses the amount of memory equal to  $1 + N * \text{the size of one value of bytes}$ . For strings, it stores a non-cryptographic hash of 8 bytes. That is, the calculation is approximated for strings

.The function also works for several arguments

It works as fast as possible, except for cases when a large N value is used and the number of unique values is slightly less than N

:Usage example

Problem: Generate a report that shows only keywords that produced at least 5 unique users.

Solution: Write in the GROUP BY query `SearchPhrase HAVING uniqUpTo(4)(UserID) >= 5`

(`sumMapFiltered(keys_to_keep)(keys, values`

Same behavior as `sumMap` except that an array of keys is passed as a parameter. This can be especially useful when working with a high cardinality of keys

## Table Functions

.Table functions are methods for constructing tables

:You can use table functions in

.`CREATE TABLE AS` query •

.It's one of the methods of creating a table

.`FROM` clause of the `SELECT` query •

The method for creating a temporary table that is available only in the current query. The table is deleted when the query finishes

## Warning

. You can't use table functions if the `allow_ddl` setting is disabled

	Description	Function
	.Creates a <b>File</b> -engine table	<code>file</code>
	.Creates a <b>Merge</b> -engine table	<code>merge</code>
	.Creates a table with a single column filled with integer numbers	<code>numbers</code>
	.Allows you to access remote servers without creating a <b>Distributed</b> -engine table	<code>remote</code>
	.Creates a <b>Url</b> -engine table	<code>url</code>
	.Creates a <b>MySQL</b> -engine table	<code>mysql</code>
	.Creates a <b>JDBC</b> -engine table	<code>jdbc</code>
	.Creates a <b>ODBC</b> -engine table	<code>odbc</code>
	.Creates a <b>HDFS</b> -engine table	<code>hdfs</code>

## `file`

.Creates a table from a file. This table function is similar to `url` and `hdfs` ones

```
file(path, format, structure)
```

### Input parameters

`path` — The relative path to the file from `user_files_path`. Path to file support following globs in readonly mode: \*, ?, • . {abc,def} and {N..M} where N, M — numbers, 'abc', 'def' — strings  
• `format` — The `format` of the file  
• `structure` — Structure of the table. Format 'column1\_name column1\_type, column2\_name column2\_type'

### Returned value

.A table with the specified structure for reading or writing data in the specified file

### Example

```
:Setting user_files_path and the contents of the file test.csv
```

```
$ grep user_files_path /etc/clickhouse-server/config.xml
<user_files_path>/var/lib/clickhouse/user_files/</user_files_path>

$ cat /var/lib/clickhouse/user_files/test.csv
1,2,3
3,2,1
78,43,45
```

:Table from test.csv and selection of the first two rows from it

```
SELECT *
FROM file('test.csv', 'CSV', 'column1 UInt32, column2 UInt32, column3 UInt32')
LIMIT 2
```

column1	column2	column3
1	2	3
3	2	1

```
-- getting the first 10 lines of a table that contains 3 columns of UInt32 type from a CSV file
SELECT * FROM file('test.csv', 'CSV', 'column1 UInt32, column2 UInt32, column3 UInt32') LIMIT 10
```

## Globs in path

Multiple path components can have globs. For being processed file should exists and matches to the whole path pattern  
.((not only suffix or prefix

- .Substitutes any number of any characters except / including empty string — \*
- .Substitutes any single character — ?
- . 'some\_string,another\_string,yet\_another\_one} — Substitutes any of strings 'some\_string', 'another\_string', 'yet\_another\_one }
- . N..M} — Substitutes any number in range from N to M including both borders}
- .(Constructions with {} are similar to the [remote table function](#)

## Example

:Suppose we have several files with the following relative paths .1

'some\_dir/some\_file\_1' .2  
'some\_dir/some\_file\_2' .3  
'some\_dir/some\_file\_3' .4  
'another\_dir/some\_file\_1' .5  
'another\_dir/some\_file\_2' .6  
'another\_dir/some\_file\_3' .7

:Query the amount of rows in these files .8

```
SELECT count(*)
FROM file('{some,another}_dir/some_file_{1..3}', 'TSV', 'name String, value UInt32')
```

:Query the amount of rows in all files of these two directories .1

```
SELECT count(*)
FROM file('{some,another}_dir/*', 'TSV', 'name String, value UInt32')
```

## Warning

. ? If your listing of files contains number ranges with leading zeros, use the construction with braces for each digit separately or use

## Example

:Query the data from files named file000 , file001 , ... , file999

```
SELECT count(*)
FROM file('big_dir/file{0..9}{0..9}{0..9}', 'CSV', 'name String, value UInt32')
```

## merge

merge(db\_name, 'tables\_regexp') – Creates a temporary Merge table. For more information, see the section "Table engines, .Merge

.The table structure is taken from the first table encountered that matches the regular expression

## numbers

numbers(N) – Returns a table with the single 'number' column (UInt64) that contains integers from 0 to N-1.

.numbers(N, M) – Returns a table with the single 'number' column (UInt64) that contains integers from N to (N + M - 1)

Similar to the system.numbers table, it can be used for testing and generating successive values, numbers(N, M) more efficient than system.numbers

:The following queries are equivalent

```
SELECT * FROM numbers(10);
SELECT * FROM numbers(0, 10);
SELECT * FROM system.numbers LIMIT 10;
```

:Examples

```
-- Generate a sequence of dates from 2010-01-01 to 2010-12-31
select toDate('2010-01-01') + number as d FROM numbers(365);
```

## remote, remoteSecure

.Allows you to access remote servers without creating a Distributed table

:Signatures

```
remote('addresses_expr', db, table[, 'user'][, 'password']])
remote('addresses_expr', db.table[, 'user'][, 'password'])
```

addresses\_expr – An expression that generates addresses of remote servers. This may be just one server address. The server address is host:port , or just host . The host can be specified as the server name, or as the IPv4 or IPv6 address. An IPv6 address is specified in square brackets. The port is the TCP port on the remote server. If the port is omitted, it uses .( tcp\_port from the server's config file (by default, 9000

**Important** 

.The port is required for an IPv6 address

:Examples

```
example01-01-1
example01-01-1:9000
localhost
127.0.0.1
[:]:9000
[2a02:6b8:0:1111::11]:9000
```

Multiple addresses can be comma-separated. In this case, ClickHouse will use distributed processing, so it will send the .(query to all specified addresses (like to shards with different data

:Example

```
example01-01-1, example01-02-1
```

:Part of the expression can be specified in curly brackets. The previous example can be written as follows

```
example01-0{1,2}-1
```

Curly brackets can contain a range of numbers separated by two dots (non-negative integers). In this case, the range is expanded to a set of values that generate shard addresses. If the first number starts with zero, the values are formed with the same zero alignment. The previous example can be written as follows

```
example01-{01..02}-1
```

.If you have multiple pairs of curly brackets, it generates the direct product of the corresponding sets

Addresses and parts of addresses in curly brackets can be separated by the pipe symbol (|). In this case, the corresponding sets of addresses are interpreted as replicas, and the query will be sent to the first healthy replica.

.However, the replicas are iterated in the order currently set in the [load\\_balancing](#) setting

:Example

```
example01-{01..02}-{1|2}
```

.This example specifies two shards that each have two replicas

.The number of addresses generated is limited by a constant. Right now this is 1000 addresses

Using the `remote` table function is less optimal than creating a `Distributed` table, because in this case, the server connection is re-established for every request. In addition, if host names are set, the names are resolved, and errors are not counted when working with various replicas. When processing a large number of queries, always create the `Distributed` table ahead of time, and don't use the `remote` table function

:The `remote` table function can be useful in the following cases

- Accessing a specific server for data comparison, debugging, and testing
- Queries between various ClickHouse clusters for research purposes
- Infrequent distributed requests that are made manually
- Distributed requests where the set of servers is re-defined each time

.If the user is not specified, `default` is used. If the password is not specified, an empty password is used

.`remoteSecure` - same as `remote` but with secured connection. Default port —[tcp\\_port\\_secure](#) from config or 9440

## url

.`url(URL, format, structure)` - returns a table created from the `URL` with given `format` and `structure`

.`URL` - HTTP or HTTPS server address, which can accept GET and/or POST requests

.`format` - [format](#) of the data

.`structure` - table structure in 'UserID UInt64, Name String' format. Determines column names and types

Example

```
-- getting the first 3 lines of a table that contains columns of String and UInt32 type from HTTP-server
which answers in CSV format.
```

```
SELECT * FROM url('http://127.0.0.1:12345/', CSV, 'column1 String, column2 UInt32') LIMIT 3
```

## mysql

.Allows SELECT queries to be performed on data that is stored on a remote MySQL server

```
mysql('host:port', 'database', 'table', 'user', 'password'[, replace_query, 'on_duplicate_clause']);
```

### Parameters

- . host:port — MySQL server address •
- . database — Remote database name •
- . table — Remote table name •
- . user — MySQL user •
- . password — User password •

.replace\_query — Flag that converts INSERT INTO queries to REPLACE INTO . If replace\_query=1 , the query is replaced •

.on\_duplicate\_clause — The ON DUPLICATE KEY on\_duplicate\_clause expression that is added to the INSERT query •

Example: INSERT INTO t (c1,c2) VALUES ('a', 2) ON DUPLICATE KEY UPDATE c2 = c2 + 1 , where on\_duplicate\_clause is UPDATE c2 = c2 + 1 . See the MySQL documentation to find which on\_duplicate\_clause you can use with the ON DUPLICATE KEY clause

To specify on\_duplicate\_clause you need to pass 0 to the replace\_query parameter. If you simultaneously pass .replace\_query = 1 and on\_duplicate\_clause , ClickHouse generates an exception

.Simple WHERE clauses such as =, !=, >, >=, <, <= are currently executed on the MySQL server

The rest of the conditions and the LIMIT sampling constraint are executed in ClickHouse only after the query to MySQL .finishes

### Returned Value

.A table object with the same columns as the original MySQL table

## Usage Example

:Table in MySQL

```
mysql> CREATE TABLE `test`.`test` (
 -> `int_id` INT NOT NULL AUTO_INCREMENT,
 -> `int_nullable` INT NULL DEFAULT NULL,
 -> `float` FLOAT NOT NULL,
 -> `float_nullable` FLOAT NULL DEFAULT NULL,
 -> PRIMARY KEY (`int_id`));
Query OK, 0 rows affected (0,09 sec)
```

```
mysql> insert into test (`int_id`, `float`) VALUES (1,2);
Query OK, 1 row affected (0,00 sec)
```

```
mysql> select * from test;
+-----+-----+-----+-----+
| int_id | int_nullable | float | float_nullable |
+-----+-----+-----+-----+
| 1 | NULL | 2 | NULL |
+-----+-----+-----+-----+
1 row in set (0,00 sec)
```

:Selecting data from ClickHouse

```
SELECT * FROM mysql('localhost:3306', 'test', 'test', 'bayonet', '123')
```

int_id	int_nullable	float	float_nullable
1	NULL	2	NULL

## See Also

- [The 'MySQL' table engine](#) •
- [Using MySQL as a source of external dictionary](#) •

## jdbc

. jdbc(jdbc\_connection\_uri, schema, table) - returns table that is connected via JDBC driver

This table function requires separate `clickhouse-jdbc-bridge` program to be running. It supports Nullable types (based on .(DDL of remote table that is queried

## Examples

```
SELECT * FROM jdbc('jdbc:mysql://localhost:3306/?user=root&password=root', 'schema', 'table')
```

```
SELECT * FROM jdbc('mysql://localhost:3306/?user=root&password=root', 'schema', 'table')
```

```
SELECT * FROM jdbc('datasource://mysql-local', 'schema', 'table')
```

## odbc

. Returns table that is connected via [ODBC](#)

```
odbc(connection_settings, external_database, external_table)
```

:Parameters

. connection\_settings — Name of the section with connection settings in the `odbc.ini` file •

. external\_database — Name of a database in an external DBMS •  
. external\_table — Name of a table in the external\_database •

To safely implement ODBC connections, ClickHouse uses a separate program `clickhouse-odbc-bridge`. If the ODBC driver is loaded directly from `clickhouse-server`, driver problems can crash the ClickHouse server. ClickHouse automatically starts `clickhouse-odbc-bridge` when it is required. The ODBC bridge program is installed from the same package as the `clickhouse-server`.

The fields with the `NULL` values from the external table are converted into the default values for the base data type. For example, if a remote MySQL table field has the `INT NULL` type it is converted to 0 (the default value for ClickHouse `Int32` data type).

## Usage example

Getting data from the local MySQL installation via ODBC

This example is checked for Ubuntu Linux 18.04 and MySQL server 5.7

. Ensure that unixODBC and MySQL Connector are installed

By default (if installed from packages), ClickHouse starts as user `clickhouse`. Thus you need to create and configure this user in the MySQL server

```
$ sudo mysql
```

```
mysql> CREATE USER 'clickhouse'@'localhost' IDENTIFIED BY 'clickhouse';
mysql> GRANT ALL PRIVILEGES ON *.* TO 'clickhouse'@'clickhouse' WITH GRANT OPTION;
```

. Then configure the connection in `/etc/odbc.ini`

```
$ cat /etc/odbc.ini
[mysqlconn]
DRIVER = /usr/local/lib/libmyodbc5w.so
SERVER = 127.0.0.1
PORT = 3306
DATABASE = test
USERNAME = clickhouse
PASSWORD = clickhouse
```

. You can check the connection using the `isql` utility from the unixODBC installation

```
$ isql -v mysqlconn
+-----+
| Connected!
|
| ...
|
```

:Table in MySQL

```

mysql> CREATE TABLE `test`.`test` (
 -> `int_id` INT NOT NULL AUTO_INCREMENT,
 -> `int_nullable` INT NULL DEFAULT NULL,
 -> `float` FLOAT NOT NULL,
 -> `float_nullable` FLOAT NULL DEFAULT NULL,
 -> PRIMARY KEY (`int_id`));
Query OK, 0 rows affected (0,09 sec)

mysql> insert into test (`int_id`, `float`) VALUES (1,2);
Query OK, 1 row affected (0,00 sec)

mysql> select * from test;
+-----+-----+-----+-----+
| int_id | int_nullable | float | float_nullable |
+-----+-----+-----+-----+
| 1 | NULL | 2 | NULL |
+-----+-----+-----+-----+
1 row in set (0,00 sec)

```

:Retrieving data from the MySQL table in ClickHouse

```
SELECT * FROM odbc('DSN=mysqlconn', 'test', 'test')
```

int_id	int_nullable	float	float_nullable
1	0	2	0

## See Also

- [ODBC external dictionaries](#) •
- [.ODBC table engine](#) •

## hdfs

.Creates a table from files in HDFS. This table function is similar to [url](#) and [file](#) ones

```
hdfs(URI, format, structure)
```

### Input parameters

- URI** — The relative URI to the file in HDFS. Path to file support following globs in readonly mode `*`, `? , {abc,def}` and `• .{N..M}` where `N , M` — numbers, `'abc', 'def'` — strings
- format** — The [format](#) of the file •
- structure** — Structure of the table. Format `'column1_name column1_type, column2_name column2_type ...'` •

### Returned value

.A table with the specified structure for reading or writing data in the specified file

### Example

:Table from `hdfs://hdfs1:9000/test` and selection of the first two rows from it

```

SELECT *
FROM hdfs('hdfs://hdfs1:9000/test', 'TSV', 'column1 UInt32, column2 UInt32, column3 UInt32')
LIMIT 2

```

column1	column2	column3
1	2	3
3	2	1

## Globs in path

Multiple path components can have globs. For being processed file should exists and matches to the whole path pattern  
.((not only suffix or prefix

- .Substitutes any number of any characters except / including empty string — \* •
- .Substitutes any single character — ? •
- . 'some\_string,another\_string,yet\_another\_one} — Substitutes any of strings 'some\_string', 'another\_string', 'yet\_another\_one } •
- . N..M} — Substitutes any number in range from N to M including both borders} •
- .(Constructions with {} are similar to the [remote table function](#)

## Example

:Suppose that we have several files with following URIs on HDFS .1

```
'hdfs://hdfs1:9000/some_dir/some_file_1' .2
'hdfs://hdfs1:9000/some_dir/some_file_2' .3
'hdfs://hdfs1:9000/some_dir/some_file_3' .4
'hdfs://hdfs1:9000/another_dir/some_file_1' .5
'hdfs://hdfs1:9000/another_dir/some_file_2' .6
'hdfs://hdfs1:9000/another_dir/some_file_3' .7
```

:Query the amount of rows in these files .8

```
SELECT count(*)
FROM hdfs('hdfs://hdfs1:9000/{some,another}_dir/some_file_{1..3}', 'TSV', 'name String, value UInt32')
```

:Query the amount of rows in all files of these two directories .1

```
SELECT count(*)
FROM hdfs('hdfs://hdfs1:9000/{some,another}_dir/*', 'TSV', 'name String, value UInt32')
```

## Warning

. ? If your listing of files contains number ranges with leading zeros, use the construction with braces for each digit separately or use

## Example

:Query the data from files named file000 , file001 , ... , file999

```
SELECT count(*)
FROM hdfs('hdfs://hdfs1:9000/big_dir/file{0..9}{0..9}{0..9}', 'CSV', 'name String, value UInt32')
```

## input

`input(structure)` - table function that allows effectively convert and insert data sent to the server with given structure to the .table with another structure

structure - structure of data sent to the server in following format column1\_name column1\_type, column2\_name column2\_type, . '...'. For example, 'id UInt32, name String

This function can be used only in `INSERT SELECT` query and only once but otherwise behaves like ordinary table function .(for example, it can be used in subquery, etc

Data can be sent in any way like for ordinary `INSERT` query and passed in any available `format` that must be specified in .(the end of query (unlike ordinary `INSERT SELECT`

The main feature of this function is that when server receives data from client it simultaneously converts it according to the list of expressions in the `SELECT` clause and inserts into the target table. Temporary table with all transferred data is not .created

## Examples

Let the `test` table has the following structure (a String, b String) and data in `data.csv` has a different structure (col1 • String, col2 Date, col3 Int32) . Query for insert data from the `data.csv` into the `test` table with simultaneous conversion :looks like this

```
$ cat data.csv | clickhouse-client --query="INSERT INTO test SELECT lower(col1), col3 * col3 FROM input('col1 String, col2 Date, col3 Int32') FORMAT CSV";
```

:If `data.csv` contains data of the same structure `test_structure` as the table `test` then these two queries are equal •

```
$ cat data.csv | clickhouse-client --query="INSERT INTO test FORMAT CSV"
$ cat data.csv | clickhouse-client --query="INSERT INTO test SELECT * FROM input('test_structure') FORMAT CSV"
```

## Dictionaries

.A dictionary is a mapping (key -> attributes) that is convenient for various types of reference lists

ClickHouse supports special functions for working with dictionaries that can be used in queries. It is easier and more .efficient to use dictionaries with functions than a `JOIN` with reference tables

.`NULL` values can't be stored in a dictionary

:ClickHouse supports

.Built-in dictionaries with a specific set of functions •

.Plug-in (external) dictionaries with a set of functions •

## External Dictionaries

You can add your own dictionaries from various data sources. The data source for a dictionary can be a local text or .executable file, an HTTP(s) resource, or another DBMS. For more information, see "Sources for external dictionaries

:ClickHouse

.Fully or partially stores dictionaries in RAM •

Periodically updates dictionaries and dynamically loads missing values. In other words, dictionaries can be loaded .dynamically

.Allows to create external dictionaries with xml-files or DDL queries •

The configuration of external dictionaries can be located in one or more xml-files. The path to the configuration is

.specified in the `dictionaries_config` parameter

.Dictionaries can be loaded at server startup or at first use, depending on the `dictionaries_lazy_load` setting

:The dictionary configuration file has the following format

```
<yandex>
 <comment>An optional element with any content. Ignored by the ClickHouse server.</comment>
 <!--Optional element. File name with substitutions-->
 <include_from>/etc/metrika.xml</include_from>

 <dictionary>
 <!-- Dictionary configuration. -->
 <!-- There can be any number of <dictionary> sections in the configuration file. -->
 </dictionary>

</yandex>
```

.You can [configure](#) any number of dictionaries in the same file

[DDL queries for dictionaries](#) doesn't require any additional records in server configuration. They allow to work with .dictionaries as first-class entities, like tables or views

#### Attention

You can convert values for a small dictionary by describing it in a `SELECT` query (see the [transform](#) function). This functionality is not related to .external dictionaries

See also

[Functions for Working with External Dictionaries](#) •

## Configuring an External Dictionary

:If dictionary is configured using xml-file, than dictionary configuration has the following structure

```
<dictionary>
 <name>dict_name</name>

 <structure>
 <!-- Complex key configuration -->
 </structure>

 <source>
 <!-- Source configuration -->
 </source>

 <layout>
 <!-- Memory layout configuration -->
 </layout>

 <lifetime>
 <!-- Lifetime of dictionary in memory -->
 </lifetime>
</dictionary>
```

:Corresponding [DDL-query](#) has the following structure

```

CREATE DICTIONARY dict_name
(
 ... -- attributes
)
PRIMARY KEY ... -- complex or single key configuration
SOURCE(...) -- Source configuration
LAYOUT(...) -- Memory layout configuration
LIFETIME(...) -- Lifetime of dictionary in memory

```

- .`name` – The identifier that can be used to access the dictionary. Use the characters[a-zA-Z0-9] •
- .`source` — Source of the dictionary •
- .`layout` — Dictionary layout in memory •
- .`structure` — Structure of the dictionary . A key and attributes that can be retrieved by this key •
- .`lifetime` — Frequency of dictionary updates •

## Storing Dictionaries in Memory

:There are a variety of ways to store dictionaries in memory

.We recommend `flat`, `hashed` and `complex_key_hashed`. which provide optimal processing speed

Caching is not recommended because of potentially poor performance and difficulties in selecting optimal parameters.

."Read more in the section "[cache](#)

:There are several ways to improve dictionary performance

.Call the function for working with the dictionary after `GROUP BY` •

Mark attributes to extract as injective. An attribute is called injective if different attribute values correspond to different keys. So when `GROUP BY` uses a function that fetches an attribute value by the key, this function is automatically taken out of `GROUP BY`

:ClickHouse generates an exception for errors with dictionaries. Examples of errors

.The dictionary being accessed could not be loaded •

.Error querying a `cached` dictionary •

.You can view the list of external dictionaries and their statuses in the `system.dictionaries` table

:The configuration looks like this

```

<yandex>
 <dictionary>
 ...
 <layout>
 <layout_type>
 <!-- layout settings -->
 </layout_type>
 </layout>
 ...
</dictionary>
</yandex>

```

in case of [DDL-query](#), equal configuration will looks like

```

CREATE DICTIONARY (...)
...
LAYOUT(LAYOUT_TYPE(param value)) -- layout settings
...

```

## Ways to Store Dictionaries in Memory

- flat •
  - hashed •
  - sparse\_hashed •
  - cache •
  - range\_hashed •
  - complex\_key\_hashed •
  - complex\_key\_cache •
  - ip\_trie •
- flat

The dictionary is completely stored in memory in the form of flat arrays. How much memory does the dictionary use? The amount is proportional to the size of the largest key (in space used

The dictionary key has the `UInt64` type and the value is limited to 500,000. If a larger key is discovered when creating the `.dictionary`, ClickHouse throws an exception and does not create the dictionary

All types of sources are supported. When updating, data (from a file or from a table) is read in its entirety

This method provides the best performance among all available methods of storing the dictionary

:Configuration example

```
<layout>
 <flat />
</layout>
```

or

```
LAYOUT(FLAT())
```

### hashed

The dictionary is completely stored in memory in the form of a hash table. The dictionary can contain any number of elements with any identifiers In practice, the number of keys can reach tens of millions of items

All types of sources are supported. When updating, data (from a file or from a table) is read in its entirety

:Configuration example

```
<layout>
 <hashed />
</layout>
```

or

```
LAYOUT(HASHED())
```

### sparse\_hashed

Similar to `hashed`, but uses less memory in favor more CPU usage

:Configuration example

```
<layout>
 <sparse_hashed />
</layout>
```

LAYOUT(SPARSE\_HASHED( ))

### **complex\_key\_hashed**

.This type of storage is for use with composite**keys**. Similar to `hashed`

:Configuration example

```
<layout>
 <complex_key_hashed />
</layout>
```

LAYOUT(COMPLEX\_KEY\_HASHED( ))

### **range\_hashed**

The dictionary is stored in memory in the form of a hash table with an ordered array of ranges and their corresponding .values

This storage method works the same way as `hashed` and allows using date/time (arbitrary numeric type) ranges in .addition to the key

:Example: The table contains discounts for each advertiser in the format

advertiser id	discount start date	discount end date	amount
123	2015-01-01	2015-01-15	0.15
123	2015-01-16	2015-01-31	0.25
456	2015-01-01	2015-01-15	0.05

To use a sample for date ranges, define the `range_min` and `range_max` elements in the **structure**. These elements must contain elements `name` and `type` (if `type` is not specified, the default type will be used - Date). `type` can be any numeric .(type (Date / DateTime / UInt64 / Int32 / others

:Example

```
<structure>
 <id>
 <name>Id</name>
 </id>
 <range_min>
 <name>first</name>
 <type>Date</type>
 </range_min>
 <range_max>
 <name>last</name>
 <type>Date</type>
 </range_max>
 ...
...
```

or

```

CREATE DICTIONARY somedict (
 id UInt64,
 first Date,
 last Date
)
PRIMARY KEY id
LAYOUT(RANGE_HASHED())
RANGE(MIN first MAX last)

```

To work with these dictionaries, you need to pass an additional argument to the `dictGetT` function, for which a range is selected

```
dictGetT('dict_name', 'attr_name', id, date)
```

.This function returns the value for the specified `id`s and the date range that includes the passed date

:Details of the algorithm

- .If the `id` is not found or a range is not found for the `id`, it returns the default value for the dictionary •
- .If there are overlapping ranges, you can use any •

If the range delimiter is `NULL` or an invalid date (such as `1900-01-01` or `2039-01-01`), the range is left open. The •  
.range can be open on both sides

:Configuration example

```

<yandex>
 <dictionary>

 ...

 <layout>
 <range_hashed />
 </layout>

 <structure>
 <id>
 <name>Abcdef</name>
 </id>
 <range_min>
 <name>StartTimeStamp</name>
 <type>UInt64</type>
 </range_min>
 <range_max>
 <name>EndTimeStamp</name>
 <type>UInt64</type>
 </range_max>
 <attribute>
 <name>XXXType</name>
 <type>String</type>
 <null_value />
 </attribute>
 </structure>

 </dictionary>
</yandex>

```

or

```

CREATE DICTIONARY somedict(
 Abcdef UInt64,
 StartTimeStamp UInt64,
 EndTimeStamp UInt64,
 XXXType String DEFAULT ''
)
PRIMARY KEY Abcdef
RANGE(MIN StartTimeStamp MAX EndTimeStamp)

```

## cache

.The dictionary is stored in a cache that has a fixed number of cells. These cells contain frequently used elements

When searching for a dictionary, the cache is searched first. For each block of data, all keys that are not found in the cache or are outdated are requested from the source using `SELECT attrs... FROM db.table WHERE id IN (k1, k2, ...)`. The .received data is then written to the cache

For cache dictionaries, the expiration `lifetime` of data in the cache can be set. If more time than `lifetime` has passed since loading the data in a cell, the cell's value is not used, and it is re-requested the next time it needs to be used. This is the least effective of all the ways to store dictionaries. The speed of the cache depends strongly on correct settings and the usage scenario. A cache type dictionary performs well only when the hit rates are high enough (recommended 99% and .higher). You can view the average hit rate in the `system.dictionaries` table

.To improve cache performance, use a subquery with `LIMIT`, and call the function with the dictionary externally

.Supported `sources`: MySQL, ClickHouse, executable, HTTP

:Example of settings

```

<layout>
 <cache>
 <!-- The size of the cache, in number of cells. Rounded up to a power of two. -->
 <size_in_cells>1000000000</size_in_cells>
 </cache>
</layout>

```

or

```
LAYOUT(CACHE(SIZE_IN_CELLS 1000000000))
```

:Set a large enough cache size. You need to experiment to select the number of cells

.Set some value .1

.Run queries until the cache is completely full .2

.Assess memory consumption using the `system.dictionaries` table .3

.Increase or decrease the number of cells until the required memory consumption is reached .4

## Warning

.Do not use ClickHouse as a source, because it is slow to process queries with random reads

## complex\_key\_cache

.This type of storage is for use with composite`keys`. Similar to `cache`

## ip\_trie

.This type of storage is for mapping network prefixes (IP addresses) to metadata such as ASN

:Example: The table contains network prefixes and their corresponding AS number and country code

prefix	asn	cca2
202.79.32.0/20	17501	NP
2620:0:870::/48	3856	US
2a02:6b8:1::/48	13238	RU
2001:db8::/32	65536	ZZ

.When using this type of layout, the structure must have a composite key

:Example

```
<structure>
 <key>
 <attribute>
 <name>prefix</name>
 <type>String</type>
 </attribute>
 </key>
 <attribute>
 <name>asn</name>
 <type>UInt32</type>
 <null_value />
 </attribute>
 <attribute>
 <name>cca2</name>
 <type>String</type>
 <null_value>??</null_value>
 </attribute>
 ...
 ...
```

or

```
CREATE DICTIONARY somedict (
 prefix String,
 asn UInt32,
 cca2 String DEFAULT '??'
)
PRIMARY KEY prefix
```

.The key must have only one String type attribute that contains an allowed IP prefix. Other types are not supported yet

:For queries, you must use the same functions (dictGetT with a tuple) as for dictionaries with composite keys

```
dictGetT('dict_name', 'attr_name', tuple(ip))
```

:The function takes either UInt32 for IPv4, or FixedString(16) for IPv6

```
dictGetString('prefix', 'asn', tuple(IPv6StringToNum('2001:db8::1')))
```

Other types are not supported yet. The function returns the attribute for the prefix that corresponds to this IP address. If there are overlapping prefixes, the most specific one is returned

.Data is stored in a trie . It must completely fit into RAM

## Dictionary Updates

ClickHouse periodically updates the dictionaries. The update interval for fully downloaded dictionaries and the invalidation .interval for cached dictionaries are defined in the `<lifetime>` tag in seconds

Dictionary updates (other than loading for first use) do not block queries. During updates, the old version of a dictionary is used. If an error occurs during an update, the error is written to the server log, and queries continue using the old version .of dictionaries

:Example of settings

```
<dictionary>
...
<lifetime>300</lifetime>
...
</dictionary>
```

```
CREATE DICTIONARY (...)

...
LIFETIME(300)
...
```

.Setting `<lifetime>0</lifetime>` (`LIFETIME(0)`) prevents dictionaries from updating

You can set a time interval for upgrades, and ClickHouse will choose a uniformly random time within this range. This is .necessary in order to distribute the load on the dictionary source when upgrading on a large number of servers

:Example of settings

```
<dictionary>
...
<lifetime>
 <min>300</min>
 <max>360</max>
</lifetime>
...
</dictionary>
```

or

```
LIFETIME(MIN 300 MAX 360)
```

:When upgrading the dictionaries, the ClickHouse server applies different logic depending on the type of `source`

For a text file, it checks the time of modification. If the time differs from the previously recorded time, the dictionary is • .updated

.For MyISAM tables, the time of modification is checked using a `SHOW TABLE STATUS` query • .Dictionaries from other sources are updated every time by default •

For MySQL (InnoDB), ODBC and ClickHouse sources, you can set up a query that will update the dictionaries only if they :really changed, rather than each time. To do this, follow these steps

.The dictionary table must have a field that always changes when the source data is updated •

The settings of the source must specify a query that retrieves the changing field. The ClickHouse server interprets the • query result as a row, and if this row has changed relative to its previous state, the dictionary is updated. Specify the .query in the `<invalidate_query>` field in the settings for the `source`

:Example of settings

```

<dictionary>
...
<odbc>
...
 <invalidate_query>SELECT update_time FROM dictionary_source where id = 1</invalidate_query>
</odbc>
...
</dictionary>

```

or

```

...
SOURCE(ODBC(... invalidate_query 'SELECT update_time FROM dictionary_source where id = 1'))
...

```

## Sources of External Dictionaries

.An external dictionary can be connected from many different sources

:If dictionary is configured using xml-file, the configuration looks like this

```

<yandex>
 <dictionary>
 ...
 <source>
 <source_type>
 <!-- Source configuration -->
 </source_type>
 </source>
 ...
 </dictionary>
 ...
</yandex>

```

:In case of **DDL-query**, equal configuration will looks like

```

CREATE DICTIONARY dict_name (...)
...
SOURCE(SOURCE_TYPE(param1 val1 ... paramN valN)) -- Source configuration
...

```

.The source is configured in the `source` section

:(Types of sources (`source_type`)

**Local file** •

**Executable file** •

**(HTTP(s)** •

**DBMS** •

**ODBC** •

**MySQL** •

**ClickHouse** •

**MongoDB** •

**Redis** •

**Local File**

:Example of settings

```
<source>
 <file>
 <path>/opt/dictionaries/os.tsv</path>
 <format>TabSeparated</format>
 </file>
</source>
```

or

```
SOURCE(FILE(path '/opt/dictionaries/os.tsv' format 'TabSeparated'))
```

:Setting fields

- . path – The absolute path to the file •
- . format – The file format. All the formats described in [Formats](#) are supported •

## Executable File

Working with executable files depends on [how the dictionary is stored in memory](#). If the dictionary is stored using `cache` and `complex_key_cache`, ClickHouse requests the necessary keys by sending a request to the executable file's STDIN. Otherwise, ClickHouse starts executable file and treats its output as dictionary data

:Example of settings

```
<source>
 <executable>
 <command>cat /opt/dictionaries/os.tsv</command>
 <format>TabSeparated</format>
 </executable>
</source>
```

or

```
SOURCE(EXECUTABLE(command 'cat /opt/dictionaries/os.tsv' format 'TabSeparated'))
```

:Setting fields

- .( command – The absolute path to the executable file, or the file name (if the program directory is written to `PATH`) •
- . format – The file format. All the formats described in [Formats](#) are supported •

## (HTTP(s)

Working with an HTTP(s) server depends on [how the dictionary is stored in memory](#). If the dictionary is stored using `cache` and `complex_key_cache`, ClickHouse requests the necessary keys by sending a request via the `POST` method

:Example of settings

```

<source>
 <http>
 <url>http://[::1]/os.tsv</url>
 <format>TabSeparated</format>
 <credentials>
 <user>user</user>
 <password>password</password>
 </credentials>
 <headers>
 <header>
 <name>API-KEY</name>
 <value>key</value>
 </header>
 </headers>
 </http>
</source>

```

or

```

SOURCE(HTTP(
 url 'http://[::1]/os.tsv'
 format 'TabSeparated'
 credentials(user 'user' password 'password')
 headers(header(name 'API-KEY' value 'key'))
))

```

.In order for ClickHouse to access an HTTPS resource, you must[configure openSSL](#) in the server configuration

:Setting fields

- . `url` – The source URL •
- . `format` – The file format. All the formats described in [Formats](#) are supported •
- . `credentials` – Basic HTTP authentication. Optional parameter •
  - . `user` – Username required for the authentication •
  - . `password` – Password required for the authentication •
- . `headers` – All custom HTTP headers entries used for the HTTP request. Optional parameter •
  - . `header` – Single HTTP header entry •
    - . `name` – Identifiant name used for the header send on the request •
    - . `value` – Value set for a specific identifiant name •

## ODBC

.You can use this method to connect any database that has an ODBC driver

:Example of settings

```

<source>
 <odbc>
 <db>DatabaseName</db>
 <table>SchemaName.TableName</table>
 <connection_string>DSN=some_parameters</connection_string>
 <invalidate_query>SQL_QUERY</invalidate_query>
 </odbc>
</source>

```

or

```
SOURCE(ODBC(
 db 'DatabaseName'
 table 'SchemaName.TableName'
 connection_string 'DSN=some_parameters'
 invalidate_query 'SQL_QUERY'
)
```

:Setting fields

- . db – Name of the database. Omit it if the database name is set in the `<connection_string>` parameters •
  - . table – Name of the table and schema if exists •
  - . connection\_string – Connection string •
- invalidate\_query – Query for checking the dictionary status. Optional parameter. Read more in the section [Updating dictionaries](#) •

ClickHouse receives quoting symbols from ODBC-driver and quote all settings in queries to driver, so it's necessary to set .table name accordingly to table name case in database

. If you have a problems with encodings when using Oracle, see the corresponding [FAQ](#) article

### Known vulnerability of the ODBC dictionary functionality

#### Attention

When connecting to the database through the ODBC driver connection parameter `Servername` can be substituted. In this case values of . `USERNAME` and `PASSWORD` from `odbc.ini` are sent to the remote server and can be compromised

Example of insecure use

:Let's configure unixODBC for PostgreSQL. Content of `/etc/odbc.ini`

```
[gregtest]
Driver = /usr/lib/pgsqlodbc.so
Servername = localhost
PORT = 5432
DATABASE = test_db
##OPTION = 3
USERNAME = test
PASSWORD = test
```

If you then make a query such as

```
SELECT * FROM odbc('DSN=gregtest;Servername=some-server.com', 'test_db');
```

. ODBC driver will send values of `USERNAME` and `PASSWORD` from `odbc.ini` to `some-server.com`

### Example of Connecting PostgreSQL

.Ubuntu OS

:Installing unixODBC and the ODBC driver for PostgreSQL

```
$ sudo apt-get install -y unixodbc odbcinst odbc-postgresql
```

:(Configuring `/etc/odbc.ini` (or `~/.odbc.ini`

```
[DEFAULT]
Driver = myconnection

[myconnection]
Description = PostgreSQL connection to my_db
Driver = PostgreSQL Unicode
Database = my_db
Servername = 127.0.0.1
UserName = username
Password = password
Port = 5432
Protocol = 9.3
ReadOnly = No
RowVersioning = No
ShowSystemTables= No
ConnSettings =
```

:The dictionary configuration in ClickHouse

```
<yandex>
<dictionary>
 <name>table_name</name>
 <source>
 <odbc>
 <!-- You can specify the following parameters in connection_string: -->
 <!-- DSN=myconnection;UID=username;PWD=password;HOST=127.0.0.1;PORT=5432;DATABASE=my_db -->
 <connection_string>DSN=myconnection</connection_string>
 <table>postgresql_table</table>
 </odbc>
 </source>
 <lifetime>
 <min>300</min>
 <max>360</max>
 </lifetime>
 <layout>
 <hashed/>
 </layout>
 <structure>
 <id>
 <name>id</name>
 </id>
 <attribute>
 <name>some_column</name>
 <type>UInt64</type>
 <null_value>0</null_value>
 </attribute>
 </structure>
 </dictionary>
</yandex>
```

or

```
CREATE DICTIONARY table_name (
 id UInt64,
 some_column UInt64 DEFAULT 0
)
PRIMARY KEY id
SOURCE(ODBC(connection_string 'DSN=myconnection' table 'postgresql_table'))
LAYOUT(HASHED())
LIFETIME(MIN 300 MAX 360)
```

. You may need to edit odbc.ini to specify the full path to the library with the driver DRIVER=/usr/local/lib/psqlodbcw.so

### Example of Connecting MS SQL Server

.Ubuntu OS

: :Installing the driver

```
$ sudo apt-get install tdsodbc freetds-bin sqsh
```

:Configuring the driver

```
$ cat /etc/freetds/freetds.conf
...
[MSSQL]
host = 192.168.56.101
port = 1433
tds version = 7.0
client charset = UTF-8

$ cat /etc/odbcinst.ini
...
[FreeTDS]
Description = FreeTDS
Driver = /usr/lib/x86_64-linux-gnu/odbc/libtdsodbc.so
Setup = /usr/lib/x86_64-linux-gnu/odbc/libtdsS.so
FileUsage = 1
UsageCount = 5

$ cat ~/.odbc.ini
...
[MSSQL]
Description = FreeTDS
Driver = FreeTDS
Servername = MSSQL
Database = test
UID = test
PWD = test
Port = 1433
```

:Configuring the dictionary in ClickHouse

```
<yandex>
 <dictionary>
 <name>test</name>
 <source>
 <odbc>
 <table>dict</table>
 <connection_string>DSN=MSSQL;UID=test;PWD=test</connection_string>
 </odbc>
 </source>

 <lifetime>
 <min>300</min>
 <max>360</max>
 </lifetime>

 <layout>
 <flat />
 </layout>

 <structure>
 <id>
 <name>k</name>
 </id>
 <attribute>
 <name>s</name>
 <type>String</type>
 <null_value></null_value>
 </attribute>
 </structure>
 </dictionary>
</yandex>
```

```
CREATE DICTIONARY test (
 k UInt64,
 s String DEFAULT ''
)
PRIMARY KEY k
SOURCE(ODBC(table 'dict' connection_string 'DSN=MSSQL;UID=test;PWD=test'))
LAYOUT(FLAT())
LIFETIME(MIN 300 MAX 360)
```

or

DBMS

## MySQL

## :Example of settings

```
<source>
 <mysql>
 <port>3306</port>
 <user>clickhouse</user>
 <password>qwerty</password>
 <replica>
 <host>example01-1</host>
 <priority>1</priority>
 </replica>
 <replica>
 <host>example01-2</host>
 <priority>1</priority>
 </replica>
 <db>db_name</db>
 <table>table_name</table>
 <where>id=10</where>
 <invalidate_query>SQL_QUERY</invalidate_query>
 </mysql>
</source>
```

or

```
SOURCE(MYSQL(
 port 3306
 user 'clickhouse'
 password 'qwerty'
 replica(host 'example01-1' priority 1)
 replica(host 'example01-2' priority 1)
 db 'db_name'
 table 'table_name'
 where 'id=10'
 invalidate_query 'SQL_QUERY'
))
```

## :Setting fields

.( <port – The port on the MySQL server. You can specify it for all replicas, or for each one individually (inside<replica •  
.( <user – Name of the MySQL user. You can specify it for all replicas, or for each one individually (inside<replica •  
password – Password of the MySQL user. You can specify it for all replicas, or for each one individually (inside •  
.( <<replica  
. replica – Section of replica configurations. There can be multiple sections •  
. replica/host – The MySQL host •  
replica/priority – The replica priority. When attempting to connect, ClickHouse traverses the replicas in order of \*  
.priority. The lower the number, the higher the priority

. db – Name of the database •  
 . table – Name of the table •  
 . where – The selection criteria. Optional parameter •  
 invalidate\_query – Query for checking the dictionary status. Optional parameter. Read more in the section [Updating dictionaries](#) •

.MySQL can be connected on a local host via sockets. To do this, set host and socket

:Example of settings

```
<source>
<mysql>
 <host>localhost</host>
 <socket>/path/to/socket/file.sock</socket>
 <user>clickhouse</user>
 <password>qwerty</password>
 <db>db_name</db>
 <table>table_name</table>
 <where>id=10</where>
 <invalidate_query>SQL_QUERY</invalidate_query>
</mysql>
</source>
```

or

```
SOURCE(MYSQL(
 host 'localhost'
 socket '/path/to/socket/file.sock'
 user 'clickhouse'
 password 'qwerty'
 db 'db_name'
 table 'table_name'
 where 'id=10'
 invalidate_query 'SQL_QUERY'
))
```

**ClickHouse**

:Example of settings

```
<source>
<clickhouse>
 <host>example01-01-1</host>
 <port>9000</port>
 <user>default</user>
 <password></password>
 <db>default</db>
 <table>ids</table>
 <where>id=10</where>
</clickhouse>
</source>
```

or

```
SOURCE(CLICKHOUSE(
 host 'example01-01-1'
 port 9000
 user 'default'
 password ''
 db 'default'
 table 'ids'
 where 'id=10'
))
```

:Setting fields

host – The ClickHouse host. If it is a local host, the query is processed without any network activity. To improve fault tolerance, you can create a **Distributed** table and enter it in subsequent configurations

- . port – The port on the ClickHouse server
- . user – Name of the ClickHouse user
- . password – Password of the ClickHouse user
- . db – Name of the database
- . table – Name of the table
- . where – The selection criteria. May be omitted

invalidate\_query – Query for checking the dictionary status. Optional parameter. Read more in the section [Updating dictionaries](#)

## MongoDB

:Example of settings

```
<source>
 <mongodb>
 <host>localhost</host>
 <port>27017</port>
 <user></user>
 <password></password>
 <db>test</db>
 <collection>dictionary_source</collection>
 </mongodb>
</source>
```

or

```
SOURCE(MONGO(
 host 'localhost'
 port 27017
 user ''
 password ''
 db 'test'
 collection 'dictionary_source'
))
```

:Setting fields

- . host – The MongoDB host
- . port – The port on the MongoDB server
- . user – Name of the MongoDB user
- . password – Password of the MongoDB user
- . db – Name of the database
- . collection – Name of the collection

## Redis

:Example of settings

```

<source>
 <redis>
 <host>localhost</host>
 <port>6379</port>
 <storage_type>simple</storage_type>
 <db_index>0</db_index>
 </redis>
</source>

```

or

```

SOURCE(REDIS(
 host 'localhost'
 port 6379
 storage_type 'simple'
 db_index 0
))

```

:Setting fields

- . host – The Redis host •
- . port – The port on the Redis server •
- storage\_type – The structure of internal Redis storage using for work with keys. simple is for simple sources and for hashed single key sources, hash\_map is for hashed sources with two keys. Ranged sources and cache sources with .complex key are unsupported. May be omitted, default value is simple
- . db\_index – The specific numeric index of Redis logical database. May be omitted, default value is 0 •

## Dictionary Key and Fields

.The `<structure>` clause describes the dictionary key and fields available for queries

:Overall structure

```

<dictionary>
 <structure>
 <id>
 <name>Id</name>
 </id>

 <attribute>
 <!-- Attribute parameters -->
 </attribute>

 ...
 </structure>
</dictionary>

```

or

```

CREATE DICTIONARY (
 Id UInt64,
 -- attributes
)
PRIMARY KEY Id
...

```

:In xml-file attributes are described in the structure section

. `id` — **Key column** •

.attribute> — **Data column**. There can be a large number of attributes> •

In DDL-query attributes are described the body of CREATE query: - PRIMARY KEY — **Key column** - AttrName AttrType — **Data column**

## Key

:ClickHouse supports the following types of keys

.Numeric key. UInt64. Defined in the <id> tag or using PRIMARY KEY keyword •

.Composite key. Set of values of different types. Defined in the tag<key> or PRIMARY KEY keyword •

.A xml-structure can contain either <id> or <key>. DDL-query must contain single PRIMARY KEY

### Numeric Key

.Type: UInt64

:Configuration example

```
<id>
 <name>Id</name>
</id>
```

:Configuration fields

. name – The name of the column with keys •

:For DDL-query

```
CREATE DICTIONARY (
 Id UInt64,
 ...
)
PRIMARY KEY Id
...
```

. PRIMARY KEY – The name of the column with keys •

### Composite Key

The key can be a tuple from any types of fields. The layout in this case must be complex\_key\_hashed or

. complex\_key\_cache

#### Tip

.A composite key can consist of a single element. This makes it possible to use a string as the key, for instance

The key structure is set in the element <key> . Key fields are specified in the same format as the dictionary**attributes**.

:Example

```

<structure>
 <key>
 <attribute>
 <name>field1</name>
 <type>String</type>
 </attribute>
 <attribute>
 <name>field2</name>
 <type>UInt32</type>
 </attribute>
 ...
 </key>
 ...

```

or

```

CREATE DICTIONARY (
 field1 String,
 field2 String
 ...
)
PRIMARY KEY field1, field2
...

```

For a query to the `dictGet*` function, a tuple is passed as the key. Example:

```

dictGetString('dict_name', 'attr_name', tuple('string
 .((for field1', num_for_field2

```

## Attributes

:Configuration example

```

<structure>
 ...
 <attribute>
 <name>Name</name>
 <type>ClickHouseDataType</type>
 <null_value></null_value>
 <expression>rand64()</expression>
 <hierarchical>true</hierarchical>
 <injective>true</injective>
 <is_object_id>true</is_object_id>
 </attribute>
</structure>

```

or

```

CREATE DICTIONARY somename (
 Name ClickHouseDataType DEFAULT '' EXPRESSION rand64() HIERARCHICAL INJECTIVE IS_OBJECT_ID
)

```

:Configuration fields

Required		Description	Tag
Yes		.Column name	name
Yes	ClickHouse tries to cast value from dictionary to the specified data type. For example, for MySQL, the field might be <code>TEXT</code> , <code>VARCHAR</code> , or <code>BLOB</code> in the MySQL source table, but it can be uploaded as <code>String</code> in ClickHouse. <b>Nullable</b> is not supported	.ClickHouse data type The expression can be a column name in the remote SQL database. Thus, you can use it to create an alias for the remote column	type
Yes	.Default value for a non-existing element In the example, it is an empty string. You cannot use <code>NULL</code> in this field		null_value
No	.Expression that ClickHouse executes on the value The expression can be a column name in the remote SQL database. Thus, you can use it to create an alias for the remote column	.Default value: no expression	expression
No	.Hierarchical support. Mirrored to the parent identifier		hierarchical
No	.Flag that shows whether the <code>id -&gt; attribute</code> image is <b>injective</b> If <code>true</code> , ClickHouse can automatically place after the <code>GROUP BY</code> clause the requests to dictionaries with injection. Usually it significantly reduces the amount of such requests	.Default value: false	injective
No	.Flag that shows whether the query is executed for a MongoDB document by <code>ObjectID</code>	.Default value: false	is_object_id

## Internal dictionaries

.ClickHouse contains a built-in feature for working with a geobase

:This allows you to

- .Use a region's ID to get its name in the desired language
- .Use a region's ID to get the ID of a city, area, federal district, country, or continent
- .Check whether a region is part of another region
- .Get a chain of parent regions

All the functions support "translocality," the ability to simultaneously use different perspectives on region ownership. For more information, see the section "Functions for working with Yandex.Metrica dictionaries

The internal dictionaries are disabled in the default package. To enable them, uncomment the parameters `path_to_regions_hierarchy_file` and `path_to_regions_names_files` in the server configuration file

.The geobase is loaded from text files

Place the `regions_hierarchy*.txt` files into the `path_to_regions_hierarchy_file` directory. This configuration parameter must contain the path to the `regions_hierarchy.txt` file (the default regional hierarchy), and the other files (`regions_hierarchy_ua.txt`) must be located in the same directory

.Put the `regions_names_*.txt` files in the `path_to_regions_names_files` directory

:You can also create these files yourself. The file format is as follows

: `regions_hierarchy*.txt` : TabSeparated (no header), columns

(region ID ( UInt32 ) •

(parent region ID ( UInt32 ) •

region type ( UInt8 ): 1 - continent, 3 - country, 4 - federal district, 5 - region, 6 - city; other types don't have values•

population ( UInt32 ) — optional column •

: `regions_names_*.txt` : TabSeparated (no header), columns

(region ID ( UInt32 ) •

.region name ( String ) — Can't contain tabs or line feeds, even escaped ones •

.A flat array is used for storing in RAM. For this reason, IDs shouldn't be more than a million

Dictionaries can be updated without restarting the server. However, the set of available dictionaries is not updated. For updates, the file modification times are checked. If a file has changed, the dictionary is updated. The interval to check for changes is configured in the `builtin_dictionaries_reload_interval` parameter. Dictionary updates (other than loading at first use) do not block queries. During updates, queries use the old versions of dictionaries. If an error occurs during an `.update`, the error is written to the server log, and queries continue using the old version of dictionaries

We recommend periodically updating the dictionaries with the geobase. During an update, generate new files and write them to a separate location. When everything is ready, rename them to the files used by the server

.There are also functions for working with OS identifiers and Yandex.Metrica search engines, but they shouldn't be used

## Operators

All operators are transformed to their corresponding functions at the query parsing stage in accordance with their precedence and associativity. Groups of operators are listed in order of priority (the higher it is in the list, the earlier the .(operator is connected to its arguments

### Access Operators

.`a[N]` – Access to an element of an array. The `arrayElement(a, N)` function

.`a.N` – Access to a tuple element. The `tupleElement(a, N)` function

### Numeric Negation Operator

.`a` – The `negate(a)` function

### Multiplication and Division Operators

.`a * b` – The `multiply(a, b)` function

.`a / b` – The `divide(a, b)` function

.`a % b` – The `modulo(a, b)` function

## Addition and Subtraction Operators

. `a + b` – The `plus(a, b)` function

. `a - b` – The `minus(a, b)` function

## Comparison Operators

. `a = b` – The `equals(a, b)` function

. `a == b` – The `equals(a, b)` function

. `a != b` – The `notEquals(a, b)` function

. `a <> b` – The `notEquals(a, b)` function

. `a <= b` – The `lessOrEquals(a, b)` function

. `a >= b` – The `greaterOrEquals(a, b)` function

. `a < b` – The `less(a, b)` function

. `a > b` – The `greater(a, b)` function

. `a LIKE s` – The `like(a, b)` function

. `a NOT LIKE s` – The `notLike(a, b)` function

. `a BETWEEN b AND c` – The same as `a >= b AND a <= c`

. `a NOT BETWEEN b AND c` – The same as `a < b OR a > c`

## Operators for Working With Data Sets

. See [IN operators](#)

. `a IN ...` – The `in(a, b)` function

. `a NOT IN ...` – The `notIn(a, b)` function

. `a GLOBAL IN ...` – The `globalIn(a, b)` function

. `a GLOBAL NOT IN ...` – The `globalNotIn(a, b)` function

## Operators for Working with Dates and Times

### EXTRACT

```
EXTRACT(part FROM date);
```

. Extracts a part from a given date. For example, you can retrieve a month from a given date, or a second from a time

: The `part` parameter specifies which part of the date to retrieve. The following values are available

. `DAY` — The day of the month. Possible values: 1–31 •

. `MONTH` — The number of a month. Possible values: 1–12 •

. `YEAR` — The year •

- .SECOND — The second. Possible values: 0–59 •
- .MINUTE — The minute. Possible values: 0–59 •
- .HOUR — The hour. Possible values: 0–23 •

.The `part` parameter is case-insensitive

.The `date` parameter specifies the date or the time to process. Either `Date` or `DateTime` type is supported

:Examples

```
SELECT EXTRACT(DAY FROM toDate('2017-06-15'));
SELECT EXTRACT(MONTH FROM toDate('2017-06-15'));
SELECT EXTRACT(YEAR FROM toDate('2017-06-15'));
```

.In the following example we create a table and insert into it a value with the `DateTime` type

```
CREATE TABLE test.Orders
(
 OrderId UInt64,
 OrderName String,
 OrderDate DateTime
)
ENGINE = Log;
```

```
INSERT INTO test.Orders VALUES (1, 'Jarlsberg Cheese', toDateTime('2008-10-11 13:23:44'));
```

```
SELECT
 toYear(OrderDate) AS OrderYear,
 toMonth(OrderDate) AS OrderMonth,
 toDayOfMonth(OrderDate) AS OrderDay,
 toHour(OrderDate) AS OrderHour,
 toMinute(OrderDate) AS OrderMinute,
 toSecond(OrderDate) AS OrderSecond
FROM test.Orders;
```

OrderYear	OrderMonth	OrderDay	OrderHour	OrderMinute	OrderSecond
2008	10	11	13	23	44

.You can see more examples in [tests](#)

## INTERVAL

.Creates an `Interval`-type value that should be used in arithmetical operations with `Date` and `DateTime`-type values

Types of intervals: - SECOND - MINUTE - HOUR - DAY - WEEK - MONTH - QUARTER - YEAR

### Warning

Intervals with different types can't be combined. You can't use expressions like `INTERVAL 4 DAY 1 HOUR`. Express intervals in units that are smaller or equal the the smallest unit of the interval, for example `INTERVAL 25 HOUR`. You can use consecutive operations like in the example .below

:Example

```
SELECT now() AS current_date_time, current_date_time + INTERVAL 4 DAY + INTERVAL 3 HOUR
```

<code>current_date_time</code>	<code>plus(plus(now(), toIntervalDay(4)), toIntervalHour(3))</code>
2019-10-23 11:16:28	2019-10-27 14:16:28

See Also

- [Interval data type](#) •
- [toInterval type conversion functions](#) •

## Logical Negation Operator

. `NOT a` – The `not(a)` function

## Logical AND Operator

. `a AND b` – The `and(a, b)` function

## Logical OR Operator

. `a OR b` – The `or(a, b)` function

## Conditional Operator

. `a ? b : c` – The `if(a, b, c)` function

:Note

The conditional operator calculates the values of b and c, then checks whether condition a is met, and then returns the corresponding value. If `b` or `C` is an `arrayJoin()` function, each row will be replicated regardless of the "a" condition

## Conditional Expression

```
CASE [x]
 WHEN a THEN b
 [WHEN ... THEN ...]
 [ELSE c]
END
```

. (If `x` is specified, then `transform(x, [a, ...], [b, ...], c)` function is used. Otherwise – `multilf(a, b, ..., c)`)  
 . If there is no `ELSE c` clause in the expression, the default value is `NULL`  
 . The `transform` function does not work with `NULL`

## Concatenation Operator

. `s1 || s2` – The `concat(s1, s2)` function

## Lambda Creation Operator

. `x -> expr` – The `lambda(x, expr)` function

:The following operators do not have a priority, since they are brackets

## Array Creation Operator

.`x1, ...]` – The `array(x1, ...)` function ]

## Tuple Creation Operator

.`x1, x2, ...)` – The `tuple(x2, x2, ...)` function )

## Associativity

All binary operators have left associativity. For example, `1 + 2 + 3` is transformed to `plus(plus(1, 2), 3)`. Sometimes this .doesn't work the way you expect. For example, `SELECT 4 > 2 > 3` will result in 0

For efficiency, the `and` and `or` functions accept any number of arguments. The corresponding chains of `AND` and `OR` .operators are transformed to a single call of these functions

## Checking for NULL

.ClickHouse supports the `IS NULL` and `IS NOT NULL` operators

### IS NULL

:For `Nullable` type values, the `IS NULL` operator returns •

.if the value is `NULL` , 1 •

.otherwise 0 •

.For other values, the `IS NULL` operator always returns 0 •

```
SELECT x+100 FROM t_null WHERE y IS NULL
```

plus(x, 100)
101

### IS NOT NULL

:For `Nullable` type values, the `IS NOT NULL` operator returns •

.if the value is `NULL` , 0 •

.otherwise 1 •

.For other values, the `IS NOT NULL` operator always returns 1 •

```
SELECT * FROM t_null WHERE y IS NOT NULL
```

x	y
2	3

## Syntax

There are two types of parsers in the system: the full SQL parser (a recursive descent parser), and the data format parser (a fast stream parser). In all cases except the `INSERT` query, only the full SQL parser is used. The `INSERT` query uses :both parsers

```
INSERT INTO t VALUES (1, 'Hello, world'), (2, 'abc'), (3, 'def')
```

The `INSERT INTO t VALUES` fragment is parsed by the full parser, and the data `(1, 'Hello, world'), (2, 'abc'), (3, 'def')` is parsed by the fast stream parser. You can also turn on the full parser for the data by using the `input_format_values_interpret_expressions` setting. When `input_format_values_interpret_expressions = 1`, ClickHouse first tries to parse values with the fast stream parser. If it fails, ClickHouse tries to use the full parser for the data, treating it like an SQL expression

Data can have any format. When a query is received, the server calculates no more than `max_query_size` bytes of the request in RAM (by default, 1 MB), and the rest is stream parsed. This means the system doesn't have problems with large `INSERT` queries, like MySQL does

When using the `Values` format in an `INSERT` query, it may seem that data is parsed the same as expressions in a `.SELECT` query, but this is not true. The `Values` format is much more limited

.Next we will cover the full parser. For more information about format parsers, see the [Formats](#) section

## Spaces

There may be any number of space symbols between syntactical constructions (including the beginning and end of a .query). Space symbols include the space, tab, line feed, CR, and form feed

## Comments

SQL-style and C-style comments are supported. SQL-style comments: from `--` to the end of the line. The space after `--` can be omitted. Comments in C-style: from `/*` to `*/`. These comments can be multiline. Spaces are not required here, .either

## Keywords

Keywords (such as `SELECT`) are not case-sensitive. Everything else (column names, functions, and so on), in contrast to standard SQL, is case-sensitive

Keywords are not reserved (they are just parsed as keywords in the corresponding context). If you use identifiers the same as the keywords, enclose them into quotes. For example, the query `SELECT "FROM" FROM table_name` is valid if the .`"table table_name has column with the name"FROM`

## Identifiers

:Identifiers are

- .Cluster, database, table, partition and column names •
- .Functions •
- .Data types •
- .Expression aliases •

.Identifiers can be quoted or non-quoted. It is recommended to use non-quoted identifiers

Non-quoted identifiers must match the regex `^[a-zA-Z_][0-9a-zA-Z_]*$` and can not be equal to `keywords`. Examples: `x, _1, _X_y_Z123`

If you want to use identifiers the same as keywords or you want to use other symbols in identifiers, quote it using double .`quotes or backticks, for example, `"id"` , ``id`

## Literals

.There are: numeric, string, compound and `NULL` literals

### Numeric

:A numeric literal tries to be parsed

.First as a 64-bit signed number, using the `strtoull` function •

.If unsuccessful, as a 64-bit unsigned number, using the `strtoll` function •

.If unsuccessful, as a floating-point number using the `strtod` function •

.Otherwise, an error is returned •

The corresponding value will have the smallest type that the value fits in. For example, 1 is parsed as `UInt8`, but 256 is  
.parsed as `UInt16`. For more information, see [Data types](#)

.Examples: 1, 18446744073709551615, 0xDEADBEEF, 01, 0.1, 1e100, -1e-100, inf, nan

### String

Only string literals in single quotes are supported. The enclosed characters can be backslash-escaped. The following escape sequences have a corresponding special value: `\b`, `\f`, `\r`, `\n`, `\t`, `\0`, `\a`, `\v`, `\xHH`. In all other cases, escape sequences in the format `\c`, where `c` is any character, are converted to `c`. This means that you can use the sequences  
.`\`` and `\\"`. The value will have the `String` type

The minimum set of characters that you need to escape in string literals: `'` and `\``. Single quote can be escaped with the  
.single quote, literals `'It\'s'` and `'It"s'` are equal

### Compound

Constructions are supported for arrays: [1, 2, 3] and tuples: (1, 'Hello, world!', 2) .. Actually, these are not literals, but  
expressions with the array creation operator and the tuple creation operator, respectively. An array must consist of at least  
one item, and a tuple must have at least two items. Tuples have a special purpose for use in the `IN` clause of a `SELECT`  
query. Tuples can be obtained as the result of a query, but they can't be saved to a database (with the exception of  
.([Memory](#) tables

### NULL

.Indicates that the value is missing

.In order to store `NULL` in a table field, it must be of the `Nullable` type

Depending on the data format (input or output), `NULL` may have a different representation. For more information, see the  
.documentation for [data formats](#)

There are many nuances to processing `NULL`. For example, if at least one of the arguments of a comparison operation is  
`NULL`, the result of this operation will also be `NULL`. The same is true for multiplication, addition, and other operations.  
.For more information, read the documentation for each operation

In queries, you can check `NULL` using the `IS NULL` and `IS NOT NULL` operators and the related functions `isNull` and  
. `isNotNull`

## Functions

Functions are written like an identifier with a list of arguments (possibly empty) in brackets. In contrast to standard SQL,  
the brackets are required, even for an empty arguments list. Example: `now()`. There are regular and aggregate functions

(see the section "Aggregate functions"). Some aggregate functions can contain two lists of arguments in brackets. Example: `quantile (0.9) (x)`. These aggregate functions are called "parametric" functions, and the arguments in the first list are called "parameters". The syntax of aggregate functions without parameters is the same as for regular functions

## Operators

Operators are converted to their corresponding functions during query parsing, taking their priority and associativity into account. For example, the expression `1 + 2 * 3 + 4` is transformed to `plus(plus(1, multiply(2, 3)), 4)`

## Data Types and Database Table Engines

Data types and table engines in the `CREATE` query are written the same way as identifiers or functions. In other words, they may or may not contain an arguments list in brackets. For more information, see the sections "Data types," "Table engines," and "CREATE

## Expression Aliases

An alias is a user-defined name for an expression in a query

```
expr AS alias
```

AS — The keyword for defining aliases. You can define the alias for a table name or a column name in a `SELECT` clause without using the `AS` keyword. For example, `SELECT table_name_alias.column_name FROM table_name table_name_alias`. In the `CAST` function, the `AS` keyword has another meaning. See the description of the function `expr` — Any expression supported by ClickHouse. For example, `SELECT column_name * 2 AS double FROM some_table`. alias — Name for `expr`. Aliases should comply with the `identifiers` syntax. "For example, `SELECT "table t".column_name FROM table_name AS "table t"`

## Notes on Usage

Aliases are global for a query or subquery and you can define an alias in any part of a query for any expression. For example, `SELECT (1 AS n) + 2, n`

Aliases are not visible in subqueries and between subqueries. For example, while executing the query `SELECT (SELECT .sum(b.a) + num FROM b) - a.a AS num FROM a` ClickHouse generates the exception Unknown identifier: num

If an alias is defined for the result columns in the `SELECT` clause of a subquery, these columns are visible in the outer query. For example, `SELECT n + m FROM (SELECT 1 AS n, 2 AS m`

:Be careful with aliases that are the same as column or table names. Let's consider the following example

```
CREATE TABLE t
(
 a Int,
 b Int
)
ENGINE = TinyLog()
```

```
SELECT
 argMax(a, b),
 sum(b) AS b
FROM t
```

```
Received exception from server (version 18.14.17):
Code: 184. DB::Exception: Received from localhost:9000, 127.0.0.1. DB::Exception: Aggregate function sum(b)
is found inside another aggregate function in query.
```

In this example, we declared table `t` with column `b`. Then, when selecting data, we defined the `sum(b)` AS `b` alias. As aliases are global, ClickHouse substituted the literal `b` in the expression `argMax(a, b)` with the expression `sum(b)`. This substitution caused the exception

## Asterisk

."In a `SELECT` query, an asterisk can replace the expression. For more information, see the section "SELECT

## Expressions

An expression is a function, identifier, literal, application of an operator, expression in brackets, subquery, or asterisk. It can also contain an alias. A list of expressions is one or more expressions separated by commas. Functions and operators, in turn, can have expressions as arguments

## Settings

There are multiple ways to make all the settings described below. Settings are configured in layers, so each subsequent layer redefines the previous settings

:Ways to configure settings, in order of priority

- .Settings in the `users.xml` server configuration file
- .. <Set in the element<profiles
- .Session settings

Send `SET setting=value` from the ClickHouse console client in interactive mode. Similarly, you can use ClickHouse .sessions in the HTTP protocol. To do this, you need to specify the `session_id` HTTP parameter

.Query settings

.When starting the ClickHouse console client in non-interactive mode, set the startup parameter`--setting=value`

- .( ...When using the HTTP API, pass CGI parameters `URL?setting_1=value&setting_2=value`
- .Settings that can only be made in the server config file are not covered in this section

## Requirements

### CPU

For installation from prebuilt deb packages, use a CPU with x86\_64 architecture and support for SSE 4.2 instructions. To run ClickHouse with processors that do not support SSE 4.2 or have AArch64 or PowerPC64LE architecture, you should .build ClickHouse from sources

ClickHouse implements parallel data processing and uses all the hardware resources available. When choosing a processor, take into account that ClickHouse works more efficiently at configurations with a large number of cores but a lower clock rate than at configurations with fewer cores and a higher clock rate. For example, 16 cores with 2600 MHz is .preferable to 8 cores with 3600 MHz

Use of Turbo Boost and hyper-threading technologies is recommended. It significantly improves performance with a typical .load

## RAM

We recommend to use a minimum of 4GB of RAM in order to perform non-trivial queries. The ClickHouse server can run with a much smaller amount of RAM, but it requires memory for processing queries

- :The required volume of RAM depends on
- .The complexity of queries •
- .The amount of data that is processed in queries •

To calculate the required volume of RAM, you should estimate the size of temporary data for **GROUP BY**, **DISTINCT**, **JOIN** and other operations you use

.ClickHouse can use external memory for temporary data. See **GROUP BY in External Memory** for details

## Swap File

.Disable the swap file for production environments

## Storage Subsystem

.You need to have 2GB of free disk space to install ClickHouse

:The volume of storage required for your data should be calculated separately. Assessment should include

- .Estimation of the data volume •

You can take a sample of the data and get the average size of a row from it. Then multiply the value by the number of

- .rows you plan to store
- .The data compression coefficient •

To estimate the data compression coefficient, load a sample of your data into ClickHouse and compare the actual size of the data with the size of the table stored. For example, clickstream data is usually compressed by 6-10 times

To calculate the final volume of data to be stored, apply the compression coefficient to the estimated data volume. If you

- .plan to store data in several replicas, then multiply the estimated volume by the number of replicas

## Network

.If possible, use networks of 10G or higher class

The network bandwidth is critical for processing distributed queries with a large amount of intermediate data. In addition,

- .network speed affects replication processes

## Software

ClickHouse is developed for the Linux family of operating systems. The recommended Linux distribution is Ubuntu. The

- .tzdata package should be installed in the system

ClickHouse can also work in other operating system families. See details in the **Getting started** section of the

- .documentation

## Monitoring

:You can monitor

- .Utilization of hardware resources •
- .ClickHouse server metrics •

## Resource Utilization

.ClickHouse does not monitor the state of hardware resources by itself  
:It is highly recommended to set up monitoring for  
.Load and temperature on processors •  
.You can use [dmesg](#), [turbostat](#) or other instruments  
.Utilization of storage system, RAM and network •

## ClickHouse Server Metrics

.ClickHouse server has embedded instruments for self-state monitoring  
.To track server events use server logs. See the [logger](#) section of the configuration file  
:ClickHouse collects  
.Different metrics of how the server uses computational resources •  
.Common statistics on query processing •

.You can find metrics in the [system.metrics](#), [system.events](#), and [system.asynchronous\\_metrics](#) tables

You can configure ClickHouse to export metrics to [Graphite](#). See the [Graphite section](#) in the ClickHouse server configuration file. Before configuring export of metrics, you should set up Graphite by following their official [guide](#)

Additionally, you can monitor server availability through the HTTP API. Send the HTTP GET request to `/`. If the server is available, it responds with `200 OK`

To monitor servers in a cluster configuration, you should set the [max\\_replica\\_delay\\_for\\_distributed\\_queries](#) parameter and use the HTTP resource `/replicas_status`. A request to `/replicas_status` returns `200 OK` if the replica is available and is not delayed behind the other replicas. If a replica is delayed, it returns information about the gap

## Troubleshooting

- [Installation](#) •
- [Connecting to the server](#) •
- [Query processing](#) •
- [Efficiency of query processing](#) •

## Installation

### You Cannot Get Deb Packages from ClickHouse Repository With apt-get

- .Check firewall settings •

If you cannot access the repository for any reason, download packages as described in the [Getting started](#) article and •  
.install them manually using the `sudo dpkg -i <packages>` command. You will also need the `tzdata` package

## Connecting to the Server

:Possible issues

- .The server is not running •
- .Unexpected or wrong configuration parameters •

### Server Is Not Running

Check if server is runnnig

:Command

```
$ sudo service clickhouse-server status
```

:If the server is not running, start it with the command

```
$ sudo service clickhouse-server start
```

Check logs

.The main log of `clickhouse-server` is in `/var/log/clickhouse-server/clickhouse-server.log` by default

:If the server started successfully, you should see the strings

. `<Information> Application: starting up. — Server started>` •

. `<Information> Application: Ready for connections. — Server is running and ready for connections>` •

If `clickhouse-server start` failed with a configuration error, you should see the `<Error>` string with an error description. For example

```
2019.01.11 15:23:25.549505 [45] {} <Error> ExternalDictionaries: Failed reloading 'event2id' external dictionary: Poco::Exception. Code: 1000, e.code() = 111, e.displayText() = Connection refused, e.what() = Connection refused
```

:If you don't see an error at the end of the file, look through the entire file starting from the string

```
<Information> Application: starting up.
```

:If you try to start a second instance of `clickhouse-server` on the server, you see the following log

```
2019.01.11 15:25:11.151730 [1] {} <Information> : Starting ClickHouse 19.1.0 with revision 54413
2019.01.11 15:25:11.154578 [1] {} <Information> Application: starting up
2019.01.11 15:25:11.156361 [1] {} <Information> StatusFile: Status file ./status already exists - unclean restart. Contents:
PID: 8510
Started at: 2019-01-11 15:24:23
Revision: 54413

2019.01.11 15:25:11.156673 [1] {} <Error> Application: DB::Exception: Cannot lock file ./status. Another server instance in same directory is already running.
2019.01.11 15:25:11.156682 [1] {} <Information> Application: shutting down
2019.01.11 15:25:11.156686 [1] {} <Debug> Application: Uninitializing subsystem: Logging Subsystem
2019.01.11 15:25:11.156716 [2] {} <Information> BaseDaemon: Stop SignalListener thread
```

See system.d logs

If you don't find any useful information in `clickhouse-server` logs or there aren't any logs, you can view `system.d` logs using the command

```
$ sudo journalctl -u clickhouse-server
```

Start clickhouse-server in interactive mode

```
$ sudo -u clickhouse /usr/bin/clickhouse-server --config-file /etc/clickhouse-server/config.xml
```

This command starts the server as an interactive app with standard parameters of the autostart script. In this mode .clickhouse-server prints all the event messages in the console

## Configuration Parameters

:Check

.Docker settings •

.If you run ClickHouse in Docker in an IPv6 network, make sure that network=host is set

.Endpoint settings •

.Check `listen_host` and `tcp_port` settings

.ClickHouse server accepts localhost connections only by default

.HTTP protocol settings •

.Check protocol settings for the HTTP API

.Secure connection settings •

:Check

.The `tcp_port_secure` setting •

.Settings for `SSL certificates` •

.Use proper parameters while connecting. For example, use the `port_secure` parameter with `clickhouse_client`

.User settings •

.You might be using the wrong user name or password

## Query Processing

If ClickHouse is not able to process the query, it sends an error description to the client. In the `clickhouse-client` you get a description of the error in the console. If you are using the HTTP interface, ClickHouse sends the error description in the :response body. For example

```
$ curl 'http://localhost:8123/' --data-binary "SELECT a"
Code: 47, e.displayText() = DB::Exception: Unknown identifier: a. Note that there are no tables (FROM clause) in your query, context: required_names: 'a' source_tables: table_aliases: private_aliases: column_aliases: public_columns: 'a' masked_columns: array_join_columns: source_columns: , e.what() = DB::Exception
```

If you start `clickhouse-client` with the `stack-trace` parameter, ClickHouse returns the server stack trace with the description .of an error

You might see a message about a broken connection. In this case, you can repeat the query. If the connection breaks .every time you perform the query, check the server logs for errors

## Efficiency of Query Processing

If you see that ClickHouse is working too slowly, you need to profile the load on the server resources and network for your .queries

You can use the `clickhouse-benchmark` utility to profile queries. It shows the number of queries processed per second, the number of rows processed per second, and percentiles of query processing times

## Usage Recommendations

### CPU Scaling Governor

Always use the `performance` scaling governor. The `on-demand` scaling governor works much worse with constantly high demand.

```
$ echo 'performance' | sudo tee /sys/devices/system/cpu/cpu*/cpufreq/scaling_governor
```

### CPU Limitations

Processors can overheat. Use `dmesg` to see if the CPU's clock rate was limited due to overheating. The restriction can also be set externally at the datacenter level. You can use `turbostat` to monitor it under a load

### RAM

For small amounts of data (up to ~200 GB compressed), it is best to use as much memory as the volume of data. For large amounts of data and when processing interactive (online) queries, you should use a reasonable amount of RAM (128 GB or more) so the hot data subset will fit in the cache of pages. Even for data volumes of ~50 TB per server, using 128 GB of RAM significantly improves query performance compared to 64 GB

Do not disable overcommit. The value `cat /proc/sys/vm/overcommit_memory` should be 0 or 1. Run

```
$ echo 0 | sudo tee /proc/sys/vm/overcommit_memory
```

### Huge Pages

Always disable transparent huge pages. It interferes with memory allocators, which leads to significant performance degradation

```
$ echo 'never' | sudo tee /sys/kernel/mm/transparent_hugepage/enabled
```

Use `perf top` to watch the time spent in the kernel for memory management. Permanent huge pages also do not need to be allocated

### Storage Subsystem

If your budget allows you to use SSD, use SSD. If not, use HDD. SATA HDDs 7200 RPM will do

Give preference to a lot of servers with local hard drives over a smaller number of servers with attached disk shelves. But for storing archives with rare queries, shelves will work

### RAID

When using HDD, you can combine their RAID-10, RAID-5, RAID-6 or RAID-50. For Linux, software RAID is better (with `mdadm`). We don't recommend using LVM. When creating RAID-10, select the `far` layout. If your budget allows, choose RAID-10.

If you have more than 4 disks, use RAID-6 (preferred) or RAID-50, instead of RAID-5. When using RAID-5, RAID-6 or

.RAID-50, always increase stripe\_cache\_size, since the default value is usually not the best choice

```
$ echo 4096 | sudo tee /sys/block/md2/md/stripe_cache_size
```

Calculate the exact number from the number of devices and the block size, using the formula  $2 * \text{num\_devices} * \text{chunk\_size\_in\_bytes} / 4096$

.A block size of 1024 KB is sufficient for all RAID configurations. Never set the block size too small or too large

.You can use RAID-0 on SSD. Regardless of RAID use, always use replication for data security

Enable NCQ with a long queue. For HDD, choose the CFQ scheduler, and for SSD, choose noop. Don't reduce the  
.readahead setting. For HDD, enable the write cache

## File System

Ext4 is the most reliable option. Set the mount options noatime, nobarrier . XFS is also suitable, but it hasn't been as  
thoroughly tested with ClickHouse. Most other file systems should also work fine. File systems with delayed allocation  
.work better

## Linux Kernel

.Don't use an outdated Linux kernel

## Network

If you are using IPv6, increase the size of the route cache. The Linux kernel prior to 3.2 had a multitude of problems with  
.IPv6 implementation

Use at least a 10 GB network, if possible. 1 Gb will also work, but it will be much worse for patching replicas with tens of  
.terabytes of data, or for processing distributed queries with a large amount of intermediate data

## ZooKeeper

You are probably already using ZooKeeper for other purposes. You can use the same installation of ZooKeeper, if it isn't  
.already overloaded

.It's best to use a fresh version of ZooKeeper – 3.4.9 or later. The version in stable Linux distributions may be outdated

You should never use manually written scripts to transfer data between different ZooKeeper clusters, because the result  
will be incorrect for sequential nodes. Never use the "zkcopy" utility for the same reason:  
<https://github.com/ksprojects/zkcopy/issues/15>

If you want to divide an existing ZooKeeper cluster into two, the correct way is to increase the number of its replicas and  
.then reconfigure it as two independent clusters

Do not run ZooKeeper on the same servers as ClickHouse. Because ZooKeeper is very sensitive for latency and  
.ClickHouse may utilize all available system resources  
:With the default settings, ZooKeeper is a time bomb

The ZooKeeper server won't delete files from old snapshots and logs when using the default configuration (see  
.autopurge), and this is the responsibility of the operator

.This bomb must be defused

:The ZooKeeper (3.5.1) configuration below is used in the Yandex.Metrica production environment as of May 20, 2017

:zoo.cfg

```
http://hadoop.apache.org/zookeeper/docs/current/zookeeperAdmin.html

The number of milliseconds of each tick
tickTime=2000
The number of ticks that the initial
synchronization phase can take
initLimit=30000
The number of ticks that can pass between
sending a request and getting an acknowledgement
syncLimit=10

maxClientCnxns=2000

maxSessionTimeout=60000000
the directory where the snapshot is stored.
dataDir=/opt/zookeeper/{{ cluster['name'] }}/data
Place the dataLogDir to a separate physical disc for better performance
dataLogDir=/opt/zookeeper/{{ cluster['name'] }}/logs

autopurge.snapRetainCount=10
autopurge.purgeInterval=1

To avoid seeks ZooKeeper allocates space in the transaction log file in
blocks of preAllocSize kilobytes. The default block size is 64M. One reason
for changing the size of the blocks is to reduce the block size if snapshots
are taken more often. (Also, see snapCount).
preAllocSize=131072

Clients can submit requests faster than ZooKeeper can process them,
especially if there are a lot of clients. To prevent ZooKeeper from running
out of memory due to queued requests, ZooKeeper will throttle clients so that
there is no more than globalOutstandingLimit outstanding requests in the
system. The default limit is 1,000. ZooKeeper logs transactions to a
transaction log. After snapCount transactions are written to a log file a
snapshot is started and a new transaction log file is started. The default
snapCount is 10,000.
snapCount=3000000

If this option is defined, requests will be will logged to a trace file named
traceFile.year.month.day.
##traceFile=

Leader accepts client connections. Default value is "yes". The leader machine
coordinates updates. For higher update throughput at the slight expense of
read throughput the leader can be configured to not accept clients and focus
on coordination.
leaderServes=yes

standaloneEnabled=false
dynamicConfigFile=/etc/zookeeper-{{ cluster['name'] }}/conf/zoo.cfg.dynamic
```

:Java version

```
Java(TM) SE Runtime Environment (build 1.8.0_25-b17)
Java HotSpot(TM) 64-Bit Server VM (build 25.25-b02, mixed mode)
```

:JVM parameters

```

NAME=zookeeper-{{ cluster['name'] }}
ZOOCFGDIR=/etc/$NAME/conf

TODO this is really ugly
How to find out, which jars are needed?
seems, that log4j requires the log4j.properties file to be in the classpath
CLASSPATH="$ZOOCFGDIR:/usr/build/classes:/usr/build/lib/*.jar:/usr/share/zookeeper/zookeeper-3.5.1-
metrika.jar:/usr/share/zookeeper/slf4j-log4j12-1.7.5.jar:/usr/share/zookeeper/slf4j-api-
1.7.5.jar:/usr/share/zookeeper/servlet-api-2.5-20081211.jar:/usr/share/zookeeper/netty-
3.7.0.Final.jar:/usr/share/zookeeper/log4j-1.2.16.jar:/usr/share/zookeeper/jline-
2.11.jar:/usr/share/zookeeper/jetty-util-6.1.26.jar:/usr/share/zookeeper/jetty-
6.1.26.jar:/usr/share/zookeeper/javacc.jar:/usr/share/zookeeper/jackson-mapper-asl-
1.9.11.jar:/usr/share/zookeeper/jackson-core-asl-1.9.11.jar:/usr/share/zookeeper/commons-cli-
1.2.jar:/usr/src/java/lib/*.jar:/usr/etc/zookeeper"

ZOOCFG="$ZOOCFGDIR/zoo.cfg"
ZOO_LOG_DIR=/var/log/$NAME
USER=zookeeper
GROUP=zookeeper
PIDDIR=/var/run/$NAME
PIDFILE=$PIDDIR/$NAME.pid
SCRIPTNAME=/etc/init.d/$NAME
JAVA=/usr/bin/java
ZOMAIN="org.apache.zookeeper.server.quorum.QuorumPeerMain"
ZOO_LOG4J_PROP="INFO,ROLLINGFILE"
JMXLOCALONLY=false
JAVA_OPTS="-Xms{{ cluster.get('xms','128M') }} \
-Xmx{{ cluster.get('xmx','1G') }} \
-Xloggc:/var/log/$NAME/zookeeper-gc.log \
-XX:+UseGCLogFileRotation \
-XX:NumberOfGCLogFiles=16 \
-XX:GCLogFileSize=16M \
-verbose:gc \
-XX:+PrintGCTimeStamps \
-XX:+PrintGCDateStamps \
-XX:+PrintGCDetails \
-XX:+PrintTenuringDistribution \
-XX:+PrintGCApplicationStoppedTime \
-XX:+PrintGCApplicationConcurrentTime \
-XX:+PrintSafepointStatistics \
-XX:+UseParNewGC \
-XX:+UseConcMarkSweepGC \
-XX:+CMSParallelRemarkEnabled"

```

:Salt init

```

description "zookeeper-{{ cluster['name'] }} centralized coordination service"

start on runlevel [2345]
stop on runlevel [!2345]

respawn

limit nofile 8192 8192

pre-start script
 [-r "/etc/zookeeper-{{ cluster['name'] }}/conf/environment"] || exit 0
 . /etc/zookeeper-{{ cluster['name'] }}/conf/environment
 [-d $ZOO_LOG_DIR] || mkdir -p $ZOO_LOG_DIR
 chown $USER:$GROUP $ZOO_LOG_DIR
end script

script
 . /etc/zookeeper-{{ cluster['name'] }}/conf/environment
 [-r /etc/default/zookeeper] && . /etc/default/zookeeper
 if [-z "$JMXDISABLE"]; then
 JAVA_OPTS="$JAVA_OPTS -Dcom.sun.management.jmxremote -
Dcom.sun.management.jmxremote.local.only=$JMXLOCALONLY"
 fi
 exec start-stop-daemon --start -c $USER --exec $JAVA --name zookeeper-{{ cluster['name'] }} \
 -- -cp $CLASSPATH $JAVA_OPTS -Dzookeeper.log.dir=${ZOO_LOG_DIR} \
 -Dzookeeper.root.logger=${ZOO_LOG4J_PROP} $ZOOMAIN $ZOOCFG
end script

```

## ClickHouse Update

:If ClickHouse was installed from deb packages, execute the following commands on the server

```

$ sudo apt-get update
$ sudo apt-get install clickhouse-client clickhouse-server
$ sudo service clickhouse-server restart

```

If you installed ClickHouse using something other than the recommended deb packages, use the appropriate update .method

ClickHouse does not support a distributed update. The operation should be performed consecutively on each separate .server. Do not update all the servers on a cluster simultaneously, or the cluster will be unavailable for some time

## Access Rights

.Users and access rights are set up in the user config. This is usually users.xml

:Users are recorded in the users section. Here is a fragment of the users.xml file

```

<!-- Users and ACL. -->
<users>
 <!-- If the user name is not specified, the 'default' user is used. -->
 <default>
 <!-- Password could be specified in plaintext or in SHA256 (in hex format).

 If you want to specify password in plaintext (not recommended), place it in 'password' element.
 Example: <password>qwerty</password>.
 Password could be empty.

 If you want to specify SHA256, place it in 'password_sha256_hex' element.
 Example:
<password_sha256_hex>65e84be33532fb784c48129675f9eff3a682b27168c0ea744b2cf58ee02337c5</password_sha256_hex>

 How to generate decent password:
 Execute: PASSWORD=$(base64 < /dev/urandom | head -c8); echo "$PASSWORD"; echo -n "$PASSWORD" | sha256sum | tr -d '-'
 In first line will be password and in second - corresponding SHA256.
 -->
 <password></password>

 <!-- A list of networks that access is allowed from.
 Each list item has one of the following forms:
 <ip> The IP address or subnet mask. For example: 198.51.100.0/24 or 2001:DB8::/32.
 <host> Host name. For example: example01. A DNS query is made for verification, and all addresses obtained are compared with the address of the customer.
 <host-regexp> Regular expression for host names. For example, ^example\d\d-\d\d-\d\host\.ru$.
 To check it, a DNS PTR request is made for the client's address and a regular expression is applied to the result.
 Then another DNS query is made for the result of the PTR query, and all received address are compared to the client address.
 We strongly recommend that the regex ends with \.host\.ru$.

 If you are installing ClickHouse yourself, specify here:
 <networks>
 <ip>::/0</ip>
 </networks>
 -->
 <networks incl="networks" />

 <!-- Settings profile for the user. -->
 <profile>default</profile>

 <!-- Quota for the user. -->
 <quota>default</quota>
 </default>

 <!-- For requests from the Yandex.Metrica user interface via the API for data on specific counters. -->
 <web>
 <password></password>
 <networks incl="networks" />
 <profile>web</profile>
 <quota>default</quota>
 <allow_databases>
 <database>test</database>
 </allow_databases>
 <allow_dictionaries>
 <dictionary>test</dictionary>
 </allow_dictionaries>
 </web>
</users>
```

. You can see a declaration from two users: default and web . We added the web user separately

The default user is chosen in cases when the username is not passed. The default user is also used for distributed query processing, if the configuration of the server or cluster doesn't specify the user and password (see the section on the [\(Distributed engine](#)

The user that is used for exchanging information between servers combined in a cluster must not have substantial

.restrictions or quotas – otherwise, distributed queries will fail

The password is specified in clear text (not recommended) or in SHA-256. The hash isn't salted. In this regard, you should not consider these passwords as providing security against potential malicious attacks. Rather, they are necessary for protection from employees

A list of networks is specified that access is allowed from. In this example, the list of networks for both users is loaded from a separate file ( /etc/metrika.xml ) containing the `networks` substitution. Here is a fragment of it

```
<yandex>
 ...
 <networks>
 <ip>::/64</ip>
 <ip>203.0.113.0/24</ip>
 <ip>2001:DB8::/32</ip>
 ...
 </networks>
</yandex>
```

You could define this list of networks directly in `users.xml`, or in a file in the `users.d` directory (for more information, see the .("section "Configuration files

.The config includes comments explaining how to open access from everywhere

For use in production, only specify `ip` elements (IP addresses and their masks), since using `host` and `host_regex` might .cause extra latency

Next the user settings profile is specified (see the section "Settings profiles"). You can specify the default profile, `default`. The profile can have any name. You can specify the same profile for different users. The most important thing you can write in the settings profile is `readonly=1`, which ensures read-only access. Then specify the quota to be used (see the section "Quotas"). You can specify the default quota: `default`. It is set in the config by default to only count resource usage, without restricting it. The quota can have any name. You can specify the same quota for different users – in this .case, resource usage is calculated for each user individually

In the optional `<allow_databases>` section, you can also specify a list of databases that the user can access. By default, all databases are available to the user. You can specify the `default` database. In this case, the user will receive access to the .database by default

In the optional `<allow_dictionaries>` section, you can also specify a list of dictionaries that the user can access. By default, .all dictionaries are available to the user

.(Access to the `system` database is always allowed (since this database is used for processing queries

The user can get a list of all databases and tables in them by using `SHOW` queries or system tables, even if access to .individual databases isn't allowed

Database access is not related to the `readonly` setting. You can't grant full access to one database and `readonly` access to .another one

## Data Backup

While `replication` provides protection from hardware failures, it does not protect against human errors: accidental deletion of data, deletion of the wrong table or a table on the wrong cluster, and software bugs that result in incorrect data processing or data corruption. In many cases mistakes like these will affect all replicas. ClickHouse has built-in safeguards to prevent some types of mistakes — for example, by default you can't just drop tables with a `MergeTree-like` engine containing more than 50 Gb of data. However, these safeguards don't cover all possible cases and can be .circumvented

In order to effectively mitigate possible human errors, you should carefully prepare a strategy for backing up and restoring .your data in advance

Each company has different resources available and business requirements, so there's no universal solution for ClickHouse backups and restores that will fit every situation. What works for one gigabyte of data likely won't work for tens of petabytes. There are a variety of possible approaches with their own pros and cons, which will be discussed below. It is .a good idea to use several approaches instead of just one in order to compensate for their various shortcomings

#### Note

Keep in mind that if you backed something up and never tried to restore it, chances are that restore will not work properly when you actually need it (or at least it will take longer than business can tolerate). So whatever backup approach you choose, make sure to automate the restore .process as well, and practice it on a spare ClickHouse cluster regularly

## Duplicating Source Data Somewhere Else

Often data that is ingested into ClickHouse is delivered through some sort of persistent queue, such as [Apache Kafka](#). In this case it is possible to configure an additional set of subscribers that will read the same data stream while it is being written to ClickHouse and store it in cold storage somewhere. Most companies already have some default recommended .cold storage, which could be an object store or a distributed filesystem like [HDFS](#)

## Filesystem Snapshots

Some local filesystems provide snapshot functionality (for example, [ZFS](#)), but they might not be the best choice for serving live queries. A possible solution is to create additional replicas with this kind of filesystem and exclude them from the [Distributed](#) tables that are used for `SELECT` queries. Snapshots on such replicas will be out of reach of any queries that modify data. As a bonus, these replicas might have special hardware configurations with more disks attached per .server, which would be cost-effective

## `clickhouse-copier`

`clickhouse-copier` is a versatile tool that was initially created to re-shard petabyte-sized tables. It can also be used for .backup and restore purposes because it reliably copies data between ClickHouse tables and clusters .For smaller volumes of data, a simple `INSERT INTO ... SELECT ...` to remote tables might work as well

## Manipulations with Parts

ClickHouse allows using the `ALTER TABLE ... FREEZE PARTITION ...` query to create a local copy of table partitions. This is implemented using hardlinks to the `/var/lib/clickhouse/shadow/` folder, so it usually does not consume extra disk space for old data. The created copies of files are not handled by ClickHouse server, so you can just leave them there: you will have a simple backup that doesn't require any additional external system, but it will still be prone to hardware issues. For this reason, it's better to remotely copy them to another location and then remove the local copies. Distributed filesystems and object stores are still a good options for this, but normal attached file servers with a large enough capacity might work as .(well (in this case the transfer will occur via the network filesystem or maybe `rsync`

.For more information about queries related to partition manipulations, see the [ALTER documentation](#) .A third-party tool is available to automate this approach: [clickhouse-backup](#)

## Configuration Files

ClickHouse supports multi-file configuration management. The main server configuration file is `/etc/clickhouse-`

Note 

. <All the configuration files should be in XML format. Also, they should have the same root element, usually <yandex

Some settings specified in the main configuration file can be overridden in other configuration files. The `replace` or `remove` attributes can be specified for the elements of these configuration files

.If neither is specified, it combines the contents of elements recursively, replacing values of duplicate children

.If `replace` is specified, it replaces the entire element with the specified one

.If `remove` is specified, it deletes the element

The config can also define "substitutions". If an element has the `incl` attribute, the corresponding substitution from the file will be used as the value. By default, the path to the file with substitutions is `/etc/metrika.xml` . This can be changed in the `include_from` element in the server config. The substitution values are specified in `/yandex/substitution_name` elements in this file. If a substitution specified in `incl` does not exist, it is recorded in the log. To prevent ClickHouse from logging .(missing substitutions, specify the `optional="true"` attribute (for example, settings for `macros`

Substitutions can also be performed from ZooKeeper. To do this, specify the attribute `from_zk = "/path/to/node"` . The element value is replaced with the contents of the node at `/path/to/node` in ZooKeeper. You can also put an entire XML .subtree on the ZooKeeper node and it will be fully inserted into the source element

The `config.xml` file can specify a separate config with user settings, profiles, and quotas. The relative path to this config is set in the 'users\_config' element. By default, it is `users.xml` . If `users_config` is omitted, the user settings, profiles, and .quotas are specified directly in `config.xml`

In addition, `users_config` may have overrides in files from the `users_config.d` directory (for example, `users.d` ) and :substitutions. For example, you can have separate config file for each user like this

```
$ cat /etc/clickhouse-server/users.d/alice.xml
```

```
<yandex>
 <users>
 <alice>
 <profile>analytics</profile>
 <networks>
 <ip>::/0</ip>
 </networks>
 <password_sha256_hex>...</password_sha256_hex>
 <quota>analytics</quota>
 </alice>
 </users>
</yandex>
```

For each config file, the server also generates `file-preprocessed.xml` files when starting. These files contain all the completed substitutions and overrides, and they are intended for informational use. If ZooKeeper substitutions were used in the config files but ZooKeeper is not available on the server start, the server loads the configuration from the .preprocessed file

The server tracks changes in config files, as well as files and ZooKeeper nodes that were used when performing substitutions and overrides, and reloads the settings for users and clusters on the fly. This means that you can modify the .cluster, users, and their settings without restarting the server

Quotas allow you to limit resource usage over a period of time, or simply track the use of resources. Quotas are set up in .the user config. This is usually 'users.xml'

The system also has a feature for limiting the complexity of a single query. See the section "Restrictions on query ."("complexity

:In contrast to query complexity restrictions, quotas

.Place restrictions on a set of queries that can be run over a period of time, instead of limiting a single query •

.Account for resources spent on all remote servers for distributed query processing •

.Let's look at the section of the 'users.xml' file that defines quotas

```
<!-- Quotas -->
<quotas>
 <!-- Quota name. -->
 <default>
 <!-- Restrictions for a time period. You can set many intervals with different restrictions. -->
 <interval>
 <!-- Length of the interval. -->
 <duration>3600</duration>

 <!-- Unlimited. Just collect data for the specified time interval. -->
 <queries>0</queries>
 <errors>0</errors>
 <result_rows>0</result_rows>
 <read_rows>0</read_rows>
 <execution_time>0</execution_time>
 </interval>
 </default>
```

By default, the quota just tracks resource consumption for each hour, without limiting usage. The resource consumption .calculated for each interval is output to the server log after each request

```
<statbox>
 <!-- Restrictions for a time period. You can set many intervals with different restrictions. -->
 <interval>
 <!-- Length of the interval. -->
 <duration>3600</duration>

 <queries>1000</queries>
 <errors>100</errors>
 <result_rows>1000000000</result_rows>
 <read_rows>100000000000</read_rows>
 <execution_time>900</execution_time>
 </interval>

 <interval>
 <duration>86400</duration>

 <queries>10000</queries>
 <errors>1000</errors>
 <result_rows>5000000000</result_rows>
 <read_rows>500000000000</read_rows>
 <execution_time>7200</execution_time>
 </interval>
</statbox>
```

For the 'statbox' quota, restrictions are set for every hour and for every 24 hours (86,400 seconds). The time interval is counted starting from an implementation-defined fixed moment in time. In other words, the 24-hour interval doesn't .necessarily begin at midnight

.When the interval ends, all collected values are cleared. For the next hour, the quota calculation starts over

:Here are the amounts that can be restricted

. queries – The total number of requests  
. errors – The number of queries that threw an exception  
. result\_rows – The total number of rows given as the result  
. read\_rows – The total number of source rows read from tables for running the query, on all remote servers  
. execution\_time – The total query execution time, in seconds (wall time)

If the limit is exceeded for at least one time interval, an exception is thrown with a text about which restriction was exceeded, for which interval, and when the new interval begins (when queries can be sent again).

Quotas can use the "quota key" feature in order to report on resources for multiple keys independently. Here is an example of this

```
<!-- For the global reports designer. -->
<web_global>
 <!-- keyed – The quota_key "key" is passed in the query parameter,
 and the quota is tracked separately for each key value.
 For example, you can pass a Yandex.Metrica username as the key,
 so the quota will be counted separately for each username.
 Using keys makes sense only if quota_key is transmitted by the program, not by a user.

 You can also write <keyed_by_ip /> so the IP address is used as the quota key.
 (But keep in mind that users can change the IPv6 address fairly easily.)
-->
<keyed />
```

."The quota is assigned to users in the 'users' section of the config. See the section "Access rights

For distributed query processing, the accumulated amounts are stored on the requestor server. So if the user goes to another server, the quota there will "start over". When the server is restarted, quotas are reset

## System tables

System tables are used for implementing part of the system's functionality, and for providing access to information about how the system is working. You can't delete a system table (but you can perform DETACH). System tables don't have files with data on the disk or files with metadata. The server creates all the system tables when it starts. System tables are read-only. They are located in the 'system' database

### system.asynchronous\_metrics

.Contains metrics that are calculated periodically in the background. For example, the amount of RAM in use

:Columns

- . metric (**String**) — Metric name •
- . value (**Float64**) — Metric value •

Example

```
SELECT * FROM system.asynchronous_metrics LIMIT 10
```

metric	value
jemalloc.background_thread.run_interval	0
jemalloc.background_thread.num_runs	0
jemalloc.background_thread.num_threads	0
jemalloc.retained	422551552
jemalloc.mapped	1682989056
jemalloc.resident	1656446976
jemalloc.metadata_thp	0
jemalloc.metadata	10226856
UncompressedCacheCells	0
MarkCacheFiles	0

See Also

- [.Monitoring](#) — Base concepts of ClickHouse monitoring •
- [.system.metrics](#) — Contains instantly calculated metrics •
- [.system.events](#) — Contains a number of events that have occurred •

## system.clusters

.Contains information about clusters available in the config file and the servers in them

:Columns

- . cluster (String) — The cluster name •
- . shard\_num (UInt32) — The shard number in the cluster, starting from 1 •
- . shard\_weight (UInt32) — The relative weight of the shard when writing data •
- . replica\_num (UInt32) — The replica number in the shard, starting from 1 •
- . host\_name (String) — The host name, as specified in the config •
- . host\_address (String) — The host IP address obtained from DNS •
- . port (UInt16) — The port to use for connecting to the server •
- . user (String) — The name of the user for connecting to the server •
- . errors\_count (UInt32) - number of times this host failed to reach replica •
- estimated\_recovery\_time (UInt32) - seconds left until replica error count is zeroed and it is considered to be back to •
- .normal

Please note that `errors_count` is updated once per query to the cluster, but `estimated_recovery_time` is recalculated on-demand. So there could be a case of non-zero `errors_count` and zero `estimated_recovery_time`, that next query will zero `errors_count` and try to use replica as if it has no errors

See also

- [Table engine Distributed](#) •
- [distributed\\_replica\\_error\\_cap setting](#) •
- [distributed\\_replica\\_error\\_half\\_life setting](#) •

## system.columns

.Contains information about columns in all the tables

.You can use this table to get information similar to the [DESCRIBE TABLE](#) query, but for multiple tables at once

: (The `system.columns` table contains the following columns (the column type is shown in brackets)

- . `database` (String) — Database name •
- . `table` (String) — Table name •
- . `name` (String) — Column name •
- . `type` (String) — Column type •

`default_kind` (String) — Expression type (DEFAULT , MATERIALIZED , ALIAS ) for the default value, or an empty string if it is not defined •

- . `default_expression` (String) — Expression for the default value, or an empty string if it is not defined •
  - . `data_compressed_bytes` (UInt64) — The size of compressed data, in bytes •
  - . `data_uncompressed_bytes` (UInt64) — The size of decompressed data, in bytes •
  - . `marks_bytes` (UInt64) — The size of marks, in bytes •
- . `comment` (String) — Comment on the column, or an empty string if it is not defined •
- . `is_in_partition_key` (UInt8) — Flag that indicates whether the column is in the partition expression •
- . `is_in_sorting_key` (UInt8) — Flag that indicates whether the column is in the sorting key expression •
- . `is_in_primary_key` (UInt8) — Flag that indicates whether the column is in the primary key expression •
- . `is_in_sampling_key` (UInt8) — Flag that indicates whether the column is in the sampling key expression •

## system.contributors

. Contains information about contributors. All contributors in random order. The order is random at query execution time

:Columns

- . `name` (String) — Contributor (author) name from git log •

Example

```
SELECT * FROM system.contributors LIMIT 10
```

name
Olga Khvostikova
Max Vetrov
LiuYangkuan
svladykin
zamulla
Šimon Podlipský
BayoNet
Ilya Khomutov
Amy Krishnevsky
Loud_Scream

: To find out yourself in the table, use a query

```
SELECT * FROM system.contributors WHERE name='Olga Khvostikova'
```

name
Olga Khvostikova

## system.databases

This table contains a single String column called 'name' – the name of a database. Each database that the server knows about has a corresponding entry in the table. This system table is used for implementing the `SHOW DATABASES` query

## system.detached\_parts

Contains information about detached parts of **MergeTree** tables. The `reason` column specifies why the part was detached.

For user-detached parts, the reason is empty. Such parts can be attached with **ALTER TABLE ATTACH PARTITION|PART** command. For the description of other columns, see [system.parts](#). If part name is invalid, values of some columns may be `NULL`. Such parts can be deleted with **ALTER TABLE DROP DETACHED PART**

## system.dictionaries

.Contains information about external dictionaries

:Columns

- . `name` (`String`) — Dictionary name •
- . `type` (`String`) — Dictionary type: Flat, Hashed, Cache •
- . `origin` (`String`) — Path to the configuration file that describes the dictionary •
- . `attribute.names` (`Array(String)`) — Array of attribute names provided by the dictionary •
- . `attribute.types` (`Array(String)`) — Corresponding array of attribute types that are provided by the dictionary •
  - . `has_hierarchy` (`UInt8`) — Whether the dictionary is hierarchical •
  - . `bytes_allocated` (`UInt64`) — The amount of RAM the dictionary uses •
- . `hit_rate` (`Float64`) — For cache dictionaries, the percentage of uses for which the value was in the cache •
  - . `element_count` (`UInt64`) — The number of items stored in the dictionary •
- . `load_factor` (`Float64`) — The percentage filled in the dictionary (for a hashed dictionary, the percentage filled in the .(hash table
- . `creation_time` (`DateTime`) — The time when the dictionary was created or last successfully reloaded •
- . `last_exception` (`String`) — Text of the error that occurs when creating or reloading the dictionary if the dictionary .couldn't be created
- . `source` (`String`) — Text describing the data source for the dictionary •

Note that the amount of memory used by the dictionary is not proportional to the number of items stored in it. So for flat and cached dictionaries, all the memory cells are pre-assigned, regardless of how full the dictionary actually is

## system.events

Contains information about the number of events that have occurred in the system. For example, in the table, you can find .how many `SELECT` queries were processed since the ClickHouse server started

:Columns

- . `event` (`String`) — Event name •
- . `value` (`UInt64`) — Number of events occurred •
- . `description` (`String`) — Event description •

Example

```
SELECT * FROM system.events LIMIT 5
```

event	value	description
Query	12   Number of queries to be interpreted and potentially executed. Does not include queries that failed to parse or were rejected due to AST size limits, quota limits or limits on the number of simultaneously running queries. May include internal queries initiated by ClickHouse itself. Does not count subqueries.	
SelectQuery	8   Same as Query, but only for SELECT queries.	
FileOpen	73   Number of files opened.	
ReadBufferFromFileDescriptorRead	155   Number of reads (read/pread) from a file descriptor. Does not include sockets.	
ReadBufferFromFileDescriptorReadBytes	9931   Number of bytes read from file descriptors. If the file is compressed, this will show the compressed data size.	

## See Also

- [.system.asynchronous\\_metrics](#) — Contains periodically calculated metrics •
- [.system.metrics](#) — Contains instantly calculated metrics •
- [.Monitoring](#) — Base concepts of ClickHouse monitoring •

## system.functions

.Contains information about normal and aggregate functions

:Columns

- . name ( String ) — The name of the function •
- . is\_aggregate ( UInt8 ) — Whether the function is aggregate •

## system.graphite\_retentions

.Contains information about parameters [graphite\\_rollup](#) which are used in tables with \*[GraphiteMergeTree](#) engines

:Columns

- . config\_name ( String ) - graphite\_rollup parameter name •
- . regexp ( String ) - A pattern for the metric name •
- . function ( String ) - The name of the aggregating function •
- . age ( UInt64 ) - The minimum age of the data in seconds •
- . precision ( UInt64 ) - How precisely to define the age of the data in seconds •
- . priority ( UInt16 ) - Pattern priority •
- . is\_default ( UInt8 ) - Whether the pattern is the default •
- . Tables.database ( Array(String) ) - Array of names of database tables that use the config\_name parameter •
- . Tables.table ( Array(String) ) - Array of table names that use the config\_name parameter •

## system.merges

.Contains information about merges and part mutations currently in process for tables in the MergeTree family

:Columns

- . database (String) — The name of the database the table is in •
- . table (String) — Table name •
- . elapsed (Float64) — The time elapsed (in seconds) since the merge started •
- . progress (Float64) — The percentage of completed work from 0 to 1 •
- . num\_parts (UInt64) — The number of pieces to be merged •
- . result\_part\_name (String) — The name of the part that will be formed as the result of merging •
  - . is\_mutation (UInt8) - 1 if this process is a part mutation •
- . total\_size\_bytes\_compressed (UInt64) — The total size of the compressed data in the merged chunks •
  - . total\_size\_marks (UInt64) — The total number of marks in the merged parts •
  - . bytes\_read\_uncompressed (UInt64) — Number of bytes read, uncompressed •
    - . rows\_read (UInt64) — Number of rows read •
  - . bytes\_written\_uncompressed (UInt64) — Number of bytes written, uncompressed •
    - . rows\_written (UInt64) — Number of rows written •

## system.metrics

Contains metrics which can be calculated instantly, or have a current value. For example, the number of simultaneously processed queries or the current replica delay. This table is always up to date

:Columns

- . metric (String) — Metric name •
- . value (Int64) — Metric value •
- . description (String) — Metric description •

.The list of supported metrics you can find in the [dbms/src/Common/CurrentMetrics.cpp](#) source file of ClickHouse

Example

```
SELECT * FROM system.metrics LIMIT 10
```

metric	value	description
Query	1	Number of executing queries
Merge	0	Number of executing background merges
PartMutation	0	Number of mutations (ALTER DELETE/UPDATE)
ReplicatedFetch	0	Number of data parts being fetched from replicas
ReplicatedSend	0	Number of data parts being sent to replicas
ReplicatedChecks	0	Number of data parts checking for consistency
BackgroundPoolTask	0	Number of active tasks in BackgroundProcessingPool (merges, mutations, fetches, or replication queue bookkeeping)
BackgroundSchedulePoolTask	0	Number of active tasks in BackgroundSchedulePool. This pool is used for periodic ReplicatedMergeTree tasks, like cleaning old data parts, altering data parts, replica re-initialization, etc.
DiskSpaceReservedForMerge	0	Disk space reserved for currently running background merges. It is slightly more than the total size of currently merging parts.
DistributedSend	0	Number of connections to remote servers sending data that was INSERTed into Distributed tables. Both synchronous and asynchronous mode.

See Also

- [.system.asynchronous\\_metrics](#) — Contains periodically calculated metrics
- [.system.events](#) — Contains a number of events that occurred
- [.Monitoring](#) — Base concepts of ClickHouse monitoring

## system.numbers

This table contains a single UInt64 column named 'number' that contains almost all the natural numbers starting from zero. You can use this table for tests, or if you need to do a brute force search. Reads from this table are not parallelized

## system.numbers\_mt

.The same as 'system.numbers' but reads are parallelized. The numbers can be returned in any order. Used for tests

## system.one

This table contains a single row with a single 'dummy' UInt8 column containing the value 0. This table is used if a SELECT query doesn't specify the FROM clause. This is similar to the DUAL table found in other DBMSs

## system.parts

.Contains information about parts of [MergeTree](#) tables

.Each row describes one data part

:Columns

- [.partition](#) (String) – The partition name. To learn what a partition is, see the description of the [ALTER](#) query

:Formats

. YYYYMM for automatic partitioning by month •  
. any\_string when partitioning manually •  
. name ( String ) – Name of the data part •

active ( UInt8 ) – Flag that indicates whether the data part is active. If a data part is active, it's used in a table. •  
. Otherwise, it's deleted. Inactive data parts remain after merging

marks ( UInt64 ) – The number of marks. To get the approximate number of rows in a data part, multiply marks by the •  
. (index granularity (usually 8192) (this hint doesn't work for adaptive granularity

. rows ( UInt64 ) – The number of rows •  
. bytes\_on\_disk ( UInt64 ) – Total size of all the data part files in bytes •

data\_compressed\_bytes ( UInt64 ) – Total size of compressed data in the data part. All the auxiliary files (for example, •  
. files with marks) are not included

data\_uncompressed\_bytes ( UInt64 ) – Total size of uncompressed data in the data part. All the auxiliary files (for •  
. example, files with marks) are not included

. marks\_bytes ( UInt64 ) – The size of the file with marks •

modification\_time ( DateTime ) – The time the directory with the data part was modified. This usually corresponds to the •  
. |.time of data part creation

. remove\_time ( DateTime ) – The time when the data part became inactive •

refcount ( UInt32 ) – The number of places where the data part is used. A value greater than 2 indicates that the data •  
. part is used in queries or merges

. min\_date ( Date ) – The minimum value of the date key in the data part •  
. max\_date ( Date ) – The maximum value of the date key in the data part •

. min\_time ( DateTime ) – The minimum value of the date and time key in the data part •  
. max\_time ( DateTime ) – The maximum value of the date and time key in the data part •

. partition\_id ( String ) – ID of the partition •

. min\_block\_number ( UInt64 ) – The minimum number of data parts that make up the current part after merging •  
. max\_block\_number ( UInt64 ) – The maximum number of data parts that make up the current part after merging •

level ( UInt32 ) – Depth of the merge tree. Zero means that the current part was created by insert rather than by •  
. merging other parts

data\_version ( UInt64 ) – Number that is used to determine which mutations should be applied to the data part •  
. ((mutations with a version higher than data\_version

. primary\_key\_bytes\_in\_memory ( UInt64 ) – The amount of memory (in bytes) used by primary key values •  
. primary\_key\_bytes\_in\_memory\_allocated ( UInt64 ) – The amount of memory (in bytes) reserved for primary key values •

is\_frozen ( UInt8 ) – Flag that shows that a partition data backup exists. 1, the backup exists. 0, the backup doesn't •  
. exist. For more details, see **FREEZE PARTITION**

. database ( String ) – Name of the database •  
. table ( String ) – Name of the table •

. engine ( String ) – Name of the table engine without parameters •  
. path ( String ) – Absolute path to the folder with data part files •

. disk ( String ) – Name of a disk that stores the data part •  
. hash\_of\_all\_files ( String ) – **sipHash128** of compressed files •

. hash\_of\_uncompressed\_files ( String ) – **sipHash128** of uncompressed files (files with marks, index file etc •  
. uncompressed\_hash\_of\_compressed\_files ( String ) – **sipHash128** of data in the compressed files as if they were •

.uncompressed

. bytes ( UInt64 ) – Alias for bytes\_on\_disk •

. marks\_size ( UInt64 ) – Alias for marks\_bytes •

## system.part\_log

.The system.part\_log table is created only if the part\_log server setting is specified

This table contains information about events that occurred with data parts in the MergeTree family tables, such as adding or merging data

:The system.part\_log table contains the following columns

: event\_type (Enum) — Type of the event that occurred with the data part. Can have one of the following values •

. NEW\_PART — Inserting of a new data part •

. MERGE\_PARTS — Merging of data parts •

. DOWNLOAD\_PART — Downloading a data part •

. REMOVE\_PART — Removing or detaching a data part using DETACH PARTITION •

. MUTATE\_PART — Mutating of a data part •

. MOVE\_PART — Moving the data part from the one disk to another one •

. event\_date (Date) — Event date •

. event\_time (DateTime) — Event time •

. duration\_ms (UInt64) — Duration •

. database (String) — Name of the database the data part is in •

. table (String) — Name of the table the data part is in •

. part\_name (String) — Name of the data part •

partition\_id (String) — ID of the partition that the data part was inserted to. The column takes the 'all' value if the •

. ()partitioning is by tuple

. rows (UInt64) — The number of rows in the data part •

. size\_in\_bytes (UInt64) — Size of the data part in bytes •

merged\_from (Array(String)) — An array of names of the parts which the current part was made up from (after the •

.(merge

. bytes\_uncompressed (UInt64) — Size of uncompressed bytes •

. read\_rows (UInt64) — The number of rows was read during the merge •

. read\_bytes (UInt64) — The number of bytes was read during the merge •

. error (UInt16) — The code number of the occurred error •

. exception (String) — Text message of the occurred error •

.The system.part\_log table is created after the first inserting data to the MergeTree table

## system.processes

.This system table is used for implementing the SHOW PROCESSLIST query

:Columns

user (String) — The user who made the query. Keep in mind that for distributed processing, queries are sent to •

remote servers under the `default` user. The field contains the username for a specific query, not for a query that this .query initiated address (String) – The IP address the request was made from. The same for distributed processing. To track where a • .distributed query was originally made from, look at `system.processes` on the query requestor server . elapsed (Float64) – The time in seconds since request execution started •

rows\_read (UInt64) – The number of rows read from the table. For distributed processing, on the requestor server, this • .is the total for all remote servers

bytes\_read (UInt64) – The number of uncompressed bytes read from the table. For distributed processing, on the • .requestor server, this is the total for all remote servers

total\_rows\_approx (UInt64) – The approximation of the total number of rows that should be read. For distributed • processing, on the requestor server, this is the total for all remote servers. It can be updated during request .processing, when new sources to process become known

memory\_usage (UInt64) – Amount of RAM the request uses. It might not include some types of dedicated memory. • .See the [max\\_memory\\_usage](#) setting

. query (String) – The query text. For `INSERT`, it doesn't include the data to insert •

. query\_id (String) – Query ID, if defined •

## system.query\_log

Contains information about execution of queries. For each query, you can see processing start time, duration of • .processing, error messages and other information

### Note

.The table doesn't contain input data for `INSERT` queries

ClickHouse creates this table only if the [query\\_log](#) server parameter is specified. This parameter sets the logging rules, .such as the logging interval or the name of the table the queries will be logged in

.To enable query logging, set the [log\\_queries](#) parameter to 1. For details, see the [Settings](#) section

:The `system.query_log` table registers two kinds of queries

.Initial queries that were run directly by the client .1

Child queries that were initiated by other queries (for distributed query execution). For these types of queries, .2 .information about the parent queries is shown in the `initial_*` columns

:Columns

: type (Enum8) — Type of event that occurred when executing the query. Values •

. `QueryStart`' = 1 — Successful start of query execution' •

. `QueryFinish`' = 2 — Successful end of query execution' •

. `ExceptionBeforeStart`' = 3 — Exception before the start of query execution' •

. `ExceptionWhileProcessing`' = 4 — Exception during the query execution' •

. `event_date` (Date) — Query starting date •

. `event_time` (DateTime) — Query starting time •

. `query_start_time` (DateTime) — Start time of query execution •

. `query_duration_ms` (UInt64) — Duration of query execution •

. written\_rows (UInt64) — For INSERT queries, the number of written rows. For other queries, the column value is 0 •  
. written\_bytes (UInt64) — For INSERT queries, the number of written bytes. For other queries, the column value is 0 •  
    . result\_rows (UInt64) — Number of rows in the result •  
    . result\_bytes (UInt64) — Number of bytes in the result •  
    . memory\_usage (UInt64) — Memory consumption by the query •  
        . query (String) — Query string •  
        . exception (String) — Exception message •  
stack\_trace (String) — Stack trace (a list of methods called before the error occurred). An empty string, if the query is • completed successfully  
    : is\_initial\_query (UInt8) — Query type. Possible values •  
        .Query was initiated by the client — 1 •  
        .Query was initiated by another query for distributed query execution — 0 •  
        . user (String) — Name of the user who initiated the current query •  
            . query\_id (String) — ID of the query •  
        . address (IPv6) — IP address that was used to make the query •  
        . port (UInt16) — The client port that was used to make the query •  
. initial\_user (String) — Name of the user who ran the initial query (for distributed query execution) •  
. initial\_query\_id (String) — ID of the initial query (for distributed query execution) •  
    . initial\_address (IPv6) — IP address that the parent query was launched from •  
    . initial\_port (UInt16) — The client port that was used to make the parent query •  
    : interface (UInt8) — Interface that the query was initiated from. Possible values •  
        .TCP — 1 •  
        .HTTP — 2 •  
            . os\_user (String) — OS's username who runs clickhouse-client •  
. client\_hostname (String) — Hostname of the client machine where the clickhouse-client or another TCP client is run •  
    . client\_name (String) — The clickhouse-client or another TCP client name •  
    . client\_revision (UInt32) — Revision of the clickhouse-client or another TCP client •  
    . client\_version\_major (UInt32) — Major version of the clickhouse-client or another TCP client •  
    . client\_version\_minor (UInt32) — Minor version of the clickhouse-client or another TCP client •  
    . client\_version\_patch (UInt32) — Patch component of the clickhouse-client or another TCP client version •  
        : http\_method (UInt8) — HTTP method that initiated the query. Possible values •  
            .The query was launched from the TCP interface — 0 •  
            . GET method was used — 1 •  
            . POST method was used — 2 •  
            . http\_user\_agent (String) — The UserAgent header passed in the HTTP request •  
. quota\_key (String) — The "quota key" specified in the quotas setting (see keyed •  
        . revision (UInt32) — ClickHouse revision •  
. thread\_numbers (Array(UInt32)) — Number of threads that are participating in query execution •

- . ProfileEvents.Names (Array(String)) — Counters that measure different metrics. The description of them could be found in the table [system.events](#)
- . ProfileEvents.Values (Array(UInt64)) — Values of metrics that are listed in the ProfileEvents.Names column
- Settings.Names (Array(String)) — Names of settings that were changed when the client ran the query. To enable logging changes to settings, set the log\_query\_settings parameter to 1
  - . Settings.Values (Array(String)) — Values of settings that are listed in the Settings.Names column
    - :Each query creates one or two rows in the `query_log` table, depending on the status of the query
      - .(If the query execution is successful, two events with types 1 and 2 are created (see the `type` column .1
        - .If an error occurred during query processing, two events with types 1 and 4 are created .2
          - .If an error occurred before launching the query, a single event with type 3 is created .3

By default, logs are added to the table at intervals of 7.5 seconds. You can set this interval in the `query_log` server setting (see the `flush_interval_milliseconds` parameter). To flush the logs forcibly from the memory buffer into the table, use the `.SYSTEM FLUSH LOGS` query.

When the table is deleted manually, it will be automatically created on the fly. Note that all the previous logs will be deleted.

The storage period for logs is unlimited. Logs aren't automatically deleted from the table. You need to organize the removal of outdated logs yourself.

You can specify an arbitrary partitioning key for the `system.query_log` table in the `query_log` server setting (see the `.( partition_by` parameter

## system.query\_thread\_log

.The table contains information about each query execution thread

ClickHouse creates this table only if the `query_thread_log` server parameter is specified. This parameter sets the logging rules, such as the logging interval or the name of the table the queries will be logged in.

To enable query logging, set the `log_query_threads` parameter to 1. For details, see the [Settings](#) section.

## :Columns

- . event\_date (Date) — the date when the thread has finished execution of the query
- . event\_time (DateTime) — the date and time when the thread has finished execution of the query
  - . query\_start\_time (DateTime) — Start time of query execution
  - . query\_duration\_ms (UInt64) — Duration of query execution
    - . read\_rows (UInt64) — Number of read rows
    - . read\_bytes (UInt64) — Number of read bytes
- nt64) — For INSERT queries, the number of written rows. For other queries, the column value is 0
- t64) — For INSERT queries, the number of written bytes. For other queries, the column value is 0
- 64) — The difference between the amount of allocated and freed memory in context of this thread
- \_usage (Int64) — The maximum difference between the amount of allocated and freed memory in
  - .context of this thread

- . thread\_name (String) — Name of the thread •
- . thread\_number (UInt32) — Internal thread ID •
- . os\_thread\_id (Int32) — OS thread ID •
- . master\_thread\_number (UInt32) — Internal ID of initial thread •
- . master\_os\_thread\_id (Int32) — OS initial ID of initial thread •
- . query (String) — Query string •
- : is\_initial\_query (UInt8) — Query type. Possible values •
  - .Query was initiated by the client — 1 •
  - .Query was initiated by another query for distributed query execution — 0 •
- . user (String) — Name of the user who initiated the current query •
- . query\_id (String) — ID of the query •
- . address (IPv6) — IP address that was used to make the query •
- . port (UInt16) — The client port that was used to make the query •
- .( initial\_user (String) — Name of the user who ran the initial query (for distributed query execution •
  - .( initial\_query\_id (String) — ID of the initial query (for distributed query execution •
    - . initial\_address (IPv6) — IP address that the parent query was launched from •
    - . initial\_port (UInt16) — The client port that was used to make the parent query •
  - : interface (UInt8) — Interface that the query was initiated from. Possible values •
    - .TCP — 1 •
    - .HTTP — 2 •
- . os\_user (String) — OS's username who runs **clickhouse-client** •
- . client\_hostname (String) — Hostname of the client machine where the **clickhouse-client** or another TCP client is run •
  - . client\_name (String) — The **clickhouse-client** or another TCP client name •
  - . client\_revision (UInt32) — Revision of the **clickhouse-client** or another TCP client •
  - . client\_version\_major (UInt32) — Major version of the **clickhouse-client** or another TCP client •
  - . client\_version\_minor (UInt32) — Minor version of the **clickhouse-client** or another TCP client •
  - . client\_version\_patch (UInt32) — Patch component of the **clickhouse-client** or another TCP client version •
    - : http\_method (UInt8) — HTTP method that initiated the query. Possible values •
      - .The query was launched from the TCP interface — 0 •
        - . GET method was used — 1 •
        - . POST method was used — 2 •
      - . http\_user\_agent (String) — The UserAgent header passed in the HTTP request •
    - .( quota\_key (String) — The "quota key" specified in the **quotas** setting (see **keyed** •
      - . revision (UInt32) — ClickHouse revision •
- ProfileEvents.Names (Array(String)) — Counters that measure different metrics for this thread. The description of them •
  - could be found in the table **system.events**
- ProfileEvents.Values (Array(UInt64)) — Values of metrics for this thread that are listed in the ProfileEvents.Names •
  - .column

By default, logs are added to the table at intervals of 7.5 seconds. You can set this interval in the **query\_thread\_log** server setting (see the `flush_interval_milliseconds` parameter). To flush the logs forcibly from the memory buffer into the table, use

.the SYSTEM FLUSH LOGS query

When the table is deleted manually, it will be automatically created on the fly. Note that all the previous logs will be deleted

#### Note

The storage period for logs is unlimited. Logs aren't automatically deleted from the table. You need to organize the removal of outdated logs yourself

You can specify an arbitrary partitioning key for the system.query\_thread\_log table in the [query\\_thread\\_log](#) server setting .(see the `partition_by` parameter

## system.trace\_log

.Contains stack traces collected by the sampling query profiler

ClickHouse creates this table when the [trace\\_log](#) server configuration section is set. Also the `.query_profiler_real_time_period_ns` and `query_profiler_cpu_time_period_ns` settings should be set

.To analyze logs, use the `addressToLine` , `addressToSymbol` and `demangle` introspection functions

:Columns

- . `event_date` ([Date](#)) — Date of sampling moment •
- . `event_time` ([DateTime](#)) — Timestamp of sampling moment •
- . `revision` ([UInt32](#)) — ClickHouse server build revision •

When connecting to server by `clickhouse-client` , you see the string similar to Connected to ClickHouse server version .19.18.1 revision 54429. . This field contains the `revision` , but not the `version` of a server

- : `timer_type` ([Enum8](#)) — Timer type •
- . `Real` represents wall-clock time •
- . `CPU` represents CPU time •

. `thread_number` ([UInt32](#)) — Thread identifier •

`query_id` ([String](#)) — Query identifier that can be used to get details about a query that was running from the [query\\_log](#) •  
system table

`trace` ([Array\(UInt64\)](#)) — Stack trace at the moment of sampling. Each element is a virtual memory address inside •  
.ClickHouse server process

Example

```
SELECT * FROM system.trace_log LIMIT 1 \G
```

Row 1:

```
event_date: 2019-11-15
event_time: 2019-11-15 15:09:38
revision: 54428
timer_type: Real
thread_number: 48
query_id: acc4d61f-5bd1-4a3e-bc91-2180be37c915
trace:
[94222141367858, 94222152240175, 94222152325351, 94222152329944, 94222152330796, 94222151449980, 94222144088167, 942:
```

## system.replicas

Contains information and status for replicated tables residing on the local server. This table can be used for monitoring.  
.The table contains a row for every Replicated\* table

:Example

```
SELECT *
FROM system.replicas
WHERE table = 'visits'
FORMAT Vertical
```

Row 1:

```
database: merge
table: visits
engine: ReplicatedCollapsingMergeTree
is_leader: 1
is_READONLY: 0
is_session_expired: 0
future_parts: 1
parts_to_check: 0
zookeeper_path: /clickhouse/tables/01-06/visits
replica_name: example01-06-1.yandex.ru
replica_path: /clickhouse/tables/01-06/visits(replicas/example01-06-1.yandex.ru
columns_version: 9
queue_size: 1
inserts_in_queue: 0
merges_in_queue: 1
log_max_index: 596273
log_pointer: 596274
total_replicas: 2
active_replicas: 2
```

:Columns

database: Database name  
table: Table name  
engine: Table engine name

is\_leader: Whether the replica is the leader.

Only one replica at a time can be the leader. The leader is responsible for selecting background merges to perform.

Note that writes can be performed to any replica that is available and has a session in ZK, regardless of whether it is a leader.

is\_READONLY: Whether the replica is in read-only mode.

This mode is turned on if the config doesn't have sections with ZooKeeper, if an unknown error occurred when reinitializing sessions in ZooKeeper, and during session reinitialization in ZooKeeper.

is\_session\_expired: Whether the session with ZooKeeper has expired.

Basically the same as 'is\_READONLY'.

future\_parts: The number of data parts that will appear as the result of INSERTs or merges that haven't been done yet.

parts\_to\_check: The number of data parts in the queue for verification.

A part is put in the verification queue if there is suspicion that it might be damaged.

zookeeper\_path: Path to table data in ZooKeeper.

replica\_name: Replica name in ZooKeeper. Different replicas of the same table have different names.

replica\_path: Path to replica data in ZooKeeper. The same as concatenating 'zookeeper\_path/replicas/replica\_path'.

columns\_version: Version number of the table structure.

Indicates how many times ALTER was performed. If replicas have different versions, it means some replicas haven't made all of the ALTERs yet.

queue\_size: Size of the queue for operations waiting to be performed.

Operations include inserting blocks of data, merges, and certain other actions.

It usually coincides with 'future\_parts'.

inserts\_in\_queue: Number of inserts of blocks of data that need to be made.

Insertions are usually replicated fairly quickly. If this number is large, it means something is wrong.

merges\_in\_queue: The number of merges waiting to be made.

Sometimes merges are lengthy, so this value may be greater than zero for a long time.

The next 4 columns have a non-zero value only where there is an active session with ZK.

log\_max\_index: Maximum entry number in the log of general activity.

log\_pointer: Maximum entry number in the log of general activity that the replica copied to its execution queue, plus one.

If log\_pointer is much smaller than log\_max\_index, something is wrong.

total\_replicas: The total number of known replicas of this table.

active\_replicas: The number of replicas of this table that have a session in ZooKeeper (i.e., the number of functioning replicas).

If you request all the columns, the table may work a bit slowly, since several reads from ZooKeeper are made for each row. If you don't request the last 4 columns (log\_max\_index, log\_pointer, total\_replicas, active\_replicas), the table works quickly.

:For example, you can check that everything is working correctly like this

```

SELECT
 database,
 table,
 is_leader,
 is_READONLY,
 is_session_expired,
 future_parts,
 parts_to_check,
 columns_version,
 queue_size,
 inserts_in_queue,
 merges_in_queue,
 log_max_index,
 log_pointer,
 total_replicas,
 active_replicas
FROM system.replicas
WHERE
 is_READONLY
 OR is_session_expired
 OR future_parts > 20
 OR parts_to_check > 10
 OR queue_size > 20
 OR inserts_in_queue > 10
 OR log_max_index - log_pointer > 10
 OR total_replicas < 2
 OR active_replicas < total_replicas

```

.If this query doesn't return anything, it means that everything is fine

## system.settings

Contains information about settings that are currently in use. I.e. used for executing the query you are using to read from .the system.settings table

:Columns

- . name (String) — Setting name •
- . value (String) — Setting value •
- . changed (UInt8) — Whether the setting was explicitly defined in the config or explicitly changed •

:Example

```

SELECT *
FROM system.settings
WHERE changed

```

name	value	changed
max_threads	8	1
use_uncompressed_cache	0	1
load_balancing	random	1
max_memory_usage	100000000000	1

## system.tables

.Contains metadata of each table that the server knows about. Detached tables are not shown in system.tables

:(This table contains the following columns (the column type is shown in brackets

- . database (String) — The name of the database the table is in •

```

 . name (String) — Table name •
 .(engine (String) — Table engine name (without parameters •
 . is_temporary (UInt8) - Flag that indicates whether the table is temporary •
 . data_path (String) - Path to the table data in the file system •
 . metadata_path (String) - Path to the table metadata in the file system •
 . metadata_modification_time (DateTime) - Time of latest modification of the table metadata •
 . dependencies_database (Array(String)) - Database dependencies •
.(dependencies_table (Array(String)) - Table dependencies MaterializedView tables based on the current table •
 . create_table_query (String) - The query that was used to create the table •
 . engine_full (String) - Parameters of the table engine •
 . partition_key (String) - The partition key expression specified in the table •
 . sorting_key (String) - The sorting key expression specified in the table •
 . primary_key (String) - The primary key expression specified in the table •
 . sampling_key (String) - The sampling key expression specified in the table •

```

.The `system.tables` table is used in `SHOW TABLES` query implementation

## system.zookeeper

The table does not exist if ZooKeeper is not configured. Allows reading data from the ZooKeeper cluster defined in the config. The query must have a 'path' equality condition in the WHERE clause. This is the path in ZooKeeper for the .children that you want to get data for

The query `SELECT * FROM system.zookeeper WHERE path = '/clickhouse'` outputs data for all children on the `/clickhouse` node. To output data for all root nodes, write path = '/'. If the path specified in 'path' doesn't exist, an exception will be thrown

:Columns

```

 . name (String) — The name of the node •
 . path (String) — The path to the node •
 . value (String) — Node value •
 . dataLength (Int32) — Size of the value •
 . numChildren (Int32) — Number of descendants •
 . czxid (Int64) — ID of the transaction that created the node •
 . mzxid (Int64) — ID of the transaction that last changed the node •
 . pzxid (Int64) — ID of the transaction that last deleted or added descendants •
 . ctime (DateTime) — Time of node creation •
 . mtime (DateTime) — Time of the last modification of the node •
 . version (Int32) — Node version: the number of times the node was changed •
 . cversion (Int32) — Number of added or removed descendants •
 . aversion (Int32) — Number of changes to the ACL •
 . ephemeralOwner (Int64) — For ephemeral nodes, the ID of the session that owns this node •

```

:Example

```
SELECT *
FROM system.zookeeper
WHERE path = '/clickhouse/tables/01-08/visits/replicas'
FORMAT Vertical
```

Row 1:

```
name: example01-08-1.yandex.ru
value:
czxid: 932998691229
mzxid: 932998691229
ctime: 2015-03-27 16:49:51
mtime: 2015-03-27 16:49:51
version: 0
cversion: 47
aversion: 0
ephemeralOwner: 0
dataLength: 0
numChildren: 7
pzxid: 987021031383
path: /clickhouse/tables/01-08/visits/replicas
```

Row 2:

```
name: example01-08-2.yandex.ru
value:
czxid: 933002738135
mzxid: 933002738135
ctime: 2015-03-27 16:57:01
mtime: 2015-03-27 16:57:01
version: 0
cversion: 37
aversion: 0
ephemeralOwner: 0
dataLength: 0
numChildren: 7
pzxid: 987021252247
path: /clickhouse/tables/01-08/visits/replicas
```

## system.mutations

The table contains information about **mutations** of MergeTree tables and their progress. Each mutation command is represented by a single row. The table has the following columns

.database, table - The name of the database and table to which the mutation was applied

mutation\_id - The ID of the mutation. For replicated tables these IDs correspond to znode names in the <table\_path\_in\_zookeeper>/mutations/ directory in ZooKeeper. For unreplicated tables the IDs correspond to file names in .the data directory of the table

.(command - The mutation command string (the part of the query after ALTER TABLE [db.]table

.create\_time - When this mutation command was submitted for execution

block\_numbers.partition\_id, block\_numbers.number - A nested column. For mutations of replicated tables, it contains one record for each partition: the partition ID and the block number that was acquired by the mutation (in each partition, only parts that contain blocks with numbers less than the block number acquired by the mutation in that partition will be mutated). In non-replicated tables, block numbers in all partitions form a single sequence. This means that for mutations of .non-replicated tables, the column will contain one record with a single block number acquired by the mutation

.parts\_to\_do - The number of data parts that need to be mutated for the mutation to finish

is\_done - Is the mutation done? Note that even if parts\_to\_do = 0 it is possible that a mutation of a replicated table is not

.done yet because of a long-running INSERT that will create a new data part that will need to be mutated

:If there were problems with mutating some parts, the following columns contain additional information

.latest\_failed\_part - The name of the most recent part that could not be mutated

.latest\_fail\_time - The time of the most recent part mutation failure

.latest\_fail\_reason - The exception message that caused the most recent part mutation failure

## system.disks

.Contains information about disks defined in the [server configuration](#)

:Columns

. name ([String](#)) — Name of a disk in the server configuration •

. path ([String](#)) — Path to the mount point in the file system •

. free\_space ([UInt64](#)) — Free space on disk in bytes •

. total\_space ([UInt64](#)) — Disk volume in bytes •

keep\_free\_space ([UInt64](#)) — Amount of disk space that should stay free on disk in bytes. Defined in the •

. keep\_free\_space\_bytes parameter of disk configuration

## system.storage\_policies

.Contains information about storage policies and volumes defined in the [server configuration](#)

:Columns

. policy\_name ([String](#)) — Name of the storage policy •

. volume\_name ([String](#)) — Volume name defined in the storage policy •

. volume\_priority ([UInt64](#)) — Volume order number in the configuration •

. disks ([Array\(String\)](#)) — Disk names, defined in the storage policy •

.( max\_data\_part\_size ([UInt64](#)) — Maximum size of a data part that can be stored on volume disks (0 — no limit •

move\_factor ([Float64](#)) — Ratio of free disk space. When the ratio exceeds the value of configuration parameter, •

.ClickHouse start to move data to the next volume in order

If the storage policy contains more then one volume, then information for each volume is stored in the individual row of the

.table

## How To Test Your Hardware With ClickHouse

.Draft

With this instruction you can run basic ClickHouse performance test on any server without installation of ClickHouse packages

Go to "commits" page: <https://github.com/ClickHouse/ClickHouse/commits/master> .1

Click on the first green check mark or red cross with green "ClickHouse Build Check" and click on the "Details" link .2

."near "ClickHouse Build Check

.Copy the link to "clickhouse" binary for amd64 or aarch64 .3

:ssh to the server and download it with wget .4

```
For amd64:
wget https://clickhouse-builds.s3.yandex.net/0/00ba767f5d2a929394ea3be193b1f79074a1c4bc/1578163263_binary/clickhouse
For aarch64:
wget https://clickhouse-builds.s3.yandex.net/0/00ba767f5d2a929394ea3be193b1f79074a1c4bc/1578161264_binary/clickhouse
Then do:
chmod a+x clickhouse
```

:Download configs .1

```
wget https://raw.githubusercontent.com/ClickHouse/ClickHouse/master/dbms/programs/server/config.xml
wget https://raw.githubusercontent.com/ClickHouse/ClickHouse/master/dbms/programs/server/users.xml
mkdir config.d
wget https://raw.githubusercontent.com/ClickHouse/ClickHouse/master/dbms/programs/server/config.d/path.xml
-O config.d/path.xml
wget
https://raw.githubusercontent.com/ClickHouse/ClickHouse/master/dbms/programs/server/config.d/log_to_console.xml
-O config.d/log_to_console.xml
```

:Download benchmark files .1

```
wget https://raw.githubusercontent.com/ClickHouse/ClickHouse/master/dbms/benchmark/clickhouse/benchmark-new.sh
chmod a+x benchmark-new.sh
wget https://raw.githubusercontent.com/ClickHouse/ClickHouse/master/dbms/benchmark/clickhouse/queries.sql
```

Download test data: According to the instruction: .1  
([https://clickhouse.yandex/docs/en/getting\\_started/example\\_datasets/metrica/](https://clickhouse.yandex/docs/en/getting_started/example_datasets/metrica/) ("hits" table containing 100 million rows

```
wget https://clickhouse-datasets.s3.yandex.net/hits/partitions/hits_100m_obfuscated_v1.tar.xz
tar xvf hits_100m_obfuscated_v1.tar.xz -C .
mv hits_100m_obfuscated_v1/* .
```

:Run the server .1

```
./clickhouse server
```

Check the data: ssh to the server in another terminal .1

```
./clickhouse client --query "SELECT count() FROM hits_100m_obfuscated"
1000000000
```

Edit the benchmark-new.sh, change "clickhouse-client" to "./clickhouse client" and add "--max\_memory\_usage .1  
.100000000000" parameter .1

```
mcedit benchmark-new.sh
```

:Run the benchmark .1

```
./benchmark-new.sh hits_100m_obfuscated
```

Send the numbers and the info about your hardware configuration to [clickhouse-feedback@yandex-team.com](mailto:clickhouse-feedback@yandex-team.com) .1

## Server configuration parameters

.This section contains descriptions of server settings that cannot be changed at the session or query level

.These settings are stored in the config.xml file on the ClickHouse server

.Other settings are described in the "Settings" section

Before studying the settings, read the Configuration files section and note the use of substitutions (the incl and optional .(attributes

## Server settings

### builtin\_dictionaries\_reload\_interval

.The interval in seconds before reloading built-in dictionaries

ClickHouse reloads built-in dictionaries every x seconds. This makes it possible to edit dictionaries "on the fly" without .restarting the server

.Default value: 3600

Example

```
<builtin_dictionaries_reload_interval>3600</builtin_dictionaries_reload_interval>
```

### compression

.Data compression settings

#### Warning

.Don't use it if you have just started using ClickHouse

:The configuration looks like this

```
<compression>
 <case>
 <parameters/>
 </case>
 ...
</compression>
```

.<You can configure multiple sections <case

: <Block field <case

. min\_part\_size – The minimum size of a table part •

. min\_part\_size\_ratio – The ratio of the minimum size of a table part to the full size of the table •

.( method – Compression method. Acceptable values : lz4 or zstd (experimental •

ClickHouse checks min\_part\_size and min\_part\_size\_ratio and processes the case blocks that match these conditions. If .none of the <case> matches, ClickHouse applies the lz4 compression algorithm

Example

```
<compression incl="clickhouse_compression">
 <case>
 <min_part_size>10000000000</min_part_size>
 <min_part_size_ratio>0.01</min_part_size_ratio>
 <method>zstd</method>
 </case>
</compression>
```

## default\_database

.The default database

.To get a list of databases, use the **SHOW DATABASES** query

Example

```
<default_database>default</default_database>
```

## default\_profile

.Default settings profile

.Settings profiles are located in the file specified in the parameter `user_config`

Example

```
<default_profile>default</default_profile>
```

## dictionaries\_config

.The path to the config file for external dictionaries

:Path

.Specify the absolute path or the path relative to the server config file •

.? The path can contain wildcards \* and •

. "See also "[External dictionaries](#)

Example

```
<dictionaries_config>*_dictionary.xml</dictionaries_config>
```

## dictionaries\_lazy\_load

.Lazy loading of dictionaries

If `true`, then each dictionary is created on first use. If dictionary creation failed, the function that was using the dictionary .throws an exception

.If `false`, all dictionaries are created when the server starts, and if there is an error, the server shuts down

.The default is `true`

Example

```
<dictionaries_lazy_load>true</dictionaries_lazy_load>
```

## format\_schema\_path

.The path to the directory with the schemes for the input data, such as schemas for the [CapnProto](#) format

Example

```
<!-- Directory containing schema files for various input formats. -->
<format_schema_path>format_schemas/</format_schema_path>
```

## graphite

.Sending data to [Graphite](#)

:Settings

- .host – The Graphite server •
- .port – The port on the Graphite server •
- .interval – The interval for sending, in seconds •
- .timeout – The timeout for sending data, in seconds •
- .root\_path – Prefix for keys •
- .metrics – Sending data from a [system.metrics](#) table •
- .events – Sending deltas data accumulated for the time period from a [system.events](#) table •
- .events\_cumulative – Sending cumulative data from a [system.events](#) table •
- .asynchronous\_metrics – Sending data from a [system.asynchronous\\_metrics](#) table •

You can configure multiple `<graphite>` clauses. For instance, you can use this for sending different data at different intervals

Example

```
<graphite>
 <host>localhost</host>
 <port>42000</port>
 <timeout>0.1</timeout>
 <interval>60</interval>
 <root_path>one_min</root_path>
 <metrics>true</metrics>
 <events>true</events>
 <events_cumulative>false</events_cumulative>
 <asynchronous_metrics>true</asynchronous_metrics>
</graphite>
```

## graphite\_rollup

.Settings for thinning data for Graphite

.For more details, see [GraphiteMergeTree](#)

Example

```
<graphite_rollup_example>
 <default>
 <function>max</function>
 <retention>
 <age>0</age>
 <precision>60</precision>
 </retention>
 <retention>
 <age>3600</age>
 <precision>300</precision>
 </retention>
 <retention>
 <age>86400</age>
 <precision>3600</precision>
 </retention>
 </default>
</graphite_rollup_example>
```

## http\_port/https\_port

.(The port for connecting to the server over HTTP(s)

.If https\_port is specified, [openSSL](#) must be configured

.If http\_port is specified, the openSSL configuration is ignored even if it is set

Example

```
<https>0000</https>
```

## http\_server\_default\_response

.The page that is shown by default when you access the ClickHouse HTTP(s) server

Example

.Opens <https://tabix.io/> when accessing [http://localhost: http\\_port](http://localhost: http_port)

```
<http_server_default_response>
 <![CDATA[<html ng-app="SMI2"><head><base href="http://ui.tabix.io/"></head><body><div ui-view="" class="content-ui"></div><script src="http://loader.tabix.io/master.js"></script></body></html>]]>
</http_server_default_response>
```

## include\_from

.The path to the file with substitutions

.For more information, see the section "[Configuration files](#)

Example

```
<include_from>/etc/metrica.xml</include_from>
```

## interserver\_http\_port

.Port for exchanging data between ClickHouse servers

Example

```
<intserver_http_port>9009</intserver_http_port>
```

## intserver\_http\_host

.The host name that can be used by other servers to access this server

.If omitted, it is defined in the same way as the `hostname-f` command

.Useful for breaking away from a specific network interface

### Example

```
<intserver_http_host>example.yandex.ru</intserver_http_host>
```

## intserver\_http\_credentials

The username and password used to authenticate during **replication** with the Replicated\* engines. These credentials are used only for communication between replicas and are unrelated to credentials for ClickHouse clients. The server is checking these credentials for connecting replicas and use the same credentials when connecting to other replicas. So, .these credentials should be set the same for all replicas in a cluster. By default, the authentication is not used

:This section contains the following parameters

- . user — username
- . password — password

### Example

```
<intserver_http_credentials>
 <user>admin</user>
 <password>222</password>
</intserver_http_credentials>
```

## keep\_alive\_timeout

.The number of seconds that ClickHouse waits for incoming requests before closing the connection. Defaults to 3 seconds

### Example

```
<keep_alive_timeout>3</keep_alive_timeout>
```

## listen\_host

. :: Restriction on hosts that requests can come from. If you want the server to answer all of them, specify

:Examples

```
<listen_host>::1</listen_host>
<listen_host>127.0.0.1</listen_host>
```

## logger

.Logging settings

:Keys

- .level – Logging level. Acceptable values: trace , debug , information , warning , error •
- .log – The log file. Contains all the entries according to level •
- .errorlog – Error log file •
- size – Size of the file. Applies to log and errorlog . Once the file reaches size , ClickHouse archives and renames it, and creates a new log file in its place •
- .count – The number of archived log files that ClickHouse stores •

Example

```
<logger>
 <level>trace</level>
 <log>/var/log/clickhouse-server/clickhouse-server.log</log>
 <errorlog>/var/log/clickhouse-server/clickhouse-server.err.log</errorlog>
 <size>1000M</size>
 <count>10</count>
</logger>
```

:Writing to the syslog is also supported. Config example

```
<logger>
 <use_syslog>1</use_syslog>
 <syslog>
 <address>syslog.remote:10514</address>
 <hostname>myhost.local</hostname>
 <facility>LOG_LOCAL6</facility>
 <format>syslog</format>
 </syslog>
</logger>
```

:Keys

- .use\_syslog — Required setting if you want to write to the syslog •
- .address — The host[:port] of syslogd. If omitted, the local daemon is used •
- .hostname — Optional. The name of the host that logs are sent from •
- facility — **The syslog facility keyword** in uppercase letters with the "LOG\_" prefix: (LOG\_USER , LOG\_DAEMON , , LOG\_LOCAL3 , and so on). Default value: LOG\_USER if address is specified, LOG\_DAEMON otherwise •
- .format – Message format. Possible values: bsd and syslog •

macros

.Parameter substitutions for replicated tables

.Can be omitted if replicated tables are not used

."For more information, see the section "[Creating replicated tables](#)

Example

```
<macros incl="macros" optional="true" />
```

mark\_cache\_size

.Approximate size (in bytes) of the cache of marks used by table engines of the[MergeTree](#) family

.The cache is shared for the server and memory is allocated as needed. The cache size must be at least 5368709120

Example

```
<mark_cache_size>5368709120</mark_cache_size>
```

### max\_concurrent\_queries

.The maximum number of simultaneously processed requests

Example

```
<max_concurrent_queries>100</max_concurrent_queries>
```

### max\_connections

.The maximum number of inbound connections

Example

```
<max_connections>4096</max_connections>
```

### max\_open\_files

.The maximum number of open files

.By default: maximum

.We recommend using this option in Mac OS X, since the `getrlimit()` function returns an incorrect value

Example

```
<max_open_files>262144</max_open_files>
```

### max\_table\_size\_to\_drop

.Restriction on deleting tables

.If the size of a **MergeTree** table exceeds `max_table_size_to_drop` (in bytes), you can't delete it using a `DROP` query

If you still need to delete the table without restarting the ClickHouse server, create the `<clickhouse-path>/flags/force_drop_table` file and run the `DROP` query

.Default value: 50 GB

.The value 0 means that you can delete all tables without any restrictions

Example

```
<max_table_size_to_drop>0</max_table_size_to_drop>
```

### merge\_tree

.Fine tuning for tables in the **MergeTree**

```
<merge_tree>
 <max_suspicious_broken_parts>5</max_suspicious_broken_parts>
</merge_tree>
```

openSSL

.SSL client/server configuration

Support for SSL is provided by the `libpoco` library. The interface is described in the file [SSLManager.h](#)

:Keys for server/client settings

privateKeyFile – The path to the file with the secret key of the PEM certificate. The file may contain a key and •  
.certificate at the same time

certificateFile – The path to the client/server certificate file in PEM format. You can omit it if `privateKeyFile` contains the •  
.certificate

.caConfig – The path to the file or directory that contains trusted root certificates •

verificationMode – The method for checking the node's certificates. Details are in the description of the [Context](#) class. •  
.Possible values: `none` , `relaxed` , `strict` , `once`

verificationDepth – The maximum length of the verification chain. Verification will fail if the certificate chain length •  
.exceeds the set value

| .loadDefaultCAFile – Indicates that built-in CA certificates for OpenSSL will be used. Acceptable values: `true` , `false` •  
.cipherList – Supported OpenSSL encryptions. For example: `ALL:!ADH:!LOW:!EXP:!MD5:@STRENGTH` •

cacheSessions – Enables or disables caching sessions. Must be used in combination with `sessionIdContext` . •  
.Acceptable values: `true` , `false`

sessionIdContext – A unique set of random characters that the server appends to each generated identifier. The •  
length of the string must not exceed `SSL_MAX_SSL_SESSION_ID_LENGTH` . This parameter is always recommended, •  
since it helps avoid problems both if the server caches the session and if the client requested caching. Default value: •  
.{\$application.name}

sessionCacheSize – The maximum number of sessions that the server caches. Default value: `1024*20`. 0 – Unlimited •  
.sessions

.sessionTimeout – Time for caching the session on the server •

extendedVerification – Automatically extended verification of certificates after the session ends. Acceptable values: •  
. true , `false`

.requireTLSv1 – Require a TLSv1 connection. Acceptable values: `true` , `false` •

.requireTLSv1\_1 – Require a TLSv1.1 connection. Acceptable values: `true` , `false` •

.requireTLSv1\_2 – Require a TLSv1.2 connection. Acceptable values: `true` , `false` •

.fips – Activates OpenSSL FIPS mode. Supported if the library's OpenSSL version supports FIPS •

privateKeyPassphraseHandler – Class (`PrivateKeyPassphraseHandler` subclass) that requests the passphrase for •  
accessing the private key. For example: `<privateKeyPassphraseHandler>` , `<name>KeyFileHandler</name>` , `<options>` •  
. `<><password>test</password></options>` , `</privateKeyPassphraseHandler>`

invalidCertificateHandler – Class (subclass of `CertificateHandler`) for verifying invalid certificates. For example: •  
. `<><invalidCertificateHandler>` `<name>ConsoleCertificateHandler</name>` `</invalidCertificateHandler>`

.disableProtocols – Protocols that are not allowed to use •

.preferServerCiphers – Preferred server ciphers on the client •

:Example of settings

```
<openSSL>
 <server>
 <!!-- openssl req -subj "/CN=localhost" -new -newkey rsa:2048 -days 365 -nodes -x509 -keyout /etc/clickhouse-server/server.key -out /etc/clickhouse-server/server.crt -->
 <certificateFile>/etc/clickhouse-server/server.crt</certificateFile>
 <privateKeyFile>/etc/clickhouse-server/server.key</privateKeyFile>
 <!!-- openssl dhparam -out /etc/clickhouse-server/dhparam.pem 4096 -->
 <dhParamsFile>/etc/clickhouse-server/dhparam.pem</dhParamsFile>
 <verificationMode>none</verificationMode>
 <loadDefaultCAFile>true</loadDefaultCAFile>
 <cacheSessions>true</cacheSessions>
 <disableProtocols>sslv2,sslv3</disableProtocols>
 <preferServerCiphers>true</preferServerCiphers>
 </server>
 <client>
 <loadDefaultCAFile>true</loadDefaultCAFile>
 <cacheSessions>true</cacheSessions>
 <disableProtocols>sslv2,sslv3</disableProtocols>
 <preferServerCiphers>true</preferServerCiphers>
 <!!-- Use for self-signed: <verificationMode>none</verificationMode> -->
 <invalidCertificateHandler>
 <!!-- Use for self-signed: <name>AcceptCertificateHandler</name> -->
 <name>RejectCertificateHandler</name>
 </invalidCertificateHandler>
 </client>
</openSSL>
```

## part\_log

Logging events that are associated with [MergeTree](#). For instance, adding or merging data. You can use the log to simulate merge algorithms and compare their characteristics. You can visualize the merge process

Queries are logged in the [system.part\\_log](#) table, not in a separate file. You can configure the name of this table in the .( table parameter (see below

:Use the following parameters to configure logging

- . database – Name of the database •
- . table – Name of the system table •
- . partition\_by – Sets a [custom partitioning key](#) •
- . flush\_interval\_milliseconds – Interval for flushing data from the buffer in memory to the table •

Example

```
<part_log>
 <database>system</database>
 <table>part_log</table>
 <partition_by>toMonday(event_date)</partition_by>
 <flush_interval_milliseconds>7500</flush_interval_milliseconds>
</part_log>
```

## path

.The path to the directory containing data

. The trailing slash is mandatory

Example

```
<path>/var/lib/clickhouse/</path>
```

## query\_log

.Setting for logging queries received with the `log_queries=1` setting

Queries are logged in the `system.query_log` table, not in a separate file. You can change the name of the table in the `(table parameter)` (see below)

:Use the following parameters to configure logging

- . `database` – Name of the database
- . `table` – Name of the system table the queries will be logged in
- . `partition_by` – Sets a `custom partitioning key` for a table
- . `flush_interval_milliseconds` – Interval for flushing data from the buffer in memory to the table

If the table doesn't exist, ClickHouse will create it. If the structure of the query log changed when the ClickHouse server was updated, the table with the old structure is renamed, and a new table is created automatically

Example

```
<query_log>
 <database>system</database>
 <table>query_log</table>
 <partition_by>toMonday(event_date)</partition_by>
 <flush_interval_milliseconds>7500</flush_interval_milliseconds>
</query_log>
```

## query\_thread\_log

.Setting for logging threads of queries received with the `log_query_threads=1` setting

Queries are logged in the `system.query_thread_log` table, not in a separate file. You can change the name of the table in `(the table parameter)` (see below)

:Use the following parameters to configure logging

- . `database` – Name of the database
- . `table` – Name of the system table the queries will be logged in
- . `partition_by` – Sets a `custom partitioning key` for a system table
- . `flush_interval_milliseconds` – Interval for flushing data from the buffer in memory to the table

If the table doesn't exist, ClickHouse will create it. If the structure of the query thread log changed when the ClickHouse server was updated, the table with the old structure is renamed, and a new table is created automatically

Example

```

<query_thread_log>
 <database>system</database>
 <table>query_thread_log</table>
 <partition_by>toMonday(event_date)</partition_by>
 <flush_interval_milliseconds>7500</flush_interval_milliseconds>
</query_thread_log>

```

## trace\_log

.Settings for the `trace_log` system table operation

:Parameters

- . `database` — Database for storing a table •
- . `table` — Table name •
- . `partition_by` — **Custom partitioning key** for a system table •
- . `flush_interval_milliseconds` — Interval for flushing data from the buffer in memory to the table •

:The default server configuration file `config.xml` contains the following settings section

```

<trace_log>
 <database>system</database>
 <table>trace_log</table>
 <partition_by>toYYYYMM(event_date)</partition_by>
 <flush_interval_milliseconds>7500</flush_interval_milliseconds>
</trace_log>

```

## query\_masking\_rules

Regexp-based rules, which will be applied to queries as well as all log messages before storing them in server logs, `system.query_log` , `system.text_log` , `system.processes` table, and in logs sent to client. That allows preventing sensitive data leakage from SQL queries (like names / emails / personal identifiers / credit card numbers etc) to logs

Example

```

<query_masking_rules>
 <rule>
 <name>hide SSN</name>
 <regexp>(^|\D)\d{3}-\d{2}-\d{4}($|\D)</regexp>
 <replace>000-00-0000</replace>
 </rule>
</query_masking_rules>

```

Config fields: - `name` - name for the rule (optional) - `regexp` - RE2 compatible regular expression (mandatory) - `replace` - (substitution string for sensitive data (optional, by default - six asterisks

.(The masking rules are applied on whole query (to prevent leaks of sensitive data from malformed / non parsable queries

. `system.events` table have counter `QueryMaskingRulesMatch` which have overall number of query masking rules matches

For distributed queries each server have to be configured separately, otherwise subqueries passed to other nodes will be .stored without masking

## remote\_servers

.Configuration of clusters used by the **Distributed** table engine and by the `cluster` table function

Example

```
<remote_servers incl="clickhouse_remote_servers" />
```

."For the value of the `incl` attribute, see the section "[Configuration files](#)

See Also

[skip\\_unavailable\\_shards](#) •

**timezone**

.The server's time zone

.(Specified as an IANA identifier for the UTC time zone or geographic location (for example, Africa/Abidjan

The time zone is necessary for conversions between String and DateTime formats when DateTime fields are output to text format (printed on the screen or in a file), and when getting DateTime from a string. In addition, the time zone is used .in functions that work with the time and date if they didn't receive the time zone in the input parameters

Example

```
<timezone>Europe/Moscow</timezone>
```

**tcp\_port**

.Port for communicating with clients over the TCP protocol

Example

```
<tcp_port>9000</tcp_port>
```

**tcp\_port\_secure**

.TCP port for secure communication with clients. Use it with[OpenSSL](#) settings

Possible values

.Positive integer

Default value

```
<tcp_port_secure>9440</tcp_port_secure>
```

**tmp\_path**

.Path to temporary data for processing large queries

**Note** 

.The trailing slash is mandatory

Example

```
<tmp_path>/var/lib/clickhouse/tmp/</tmp_path>
```

## uncompressed\_cache\_size

.Cache size (in bytes) for uncompressed data used by table engines from the [MergeTree](#)

There is one shared cache for the server. Memory is allocated on demand. The cache is used if the option [.use\\_uncompressed\\_cache](#) is enabled

.The uncompressed cache is advantageous for very short queries in individual cases

Example

```
<uncompressed_cache_size>8589934592</uncompressed_cache_size>
```

## user\_files\_path

.() The directory with user files. Used in the table function [file](#)

Example

```
<user_files_path>/var/lib/clickhouse/user_files/</user_files_path>
```

## users\_config

:Path to the file that contains

- .User configurations •
- .Access rights •
- .Settings profiles •
- .Quota settings •

Example

```
<users_config>users.xml</users_config>
```

## zookeeper

.Contains settings that allow ClickHouse to interact with a [ZooKeeper](#) cluster

ClickHouse uses ZooKeeper for storing metadata of replicas when using replicated tables. If replicated tables are not used, this section of parameters can be omitted

:This section contains the following parameters

- . node — ZooKeeper endpoint. You can set multiple endpoints •  
:For example

```
<node index="1">
 <host>example_host</host>
 <port>2181</port>
</node>
```

The `index` attribute specifies the node order when trying to connect to the ZooKeeper cluster.

- . `session_timeout` — Maximum timeout for the client session in milliseconds •
- . `root` — The **znode** that is used as the root for znodes used by the ClickHouse server. Optional •
- . `identity` — User and password, that can be required by ZooKeeper to give access to requested znodes. Optional •

Example configuration

```
<zookeeper>
 <node>
 <host>example1</host>
 <port>2181</port>
 </node>
 <node>
 <host>example2</host>
 <port>2181</port>
 </node>
 <session_timeout_ms>30000</session_timeout_ms>
 <operation_timeout_ms>10000</operation_timeout_ms>
 <!-- Optional. Chroot suffix. Should exist. -->
 <root>/path/to/zookeeper/node</root>
 <!-- Optional. Zookeeper digest ACL string. -->
 <identity>user:password</identity>
</zookeeper>
```

See Also

[Replication](#) •

[ZooKeeper Programmer's Guide](#) •

## use\_minimalistic\_part\_header\_in\_zookeeper

.Storage method for data part headers in ZooKeeper

:This setting only applies to the `MergeTree` family. It can be specified

.Globally in the `merge_tree` section of the `config.xml` file •

ClickHouse uses the setting for all the tables on the server. You can change the setting at any time. Existing tables  
.change their behavior when the setting changes  
.For each individual table •

When creating a table, specify the corresponding **engine setting**. The behavior of an existing table with this setting  
.does not change, even if the global setting changes

Possible values

- .Functionality is turned off — 0 •
- .Functionality is turned on — 1 •

If `use_minimalistic_part_header_in_zookeeper = 1`, then **replicated** tables store the headers of the data parts compactly using a single `znode`. If the table contains many columns, this storage method significantly reduces the volume of the data stored in Zookeeper

After applying `use_minimalistic_part_header_in_zookeeper = 1`, you can't downgrade the ClickHouse server to a version that doesn't support this setting. Be careful when upgrading ClickHouse on servers in a cluster. Don't upgrade all the servers at once. It is safer to test new versions of ClickHouse in a test environment, or on just a few servers of a cluster.

Data part headers already stored with this setting can't be restored to their previous (non-compact) representation

.Default value: 0

### `disable_internal_dns_cache`

Disables the internal DNS cache. Recommended for operating ClickHouse in systems with frequently changing infrastructure such as Kubernetes

.Default value: 0

### `dns_cache_update_period`

The period of updating IP addresses stored in the ClickHouse internal DNS cache (in seconds). The update is performed asynchronously, in a separate system thread

.Default value: 15

## Settings

There are multiple ways to make all the settings described below. Settings are configured in layers, so each subsequent layer redefines the previous settings

:Ways to configure settings, in order of priority

- .Settings in the `users.xml` server configuration file
- .. <Set in the element `<profiles`
- .. .Session settings

Send `SET setting=value` from the ClickHouse console client in interactive mode. Similarly, you can use ClickHouse sessions in the HTTP protocol. To do this, you need to specify the `session_id` HTTP parameter

.Query settings

.When starting the ClickHouse console client in non-interactive mode, set the startup parameter `--setting=value`

- ..( ...When using the HTTP API, pass CGI parameters `URL?setting_1=value&setting_2=value`
- .. .Settings that can only be made in the server config file are not covered in this section

## Permissions for queries

:Queries in ClickHouse can be divided into several types

.Read data queries: `SELECT` , `SHOW` , `DESCRIBE` , `EXISTS`

.Write data queries: `INSERT` , `OPTIMIZE`

.Change settings queries: `SET` , `USE`

.**DDL** queries: `CREATE` , `ALTER` , `RENAME` , `ATTACH` , `DETACH` , `DROP` `TRUNCATE`

:The following settings regulate user permissions by the type of query

.**readonly** — Restricts permissions for all types of queries except DDL queries •

.**allow\_ddl** — Restricts permissions for DDL queries •

. KILL QUERY can be performed with any settings

### readonly

.Restricts permissions for read data, write data and change settings queries

.See how the queries are divided into types [above](#)

:Possible values

.All queries are allowed — 0 •

.Only read data queries are allowed — 1 •

.Read data and change settings queries are allowed — 2 •

.After setting `readonly = 1`, the user can't change `readonly` and `allow_ddl` settings in the current session

When using the `GET` method in the [HTTP interface](#), `readonly = 1` is set automatically. To modify data, use the `POST` method

Setting `readonly = 1` prohibit the user from changing all the settings. There is a way to prohibit the user from changing only specific settings, for details see [constraints on settings](#)

Default value: 0

### allow\_ddl

.Allows or denies [DDL](#) queries

.See how the queries are divided into types [above](#)

:Possible values

.DDL queries are not allowed — 0 •

.DDL queries are allowed — 1 •

.You can't execute `SET allow_ddl = 1` if `allow_ddl = 0` for the current session

Default value: 1

## Restrictions on query complexity

Restrictions on query complexity are part of the settings. They are used in order to provide safer execution from the user interface. Almost all the restrictions only apply to `SELECT`. For distributed query processing, restrictions are applied on each server separately

ClickHouse checks the restrictions for data parts, not for each row. It means that you can exceed the value of restriction with a size of the data part

Restrictions on the "maximum amount of something" can take the value 0, which means "unrestricted". Most restrictions

also have an 'overflow\_mode' setting, meaning what to do when the limit is exceeded. It can take one of two values: `throw` or `break`. Restrictions on aggregation (`group_by_overflow_mode`) also have the value any  
.`throw` – Throw an exception (default)  
`break` – Stop executing the query and return the partial result, as if the source data ran out  
any (only for `group_by_overflow_mode`) – Continuing aggregation for the keys that got into the set, but don't add new keys to  
.the set

### `max_memory_usage`

.The maximum amount of RAM to use for running a query on a single server  
.In the default configuration file, the maximum is 10 GB

The setting doesn't consider the volume of available memory or the total volume of memory on the machine. The restriction applies to a single query within a single server. You can use `SHOW PROCESSLIST` to see the current memory consumption for each query. In addition, the peak memory consumption is tracked for each query and written to the log

.Memory usage is not monitored for the states of certain aggregate functions

Memory usage is not fully tracked for states of the aggregate functions `min`, `max`, `any`, `anyLast`, `argMin`, `argMax` from  
.String and Array arguments

Memory consumption is also restricted by the parameters `max_memory_usage_for_user` and  
. `max_memory_usage_for_all_queries`

### `max_memory_usage_for_user`

.The maximum amount of RAM to use for running a user's queries on a single server  
. (Default values are defined in [Settings.h](#)). By default, the amount is not restricted (`max_memory_usage_for_user = 0`  
.See also the description of [max\\_memory\\_usage](#)

### `max_memory_usage_for_all_queries`

.The maximum amount of RAM to use for running all queries on a single server  
. (Default values are defined in [Settings.h](#)). By default, the amount is not restricted (`max_memory_usage_for_all_queries = 0`  
.See also the description of [max\\_memory\\_usage](#)

### `max_rows_to_read`

The following restrictions can be checked on each block (instead of on each row). That is, the restrictions can be broken a little. When running a query in multiple threads, the following restrictions apply to each thread separately  
.Maximum number of rows that can be read from a table when running a query

### `max_bytes_to_read`

.Maximum number of bytes (uncompressed data) that can be read from a table when running a query

### `read_overflow_mode`

.What to do when the volume of data read exceeds one of the limits: 'throw' or 'break'. By default, throw

### **max\_rows\_to\_group\_by**

Maximum number of unique keys received from aggregation. This setting lets you limit memory consumption when aggregating

### **group\_by\_overflow\_mode**

What to do when the number of unique keys for aggregation exceeds the limit: 'throw', 'break', or 'any'. By default, throw.

Using the 'any' value lets you run an approximation of GROUP BY. The quality of this approximation depends on the statistical nature of the data

### **max\_bytes\_before\_external\_group\_by**

.Enables or disables execution of GROUP BY clauses in external memory. See [GROUP BY in external memory](#)

:Possible values

.Maximum volume of RAM (in bytes) that can be used by the single GROUP BY operation •

. GROUP BY in external memory disabled — 0 •

.Default value: 0

### **max\_rows\_to\_sort**

.Maximum number of rows before sorting. This allows you to limit memory consumption when sorting

### **max\_bytes\_to\_sort**

.Maximum number of bytes before sorting

### **sort\_overflow\_mode**

.What to do if the number of rows received before sorting exceeds one of the limits: 'throw' or 'break'. By default, throw

### **max\_result\_rows**

Limit on the number of rows in the result. Also checked for subqueries, and on remote servers when running parts of a distributed query

### **max\_result\_bytes**

.Limit on the number of bytes in the result. The same as the previous setting

### **result\_overflow\_mode**

What to do if the volume of the result exceeds one of the limits: 'throw' or 'break'. By default, throw. Using 'break' is similar to using LIMIT

### **max\_execution\_time**

Maximum query execution time in seconds. At this time, it is not checked for one of the sorting stages, or when merging  
.and finalizing aggregate functions

#### **timeout\_overflow\_mode**

.What to do if the query is run longer than 'max\_execution\_time': 'throw' or 'break'. By default, throw

#### **min\_execution\_speed**

Minimal execution speed in rows per second. Checked on every data block when  
'timeout\_before\_checking\_execution\_speed' expires. If the execution speed is lower, an exception is thrown

#### **min\_execution\_speed\_bytes**

Minimum number of execution bytes per second. Checked on every data block when  
'timeout\_before\_checking\_execution\_speed' expires. If the execution speed is lower, an exception is thrown

#### **max\_execution\_speed**

Maximum number of execution rows per second. Checked on every data block when  
'timeout\_before\_checking\_execution\_speed' expires. If the execution speed is high, the execution speed will be reduced

#### **max\_execution\_speed\_bytes**

Maximum number of execution bytes per second. Checked on every data block when  
'timeout\_before\_checking\_execution\_speed' expires. If the execution speed is high, the execution speed will be reduced

#### **timeout\_before\_checking\_execution\_speed**

Checks that execution speed is not too slow (no less than 'min\_execution\_speed'), after the specified time in seconds has  
.expired

#### **max\_columns\_to\_read**

Maximum number of columns that can be read from a table in a single query. If a query requires reading a greater number  
.of columns, it throws an exception

#### **max\_temporary\_columns**

Maximum number of temporary columns that must be kept in RAM at the same time when running a query, including  
.constant columns. If there are more temporary columns than this, it throws an exception

#### **max\_temporary\_non\_const\_columns**

The same thing as 'max\_temporary\_columns', but without counting constant columns. Note that constant columns are  
.formed fairly often when running a query, but they require approximately zero computing resources

#### **max\_subquery\_depth**

.Maximum nesting depth of subqueries. If subqueries are deeper, an exception is thrown. By default, 100

## **max\_pipeline\_depth**

Maximum pipeline depth. Corresponds to the number of transformations that each data block goes through during query processing. Counted within the limits of a single server. If the pipeline depth is greater, an exception is thrown. By default, .1000

## **max\_ast\_depth**

Maximum nesting depth of a query syntactic tree. If exceeded, an exception is thrown. At this time, it isn't checked during parsing, but only after parsing the query. That is, a syntactic tree that is too deep can be created during parsing, but the .query will fail. By default, 1000

## **max\_ast\_elements**

Maximum number of elements in a query syntactic tree. If exceeded, an exception is thrown. In the same way as the .previous setting, it is checked only after parsing the query. By default, 50,000

## **max\_rows\_in\_set**

.Maximum number of rows for a data set in the IN clause created from a subquery

## **max\_bytes\_in\_set**

.Maximum number of bytes (uncompressed data) used by a set in the IN clause created from a subquery

## **set\_overflow\_mode**

.What to do when the amount of data exceeds one of the limits: 'throw' or 'break'. By default, throw

## **max\_rows\_in\_distinct**

.Maximum number of different rows when using DISTINCT

## **max\_bytes\_in\_distinct**

.Maximum number of bytes used by a hash table when using DISTINCT

## **distinct\_overflow\_mode**

.What to do when the amount of data exceeds one of the limits: 'throw' or 'break'. By default, throw

## **max\_rows\_to\_transfer**

.Maximum number of rows that can be passed to a remote server or saved in a temporary table when using GLOBAL IN

## **max\_bytes\_to\_transfer**

Maximum number of bytes (uncompressed data) that can be passed to a remote server or saved in a temporary table .when using GLOBAL IN

## `transfer_overflow_mode`

.What to do when the amount of data exceeds one of the limits: 'throw' or 'break'. By default, throw

### `max_rows_in_join`

.Limits the number of rows in the hash table that is used when joining tables

.This settings applies to `SELECT ... JOIN` operations and the `Join` table engine

.If a query contains multiple joins, ClickHouse checks this setting for every intermediate result

ClickHouse can proceed with different actions when the limit is reached. Use the `join_overflow_mode` setting to choose .the action

:Possible values

.Positive integer •

.Unlimited number of rows — 0 •

.Default value: 0

### `max_bytes_in_join`

.Limits the size in bytes of the hash table used when joining tables

.This settings applies to `SELECT ... JOIN` operations and `Join table engine`

.If the query contains joins, ClickHouse checks this setting for every intermediate result

ClickHouse can proceed with different actions when the limit is reached. Use `join_overflow_mode` settings to choose the .action

:Possible values

.Positive integer •

.Memory control is disabled — 0 •

.Default value: 0

### `join_overflow_mode`

:Defines what action ClickHouse performs when any of the following join limits is reached

`max_bytes_in_join` •

`max_rows_in_join` •

:Possible values

. `THROW` — ClickHouse throws an exception and breaks operation •

. `BREAK` — ClickHouse breaks operation and doesn't throw an exception •

.Default value: `THROW`

See Also

`JOIN clause` •

**max\_partitions\_per\_insert\_block**

.Limits the maximum number of partitions in a single inserted block

.Positive integer •

.Unlimited number of partitions — 0 •

.Default value: 100

## Details

When inserting data, ClickHouse calculates the number of partitions in the inserted block. If the number of partitions is more than `max_partitions_per_insert_block`, ClickHouse throws an exception with the following text

Too many partitions for single INSERT block (more than " + `toString(max_parts)` + "). The limit is controlled by '`max_partitions_per_insert_block`' setting. Large number of partitions is a common misconception. It will lead to severe negative performance impact, including slow server startup, slow INSERT queries and slow SELECT queries. Recommended total number of partitions for a table is under 1000..10000. Please note, that partitioning is not intended to speed up SELECT queries (ORDER BY key is sufficient to make range queries fast). Partitions are intended for data manipulation (DROP PARTITION, etc

**Settings****distributed\_product\_mode**

.Changes the behavior of [distributed subqueries](#)

ClickHouse applies this setting when the query contains the product of distributed tables, i.e. when the query for a distributed table contains a non-GLOBAL subquery for the distributed table

:Restrictions

.Only applied for IN and JOIN subqueries •

.Only if the FROM section uses a distributed table containing more than one shard •

.If the subquery concerns a distributed table containing more than one shard •

.Not used for a table-valued [remote](#) function •

:Possible values

`deny` — Default value. Prohibits using these types of subqueries (returns the "Double-distributed in/JION subqueries • .(is denied" exception

`local` — Replaces the database and table in the subquery with local ones for the destination server (shard), leaving • .the normal IN /JOIN

. `global` — Replaces the IN / JOIN query with GLOBAL IN /GLOBAL JOIN •

. `allow` — Allows the use of these types of subqueries •

**enable\_optimize\_predicate\_expression**

.Turns on predicate pushdown in SELECT queries

.Predicate pushdown may significantly reduce network traffic for distributed queries

:Possible values

.Disabled — 0 •

.Enabled — 1 •

.Default value: 1

Usage

:Consider the following queries

```
'SELECT count() FROM test_table WHERE date = '2018-10-10' .1
```

```
'SELECT count() FROM (SELECT * FROM test_table) WHERE date = '2018-10-10' .2
```

If `enable_optimize_predicate_expression = 1` , then the execution time of these queries is equal, because ClickHouse applies `WHERE` to the subquery when processing it

If `enable_optimize_predicate_expression = 0` , then the execution time of the second query is much longer, because the `WHERE` clause applies to all the data after the subquery finishes

### `fallback_to_stale_replicas_for_distributed_queries`

."Forces a query to an out-of-date replica if updated data is not available. See [Replication](#)

.ClickHouse selects the most relevant from the outdated replicas of the table

.Used when performing `SELECT` from a distributed table that points to replicated tables

.(By default, 1 (enabled

### `force_index_by_date`

.Disables query execution if the index can't be used by date

.Works with tables in the MergeTree family

If `force_index_by_date=1` , ClickHouse checks whether the query has a date key condition that can be used for restricting data ranges. If there is no suitable condition, it throws an exception. However, it does not check whether the condition actually reduces the amount of data to read. For example, the condition `Date != '2000-01-01'` is acceptable even when it matches all the data in the table (i.e., running the query requires a full scan). For more information about ranges of data in

."MergeTree tables, see "[MergeTree](#)

### `force_primary_key`

.Disables query execution if indexing by the primary key is not possible

.Works with tables in the MergeTree family

If `force_primary_key=1` , ClickHouse checks to see if the query has a primary key condition that can be used for restricting data ranges. If there is no suitable condition, it throws an exception. However, it does not check whether the condition actually reduces the amount of data to read. For more information about data ranges in MergeTree tables, see

."[MergeTree](#)

### `format_schema`

This parameter is useful when you are using formats that require a schema definition, such as[Cap'n Proto](#) or [Protobuf](#).

.The value depends on the format

### **fsync\_metadata**

.Enables or disables **fsync** when writing `.sql` files. Enabled by default

.It makes sense to disable it if the server has millions of tiny tables that are constantly being created and destroyed

### **enable\_http\_compression**

.Enables or disables data compression in the response to an HTTP request

.For more information, read the [HTTP interface description](#)

:Possible values

.Disabled — 0 •

.Enabled — 1 •

.Default value: 0

### **http\_zlib\_compression\_level**

.Sets the level of data compression in the response to an HTTP request if **enable\_http\_compression = 1**

.Possible values: Numbers from 1 to 9

.Default value: 3

### **http\_native\_compression\_disable\_checksumming\_on\_decompress**

Enables or disables checksum verification when decompressing the HTTP POST data from the client. Used only for

.(ClickHouse native compression format (not used with `gzip` or `deflate`)

.For more information, read the [HTTP interface description](#)

:Possible values

.Disabled — 0 •

.Enabled — 1 •

.Default value: 0

### **send\_progress\_in\_http\_headers**

.Enables or disables `X-ClickHouse-Progress` HTTP response headers in `clickhouse-server` responses

.For more information, read the [HTTP interface description](#)

:Possible values

.Disabled — 0 •

.Enabled — 1 •

.Default value: 0

## max\_http\_get\_redirects

Limits the maximum number of HTTP GET redirect hops for **URL**-engine tables. The setting applies to both types of .tables: those created by the **CREATE TABLE** query and by the **url** table function

:Possible values

.Any positive integer number of hops •

.No hops allowed — 0 •

.Default value: 0

## input\_format\_allow\_errors\_num

.(Sets the maximum number of acceptable errors when reading from text formats (CSV, TSV, etc

.The default value is 0

.Always pair it with `input_format_allow_errors_ratio`

If an error occurred while reading rows but the error counter is still less than `input_format_allow_errors_num`, ClickHouse ignores the row and moves on to the next one

.If both `input_format_allow_errors_num` and `input_format_allow_errors_ratio` are exceeded, ClickHouse throws an exception

## input\_format\_allow\_errors\_ratio

Sets the maximum percentage of errors allowed when reading from text formats (CSV, TSV, etc.). The percentage of errors is set as a floating-point number between 0 and 1

.The default value is 0

.Always pair it with `input_format_allow_errors_num`

If an error occurred while reading rows but the error counter is still less than `input_format_allow_errors_ratio`, ClickHouse ignores the row and moves on to the next one

.If both `input_format_allow_errors_num` and `input_format_allow_errors_ratio` are exceeded, ClickHouse throws an exception

## input\_format\_values\_interpret\_expressions

Enables or disables the full SQL parser if the fast stream parser can't parse the data. This setting is used only for the **Values** format at the data insertion. For more information about syntax parsing, see the **Syntax** section

:Possible values

.Disabled — 0 •

.In this case, you must provide formatted data. See the **Formats** section

.Enabled — 1 •

In this case, you can use an SQL expression as a value, but data insertion is much slower this way. If you insert only .formatted data, then ClickHouse behaves as if the setting value is 0

.Default value: 1

Example of Use

.Insert the **DateTime** type value with the different settings

```
SET input_format_values_interpret_expressions = 0;
INSERT INTO datetime_t VALUES (now())
```

Exception on client:

Code: 27. DB::Exception: Cannot parse input: expected ) before: now(): (at row 1)

```
SET input_format_values_interpret_expressions = 1;
INSERT INTO datetime_t VALUES (now())
```

Ok.

:The last query is equivalent to the following

```
SET input_format_values_interpret_expressions = 0;
INSERT INTO datetime_t SELECT now()
```

Ok.

## input\_format\_values\_deduce\_templates\_of\_expressions

Enables or disables template deduction for an SQL expressions in**Values** format. It allows to parse and interpret expressions in **Values** much faster if expressions in consecutive rows have the same structure. ClickHouse will try to deduce template of an expression, parse the following rows using this template and evaluate the expression on batch of successfully parsed rows. For the following query

```
INSERT INTO test VALUES (lower('Hello')), (lower('world')), (lower('INSERT')), (upper('Values')), ...
```

if `input_format_values_interpret_expressions=1` and `format_values_deduce_templates_of_expressions=0` expressions will be •  
(interpreted separately for each row (this is very slow for large number of rows

if `input_format_values_interpret_expressions=0` and `format_values_deduce_templates_of_expressions=1` expressions in the •  
first, second and third rows will be parsed using template `lower(String)` and interpreted together, expression is the forth  
(row will be parsed with another template `upper(String`)

if `input_format_values_interpret_expressions=1` and `format_values_deduce_templates_of_expressions=1` - the same as in •  
.previous case, but also allows fallback to interpreting expressions separately if it's not possible to deduce template

.Enabled by default

## input\_format\_values\_accurate\_types\_of\_literals

This setting is used only when `input_format_values_deduce_templates_of_expressions = 1` . It can happen, that expressions for some column have the same structure, but contain numeric literals of different types, e.g

```
(..., abs(0), ...), -- UInt64 literal
(..., abs(3.141592654), ...), -- Float64 literal
(..., abs(-1), ...), -- Int64 literal
```

When this setting is enabled, ClickHouse will check actual type of literal and will use expression template of the corresponding type. In some cases it may significantly slow down expression evaluation in **Values** . When disabled, ClickHouse may use more general type for some literals (e.g. `Float64` or `Int64` instead of `UInt64` for `42` ), but it may cause overflow and precision issues. Enabled by default

## `input_format_defaults_for_omitted_fields`

When performing `INSERT` queries, replace omitted input column values with default values of the respective columns.  
This option only applies to `JSONEachRow`, `CSV` and `TabSeparated` formats

### Note

When this option is enabled, extended table metadata are sent from server to client. It consumes additional computing resources on the server  
.and can reduce performance

:Possible values

- .Disabled — 0 •
- .Enabled — 1 •

.Default value: 1

## `input_format_tsv_empty_as_default`

When enabled, replace empty input fields in TSV with default values. For complex default expressions  
. `input_format_defaults_for_omitted_fields` must be enabled too

.Disabled by default

## `input_format_null_as_default`

Enables or disables using default values if input data contain `NULL`, but data type of corresponding column is not  
.(`Nullable(T)`) (for text input formats

## `input_format_skip_unknown_fields`

.Enables or disables skipping insertion of extra data

When writing data, ClickHouse throws an exception if input data contain columns that do not exist in the target table. If  
.skipping is enabled, ClickHouse doesn't insert extra data and doesn't throw an exception

:Supported formats

- `JSONEachRow` •
- `CSVWithNames` •
- `TabSeparatedWithNames` •
- `TSKV` •

:Possible values

- .Disabled — 0 •
- .Enabled — 1 •

.Default value: 0

## `input_format_import_nested_json`

.Enables or disables the insertion of JSON data with nested objects

:Supported formats

[JSONEachRow](#) •

:Possible values

.Disabled — 0 •

.Enabled — 1 •

.Default value: 0

See Also

[.Usage of Nested Structures with the JSONEachRow format](#) •

## input\_format\_with\_names\_use\_header

.Enables or disables checking the column order when inserting data

To improve insert performance, we recommend disabling this check if you are sure that the column order of the input data  
.is the same as in the target table

:Supported formats

[CSVWithNames](#) •

[TabSeparatedWithNames](#) •

:Possible values

.Disabled — 0 •

.Enabled — 1 •

.Default value: 1

## date\_time\_input\_format

.Allows to choose a parser of text representation of date and time

.The setting doesn't apply to [date and time functions](#)

:Possible values

. 'best\_effort' — Enables extended parsing' •

ClickHouse can parse the basic YYYY-MM-DD HH:MM:SS format and all [ISO 8601](#) date and time formats. For example,

. "2018-06-08T01:02:03.000Z

. 'basic' — Use basic parser' •

. ClickHouse can parse only the basic YYYY-MM-DD HH:MM:SS format. For example, '2019-08-20 10:18:56

. 'Default value: 'basic'

See Also

[.DateTime data type](#) •

[.Functions for working with dates and times](#) •

## `join_default_strictness`

.Sets default strictness for **JOIN clauses**

:Possible values

`ALL` — If the right table has several matching rows, ClickHouse creates a **Cartesian product** from matching rows. This •  
is the normal `JOIN` behavior from standard SQL

`ANY` — If the right table has several matching rows, only the first one found is joined. If the right table has only one •  
.matching row, the results of `ANY` and `ALL` are the same  
. `ASOF` — For joining sequences with an uncertain match •  
. Empty string — If `ALL` or `ANY` is not specified in the query, ClickHouse throws an exception •

.Default value: `ALL`

## `join_any_take_last_row`

.Changes behavior of join operations with `ANY` strictness

### Attention

.This setting applies only for `JOIN` operations with **Join** engine tables

:Possible values

.If the right table has more than one matching row, only the first one found is joined — 0 •  
.If the right table has more than one matching row, only the last one found is joined — 1 •

.Default value: 0

See Also

[JOIN clause](#) •

[Join table engine](#) •

[join\\_default\\_strictness](#) •

## `join_use_nulls`

Sets the type of **JOIN** behavior. When merging tables, empty cells may appear. ClickHouse fills them differently based on  
.this setting

:Possible values

.The empty cells are filled with the default value of the corresponding field type — 0 •  
`JOIN` behaves the same way as in standard SQL. The type of the corresponding field is converted to **Nullable**, — 1 •  
.and empty cells are filled with **NULL**

.Default value: 0

## `join_any_take_last_row`

Changes the behavior of ANY `JOIN`. When disabled, ANY `JOIN` takes the first row found for a key. When enabled, ANY  
`JOIN` takes the last matched row if there are multiple rows for the same key. The setting is used only in **Join table engine**

:Possible values

.Disabled — 0 •

.Enabled — 1 •

.Default value: 1

### max\_block\_size

In ClickHouse, data is processed by blocks (sets of column parts). The internal processing cycles for a single block are efficient enough, but there are noticeable expenditures on each block. The `max_block_size` setting is a recommendation for what size of block (in number of rows) to load from tables. The block size shouldn't be too small, so that the expenditures on each block are still noticeable, but not too large, so that the query with LIMIT that is completed after the first block is processed quickly. The goal is to avoid consuming too much memory when extracting a large number of columns in multiple threads, and to preserve at least some cache locality

.Default value: 65,536

Blocks the size of `max_block_size` are not always loaded from the table. If it is obvious that less data needs to be retrieved, a smaller block is processed

### preferred\_block\_size\_bytes

Used for the same purpose as `max_block_size`, but it sets the recommended block size in bytes by adapting it to the number of rows in the block. However, the block size cannot be more than `max_block_size` rows. By default: 1,000,000. It only works when reading from MergeTree engines

### merge\_tree\_uniform\_read\_distribution

ClickHouse uses multiple threads when reading from [MergeTree\\*](#) tables. This setting turns on/off the uniform distribution of reading tasks over the working threads. The algorithm of the uniform distribution aims to make execution time for all the threads approximately equal in a `SELECT` query

:Possible values

.Do not use uniform read distribution — 0 •

.Use uniform read distribution — 1 •

.Default value: 1

### merge\_tree\_min\_rows\_for\_concurrent\_read

If the number of rows to be read from a file of a [MergeTree\\*](#) table exceeds `merge_tree_min_rows_for_concurrent_read` then ClickHouse tries to perform a concurrent reading from this file on several threads

:Possible values

.Any positive integer •

.Default value: 163840

### merge\_tree\_min\_bytes\_for\_concurrent\_read

If the number of bytes to read from one file of a [MergeTree\\*](#)-engine table exceeds

.`merge_tree_min_bytes_for_concurrent_read`, then ClickHouse tries to concurrently read from this file from several threads

:Possible values

.Any positive integer •

.Default value:  $240 \times 1024 \times 1024$

### `merge_tree_min_rows_for_seek`

If the distance between two data blocks to be read in one file is less than `merge_tree_min_rows_for_seek` rows, then ClickHouse does not seek through the file, but reads the data sequentially

:Possible values

.Any positive integer •

.Default value: 0

### `merge_tree_min_bytes_for_seek`

If the distance between two data blocks to be read in one file is less than `merge_tree_min_bytes_for_seek` bytes, then ClickHouse sequentially reads range of file that contains both blocks, thus avoiding extra seek

:Possible values

.Any positive integer •

.Default value: 0

### `merge_tree_coarse_index_granularity`

When searching data, ClickHouse checks the data marks in the index file. If ClickHouse finds that required keys are in some range, it divides this range into `merge_tree_coarse_index_granularity` subranges and searches the required keys there recursively

:Possible values

.Any positive even integer •

.Default value: 8

### `merge_tree_max_rows_to_use_cache`

If ClickHouse should read more than `merge_tree_max_rows_to_use_cache` rows in one query, it doesn't use the cache of uncompressed blocks

The cache of uncompressed blocks stores data extracted for queries. ClickHouse uses this cache to speed up responses to repeated small queries. This setting protects the cache from trashing by queries that read a large amount of data. The `uncompressed_cache_size` server setting defines the size of the cache of uncompressed blocks

:Possible values

.Any positive integer •

.Default value:  $128 \times 8192$

## `merge_tree_max_bytes_to_use_cache`

If ClickHouse should read more than `merge_tree_max_bytes_to_use_cache` bytes in one query, it doesn't use the cache of .uncompressed blocks

The cache of uncompressed blocks stores data extracted for queries. ClickHouse uses this cache to speed up responses to repeated small queries. This setting protects the cache from trashing by queries that read a large amount of data. The `.uncompressed_cache_size` server setting defines the size of the cache of uncompressed blocks

:Possible values

• Any positive integer

.Default value:  $1920 \times 1024 \times 1024$

## `min_bytes_to_use_direct_io`

.The minimum data volume required for using direct I/O access to the storage disk

ClickHouse uses this setting when reading data from tables. If the total storage volume of all the data to be read exceeds .`min_bytes_to_use_direct_io` bytes, then ClickHouse reads the data from the storage disk with the `O_DIRECT` option

Possible values

• Direct I/O is disabled — 0

• Positive integer

.Default value: 0

## `log_queries`

.Setting up query logging

Queries sent to ClickHouse with this setup are logged according to the rules in the `query_log` server configuration .parameter

:Example

```
log_queries=1
```

## `log_query_threads`

.Setting up query threads logging

Queries' threads runned by ClickHouse with this setup are logged according to the rules in the `query_thread_log` server .configuration parameter

:Example

```
log_query_threads=1
```

## `max_insert_block_size`

The size of blocks to form for insertion into a table. This setting only applies in cases when the server forms the blocks. For example, for an INSERT via the HTTP interface, the server parses the data format and forms blocks of the specified

size. But when using clickhouse-client, the client parses the data itself, and the 'max\_insert\_block\_size' setting on the server doesn't affect the size of the inserted blocks. The setting also doesn't have a purpose when using INSERT .SELECT, since data is inserted using the same blocks that are formed after SELECT

.Default value: 1,048,576

The default is slightly more than `max_block_size`. The reason for this is because certain table engines (\*MergeTree) form a data part on the disk for each inserted block, which is a fairly large entity. Similarly, \*MergeTree tables sort data during insertion, and a large enough block size allows sorting more data in RAM

### `max_replica_delay_for_distributed_queries`

."Disables lagging replicas for distributed queries. See "[Replication](#)

.Sets the time in seconds. If a replica lags more than the set value, this replica is not used

.Default value: 300

.Used when performing `SELECT` from a distributed table that points to replicated tables

### `max_threads`

The maximum number of query processing threads, excluding threads for retrieving data from remote servers (see the .('max\_distributed\_connections' parameter

This parameter applies to threads that perform the same stages of the query processing pipeline in parallel. For example, when reading from a table, if it is possible to evaluate expressions with functions, filter with WHERE and pre-aggregate for .GROUP BY in parallel using at least 'max\_threads' number of threads, then 'max\_threads' are used

.Default value: the number of physical CPU cores

If less than one `SELECT` query is normally run on a server at a time, set this parameter to a value slightly less than the .actual number of processor cores

For queries that are completed quickly because of a `LIMIT`, you can set a lower 'max\_threads'. For example, if the necessary number of entries are located in every block and `max_threads = 8`, then 8 blocks are retrieved, although it .would have been enough to read just one

.The smaller the `max_threads` value, the less memory is consumed

### `max_compress_block_size`

The maximum size of blocks of uncompressed data before compressing for writing to a table. By default, 1,048,576 (1 MiB). If the size is reduced, the compression rate is significantly reduced, the compression and decompression speed increases slightly due to cache locality, and memory consumption is reduced. There usually isn't any reason to change .this setting

Don't confuse blocks for compression (a chunk of memory consisting of bytes) with blocks for query processing (a set of .rows from a table

### `min_compress_block_size`

For [MergeTree](#)" tables. In order to reduce latency when processing queries, a block is compressed when writing the next .mark if its size is at least 'min\_compress\_block\_size'. By default, 65,536

The actual size of the block, if the uncompressed data is less than 'max\_compress\_block\_size', is no less than this value

.and no less than the volume of data for one mark

.Let's look at an example. Assume that 'index\_granularity' was set to 8192 during table creation

We are writing a UInt32-type column (4 bytes per value). When writing 8192 rows, the total will be 32 KB of data. Since  
.min\_compress\_block\_size = 65,536, a compressed block will be formed for every two marks

We are writing a URL column with the String type (average size of 60 bytes per value). When writing 8192 rows, the average will be slightly less than 500 KB of data. Since this is more than 65,536, a compressed block will be formed for each mark. In this case, when reading data from the disk in the range of a single mark, extra data won't be  
.decompressed

.There usually isn't any reason to change this setting

### **max\_query\_size**

The maximum part of a query that can be taken to RAM for parsing with the SQL parser. The INSERT query also contains data for INSERT that is processed by a separate stream parser (that consumes O(1) RAM), which is not included in this  
.restriction

.Default value: 256 KiB

### **interactive\_delay**

.The interval in microseconds for checking whether request execution has been canceled and sending the progress  
. (Default value: 100,000 (checks for canceling and sends the progress ten times per second

### **connect\_timeout, receive\_timeout, send\_timeout**

.Timeouts in seconds on the socket used for communicating with the client  
.Default value: 10, 300, 300

### **cancel\_http\_READONLY\_queries\_on\_client\_close**

.Cancels HTTP readonly queries (e.g. SELECT) when a client closes the connection without waiting for response  
Default value: 0

### **poll\_interval**

.Lock in a wait loop for the specified number of seconds  
.Default value: 10

### **max\_distributed\_connections**

The maximum number of simultaneous connections with remote servers for distributed processing of a single query to a  
.single Distributed table. We recommend setting a value no less than the number of servers in the cluster

.Default value: 1024

The following parameters are only used when creating Distributed tables (and when launching a server), so there is no  
.reason to change them at runtime

## `distributed_connections_pool_size`

The maximum number of simultaneous connections with remote servers for distributed processing of all queries to a single Distributed table. We recommend setting a value no less than the number of servers in the cluster

.Default value: 1024

## `connect_timeout_with_failover_ms`

The timeout in milliseconds for connecting to a remote server for a Distributed table engine, if the 'shard' and 'replica' sections are used in the cluster definition. If unsuccessful, several attempts are made to connect to various replicas

.Default value: 50

## `connections_with_failover_max_tries`

.The maximum number of connection attempts with each replica for the Distributed table engine

.Default value: 3

## `extremes`

Whether to count extreme values (the minimums and maximums in columns of a query result). Accepts 0 or 1. By default, "0 (disabled). For more information, see the section "Extreme values

## `use_uncompressed_cache`

Whether to use a cache of uncompressed blocks. Accepts 0 or 1. By default, 0 (disabled). Using the uncompressed cache (only for tables in the MergeTree family) can significantly reduce latency and increase throughput when working with a large number of short queries. Enable this setting for users who send frequent short requests. Also pay attention to the `uncompressed_cache_size` configuration parameter (only set in the config file) – the size of uncompressed cache blocks. By default, it is 8 GiB. The uncompressed cache is filled in as needed and the least-used data is automatically deleted

For queries that read at least a somewhat large volume of data (one million rows or more), the uncompressed cache is disabled automatically in order to save space for truly small queries. This means that you can keep the `'use_uncompressed_cache'` setting always set to 1

## `replace_running_query`

When using the HTTP interface, the 'query\_id' parameter can be passed. This is any string that serves as the query identifier. If a query from the same user with the same 'query\_id' already exists at this time, the behavior depends on the `'replace_running_query'` parameter

.(default) – Throw an exception (don't allow the query to run if a query with the same 'query\_id' is already running) 0

.Cancel the old query and start running the new one – 1

Yandex.Metrica uses this parameter set to 1 for implementing suggestions for segmentation conditions. After entering the .next character, if the old query hasn't finished yet, it should be canceled

## `stream_flush_interval_ms`

.Works for tables with streaming in the case of a timeout, or when a thread generates `max_insert_block_size` rows

.The default value is 7500

.The smaller the value, the more often data is flushed into the table. Setting the value too low leads to poor performance

## load\_balancing

.Specifies the algorithm of replicas selection that is used for distributed query processing

:ClickHouse supports the following algorithms of choosing replicas

(Random (by default •

Nearest hostname •

In order •

First or random •

(Random (by default

```
load_balancing = random
```

The number of errors is counted for each replica. The query is sent to the replica with the fewest errors, and if there are several of these, to any one of them. Disadvantages: Server proximity is not accounted for; if the replicas have different data, you will also get different data

### Nearest Hostname

```
load_balancing = nearest_hostname
```

The number of errors is counted for each replica. Every 5 minutes, the number of errors is integrally divided by 2. Thus, the number of errors is calculated for a recent time with exponential smoothing. If there is one replica with a minimal number of errors (i.e. errors occurred recently on the other replicas), the query is sent to it. If there are multiple replicas with the same minimal number of errors, the query is sent to the replica with a host name that is most similar to the server's host name in the config file (for the number of different characters in identical positions, up to the minimum length .(of both host names

For instance, example01-01-1 and example01-01-2.yandex.ru are different in one position, while example01-01-1 and example01-02-2 differ in two places. This method might seem primitive, but it doesn't require external data about network topology, and it doesn't compare IP addresses, which would be complicated for our IPv6 addresses

Thus, if there are equivalent replicas, the closest one by name is preferred. We can also assume that when sending a query to the same server, in the absence of failures, a distributed query will also go to the same servers. So even if different data is placed on the replicas, the query will return mostly the same results

### In Order

```
load_balancing = in_order
```

Replicas with the same number of errors are accessed in the same order as they are specified in configuration. This method is appropriate when you know exactly which replica is preferable

### First or Random

```
load_balancing = first_or_random
```

This algorithm chooses the first replica in the set or a random replica if the first is unavailable. It's effective in cross-replication topology setups, but useless in other configurations

The `first_or_random` algorithm solves the problem of the `in_order` algorithm. With `in_order`, if one replica goes down, the next one gets a double load while the remaining replicas handle the usual amount of traffic. When using the `.first_or_random` algorithm, load is evenly distributed among replicas that are still available

### `prefer_localhost_replica`

.Enables/disables preferable using the localhost replica when processing distributed queries

:Possible values

.ClickHouse always sends a query to the localhost replica if it exists — 1 •

.ClickHouse uses the balancing strategy specified by the `load_balancing` setting — 0 •

.Default value: 1

### Warning

.Disable this setting if you use `max_parallel_replicas`

### `totals_mode`

How to calculate TOTALS when HAVING is present, as well as when `max_rows_to_group_by` and `."group_by_overflow_mode = 'any'` are present. See the section "WITH TOTALS modifier

### `totals_auto_threshold`

."The threshold for `totals_mode = 'auto'` . See the section "WITH TOTALS modifier

### `max_parallel_replicas`

The maximum number of replicas for each shard when executing a query. For consistency (to get different parts of the same data split), this option only works when the sampling key is set. Replica lag is not controlled

### `compile`

.(Enable compilation of queries. By default, 0 (disabled)

Compilation is only used for part of the query-processing pipeline: for the first stage of aggregation (GROUP BY). If this portion of the pipeline was compiled, the query may run faster due to deployment of short cycles and inlining aggregate function calls. The maximum performance improvement (up to four times faster in rare cases) is seen for queries with multiple simple aggregate functions. Typically, the performance gain is insignificant. In very rare cases, it may slow down .query execution

### `min_count_to_compile`

How many times to potentially use a compiled chunk of code before running compilation. By default, 3. For testing, the value can be set to 0: compilation runs synchronously and the query waits for the end of the compilation process before continuing execution. For all other cases, use values starting with 1. Compilation normally takes about 5-10 seconds. If the value is 1 or more, compilation occurs asynchronously in a separate thread. The result will be used as soon as it is ready, .including queries that are currently running

Compiled code is required for each different combination of aggregate functions used in the query and the type of keys in the GROUP BY clause. The results of compilation are saved in the build directory in the form of .so files. There is no

restriction on the number of compilation results, since they don't use very much space. Old results will be used after .server restarts, except in the case of a server upgrade – in this case, the old results are deleted

### **output\_format\_json\_quote\_64bit\_integers**

If the value is true, integers appear in quotes when using JSON\* Int64 and UInt64 formats (for compatibility with most .JavaScript implementations); otherwise, integers are output without the quotes

### **format\_csv\_delimiter**

. The character interpreted as a delimiter in the CSV data. By default, the delimiter is

### **input\_format\_csv\_unquoted\_null\_literal\_as\_null**

.(For CSV input format enables or disables parsing of unquoted NULL as literal (synonym for \N

### **insert\_quorum**

.Enables quorum writes

.If insert\_quorum < 2 , the quorum writes are disabled •

.If insert\_quorum >= 2 , the quorum writes are enabled •

.Default value: 0

Quorum writes

INSERT succeeds only when ClickHouse manages to correctly write data to the insert\_quorum of replicas during the insert\_quorum\_timeout . If for any reason the number of replicas with successful writes does not reach the insert\_quorum , the write is considered failed and ClickHouse will delete the inserted block from all the replicas where data has already .been written

All the replicas in the quorum are consistent, i.e., they contain data from all previous INSERT queries. The INSERT .sequence is linearized

.When reading the data written from the insert\_quorum , you can use the select\_sequential\_consistency option

ClickHouse generates an exception

.If the number of available replicas at the time of the query is less than the insert\_quorum •

At an attempt to write data when the previous block has not yet been inserted in the insert\_quorum of replicas. This • situation may occur if the user tries to perform an INSERT before the previous one with the insert\_quorum is .completed

:See also the following parameters

**insert\_quorum\_timeout** •

**select\_sequential\_consistency** •

### **insert\_quorum\_timeout**

Quorum write timeout in seconds. If the timeout has passed and no write has taken place yet, ClickHouse will generate an .exception and the client must repeat the query to write the same block to the same or any other replica

.Default value: 60 seconds

:See also the following parameters

- [insert\\_quorum](#) •
- [select\\_sequential\\_consistency](#) •

## select\_sequential\_consistency

:Enables or disables sequential consistency for `SELECT` queries

:Possible values

.Disabled — 0 •

.Enabled — 1 •

.Default value: 0

Usage

When sequential consistency is enabled, ClickHouse allows the client to execute the `SELECT` query only for those replicas that contain data from all previous `INSERT` queries executed with `insert_quorum`. If the client refers to a partial replica, ClickHouse will generate an exception. The `SELECT` query will not include data that has not yet been written to .the quorum of replicas

See Also

- [insert\\_quorum](#) •
- [insert\\_quorum\\_timeout](#) •

## max\_network\_bytes

Limits the data volume (in bytes) that is received or transmitted over the network when executing a query. This setting .applies to every individual query

:Possible values

.Positive integer •

.Data volume control is disabled — 0 •

.Default value: 0

## max\_network\_bandwidth

Limits the speed of the data exchange over the network in bytes per second. This setting applies to every query

:Possible values

.Positive integer •

.Bandwidth control is disabled — 0 •

.Default value: 0

## max\_network\_bandwidth\_for\_user

Limits the speed of the data exchange over the network in bytes per second. This setting applies to all concurrently running queries performed by a single user

:Possible values

.Positive integer •

.Control of the data speed is disabled — 0 •

.Default value: 0

### max\_network\_bandwidth\_for\_all\_users

Limits the speed that data is exchanged at over the network in bytes per second. This setting applies to all concurrently running queries on the server

:Possible values

.Positive integer •

.Control of the data speed is disabled — 0 •

.Default value: 0

### allow\_experimental\_cross\_to\_join\_conversion

:Enables or disables

Rewriting queries for join from the syntax with commas to the JOIN ON/USING syntax. If the setting value is 0, ClickHouse doesn't process queries with syntax that uses commas, and throws an exception

.Converting CROSS JOIN to INNER JOIN if WHERE conditions allow it .2

:Possible values

.Disabled — 0 •

.Enabled — 1 •

.Default value: 1

See Also

[Multiple JOIN](#) •

### count\_distinctImplementation

.Specifies which of the uniq\* functions should be used to perform the COUNT(DISTINCT ...) construction

:Possible values

uniq •

uniqCombined •

uniqCombined64 •

uniqHLL12 •

uniqExact •

.Default value: uniqExact

## `skip_unavailable_shards`

.Enables or disables silently skipping of unavailable shards

:Shard is considered unavailable if all its replicas are unavailable. A replica is unavailable in the following cases

.ClickHouse can't connect to replica for any reason •

When connecting to a replica, ClickHouse performs several attempts. If all these attempts fail, the replica is  
.considered unavailable

.Replica can't be resolved through DNS •

:If replica's hostname can't be resolved through DNS, it can indicate the following situations

Replica's host has no DNS record. It can occur in systems with dynamic DNS, for example,[Kubernetes](#), where  
.nodes can be unresolvable during downtime, and this is not an error

.Configuration error. ClickHouse configuration file contains a wrong hostname •

:Possible values

.skipping enabled — 1 •

.If a shard is unavailable, ClickHouse returns a result based on partial data and doesn't report node availability issues

.skipping disabled — 0 •

.If a shard is unavailable, ClickHouse throws an exception

.Default value: 0

## `optimize_throw_if_noop`

.Enables or disables throwing an exception if an[OPTIMIZE](#) query didn't perform a merge

By default, `OPTIMIZE` returns successfully even if it didn't do anything. This setting lets you differentiate these situations  
.and get the reason in an exception message

:Possible values

.Throwing an exception is enabled — 1 •

.Throwing an exception is disabled — 0 •

.Default value: 0

## `distributed_replica_error_half_life`

Type: seconds •

Default value: 60 seconds •

Controls how fast errors in distributed tables are zeroed. If a replica is unavailable for some time, accumulates 5 errors,  
.and `distributed_replica_error_half_life` is set to 1 second, then the replica is considered normal 3 seconds after last error

See also

[Table engine Distributed](#) •

[distributed\\_replica\\_error\\_cap](#) •

## `distributed_replica_error_cap`

Type: unsigned int •

Default value: 1000 •

.Error count of each replica is capped at this value, preventing a single replica from accumulating too many errors

See also

[Table engine Distributed](#) •

[distributed\\_replica\\_error\\_half\\_life](#) •

## distributed\_directory\_monitor\_sleep\_time\_ms

.Base interval for the [Distributed](#) table engine to send data. The actual interval grows exponentially in the event of errors

:Possible values

.Positive integer number of milliseconds •

.Default value: 100 milliseconds

## distributed\_directory\_monitor\_max\_sleep\_time\_ms

Maximum interval for the [Distributed](#) table engine to send data. Limits exponential growth of the interval set in the [distributed\\_directory\\_monitor\\_sleep\\_time\\_ms](#) setting

:Possible values

.Positive integer number of milliseconds •

.(Default value: 30000 milliseconds (30 seconds

## distributed\_directory\_monitor\_batch\_inserts

.Enables/disables sending of inserted data in batches

When batch sending is enabled, the [Distributed](#) table engine tries to send multiple files of inserted data in one operation instead of sending them separately. Batch sending improves cluster performance by better utilizing server and network resources

:Possible values

.Enabled — 1 •

.Disabled — 0 •

.Default value: 0

## os\_thread\_priority

Sets the priority ([nice](#)) for threads that execute queries. The OS scheduler considers this priority when choosing the next thread to run on each available CPU core

### Warning

To use this setting, you need to set the `CAP_SYS_NICE` capability. The `clickhouse-server` package sets it up during installation. Some virtual environments don't allow you to set the `CAP_SYS_NICE` capability. In this case, `clickhouse-server` shows a message about it at the start

:Possible values

. [You can set values in the range[-20, 19] •

Lower values mean higher priority. Threads with low nice priority values are executed more frequently than threads with high values. High values are preferable for long running non-interactive queries because it allows them to quickly give up resources in favor of short interactive queries when they arrive

.Default value: 0

### query\_profiler\_real\_time\_period\_ns

.Sets the period for a real clock timer of the query profiler. Real clock timer counts wall-clock time

:Possible values

.Positive integer number, in nanoseconds •

:Recommended values

- 100000000 (100 times a second) nanoseconds and less for single queries.
- 1000000000 (once a second) for cluster-wide profiling.

.for turning off the timer 0 •

.Type: UInt64

.(Default value: 1000000000 nanoseconds (once a second

See Also

[system.trace\\_log](#) •

### query\_profiler\_cpu\_time\_period\_ns

.Sets the period for a CPU clock timer of the query profiler. This timer counts only CPU time

:Possible values

.Positive integer number of nanoseconds •

:Recommended values

- 10000000 (100 times a second) nanoseconds and more for single queries.
- 1000000000 (once a second) for cluster-wide profiling.

.for turning off the timer 0 •

.Type: UInt64

.Default value: 1000000000 nanoseconds

See Also

[system.trace\\_log](#) •

### allow\_introspection\_functions

.Enables or disables [introspections functions](#) for query profiling

:Possible values

- .Introspection functions enabled — 1 •
  - .Introspection functions disabled — 0 •
- .Default value: 0

### input\_format\_parallel\_parsing

Type: bool •

Default value: True •

Enable order-preserving parallel parsing of data formats. Supported only for TSV, TKSV, CSV and JSONEachRow  
.formats

### min\_chunk\_bytes\_for\_parallel\_parsing

Type: unsigned int •

Default value: 1 MiB •

.The minimum chunk size in bytes, which each thread will parse in parallel

[Original article](#)

## Settings profiles

A settings profile is a collection of settings grouped under the same name. Each ClickHouse user has a profile. To apply  
.all the settings in a profile, set the `profile` setting

:Example

.Install the `web` profile

```
SET profile = 'web'
```

.Settings profiles are declared in the user config file. This is usually `users.xml`

:Example

```

<!-- Settings profiles -->
<profiles>
 <!-- Default settings -->
 <default>
 <!-- The maximum number of threads when running a single query. -->
 <max_threads>8</max_threads>
 </default>

 <!-- Settings for queries from the user interface -->
 <web>
 <max_rows_to_read>1000000000</max_rows_to_read>
 <max_bytes_to_read>100000000000</max_bytes_to_read>

 <max_rows_to_group_by>1000000</max_rows_to_group_by>
 <group_by_overflow_mode>any</group_by_overflow_mode>

 <max_rows_to_sort>1000000</max_rows_to_sort>
 <max_bytes_to_sort>10000000000</max_bytes_to_sort>

 <max_result_rows>100000</max_result_rows>
 <max_result_bytes>1000000000</max_result_bytes>
 <result_overflow_mode>break</result_overflow_mode>

 <max_execution_time>600</max_execution_time>
 <min_execution_speed>1000000</min_execution_speed>
 <timeout_before_checking_execution_speed>15</timeout_before_checking_execution_speed>

 <max_columns_to_read>25</max_columns_to_read>
 <max_temporary_columns>100</max_temporary_columns>
 <max_temporary_non_const_columns>50</max_temporary_non_const_columns>

 <max_subquery_depth>2</max_subquery_depth>
 <max_pipeline_depth>25</max_pipeline_depth>
 <max_ast_depth>50</max_ast_depth>
 <max_ast_elements>100</max_ast_elements>

 <readonly>1</readonly>
 </web>
</profiles>

```

The example specifies two profiles: `default` and `web`. The `default` profile has a special purpose: it must always be present and is applied when starting the server. In other words, the `default` profile contains default settings. The `web` profile is a regular profile that can be set using the `SET` query or using a URL parameter in an HTTP query.

Settings profiles can inherit from each other. To use inheritance, indicate one or multiple `profile` settings before the other settings that are listed in the profile. In case when one setting is defined in different profiles, the latest defined is used.

## User settings

The `users` section of the `user.xml` configuration file contains user settings

:Structure of the `users` section

```

<users>
 <!-- If user name was not specified, 'default' user is used. -->
 <user_name>
 <password></password>
 <!-- Or -->
 <password_sha256_hex></password_sha256_hex>

 <networks incl="networks" replace="replace">
 </networks>

 <profile>profile_name</profile>

 <quota>default</quota>

 <databases>
 <database_name>
 <table_name>
 <filter>expression</filter>
 </table_name>
 </database_name>
 </databases>
 </user_name>
 <!-- Other users settings -->
</users>

```

### user\_name/password

.(Password could be specified in plaintext or in SHA256 (hex format

- .To assign a password in plaintext (not recommended), place it in a `password` element •

- .For example, `<password>qwerty</password>` . The password can be left blank

- .To assign a password using its SHA256 hash, place it in a `password_sha256_hex` element •

- For example,

- . `<>password_sha256_hex>65e84be33532fb784c48129675f9eff3a682b27168c0ea744b2cf58ee02337c5</password_sha256_hex`

- :Example of how to generate a password from shell

- '-' `PASSWORD=$(base64 < /dev/urandom | head -c8); echo "$PASSWORD"; echo -n "$PASSWORD" | sha256sum | tr -d`

- .The first line of the result is the password. The second line is the corresponding SHA256 hash

### user\_name/networks

.List of networks from which the user can connect to the ClickHouse server

:Each element of the list can have one of the following forms

- . `ip>` — IP address or network mask> •

- . ::Examples: `213.180.204.3` , `10.0.0.1/8` , `10.0.0.1/255.255.255.0` , `2a02:6b8::3` , `2a02:6b8::3/64` , `2a02:6b8::3/ffff:ffff:ffff:ffff`

- . `host>` — Hostname> •

- .Example: `example01.host.ru`

- .To check access, a DNS query is performed, and all returned IP addresses are compared to the peer address

- . `host_regex>` — Regular expression for hostnames> •

- \$Example, `^example\d\d-\d\d-\d\.\host\.ru`

To check access, a **DNS PTR query** is performed for the peer address and then the specified regexp is applied. Then,

another DNS query is performed for the results of the PTR query and all the received addresses are compared to the

.\$ peer address. We strongly recommend that regexp ends with

.All results of DNS requests are cached until the server restarts

:To open access for user from any network, specify

```
<ip>::/0</ip>
```

### Warning

.It's insecure to open access from any network unless you have a firewall properly configured or the server is not directly connected to Internet

:To open access only from localhost, specify

```
<ip>::1</ip>
<ip>127.0.0.1</ip>
```

### **user\_name/profile**

You can assign a settings profile for the user. Settings profiles are configured in a separate section of the `users.xml` file.

.For more information, see [Profiles of Settings](#)

### **user\_name/quota**

Quotas allow you to track or limit resource usage over a period of time. Quotas are configured in the `quotas` section of the `.users.xml` configuration file

.You can assign a quotas set for the user. For a detailed description of quotas configuration, see [Quotas](#)

### **user\_name/databases**

In this section, you can limit rows that are returned by ClickHouse for `SELECT` queries made by the current user,  
.thus implementing basic row-level security

### Example

The following configuration forces that user `user1` can only see the rows of `table1` as the result of `SELECT` queries,  
.where the value of the `id` field is 1000

```
<user1>
 <databases>
 <database_name>
 <table1>
 <filter>id = 1000</filter>
 </table1>
 </database_name>
 </databases>
</user1>
```

The `filter` can be any expression resulting in a `UInt8`-type value. It usually contains comparisons and logical operators.  
Rows from `database_name.table1` where filter results to 0 are not returned for this user. The filtering is incompatible with  
. `PREWHERE` operations and disables `WHERE → PREWHERE` optimization

## Constraints on Settings

The constraints on settings can be defined in the `users` section of the `user.xml` configuration file and prohibit users from  
. changing some of the settings with the `SET` query. The constraints are defined as following

```

<profiles>
 <user_name>
 <constraints>
 <setting_name_1>
 <min>lower_boundary</min>
 </setting_name_1>
 <setting_name_2>
 <max>upper_boundary</max>
 </setting_name_2>
 <setting_name_3>
 <min>lower_boundary</min>
 <max>upper_boundary</max>
 </setting_name_3>
 <setting_name_4>
 <readonly/>
 </setting_name_4>
 </constraints>
 </user_name>
</profiles>

```

If user tries to violate the constraints an exception is thrown and the setting isn't actually changed. There are supported three types of constraints: `min`, `max`, `readonly`. The `min` and `max` constraints specify upper and lower boundaries for a numeric setting and can be used in combination. The `readonly` constraint specify that the user cannot change the corresponding setting at all

:Example: Let `users.xml` includes lines

```

<profiles>
 <default>
 <max_memory_usage>10000000000</max_memory_usage>
 <force_index_by_date>0</force_index_by_date>
 ...
 <constraints>
 <max_memory_usage>
 <min>5000000000</min>
 <max>20000000000</max>
 </max_memory_usage>
 <force_index_by_date>
 <readonly/>
 </force_index_by_date>
 </constraints>
 </default>
</profiles>

```

:The following queries all throw exceptions

```

SET max_memory_usage=20000000001;
SET max_memory_usage=4999999999;
SET force_index_by_date=1;

```

```

Code: 452, e.displayText() = DB::Exception: Setting max_memory_usage should not be greater than
20000000000.
Code: 452, e.displayText() = DB::Exception: Setting max_memory_usage should not be less than 5000000000.
Code: 452, e.displayText() = DB::Exception: Setting force_index_by_date should not be changed.

```

Note: the `default` profile has a special handling: all the constraints defined for the `default` profile become the default constraints, so they restrict all the users until they're overridden explicitly for these users

## ClickHouse Utility

**clickhouse-local** — Allows running SQL queries on data without stopping the ClickHouse server, similar to howawk •  
• does this

- .`clickhouse-copier` — Copies (and reshards) data from one cluster to another cluster •
- .`clickhouse-benchmark` — Loads server with the custom queries and settings •

## clickhouse-copier

.Copies data from the tables in one cluster to tables in another (or the same) cluster

You can run multiple `clickhouse-copier` instances on different servers to perform the same job. ZooKeeper is used for syncing the processes

:After starting, `clickhouse-copier`

:Connects to ZooKeeper and receives •

.Copying jobs •

.The state of the copying jobs •

.It performs the jobs •

Each running process chooses the "closest" shard of the source cluster and copies the data into the destination cluster, resharding the data if necessary

. `clickhouse-copier` tracks the changes in ZooKeeper and applies them on the fly

.To reduce network traffic, we recommend running `clickhouse-copier` on the same server where the source data is located

## Running clickhouse-copier

:The utility should be run manually

```
$ clickhouse-copier copier --daemon --config zookeeper.xml --task-path /task/path --base-dir /path/to/dir
```

:Parameters

.`daemon` — Starts `clickhouse-copier` in daemon mode •

.`config` — The path to the `zookeeper.xml` file with the parameters for the connection to ZooKeeper •

`task-path` — The path to the ZooKeeper node. This node is used for syncing `clickhouse-copier` processes and storing .tasks. Tasks are stored in `$task-path/description`

.`task-file` — Optional path to file with task configuration for initial upload to ZooKeeper •

.`task-upload-force` — Force upload `task-file` even if node already exists •

`base-dir` — The path to logs and auxiliary files. When it starts, `clickhouse-copier` creates `clickhouse-copier_YYYYMMHHSS_<PID>` subdirectories in `$base-dir`. If this parameter is omitted, the directories are created in the .directory where `clickhouse-copier` was launched

## Format of `zookeeper.xml`

```

<yandex>
 <logger>
 <level>trace</level>
 <size>100M</size>
 <count>3</count>
 </logger>

 <zookeeper>
 <node index="1">
 <host>127.0.0.1</host>
 <port>2181</port>
 </node>
 </zookeeper>
</yandex>

```

## Configuration of copying tasks

```

<yandex>
 <!-- Configuration of clusters as in an ordinary server config -->
 <remote_servers>
 <source_cluster>
 <shard>
 <internal_replication>false</internal_replication>
 <replica>
 <host>127.0.0.1</host>
 <port>9000</port>
 </replica>
 </shard>
 ...
 </source_cluster>

 <destination_cluster>
 ...
 </destination_cluster>
</remote_servers>

 <!-- How many simultaneously active workers are possible. If you run more workers superfluous workers will sleep. -->
 <max_workers>2</max_workers>

 <!-- Setting used to fetch (pull) data from source cluster tables -->
 <settings_pull>
 <readonly>1</readonly>
 </settings_pull>

 <!-- Setting used to insert (push) data to destination cluster tables -->
 <settings_push>
 <readonly>0</readonly>
 </settings_push>

 <!-- Common setting for fetch (pull) and insert (push) operations. Also, copier process context uses it.
 They are overlaid by <settings_pull/> and <settings_push/> respectively. -->
 <settings>
 <connect_timeout>3</connect_timeout>
 <!-- Sync insert is set forcibly, leave it here just in case. -->
 <insert_distributed_sync>1</insert_distributed_sync>
 </settings>

 <!-- Copying tasks description.
 You could specify several table task in the same task description (in the same ZooKeeper node), they will be performed sequentially.
 -->
 <tables>
 <!-- A table task, copies one table. -->
 <table_hits>
 <!-- Source cluster name (from <remote_servers/> section) and tables in it that should be copied -->
 <cluster_pull>source cluster</cluster_pull>

```

```

<database_pull>test</database_pull>
<table_pull>hits</table_pull>

<!-- Destination cluster name and tables in which the data should be inserted -->
<cluster_push>destination_cluster</cluster_push>
<database_push>test</database_push>
<table_push>hits2</table_push>

<!-- Engine of destination tables.
 If destination tables have not be created, workers create them using columns definition
from source tables and engine
 definition from here.

 NOTE: If the first worker starts insert data and detects that destination partition is not
empty then the partition will
 be dropped and refilled, take it into account if you already have some data in destination
tables. You could directly
 specify partitions that should be copied in <enabled_partitions/>, they should be in
quoted format like partition column of
 system.parts table.

-->
<engine>
ENGINE=ReplicatedMergeTree('/clickhouse/tables/{cluster}/{shard}/hits2', '{replica}')
PARTITION BY toMonday(date)
ORDER BY (CounterID, EventDate)
</engine>

<!-- Sharding key used to insert data to destination cluster -->
<sharding_key>jumpConsistentHash(intHash64(UserID), 2)</sharding_key>

<!-- Optional expression that filter data while pull them from source servers -->
<where_condition>CounterID != 0</where_condition>

<!-- This section specifies partitions that should be copied, other partition will be ignored.
 Partition names should have the same format as
 partition column of system.parts table (i.e. a quoted text).
 Since partition key of source and destination cluster could be different,
 these partition names specify destination partitions.

 NOTE: In spite of this section is optional (if it is not specified, all partitions will be
copied),
 it is strictly recommended to specify them explicitly.
 If you already have some ready partitions on destination cluster they
 will be removed at the start of the copying since they will be interpreted
 as unfinished data from the previous copying!!!
-->
<enabled_partitions>
 <partition>'2018-02-26'</partition>
 <partition>'2018-03-05'</partition>
 ...
</enabled_partitions>
</table_hits>

<!-- Next table to copy. It is not copied until previous table is copying. -->
</table_visits>
...
</table_visits>
...
</tables>
</yandex>

```

clickhouse-copier tracks the changes in `/task/path/description` and applies them on the fly. For instance, if you change the .value of `max_workers`, the number of processes running tasks will also change

## clickhouse-local

The `clickhouse-local` program enables you to perform fast processing on local files, without having to deploy and configure .the ClickHouse server

.Accepts data that represent tables and queries them using [ClickHouse SQL dialect](#)

`clickhouse-local` uses the same core as ClickHouse server, so it supports most of the features and the same set of formats  
.and table engines

By default `clickhouse-local` does not have access to data on the same host, but it supports loading server configuration  
.using `--config-file` argument

### Warning

.It is not recommended to load production server configuration into `clickhouse-local` because data can be damaged in case of human error

## Usage

:Basic usage

```
$ clickhouse-local --structure "table_structure" --input-format "format_of_incoming_data" -q "query"
```

:Arguments

- . S, `--structure` — table structure for input data- •
- . if, `--input-format` — input format, TSV by default- •
- . f, `--file` — path to data, stdin by default- •
- . q `--query` — queries to execute with ; as delimiter- •
- . N, `--table` — table name where to put output data, table by default- •
- . of, `--format` , `--output-format` — output format, TSV by default- •
- . stacktrace — whether to dump debug output in case of exception- •
- . verbose — more details on query execution- •
- . s — disables stderr logging- •
- . config-file — path to configuration file in same format as for ClickHouse server, by default the configuration empty- •
- . help — arguments references for `clickhouse-local` -- •

Also there are arguments for each ClickHouse configuration variable which are more commonly used instead of `--config-file`

## Examples

```
$ echo -e "1,2\n3,4" | clickhouse-local -S "a Int64, b Int64" -if "CSV" -q "SELECT * FROM table"
Read 2 rows, 32.00 B in 0.000 sec., 5182 rows/sec., 80.97 KiB/sec.
1 2
3 4
```

:Previous example is the same as

```
$ echo -e "1,2\n3,4" | clickhouse-local -q "CREATE TABLE table (a Int64, b Int64) ENGINE = File(CSV,
stdin); SELECT a, b FROM table; DROP TABLE table"
Read 2 rows, 32.00 B in 0.000 sec., 4987 rows/sec., 77.93 KiB/sec.
1 2
3 4
```

:Now let's output memory user for each Unix user

```
$ ps aux | tail -n +2 | awk '{ printf("%s\t%s\n", $1, $4) }' | clickhouse-local -S "user String, mem Float64" -q "SELECT user, round(sum(mem), 2) as memTotal FROM table GROUP BY user ORDER BY memTotal DESC FORMAT Pretty"
```

Read 186 rows, 4.15 KiB in 0.035 sec., 5302 rows/sec., 118.34 KiB/sec.

user	memTotal
bayonet	113.5
root	8.8
...	

## clickhouse-benchmark

.Connects to a ClickHouse server and repeatedly sends specified queries

:Syntax

```
$ echo "single query" | clickhouse-benchmark [keys]
```

or

```
$ clickhouse-benchmark [keys] <<< "single query"
```

:If you want to send a set of queries, create a text file and place each query on the individual string in this file. For example

```
SELECT * FROM system.numbers LIMIT 10000000
SELECT 1
```

.Then pass this file to a standard input of clickhouse-benchmark

```
clickhouse-benchmark [keys] < queries_file
```

## Keys

- . c N, --concurrency=N — Number of queries that clickhouse-benchmark sends simultaneously. Default value: 1- •
- . d N, --delay=N — Interval in seconds between intermediate reports (set 0 to disable reports). Default value: 1- •
- h WORD, --host=WORD — Server host. Default value: localhost . For the **comparison mode** you can use multiple -h - •  
.keys
- . p N, --port=N — Server port. Default value: 9000. For the **comparison mode** you can use multiple -p keys- •  
•  
. i N, --iterations=N — Total number of queries. Default value: 0- •  
•  
. r, --randomize — Random order of queries execution if there is more then one input query- •  
•  
. s, --secure — Using TLS connection- •  
•  
t N, --timelimit=N — Time limit in seconds. clickhouse-benchmark stops sending queries when the specified time limit- •  
•  
.is reached. Default value: 0 (time limit disabled  
confidence=N — Level of confidence for T-test. Possible values: 0 (80%), 1 (90%), 2 (95%), 3 (98%), 4 (99%), 5- •  
•  
(99.5%). Default value: 5. In the **comparison mode** clickhouse-benchmark performs the **Independent two-sample**  
**Student's t-test** test to determine whether the two distributions aren't different with the selected level of confidence  
•  
. cumulative — Printing cumulative data instead of data per interval-- •

```

 . database=DATABASE_NAME — ClickHouse database name. Default value: default •
 json=FILEPATH — JSON output. When the key is set, clickhouse-benchmark outputs a report to the specified JSON--- •
 .file
 . user=USERNAME — ClickHouse user name. Default value: default •
 . password=PSWD — ClickHouse user password. Default value: empty string-- •
 . stacktrace — Stack traces output. When the key is set, clickhouse-benchmark outputs stack traces of exceptions-- •
 stage=WORD — Query processing stage at server. ClickHouse stops query processing and returns answer to--- •
 clickhouse-benchmark at the specified stage. Possible values: complete , fetch_columns , with_mergeable_state . Default
 .value: complete
 . help — Shows the help message-- •

```

If you want to apply some **settings** for queries, pass them as a key --<session setting name>= SETTING\_VALUE . For example,  
 . --max\_memory\_usage=1048576

## Output

.By default, clickhouse-benchmark reports for each --delay interval

:Example of the report

```

Queries executed: 10.

localhost:9000, queries 10, QPS: 6.772, RPS: 67904487.440, MiB/s: 518.070, result RPS: 67721584.984, result
MiB/s: 516.675.

0.000% 0.145 sec.
10.000% 0.146 sec.
20.000% 0.146 sec.
30.000% 0.146 sec.
40.000% 0.147 sec.
50.000% 0.148 sec.
60.000% 0.148 sec.
70.000% 0.148 sec.
80.000% 0.149 sec.
90.000% 0.150 sec.
95.000% 0.150 sec.
99.000% 0.150 sec.
99.900% 0.150 sec.
99.990% 0.150 sec.

```

:In the report you can find

```

 .Number of queries in the Queries executed: field •
 :(Status string containing (in order •
 .Endpoint of ClickHouse server •
 .Number of processed queries •

```

.QPS: QPS: How many queries server performed per second during a period specified in the--delay argument •

.RPS: How many rows server read per second during a period specified in the--delay argument •

.MiB/s: How many mebibytes server read per second during a period specified in the--delay argument •

result RPS: How many rows placed by server to the result of a query per second during a period specified in the--delay argument •

result MiB/s. How many mebibytes placed by server to the result of a query per second during a period specified in the--delay argument •

## Comparison mode

. clickhouse-benchmark can compare performances for two running ClickHouse servers

To use the comparison mode, specify endpoints of both servers by two pairs of --host , --port keys. Keys matched together by position in arguments list, the first --host is matched with the first --port and so on. clickhouse-benchmark establishes connections to both servers, then sends queries. Each query addressed to a randomly selected server. The .results are shown for each server separately

## Example

```
$ echo "SELECT * FROM system.numbers LIMIT 10000000 OFFSET 10000000" | clickhouse-benchmark -i 10
```

Loaded 1 queries.

Queries executed: 6.

localhost:9000, queries 6, QPS: 6.153, RPS: 123398340.957, MiB/s: 941.455, result RPS: 61532982.200, result MiB/s: 469.459.

0.000%	0.159 sec.
10.000%	0.159 sec.
20.000%	0.159 sec.
30.000%	0.160 sec.
40.000%	0.160 sec.
50.000%	0.162 sec.
60.000%	0.164 sec.
70.000%	0.165 sec.
80.000%	0.166 sec.
90.000%	0.166 sec.
95.000%	0.167 sec.
99.000%	0.167 sec.
99.900%	0.167 sec.
99.990%	0.167 sec.

Queries executed: 10.

localhost:9000, queries 10, QPS: 6.082, RPS: 121959604.568, MiB/s: 930.478, result RPS: 60815551.642, result MiB/s: 463.986.

0.000%	0.159 sec.
10.000%	0.159 sec.
20.000%	0.160 sec.
30.000%	0.163 sec.
40.000%	0.164 sec.
50.000%	0.165 sec.
60.000%	0.166 sec.
70.000%	0.166 sec.
80.000%	0.167 sec.
90.000%	0.167 sec.
95.000%	0.170 sec.
99.000%	0.172 sec.
99.900%	0.172 sec.
99.990%	0.172 sec.

## General Questions

?Why Not Use Something Like MapReduce

We can refer to systems like MapReduce as distributed computing systems in which the reduce operation is based on distributed sorting. The most common open source solution in this class is [Apache Hadoop](#). Yandex uses their in-house solution, YT

These systems aren't appropriate for online queries due to their high latency. In other words, they can't be used as the back-end for a web interface. These types of systems aren't useful for real-time data updates. Distributed sorting isn't the best way to perform reduce operations if the result of the operation and all the intermediate results (if there are any) are located in the RAM of a single server, which is usually the case for online queries. In such a case, a hash table is the optimal way to perform reduce operations. A common approach to optimizing map-reduce tasks is pre-aggregation (partial reduce) using a hash table in RAM. The user performs this optimization manually. Distributed sorting is one of the main causes of reduced performance when running simple map-reduce tasks

Most MapReduce implementations allow you to execute arbitrary code on a cluster. But a declarative query language is better suited to OLAP in order to run experiments quickly. For example, Hadoop has Hive and Pig. Also consider Cloudera Impala or Shark (outdated) for Spark, as well as Spark SQL, Presto, and Apache Drill. Performance when running such tasks is highly sub-optimal compared to specialized systems, but relatively high latency makes it unrealistic to use these systems as the backend for a web interface

## ?What If I Have a Problem with Encodings When Using Oracle Through ODBC

If you use Oracle through the ODBC driver as a source of external dictionaries, you need to set the correct value for the `.NLS_LANG` environment variable in `/etc/default/clickhouse`. For more information, see the [Oracle NLS\\_LANG FAQ](#)

:Example

```
NLS_LANG=RUSSIAN_RUSSIA.UTF8
```

## ?How to export data from ClickHouse to the file

### Using INTO OUTFILE Clause

:Add [INTO OUTFILE](#) clause to your query

:For example

```
SELECT * FROM table INTO OUTFILE 'file'
```

:By default, ClickHouse uses the [TabSeparated](#) format for output data. To select the [data format](#), use the [FORMAT](#) clause

:For example

```
SELECT * FROM table INTO OUTFILE 'file' FORMAT CSV
```

### Using File-engine Table

:See [File](#)

### Using Command-line Redirection

```
$ clickhouse-client --query "SELECT * from table" > result.txt
```

:See [clickhouse-client](#)

## ClickHouse Development

# Overview of ClickHouse Architecture

ClickHouse is a true column-oriented DBMS. Data is stored by columns, and during the execution of arrays (vectors or chunks of columns). Whenever possible, operations are dispatched on arrays, rather than on individual values. This is called "vectorized query execution," and it helps lower the cost of actual data processing

This idea is nothing new. It dates back to the APL programming language and its descendants: A+, J, K, and Q. Array programming is used in scientific data processing. Neither is this idea something new in relational databases: for example, it is used in the Vectorwise system

There are two different approaches for speeding up the query processing: vectorized query execution and runtime code generation. In the latter, the code is generated for every kind of query on the fly, removing all indirection and dynamic dispatch. Neither of these approaches is strictly better than the other. Runtime code generation can be better when it fuses many operations together, thus fully utilizing CPU execution units and the pipeline. Vectorized query execution can be less practical, because it involves temporary vectors that must be written to the cache and read back. If the temporary data does not fit in the L2 cache, this becomes an issue. But vectorized query execution more easily utilizes the SIMD capabilities of the CPU. A [research paper](#) written by our friends shows that it is better to combine both approaches.

ClickHouse uses vectorized query execution and has limited initial support for runtime code generation

## Columns

To represent columns in memory (actually, chunks of columns), the `IColumn` interface is used. This interface provides helper methods for implementation of various relational operators. Almost all operations are immutable: they do not modify the original column, but create a new modified one. For example, the `IColumn::filter` method accepts a filter byte mask. It is used for the `WHERE` and `HAVING` relational operators. Additional examples: the `IColumn::permute` method to support `.ORDER BY`, the `IColumn::cut` method to support `LIMIT`, and so on

Various `IColumn` implementations (`ColumnUInt8`, `ColumnString` and so on) are responsible for the memory layout of columns. Memory layout is usually a contiguous array. For the integer type of columns it is just one contiguous array, like `std::vector`. For `String` and `Array` columns, it is two vectors: one for all array elements, placed contiguously, and a second one for offsets to the beginning of each array. There is also `ColumnConst` that stores just one value in memory, but looks like a column

## Field

Nevertheless, it is possible to work with individual values as well. To represent an individual value, the `Field` is used. `Field` is just a discriminated union of `UInt64`, `Int64`, `Float64`, `String` and `Array`. `IColumn` has the `operator[]` method to get the `n`th value as a `Field`, and the `insert` method to append a `Field` to the end of a column. These methods are not very efficient, because they require dealing with temporary `Field` objects representing an individual value. There are more efficient methods, such as `insertFrom`, `insertRangeFrom`, and so on

`Field` doesn't have enough information about a specific data type for a table. For example, `UInt8`, `UInt16`, `UInt32`, and `UInt64` are all represented as `UInt64` in a `Field`

## Leaky Abstractions

`IColumn` has methods for common relational transformations of data, but they don't meet all needs. For example, `ColumnUInt64` doesn't have a method to calculate the sum of two columns, and `ColumnString` doesn't have a method to run a substring search. These countless routines are implemented outside of `IColumn`

Various functions on columns can be implemented in a generic, non-efficient way using `IColumn` methods to extract `Field` values, or in a specialized way using knowledge of inner memory layout of data in a specific `IColumn` implementation. To do this, functions are cast to a specific `IColumn` type and deal with internal representation directly. For example,

`ColumnUInt64` has the `getData` method that returns a reference to an internal array, then a separate routine reads or fills that array directly. In fact, we have "leaky abstractions" to allow efficient specializations of various routines

## Data Types

`IDataType` is responsible for serialization and deserialization: for reading and writing chunks of columns or individual values in binary or text form. `IDataType` directly corresponds to data types in tables. For example, there are `DataTypeUInt32`, `DataTypeDateTime`, `DataTypeString` and so on

`IDataType` and `IColumn` are only loosely related to each other. Different data types can be represented in memory by the same `IColumn` implementations. For example, `DataTypeUInt32` and `DataTypeDateTime` are both represented by `ColumnUInt32` or `ColumnConstUInt32`. In addition, the same data type can be represented by different `IColumn` implementations. For example, `DataTypeUInt8` can be represented by `ColumnUInt8` or `ColumnConstUInt8`

`IDataType` only stores metadata. For instance, `DataTypeUInt8` doesn't store anything at all (except vptr) and `( DataTypeFixedString` stores just `N` (the size of fixed-size strings

`IDataType` has helper methods for various data formats. Examples are methods to serialize a value with possible quoting, to serialize a value for JSON, and to serialize a value as part of XML format. There is no direct correspondence to data formats. For example, the different data formats `Pretty` and `TabSeparated` can use the same `serializeTextEscaped` helper method from the `IDataType` interface

## Block

A `Block` is a container that represents a subset (chunk) of a table in memory. It is just a set of triples (`IColumn`, `IDataType`, column name). During query execution, data is processed by `Block`s. If we have a `Block`, we have data (in the `IColumn` object), we have information about its type (in `IDataType`) that tells us how to deal with that column, and we have the column name (either the original column name from the table, or some artificial name assigned for getting temporary results of calculations

When we calculate some function over columns in a block, we add another column with its result to the block, and we don't touch columns for arguments of the function because operations are immutable. Later, unneeded columns can be removed from the block, but not modified. This is convenient for elimination of common subexpressions

Blocks are created for every processed chunk of data. Note that for the same type of calculation, the column names and types remain the same for different blocks, and only column data changes. It is better to split block data from the block header, because small block sizes will have a high overhead of temporary strings for copying `shared_ptrs` and column names

## Block Streams

Block streams are for processing data. We use streams of blocks to read data from somewhere, perform data transformations, or write data to somewhere. `IBlockInputStream` has the `read` method to fetch the next block while available. `IBlockOutputStream` has the `write` method to push the block somewhere

:Streams are responsible for

.Reading or writing to a table. The table just returns a stream for reading or writing blocks .1

Implementing data formats. For example, if you want to output data to a terminal in `Pretty` format, you create a block .2 output stream where you push blocks, and it formats them

Performing data transformations. Let's say you have `IBlockInputStream` and want to create a filtered stream. You .3 create `FilterBlockInputStream` and initialize it with your stream. Then when you pull a block from `FilterBlockInputStream`, it pulls a block from your stream, filters it, and returns the filtered block to you. Query execution pipelines are represented this way

There are more sophisticated transformations. For example, when you pull from `AggregatingBlockInputStream`, it reads all data from its source, aggregates it, and then returns a stream of aggregated data for you. Another example: `UnionBlockInputStream` accepts many input sources in the constructor and also a number of threads. It launches multiple threads and reads from multiple sources in parallel.

Block streams use the "pull" approach to control flow: when you pull a block from the first stream, it consequently pulls the required blocks from nested streams, and the entire execution pipeline will work. Neither "pull" nor "push" is the best solution, because control flow is implicit, and that limits implementation of various features like simultaneous execution of multiple queries (merging many pipelines together). This limitation could be overcome with coroutines or just running extra threads that wait for each other. We may have more possibilities if we make control flow explicit: if we locate the logic for passing data from one calculation unit to another outside of those calculation units. Read this [article](#) for more thoughts.

We should note that the query execution pipeline creates temporary data at each step. We try to keep block size small enough so that temporary data fits in the CPU cache. With that assumption, writing and reading temporary data is almost free in comparison with other calculations. We could consider an alternative, which is to fuse many operations in the pipeline together, to make the pipeline as short as possible and remove much of the temporary data. This could be an advantage, but it also has drawbacks. For example, a split pipeline makes it easy to implement caching intermediate data, stealing intermediate data from similar queries running at the same time, and merging pipelines for similar queries.

## Formats

Data formats are implemented with block streams. There are "presentational" formats only suitable for output of data to the client, such as `Pretty` format, which provides only `IBlockOutputStream`. And there are input/output formats, such as `TabSeparated` or `JSONEachRow`.

There are also row streams: `IRowInputStream` and `IRowOutputStream`. They allow you to pull/push data by individual rows, not by blocks. And they are only needed to simplify implementation of row-oriented formats. The wrappers `BlockInputStreamFromRowInputStream` and `BlockOutputStreamFromRowOutputStream` allow you to convert row-oriented streams to regular block-oriented streams.

## I/O

For byte-oriented input/output, there are `ReadBuffer` and `WriteBuffer` abstract classes. They are used instead of C++ `iostream`s. Don't worry: every mature C++ project is using something other than `iostream`s for good reasons.

`ReadBuffer` and `WriteBuffer` are just a contiguous buffer and a cursor pointing to the position in that buffer. Implementations may own or not own the memory for the buffer. There is a virtual method to fill the buffer with the following data (for `ReadBuffer`) or to flush the buffer somewhere (for `WriteBuffer`). The virtual methods are rarely called.

Implementations of `ReadBuffer` / `WriteBuffer` are used for working with files and file descriptors and network sockets, for implementing compression (`CompressedWriteBuffer` is initialized with another `WriteBuffer` and performs compression before writing data to it), and for other purposes – the names `ConcatReadBuffer`, `LimitReadBuffer`, and `HashingWriteBuffer` speak for themselves.

`Read/WriteBuffers` only deal with bytes. To help with formatted input/output (for instance, to write a number in decimal format), there are functions from `ReadHelpers` and `WriteHelpers` header files.

Let's look at what happens when you want to write a result set in `JSON` format to `stdout`. You have a result set ready to be fetched from `IBlockInputStream`. You create `WriteBufferFromFileDescriptor(STDOUT_FILENO)` to write bytes to `stdout`. You create `JSONRowOutputStream`, initialized with that `WriteBuffer`, to write rows in `JSON` to `stdout`. You create `BlockOutputStreamFromRowOutputStream` on top of it, to represent it as `IBlockOutputStream`. Then you call `copyData` to transfer data from `IBlockInputStream` to `IBlockOutputStream`, and everything works. Internally, `JSONRowOutputStream` will

write various JSON delimiters and call the `IDataType::serializeTextJSON` method with a reference to `IColumn` and the row number as arguments. Consequently, `IDataType::serializeTextJSON` will call a method from `WriteHelpers.h`: for example, `.writeText` for numeric types and `writeJSONString` for `DataTypeString`

## Tables

Tables are represented by the `IStorage` interface. Different implementations of that interface are different table engines. Examples are `StorageMergeTree`, `StorageMemory`, and so on. Instances of these classes are just tables

The most important `IStorage` methods are `read` and `write`. There are also `alter`, `rename`, `drop`, and so on. The `read` method accepts the following arguments: the set of columns to read from a table, the `AST` query to consider, and the desired number of streams to return. It returns one or multiple `IBlockInputStream` objects and information about the stage of data processing that was completed inside a table engine during query execution

In most cases, the `read` method is only responsible for reading the specified columns from a table, not for any further data processing. All further data processing is done by the query interpreter and is outside the responsibility of `IStorage`

:But there are notable exceptions

The `AST` query is passed to the `read` method and the table engine can use it to derive index usage and to read less data from a table

Sometimes the table engine can process data itself to a specific stage. For example, `StorageDistributed` can send a query to remote servers, ask them to process data to a stage where data from different remote servers can be merged, and return that preprocessed data. The query interpreter then finishes processing the data

The table's `read` method can return multiple `IBlockInputStream` objects to allow parallel data processing. These multiple block input streams can read from a table in parallel. Then you can wrap these streams with various transformations (such as expression evaluation or filtering) that can be calculated independently and create a `UnionBlockInputStream` on top of them, to read from multiple streams in parallel

There are also `TableFunction`s. These are functions that return a temporary `IStorage` object to use in the `FROM` clause of a query

To get a quick idea of how to implement your own table engine, look at something simple, like `StorageMemory` or `StorageTinyLog`

As the result of the `read` method, `IStorage` returns `QueryProcessingStage` – information about what parts of the query were already calculated inside storage. Currently we have only very coarse granularity for that information. There is no way for the storage to say "I have already processed this part of the expression in WHERE, for this range of data". We need to work on that

## Parsers

A query is parsed by a hand-written recursive descent parser. For example, `ParserSelectQuery` just recursively calls the underlying parsers for various parts of the query. Parsers create an `AST`. The `AST` is represented by nodes, which are instances of `IAST`

.Parser generators are not used for historical reasons

## Interpreters

Interpreters are responsible for creating the query execution pipeline from an `AST`. There are simple interpreters, such as `InterpreterExistsQuery` and `InterpreterDropQuery`, or the more sophisticated `InterpreterSelectQuery`. The query execution pipeline is a combination of block input or output streams. For example, the result of interpreting the `SELECT` query is the `IBlockInputStream` to read the result set from; the result of the `INSERT` query is the `IBlockOutputStream` to write data for

insertion to; and the result of interpreting the `INSERT SELECT` query is the `IBlockInputStream` that returns an empty result .set on the first read, but that copies data from `SELECT` to `INSERT` at the same time

`InterpreterSelectQuery` uses `ExpressionAnalyzer` and `ExpressionActions` machinery for query analysis and transformations. This is where most rule-based query optimizations are done. `ExpressionAnalyzer` is quite messy and should be rewritten: various query transformations and optimizations should be extracted to separate classes to allow modular transformations .or query

## Functions

.There are ordinary functions and aggregate functions. For aggregate functions, see the next section

Ordinary functions don't change the number of rows – they work as if they are processing each row independently. In fact, .functions are not called for individual rows, but for `Block`'s of data to implement vectorized query execution

There are some miscellaneous functions, like `blockSize`, `rowNumberInBlock`, and `runningAccumulate`, that exploit block .processing and violate the independence of rows

ClickHouse has strong typing, so implicit type conversion doesn't occur. If a function doesn't support a specific combination of types, an exception will be thrown. But functions can work (be overloaded) for many different combinations of types. For example, the `plus` function (to implement the `+` operator) works for any combination of numeric types: `UInt8` + `Float32` , `UInt16` + `Int8` , and so on. Also, some variadic functions can accept any number of arguments, such as the .`concat` function

Implementing a function may be slightly inconvenient because a function explicitly dispatches supported data types and supported `IColumns` . For example, the `plus` function has code generated by instantiation of a C++ template for each .combination of numeric types, and for constant or non-constant left and right arguments

This is a nice place to implement runtime code generation to avoid template code bloat. Also, it will make it possible to .add fused functions like fused multiply-add, or to make multiple comparisons in one loop iteration

Due to vectorized query execution, functions are not short-circuit. For example, if you write `WHERE f(x) AND g(y)` , both sides will be calculated, even for rows, when `f(x)` is zero (except when `f(x)` is a zero constant expression). But if selectivity of the `f(x)` condition is high, and calculation of `f(x)` is much cheaper than `g(y)` , it's better to implement multi-pass calculation: first calculate `f(x)` , then filter columns by the result, and then calculate `g(y)` only for smaller, filtered .chunks of data

## Aggregate Functions

Aggregate functions are stateful functions. They accumulate passed values into some state, and allow you to get results from that state. They are managed with the `IAggregateFunction` interface. States can be rather simple (the state for `AggregateFunctionCount` is just a single `UInt64` value) or quite complex (the state of `AggregateFunctionUniqCombined` is a .combination of a linear array, a hash table and a `HyperLogLog` probabilistic data structure

To deal with multiple states while executing a high-cardinality `GROUP BY` query, states are allocated in `Arena` (a memory pool), or they could be allocated in any suitable piece of memory. States can have a non-trivial constructor and destructor: for example, complex aggregation states can allocate additional memory themselves. This requires some attention to .creating and destroying states and properly passing their ownership, to keep track of who and when will destroy states

Aggregation states can be serialized and deserialized to pass over the network during distributed query execution or to write them on disk where there is not enough RAM. They can even be stored in a table with the `DataTypeAggregateFunction` .to allow incremental aggregation of data

The serialized data format for aggregate function states is not versioned right now. This is ok if aggregate states are only stored temporarily. But we have the `AggregatingMergeTree` table engine for incremental aggregation, and people are

already using it in production. This is why we should add support for backward compatibility when changing the .serialized format for any aggregate function in the future

## Server

:The server implements several different interfaces

.An HTTP interface for any foreign clients •

A TCP interface for the native ClickHouse client and for cross-server communication during distributed query • .execution

.An interface for transferring data for replication •

Internally, it is just a basic multithreaded server without coroutines, fibers, etc. Since the server is not designed to process a high rate of simple queries but is intended to process a relatively low rate of complex queries, each of them can process .a vast amount of data for analytics

The server initializes the `Context` class with the necessary environment for query execution: the list of available databases, users and access rights, settings, clusters, the process list, the query log, and so on. This environment is used .by interpreters

We maintain full backward and forward compatibility for the server TCP protocol: old clients can talk to new servers and new clients can talk to old servers. But we don't want to maintain it eternally, and we are removing support for old versions .after about one year

For all external applications, we recommend using the HTTP interface because it is simple and easy to use. The TCP protocol is more tightly linked to internal data structures: it uses an internal format for passing blocks of data and it uses custom framing for compressed data. We haven't released a C library for that protocol because it requires linking most .of the ClickHouse codebase, which is not practical

## Distributed Query Execution

Servers in a cluster setup are mostly independent. You can create a `Distributed` table on one or all servers in a cluster. The `Distributed` table does not store data itself – it only provides a "view" to all local tables on multiple nodes of a cluster.

When you `SELECT` from a `Distributed` table, it rewrites that query, chooses remote nodes according to load balancing settings, and sends the query to them. The `Distributed` table requests remote servers to process a query just up to a stage where intermediate results from different servers can be merged. Then it receives the intermediate results and merges them. The distributed table tries to distribute as much work as possible to remote servers, and does not send much .intermediate data over the network

Things become more complicated when you have subqueries in IN or JOIN clauses and each of them uses a .`Distributed` table. We have different strategies for execution of these queries

There is no global query plan for distributed query execution. Each node has its own local query plan for its part of the job. We only have simple one-pass distributed query execution: we send queries for remote nodes and then merge the results.

But this is not feasible for difficult queries with high cardinality GROUP BYs or with a large amount of temporary data for JOIN: in such cases, we need to "reshuffle" data between servers, which requires additional coordination. ClickHouse .does not support that kind of query execution, and we need to work on it

## Merge Tree

`MergeTree` is a family of storage engines that supports indexing by primary key. The primary key can be an arbitrary tuple of columns or expressions. Data in a `MergeTree` table is stored in "parts". Each part stores data in the primary key order (data is ordered lexicographically by the primary key tuple). All the table columns are stored in separate `column.bin` files in these parts. The files consist of compressed blocks. Each block is usually from 64 KB to 1 MB of uncompressed data,

depending on the average value size. The blocks consist of column values placed contiguously one after the other. Column values are in the same order for each column (the order is defined by the primary key), so when you iterate by many columns, you get values for the corresponding rows

The primary key itself is "sparse". It doesn't address each single row, but only some ranges of data. A separate `primary.idx` file has the value of the primary key for each N-th row, where N is called `index_granularity` (usually, N = 8192). Also, for each column, we have `column.mrk` files with "marks," which are offsets to each N-th row in the data file. Each mark is a pair: the offset in the file to the beginning of the compressed block, and the offset in the decompressed block to the beginning of data. Usually compressed blocks are aligned by marks, and the offset in the decompressed block is zero.

.Data for `primary.idx` always resides in memory and data for `column.mrk` files is cached

When we are going to read something from a part in `MergeTree`, we look at `primary.idx` data and locate ranges that could possibly contain requested data, then look at `column.mrk` data and calculate offsets for where to start reading those ranges. Because of sparseness, excess data may be read. ClickHouse is not suitable for a high load of simple point queries, because the entire range with `index_granularity` rows must be read for each key, and the entire compressed block must be decompressed for each column. We made the index sparse because we must be able to maintain trillions of rows per single server without noticeable memory consumption for the index. Also, because the primary key is sparse, it is not unique: it cannot check the existence of the key in the table at `INSERT` time. You could have many rows with the same .key in a table

When you `INSERT` a bunch of data into `MergeTree`, that bunch is sorted by primary key order and forms a new part. To keep the number of parts relatively low, there are background threads that periodically select some parts and merge them to a single sorted part. That's why it is called `MergeTree`. Of course, merging leads to "write amplification". All parts are immutable: they are only created and deleted, but not modified. When `SELECT` is run, it holds a snapshot of the table (a set of parts). After merging, we also keep old parts for some time to make recovery after failure easier, so if we see that .some merged part is probably broken, we can replace it with its source parts

`MergeTree` is not an LSM tree because it doesn't contain "memtable" and "log": inserted data is written directly to the filesystem. This makes it suitable only to `INSERT` data in batches, not by individual row and not very frequently – about once per second is ok, but a thousand times a second is not. We did it this way for simplicity's sake, and because we are .already inserting data in batches in our applications

`MergeTree` tables can only have one (primary) index: there aren't any secondary indices. It would be nice to allow multiple physical representations under one logical table, for example, to store data in more than one physical order or .even to allow representations with pre-aggregated data along with original data

There are `MergeTree` engines that are doing additional work during background merges. Examples are `CollapsingMergeTree` and `AggregatingMergeTree`. This could be treated as special support for updates. Keep in mind that these are not real updates because users usually have no control over the time when background merges will be .executed, and data in a `MergeTree` table is almost always stored in more than one part, not in completely merged form

## Replication

Replication in ClickHouse is implemented on a per-table basis. You could have some replicated and some non-replicated tables on the same server. You could also have tables replicated in different ways, such as one table with two-factor .replication and another with three-factor

Replication is implemented in the `ReplicatedMergeTree` storage engine. The path in `ZooKeeper` is specified as a parameter for the storage engine. All tables with the same path in `ZooKeeper` become replicas of each other: they synchronize their .data and maintain consistency. Replicas can be added and removed dynamically simply by creating or dropping a table

Replication uses an asynchronous multi-master scheme. You can insert data into any replica that has a session with `ZooKeeper`, and data is replicated to all other replicas asynchronously. Because ClickHouse doesn't support `UPDATE`s, replication is conflict-free. As there is no quorum acknowledgment of inserts, just-inserted data might be lost if one node .fails

Metadata for replication is stored in ZooKeeper. There is a replication log that lists what actions to do. Actions are: get part; merge parts; drop partition, etc. Each replica copies the replication log to its queue and then executes the actions from the queue. For example, on insertion, the "get part" action is created in the log, and every replica downloads that part. Merges are coordinated between replicas to get byte-identical results. All parts are merged in the same way on all replicas. To achieve this, one replica is elected as the leader, and that replica initiates merges and writes "merge parts" .actions to the log

Replication is physical: only compressed parts are transferred between nodes, not queries. To lower the network cost (to avoid network amplification), merges are processed on each replica independently in most cases. Large merged parts are .sent over the network only in cases of significant replication lag

In addition, each replica stores its state in ZooKeeper as the set of parts and its checksums. When the state on the local filesystem diverges from the reference state in ZooKeeper, the replica restores its consistency by downloading missing and broken parts from other replicas. When there is some unexpected or broken data in the local filesystem, ClickHouse .does not remove it, but moves it to a separate directory and forgets it

The ClickHouse cluster consists of independent shards, and each shard consists of replicas. The cluster is not elastic, so after adding a new shard, data is not rebalanced between shards automatically. Instead, the cluster load will be uneven. This implementation gives you more control, and it is fine for relatively small clusters such as tens of nodes. But for clusters with hundreds of nodes that we are using in production, this approach becomes a significant drawback. We should implement a table engine that will span its data across the cluster with dynamically replicated regions that .could be split and balanced between clusters automatically

## How to Build ClickHouse Release Package

### Install Git and Pbuilder

```
$ sudo apt-get update
$ sudo apt-get install git pbuilder debhelper lsb-release fakeroot sudo debian-archive-keyring debian-keyring
```

### Checkout ClickHouse Sources

```
$ git clone --recursive --branch master https://github.com/ClickHouse/ClickHouse.git
$ cd ClickHouse
```

### Run Release Script

```
$./release
```

## How to Build ClickHouse for Development

The following tutorial is based on the Ubuntu Linux system. With appropriate changes, it should also work on any other .Linux distribution. Supported platforms: x86\_64 and AArch64. Support for Power9 is experimental

### Install Git, CMake and Ninja

```
$ sudo apt-get install git cmake ninja-build
```

.Or cmake3 instead of cmake on older systems

## Install GCC 9

.There are several ways to do this

### Install from a PPA Package

```
$ sudo apt-get install software-properties-common
$ sudo apt-add-repository ppa:ubuntu-toolchain-r/test
$ sudo apt-get update
$ sudo apt-get install gcc-9 g++-9
```

### Install from Sources

Look at [utils/ci/build-gcc-from-sources.sh](#)

### Use GCC 9 for Builds

```
$ export CC=gcc-9
$ export CXX=g++-9
```

## Install Required Libraries from Packages

```
$ sudo apt-get install libreadline-dev
```

## Checkout ClickHouse Sources

```
$ git clone --recursive git@github.com:ClickHouse/ClickHouse.git
```

or

```
$ git clone --recursive https://github.com/ClickHouse/ClickHouse.git
$ cd ClickHouse
```

## Build ClickHouse

```
$ mkdir build
$ cd build
$ cmake ..
$ ninja
$ cd ..
```

To create an executable, run `ninja clickhouse` . This will create the `dbms/programs clickhouse` executable, which can be used .with `client` or `server` arguments

## How to Build ClickHouse on Mac OS X

.Build should work on Mac OS X 10.12

### Install Homebrew

```
$ /usr/bin/ruby -e "$(curl -fsSL https://raw.githubusercontent.com/Homebrew/install/master/install)"
```

## Install Required Compilers, Tools, and Libraries

```
$ brew install cmake ninja libtool gettext readline
```

## Checkout ClickHouse Sources

```
$ git clone --recursive git@github.com:yandex/ClickHouse.git
```

or

```
$ git clone --recursive https://github.com/yandex/ClickHouse.git
```

```
$ cd ClickHouse
```

.For the latest stable version, switch to the stable branch

## Build ClickHouse

```
$ mkdir build
$ cd build
$ cmake .. -DCMAKE_CXX_COMPILER=`which clang++` -DCMAKE_C_COMPILER=`which clang`
$ ninja
$ cd ..
```

## Caveats

.If you intend to run clickhouse-server, make sure to increase the system's maxfiles variable

Note 

.You'll need to use sudo

:To do so, create the following file

:Library/LaunchDaemons/limit.maxfiles.plist/

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC "-//Apple//DTD PLIST 1.0//EN"
 "http://www.apple.com/DTDs/PropertyList-1.0.dtd">
<plist version="1.0">
 <dict>
 <key>Label</key>
 <string>limit.maxfiles</string>
 <key>ProgramArguments</key>
 <array>
 <string>launchctl</string>
 <string>limit</string>
 <string>maxfiles</string>
 <string>524288</string>
 <string>524288</string>
 </array>
 <key>RunAtLoad</key>
 <true/>
 <key>ServiceIPC</key>
 <false/>
 </dict>
</plist>
```

:Execute the following command

```
$ sudo chown root:wheel /Library/LaunchDaemons/limit.maxfiles.plist
```

.Reboot

.To check if it's working, you can use `ulimit -n` command

## How to Write C++ Code

### General Recommendations

.The following are recommendations, not requirements .1

.If you are editing code, it makes sense to follow the formatting of the existing code .2

Code style is needed for consistency. Consistency makes it easier to read the code, and it also makes it easier to .3  
.search the code

.Many of the rules do not have logical reasons; they are dictated by established practices .4

### Formatting

.Most of the formatting will be done automatically by `clang-format` .1

.Indents are 4 spaces. Configure your development environment so that a tab adds four spaces .2

.Opening and closing curly brackets must be on a separate line .3

```
inline void readBoolText(bool & x, ReadBuffer & buf)
{
 char tmp = '0';
 readChar(tmp, buf);
 x = tmp != '0';
}
```

If the entire function body is a single `statement`, it can be placed on a single line. Place spaces around curly braces .4  
.((besides the space at the end of the line

```
inline size_t mask() const { return buf_size() - 1; }
inline size_t place(HashValue x) const { return x & mask(); }
```

.For functions. Don't put spaces around brackets .5

```
void reinsert(const Value & x)
```

```
memcpy(&buf[place_value], &x, sizeof(x));
```

In `if`, `for`, `while` and other expressions, a space is inserted in front of the opening bracket (as opposed to function .6  
.calls

```
for (size_t i = 0; i < rows; i += storage.index_granularity)
```

.?: Add spaces around binary operators (+, -, \*, /, %, ...) and the ternary operator .7

```
UInt16 year = (s[0] - '0') * 1000 + (s[1] - '0') * 100 + (s[2] - '0') * 10 + (s[3] - '0');
UInt8 month = (s[5] - '0') * 10 + (s[6] - '0');
UInt8 day = (s[8] - '0') * 10 + (s[9] - '0');
```

.If a line feed is entered, put the operator on a new line and increase the indent before it .8

```
if (elapsed_ns)
 message << " ("
 << rows_read_on_server * 1000000000 / elapsed_ns << " rows/s., "
 << bytes_read_on_server * 1000.0 / elapsed_ns << " MB/s.) ";
```

.You can use spaces for alignment within a line, if desired .9

```
dst.ClickLogID = click.LogID;
dst.ClickEventID = click.EventID;
dst.ClickGoodEvent = click.GoodEvent;
```

.`<- ,` Don't use spaces around the operators .10

.If necessary, the operator can be wrapped to the next line. In this case, the offset in front of it is increased

.Do not use a space to separate unary operators (`-`, `++`, `*`, `&`, ...) from the argument .11

.Put a space after a comma, but not before it. The same rule goes for a semicolon inside a `for` expression .12

.Do not use spaces to separate the `[]` operator .13

.`<` In a `template<...>` expression, use a space between `template` and `<`; no spaces after `<` or before .14

```
template <typename TKey, typename TValue>
struct AggregatedStatElement
{}
```

In classes and structures, write `public`, `private`, and `protected` on the same level as `class/struct`, and indent the rest of .15  
.the code

```
template <typename T>
class MultiVersion
{
public:
 /// Version of object for usage. shared_ptr manage lifetime of version.
 using Version = std::shared_ptr<const T>;
 ...
}
```

If the same `namespace` is used for the entire file, and there isn't anything else significant, an offset is not necessary .16  
.inside `namespace`

If the block for an `if`, `for`, `while`, or other expression consists of a single statement, the curly brackets are optional .17  
... ,Place the `statement` on a separate line, instead. This rule is also valid for nested `if`, `for`, `while`

.But if the inner `statement` contains curly brackets or `else`, the external block should be written in curly brackets

```
/// Finish write.
for (auto & stream : streams)
 stream.second->finalize();
```

.There shouldn't be any spaces at the ends of lines .18

.Source files are UTF-8 encoded .19

.Non-ASCII characters can be used in string literals .20

```
<< ", " << (timer.elapsed() / chunks_stats.hits) << " usec/hit.";
```

.Do not write multiple expressions in a single line .21

.Group sections of code inside functions and separate them with no more than one empty line .22

.Separate functions, classes, and so on with one or two empty lines .23

. A `const` (related to a value) must be written before the type name .24

```
//correct
const char * pos
const std::string & s
//incorrect
char const * pos
```

.When declaring a pointer or reference, the `*` and `&` symbols should be separated by spaces on both sides .25

```
//correct
const char * pos
//incorrect
const char* pos
const char *pos
```

.(When using template types, alias them with the `using` keyword (except in the simplest cases .26

.In other words, the template parameters are specified only in `using` and aren't repeated in the code

. `using` can be declared locally, such as inside a function

```
//correct
using FileStreams = std::map<std::string, std::shared_ptr<Stream>>;
FileStreams streams;
//incorrect
std::map<std::string, std::shared_ptr<Stream>> streams;
```

.Do not declare several variables of different types in one statement .27

```
//incorrect
int x, *y;
```

.Do not use C-style casts .28

```
//incorrect
std::cerr << (int)c << std::endl;
//correct
std::cerr << static_cast<int>(c) << std::endl;
```

.In classes and structs, group members and functions separately inside each visibility scope .29

.For small classes and structs, it is not necessary to separate the method declaration from the implementation .30

.The same is true for small methods in any classes or structs

For templated classes and structs, don't separate the method declarations from the implementation (because otherwise  
.they must be defined in the same translation unit

.You can wrap lines at 140 characters, instead of 80 .31

.Always use the prefix increment/decrement operators if postfix is not required .32

```
for (Names::const_iterator it = column_names.begin(); it != column_names.end(); ++it)
```

## Comments

.Be sure to add comments for all non-trivial parts of code .1

This is very important. Writing the comment might help you realize that the code isn't necessary, or that it is designed  
.wrong

```
/** Part of piece of memory, that can be used.
 * For example, if internal_buffer is 1MB, and there was only 10 bytes loaded to buffer from file for
reading,
 * then working_buffer will have size of only 10 bytes
 * (working_buffer.end() will point to position right after those 10 bytes available for read).
 */
```

.Comments can be as detailed as necessary .2

.Place comments before the code they describe. In rare cases, comments can come after the code, on the same line .3

```
/** Parses and executes the query.
 */
void executeQuery(
 ReadBuffer & istr, /// Where to read the query from (and data for INSERT, if applicable)
 WriteBuffer & ostr, /// Where to write the result
 Context & context, /// DB, tables, data types, engines, functions, aggregate functions...
 BlockInputStreamPtr & query_plan, /// Here could be written the description on how query was executed
 QueryProcessingStage::Enum stage = QueryProcessingStage::Complete /// Up to which stage process the
SELECT query
)
```

.Comments should be written in English only .4

.If you are writing a library, include detailed comments explaining it in the main header file .5

:Do not add comments that do not provide additional information. In particular, do not leave empty comments like this .6

```
/*
 * Procedure Name:
 * Original procedure name:
 * Author:
 * Date of creation:
 * Dates of modification:
 * Modification authors:
 * Original file name:
 * Purpose:
 * Intent:
 * Designation:
 * Classes used:
 * Constants:
 * Local variables:
 * Parameters:
 * Date of creation:
 * Purpose:
 */
```

./The example is borrowed from the resource <http://home.tamk.fi/~jaalto/course/coding-style/doc/unmaintainable-code>

.Do not write garbage comments (author, creation date ..) at the beginning of each file .7

Single-line comments begin with three slashes: /// and multi-line comments begin with /\*\* . These comments are .8  
.considered "documentation

Note: You can use Doxygen to generate documentation from these comments. But Doxygen is not generally used  
.because it is more convenient to navigate the code in the IDE

Multi-line comments must not have empty lines at the beginning and end (except the line that closes a multi-line) .9  
.comment

.For commenting out code, use basic comments, not “documenting” comments .10

.Delete the commented out parts of the code before committing .11

.Do not use profanity in comments or code .12

.Do not use uppercase letters. Do not use excessive punctuation .13

```
/// WHAT THE FAIL???
```

.Do not use comments to make delimiters .14

```
//
```

.Do not start discussions in comments .15

```
/// Why did you do this stuff?
```

.There's no need to write a comment at the end of a block describing what it was about .16

```
/// for
```

## Names

.Use lowercase letters with underscores in the names of variables and class members .1

```
size_t max_block_size;
```

.For the names of functions (methods), use camelCase beginning with a lowercase letter .2

```
std::string getName() const override { return "Memory"; }
```

For the names of classes (structs), use CamelCase beginning with an uppercase letter. Prefixes other than I are not .3  
.used for interfaces

```
class StorageMemory : public IStorage
```

. using are named the same way as classes, or with \_t on the end .4

.Names of template type arguments: in simple cases, use T ; T , U ; T1 , T2 .5

.For more complex cases, either follow the rules for class names, or add the prefix T

```
template <typename TKey, typename TValue>
struct AggregatedStatElement
```

.Names of template constant arguments: either follow the rules for variable names, or use N in simple cases .6

```
template <bool without_www>
struct ExtractDomain
```

.For abstract classes (interfaces) you can add the I prefix .7

```
class IBlockInputStream
```

.If you use a variable locally, you can use the short name .8

.In all other cases, use a name that describes the meaning

```
bool info_successfully_loaded = false;
```

.Names of `defines` and global constants use ALL\_CAPS with underscores .9

```
##define MAX_SRC_TABLE_NAMES_TO_STORE 1000
```

.File names should use the same style as their contents .10

.(If a file contains a single class, name the file the same way as the class (CamelCase

.(If the file contains a single function, name the file the same way as the function (camelCase

:If the name contains an abbreviation, then .11

.(For variable names, the abbreviation should use lowercase letters `mysql_connection` (not `mySQL_connection` •

For names of classes and functions, keep the uppercase letters in the abbreviation `MySQLConnection` (not •

.( `MySqlConnection`

Constructor arguments that are used just to initialize the class members should be named the same way as the class .12

.members, but with an underscore at the end

```
FileQueueProcessor(
 const std::string & path_,
 const std::string & prefix_,
 std::shared_ptr<FileHandler> handler_)
: path(path_),
prefix(prefix_),
handler(handler_),
log(&Logger::get("FileQueueProcessor"))
{
}
```

.The underscore suffix can be omitted if the argument is not used in the constructor body

.(There is no difference in the names of local variables and class members (no prefixes required .13

```
timer (not m_timer)
```

For the constants in an `enum`, use CamelCase with a capital letter. ALL\_CAPS is also acceptable. If the `enum` is non-.14

.local, use an `enum class`

```
enum class CompressionMethod
{
 QuickLZ = 0,
 LZ4 = 1,
};
```

.All names must be in English. Transliteration of Russian words is not allowed .15

```
not Stroka
```

Abbreviations are acceptable if they are well known (when you can easily find the meaning of the abbreviation in .16

.(Wikipedia or in a search engine

```
`AST`, `SQL`.
Not `NVDH` (some random letters)
```

.Incomplete words are acceptable if the shortened version is common use

.You can also use an abbreviation if the full name is included next to it in the comments

.File names with C++ source code must have the .cpp extension. Header files must have the .h extension .17

## How to Write Code

.Memory management .1

.Manual memory deallocation (`delete`) can only be used in library code

.In library code, the `delete` operator can only be used in destructors

.In application code, memory must be freed by the object that owns it

:Examples

.The easiest way is to place an object on the stack, or make it a member of another class •

.For a large number of small objects, use containers •

.For automatic deallocation of a small number of objects that reside in the heap, use `shared_ptr/unique_ptr` •

.Resource management .2

.Use RAII and see above

.Error handling .3

.(Use exceptions. In most cases, you only need to throw an exception, and don't need to catch it (because of RAII

.In offline data processing applications, it's often acceptable to not catch exceptions

.In servers that handle user requests, it's usually enough to catch exceptions at the top level of the connection handler

.In thread functions, you should catch and keep all exceptions to rethrow them in the main thread after `join`

```
/// If there weren't any calculations yet, calculate the first block synchronously
if (!started)
{
 calculate();
 started = true;
}
else /// If calculations are already in progress, wait for the result
 pool.wait();

if (exception)
 exception->rethrow();
```

.Never hide exceptions without handling. Never just blindly put all exceptions to log

```
//Not correct
catch (...) {}
```

.If you need to ignore some exceptions, do so only for specific ones and rethrow the rest

```

catch (const DB::Exception & e)
{
 if (e.code() == ErrorCodes::UNKNOWN_AGGREGATE_FUNCTION)
 return nullptr;
 else
 throw;
}

```

.When using functions with response codes or `errno` , always check the result and throw an exception in case of error

```

if (0 != close(fd))
 throwError("Cannot close file " + file_name, ErrorCodes::CANNOT_CLOSE_FILE);

```

. Do not use assert

.Exception types .4

There is no need to use complex exception hierarchy in application code. The exception text should be understandable to  
a system administrator

.Throwing exceptions from destructors .5

.This is not recommended, but it is allowed

:Use the following options

Create a function (`done()` or `finalize()` ) that will do all the work in advance that might lead to an exception. If that •  
.function was called, there should be no exceptions in the destructor later

Tasks that are too complex (such as sending messages over the network) can be put in separate method that the •  
.class user will have to call before destruction

.(If there is an exception in the destructor, it's better to log it than to hide it (if the logger is available •

In simple applications, it is acceptable to rely on `std::terminate` (for cases of `noexcept` by default in C++11) to handle •  
.exceptions

.Anonymous code blocks .6

You can create a separate code block inside a single function in order to make certain variables local, so that the  
.destructors are called when exiting the block

```

Block block = data.in->read();

{
 std::lock_guard<std::mutex> lock(mutex);
 data.ready = true;
 data.block = block;
}

ready_any.set();

```

.Multithreading .7

:In offline data processing programs

.Try to get the best possible performance on a single CPU core. You can then parallelize your code if necessary •

:In server applications

Use the thread pool to process requests. At this point, we haven't had any tasks that required userspace context •  
.switching

.Fork is not used for parallelization

.Syncing threads .8

Often it is possible to make different threads use different memory cells (even better: different cache lines,) and to not use  
.any thread synchronization (except joinAll

.If synchronization is required, in most cases, it is sufficient to use mutex under lock\_guard

.In other cases use system synchronization primitives. Do not use busy wait

.Atomic operations should be used only in the simplest cases

.Do not try to implement lock-free data structures unless it is your primary area of expertise

.Pointers vs references .9

.In most cases, prefer references

.const .10

.Use constant references, pointers to constants, const\_iterator , and const methods

.Consider const to be default and use non-const only when necessary

.When passing variables by value, using const usually does not make sense

.unsigned .11

.Use unsigned if necessary

.Numeric types .12

.Use the types UInt8 , UInt16 , UInt32 , UInt64 , Int8 , Int16 , Int32 , and Int64 , as well as size\_t , ssize\_t , and ptrdiff\_t

.Don't use these types for numbers: signed/unsigned long , long long , short , signed/unsigned char , char

.Passing arguments .13

.(Pass complex values by reference (including std::string

.If a function captures ownership of an object created in the heap, make the argument typeshared\_ptr or unique\_ptr

.Return values .14

. {In most cases, just use return . Do not write [return std::move(res)].strike

.If the function allocates an object on heap and returns it, use shared\_ptr or unique\_ptr

.In rare cases you might need to return the value via an argument. In this case, the argument should be a reference

```
using AggregateFunctionPtr = std::shared_ptr<IAggregateFunction>;

/** Allows creating an aggregate function by its name.
 */
class AggregateFunctionFactory
{
public:
 AggregateFunctionFactory();
 AggregateFunctionPtr get(const String & name, const DataTypes & argument_types) const;
```

.namespace .15

.There is no need to use a separate namespace for application code

.Small libraries don't need this, either

.For medium to large libraries, put everything in a namespace

.In the library's .h file, you can use `namespace detail` to hide implementation details not needed for the application code

.In a .cpp file, you can use a `static` or anonymous namespace to hide symbols

Also, a `namespace` can be used for an `enum` to prevent the corresponding names from falling into an external namespace

.((but it's better to use an `enum class`

.Deferred initialization .16

.If arguments are required for initialization, then you normally shouldn't write a default constructor

If later you'll need to delay initialization, you can add a default constructor that will create an invalid object. Or, for a small

.number of objects, you can use `shared_ptr/unique_ptr`

```
Loader(DB::Connection * connection_, const std::string & query, size_t max_block_size_);
/// For deferred initialization
Loader() {}
```

.Virtual functions .17

If the class is not intended for polymorphic use, you do not need to make functions virtual. This also applies to the  
.destructor

.Encodings .18

.Use UTF-8 everywhere. Use `std::string` and `char *`. Do not use `std::wstring` and `wchar_t`

.Logging .19

.See the examples everywhere in the code

.Before committing, delete all meaningless and debug logging, and any other types of debug output

.Logging in cycles should be avoided, even on the Trace level

.Logs must be readable at any logging level

.Logging should only be used in application code, for the most part

.Log messages must be written in English

.The log should preferably be understandable for the system administrator

.Do not use profanity in the log

.Use UTF-8 encoding in the log. In rare cases you can use non-ASCII characters in the log

.Input-output .20

.(Don't use `iostreams` in internal cycles that are critical for application performance (and never use `stringstream`

.Use the DB/IO library instead

.Date and time .21

.See the DateLUT library

.include .22

.Always use #pragma once instead of include guards

.using .23

. using namespace is not used. You can use using with something specific. But make it local inside a class or function

.Do not use trailing return type for functions unless necessary .24

```
[auto f() -> void;]{.strike}
```

.Declaration and initialization of variables .25

```
//right way
std::string s = "Hello";
std::string s{"Hello"};
```

```
//wrong way
auto s = std::string{"Hello"};
```

.For virtual functions, write virtual in the base class, but write override instead of virtual in descendent classes .26

## ++Unused Features of C

.Virtual inheritance is not used .1

.Exception specifiers from C++03 are not used .2

## Platform

.We write code for a specific platform .1

.But other things being equal, cross-platform or portable code is preferred

.Language: C++17 .2

Compiler: gcc . At this time (December 2017), the code is compiled using version 7.2. (It can also be compiled using .3  
. clang 4

.( ++The standard library is used ( libstdc++ or libc

.OS: Linux Ubuntu, not older than Precise .4

.Code is written for x86\_64 CPU architecture .5

.The CPU instruction set is the minimum supported set among our servers. Currently, it is SSE 4.2

.Use -Wall -Wextra -Werror compilation flags .6

Use static linking with all libraries except those that are difficult to connect to statically (see the output of the ldd .7  
.command

.Code is developed and debugged with release settings .8

## Tools

.KDevelop is a good IDE .1

.For debugging, use `gdb`, `valgrind` (`memcheck`), `strace`, `-fsanitize=...`, or `tcmalloc_minimal_debug` .2

.For profiling, use `Linux Perf`, `valgrind` (`callgrind`), or `strace -cF` .3

.Sources are in Git .4

.Assembly uses `CMake` .5

.Programs are released using `deb` packages .6

.Commits to master must not break the build .7

.Though only selected revisions are considered workable

.Make commits as often as possible, even if the code is only partially ready .8

.Use branches for this purpose

If your code in the `master` branch is not buildable yet, exclude it from the build before the push . You'll need to finish it or  
.remove it within a few days

.For non-trivial changes, use branches and publish them on the server .9

.Unused code is removed from the repository .10

## Libraries

.The C++14 standard library is used (experimental extensions are allowed), as well as `boost` and `Poco` frameworks .1

.If necessary, you can use any well-known libraries available in the OS package .2

.If there is a good solution already available, then use it, even if it means you have to install another library  
(.But be prepared to remove bad libraries from code)

You can install a library that isn't in the packages, if the packages don't have what you need or have an outdated .3  
.version or the wrong type of compilation

.If the library is small and doesn't have its own complex build system, put the source files in the `contrib` folder .4

.Preference is always given to libraries that are already in use .5

## General Recommendations

.Write as little code as possible .1

.Try the simplest solution .2

.Don't write code until you know how it's going to work and how the inner loop will function .3

.In the simplest cases, use `using` instead of classes or structs .4

If possible, do not write copy constructors, assignment operators, destructors (other than a virtual one, if the class .5 contains at least one virtual function), move constructors or move assignment operators. In other words, the compiler-generated functions must work correctly. You can use `default`

.Code simplification is encouraged. Reduce the size of your code where possible .6

## Additional Recommendations

Explicitly specifying `std::` for types from `stddef.h` .1

.is not recommended. In other words, we recommend writing `size_t` instead `std::size_t`, because it's shorter

. ::It is acceptable to add `std`

Explicitly specifying `std::` for functions from the standard C library .2

.is not recommended. In other words, write `memcpy` instead of `std::memcpy`

The reason is that there are similar non-standard functions, such as `memmem` . We do use these functions on occasion.

.These functions do not exist in `namespace std`

.If you write `std::memcpy` instead of `memcpy` everywhere, then `memmem` without `std::` will look strange

.Nevertheless, you can still use `std::` if you prefer it

.Using functions from C when the same ones are available in the standard C++ library .3

.This is acceptable if it is more efficient

.For example, use `memcpy` instead of `std::copy` for copying large chunks of memory

.Multiline function arguments .4

:Any of the following wrapping styles are allowed

```
function(
 T1 x1,
 T2 x2)
```

```
function(
 size_t left, size_t right,
 const & RangesInDataParts ranges,
 size_t limit)
```

```
function(size_t left, size_t right,
 const & RangesInDataParts ranges,
 size_t limit)
```

```
function(size_t left, size_t right,
 const & RangesInDataParts ranges,
 size_t limit)
```

```
function(
 size_t left,
 size_t right,
 const & RangesInDataParts ranges,
 size_t limit)
```

## ClickHouse Testing

### Functional Tests

Functional tests are the most simple and convenient to use. Most of ClickHouse features can be tested with functional .tests and they are mandatory to use for every change in ClickHouse code that can be tested that way

Each functional test sends one or multiple queries to the running ClickHouse server and compares the result with .reference

Tests are located in dbms/tests/queries directory. There are two subdirectories: stateless and stateful . Stateless tests run queries without any preloaded test data - they often create small synthetic datasets on the fly, within the test itself. Stateful tests require preloaded test data from Yandex.Metrica and not available to general public. We tend to use only . stateless tests and avoid adding new stateful tests

Each test can be one of two types: .sql and .sh . .sql test is the simple SQL script that is piped to clickhouse-client --multiquery --testmode . .sh test is a script that is run by itself

To run all tests, use dbms/tests/clickhouse-test tool. Look --help for the list of possible options. You can simply run all tests .or run subset of tests filtered by substring in test name: ./clickhouse-test substring

The most simple way to invoke functional tests is to copy clickhouse-client to /usr/bin/ , run clickhouse-server and then run . ./clickhouse-test from its own directory

To add new test, create a .sql or .sh file in dbms/tests/queries/0\_stateless directory, check it manually and then generate .reference file in the following way: clickhouse-client -n --testmode < 00000\_test.sql > 00000\_test.reference or ./00000\_test.sh > ./00000\_test.reference

Tests should use (create, drop, etc) only tables in test database that is assumed to be created beforehand; also tests can .use temporary tables

If you want to use distributed queries in functional tests, you can leverage remote table function with 127.0.0.{1..2} addresses for the server to query itself; or you can use predefined test clusters in server configuration file like . test\_shard\_localhost

Some tests are marked with zookeeper , shard or long in their names. zookeeper is for tests that are using ZooKeeper. shard is for tests that requires server to listen 127.0.0.\* ; distributed or global have the same meaning. long is for tests that run slightly longer than one second. You can disable these groups of tests using --no-zookeeper , --no-shard and --no-long options, respectively

## Known bugs

If we know some bugs that can be easily reproduced by functional tests, we place prepared functional tests in . dbms/tests/queries/bugs directory. These tests will be moved to dbms/tests/queries/0\_stateless when bugs are fixed

## Integration Tests

Integration tests allow to test ClickHouse in clustered configuration and ClickHouse interaction with other servers like MySQL, Postgres, MongoDB. They are useful to emulate network splits, packet drops, etc. These tests are run under .Docker and create multiple containers with various software

.See dbms/tests/integration/README.md on how to run these tests

Note that integration of ClickHouse with third-party drivers is not tested. Also we currently don't have integration tests with .our JDBC and ODBC drivers

## Unit Tests

Unit tests are useful when you want to test not the ClickHouse as a whole, but a single isolated library or class. You can enable or disable build of tests with ENABLE\_TESTS CMake option. Unit tests (and other test programs) are located in tests subdirectories across the code. To run unit tests, type ninja test . Some tests use gtest , but some are just programs .that return non-zero exit code on test failure

It's not necessarily to have unit tests if the code is already covered by functional tests (and functional tests are usually .(much more simple to use

## Performance Tests

Performance tests allow to measure and compare performance of some isolated part of ClickHouse on synthetic queries. Tests are located at `dbms/tests/performance`. Each test is represented by `.xml` file with description of test case. Tests are .run with `clickhouse performance-test` tool (that is embedded in `clickhouse` binary). See `--help` for invocation

Each test run one or multiple queries (possibly with combinations of parameters) in a loop with some conditions for stop (like "maximum execution speed is not changing in three seconds") and measure some metrics about query performance .(like "maximum execution speed"). Some tests can contain preconditions on preloaded test dataset

If you want to improve performance of ClickHouse in some scenario, and if improvements can be observed on simple queries, it is highly recommended to write a performance test. It always makes sense to use `perf top` or other perf tools .during your tests

## Test Tools And Scripts

Some programs in `tests` directory are not prepared tests, but are test tools. For example, for `Lexer` there is a tool `dbms/src/Parsers/tests/lexer` that just do tokenization of `stdin` and writes colorized result to `stdout`. You can use these kind of .tools as a code examples and for exploration and manual testing

You can also place pair of files `.sh` and `.reference` along with the tool to run it on some predefined input - then script result .can be compared to `.reference` file. These kind of tests are not automated

## Miscellaneous Tests

There are tests for external dictionaries located at `dbms/tests/external_dictionaries` and for machine learned models in .`dbms/tests/external_models`. These tests are not updated and must be transferred to integration tests

There is separate test for quorum inserts. This test run ClickHouse cluster on separate servers and emulate various failure cases: network split, packet drop (between ClickHouse nodes, between ClickHouse and ZooKeeper, between ClickHouse server and client, etc.), `kill -9`, `kill -STOP` and `kill -CONT`, like **Jepsen**. Then the test checks that all .acknowledged inserts was written and all rejected inserts was not

Quorum test was written by separate team before ClickHouse was open-sourced. This team no longer work with ClickHouse. Test was accidentally written in Java. For these reasons, quorum test must be rewritten and moved to .integration tests

## Manual Testing

:When you develop a new feature, it is reasonable to also test it manually. You can do it with the following steps

Build ClickHouse. Run ClickHouse from the terminal: change directory to `dbms/src/programs/clickhouse-server` and run it with `./clickhouse-server`. It will use configuration (`config.xml`, `users.xml` and files within `config.d` and `users.d` directories) from the .current directory by default. To connect to ClickHouse server, run `dbms/src/programs/clickhouse-client/clickhouse-client`

Note that all `clickhouse` tools (server, client, etc) are just symlinks to a single binary named `clickhouse`. You can find this .binary at `dbms/src/programs/clickhouse`. All tools can also be invoked as `clickhouse` tool instead of `clickhouse-tool`

Alternatively you can install ClickHouse package: either stable release from Yandex repository or you can build package for yourself with `./release` in ClickHouse sources root. Then start the server with sudo service `clickhouse-server start` (or stop .to stop the server). Look for logs at `/etc/clickhouse-server/clickhouse-server.log`

When ClickHouse is already installed on your system, you can build a new clickhouse binary and replace the existing :binary

```
$ sudo service clickhouse-server stop
$ sudo cp ./clickhouse /usr/bin/
$ sudo service clickhouse-server start
```

:Also you can stop system clickhouse-server and run your own with the same configuration but with logging to terminal

```
$ sudo service clickhouse-server stop
$ sudo -u clickhouse /usr/bin/clickhouse server --config-file /etc/clickhouse-server/config.xml
```

:Example with gdb

```
$ sudo -u clickhouse gdb --args /usr/bin/clickhouse server --config-file /etc/clickhouse-server/config.xml
```

If the system clickhouse-server is already running and you don't want to stop it, you can change port numbers in your .config.xml (or override them in a file in config.d directory), provide appropriate data path, and run it clickhouse binary has almost no dependencies and works across wide range of Linux distributions. To quick and dirty test your changes on a server, you can simply scp your fresh built clickhouse binary to your server and then run it as in .examples above

## Testing Environment

Before publishing release as stable we deploy it on testing environment. Testing environment is a cluster that process 1/39 part of Yandex.Metrica data. We share our testing environment with Yandex.Metrica team. ClickHouse is upgraded without downtime on top of existing data. We look at first that data is processed successfully without lagging from realtime, the replication continue to work and there is no issues visible to Yandex.Metrica team. First check can be done in :the following way

```
SELECT hostName() AS h, any(version()), any(uptime()), max(UTCEventTime), count() FROM remote('example01-01-{1..3}t', merge, hits) WHERE EventDate >= today() - 2 GROUP BY h ORDER BY h;
```

In some cases we also deploy to testing environment of our friend teams in Yandex: Market, Cloud, etc. Also we have some hardware servers that are used for development purposes

## Load Testing

.After deploying to testing environment we run load testing with queries from production cluster. This is done manually .Make sure you have enabled query\_log on your production cluster :Collect query log for a day or more

```
$ clickhouse-client --query="SELECT DISTINCT query FROM system.query_log WHERE event_date = today() AND query LIKE '%ym:%' AND query NOT LIKE '%system.query_log%' AND type = 2 AND is_initial_query" > queries.tsv
```

This is a way complicated example. type = 2 will filter queries that are executed successfully. query LIKE '%ym:%' is to select relevant queries from Yandex.Metrica. is\_initial\_query is to select only queries that are initiated by client, not by .(ClickHouse itself (as parts of distributed query processing

:scp this log to your testing cluster and run it as following

```
$ clickhouse benchmark --concurrency 16 < queries.tsv
```

(probably you also want to specify a `--user`)

.Then leave it for a night or weekend and go take a rest

You should check that `clickhouse-server` doesn't crash, memory footprint is bounded and performance not degrading over .time

.Precise query execution timings are not recorded and not compared due to high variability of queries and environment

## Build Tests

Build tests allow to check that build is not broken on various alternative configurations and on some foreign systems. Tests are located at `ci` directory. They run build from source inside Docker, Vagrant, and sometimes with `qemu-user-static` .inside Docker. These tests are under development and test runs are not automated

:Motivation

Normally we release and run all tests on a single variant of ClickHouse build. But there are alternative build variants that :are not thoroughly tested. Examples

- ;build on FreeBSD •
- ;build on Debian with libraries from system packages •
- ;build with shared linking of libraries •
- ;build on AArch64 platform •
- .build on PowerPc platform •

For example, build with system packages is bad practice, because we cannot guarantee what exact version of packages a system will have. But this is really needed by Debian maintainers. For this reason we at least have to support this variant .of build. Another example: shared linking is a common source of trouble, but it is needed for some enthusiasts

Though we cannot run all tests on all variant of builds, we want to check at least that various build variants are not broken. .For this purpose we use build tests

## Testing For Protocol Compatibility

When we extend ClickHouse network protocol, we test manually that old `clickhouse-client` works with new `clickhouse-server` and new `clickhouse-client` works with old `clickhouse-server` (simply by running binaries from corresponding .packages)

## Help From The Compiler

Main ClickHouse code (that is located in `dbms` directory) is built with `-Wall -Wextra -Werror` and with some additional .enabled warnings. Although these options are not enabled for third-party libraries

.Clang has even more useful warnings - you can look for them with `-Weverything` and pick something to default build

For production builds, gcc is used (it still generates slightly more efficient code than clang). For development, clang is usually more convenient to use. You can build on your own machine with debug mode (to save battery of your laptop), but please note that compiler is able to generate more warnings with `-O3` due to better control flow and inter-procedure analysis. When building with clang, `libc++` is used instead of `libstdc++` and when building with debug mode, debug version .of `libc++` is used that allows to catch more errors at runtime

## Sanitizers

.Address sanitizer. We run functional and integration tests under ASan on per-commit basis

Valgrind (Memcheck). We run functional tests under Valgrind overnight. It takes multiple hours. Currently there is one  
.known false positive in `re2` library, see [this article](#)

.Undefined behaviour sanitizer. We run functional and integration tests under ASan on per-commit basis

Thread sanitizer. We run functional tests under TSan on per-commit basis. We still don't run integration tests under TSan  
.on per-commit basis

.Memory sanitizer. Currently we still don't use MSan

.Debug allocator. Debug version of `jemalloc` is used for debug build

## Fuzzing

We use simple fuzz test to generate random SQL queries and to check that the server doesn't die. Fuzz testing is performed with Address sanitizer. You can find it in `00746_sql_fuzzy.pl`. This test should be run continuously (overnight and .(longer

.As of December 2018, we still don't use isolated fuzz testing of library code

## Security Audit

.People from Yandex Cloud department do some basic overview of ClickHouse capabilities from the security standpoint

## Static Analyzers

We run PVS-Studio on per-commit basis. We have evaluated `clang-tidy`, `Coverity`, `cppcheck`, `PVS-Studio`, `tscancode`. You .will find instructions for usage in `dbms/tests/instructions/` directory. Also you can read [the article in russian](#)

.If you use `CLion` as an IDE, you can leverage some `clang-tidy` checks out of the box

## Hardening

.`FORTIFY_SOURCE` is used by default. It is almost useless, but still makes sense in rare cases and we don't disable it

## Code Style

.Code style rules are described [here](#)

.To check for some common style violations, you can use `utils/check-style` script

To force proper style of your code, you can use `clang-format`. File `.clang-format` is located at the sources root. It mostly corresponding with our actual code style. But it's not recommended to apply `clang-format` to existing files because it .makes formatting worse. You can use `clang-format-diff` tool that you can find in clang source repository

Alternatively you can try `uncrustify` tool to reformat your code. Configuration is in `uncrustify.cfg` in the sources root. It is less .tested than `clang-format`

. `CLion` has its own code formatter that has to be tuned for our code style

## Metrica B2B Tests

Each ClickHouse release is tested with Yandex Metrica and AppMetrica engines. Testing and stable versions of

ClickHouse are deployed on VMs and run with a small copy of Metrica engine that is processing fixed sample of input .data. Then results of two instances of Metrica engine are compared together

These tests are automated by separate team. Due to high number of moving parts, tests fail most of the time by completely unrelated reasons, that are very difficult to figure out. Most likely these tests have negative value for us. Nevertheless these tests were proved to be useful in about one or two times out of hundreds

## Test Coverage

As of July 2018 we don't track test coverage

## Test Automation

We run tests with Yandex internal CI and job automation system named "Sandbox"

Build jobs and tests are run in Sandbox on per commit basis. Resulting packages and test results are published in GitHub and can be downloaded by direct links. Artifacts are stored eternally. When you send a pull request on GitHub, we tag it as "can be tested" and our CI system will build ClickHouse packages (release, debug, with address sanitizer, etc) for you

We don't use Travis CI due to the limit on time and computational power. We don't use Jenkins. It was used before and now we are happy we are not using Jenkins

.Building of ClickHouse is supported on Linux, FreeBSD and Mac OS X

## If you use Windows

If you use Windows, you need to create a virtual machine with Ubuntu. To start working with a virtual machine please install VirtualBox. You can download Ubuntu from the website: <https://www.ubuntu.com/#download>. Please create a virtual machine from the downloaded image (you should reserve at least 4GB of RAM for it). To run a command line terminal in Ubuntu, please locate a program containing the word "terminal" in its name (gnome-terminal, konsole etc.) or just press .Ctrl+Alt+T

## Creating a repository on GitHub

To start working with ClickHouse repository you will need a GitHub account

You probably already have one, but if you don't, please register at <https://github.com>. In case you do not have SSH keys, you should generate them and then upload them on GitHub. It is required for sending over your patches. It is also possible to use the same SSH keys that you use with any other SSH servers - probably you already have those

Create a fork of ClickHouse repository. To do that please click on the "fork" button in the upper right corner at <https://github.com/ClickHouse/ClickHouse>. It will fork your own copy of ClickHouse/ClickHouse to your account

Development process consists of first committing the intended changes into your fork of ClickHouse and then creating a ("pull request" for these changes to be accepted into the main repository ([ClickHouse/ClickHouse](https://github.com/ClickHouse/ClickHouse)

.To work with git repositories, please install git

:To do that in Ubuntu you would run in the command line terminal

```
sudo apt update
sudo apt install git
```

A brief manual on using Git can be found here: <https://services.github.com/on-demand/downloads/github-git-cheat-sheet.pdf>

## Cloning a repository to your development machine

Next, you need to download the source files onto your working machine. This is called "to clone a repository" because it creates a local copy of the repository on your working machine

:In the command line terminal run

```
git clone --recursive git@github.com:your_github_username/ClickHouse.git
cd ClickHouse
```

Note: please, substitute *your\_github\_username* with what is appropriate

.This command will create a directory ClickHouse containing the working copy of the project

It is important that the path to the working directory contains no whitespaces as it may lead to problems with running the .build system

Please note that ClickHouse repository uses submodules . That is what the references to additional repositories are called (i.e. external libraries on which the project depends). It means that when cloning the repository you need to specify the --recursive flag as in the example above. If the repository has been cloned without submodules, to download them you need :to run the following

```
git submodule init
git submodule update
```

.You can check status with command: git submodule status

:If you get the following error message

```
Permission denied (publickey).
fatal: Could not read from remote repository.
```

Please make sure you have the correct access rights  
and the repository exists.

It generally means that the SSH keys for connecting to GitHub are missing. These keys are normally located in~/.ssh . For .SSH keys to be accepted you need to upload them in the settings section of GitHub UI

:You can also clone the repository via https protocol

```
git clone https://github.com/ClickHouse/ClickHouse.git
```

This however will not let you send your changes to the server. You can still use it temporarily and add the SSH keys later .replacing the remote address of the repository with git remote command

:You can also add original ClickHouse repo's address to your local repository to pull updates from there

```
git remote add upstream git@github.com:ClickHouse/ClickHouse.git
```

After successfully running this command you will be able to pull updates from the main ClickHouse repo by running git pull .upstream master

.ClickHouse uses CMake and Ninja for building  
CMake - a meta-build system that can generate Ninja files (build tasks). Ninja - a smaller build system with focus on  
.speed used to execute those cmake generated tasks

.To install on Ubuntu, Debian or Mint run sudo apt install cmake ninja-build

.On CentOS, RedHat run sudo yum install cmake ninja-build

.If you use Arch or Gentoo, you probably know it yourself how to install CMake

:For installing CMake and Ninja on Mac OS X first install Homebrew and then install everything else via brew

```
/usr/bin/ruby -e "$(curl -fsSL https://raw.githubusercontent.com/Homebrew/install/master/install)"
brew install cmake ninja
```

Next, check the version of CMake: cmake --version . If it is below 3.3, you should install a newer version from the website:  
.https://cmake.org/download

## Optional External Libraries

ClickHouse uses several external libraries for building. Most of them do not need to be installed separately as they are  
.built together with ClickHouse from the sources located in the submodules. You can check the list in contrib

There is one library that is not built from sources but is supplied by the system: Readline, and thus is recommended to be  
.installed

Ubuntu: sudo apt install libreadline-dev

Mac OS X: brew install readline

However, these libraries are optional and ClickHouse can well be built without them. ICU is used for support of COLLATE  
in ORDER BY (i.e. for sorting in turkish alphabet). Readline is used for more convenient command input in clickhouse-  
.client

## C++ Compiler

.Compilers GCC starting from version 9 and Clang version 8 or above are supported for building ClickHouse

Official Yandex builds currently use GCC because it generates machine code of slightly better performance (yielding a  
difference of up to several percent according to our benchmarks). And Clang is more convenient for development usually.  
.Though, our continuous integration (CI) platform runs checks for about a dozen of build combinations

++To install GCC on Ubuntu run: sudo apt install gcc g

Check the version of gcc: gcc --version . If it is below 9, then follow the instruction here:  
.https://clickhouse.yandex/docs/en/development/build/#install-gcc-9

Mac OS X build is supported only for Clang. Just run brew install llvm

.If you decide to use Clang, you can also install libc++ and lld , if you know what it is. Using ccache is also recommended

## The Building process

Now that you are ready to build ClickHouse we recommend you to create a separate directory build inside ClickHouse  
:that will contain all of the build artefacts

```
mkdir build
cd build
```

.You can have several different directories (build\_release, build\_debug, etc.) for different types of build

While inside the build directory, configure your build by running CMake. Before the first run you need to define .(environment variables that specify compiler (version 9 gcc compiler in this example

:Linux

```
export CC=gcc-9 CXX=g++-9
cmake ..
```

:Mac OS X

```
export CC=clang CXX=clang++
cmake ..
```

The CC variable specifies the compiler for C (short for C Compiler), and CXX variable instructs which C++ compiler is to .be used for building

For a faster build you can resort to the debug build type - a build with no optimizations. For that supply the following :parameter -D CMAKE\_BUILD\_TYPE=Debug

```
cmake -D CMAKE_BUILD_TYPE=Debug ..
```

.You can change the type of build by running this command in the build directory

:Run ninja to build

```
ninja clickhouse-server clickhouse-client
```

.Only the required binaries are going to be built in this example

:If you require to build all the binaries (utilities and tests), you should run ninja with no parameters

```
ninja
```

.Full build requires about 30GB of free disk space or 15GB to build the main binaries

When large amount of RAM is available on build machine you should limit the number of build tasks run in parallel with-j :param

```
ninja -j 1 clickhouse-server clickhouse-client
```

.On machines with 4GB of RAM it is recommended to specify 1, for 8GB of RAM-j 2 is recommended

If you get the message: ninja: error: loading 'build.ninja': No such file or directory , it means that generating a build configuration .has failed and you need to inspect the message above

Upon successful start of the building process you'll see the build progress - the number of processed tasks and the total .number of tasks

While building messages about protobuf files in libhdfs2 library like libprotobuf WARNING may show up. They affect nothing .and are safe to be ignored

:Upon successful build you get an executable file ClickHouse/<build\_dir>/dbms/programs/clickhouse

```
ls -l dbms/programs/clickhouse
```

## Running the built executable of ClickHouse

To run the server under the current user you need to navigate to ClickHouse/dbms/programs/server/ (located outside of :build ) and run

```
../../../../build/dbms/programs/clickhouse server
```

In this case ClickHouse will use config files located in the current directory. You can run clickhouse server from any .directory specifying the path to a config file as a command line parameter --config-file

To connect to ClickHouse with clickhouse-client in another terminal navigate to ClickHouse/build/dbms/programs/ and run . clickhouse client

:If you get Connection refused message on Mac OS X or FreeBSD, try specifying host address 127.0.0.1

```
clickhouse client --host 127.0.0.1
```

You can replace production version of ClickHouse binary installed in your system with your custom built ClickHouse binary. To do that install ClickHouse on your machine following the instructions from the official website. Next, run the :following

```
sudo service clickhouse-server stop
sudo cp ClickHouse/build/dbms/programs/clickhouse /usr/bin/
sudo service clickhouse-server start
```

.Note that clickhouse-client , clickhouse-server and others are symlinks to the commonly shared clickhouse binary

You can also run your custom built ClickHouse binary with the config file from the ClickHouse package installed on your :system

```
sudo service clickhouse-server stop
sudo -u clickhouse ClickHouse/build/dbms/programs/clickhouse server --config-file /etc/clickhouse-server/config.xml
```

## (IDE (Integrated Development Environment

If you do not know which IDE to use, we recommend that you use CLion. CLion is a commercial software, but it offers 30 .day free trial period. It is also free of charge for students. CLion can be used both on Linux and on Mac OS X

KDevelop and QTCreator are another great alternatives of an IDE for developing ClickHouse. KDevelop comes in as a very handy IDE although unstable. If KDevelop crashes after a while upon opening project, you should click "Stop All" .button as soon as it has opened the list of project's files. After doing so KDevelop should be fine to work with

.(As simple code editors you can use Sublime Text or Visual Studio Code, or Kate (all of which are available on Linux

Just in case, it is worth mentioning that CLion creates build path on its own, it also on its own selects debug for build type, for configuration it uses a version of CMake that is defined in CLion and not the one installed by you, and finally CLion will .use make to run build tasks instead of ninja . This is a normal behaviour, just keep that in mind to avoid confusion

The description of ClickHouse architecture can be found here:  
[/https://clickhouse.yandex/docs/en/development/architecture](https://clickhouse.yandex/docs/en/development/architecture)

/The Code Style Guide: <https://clickhouse.yandex/docs/en/development/style>

/Writing tests: <https://clickhouse.yandex/docs/en/development/tests>

List of tasks: [https://github.com/yandex/ClickHouse/blob/master/dbms/tests/instructions/easy\\_tasks\\_sorted\\_en.md](https://github.com/yandex/ClickHouse/blob/master/dbms/tests/instructions/easy_tasks_sorted_en.md)

## Test Data

Developing ClickHouse often requires loading realistic datasets. It is particularly important for performance testing. We have a specially prepared set of anonymized data from Yandex.Metrica. It requires additionally some 3GB of free disk space. Note that this data is not required to accomplish most of development tasks

```
sudo apt install wget xz-utils

wget https://clickhouse-datasets.s3.yandex.net/hits/tsv/hits_v1.tsv.xz
wget https://clickhouse-datasets.s3.yandex.net/visits/tsv/visits_v1.tsv.xz

xz -v -d hits_v1.tsv.xz
xz -v -d visits_v1.tsv.xz

clickhouse-client

CREATE TABLE test.hits (WatchID UInt64, JavaEnable UInt8, Title String, GoodEvent Int16, EventTime DateTime, EventDate Date, CounterID UInt32, ClientIP UInt32, ClientIP6 FixedString(16), RegionID UInt32, UserID UInt64, CounterClass Int8, OS UInt8, UserAgent UInt8, URL String, Referer String, URLDomain String, RefererDomain String, Refresh UInt8, IsRobot UInt8, RefererCategories Array(UInt16), URLCategories Array(UInt16), URLRegions Array(UInt32), RefererRegions Array(UInt32), ResolutionWidth UInt16, ResolutionHeight UInt16, ResolutionDepth UInt8, FlashMajor UInt8, FlashMinor UInt8, FlashMinor2 String, NetMajor UInt8, NetMinor UInt8, UserAgentMajor UInt16, UserAgentMinor FixedString(2), CookieEnable UInt8, JavascriptEnable UInt8, IsMobile UInt8, MobilePhone UInt8, MobilePhoneModel String, Params String, IPNetworkID UInt32, TraficSourceID UInt8, SearchEngineID UInt16, SearchPhrase String, AdvEngineID UInt8, IsArtifical UInt8, WindowClientWidth UInt16, WindowClientHeight UInt16, ClientTimeZone Int16, ClientEventTime DateTime, SilverlightVersion1 UInt8, SilverlightVersion2 UInt8, SilverlightVersion3 UInt32, SilverlightVersion4 UInt16, PageCharset String, CodeVersion UInt32, IsLink UInt8, IsDownload UInt8, IsNotBounce UInt8, FUniqID UInt64, HID UInt32, IsOldCounter UInt8, IsEvent UInt8, IsParameter UInt8, DontCountHits UInt8, WithHash UInt8, HitColor FixedString(1), UTCEventTime DateTime, Age UInt8, Sex UInt8, Income UInt8, Interests UInt16, Robotness UInt8, GeneralInterests Array(UInt16), RemoteIP UInt32, RemoteIP6 FixedString(16), WindowName Int32, OpenerName Int32, HistoryLength Int16, BrowserLanguage FixedString(2), BrowserCountry FixedString(2), SocialNetwork String, SocialAction String, HTTPError UInt16, SendTiming Int32, DNSTiming Int32, ConnectTiming Int32, ResponseStartTiming Int32, ResponseEndTiming Int32, FetchTiming Int32, RedirectTiming Int32, DOMInteractiveTiming Int32, DOMContentLoadedTiming Int32, DOMCompleteTiming Int32, LoadEventStartTiming Int32, LoadEventEndTiming Int32, NSToDOMContentLoadedTiming Int32, FirstPaintTiming Int32, RedirectCount Int8, SocialSourceNetworkID UInt8, SocialSourcePage String, ParamPrice Int64, ParamOrderID String, ParamCurrency FixedString(3), ParamCurrencyID UInt16, GoalsReached Array(UInt32), OpenstatServiceName String, OpenstatCampaignID String, OpenstatAdID String, OpenstatSourceID String, UTMSource String, UTMMedium String, UTMCampaign String, UTMContent String, UTMTerm String, FromTag String, HasCLID UInt8, RefererHash UInt64, URLHash UInt64, CLID UInt32, YCLID UInt64, ShareService String, ShareURL String, ShareTitle String, `ParsedParams.Key1` Array(String), `ParsedParams.Key2` Array(String), `ParsedParams.Key3` Array(String), `ParsedParams.Key4` Array(String), `ParsedParams.Key5` Array(String), `ParsedParams.ValueDouble` Array(Float64), IslandID FixedString(16), RequestNum UInt32, RequestTry UInt8) ENGINE = MergeTree PARTITION BY toYYYYMM(EventDate) SAMPLE BY intHash32(UserID) ORDER BY (CounterID, EventDate, intHash32(UserID), EventTime);

CREATE TABLE test.visits (CounterID UInt32, StartDate Date, Sign Int8, IsNew UInt8, VisitID UInt64, UserID UInt64, StartTime DateTime, Duration UInt32, UTCStartTime DateTime, PageViews Int32, Hits Int32, IsBounce UInt8, Referer String, StartURL String, RefererDomain String, StartURLDomain String, EndURL String, LinkURL String, IsDownload UInt8, TraficSourceID Int8, SearchEngineID UInt16, SearchPhrase String, AdvEngineID UInt8, PlaceID Int32, RefererCategories Array(UInt16), URLCategories Array(UInt16), URLRegions Array(UInt32), RefererRegions Array(UInt32), IsYandex UInt8, GoalReachesDepth Int32, GoalReachesURL Int32, GoalReachesAny Int32, SocialSourceNetworkID UInt8, SocialSourcePage String, MobilePhoneModel String, ClientEventTime DateTime, RegionID UInt32, ClientIP UInt32, ClientIP6 FixedString(16), RemoteIP UInt32, RemoteIP6 FixedString(16), IPNetworkID UInt32, SilverlightVersion3 UInt32, CodeVersion UInt32, ResolutionWidth UInt16, ResolutionHeight UInt16, UserAgentMajor UInt16, UserAgentMinor UInt16, WindowClientWidth UInt16, WindowClientHeight UInt16, SilverlightVersion2 UInt16)
```

```

USERAgentVersion UInt16, WindowClientWidth UInt16, WindowClientHeight UInt16, SilverlightVersionZ UInt16,
SilverlightVersion4 UInt16, FlashVersion3 UInt16, FlashVersion4 UInt16, ClientTimeZone Int16, OS UInt8,
UserAgent UInt8, ResolutionDepth UInt8, FlashMajor UInt8, FlashMinor UInt8, NetMajor UInt8, NetMinor
UInt8, MobilePhone UInt8, SilverlightVersion1 UInt8, Age UInt8, Sex UInt8, Income UInt8, JavaEnable
UInt8, CookieEnable UInt8, JavascriptEnable UInt8, IsMobile UInt8, BrowserLanguage UInt16,
BrowserCountry UInt16, Interests UInt16, Robotness UInt8, GeneralInterests Array(UInt16), Params
Array(String), `Goals.ID` Array(UInt32), `Goals.Serial` Array(UInt32), `Goals.EventTime`
Array(DateTime), `Goals.Price` Array(Int64), `Goals.OrderID` Array(String), `Goals.CurrencyID`
Array(UInt32), WatchIDs Array(UInt64), ParamSumPrice Int64, ParamCurrency FixedString(3),
ParamCurrencyID UInt16, ClickLogID UInt64, ClickEventID Int32, ClickGoodEvent Int32, ClickEventTime
DateTime, ClickPriorityID Int32, ClickPhraseID Int32, ClickPageID Int32, ClickPlaceID Int32,
ClickTypeID Int32, ClickResourceID Int32, ClickCost UInt32, ClickClientIP UInt32, ClickDomainID UInt32,
ClickURL String, ClickAttempt UInt8, ClickOrderID UInt32, ClickBannerID UInt32, ClickMarketCategoryID
UInt32, ClickMarketPP UInt32, ClickMarketCategoryName String, ClickMarketPPName String,
ClickAWAPSCampaignName String, ClickPageName String, ClickTargetType UInt16, ClickTargetPhraseID UInt64,
ClickContextType UInt8, ClickSelectType Int8, ClickOptions String, ClickGroupBannerID Int32,
OpenstatServiceName String, OpenstatCampaignID String, OpenstatAdID String, OpenstatSourceID String,
UTMSource String, UTMMedium String, UTMCampaign String, UTMContent String, UTMTerm String, FromTag
String, HasGCLID UInt8, FirstVisit DateTime, PredLastVisit Date, LastVisit Date, TotalVisits UInt32,
`TraficSource.ID` Array(Int8), `TraficSource.SearchEngineID` Array(UInt16), `TraficSource.AdvEngineID` Array(UInt8),
`TraficSource.PlaceID` Array(UInt16), `TraficSource.SocialSourceNetworkID` Array(UInt8),
`TraficSource.Domain` Array(String), `TraficSource.SearchPhrase` Array(String),
`TraficSource.SocialSourcePage` Array(String), Attendance FixedString(16), CLID UInt32, YCLID UInt64,
NormalizedRefererHash UInt64, SearchPhraseHash UInt64, RefererDomainHash UInt64, NormalizedStartURLHash
UInt64, StartURLDomainHash UInt64, NormalizedEndURLHash UInt64, TopLevelDomain UInt64, URLScheme
UInt64, OpenstatServiceNameHash UInt64, OpenstatCampaignIDHash UInt64, OpenstatAdIDHash UInt64,
OpenstatSourceIDHash UInt64, UTMSourceHash UInt64, UTMMediumHash UInt64, UTMCampaignHash UInt64,
UTMContentHash UInt64, UTMTermHash UInt64, FromHash UInt64, WebVisorEnabled UInt8, WebVisorActivity
UInt32, `ParsedParams.Key1` Array(String), `ParsedParams.Key2` Array(String), `ParsedParams.Key3` Array(String),
`ParsedParams.Key4` Array(String), `ParsedParams.Key5` Array(String),
`ParsedParams.ValueDouble` Array(Float64), `Market.Type` Array(UInt8), `Market.GoalID` Array(UInt32),
`Market.OrderID` Array(String), `Market.OrderPrice` Array(Int64), `Market.PP` Array(UInt32),
`Market.DirectPlaceID` Array(UInt32), `Market.DirectOrderID` Array(UInt32), `Market.DirectBannerID` Array(UInt32),
`Market.GoodID` Array(String), `Market.GoodName` Array(String), `Market.GoodQuantity` Array(Int32),
`Market.GoodPrice` Array(Int64), IslandID FixedString(16)) ENGINE =
CollapsingMergeTree(Sign) PARTITION BY toYYYYMM(StartDate) SAMPLE BY intHash32(UserID) ORDER BY (CounterID,
StartDate, intHash32(UserID), VisitID);

```

```

clickhouse-client --max_insert_block_size 100000 --query "INSERT INTO test.hits FORMAT TSV" < hits_v1.tsv
clickhouse-client --max_insert_block_size 100000 --query "INSERT INTO test.visits FORMAT TSV" <
visits_v1.tsv

```

## Creating Pull Request

Navigate to your fork repository in GitHub's UI. If you have been developing in a branch, you need to select that branch.

There will be a "Pull request" button located on the screen. In essence this means "create a request for accepting my .changes into the main repository

A pull request can be created even if the work is not completed yet. In this case please put the word "WIP" (work in progress) at the beginning of the title, it can be changed later. This is useful for cooperative reviewing and discussion of changes as well as for running all of the available tests. It is important that you provide a brief description of your changes, .it will later be used for generating realease changelogs

Testing will commence as soon as Yandex employees label your PR with a tag "can be tested". The results of some first checks (e.g. code style) will come in within several minutes. Build check results will arrive within a half an hour. And the .main set of tests will report itself within an hour

The system will prepare ClickHouse binary builds for your pull request individually. To retrieve these builds click the "Details" link next to "ClickHouse build check" entry in the list of checks. There you will find direct links to the built .deb .(packages of ClickHouse which you can deploy even on your production servers (if you have no fear

Most probably some of the builds will fail at first times. This is due to the fact that we check builds both with gcc as well as with clang, with almost all of existing warnings (always with the -Werror flag) enabled for clang. On that same page you .can find all of the build logs so that you do not have to build ClickHouse in all of the possible ways

## Third-Party Libraries Used

License	Library
BSD 2-Clause License	base64
Boost Software License 1.0	boost
MIT	brotli
MIT	capnproto
Apache License 2.0	cctz
BSD 3-Clause License	double-conversion
MIT	FastMemcpy
BSD 3-Clause License	googletest
Apache License 2.0	h3
BSD 3-Clause License	hyperscan
BSD 2-Clause License	libbtrie
BSD + MIT	libcxxabi
Zlib License	libdivide
LGPL v2.1	libgsasl
Apache License 2.0	libhdfs3
Apache License 2.0	libmetrohash
Apache License 2.0	libpcg-random
OpenSSL License	libressl
BSD 2-Clause License	librdkafka
CC0 1.0 Universal	libwidechar_width
BSD 3-Clause License	llvm
BSD 2-Clause License	lz4
LGPL v2.1	mariadb-connector-c
Public Domain	murmurhash
Zlib License	pdqsort
Boost Software License - Version 1.0	poco
BSD 3-Clause License	protobuf

License	BSD 3-Clause License	Library
LGPL v2.1		UnixODBC
Zlib License		zlib-ng
BSD 3-Clause License		zstd

## Roadmap

Q1 2020

- Resource pools for more precise distribution of cluster capacity between users •
- Fine-grained authorization •
- Integration with external authentication services •

ClickHouse release v19.17

ClickHouse release v19.17.6.36, 2019-12-27

BUG FIX

Fixed potential buffer overflow in decompress. Malicious user can pass fabricated compressed data that could cause •  
read after buffer. This issue was found by Eldar Zaitov from Yandex information security team. #8404 (alexey-  
milovidov)

Fixed possible server crash ( std::terminate ) when the server cannot send or write data in JSON or XML format with •  
values of String data type (that require UTF-8 validation) or when compressing result data with Brotli algorithm or in  
(some other rare cases. #8384 (alexey-milovidov)

Fixed dictionaries with source from a clickhouse VIEW , now reading such dictionaries doesn't cause the errorThere is •  
(no query . #8351 (Nikolai Kochetov)

(Fixed checking if a client host is allowed by host\_regexp specified in users.xml.#8241, #8342 (Vitaly Baranov •

RENAME TABLE for a distributed table now renames the folder containing inserted data before sending to shards. •  
(This fixes an issue with successive renames tableA->tableB , tableC->tableA . #8306 (tavplubix

range\_hashed external dictionaries created by DDL queries now allow ranges of arbitrary numeric types#8275 •  
(alesapin)

(Fixed INSERT INTO table SELECT ... FROM mysql(...) table function. #8234 (tavplubix •

Fixed segfault in INSERT INTO TABLE FUNCTION file() while inserting into a file which doesn't exist. Now in this case file •  
(would be created and then insert would be processed. #8177 (Olga Khvostikova

(Fixed bitmapAnd error when intersecting an aggregated bitmap and a scalar bitmap.#8082 (Yue Huang •

Fixed segfault when EXISTS query was used without TABLE or DICTIONARY qualifier, just like EXISTS t . #8213 •  
(alexey-milovidov)

Fixed return type for functions rand and randConstant in case of nullable argument. Now functions always return •

( UInt32 and never Nullable(UInt32) . #8204 (Nikolai Kochetov

(Fixed DROP DICTIONARY IF EXISTS db.dict , now it doesn't throw exception if db doesn't exist. #8185 (Vitaly Baranov

(If a table wasn't completely dropped because of server crash, the server will try to restore and load it #8176 (tavplubix

(Fixed a trivial count query for a distributed table if there are more than two shard local table#8164 (小路))

Fixed bug that lead to a data race in DB::BlockStreamProfileInfo::calculateRowsBeforeLimit() #8143 (Alexander Kazakov)

Fixed ALTER table MOVE part executed immediately after merging the specified part, which could cause moving a part

(which the specified part merged into. Now it correctly moves the specified part. #8104 (Vladimir Chebotarev

Expressions for dictionaries can be specified as strings now. This is useful for calculation of attributes while extracting

data from non-ClickHouse sources because it allows to use non-ClickHouse syntax for those expressions. #8098  
((alesapin))

(Fixed a very rare race in clickhouse-copier because of an overflow in ZXid. #8088 (Ding Xiang Fei

Fixed the bug when after the query failed (due to "Too many simultaneous queries" for example) it would not read external tables info, and the next request would interpret this info as the beginning of the next query causing an error

(like Unknown packet from client . #8084 (Azat Khuzhin

(Avoid null dereference after "Unknown packet X from server" #8071 (Azat Khuzhin

Restore support of all ICU locales, add the ability to apply collations for constant expressions and add language name  
(to system.collations table. #8051 (alesapin

Number of streams for read from `StorageFile` and `StorageHDFS` is now limited, to avoid exceeding the memory limit. (#7981 (alesapin))

(Fixed `CHECK TABLE` query for `*MergeTree` tables without key. #7979 (alesapin))  
Removed the mutation number from a part name in case there were no mutations. This removing improved the

(compatibility with older versions. #8250 (alesapin

(mutation version. #7812 (Zhichang Yu

(Chebotarev

((Boris Granveaud

(with LIMIT BY. #7637 (Nikita Mikhaylov

(#8029 (alesapin

The release v19.17.4.11, 2019-11-22

Using column instead of AST to store scalar subquery results for better performance. Setting `enable_scalar_subquery_optimization` was added in 19.17 and it was enabled by default. It leads to errors like [this](#) during upgrade to 19.17.2 or 19.17.3 from previous versions. This setting was disabled by default in 19.17.4, to make (possible) upgrading from 19.16 and older versions without errors. [#7909 \(Merge Bird\)](#)

(Add the following text to the bottom of the RDL code: #Z00041)

(Add function `isValidJSON`, to check that passed string is a valid json. #5010 #Z003 [Admir](#)

- (Implement `arrayCompact` function #7328 (Memo) •  
Created function `hex` for Decimal numbers. It works like `hex(reinterpretAsString())` , but doesn't delete last zero bytes. •  
(#7355 (Mikhail Korotov))
- Add `arrayFill` and `arrayReverseFill` functions, which replace elements by other elements in front/back of them in the •  
(array. #7380 (hcz))  
(Add `CRC32IEEE()` / `CRC64()` support #7480 (Azat Khuzhin) •  
(Implement `char` function similar to one in mysql #7486 (sundlyi) •
- Add `bitmapTransform` function. It transforms an array of values in a bitmap to another array of values, the result is a •  
(new bitmap #7598 (Zhichang Yu))  
(Implemented `javaHashUTF16LE()` function #7651 (achimbab) •  
(Add `_shard_num` virtual column for the Distributed engine #7624 (Azat Khuzhin) •
- EXPERIMENTAL FEATURE**
- (Support for processors (new query execution pipeline) in MergeTree . #7181 (Nikolai Kochetov) •
- BUG FIX**
- (Fix incorrect float parsing in Values #7817 #7870 (tavplubix) •  
(Fix rare deadlock which can happen when `trace_log` is enabled. #7838 (filimonov) •  
(Prevent message duplication when producing Kafka table has any MVs selecting from it #7265 (Ivan) •  
(Support for `Array(LowCardinality(Nullable(String)))` in IN . Resolves #7364 #7366 (achimbab) •
- Add handling of `SQL_TINYINT` and `SQL_BIGINT` , and fix handling of `SQL_FLOAT` data source types in ODBC Bridge. •  
(#7491 (Denis Glazachev))  
(Fix aggregation ( `avg` and `quantiles`) over empty decimal columns #7431 (Andrey Konyaev) •  
(Fix `INSERT` into Distributed with `MATERIALIZED` columns #7377 (Azat Khuzhin) •
- Make `MOVE PARTITION` work if some parts of partition are already on destination disk or volume #7434 (Vladimir) •  
(Chebotarev)
- Fixed bug with hardlinks failing to be created during mutations in `ReplicatedMergeTree` in multi-disk configurations. •  
(#7558 (Vladimir Chebotarev))
- Fixed a bug with a mutation on a MergeTree when whole part remains unchanged and best space is being found on •  
(another disk #7602 (Vladimir Chebotarev))  
(Fixed bug with `keep_free_space_ratio` not being read from disks configuration #7645 (Vladimir Chebotarev) •  
(Fix bug with table contains only `Tuple` columns or columns with complex paths. Fixes 7541. #7545 (alesapin) •  
(Do not account memory for Buffer engine in `max_memory_usage` limit #7552 (Azat Khuzhin) •
- Fix final mark usage in MergeTree tables ordered by `tuple()` . In rare cases it could lead to Can't adjust last granule error •  
(while select. #7639 (Anton Popov))
- Fix bug in mutations that have predicate with actions that require context (for example functions for json), which may •  
(lead to crashes or strange exceptions. #7664 (alesapin))  
(Fix mismatch of database and table names escaping in `data/` and `shadow/` directories #7575 (Alexander Burmak) •
- Support duplicated keys in `RIGHT|FULL JOINs`, e.g. `ON t.x = u.x AND t.x = u.y` . Fix crash in this case. #7586 (Artem) •  
(Zuikov)
- (Fix Not found column <expression> in block when joining on expression with `RIGHT` or `FULL JOIN`. #7641 (Artem Zuikov) •  
(One more attempt to fix infinite loop in `PrettySpace` format #7591 (Olga Khvostikova) •  
(Fix bug in `concat` function when all arguments were `FixedString` of the same size. #7635 (alesapin) •

(Fixed exception in case of using 1 argument while defining S3, URL and HDFS storages.[#7618](#) ([Vladimir Chebotarev](#)) •  
(Fix scope of the InterpreterSelectQuery for views with query[#7601](#) ([Azat Khuzhin](#)) •

#### IMPROVEMENT

(`Nullable` columns recognized and NULL-values handled correctly by ODBC-bridge.[#7402](#) ([Vasily Nemkov](#)) •

(Write current batch for distributed send atomically.[#7600](#) ([Azat Khuzhin](#)) •

(Throw an exception if we cannot detect table for column name in query.[#7358](#) ([Artem Zuikov](#)) •

(Add `merge_max_block_size` setting to MergeTreeSettings [#7412](#) ([Artem Zuikov](#)) •

Queries with `HAVING` and without `GROUP BY` assume group by constant. So, `SELECT 1 HAVING 1` now returns a •  
(result. [#7496](#) ([Amos Bird](#)) •

(Support parsing `(X,)` as tuple similar to python.[#7501](#), [#7562](#) ([Amos Bird](#)) •

(Make `range` function behaviors almost like pythonic one.[#7518](#) ([sundyli](#)) •

(Add `constraints` columns to table `system.settings` [#7553](#) ([Vitaly Baranov](#)) •

Better Null format for tcp handler, so that it's possible to use `select ignore(<expression>)` from table format Null for perf •  
(measure via clickhouse-client [#7606](#) ([Amos Bird](#)) •

(Queries like `CREATE TABLE ... AS (SELECT (1, 2))` are parsed correctly [#7542](#) ([hczo](#)) •

#### PERFORMANCE IMPROVEMENT

(The performance of aggregation over short string keys is improved.[#6243](#) ([Alexander Kuzmenkov](#), [Amos Bird](#)) •

Run another pass of syntax/expression analysis to get potential optimizations after constant predicates are folded. •  
([#7497](#) ([Amos Bird](#)) •

(Use storage meta info to evaluate trivial `SELECT count()` FROM table; [#7510](#) ([Amos Bird](#), [alexey-milovidov](#)) •

(Vectorize processing `arrayReduce` similar to Aggregator `addBatch`. [#7608](#) ([Amos Bird](#)) •

(Minor improvements in performance of Kafka consumption [#7475](#) ([Ivan](#)) •

#### BUILD/TESTING/PACKAGING IMPROVEMENT

(Add support for cross-compiling to the CPU architecture AARCH64. Refactor packager script.[#7370](#) [#7539](#) ([Ivan](#)) •

Unpack darwin-x86\_64 and linux-aarch64 toolchains into mounted Docker volume when building packages[#7534](#) •  
(([Ivan](#)) •

(Update Docker Image for Binary Packager [#7474](#) ([Ivan](#)) •

(Fixed compile errors on MacOS Catalina [#7585](#) ([Ernest Poletaev](#)) •

(Some refactoring in query analysis logic: split complex class into several simple ones.[#7454](#) ([Artem Zuikov](#)) •

(Fix build without submodules [#7295](#) ([proller](#)) •

(Better `add_globs` in CMake files [#7418](#) ([Amos Bird](#)) •

(Remove hardcoded paths in `unwind` target [#7460](#) ([Konstantin Podshumok](#)) •

(Allow to use mysql format without ssl [#7524](#) ([proller](#)) •

#### OTHER

(Added ANTLR4 grammar for ClickHouse SQL dialect[#7595](#) [#7596](#) ([alexey-milovidov](#)) •

ClickHouse release v19.16

ClickHouse release v19.16.2.2, 2019-10-30

BACKWARD INCOMPATIBLE CHANGE

(Add missing arity validation for count/counlf. #7095 #7298 (Vdimir •  
(Remove legacy `asterisk_left_columns_only` setting (it was disabled by default). #7335 (Artem Zuikov •  
(Format strings for Template data format are now specified in files. #7118 (tavplubix •

#### NEW FEATURE

(Introduce `uniqCombined64()` to calculate cardinality greater than `UINT_MAX`. #7213, #7222 (Azat Khuzhin •  
(Support Bloom filter indexes on Array columns. #6984 (achimbab •  
Add a function `getMacro(name)` that returns String with the value of corresponding `<macros>` from server configuration. •  
(#7240 (alexey-milovidov  
Set two configuration options for a dictionary based on an HTTP source: `credentials` and `http-headers`. #7092 •  
((Guillaume Tassery  
(Add a new `ProfileEvent Merge` that counts the number of launched background merges. #7093 (Mikhail Korotov •  
    (Add fullHostName function that returns a fully qualified domain name. #7263 #7291 (sundyl •  
Add function `arraySplit` and `arrayReverseSplit` which split an array by "cut off" conditions. They are useful in time •  
    (sequence handling. #7294 (hcz  
Add new functions that return the Array of all matched indices in multiMatch family of functions. #7299 (Danila Kutenin •  
    (  
Add a new database engine `Lazy` that is optimized for storing a large number of small -Log tables. #7171 (Nikita •  
    (Vasilev  
    (Add aggregate functions `groupBitmapAnd`, `-Or`, `-Xor` for bitmap columns. #7109 (Zhichang Yu •  
Add aggregate function combinators `-OrNull` and `-OrDefault`, which return null or default values when there is nothing •  
    (to aggregate. #7331 (hcz  
    (Introduce `CustomSeparated` data format that supports custom escaping and delimiter rules. #7118 (tavplubix •  
    (Support Redis as source of external dictionary. #4361 #6962 (comunodi, Anton Popov •

#### BUG FIX

(Fix wrong query result if it has `WHERE IN (SELECT ...)` section and `optimize_read_in_order` is used. #7371 (Anton Popov •  
    (Disabled MariaDB authentication plugin, which depends on files outside of project. #7140 (Yuriy Baranov •  
        Fix exception `Cannot convert column ... because it is constant but values of constants are` •  
        different in source and result which could rarely happen when functions `now()`, `today()`, `yesterday()`, `randConstant()` are •  
        used. #7156 (Nikolai Kochetov  
    (Fixed issue of using HTTP keep alive timeout instead of TCP keep alive timeout. #7351 (Vasily Nemkov •  
        (Fixed a segmentation fault in `groupBitmapOr` (issue #7109). #7289 (Zhichang Yu •  
    (For materialized views the commit for Kafka is called after all data were written. #7175 (Ivan •  
    (Fixed wrong `duration_ms` value in `system.part_log` table. It was ten times off. #7172 (Vladimir Chebotarev •  
    (A quick fix to resolve crash in LIVE VIEW table and re-enabling all LIVE VIEW tests. #7201 (vzakaznikov •  
    (Serialize NULL values correctly in min/max indexes of MergeTree parts. #7234 (Alexander Kuzmenkov •  
        (Don't put virtual columns to `.sql` metadata when table is created as `CREATE TABLE AS`. #7183 (Ivan •  
            (Fix segmentation fault in `ATTACH PART` query. #7185 (alesapin •  
Fix wrong result for some queries given by the optimization of empty IN subqueries and empty INNER/RIGHT JOIN. •  
    (#7284 (Nikolai Kochetov  
    (Fixing AddressSanitizer error in the LIVE VIEW `getHeader()` method. #7271 (vzakaznikov •

#### IMPROVEMENT

(Add a message in case of queue\_wait\_max\_ms wait takes place. #7390 (Azat Khuzhin) •  
(Made setting s3\_min\_upload\_part\_size table-level. #7059 (Vladimir Chebotarev) •  
(Check TTL in StorageFactory. #7304 (sundyli) •  
(Squash left-hand blocks in partial merge join (optimization). #7122 (Artem Zuikov) •  
Do not allow non-deterministic functions in mutations of Replicated table engines, because this can introduce  
(inconsistencies between replicas. #7247 (Alexander Kazakov) •  
Disable memory tracker while converting exception stack trace to string. It can prevent the loss of error messages of  
type Memory limit exceeded on server, which caused the Attempt to read  
(after eof exception on client. #7264 (Nikolai Kochetov) •  
(Miscellaneous format improvements. Resolves #6033, #2633, #6611, #6742 #7215 (tavplubix) •  
ClickHouse ignores values on the right side of IN operator that are not convertible to the left side type. Make it work  
(properly for compound types -- Array and Tuple. #7283 (Alexander Kuzmenkov) •  
Support missing inequalities for ASOF JOIN. It's possible to join less-or-equal variant and strict greater and less  
(variants for ASOF column in ON syntax. #7282 (Artem Zuikov) •  
(Optimize partial merge join. #7070 (Artem Zuikov) •  
(Do not use more than 98K of memory in uniqCombined functions. #7236, #7270 (Azat Khuzhin) •  
Flush parts of right-hand joining table on disk in PartialMergeJoin (if there is not enough memory). Load data back  
(when needed. #7186 (Artem Zuikov) •

#### PERFORMANCE IMPROVEMENT

(Speed up joinGet with const arguments by avoiding data duplication. #7359 (Amos Bird) •  
(Return early if the subquery is empty. #7007 (小路) •  
(Optimize parsing of SQL expression in Values. #6781 (tavplubix) •

#### BUILD/TESTING/PACKAGING IMPROVEMENT

(Disable some contribs for cross-compilation to Mac OS. #7101 (Ivan) •  
(Add missing linking with PocoXML for clickhouse\_common\_io. #7200 (Azat Khuzhin) •  
(Accept multiple test filter arguments in clickhouse-test. #7226 (Alexander Kuzmenkov) •  
(Enable musl and jemalloc for ARM. #7300 (Amos Bird) •  
(Added --client-option parameter to clickhouse-test to pass additional parameters to client. #7277 (Nikolai Kochetov) •  
(Preserve existing configs on rpm package upgrade. #7103 (filimonov) •  
(Fix errors detected by PVS. #7153 (Artem Zuikov) •  
(Fix build for Darwin. #7149 (Ivan) •  
(glibc 2.29 compatibility. #7142 (Amos Bird) •  
(Make sure dh\_clean does not touch potential source files. #7205 (Amos Bird) •

Attempt to avoid conflict when updating from altinity rpm - it has config file packaged separately in clickhouse-server-  
(common. #7073 (filimonov) •  
(Optimize some header files for faster rebuilds. #7212, #7231 (Alexander Kuzmenkov) •  
(Add performance tests for Date and DateTime. #7332 (Vasily Nemkov) •  
(Fix some tests that contained non-deterministic mutations. #7132 (Alexander Kazakov) •  
(Add build with MemorySanitizer to CI. #7066 (Alexander Kuzmenkov) •  
(Avoid use of uninitialized values in MetricsTransmitter. #7158 (Azat Khuzhin) •

(Fix some issues in Fields found by MemorySanitizer. #7135, #7179 (Alexander Kuzmenkov), #7376 (Amos Bird) •  
    (Fix undefined behavior in murmurhash32. #7388 (Amos Bird) •  
        (Fix undefined behavior in StoragesInfoStream. #7384 (tavplubix) •  
    Fixed constant expressions folding for external database engines (MySQL, ODBC, JDBC). In previous versions it was't working for multiple constant expressions and was not working at all for Date, DateTime and UUID. This fixes (#7245 #7252 (alexey-milovidov) •

Fixing ThreadSanitizer data race error in the LIVE VIEW when accessing no\_users\_thread variable. #7353 •  
    ((vzakaznikov  
        (Get rid of malloc symbols in libcommon #7134, #7065 (Amos Bird) •  
        (Add global flag ENABLE\_LIBRARIES for disabling all libraries. #7063 (proller) •

#### CODE CLEANUP

(Generalize configuration repository to prepare for DDL for Dictionaries. #7155 (alesapin) •  
    (Parser for dictionaries DDL without any semantic. #7209 (alesapin) •  
        (Split ParserCreateQuery into different smaller parsers. #7253 (alesapin) •  
            (Small refactoring and renaming near external dictionaries. #7111 (alesapin) •  
            (Refactor some code to prepare for role-based access control. #7235 (Vitaly Baranov) •  
                (Some improvements in DatabaseOrdinary code. #7086 (Nikita Vasilev) •  
                (Do not use iterators in find() and emplace() methods of hash tables. #7026 (Alexander Kuzmenkov) •  
            (Fix getMultipleValuesFromConfig in case when parameter root is not empty. #7374 (Mikhail Korotov) •  
                (Remove some copy-paste (TemporaryFile and TemporaryFileStream) #7166 (Artem Zuikov) •  
                (Improved code readability a little bit (MergeTreeData::getActiveContainingPart). #7361 (Vladimir Chebotarev) •  
Wait for all scheduled jobs, which are using local objects, if ThreadPool::schedule(...) throws an exception. Rename ThreadPool::schedule(...) to ThreadPool::scheduleOrThrowOnError(...) and fix comments to make obvious that it may throw. (#7350 (tavplubix) •

## ClickHouse release 19.15

### ClickHouse release 19.15.4.10, 2019-10-31

#### BUG FIX

Added handling of SQL\_TINYINT and SQL\_BIGINT, and fix handling of SQL\_FLOAT data source types in ODBC •  
    (Bridge. #7491 (Denis Glazachev) •  
    (Allowed to have some parts on destination disk or volume in MOVE PARTITION. #7434 (Vladimir Chebotarev) •  
        (Fixed NULL-values in nullable columns through ODBC-bridge. #7402 (Vasily Nemkov) •  
        (Fixed INSERT into Distributed non local node with MATERIALIZED columns. #7377 (Azat Khuzhin) •  
            (Fixed function getMultipleValuesFromConfig. #7374 (Mikhail Korotov) •  
        (Fixed issue of using HTTP keep alive timeout instead of TCP keep alive timeout. #7351 (Vasily Nemkov) •  
            (Wait for all jobs to finish on exception (fixes rare segfaults). #7350 (tavplubix) •  
                (Don't push to MVs when inserting into Kafka table. #7265 (Ivan) •  
                (Disable memory tracker for exception stack. #7264 (Nikolai Kochetov) •  
            (Fixed bad code in transforming query for external database. #7252 (alexey-milovidov) •  
                (Avoid use of uninitialized values in MetricsTransmitter. #7158 (Azat Khuzhin) •

**ClickHouse release 19.15.3.6, 2019-10-09**

## BUG FIX

- (Fixed bad\_variant in hashed dictionary. [alesapin](#) •)
- (Fixed up bug with segmentation fault in ATTACH PART query. [alesapin](#) •)
- (Fixed time calculation in MergeTreeData. [Vladimir Chebotarev](#) •)
- (Commit to Kafka explicitly after the writing is finalized. #7175 ([Ivan](#) •))
- (Serialize NULL values correctly in min/max indexes of MergeTree parts #7234 ([Alexander Kuzmenkov](#) •))

**ClickHouse release 19.15.2.2, 2019-10-01**

## NEW FEATURE

- Tiered storage: support to use multiple storage volumes for tables with MergeTree engine. It's possible to store fresh • data on SSD and automatically move old data to HDD. ([example](#)). #4918 ([lgr](#)) #6489 ([alesapin](#) •))
- (Add table function `input` for reading incoming data in `INSERT SELECT` query. #5450 ([palasonic1](#)) #6832 ([Anton Popov](#) •))
- Add a `sparse_hashed` dictionary layout, that is functionally equivalent to the `hashed` layout, but is more memory • efficient. It uses about twice as less memory at the cost of slower value retrieval. #6894 ([Azat Khuzhin](#) •))
- Implement ability to define list of users for access to dictionaries. Only current connected database using. #6907 • (([Guillaume Tassery](#) •))
- (Add `LIMIT` option to `SHOW` query. #6944 ([Philipp Malkovsky](#) •))
- Add `bitmapSubsetLimit(bitmap, range_start, limit)` function, that returns subset of the smallest `limit` values in set that is no • (smaller than `range_start`. #6957 ([Zhichang Yu](#) •))
- (Add `bitmapMin` and `bitmapMax` functions. #6970 ([Zhichang Yu](#) •))
- (Add function `repeat` related to [issue-6648](#) #6999 ([flynn](#) •))

## EXPERIMENTAL FEATURE

- Implement (in memory) Merge Join variant that does not change current pipeline. Result is partially sorted by merge • (key. Set `partial_merge_join = 1` to use this feature. The Merge Join is still in development. #6940 ([Artem Zuikov](#) •))
- Add `S3` engine and table function. It is still in development (no authentication support yet). #5596 ([Vladimir](#) • (Chebotarev •))

## IMPROVEMENT

- Every message read from Kafka is inserted atomically. This resolves almost all known issues with Kafka engine. • (#6950 ([Ivan](#) •))
- Improvements for failover of Distributed queries. Shorten recovery time, also it is now configurable and can be seen in • (`system.clusters` . #6399 ([Vasily Nemkov](#) •))
- (Support numeric values for Enums directly in `IN` section. #6766 #6941 ([dimarub2000](#) •))
- (Support (optional, disabled by default) redirects on URL storage. #6914 ([maqroll](#) •))
- (Add information message when client with an older version connects to a server. #6893 ([Philipp Malkovsky](#) •))
- (Remove maximum backoff sleep time limit for sending data in Distributed tables #6895 ([Azat Khuzhin](#) •))
- Add ability to send profile events (counters) with cumulative values to graphite. It can be enabled under • (`<events_cumulative>` in server config.xml . #6969 ([Azat Khuzhin](#) •))
- Add automatically cast type `T` to `LowCardinality(T)` while inserting data in column of type `LowCardinality(T)` in Native • (format via HTTP. #6891 ([Nikolai Kochetov](#) •))

(Add ability to use function `hex` without using `reinterpretAsString` for `Float32`, `Float64`. #7024 (Mikhail Korotov •

#### BUILD/TESTING/PACKAGING IMPROVEMENT

(Add gdb-index to clickhouse binary with debug info. It will speed up startup time of gdb. #6947 (alesapin •

(Speed up deb packaging with patched dpkg-deb which uses `pietz`. #6960 (alesapin •

(Set `enable_fuzzing = 1` to enable libfuzzer instrumentation of all the project code. #7042 (kyprizel •

(Add split build smoke test in CI. #7061 (alesapin •

(Add build with MemorySanitizer to CI. #7066 (Alexander Kuzmenkov •

(Replace `libsparsehash` with `sparsehash-c11` #6965 (Azat Khuzhin •

#### BUG FIX

Fixed performance degradation of index analysis on complex keys on large tables. This fixes #6924. #7075 (alexey-milovidov •

(Fix logical error causing segfaults when selecting from Kafka empty topic. #6909 (Ivan •

(Fix too early MySQL connection close in MySQLBlockInputStream.cpp. #6882 (Clément Rodriguez •

(Returned support for very old Linux kernels (fix #6841) #6853 (alexey-milovidov •

Fix possible data loss in `insert select` query in case of empty block in input stream. #6834 #6862 #6911 (Nikolai Kochetov •

(Fix for function `ArrayEnumerateUniqRanked` with empty arrays in params #6928 (proller •

(Fix complex queries with array joins and global subqueries. #6934 (Ivan •

(Fix `Unknown identifier` error in ORDER BY and GROUP BY with multiple JOINs #7022 (Artem Zuikov •

(Fixed MSan warning while executing function with `LowCardinality` argument. #7062 (Nikolai Kochetov •

#### BACKWARD INCOMPATIBLE CHANGE

Changed serialization format of bitmap aggregate function states to improve performance. Serialized states of bitmap •  
(from previous versions cannot be read. #6908 (Zhichang Yu

### ClickHouse release 19.14

#### ClickHouse release 19.14.7.15, 2019-10-02

#### BUG FIX

. This release also contains all bug fixes from 19.11.12.69 •

Fixed compatibility for distributed queries between 19.14 and earlier versions. This fixes #7068. #7069 (alexey-milovidov •

#### ClickHouse release 19.14.6.12, 2019-09-19

#### BUG FIX

(Fix for function `ArrayEnumerateUniqRanked` with empty arrays in params. #6928 (proller •

Fixed subquery name in queries with `ARRAY JOIN` and `GLOBAL IN` subquery with alias. Use subquery alias for external •  
(table name if it is specified. #6934 (Ivan

#### BUILD/TESTING/PACKAGING IMPROVEMENT

Fix flapping test `00715_fetch_merged_or_mutated_part_zookeeper` by rewriting it to a shell scripts because it needs to wait •  
(for mutations to apply. #6977 (Alexander Kazakov

Fixed UBSan and MemSan failure in function `groupUniqArray` with empty array argument. It was caused by placing of •

empty `PaddedPODArray` into hash table zero cell because constructor for zero cell value was not called #6937 (Amos Bird)

ClickHouse release 19.14.3.3, 2019-09-10

NEW FEATURE

( WITH FILL modifier for ORDER BY . (continuation of #5069) #6610 (Anton Popov •

( WITH TIES modifier for LIMIT . (continuation of #5069) #6610 (Anton Popov •

Parse unquoted `NULL` literal as `NULL` (if setting `format_csv_unquoted_null_literal_as_null=1` ). Initialize null fields with default values if data type of this field is not nullable (if setting `input_format_null_as_default=1` ). #5990 #6055 (tavplubix

Support for wildcards in paths of table functions `file` and `hdfs` . If the path contains wildcards, the table will be readonly. Example of usage: `select * from hdfs('hdfs://hdfs1:9000/some_dir/another_dir/*/file{0..9}{0..9}')` and `select * from (file('some_dir/{some_file,another_file,yet_another}.tsv', 'TSV', 'value UInt32'))` . #6092 (Olga Khvostikova

New `system.metric_log` table which stores values of `system.events` and `system.metrics` with specified time interval. (#6363 #6467 (Nikita Mikhaylov) #6530 (alexey-milovidov

(Allow to write ClickHouse text logs to `system.text_log` table. #6037 #6103 (Nikita Mikhaylov) #6164 (alexey-milovidov

Show private symbols in stack traces (this is done via parsing symbol tables of ELF files). Added information about file and line number in stack traces if debug info is present. Speedup symbol name lookup with indexing symbols present in program. Added new SQL functions for introspection: `demangle` and `addressToLine` . Renamed function `symbolizeAddress` to `addressToSymbol` for consistency. Function `addressToSymbol` will return mangled name for performance reasons and you have to apply `demangle` . Added setting `allow_introspection_functions` which is turned off (by default. #6201 (alexey-milovidov

Table function `values` (the name is case-insensitive). It allows to read from `VALUES` list proposed in #5984. Example: ( SELECT \* FROM VALUES('a UInt64, s String', (1, 'one'), (2, 'two'), (3, 'three')) . #6217. #6209 (dimarub2000

Added an ability to alter storage settings. Syntax: `ALTER TABLE <table> MODIFY SETTING <setting> = <value>` . #6366 (#6669 #6685 (alesapin

Support for removing of detached parts. Syntax: `ALTER TABLE <table_name> DROP DETACHED PART '<part_id>'` . #6158 ((tavplubix

Table constraints. Allows to add constraint to table definition which will be checked at insert. #5273 (Gleb Novikov) (#6652 (alexey-milovidov

(Suppport for cascaded materialized views. #6324 (Amos Bird

(Turn on query profiler by default to sample every query execution thread once a second. #6283 (alexey-milovidov (Input format ORC . #6454 #6703 (akonyaev90

Added two new functions: `sigmoid` and `tanh` (that are useful for machine learning applications). #6254 (alexey- (milovidov

Function `hasToken(haystack, token)` , `hasTokenCaseInsensitive(haystack, token)` to check if given token is in haystack. Token is a maximal length substring between two non alphanumeric ASCII characters (or boundaries of haystack).

(Token must be a constant string. Supported by `tokenbf_v1` index specialization. #6596, #6662 (Vasily Nemkov

New function `neighbor(value, offset[, default_value])` . Allows to reach prev/next value within column in a block of data. #5925 (Alex Krash) 6685365ab8c5b74f9650492c88a012596eb1b0c6 341e2e4587a18065c2da1ca888c73389f48ce36c Alexey Milovidov

Created a function `currentUser()` , returning login of authorized user. Added alias `user()` for compatibility with MySQL. (#6470 (Alex Krash

New aggregate functions `quantilesExactInclusive` and `quantilesExactExclusive` which were proposed in #5885. #6477 ((dimarub2000

Function `bitmapRange(bitmap, range_begin, range_end)` which returns new set with specified range (not include the

( range\_end ). #6314 (Zhichang Yu

Function geohashesInBox(longitude\_min, latitude\_min, longitude\_max, latitude\_max, precision) which creates array of (precision-long strings of geohash-boxes covering provided area. #6127 (Vasily Nemkov

(Implement support for INSERT query with Kafka tables. #6012 (Ivan

(Added support for \_partition and \_timestamp virtual columns to Kafka engine. #6400 (Ivan

Possibility to remove sensitive data from query\_log , server logs, process list with regexp-based rules.#5710 (filimonov

(

## EXPERIMENTAL FEATURE

Input and output data format Template . It allows to specify custom format string for input and output.#4354 #6727 •  
((tavplubix

Implementation of LIVE VIEW tables that were originally proposed in #2898, prepared in #3925, and then updated in #5541. See #5541 for detailed description. #5541 (vzakaznikov) #6425 (Nikolai Kochetov) #6656 (vzakaznikov) Note .that LIVE VIEW feature may be removed in next versions

## BUG FIX

.This release also contains all bug fixes from 19.13 and 19.11 •

(Fix segmentation fault when the table has skip indices and vertical merge happens.#6723 (alesapin

Fix per-column TTL with non-trivial column defaults. Previously in case of force TTL merge withOPTIMIZE ... FINAL (query, expired values was replaced by type defaults instead of user-specified column defaults. #6796 (Anton Popov

(Fix Kafka messages duplication problem on normal server restart.#6597 (Ivan

Fixed infinite loop when reading Kafka messages. Do not pause/resume consumer on subscription at all - otherwise it (may get paused indefinitely in some scenarios. #6354 (Ivan

Fix Key expression contains comparison between invertible types exception in bitmapContains function. #6136 #6146 •  
(#6156 (dimarub2000

(Fix segfault with enabled optimize\_skip\_unused\_shards and missing sharding key. #6384 (Anton Popov

Fixed wrong code in mutations that may lead to memory corruption. Fixed segfault with read of address0x14c0 that may happed due to concurrent DROP TABLE and SELECT from system.parts or system.parts\_columns . Fixed race condition in preparation of mutation queries. Fixed deadlock caused by OPTIMIZE of Replicated tables and concurrent (modification operations like ALTERs. #6514 (alexey-milovidov

(Removed extra verbose logging in MySQL interface#6389 (alexey-milovidov

(Return the ability to parse boolean settings from 'true' and 'false' in the configuration file.#6278 (alesapin

(Fix crash in quantile and median function over Nullable(Decimal128) . #6378 (Artem Zuikov

Fixed possible incomplete result returned by SELECT query with WHERE condition on primary key contained conversion to Float type. It was caused by incorrect checking of monotonicity in toFloat function. #6248 #6374 ((dimarub2000

Check max\_expanded\_ast\_elements setting for mutations. Clear mutations after TRUNCATE TABLE . #6205 (Winter  
(Zhang

Fix JOIN results for key columns when used with join\_use\_nulls . Attach Nulls instead of columns defaults.#6249 •  
((Artem Zuikov

(Fix for skip indices with vertical merge and alter. Fix for Bad size of marks file exception. #6594 #6713 (alesapin

Fix rare crash in ALTER MODIFY COLUMN and vertical merge when one of merged/altered parts is empty (0 rows) (#6746 #6780 (alesapin

Fixed bug in conversion of LowCardinality types in AggregateFunctionFactory . This fixes #6257. #6281 (Nikolai Kochetov

(

(Fix wrong behavior and possible segfaults in `topK` and `topKWeighted` aggregated functions. #6404 (Anton Popov) •  
    (Fixed unsafe code around `getIdentifier` function. #6401 #6409 (alexey-milovidov) •

Fixed bug in MySQL wire protocol (is used while connecting to ClickHouse from MySQL client). Caused by heap  
    (buffer overflow in `PacketPayloadWriteBuffer`. #6212 (Yuriy Baranov) •  
        (Fixed memory leak in `bitmapSubsetInRange` function. #6819 (Zhichang Yu) •  
            (Fix rare bug when mutation executed after granularity change. #6816 (alesapin) •  
                (Allow protobuf message with all fields by default. #6132 (Vitaly Baranov) •  
                    Resolve a bug with `nullIf` function when we send a `NULL` argument on the second argument. #6446 (Guillaume Tassery) •  
                        Fix rare bug with wrong memory allocation/deallocation in complex key cache dictionaries with string fields which  
                        leads to infinite memory consumption (looks like memory leak). Bug reproduces when string size was a power of two  
                        (starting from eight (8, 16, 32, etc). #6447 (alesapin) •  
                Fixed Gorilla encoding on small sequences which caused exception Cannot write after end of buffer. #6398 #6444 •  
                        ((Vasily Nemkov)  
                        (Allow to use not nullable types in JOINs with `join_use_nulls` enabled. #6705 (Artem Zuikov) •  
                        (Disable `Poco::AbstractConfiguration` substitutions in query in `clickhouse-client`. #6706 (alexey-milovidov) •  
                        (Avoid deadlock in REPLACE PARTITION. #6677 (alexey-milovidov) •  
                        (Using `arrayReduce` for constant arguments may lead to segfault. #6242 #6326 (alexey-milovidov) •  
                (Fix inconsistent parts which can appear if replica was restored after `DROP PARTITION`. #6522 #6523 (tavplubix) •  
                        (Fixed hang in `JSONExtractRaw` function. #6195 #6198 (alexey-milovidov) •  
                (Fix bug with incorrect skip indices serialization and aggregation with adaptive granularity. #6594. #6748 (alesapin) •  
                        (Fix `WITH ROLLUP` and `WITH CUBE` modifiers of `GROUP BY` with two-level aggregation. #6225 (Anton Popov) •  
                            (Fix bug with writing secondary indices marks with adaptive granularity. #6126 (alesapin) •  
                Fix initialization order while server startup. Since `StorageMergeTree::background_task_handle` is initialized in `startup()` the  
                        (`MergeTreeBlockOutputStream::write()` may try to use it before initialization. Just check if it is initialized. #6080 (Ivan  
                            (Clearing the data buffer from the previous read operation that was completed with an error. #6026 (Nikolay) •  
                Fix bug with enabling adaptive granularity when creating a new replica for Replicated\*MergeTree table. #6394 #6452 •  
                        ((alesapin)  
                Fixed possible crash during server startup in case of exception happened in libunwind during exception at access to  
                        (uninitialized `ThreadStatus` structure. #6456 (Nikita Mikhaylov) •  
                        (Fix crash in `yandexConsistentHash` function. Found by fuzz test. #6304 #6305 (alexey-milovidov) •  
                Fixed the possibility of hanging queries when server is overloaded and global thread pool becomes near full. This  
                        have higher chance to happen on clusters with large number of shards (hundreds), because distributed queries  
                        allocate a thread per connection to each shard. For example, this issue may reproduce if a cluster of 330 shards is  
                        processing 30 concurrent distributed queries. This issue affects all versions starting from 19.2. #6301 (alexey-  
                            (milovidov)  
                        (Fixed logic of `arrayEnumerateUniqRanked` function. #6423 (alexey-milovidov) •  
                        (Fix segfault when decoding symbol table. #6603 (Amos Bird) •  
                Fixed irrelevant exception in cast of `LowCardinalityNullable` to not-Nullable column in case if it doesn't contain Nulls  
                        (e.g. in query like `SELECT CAST(CAST('Hello' AS LowCardinalityNullable(String))) AS String`). #6094 #6119 (Nikolai  
                            (Kochetov)  
                        (Removed extra quoting of description in `system.settings` table. #6696 #6699 (alexey-milovidov) •  
                        (Avoid possible deadlock in `TRUNCATE` of Replicated table. #6695 (alexey-milovidov) •

(Fix reading in order of sorting key. #6189 (Anton Popov) •  
(Fix ALTER TABLE ... UPDATE query for tables with enable\_mixed\_granularity\_parts=1. #6543 (alesapin) •  
Fix bug opened by #4405 (since 19.4.0). Reproduces in queries to Distributed tables over MergeTree tables when we •  
(doesn't query any columns ( SELECT 1 ). #6236 (alesapin) •  
Fixed overflow in integer division of signed type to unsigned type. The behaviour was exactly as in C or C++ language •  
(integer promotion rules) that may be surprising. Please note that the overflow is still possible when dividing large  
signed number to large unsigned number or vice-versa (but that case is less usual). The issue existed in all server  
(versions. #6214 #6233 (alexey-milovidov) •  
Limit maximum sleep time for throttling when max\_execution\_speed or max\_execution\_speed\_bytes is set. Fixed false •  
(errors like Estimated query execution time (inf seconds) is too long. #5547 #6232 (alexey-milovidov) •  
Fixed issues about using MATERIALIZED columns and aliases in MaterializedView. #448 #3484 #3450 #2878 #2285 •  
(#3796 (Amos Bird) #6316 (alexey-milovidov) •  
(Fix FormatFactory behaviour for input streams which are not implemented as processor. #6495 (Nikolai Kochetov) •  
(Fixed typo. #6631 (Alex Ryndin) •  
(Typo in the error message ( is -> are ). #6839 (Denis Zhuravlev) •  
Fixed error while parsing of columns list from string if type contained a comma (this issue was relevant forFile , URL , •  
( HDFS storages) #6217. #6209 (dimarub2000) •

#### SECURITY FIX

. This release also contains all bug security fixes from 19.13 and 19.11 •  
Fixed the possibility of a fabricated query to cause server crash due to stack overflow in SQL parser. Fixed the •  
possibility of stack overflow in Merge and Distributed tables, materialized views and conditions for row-level security  
(that involve subqueries. #6433 (alexey-milovidov) •

#### IMPROVEMENT

(Correct implementation of ternary logic for AND/OR. #6048 (Alexander Kazakov) •  
Now values and rows with expired TTL will be removed after OPTIMIZE ... FINAL query from old parts without TTL •  
infos or with outdated TTL infos, e.g. after ALTER ... MODIFY TTL query. Added queries SYSTEM STOP/START TTL  
(MERGES to disallow/allow assign merges with TTL and filter expired values in all merges #6274 (Anton Popov) •  
Possibility to change the location of ClickHouse history file for client using CLICKHOUSE\_HISTORY\_FILE env. #6840 •  
((filimonov)  
(Remove dry\_run flag from InterpreterSelectQuery . . . #6375 (Nikolai Kochetov) •  
(Support ASOF JOIN with ON section. #6211 (Artem Zuikov) •  
Better support of skip indexes for mutations and replication. Support for MATERIALIZE/CLEAR INDEX ... IN PARTITION •  
(query. UPDATE x = x recalculates all indices that use column x. #5053 (Nikita Vasilev) •  
Allow to ATTACH live views (for example, at the server startup) regardless to allow\_experimental\_live\_view setting. •  
(#6754 (alexey-milovidov) •  
For stack traces gathered by query profiler, do not include stack frames generated by the query profiler itself #6250 •  
((alexey-milovidov)  
(Now table functions values , file , url , hdfs have support for ALIAS columns. #6255 (alexey-milovidov) •  
Throw an exception if config.d file doesn't have the corresponding root element as the config file. #6123 (dimarub2000) •  
(

(Print extra info in exception message for no space left on device . #6182, #6252 #6352 (tavplubix) •

When determining shards of a Distributed table to be covered by a read query (for optimize\_skip\_unused\_shards = 1) •  
ClickHouse now checks conditions from both prewhere and where clauses of select statement. #6521 (Alexander •

(Kazakov

Enabled SIMDJSON for machines without AVX2 but with SSE 4.2 and PCLMUL instruction set. #6285 #6320 (alexey-milovidov) •

ClickHouse can work on filesystems without `O_DIRECT` support (such as ZFS and Btrfs) without additional tuning. (#4449 #6730 (alexey-milovidov) •

(Support push down predicate for final subquery. #6120 (TCeason) #6162 (alexey-milovidov) •

(Better JOIN ON keys extraction #6131 (Artem Zuikov) •

(Updated SIMDJSON. #6285. #6306 (alexey-milovidov) •

(Optimize selecting of smallest column for `SELECT count()` query. #6344 (Amos Bird) •

Added strict parameter in `windowFunnel()`. When the strict is set, the `windowFunnel()` applies conditions only for the (unique values. #6548 (achimbab) •

(Safer interface of `mysqlxx::Pool`. #6150 (avasiliev) •

(Options line size when executing with `--help` option now corresponds with terminal size. #6590 (dimarub2000) •

(Disable "read in order" optimization for aggregation without keys. #6599 (Anton Popov) •

HTTP status code for `INCORRECT_DATA` and `TYPE_MISMATCH` error codes was changed from default 500 Internal (Server Error to 400 Bad Request. #6271 (Alexander Rodin) •

Move Join object from `ExpressionAction` into `AnalyzedJoin`. `ExpressionAnalyzer` and `ExpressionAction` do not know about (Join class anymore. Its logic is hidden by `AnalyzedJoin` iface. #6801 (Artem Zuikov) •

Fixed possible deadlock of distributed queries when one of shards is localhost but the query is sent via network (connection. #6759 (alexey-milovidov) •

(Changed semantic of multiple tables `RENAME` to avoid possible deadlocks. #6757. #6756 (alexey-milovidov) •

Rewritten MySQL compatibility server to prevent loading full packet payload in memory. Decreased memory consumption for each connection to approximately `2 * DBMS_DEFAULT_BUFFER_SIZE` (read/write buffers). #5811 ((Yuriy Baranov) •

Move AST alias interpreting logic out of parser that doesn't have to know anything about query semantics #6108 ((Artem Zuikov) •

(Slightly more safe parsing of `NamesAndTypesList`. #6408. #6410 (alexey-milovidov) •

clickhouse-copier : Allow use `where_condition` from config with `partition_key` alias in query for checking partition (existence (Earlier it was used only in reading data queries). #6577 (proller) •

(Added optional message argument in `throwIf`. (#5772) #6329 (Vdimir) •

Server exception got while sending insertion data is now being processed in client as well #5891 #6711 ((dimarub2000) •

Added a metric `DistributedFilesToInsert` that shows the total number of files in filesystem that are selected to send to (remote servers by Distributed tables. The number is summed across all shards. #6600 (alexey-milovidov) •

(Move most of JOINs prepare logic from `ExpressionAction/ExpressionAnalyzer` to `AnalyzedJoin`. #6785 (Artem Zuikov) • (Fix TSan warning 'lock-order-inversion'. #6740 (Vasily Nemkov) •

Better information messages about lack of Linux capabilities. Logging fatal errors with "fatal" level, that will make it (easier to find in `system.text_log`. #6441 (alexey-milovidov) •

When enable dumping temporary data to the disk to restrict memory usage during `GROUP BY`, `ORDER BY`, it didn't check the free disk space. The fix add a new setting `min_free_disk_space`, when the free disk space is smaller than the threshold, the query will stop and throw `ErrorCodes::NOT_ENOUGH_SPACE`. #6678 (WeiQing Xu) #6691 (alexey-milovidov) •

Removed recursive rwlock by thread. It makes no sense, because threads are reused between queries. `SELECT` query may acquire a lock in one thread, hold a lock from another thread and exit from first thread. In the same time, •

first thread can be reused by `DROP` query. This will lead to false "Attempt to acquire exclusive lock recursively" messages. #6771 (alexey-milovidov)

(Split `ExpressionAnalyzer.appendJoin()` . Prepare a place in `ExpressionAnalyzer` for `MergeJoin`. #6524 (Artem Zuikov) •  
(Added `mysql_native_password` authentication plugin to MySQL compatibility server. #6194 (Yuriy Baranov) •  
Less number of `clock_gettime` calls; fixed ABI compatibility between debug/release in Allocator (insignificant issue). (#6197 (alexey-milovidov) •  
Move `collectUsedColumns` from `ExpressionAnalyzer` to `SyntaxAnalyzer` . SyntaxAnalyzer makes `required_source_columns` (itself now. #6416 (Artem Zuikov) •  
Add setting `joined_subquery_requires_alias` to require aliases for subselects and table functions in `FROM` that more than (one table is present (i.e. queries with `JOINS`). #6733 (Artem Zuikov) •  
(Extract `GetAggregatesVisitor` class from `ExpressionAnalyzer` . #6458 (Artem Zuikov) •  
( `system.query_log` : change data type of type `column` to `Enum` . #6265 (Nikita Mikhaylov) •  
(Static linking of `sha256_password` authentication plugin. #6512 (Yuriy Baranov) •  
Avoid extra dependency for the setting `compile` to work. In previous versions, the user may get error like `cannot open (crti.o , unable to find library -lc etc.` #6309 (alexey-milovidov) •  
(More validation of the input that may come from malicious replica. #6303 (alexey-milovidov) •  
Now `clickhouse-obfuscator` file is available in `clickhouse-client` package. In previous versions it was available as ( `clickhouse obfuscator` (with whitespace). #5816 #6609 (dimarub2000) •  
Fixed deadlock when we have at least two queries that read at least two tables in different order and another query (that performs DDL operation on one of tables. Fixed another very rare deadlock. #6764 (alexey-milovidov) •  
Added `os_thread_ids` column to `system.processes` and `system.query_log` for better debugging possibilities. #6763 ((alexey-milovidov) •  
A workaround for PHP `mysqlnd` extension bugs which occur when `sha256_password` is used as a default (authentication plugin (described in #6031). #6113 (Yuriy Baranov) •  
(Remove unneeded place with changed nullability columns. #6693 (Artem Zuikov) •  
Set default value of `queue_max_wait_ms` to zero, because current value (five seconds) makes no sense. There are rare circumstances when this settings has any use. Added settings `replace_running_query_max_wait_ms` , ( `kafka_max_wait_ms` and `connection_pool_max_wait_ms` for disambiguation. #6692 (alexey-milovidov) •  
Extract `SelectQueryExpressionAnalyzer` from `ExpressionAnalyzer` . Keep the last one for non-select queries. #6499 (Artem Zuikov) •  
(Removed duplicating input and output formats. #6239 (Nikolai Kochetov) •  
(Allow user to override `poll_interval` and `idle_connection_timeout` settings on connection. #6230 (alexey-milovidov) •  
MergeTree now has an additional option `ttl_only_drop_parts` (disabled by default) to avoid partial pruning of parts, so (that they dropped completely when all the rows in a part are expired. #6191 (Sergi Vladyslav) •  
Type checks for set index functions. Throw exception if function got a wrong type. This fixes fuzz test with UBSan. (#6511 (Nikita Vasilev) •  

## PERFORMANCE IMPROVEMENT

Optimize queries with `ORDER BY` expressions clause, where `expressions` have coinciding prefix with sorting key in ( MergeTree tables. This optimization is controlled by `optimize_read_in_order` setting. #6054 #6629 (Anton Popov) •  
(Allow to use multiple threads during parts loading and removal. #6372 #6074 #6438 (alexey-milovidov) •  
Implemented batch variant of updating aggregate function states. It may lead to performance benefits #6435 (alexey- (milovidov) •  
Using `FastOps` library for functions `exp` , `log` , `sigmoid` , `tanh` . `FastOps` is a fast vector math library from Michael (

Parakhin (Yandex CTO). Improved performance of `exp` and `log` functions more than 6 times. The functions `exp` and `log` from `Float32` argument will return `Float32` (in previous versions they always return `Float64`). Now `exp(nan)` may return `inf`. The result of `exp` and `log` functions may be not the nearest machine representable number to the true (answer. #6254 (alexey-milovidov) Using Danila Kutenin variant to make fastops working#6317 (alexey-milovidov

(Disable consecutive key optimization for `UInt8/16` . #6298 #6701 (akuzm •

Improved performance of `simdjson` library by getting rid of dynamic allocation in `ParsedJson::Iterator` . #6479 (Vitaly Baranov

(Pre-fault pages when allocating memory with `mmap()` . #6667 (akuzm •

(Fix performance bug in `Decimal` comparison. #6380 (Artem Zuikov •

#### BUILD/TESTING/PACKAGING IMPROVEMENT

(Remove Compiler (runtime template instantiation) because we've win over it's performance.#6646 (alexey-milovidov •

(Added performance test to show degradation of performance in gcc-9 in more isolated way#6302 (alexey-milovidov •

Added table function `numbers_mt` , which is multithreaded version of `numbers` . Updated performance tests with hash functions. #6554 (Nikolai Kochetov

(Comparison mode in `clickhouse-benchmark` #6220 #6343 (dimarub2000 •

Best effort for printing stack traces. Also added `SIGPROF` as a debugging signal to print stack trace of a running thread. #6529 (alexey-milovidov

(Every function in its own file, part 10.#6321 (alexey-milovidov •

(Remove doubled const `TABLE_IS_READ_ONLY` . #6566 (filimonov •

(Formatting changes for `StringHashMap` PR #5417. #6700 (akuzm •

(Better subquery for join creation in `ExpressionAnalyzer` . #6824 (Artem Zuikov •

(Remove a redundant condition (found by PVS Studio).#6775 (akuzm •

(Separate the hash table interface for `ReverselIndex` . #6672 (akuzm •

(Refactoring of settings. #6689 (alesapin •

(Add comments for `set` index functions. #6319 (Nikita Vasilev •

(Increase OOM score in debug version on Linux.#6152 (akuzm •

(HDFS HA now work in debug build.#6650 (Weiqing Xu •

(Added a test to `transform_query_for_external_database` . #6388 (alexey-milovidov •

(Add test for multiple materialized views for Kafka table.#6509 (Ivan •

(Make a better build scheme. #6500 (Ivan •

(Fixed `test_external_dictionaries` integration in case it was executed under non root user.#6507 (Nikolai Kochetov •

The bug reproduces when total size of written packets exceeds `DBMS_DEFAULT_BUFFER_SIZE` . #6204 (Yuri Baranov

(Added a test for `RENAME` table race condition #6752 (alexey-milovidov •

(Avoid data race on Settings in `KILL QUERY` . #6753 (alexey-milovidov •

(Add integration test for handling errors by a cache dictionary.#6755 (Vitaly Baranov •

(Disable parsing of ELF object files on Mac OS, because it makes no sense#6578 (alexey-milovidov •

(Attempt to make changelog generator better.#6327 (alexey-milovidov •

(Adding `-Wshadow` switch to the GCC.#6325 (kreuzerkrieg •

(Removed obsolete code for `mimalloc` support. #6715 (alexey-milovidov •

`zlib-ng` determines x86 capabilities and saves this info to global variables. This is done in `defalteInit` call, which may •

(be made by different threads simultaneously. To avoid multithreaded writes, do it on library startup. #6141 (akuzm  
    (Regression test for a bug which in join which was fixed in#5192. #6147 (Bakhtiyor Ruziev •  
        (Fixed MSan report. #6144 (alexey-milovidov •  
            (Fix flapping TTL test. #6782 (Anton Popov •  
                (Fixed false data race in MergeTreeDataPart::is\_frozen field. #6583 (alexey-milovidov •  
Fixed timeouts in fuzz test. In previous version, it managed to find false hangup in querySELECT \* FROM  
    (numbers\_mt(gccMurmurHash(")) . #6582 (alexey-milovidov •  
        (Added debug checks to static\_cast of columns. #6581 (alexey-milovidov •  
    Support for Oracle Linux in official RPM packages.#6356 #6585 (alexey-milovidov •  
        (Changed json perftests from once to loop type. #6536 (Nikolai Kochetov •  
    (odbc-bridge.cpp defines main() so it should not be included in clickhouse-lib. #6538 (Orivej Desh •  
        (Test for crash in FULL|RIGHT JOIN with nulls in right table's keys.#6362 (Artem Zuikov •  
        (Added a test for the limit on expansion of aliases just in case.#6442 (alexey-milovidov •  
    (Switched from boost::filesystem to std::filesystem where appropriate. #6253 #6385 (alexey-milovidov •  
        (Added RPM packages to website. #6251 (alexey-milovidov •  
        (Add a test for fixed Unknown identifier exception in IN section. #6708 (Artem Zuikov •  
    (Simplify shared\_ptr\_helper because people facing difficulties understanding it.#6675 (alexey-milovidov •  
        (Added performance tests for fixed Gorilla and DoubleDelta codec. #6179 (Vasily Nemkov •  
        (Split the integration test test\_dictionaries into 4 separate tests. #6776 (Vitaly Baranov •  
            (Fix PVS-Studio warning in PipelineExecutor . #6777 (Nikolai Kochetov •  
                (Allow to use library dictionary source with ASan. #6482 (alexey-milovidov •  
                (Added option to generate changelog from a list of PRs. #6350 (alexey-milovidov •  
                    (Lock the TinyLog storage when reading. #6226 (akuzm •  
                        (Check for broken symlinks in CI. #6634 (alexey-milovidov •  
    (Increase timeout for "stack overflow" test because it may take a long time in debug build#6637 (alexey-milovidov •  
        (Added a check for double whitespaces. #6643 (alexey-milovidov •  
    Fix new/delete memory tracking when build with sanitizers. Tracking is not clear. It only prevents memory limit  
        (exceptions in tests. #6450 (Artem Zuikov •  
            (Enable back the check of undefined symbols while linking.#6453 (Ivan •  
                (Avoid rebuilding hyperscan every day. #6307 (alexey-milovidov •  
                    (Fixed UBSan report in ProtobufWriter . #6163 (alexey-milovidov •  
    (Don't allow to use query profiler with sanitizers because it is not compatible.#6769 (alexey-milovidov •  
        (Add test for reloading a dictionary after fail by timer.#6114 (Vitaly Baranov •  
        (Fix inconsistency in PipelineExecutor::prepareProcessor argument type. #6494 (Nikolai Kochetov •  
            (Added a test for bad URLs. #6493 (alexey-milovidov •  
Added more checks to CAST function. This should get more information about segmentation fault in fuzzy test#6346 •  
    ((Nikolai Kochetov  
        (Added gcc-9 support to docker/builder container that builds image locally. #6333 (Gleb Novikov •  
            (Test for primary key with LowCardinality(String) . #5044 #6219 (dimarub2000 •  
                (Fixed tests affected by slow stack traces printing. #6315 (alexey-milovidov •

(Add a test case for crash in `groupUniqArray` fixed in #6029. #4402 #6129 (akuzm •  
(Fixed indices mutations tests. #6645 (Nikita Vasilev •  
(In performance test, do not read query log for queries we didn't run. #6427 (akuzm •  
Materialized view now could be created with any low cardinality types regardless to the setting about suspicious low •  
(cardinality types. #6428 (Olga Khvostikova •  
(Updated tests for `send_logs_level` setting. #6207 (Nikolai Kochetov •  
(Fix build under gcc-8.2. #6196 (Max Akhmedov •  
(Fix build with internal libc++. #6724 (Ivan •  
(Fix shared build with rdafka library #6101 (Ivan •  
(Fixes for Mac OS build (incomplete). #6390 (alexey-milovidov) #6429 (alex-zaitsev •  
(Fix "splitted" build. #6618 (alexey-milovidov •  
(Other build fixes: #6186 (Amos Bird) #6486 #6348 (vxider) #6744 (Ivan) #6016 #6421 #6491 (proller •

#### BACKWARD INCOMPATIBLE CHANGE

Removed rarely used table function `catBoostPool` and storage `CatBoostPool`. If you have used this table function, •  
please write email to `clickhouse-feedback@yandex-team.com`. Note that CatBoost integration remains and will be •  
(supported. #6279 (alexey-milovidov •

Disable `ANY RIGHT JOIN` and `ANY FULL JOIN` by default. Set `any_join_distinct_right_table_keys` setting to enable them. •  
(#5126 #6351 (Artem Zuikov •

### ClickHouse release 19.13

#### ClickHouse release 19.13.6.51, 2019-10-02

##### BUG FIX

. This release also contains all bug fixes from 19.11.12.69 •

#### ClickHouse release 19.13.5.44, 2019-09-20

##### BUG FIX

. This release also contains all bug fixes from 19.14.6.12 •

Fixed possible inconsistent state of table while executing `DROP` query for replicated table while zookeeper is not •  
(accessible. #6045 #6413 (Nikita Mikhaylov •

(Fix for data race in `StorageMerge`. #6717 (alexey-milovidov •

(Fix bug introduced in query profiler which leads to endless recv from socket. #6386 (alesapin •

(Fix excessive CPU usage while executing `JSONExtractRaw` function over a boolean value. #6208 (Vitaly Baranov •  
(Fixes the regression while pushing to materialized view. #6415 (Ivan •

Table function `url` had the vulnerability allowed the attacker to inject arbitrary HTTP headers in the request. This •  
(issue was found by Nikita Tikhomirov. #6466 (alexey-milovidov •

(Fix useless AST check in Set index. #6510 #6651 (Nikita Vasilev •

(Fixed parsing of `AggregateFunction` values embedded in query. #6575 #6773 (Zhichang Yu •

(Fixed wrong behaviour of `trim` functions family. #6647 (alexey-milovidov •

#### ClickHouse release 19.13.4.32, 2019-09-10

##### BUG FIX

. This release also contains all bug security fixes from 19.11.9.52 and 19.11.10.54 •  
(Fixed data race in system.parts table and ALTER query. #6245 #6513 (alexey-milovidov) •  
Fixed mismatched header in streams happened in case of reading from empty distributed table with sample and •  
(prewhere. #6167 (Lixiang Qian) #6823 (Nikolai Kochetov) •  
(Fixed crash when using IN clause with a subquery with a tuple. #6125 #6550 (tavplubix) •  
(Fix case with same column names in GLOBAL JOIN ON section. #6181 (Artem Zuikov) •  
(Fix crash when casting types to Decimal that do not support it. Throw exception instead. #6297 (Artem Zuikov) •  
(Fixed crash in extractAll() function. #6644 (Artem Zuikov) •  
Query transformation for MySQL , ODBC , JDBC table functions now works properly for SELECT WHERE queries with •  
(multiple AND expressions. #6381 #6676 (dimarub2000)  
(Added previous declaration checks for MySQL 8 integration. #6569 (Rafael David Tinoco) •

#### SECURITY FIX

Fix two vulnerabilities in codecs in decompression phase (malicious user can fabricate compressed data that will lead •  
(to buffer overflow in decompression). #6670 (Artem Zuikov)

### ClickHouse release 19.13.3.26, 2019-08-22

#### BUG FIX

(Fix ALTER TABLE ... UPDATE query for tables with enable\_mixed\_granularity\_parts=1 . #6543 (alesapin) •  
(Fix NPE when using IN clause with a subquery with a tuple. #6125 #6550 (tavplubix) •

Fixed an issue that if a stale replica becomes alive, it may still have data parts that were removed by DROP •  
(PARTITION. #6522 #6523 (tavplubix)  
(Fixed issue with parsing CSV #6426 #6559 (tavplubix) •

(Fixed data race in system.parts table and ALTER query. This fixes #6245. #6513 (alexey-milovidov) •

Fixed wrong code in mutations that may lead to memory corruption. Fixed segfault with read of address0x14c0 that •  
may happen due to concurrent DROP TABLE and SELECT from system.parts or system.parts\_columns . Fixed race  
condition in preparation of mutation queries. Fixed deadlock caused by OPTIMIZE of Replicated tables and concurrent  
(modification operations like ALTERs. #6514 (alexey-milovidov)

(Fixed possible data loss after ALTER DELETE query on table with skipping index. #6224 #6282 (Nikita Vasilev) •

#### SECURITY FIX

If the attacker has write access to ZooKeeper and is able to run custom server available from the network where •  
ClickHouse run, it can create custom-built malicious server that will act as ClickHouse replica and register it in  
ZooKeeper. When another replica will fetch data part from malicious replica, it can force clickhouse-server to write to  
(arbitrary path on filesystem. Found by Eldar Zaitov, information security team at Yandex. #6247 (alexey-milovidov)

### ClickHouse release 19.13.2.19, 2019-08-14

#### NEW FEATURE

Sampling profiler on query level. Example. #4247 (laplab) #6124 (alexey-milovidov) #6250 #6283 #6386 •

Allow to specify a list of columns with COLUMNS('regexp') expression that works like a more sophisticated variant of \* •  
(asterisk. #5951 (mfridental), (alexey-milovidov)

( CREATE TABLE AS table\_function() ) is now possible #6057 (dimarub2000) •

Adam optimizer for stochastic gradient descent is used by default in stochasticLinearRegression() and •  
stochasticLogisticRegression() aggregate functions, because it shows good quality without almost any tuning. #6000  
((Quid37))

(Added functions for working with the custom week number #5212 (Andy Yang) •

( RENAME queries now work with all storages. #5953 (Ivan) •

Now client receive logs from server with any desired level by setting `send_logs_level` regardless to the log level (specified in server settings. #5964 (Nikita Mikhaylov) •

#### BACKWARD INCOMPATIBLE CHANGE

The setting `input_format_defaults_for_omitted_fields` is enabled by default. Inserts in Distributed tables need this setting to be the same on cluster (you need to set it before rolling update). It enables calculation of complex default expressions for omitted fields in `JSONEachRow` and `CSV*` formats. It should be the expected behavior but may lead (to negligible performance difference. #6043 (Artem Zuikov), #5625 (akuzm) •

#### EXPERIMENTAL FEATURES

New query processing pipeline. Use `experimental_use_processors=1` option to enable it. Use for your own trouble. (#4914 (Nikolai Kochetov) •

#### BUG FIX

.Kafka integration has been fixed in this version •

Fixed `DoubleDelta` encoding of `Int64` for large `DoubleDelta` values, improved `DoubleDelta` encoding for random data for ( `Int32` . #5998 (Vasily Nemkov) •

Fixed overestimation of `max_rows_to_read` if the setting `merge_tree_uniform_read_distribution` is set to 0. #6019 (alexey-milovidov) •

#### IMPROVEMENT

Throws an exception if `config.d` file doesn't have the corresponding root element as the config file #6123 ((dimarub2000) •

#### PERFORMANCE IMPROVEMENT

(Optimize `count()` . Now it uses the smallest column (if possible). #6028 (Amos Bird) •

#### BUILD/TESTING/PACKAGING IMPROVEMENT

(Report memory usage in performance tests. #5899 (akuzm) •

(Fix build with external `libcxx` #6010 (Ivan) •

(Fix shared build with `rdkafka` library #6101 (Ivan) •

## ClickHouse release 19.11

### ClickHouse release 19.11.13.74, 2019-11-01

#### BUG FIX

Fixed rare crash in `ALTER MODIFY COLUMN` and vertical merge when one of merged/altered parts is empty (0 rows). (#6780 (alesapin) •

Manual update of `SIMDJSON` . This fixes possible flooding of `stderr` files with bogus json diagnostic messages #7548 ((Alexander Kazakov) •

(Fixed bug with `mrk` file extension for mutations (alesapin) •

### ClickHouse release 19.11.12.69, 2019-10-02

#### BUG FIX

Fixed performance degradation of index analysis on complex keys on large tables. This fixes #6924. #7075 (alexey- •

(milovidov

Avoid rare SIGSEGV while sending data in tables with Distributed engine Failed to send batch: file with index XXXXX is •  
(absent). #7032 (Azat Khuzhin

(Fix Unknown identifier with multiple joins. This fixes#5254. #7022 (Artem Zuikov •

## ClickHouse release 19.11.11.57, 2019-09-13

(Fix logical error causing segfaults when selecting from Kafka empty topic.#6902 #6909 (ivan •

(Fix for function ArrayEnumerateUniqRanked with empty arrays in params.#6928 (proller •

## ClickHouse release 19.11.10.54, 2019-09-10

### BUG FIX

Do store offsets for Kafka messages manually to be able to commit them all at once for all partitions. Fixes potential •  
(duplication in "one consumer - many partitions" scenario. #6872 (ivan

## ClickHouse release 19.11.9.52, 2019-09-6

(Improve error handling in cache dictionaries. #6737 (Vitaly Baranov •

(Fixed bug in function arrayEnumerateUniqRanked . #6779 (proller •

(Fix JSONExtract function while extracting a Tuple from JSON. #6718 (Vitaly Baranov •

(Fixed possible data loss after ALTER DELETE query on table with skipping index. #6224 #6282 (Nikita Vasilev •

(Fixed performance test. #6392 (alexey-milovidov •

(Parquet: Fix reading boolean columns. #6579 (alexey-milovidov •

(Fixed wrong behaviour of nullif function for constant arguments. #6518 (Guillaume Tassery) #6580 (alexey-milovidov •

(Fix Kafka messages duplication problem on normal server restart. #6597 (ivan •

Fixed an issue when long ALTER UPDATE or ALTER DELETE may prevent regular merges to run. Prevent mutations •  
(from executing if there is no enough free threads available. #6502 #6617 (tavplubix

(Fixed error with processing "timezone" in server configuration file. #6709 (alexey-milovidov •

(Fix kafka tests. #6805 (ivan •

### SECURITY FIX

If the attacker has write access to ZooKeeper and is able to run custom server available from the network where •  
ClickHouse runs, it can create custom-built malicious server that will act as ClickHouse replica and register it in  
ZooKeeper. When another replica will fetch data part from malicious replica, it can force clickhouse-server to write to  
(arbitrary path on filesystem. Found by Eldar Zaitov, information security team at Yandex. #6247 (alexey-milovidov

## ClickHouse release 19.11.8.46, 2019-08-22

### BUG FIX

(Fix ALTER TABLE ... UPDATE query for tables with enable\_mixed\_granularity\_parts=1 . #6543 (alesapin •

(Fix NPE when using IN clause with a subquery with a tuple. #6125 #6550 (tavplubix •

Fixed an issue that if a stale replica becomes alive, it may still have data parts that were removed by DROP •  
(PARTITION. #6522 #6523 (tavplubix

(Fixed issue with parsing CSV#6426 #6559 (tavplubix •

(Fixed data race in system.parts table and ALTER query. This fixes#6245. #6513 (alexey-milovidov •

Fixed wrong code in mutations that may lead to memory corruption. Fixed segfault with read of address0x14c0 that •  
may happed due to concurrent DROP TABLE and SELECT from system.parts or system.parts\_columns . Fixed race

condition in preparation of mutation queries. Fixed deadlock caused by `OPTIMIZE` of Replicated tables and concurrent modification operations like `ALTERs`. #6514 (alexey-milovidov)

## ClickHouse release 19.11.7.40, 2019-08-14

### BUG FIX

- Kafka integration has been fixed in this version
- (Fix segfault when using `arrayReduce` for constant arguments. #6326 (alexey-milovidov))
- (Fixed `toFloat()` monotonicity. #6374 (dimarub2000))
- (Fix segfault with enabled `optimize_skip_unused_shards` and missing sharding key. #6384 (CurtizJ))
- (Fixed logic of `arrayEnumerateUniqRanked` function. #6423 (alexey-milovidov))
- (Removed extra verbose logging from MySQL handler. #6389 (alexey-milovidov))
- (Fix wrong behavior and possible segfaults in `topK` and `topKWeighted` aggregated functions. #6404 (CurtizJ))
- Do not expose virtual columns in `system.columns` table. This is required for backward compatibility. #6406 (alexey-milovidov)
- (Fix bug with memory allocation for string fields in complex key cache dictionary. #6447 (alesapin))
- (Fix bug with enabling adaptive granularity when creating new replica for `Replicated*MergeTree` table. #6452 (alesapin))
  - (Fix infinite loop when reading Kafka messages. #6354 (abyss7))
- Fixed the possibility of a fabricated query to cause server crash due to stack overflow in SQL parser and possibility of stack overflow in Merge and Distributed tables #6433 (alexey-milovidov)
  - (Fixed Gorilla encoding error on small sequences. #6444 (Enmk))

### IMPROVEMENT

- (Allow user to override `poll_interval` and `idle_connection_timeout` settings on connection. #6230 (alexey-milovidov))

## ClickHouse release 19.11.5.28, 2019-08-05

### BUG FIX

- (Fixed the possibility of hanging queries when server is overloaded. #6301 (alexey-milovidov))
- (Fix FPE in `yandexConsistentHash` function. This fixes #6304. #6126 (alexey-milovidov))
- Fixed bug in conversion of `LowCardinality` types in `AggregateFunctionFactory`. This fixes #6257. #6281 (Nikolai Kochetov)
  - (
  - (Fix parsing of `bool` settings from `true` and `false` strings in configuration files. #6278 (alesapin))
- Fix rare bug with incompatible stream headers in queries to `Distributed` table over `MergeTree` table when part of ( WHERE moves to PREWHERE . #6236 (alesapin))
- (Fixed overflow in integer division of signed type to unsigned type. This fixes #6214. #6233 (alexey-milovidov))

### BACKWARD INCOMPATIBLE CHANGE

- . Kafka still broken

## ClickHouse release 19.11.4.24, 2019-08-01

### BUG FIX

- (Fix bug with writing secondary indices marks with adaptive granularity. #6126 (alesapin))
- (Fix `WITH ROLLUP` and `WITH CUBE` modifiers of `GROUP BY` with two-level aggregation. #6225 (Anton Popov))
- (Fixed hang in `JSONExtractRaw` function. Fixed #6195 #6198 (alexey-milovidov))

(Fix segfault in ExternalLoader::reloadOutdated(). #6082 (Vitaly Baranov •  
Fixed the case when server may close listening sockets but not shutdown and continue serving remaining queries. •  
You may end up with two running clickhouse-server processes. Sometimes, the server may return an error  
( bad\_function\_call for remaining queries. #6231 (alexey-milovidov  
Fixed useless and incorrect condition on update field for initial loading of external dictionaries via ODBC, MySQL, •  
(ClickHouse and HTTP. This fixes #6069 #6083 (alexey-milovidov  
Fixed irrelevant exception in cast of LowCardinality(Nullable) to not-Nullable column in case if it doesn't contain Nulls •  
(e.g. in query like SELECT CAST(CAST('Hello' AS LowCardinality(Nullable(String))) AS String) . #6094 #6119 (Nikolai  
(Kochetov  
Fix non-deterministic result of "uniq" aggregate function in extreme rare cases. The bug was present in all ClickHouse •  
(versions. #6058 (alexey-milovidov  
(Segfault when we set a little bit too high CIDR on the function IPv6CIDRToRange . #6068 (Guillaume Tassery •  
(Fixed small memory leak when server throw many exceptions from many different contexts#6144 (alexey-milovidov •  
Fix the situation when consumer got paused before subscription and not resumed afterwards#6075 (Ivan) Note that •  
.Kafka is broken in this version  
Clearing the Kafka data buffer from the previous read operation that was completed with an error#6026 (Nikolay) •  
.Note that Kafka is broken in this version  
Since StorageMergeTree::background\_task\_handle is initialized in startup() the MergeTreeBlockOutputStream::write() may try •  
(to use it before initialization. Just check if it is initialized. #6080 (Ivan

#### BUILD/TESTING/PACKAGING IMPROVEMENT

(Added official rpm packages. #5740 (proller) (alesapin •  
(Add an ability to build .rpm and .tgz packages with packager script. #5769 (alesapin •  
(Fixes for "Arcadia" build system. #6223 (proller •

#### BACKWARD INCOMPATIBLE CHANGE

. Kafka is broken in this version •

### ClickHouse release 19.11.3.11, 2019-07-18

#### NEW FEATURE

(Added support for prepared statements. #5331 (Alexander) #5630 (alexey-milovidov •  
( DoubleDelta and Gorilla column codecs #5600 (Vasily Nemkov •  
Added os\_thread\_priority setting that allows to control the "nice" value of query processing threads that is used by OS •  
to adjust dynamic scheduling priority. It requires CAP\_SYS\_NICE capabilities to work. This implements#5858 #5909  
((alexey-milovidov  
.Implement \_topic , \_offset , \_key columns for Kafka engine #5382 (Ivan) Note that Kafka is broken in this version •  
(Add aggregate function combinator -Resample #5590 (hcz •  
Aggregate functions groupArrayMovingSum(win\_size)(x) and groupArrayMovingAvg(win\_size)(x) , which calculate moving •  
(sum/avg with or without window-size limitation. #5595 (inv2004  
(Add synonym arrayFlatten <-> flatten #5764 (hcz •  
(Intergate H3 function geoToH3 from Uber. #4724 (Remen Ivan) #5805 (alexey-milovidov •

#### BUG FIX

Implement DNS cache with asynchronous update. Separate thread resolves all hosts and updates DNS cache with •  
(period (setting dns\_cache\_update\_period ). It should help, when ip of hosts changes frequently.#5857 (Anton Popov

Fix segfault in `Delta` codec which affects columns with values less than 32 bits size. The bug led to random memory corruption. #5786 (alesapin) •  
(Fix segfault in TTL merge with non-physical columns in block. #5819 (Anton Popov) •

Fix rare bug in checking of part with `LowCardinality` column. Previously `checkDataPart` always fails for part with ( `LowCardinality` column. #5832 (alesapin) •

Avoid hanging connections when server thread pool is full. It is important for connections from `remote` table function or connections to a shard without replicas when there is long connection timeout. This fixes #5878 #5881 (alexey-milovidov) •  
(Support for constant arguments to `evalMLModel` function. This fixes #5817 #5820 (alexey-milovidov) •

Fixed the issue when ClickHouse determines default time zone as `UCT` instead of `UTC`. This fixes #5804. #5828 ((alexey-milovidov) •  
(Fixed buffer underflow in `visitParamExtractRaw`. This fixes #5901 #5902 (alexey-milovidov) •

Now distributed `DROP/ALTER/TRUNCATE/OPTIMIZE ON CLUSTER` queries will be executed directly on leader replica. (#5757 (alesapin) •  
(Fix coalesce for `ColumnConst` with `ColumnNullable` + related changes. #5755 (Artem Zuikov) •

Fix the `ReadBufferFromKafkaConsumer` so that it keeps reading new messages after `commit()` even if it was stalled (before #5852 (Ivan) •  
(Fix `FULL` and `RIGHT` JOIN results when joining on `Nullable` keys in right table. #5859 (Artem Zuikov) •  
(Possible fix of infinite sleeping of low-priority queries. #5842 (alexey-milovidov) •

Fix race condition, which cause that some queries may not appear in `query_log` after `SYSTEM FLUSH LOGS` query. (#5456 #5685 (Anton Popov) •  
Fixed heap-use-after-free ASan warning in `ClusterCopier` caused by watch which try to use already removed copier (object. #5871 (Nikolai Kochetov) •  
Fixed wrong `StringRef` pointer returned by some implementations of `IColumn::deserializeAndInsertFromArena`. This bug (affected only unit-tests. #5973 (Nikolai Kochetov) •  
(Prevent source and intermediate array join columns of masking same name columns. #5941 (Artem Zuikov) •  
(Fix insert and select query to MySQL engine with MySQL style identifier quoting #5704 (Winter Zhang) •  
Now `CHECK TABLE` query can work with MergeTree engine family. It returns check status and message if any for (each part (or file in case of simpler engines). Also, fix bug in fetch of a broken part. #5865 (alesapin) •  
(Fix `SPLIT_SHARED_LIBRARIES` runtime #5793 (Danila Kutenin) •  
Fixed time zone initialization when `/etc/localtime` is a relative symlink like `..../usr/share/zoneinfo/Europe/Moscow` #5922 ((alexey-milovidov) •  
(clickhouse-copier: Fix use-after free on shutdown #5752 (proller) •  
Updated `simdjson`. Fixed the issue that some invalid JSONs with zero bytes successfully parse #5938 (alexey-milovidov) •  
(Fix shutdown of `SystemLogs` #5802 (Anton Popov) •  
(Fix hanging when condition in `invalidate_query` depends on a dictionary. #6011 (Vitaly Baranov) •

## IMPROVEMENT

Allow unresolvable addresses in cluster configuration. They will be considered unavailable and tried to resolve at (every connection attempt. This is especially useful for Kubernetes. This fixes #5714 #5924 (alexey-milovidov) •  
Close idle TCP connections (with one hour timeout by default). This is especially important for large clusters with multiple distributed tables on every server, because every server can possibly keep a connection pool to every other (server, and after peak query concurrency, connections will stall. This fixes #5879 #5880 (alexey-milovidov) •

Better quality of `topK` function. Changed the `SavingSpace` set behavior to remove the last element if the new element  
•  
(have a bigger weight. #5833 #5850 (Guillaume Tassery

(URL functions to work with domains now can work for incomplete URLs without scheme#5725 (alesapin •  
•  
(Checksums added to the `system.parts_columns` table. #5874 (Nikita Mikhaylov •  
•  
(Added `Enum` data type as a synonym for `Enum8` or `Enum16`. #5886 (dimarub2000 •  
•  
(Full bit transpose variant for `T64` codec. Could lead to better compression with `zstd`. #5742 (Artem Zuikov •  
•  
(Condition on `startsWith` function now can uses primary key. This fixes#5310 and #5882 #5919 (dimarub2000 •  
•  
Allow to use `clickhouse-copier` with cross-replication cluster topology by permitting empty database name.#5745 •  
•  
((nvartolomei

Use `UTC` as default timezone on a system without `tzdata` (e.g. bare Docker container). Before this patch, error  
•  
(message Could not determine local time zone was printed and server or client refused to start.#5827 (alexey-milovidov

Returned back support for floating point argument in function `quantileTiming` for backward compatibility. #5911 (alexey- •  
•  
(milovidov  
•  
(Show which table is missing column in error messages.#5768 (ivan •  
•  
(Disallow run query with same `query_id` by various users#5430 (proller •  
•  
More robust code for sending metrics to Graphite. It will work even during long multiple `RENAME TABLE` operation. •  
•  
(#5875 (alexey-milovidov

More informative error messages will be displayed when ThreadPool cannot schedule a task for execution. This fixes •  
•  
(#5305 #5801 (alexey-milovidov  
•  
(Inverting `ngramSearch` to be more intuitive#5807 (Danila Kutenin •  
•  
(Add user parsing in HDFS engine builder#5946 (akonyaev90 •  
•  
(Update default value of `max_ast_elements` parameter #5933 (Artem Konovalov •  
•  
Added a notion of obsolete settings. The obsolete setting `allow_experimental_low_cardinality_type` can be used with no •  
•  
effect. 0f15c01c6802f7ce1a1494c12c846be8c98944cd Alexey Milovidov

## PERFORMANCE IMPROVEMENT

Increase number of streams to SELECT from Merge table for more uniform distribution of threads. Added setting •  
•  
( `max_streams_multiplier_for_merge_tables` . This fixes #5797 #5915 (alexey-milovidov

## BUILD/TESTING/PACKAGING IMPROVEMENT

(Add a backward compatibility test for client-server interaction with different versions of clickhouse.#5868 (alesapin •  
•  
(Test coverage information in every commit and pull request.#5896 (alesapin •  
•  
Cooperate with address sanitizer to support our custom allocators (`Arena` and `ArenaWithFreeLists`) for better •  
•  
(debugging of "use-after-free" errors. #5728 (akuzm  
•  
Switch to **LLVM libunwind implementation** for C++ exception handling and for stack traces printing#4828 (Nikita •  
•  
(Lapkov  
•  
(Add two more warnings from -Weverything#5923 (alexey-milovidov •  
•  
(Allow to build ClickHouse with Memory Sanitizer.#3949 (alexey-milovidov •  
•  
(Fixed ubsan report about `bitTest` function in fuzz test. #5943 (alexey-milovidov •  
•  
(Docker: added possibility to init a ClickHouse instance which requires authentication.#5727 (Korviakov Andrey •  
•  
(Update librdkafka to version 1.1.0 #5872 (ivan •  
•  
(Add global timeout for integration tests and disable some of them in tests code.#5741 (alesapin •  
•  
(Fix some ThreadSanitizer failures. #5854 (akuzm •  
•

The `--no-undefined` option forces the linker to check all external names for existence while linking. It's very useful to •  
(track real dependencies between libraries in the split build mode. #5855 (ivan  
•  
(Added performance test for #5797 #5914 (alexey-milovidov •  
(Fixed compatibility with gcc-7. #5840 (alexey-milovidov •  
(Added support for gcc-9. This fixes#5717 #5774 (alexey-milovidov •  
(Fixed error when libunwind can be linked incorrectly. #5948 (alexey-milovidov •  
(Fixed a few warnings found by PVS-Studio. #5921 (alexey-milovidov •  
(Added initial support for clang-tidy static analyzer. #5806 (alexey-milovidov •  
(Convert BSD/Linux endian macros( 'be64toh' and 'htobe64') to the Mac OS X equivalents#5785 (Fu Chen •  
(Improved integration tests guide. #5796 (Vladimir Chebotarev •  
(Fixing build at macosx + gcc9 #5822 (filimonov •  
(Fix a hard-to-spot typo: aggreAGte -> aggregate. #5753 (akuzm •  
(Fix freebsd build #5760 (proller •  
(Add link to experimental YouTube channel to website#5845 (ivan Blinkov •  
(CMake: add option for coverage flags: WITH\_COVERAGE #5776 (proller •  
(Fix initial size of some inline PODArray's. #5787 (akuzm •  
(clickhouse-server.postinst: fix os detection for centos 6 #5788 (proller •  
(Added Arch linux package generation. #5719 (Vladimir Chebotarev •  
(Split Common/config.h by libs (dbms) #5715 (proller •  
(Fixes for "Arcadia" build platform #5795 (proller •  
(Fixes for unconventional build (gcc9, no submodules) #5792 (proller •  
(Require explicit type in unalignedStore because it was proven to be bug-prone#5791 (akuzm •  
(Fixes MacOS build #5830 (filimonov •  
Performance test concerning the new JIT feature with bigger dataset, as requested here#5263 #5887 (Guillaume •  
(Tassery  
(Run stateful tests in stress test 12693e568722f11e19859742f56428455501fd2a (alesapin •

#### BACKWARD INCOMPATIBLE CHANGE

. Kafka is broken in this version •

Enable `adaptive_index_granularity = 10MB` by default for new MergeTree tables. If you created new MergeTree tables •  
(on version 19.11+, downgrade to versions prior to 19.6 will be impossible. #5628 (alesapin

Removed obsolete undocumented embedded dictionaries that were used by Yandex.Metrica. The functions OSIn , •  
SEIn , OSToRoot , SEToRoot , OSHierarchy , SEHierarchy are no longer available. If you are using these functions, write  
email to clickhouse-feedback@yandex-team.com. Note: at the last moment we decided to keep these functions for a  
(while. #5780 (alexey-milovidov

## ClickHouse release 19.10

### ClickHouse release 19.10.1.5, 2019-07-12

#### NEW FEATURE

Add new column codec: T64 . Made for (U)IntX/EnumX/Data(Time)/DecimalX columns. It should be good for columns •  
with constant or small range values. Codec itself allows enlarge or shrink data type without re-compression. #5557  
((Artem Zuikov

(Add database engine MySQL that allow to view all the tables in remote MySQL server #5599 (Winter Zhang • bitmapContains implementation. It's 2x faster than bitmapHasAny if the second bitmap contains one element. #5535 • ((Zhichang Yu

Support for crc32 function (with behaviour exactly as in MySQL or PHP). Do not use it if you need a hash function. • (#5661 (Remen Ivan

Implemented SYSTEM START/STOP DISTRIBUTED SENDS queries to control asynchronous inserts into Distributed • (tables. #4935 (Winter Zhang

#### BUG FIX

(Ignore query execution limits and max parts size for merge limits while executing mutations #5659 (Anton Popov • Fix bug which may lead to deduplication of normal blocks (extremely rare) and insertion of duplicate blocks (more • (often). #5549 (alesapin

(Fix of function arrayEnumerateUniqRanked for arguments with empty arrays #5559 (proller • (Don't subscribe to Kafka topics without intent to poll any messages. #5698 (Ivan •

(Make setting join\_use\_nulls get no effect for types that cannot be inside Nullable #5700 (Olga Khvostikova • (Fixed Incorrect size of index granularity errors #5720 (coraxster • (Fix Float to Decimal convert overflow #5607 (coraxster •

(Flush buffer when WriteBufferFromHDFS 's destructor is called. This fixes writing into HDFS. #5684 (Xindong Peng •

#### IMPROVEMENT

Treat empty cells in CSV as default values when the setting input\_format\_defaults\_for\_omitted\_fields is enabled. #5625 • ((akuzm

(Non-blocking loading of external dictionaries. #5567 (Vitaly Baranov •

Network timeouts can be dynamically changed for already established connections according to the settings #4558 • ((Konstantin Podshumok

Using "public\_suffix\_list" for functions firstSignificantSubdomain , cutToFirstSignificantSubdomain . It's using a perfect hash • table generated by gperf with a list generated from the file:[https://publicsuffix.org/list/public\\_suffix\\_list.dat](https://publicsuffix.org/list/public_suffix_list.dat). (for example, now we recognize the domain ac.uk as non-significant). #5030 (Guillaume Tassery

Adopted IPv6 data type in system tables; unified client info columns in system.processes and system.query\_log #5640 • ((alexey-milovidov

(Using sessions for connections with MySQL compatibility protocol. #5476#5646 (Yuriy Baranov •

(Support more ALTER queries ON CLUSTER . #5593 #5613 (sundyl •

(Support <logger> section in clickhouse-local config file. #5540 (proller •

(Allow run query with remote table function in clickhouse-local #5627 (proller •

#### PERFORMANCE IMPROVEMENT

Add the possibility to write the final mark at the end of MergeTree columns. It allows to avoid useless reads for keys • (that are out of table data range. It is enabled only if adaptive index granularity is in use. #5624 (alesapin

Improved performance of MergeTree tables on very slow filesystems by reducing number of stat syscalls. #5648 • ((alexey-milovidov

Fixed performance degradation in reading from MergeTree tables that was introduced in version 19.6. Fixes #5631. • (#5633 (alexey-milovidov

#### BUILD/TESTING/PACKAGING IMPROVEMENT

Implemented TestKeeper as an implementation of ZooKeeper interface used for testing #5643 (alexey-milovidov) •

((levushkin aleksei)

From now on `.sql` tests can be run isolated by server, in parallel, with random database. It allows to run them faster, • add new tests with custom server configurations, and be sure that different tests doesn't affect each other. #5554

((Ivan

(Remove `<name>` and `<metrics>` from performance tests #5672 (Olga Khvostikova •  
(Fixed "select\_format" performance test for Pretty formats #5642 (alexey-milovidov •

## ClickHouse release 19.9

**ClickHouse release 19.9.3.31, 2019-07-05**

BUG FIX

Fix segfault in Delta codec which affects columns with values less than 32 bits size. The bug led to random memory • corruption. #5786 (alesapin

(Fix rare bug in checking of part with LowCardinality column. #5832 (alesapin •

(Fix segfault in TTL merge with non-physical columns in block. #5819 (Anton Popov •

(Fix potential infinite sleeping of low-priority queries. #5842 (alexey-milovidov •

(Fix how ClickHouse determines default time zone as UCT instead of UTC. #5828 (alexey-milovidov •

Fix bug about executing distributed DROP/ALTER/TRUNCATE/OPTIMIZE ON CLUSTER queries on follower replica • (before leader replica. Now they will be executed directly on leader replica. #5757 (alesapin

Fix race condition, which cause that some queries may not appear in query\_log instantly after SYSTEM FLUSH • (LOGS query. #5685 (Anton Popov

(Added missing support for constant arguments to evalMLModel function. #5820 (alexey-milovidov •

**ClickHouse release 19.9.2.4, 2019-06-24**

NEW FEATURE

(Print information about frozen parts in system.parts table. #5471 (proller •

(Ask client password on clickhouse-client start on tty if not set in arguments #5092 (proller •

(Implement dictGet and dictGetOrDefault functions for Decimal types. #5394 (Artem Zuikov •

IMPROVEMENT

(Debian init: Add service stop timeout #5522 (proller •

(Add setting forbidden by default to create table with suspicious types for LowCardinality #5448 (Olga Khvostikova •

(Regression functions return model weights when not used as State in function evalMLMethod . #5411 (Quid37 •

(Rename and improve regression methods. #5492 (Quid37 •

(Clearer interfaces of string searchers. #5586 (Danila Kutenin •

BUG FIX

(Fix potential data loss in Kafka #5445 (Ivan •

(Fix potential infinite loop in PrettySpace format when called with zero columns #5560 (Olga Khvostikova •

Fixed UInt32 overflow bug in linear models. Allow eval ML model for non-const model argument. #5516 (Nikolai • (Kochetov

ALTER TABLE ... DROP INDEX IF EXISTS ... should not raise an exception if provided index does not exist #5524 (Gleb • (Novikov

(Fix segfault with bitmapHasAny in scalar subquery #5528 (Zhichang Yu •

Fixed error when replication connection pool doesn't retry to resolve host, even when DNS cache was dropped #5534 • ((alesapin))

(Fixed ALTER ... MODIFY TTL on ReplicatedMergeTree. #5539 (Anton Popov) •

(Fix INSERT into Distributed table with MATERIALIZED column #5429 (Azat Khuzhin) •

(Fix bad alloc when truncate Join storage #5437 (TCeason) •

In recent versions of package tzdata some of files are symlinks now. The current mechanism for detecting default timezone gets broken and gives wrong names for some timezones. Now at least we force the timezone name to the (contents of TZ if provided. #5443 (Ivan)

Fix some extremely rare cases with MultiVolnitsky searcher when the constant needles in sum are at least 16KB long. •

The algorithm missed or overwrote the previous results which can lead to the incorrect result of multiSearchAny . (#5588 (Danila Kutenin))

Fix the issue when settings for ExternalData requests couldn't use ClickHouse settings. Also, for now, settings date\_time\_input\_format and low\_cardinality\_allow\_in\_native\_format cannot be used because of the ambiguity of names (in external data it can be interpreted as table format and in the query it can be a setting). #5455 (Danila Kutenin)

(Fix bug when parts were removed only from FS without dropping them from Zookeeper. #5520 (alesapin) •

(Remove debug logging from MySQL protocol #5478 (alexey-milovidov) •

(Skip ZNONODE during DDL query processing #5489 (Azat Khuzhin) •

Fix mix UNION ALL result column type. There were cases with inconsistent data and column types of resulting columns. #5503 (Artem Zuikov)

(Throw an exception on wrong integers in dictGetT functions instead of crash. #5446 (Artem Zuikov) •

(Fix wrong element\_count and load\_factor for hashed dictionary in system.dictionaries table. #5440 (Azat Khuzhin) •

BUILD/TESTING/PACKAGING IMPROVEMENT

Fixed build without Brotli HTTP compression support (ENABLE\_BROTLI=OFF cmake variable). #5521 (Anton Yuzhaninov)

(Include roaring.h as roaring/roaring.h #5523 (Orivej Desh) •

(Fix gcc9 warnings in hyperscan (#line directive is evil!) #5546 (Danila Kutenin) •

Fix all warnings when compiling with gcc-9. Fix some contrib issues. Fix gcc9 ICE and submit it to bugzilla#5498 • ((Danila Kutenin))

(Fixed linking with lld #5477 (alexey-milovidov) •

(Remove unused specializations in dictionaries #5452 (Artem Zuikov) •

(Improvement performance tests for formatting and parsing tables for different types of files#5497 (Olga Khvostikova) •

(Fixes for parallel test run #5506 (proller) •

(Docker: use configs from clickhouse-test #5531 (proller) •

(Fix compile for FreeBSD #5447 (proller) •

(Upgrade boost to 1.70 #5570 (proller) •

(Fix build clickhouse as submodule #5574 (proller) •

(Improve JSONExtract performance tests #5444 (Vitaly Baranov) •

ClickHouse release 19.8

ClickHouse release 19.8.3.8, 2019-06-11

NEW FEATURES

(Added functions to work with JSON #4686 (hc) #5124. (Vitaly Baranov •

Add a function basename, with a similar behaviour to a basename function, which exists in a lot of languages (os.path.basename in python, basename in PHP, etc...). Work with both an UNIX-like path or a Windows path #5136 ((Guillaume Tassery

(Added LIMIT n, m BY or LIMIT m OFFSET n BY syntax to set offset of n for LIMIT BY clause. #5138 (Anton Popov •

Added new data type SimpleAggregateFunction , which allows to have columns with light aggregation in an AggregatingMergeTree . This can only be used with simple functions like any , anyLast , sum , min , max . #4629 (Boris Granveaud

(Added support for non-constant arguments in function ngramDistance #5198 (Danila Kutenin •

Added functions skewPop , skewSamp , kurtPop and kurtSamp to compute for sequence skewness, sample skewness, (kurtosis and sample kurtosis respectively. #5200 (hc)

(Support rename operation for MaterializeView storage. #5209 (Guillaume Tassery •

(Added server which allows connecting to ClickHouse using MySQL client. #4715 (Yuriy Baranov •

(Add toDecimal\*OrZero and toDecimal\*OrNull functions. #5291 (Artem Zuikov •

Support Decimal types in functions: quantile , quantiles , median , quantileExactWeighted , quantilesExactWeighted , (medianExactWeighted. #5304 (Artem Zuikov

Added toValidUTF8 function, which replaces all invalid UTF-8 characters by replacement character ♦ (U+FFFD). (#5322 (Danila Kutenin

Added format function. Formatting constant pattern (simplified Python format pattern) with the strings listed in the (arguments. #5330 (Danila Kutenin

(Added system.detached\_parts table containing information about detached parts of MergeTree tables. #5353 (akuzm •

Added ngramSearch function to calculate the non-symmetric difference between needle and haystack. #5418#5422 ((Danila Kutenin

Implementation of basic machine learning methods (stochastic linear regression and logistic regression) using aggregate functions interface. Has different strategies for updating model weights (simple gradient descent, (momentum method, Nesterov method). Also supports mini-batches of custom size. #4943 (Quid37

(Implementation of geohashEncode and geohashDecode functions. #5003 (Vasily Nemkov •

Added aggregate function timeSeriesGroupSum , which can aggregate different time series that sample timestamp not alignment. It will use linear interpolation between two sample timestamp and then sum time-series together. Added aggregate function timeSeriesGroupRateSum , which calculates the rate of time-series and then sum rates together. (#4542 (Yangkuan Liu

Added functions IPv4CIDRtoIPv4Range and IPv6CIDRtoIPv6Range to calculate the lower and higher bounds for an IP in (the subnet using a CIDR. #5095 (Guillaume Tassery

Add a X-ClickHouse-Summary header when we send a query using HTTP with enabled setting send\_progress\_in\_http\_headers . Return the usual information of X-ClickHouse-Progress, with additional information like (how many rows and bytes were inserted in the query. #5116 (Guillaume Tassery

## IMPROVEMENTS

Added max\_parts\_in\_total setting for MergeTree family of tables (default: 100 000) that prevents unsafe specification of (partition key #5166. #5171 (alexey-milovidov

clickhouse-obfuscator : derive seed for individual columns by combining initial seed with column name, not column position. This is intended to transform datasets with multiple related tables, so that tables will remain JOINable after (transformation. #5178 (alexey-milovidov

Added functions JSONExtractRaw , JSONExtractKeyAndValues . Renamed functions jsonExtract<type> to JSONExtract<type> . When something goes wrong these functions return the correspondent values, not NULL .

Modified function `JSONExtract`, now it gets the return type from its last parameter and doesn't inject nullables. Implemented fallback to RapidJSON in case AVX2 instructions are not available. Simdjson library updated to a new version. #5235 (Vitaly Baranov •)

Now `if` and `multilf` functions don't rely on the condition's `Nullable`, but rely on the branches for sql compatibility. #5238 • ((Jian Wu •))

(`In` predicate now generates `Null` result from `Null` input like the `Equal` function. #5152 (Jian Wu •))

Check the time limit every (`flush_interval` / `poll_timeout`) number of rows from Kafka. This allows to break the reading (from Kafka consumer more frequently and to check the time limits for the top-level streams #5249 (Ivan •))

(Link rdkafka with bundled SASL. It should allow to use SASL SCRAM authentication#5253 (Ivan •))

(Batched version of RowRefList for ALL JOINS. #5267 (Artem Zuikov •))

(clickhouse-server: more informative listen error messages. #5268 (proller •))

(Support dictionaries in clickhouse-copier for functions in `<sharding_key>` #5270 (proller •))

Add new setting `kafka_commit_every_batch` to regulate Kafka committing policy. It allows to set commit mode: after every batch of messages is handled, or after the whole block is written to the storage. It's a trade-off between losing (some messages or reading them twice in some extreme situations. #5308 (Ivan •))

(Make `windowFunnel` support other Unsigned Integer Types. #5320 (sundyl •))

(Allow to shadow virtual column `_table` in Merge engine. #5325 (Ivan •))

(Make `sequenceMatch` aggregate functions support other unsigned Integer types#5339 (sundyl •))

(Better error messages if checksum mismatch is most likely caused by hardware failures. #5355 (alexey-milovidov •))

(Check that underlying tables support sampling for StorageMerge #5366 (Ivan •))

Close MySQL connections after their usage in external dictionaries. It is related to issue #893#5395 (Clément (Rodriguez •))

Improvements of MySQL Wire Protocol. Changed name of format to MySQLWire. Using RAll for calling RSA\_free. • (Disabling SSL if context cannot be created. #5419 (Yuriy Baranov •))

clickhouse-client: allow to run with unaccessible history file (read-only, no disk space, file is directory, ...)#5431 • ((proller •))

(Respect query settings in asynchronous INSERTs into Distributed tables. #4936 (TCeason •))

Renamed functions `leastSqr` to `simpleLinearRegression`, `LinearRegression` to `linearRegression`, `LogisticRegression` to ( `logisticRegression`. #5391 (Nikolai Kochetov •))

## PERFORMANCE IMPROVEMENTS

(Parallelize processing of parts of non-replicated MergeTree tables in ALTER MODIFY query #4639 (Ivan Kush •) (Optimizations in regular expressions extraction. #5193 #5191 (Danila Kutenin •))

(Do not add right join key column to join result if it's used only in join on section#5260 (Artem Zuikov •))

Freeze the Kafka buffer after first empty response. It avoids multiple invocations of `ReadBuffer::next()` for empty result (in some row-parsing streams. #5283 (Ivan •))

(concat function optimization for multiple arguments. #5357 (Danila Kutenin •))

Query optimisation. Allow push down IN statement while rewriting comma/cross join into inner one.#5396 (Artem (Zuikov •))

(Upgrade our LZ4 implementation with reference one to have faster decompression. #5070 (Danila Kutenin •))

(Implemented MSD radix sort (based on kxsort), and partial sorting. #5129 (Evgenii Pravda •))

## BUG FIXES

(Fix push require columns with join #5192 (Winter Zhang •))

- Fixed bug, when ClickHouse is run by systemd, the command `sudo service clickhouse-server force-restart` was not working as expected. #5204 (proller)
- Fix http error codes in DataPartsExchange (interserver http server on 9009 port always returned code 200, even on errors). #5216 (proller)
- (Fix SimpleAggregateFunction for String longer than MAX\_SMALL\_STRING\_SIZE.) #5311 (Azat Khuzhin)
- Fix error for `Decimal` to `Nullable(Decimal)` conversion in IN. Support other Decimal to Decimal conversions (including different scales). #5350 (Artem Zuikov)
- Fixed FPU clobbering in simdjson library that lead to wrong calculation of `uniqHLL` and `uniqCombined` aggregate function and math functions such as `log`. #5354 (alexey-milovidov)
- (Fixed handling mixed const/nonconst cases in JSON functions.) #5435 (Vitaly Baranov)
- (Fix retention function. Now all conditions that satisfy in a row of data are added to the data state.) #5119 (小路)
- (Fix result type for `quantileExact` with Decimals.) #5304 (Artem Zuikov)

#### DOCUMENTATION

- (Translate documentation for `CollapsingMergeTree` to chinese.) #5168 (张风啸)
- (Translate some documentation about table engines to chinese.) #5134 #5328 (never lee)

#### BUILD/TESTING/PACKAGING IMPROVEMENTS

- (Fix some sanitizer reports that show probable use-after-free.) #5139 #5143 #5393 (Ivan)
- (Move performance tests out of separate directories for convenience.) #5158 (alexey-milovidov)
- (Fix incorrect performance tests.) #5255 (alesapin)
- (Added a tool to calculate checksums caused by bit flips to debug hardware issues.) #5334 (alexey-milovidov)
- (Make runner script more usable.) #5340 #5360 (filimonov)
- (Add small instruction how to write performance tests.) #5408 (alesapin)
- (Add ability to make substitutions in create, fill and drop query in performance tests.) #5367 (Olga Khvostikova)

### ClickHouse release 19.7

#### ClickHouse release 19.7.5.29, 2019-07-05

##### BUG FIX

- (Fix performance regression in some queries with JOIN.) #5192 (Winter Zhang)

#### ClickHouse release 19.7.5.27, 2019-06-09

##### NEW FEATURES

- Added bitmap related functions `bitmapHasAny` and `bitmapHasAll` analogous to `hasAny` and `hasAll` functions for arrays. (#5279 (Sergi Vladkyin))

##### BUG FIXES

- (Fix segfault on `minmax` INDEX with Null value.) #5246 (Nikita Vasilev)

- Mark all input columns in LIMIT BY as required output. It fixes 'Not found column' error in some distributed queries. (#5407 (Constantin S. Pan))

- (Fix "Column '0' already exists" error in `SELECT .. PREWHERE` on column with DEFAULT.) #5397 (proller)

- (Fix `ALTER MODIFY TTL` query on `ReplicatedMergeTree`.) #5539 (Anton Popov)

- (Don't crash the server when Kafka consumers have failed to start.) #5285 (Ivan)

(Fixed bitmap functions produce wrong result. #5359 (Andy Yang •  
(Fix element\_count for hashed dictionary (do not include duplicates) #5440 (Azat Khuzhin •  
Use contents of environment variable TZ as the name for timezone. It helps to correctly detect default timezone in •  
(some cases. #5443 (Ivan •  
Do not try to convert integers in dictGetT functions, because it doesn't work correctly. Throw an exception instead. •  
(#5446 (Artem Zuikov •  
(Fix settings in ExternalData HTTP request. #5455 (Danila Kutenin •  
(Fix bug when parts were removed only from FS without dropping them from Zookeeper. #5520 (alesapin •  
(Fix segmentation fault in bitmapHasAny function. #5528 (Zhichang Yu •  
Fixed error when replication connection pool doesn't retry to resolve host, even when DNS cache was dropped #5534 •  
(alesapin •  
Fixed DROP INDEX IF EXISTS query. Now ALTER TABLE ... DROP INDEX IF EXISTS ... query doesn't raise an exception •  
(if provided index does not exist. #5524 (Gleb Novikov •  
Fix union all supertype column. There were cases with inconsistent data and column types of resulting columns. •  
(#5503 (Artem Zuikov •  
Skip ZNONODE during DDL query processing. Before if another node removes the znode in task queue, the one that •  
(did not process it, but already get list of children, will terminate the DDLWorker thread. #5489 (Azat Khuzhin •  
(Fix INSERT into Distributed() table with MATERIALIZED column. #5429 (Azat Khuzhin •

## ClickHouse release 19.7.3.9, 2019-05-30

### NEW FEATURES

Allow to limit the range of a setting that can be specified by user. These constraints can be set up in user settings •  
(profile. #4931 (Vitaly Baranov •  
Add a second version of the function groupUniqArray with an optional max\_size parameter that limits the size of the •  
(resulting array. This behavior is similar to groupArray(max\_size)(x) function. #5026 (Guillaume Tassery •  
For TSVWithNames/CSVWithNames input file formats, column order can now be determined from file header. This is •  
(controlled by input\_format\_with\_names\_use\_header parameter. #5081 (Alexander •

### BUG FIXES

(Crash with uncompressed\_cache + JOIN during merge (#5197) #5133 (Danila Kutenin •  
(Segmentation fault on a clickhouse-client query to system tables. #5066 #5127 (Ivan •  
(Data loss on heavy load via KafkaEngine (#4736) #5080 (Ivan •  
Fixed very rare data race condition that could happen when executing a query with UNION ALL involving at least two •  
SELECTs from system.columns, system.tables, system.parts, system.parts\_tables or tables of Merge family and  
(performing ALTER of columns of the related tables concurrently. #5189 (alexey-milovidov •

### PERFORMANCE IMPROVEMENTS

Use radix sort for sorting by single numeric column in ORDER BY without LIMIT . #5106, #4439 (Evgenii Pravda, •  
(alexey-milovidov •

### DOCUMENTATION

(Translate documentation for some table engines to Chinese. #5107, #5094, #5087 (张风啸), #5068 (never lee •

### BUILD/TESTING/PACKAGING IMPROVEMENTS

(Print UTF-8 characters properly in clickhouse-test . #5084 (alexey-milovidov •  
(Add command line parameter for clickhouse-client to always load suggestion data. #5102 (alexey-milovidov •

(Resolve some of PVS-Studio warnings. #5082 (alexey-milovidov •

(Update LZ4 #5040 (Danila Kutenin •

(Add gperf to build requirements for upcoming pull request #5030. #5110 (proller •

## ClickHouse release 19.6

### ClickHouse release 19.6.3.18, 2019-06-13

#### BUG FIXES

Fixed IN condition pushdown for queries from table functions mysql and odbc and corresponding table engines. This •

(fixes #3540 and #2384. #5313 (alexey-milovidov •

(Fix deadlock in Zookeeper. #5297 (github1youlc •

Allow quoted decimals in CSV. #5284 (Artem Zuikov •

(Disallow conversion from float Inf/NaN into Decimals (throw exception). #5282 (Artem Zuikov •

(Fix data race in rename query. #5247 (Winter Zhang •

Temporarily disable LFAlloc. Usage of LFAlloc might lead to a lot of MAP\_FAILED in allocating UncompressedCache •

(and in a result to crashes of queries at high loaded servers. cfdba93(Danila Kutenin

### ClickHouse release 19.6.2.11, 2019-05-13

#### NEW FEATURES

(TTL expressions for columns and tables. #4212 (Anton Popov •

(Added support for brotli compression for HTTP responses (Accept-Encoding: br) #4388 (Mikhail •

(Added new function isValidUTF8 for checking whether a set of bytes is correctly utf-8 encoded. #4934 (Danila Kutenin •

Add new load balancing policy first\_or\_random which sends queries to the first specified host and if it's inaccessible •  
(send queries to random hosts of shard. Useful for cross-replication topology setups. #5012 (nvartolomei

#### EXPERIMENTAL FEATURES

(Add setting index\_granularity\_bytes (adaptive index granularity) for MergeTree\* tables family. #4826 (alesapin •

#### IMPROVEMENTS

Added support for non-constant and negative size and length arguments for function substringUTF8 . #4989 (alexey- •  
(milovidov

Disable push-down to right table in left join, left table in right join, and both tables in full join. This fixes wrong JOIN •  
(results in some cases. #4846 (Ivan

( clickhouse-copier : auto upload task configuration from --task-file option #4876 (proller •

(Added typos handler for storage factory and table functions factory. #4891 (Danila Kutenin •

(Support asterisks and qualified asterisks for multiple joins without subqueries #4898 (Artem Zuikov •

(Make missing column error message more user friendly. #4915 (Artem Zuikov •

#### PERFORMANCE IMPROVEMENTS

(Significant speedup of ASOF JOIN #4924 (Martijn Bakker •

#### BACKWARD INCOMPATIBLE CHANGES

(HTTP header Query-Id was renamed to X-ClickHouse-Query-Id for consistency. #4972 (Mikhail •

#### BUG FIXES

(Fixed potential null pointer dereference in clickhouse-copier . #4900 (proller •  
(Fixed error on query with JOIN + ARRAY JOIN#4938 (Artem Zuikov •  
Fixed hanging on start of the server when a dictionary depends on another dictionary via a database with •  
(engine=Dictionary. #4962 (Vitaly Baranov •

Partially fix distributed\_product\_mode = local. It's possible to allow columns of local tables in where/having/order by/... •  
via table aliases. Throw exception if table does not have alias. There's not possible to access to the columns without  
(table aliases yet. #4986 (Artem Zuikov •

(Fix potentially wrong result for SELECT DISTINCT with JOIN #5001 (Artem Zuikov •  
Fixed very rare data race condition that could happen when executing a query with UNION ALL involving at least two •  
SELECTs from system.columns, system.tables, system.parts, system.parts\_tables or tables of Merge family and  
(performing ALTER of columns of the related tables concurrently. #5189 (alexey-milovidov •

#### BUILD/TESTING/PACKAGING IMPROVEMENTS

(Fixed test failures when running clickhouse-server on different host#4713 (Vasily Nemkov •  
(clickhouse-test: Disable color control sequences in non tty environment.#4937 (alesapin •  
(clickhouse-test: Allow use any test database (remove test. qualification where it possible) #5008 (proller •  
(Fix ubsan errors #5037 (Vitaly Baranov •  
Yandex LFAlloc was added to ClickHouse to allocate MarkCache and UncompressedCache data in different ways to •  
(catch segfaults more reliable #4995 (Danila Kutenin  
(Python util to help with backports and changelogs.#4949 (Ivan •

### ClickHouse release 19.5

#### ClickHouse release 19.5.4.22, 2019-05-13

##### BUG FIXES

(Fixed possible crash in bitmap\* functions #5220 #5228 (Andy Yang •  
Fixed very rare data race condition that could happen when executing a query with UNION ALL involving at least two •  
SELECTs from system.columns, system.tables, system.parts, system.parts\_tables or tables of Merge family and  
(performing ALTER of columns of the related tables concurrently. #5189 (alexey-milovidov •

Fixed error Set for IN is not created yet in case of using single LowCardinality column in the left part of IN . This error happened if •  
(LowCardinality column was the part of primary key. #5031 #5154 (Nikolai Kochetov •

Modification of retention function: If a row satisfies both the first and NTH condition, only the first satisfied condition is •  
(added to the data state. Now all conditions that satisfy in a row of data are added to the data state. #5119 (小路 •

#### ClickHouse release 19.5.3.8, 2019-04-18

##### BUG FIXES

(Fixed type of setting max\_partitions\_per\_insert\_block from boolean to UInt64. #5028 (Mohammad Hossein Sekhavat •

#### ClickHouse release 19.5.2.6, 2019-04-15

##### NEW FEATURES

Hyperscan multiple regular expression matching was added (functions multiMatchAny , multiMatchAnyIndex , •  
( multiFuzzyMatchAny , multiFuzzyMatchAnyIndex ). #4780, #4841 (Danila Kutenin •  
( multiSearchFirstPosition function was added. #4780 (Danila Kutenin •  
(Implement the predefined expression filter per row for tables. #4792 (Ivan •

A new type of data skipping indices based on bloom filters (can be used for equal , in and like functions). #4499 •  
((Nikita Vasilev

Added ASOF JOIN which allows to run queries that join to the most recent value known #4774 #4867 #4863 #4875 •  
((Martijn Bakker, Artem Zuikov

(Rewrite multiple COMMA JOIN to CROSS JOIN . Then rewrite them to INNER JOIN if possible. #4661 (Artem Zuikov •

## IMPROVEMENT

( topK and topKWeighted now supports custom loadFactor (fixes issue #4252). #4634 (Kirill Danshin •

Allow to use parallel\_replicas\_count > 1 even for tables without sampling (the setting is simply ignored for them). In •  
(previous versions it was lead to exception. #4637 (Alexey Elymanov

Support for CREATE OR REPLACE VIEW . Allow to create a view or set a new definition in a single statement #4654 •  
((Boris Granveaud

( Buffer table engine now supports PREWHERE . #4671 (Yangkuan Liu •

(Add ability to start replicated table without metadata in zookeeper in readonly mode. #4691 (alesapin •

Fixed flicker of progress bar in clickhouse-client. The issue was most noticeable when using FORMAT Null with •  
(streaming queries. #4811 (alexey-milovidov

Allow to disable functions with hyperscan library on per user basis to limit potentially excessive and uncontrolled •  
(resource usage. #4816 (alexey-milovidov

(Add version number logging in all errors. #4824 (proller •

Added restriction to the multiMatch functions which requires string size to fit into unsigned int . Also added the number •  
(of arguments limit to the multiSearch functions. #4834 (Danila Kutenin

(Improved usage of scratch space and error handling in Hyperscan. #4866 (Danila Kutenin •

(Fill system.graphite\_detentions from a table config of \*GraphiteMergeTree engine tables. #4584 (Mikhail f. Shiryaev •

Rename trigramDistance function to ngramDistance and add more functions with CaseInsensitive and UTF . #4602 •  
((Danila Kutenin

(Improved data skipping indices calculation. #4640 (Nikita Vasilev •

Keep ordinary, DEFAULT , MATERIALIZED and ALIAS columns in a single list (fixes issue #2867). #4707 (Alex •  
(Zatelepin

## BUG FIX

Avoid std::terminate in case of memory allocation failure. Now std::bad\_alloc exception is thrown as expected. #4665 •  
((alexey-milovidov

(Fixes capnproto reading from buffer. Sometimes files wasn't loaded successfully by HTTP. #4674 (Vladislav •

(Fix error Unknown log entry type: 0 after OPTIMIZE TABLE FINAL query. #4683 (Amos Bird •

(Wrong arguments to hasAny or hasAll functions may lead to segfault. #4698 (alexey-milovidov •

(Deadlock may happen while executing DROP DATABASE dictionary query. #4701 (alexey-milovidov •

(Fix undefined behavior in median and quantile functions. #4702 (hczi •

(Fix compression level detection when network\_compression\_method in lowercase. Broken in v19.1. #4706 (proller •

(Fixed ignorance of <timezone>UTC</timezone> setting (fixes issue #4658). #4718 (proller •

(Fix histogram function behaviour with Distributed tables. #4741 (olegkv •

(Fixed tsan report destroy of a locked mutex . #4742 (alexey-milovidov •

Fixed TSan report on shutdown due to race condition in system logs usage. Fixed potential use-after-free on •  
(shutdown when part\_log is enabled. #4758 (alexey-milovidov

(Fix recheck parts in `ReplicatedMergeTreeAlterThread` in case of error. #4772 (Nikolai Kochetov) •  
Arithmetic operations on intermediate aggregate function states were not working for constant arguments (such as •  
(subquery results). #4776 (alexey-milovidov)  
Always backquote column names in metadata. Otherwise it's impossible to create a table with column named `index` •  
((server won't restart due to malformed `ATTACH` query in metadata). #4782 (alexey-milovidov  
(Fix crash in `ALTER ... MODIFY ORDER BY` on Distributed table. #4790 (TCeason) •  
(Fix segfault in `JOIN ON` with enabled `enable_optimize_predicate_expression`. #4794 (Winter Zhang) •  
(Fix bug with adding an extraneous row after consuming a protobuf message from Kafka. #4808 (Vitaly Baranov) •  
Fix crash of `JOIN` on not-nullable vs nullable column. Fix `NULLs` in right keys in `ANY JOIN + join_use_nulls`. #4815 •  
((Artem Zuikov  
(Fix segmentation fault in `clickhouse-copier`. #4835 (proller) •  
Fixed race condition in `SELECT` from `system.tables` if the table is renamed or altered concurrently. #4836 (alexey- •  
milovidov  
(Fixed data race when fetching data part that is already obsolete. #4839 (alexey-milovidov) •  
(Fixed rare data race that can happen during `RENAME` table of MergeTree family. #4844 (alexey-milovidov) •  
Fixed segmentation fault in function `arrayIntersect`. Segmentation fault could happen if function was called with mixed •  
(constant and ordinary arguments. #4847 (Lixiang Qian  
Fixed reading from `Array(LowCardinality)` column in rare case when column contained a long sequence of empty •  
(arrays. #4850 (Nikolai Kochetov  
(Fix crash in `FULL/RIGHT JOIN` when we joining on nullable vs not nullable. #4855 (Artem Zuikov) •  
(Fix `No message received` exception while fetching parts between replicas. #4856 (alesapin) •  
(Fixed `arrayIntersect` function wrong result in case of several repeated values in single array. #4871 (Nikolai Kochetov) •  
Fix a race condition during concurrent `ALTER COLUMN` queries that could lead to a server crash (fixes issue #3421). •  
(#4592 (Alex Zatelepin  
(Fix incorrect result in `FULL/RIGHT JOIN` with const column. #4723 (Artem Zuikov) •  
(Fix duplicates in `GLOBAL JOIN` with asterisk. #4705 (Artem Zuikov) •  
(Fix parameter deduction in `ALTER MODIFY` of column `CODEC` when column type is not specified. #4883 (alesapin) •  
Functions `cutQueryStringAndFragment()` and `queryStringAndFragment()` now works correctly when `URL` contains a •  
(fragment and no query. #4894 (Vitaly Baranov  
Fix rare bug when setting `min_bytes_to_use_direct_io` is greater than zero, which occurs when thread have to seek •  
(backward in column file. #4897 (alesapin  
Fix wrong argument types for aggregate functions with `LowCardinality` arguments (fixes issue #4919). #4922 (Nikolai •  
(Kochetov  
(Fix wrong name qualification in `GLOBAL JOIN`. #4969 (Artem Zuikov) •  
(Fix function `toISOWeek` result for year 1970. #4988 (alexey-milovidov) •  
Fix `DROP`, `TRUNCATE` and `OPTIMIZE` queries duplication, when executed on `ON CLUSTER` for `ReplicatedMergeTree*` •  
(tables family. #4991 (alesapin

#### BACKWARD INCOMPATIBLE CHANGE

(Rename setting `insert_sample_with_metadata` to setting `input_format_defaults_for_omitted_fields`. #4771 (Artem Zuikov) •  
Added setting `max_partitions_per_insert_block` (with value 100 by default). If inserted block contains larger number of •  
partitions, an exception is thrown. Set it to 0 if you want to remove the limit (not recommended). #4845 (alexey- •  
(milovidov

Multi-search functions were renamed ( `multiPosition` to `multiSearchAllPositions` , `multiSearch` to `multiSearchAny` , `firstMatch` (to `multiSearchFirstIndex` ). #4780 (Danila Kutenin •

#### PERFORMANCE IMPROVEMENT

Optimize Volnitsky searcher by inlining, giving about 5-10% search improvement for queries with many needles or (many similar bigrams. #4862 (Danila Kutenin •

Fix performance issue when setting `use_uncompressed_cache` is greater than zero, which appeared when all read data (contained in cache. #4913 (alesapin •

#### BUILD/TESTING/PACKAGING IMPROVEMENT

Hardening debug build: more granular memory mappings and ASLR; add memory protection for mark cache and index. This allows to find more memory stomping bugs in case when ASan and MSan cannot do it. #4632 (alexey-milovidov •

Add support for cmake variables `ENABLE_PROTOBUF` , `ENABLE_PARQUET` and `ENABLE_BROTLI` which allows to (enable/disable the above features (same as we can do for librdkafka, mysql, etc). #4669 (Silviu Caragea •

(Add ability to print process list and stacktraces of all threads if some queries are hung after test run#4675 (alesapin (Add retries on Connection loss error in `clickhouse-test` . #4682 (alesapin •

(Add freebsd build with vagrant and build with thread sanitizer to packager script.#4712 #4748 (alesapin •

(Now user asked for password for user 'default' during installation. #4725 (proller •

(Suppress warning in `rdkafka` library. #4740 (alexey-milovidov •

(Allow ability to build without ssl. #4750 (proller •

(Add a way to launch `clickhouse-server` image from a custom user.#4753 (Mikhail f. Shiryaev •

(Upgrade contrib boost to 1.69. #4793 (proller •

Disable usage of `mremap` when compiled with Thread Sanitizer. Surprisingly enough, TSan does not intercept `mremap` (though it does intercept `mmap` , `munmap` ) that leads to false positives. Fixed TSan report in stateful tests. (#4859 (alexey-milovidov •

(Add test checking using format schema via HTTP interface.#4864 (Vitaly Baranov •

## ClickHouse release 19.4

### ClickHouse release 19.4.4.33, 2019-04-17

#### BUG FIXES

Avoid `std::terminate` in case of memory allocation failure. Now `std::bad_alloc` exception is thrown as expected. #4665 ((alexey-milovidov •

(Fixes capnproto reading from buffer. Sometimes files wasn't loaded successfully by HTTP #4674 (Vladislav •

(Fix error Unknown log entry type: 0 after `OPTIMIZE TABLE FINAL` query. #4683 (Amos Bird •

(Wrong arguments to `hasAny` or `hasAll` functions may lead to segfault. #4698 (alexey-milovidov •

(Deadlock may happen while executing `DROP DATABASE` dictionary query. #4701 (alexey-milovidov •

(Fix undefined behavior in `median` and `quantile` functions. #4702 (hcz •

(Fix compression level detection when `network_compression_method` in lowercase. Broken in v19.1. #4706 (proller •

(Fixed ignorance of `<timezone>UTC</timezone>` setting (fixes issue #4658). #4718 (proller •

(Fix `histogram` function behaviour with `Distributed` tables. #4741 (olegkv •

(Fixed tsan report destroy of a locked mutex . #4742 (alexey-milovidov •

Fixed TSan report on shutdown due to race condition in system logs usage. Fixed potential use-after-free on •

(shutdown when part\_log is enabled. #4758 (alexey-milovidov •  
(Fix recheck parts in ReplicatedMergeTreeAlterThread in case of error. #4772 (Nikolai Kochetov •  
Arithmetic operations on intermediate aggregate function states were not working for constant arguments (such as  
(subquery results). #4776 (alexey-milovidov •  
Always backquote column names in metadata. Otherwise it's impossible to create a table with column named index  
(server won't restart due to malformed ATTACH query in metadata). #4782 (alexey-milovidov •  
(Fix crash in ALTER ... MODIFY ORDER BY on Distributed table. #4790 (TCeason •  
(Fix segfault in JOIN ON with enabled enable\_optimize\_predicate\_expression . #4794 (Winter Zhang •  
(Fix bug with adding an extraneous row after consuming a protobuf message from Kafka. #4808 (Vitaly Baranov •  
(Fix segmentation fault in clickhouse-copier . #4835 (proller •  
Fixed race condition in SELECT from system.tables if the table is renamed or altered concurrently. #4836 (alexey-  
(milovidov •  
(Fixed data race when fetching data part that is already obsolete. #4839 (alexey-milovidov •  
(Fixed rare data race that can happen during RENAME table of MergeTree family. #4844 (alexey-milovidov •  
Fixed segmentation fault in function arrayIntersect . Segmentation fault could happen if function was called with mixed  
(constant and ordinary arguments. #4847 (Lixiang Qian •  
Fixed reading from Array(LowCardinality) column in rare case when column contained a long sequence of empty  
(arrays. #4850 (Nikolai Kochetov •  
(Fix No message received exception while fetching parts between replicas. #4856 (alesapin •  
(Fixed arrayIntersect function wrong result in case of several repeated values in single array. #4871 (Nikolai Kochetov •  
Fix a race condition during concurrent ALTER COLUMN queries that could lead to a server crash (fixes issue #3421).  
(#4592 (Alex Zatelepin •  
(Fix parameter deduction in ALTER MODIFY of column CODEC when column type is not specified. #4883 (alesapin •  
Functions cutQueryStringAndFragment() and queryStringAndFragment() now works correctly when URL contains a  
(fragment and no query. #4894 (Vitaly Baranov •  
Fix rare bug when setting min\_bytes\_to\_use\_direct\_io is greater than zero, which occurs when thread have to seek  
(backward in column file. #4897 (alesapin •  
Fix wrong argument types for aggregate functions with LowCardinality arguments (fixes issue #4919). #4922 (Nikolai  
(Kochetov •  
(Fix function toISOWeek result for year 1970. #4988 (alexey-milovidov •  
Fix DROP , TRUNCATE and OPTIMIZE queries duplication, when executed on ON CLUSTER for ReplicatedMergeTree\*  
(tables family. #4991 (alesapin •

## IMPROVEMENTS

Keep ordinary, DEFAULT , MATERIALIZED and ALIAS columns in a single list (fixes issue #2867). #4707 (Alex  
(Zatelepin •

## ClickHouse release 19.4.3.11, 2019-04-02

### BUG FIXES

(Fix crash in FULL/RIGHT JOIN when we joining on nullable vs not nullable. #4855 (Artem Zuikov •  
(Fix segmentation fault in clickhouse-copier . #4835 (proller •

### BUILD/TESTING/PACKAGING IMPROVEMENT

(Add a way to launch clickhouse-server image from a custom user. #4753 (Mikhail f. Shiryaev •

## BUG FIXES

Fixed reading from `Array(LowCardinality)` column in rare case when column contained a long sequence of empty arrays. • #4850 (Nikolai Kochetov)

## ClickHouse release 19.4.1.3, 2019-03-19

## BUG FIXES

Fixed remote queries which contain both `LIMIT BY` and `LIMIT`. Previously, if `LIMIT BY` and `LIMIT` were used for (remote query, `LIMIT` could happen before `LIMIT BY`, which led to too filtered result. • #4708 (Constantin S. Pan)

## ClickHouse release 19.4.0.49, 2019-03-09

## NEW FEATURES

(Added full support for Protobuf format (input and output, nested data structures). • #4174 #4493 (Vitaly Baranov)

(Added bitmap functions with Roaring Bitmaps. • #4207 (Andy Yang) #4568 (Vitaly Baranov)

(Parquet format support. • #4448 (proller))

N-gram distance was added for fuzzy string comparison. It is similar to q-gram metrics in R language. • #4466 (Danila (Kutnenin))

(Combine rules for graphite rollup from dedicated aggregation and retention patterns. • #4426 (Mikhail f. Shiryaev))

Added `max_execution_speed` and `max_execution_speed_bytes` to limit resource usage. Added `min_execution_speed_bytes` (setting to complement the `min_execution_speed`). • #4430 (Winter Zhang)

(Implemented function `flatten`. • #4555 #4409 (alexey-milovidov, kzon))

Added functions `arrayEnumerateDenseRanked` and `arrayEnumerateUniqRanked` (it's like `arrayEnumerateUniq` but allows to fine tune array depth to look inside multidimensional arrays). • #4475 (proller) #4601 (alexey-milovidov)

Multiple JOINS with some restrictions: no asterisks, no complex aliases in ON/WHERE/GROUP BY/... • #4462 (Artem (Zuikov))

## BUG FIXES

. This release also contains all bug fixes from 19.3 and 19.1 •

(Fixed bug in data skipping indices: order of granules after INSERT was incorrect. • #4407 (Nikita Vasilev))

Fixed `set index` for `Nullable` and `LowCardinality` columns. Before it, `set index` with `Nullable` or `LowCardinality` column (led to error Data type must be deserialized with multiple streams while selecting. • #4594 (Nikolai Kochetov))

(Correctly set `update_time` on full executable dictionary update. • #4551 (Tema Novikov))

(Fix broken progress bar in 19.3. • #4627 (filimonov))

Fixed inconsistent values of `MemoryTracker` when memory region was shranked, in certain cases. • #4619 (alexey- (milovidov))

(Fixed undefined behaviour in `ThreadPool`. • #4612 (alexey-milovidov))

Fixed a very rare crash with the message `mutex lock failed: Invalid argument` that could happen when a `MergeTree` table (was dropped concurrently with a `SELECT`). • #4608 (Alex Zatelepin)

(ODBC driver compatibility with `LowCardinality` data type. • #4381 (proller))

(FreeBSD: Fixup for `AIOContextPool`: Found `io_event` with unknown id 0 error. • #4438 (urgordeadbeef))

(`system.part_log` table was created regardless to configuration. • #4483 (alexey-milovidov))

(Fix undefined behaviour in `dictIsIn` function for cache dictionaries. • #4515 (alesapin))

Fixed a deadlock when a `SELECT` query locks the same table multiple times (e.g. from different threads or when

(executing multiple subqueries) and there is a concurrent DDL query. #4535 (Alex Zatelepin)  
Disable compile\_expressions by default until we get own llvm contrib and can test it with clang and asan. #4579 •  
(alesapin)

Prevent std::terminate when invalidate\_query for clickhouse external dictionary source has returned wrong resultset •  
(empty or more than one row or more than one column). Fixed issue when the invalidate\_query was performed every  
(five seconds regardless to the lifetime. #4583 (alexey-milovidov)

Avoid deadlock when the invalidate\_query for a dictionary with clickhouse source was involving system.dictionaries table •  
(or Dictionaries database (rare case). #4599 (alexey-milovidov)  
(Fixes for CROSS JOIN with empty WHERE. #4598 (Artem Zuikov •  
(Fixed segfault in function "replicate" when constant argument is passed. #4603 (alexey-milovidov •  
(Fix lambda function with predicate optimizer. #4408 (Winter Zhang •  
(Multiple JOINs multiple fixes. #4595 (Artem Zuikov •

#### IMPROVEMENTS

(Support aliases in JOIN ON section for right table columns. #4412 (Artem Zuikov •  
Result of multiple JOINs need correct result names to be used in subselects. Replace flat aliases with source names •  
(in result. #4474 (Artem Zuikov  
(Improve push-down logic for joined statements. #4387 (Ivan •

#### PERFORMANCE IMPROVEMENTS

(Improved heuristics of "move to PREWHERE" optimization. #4405 (alexey-milovidov •  
(Use proper lookup tables that uses HashTable's API for 8-bit and 16-bit keys. #4536 (Amos Bird •  
(Improved performance of string comparison. #4564 (alexey-milovidov •  
Cleanup distributed DDL queue in a separate thread so that it doesn't slow down the main loop that processes •  
(distributed DDL tasks. #4502 (Alex Zatelepin

When min\_bytes\_to\_use\_direct\_io is set to 1, not every file was opened with O\_DIRECT mode because the data size to •  
(read was sometimes underestimated by the size of one compressed block. #4526 (alexey-milovidov

#### BUILD/TESTING/PACKAGING IMPROVEMENT

(Added support for clang-9 #4604 (alexey-milovidov •  
(Fix wrong \_\_asm\_\_ instructions (again) #4621 (Konstantin Podshumok •  
(Add ability to specify settings for clickhouse-performance-test from command line. #4437 (alesapin •  
(Add dictionaries tests to integration tests. #4477 (alesapin •  
(Added queries from the benchmark on the website to automated performance tests. #4496 (alexey-milovidov •  
xxhash.h does not exist in external lz4 because it is an implementation detail and its symbols are namespaced with •  
XXH\_NAMESPACE macro. When lz4 is external, xxHash has to be external too, and the dependents have to link to it.  
(#4495 (Orivej Desh

Fixed a case when quantileTiming aggregate function can be called with negative or floating point argument (this fixes •  
(fuzz test with undefined behaviour sanitizer). #4506 (alexey-milovidov  
(Spelling error correction. #4531 (sdk2 •  
(Fix compilation on Mac. #4371 (Vitaly Baranov •  
(Build fixes for FreeBSD and various unusual build configurations. #4444 (proller •

## ClickHouse release 19.3.9.1, 2019-04-02

### BUG FIXES

(Fix crash in FULL/RIGHT JOIN when we joining on nullable vs not nullable. #4855 (Artem Zuikov •  
(Fix segmentation fault in clickhouse-copier . #4835 (proller •

Fixed reading from `Array(LowCardinality)` column in rare case when column contained a long sequence of empty •  
(arrays. #4850 (Nikolai Kochetov •

### BUILD/TESTING/PACKAGING IMPROVEMENT

(Add a way to launch clickhouse-server image from a custom user#4753 (Mikhail f. Shiryaev •

## ClickHouse release 19.3.7, 2019-03-12

### BUG FIXES

Fixed error in #3920. This error manifests itself as random cache corruption (messages Unknown codec family code , •  
Cannot seek through file ) and segfaults. This bug first appeared in version 19.1 and is present in versions up to 19.1.10  
(and 19.3.6. #4623 (alexey-milovidov •

## ClickHouse release 19.3.6, 2019-03-02

### BUG FIXES

When there are more than 1000 threads in a thread pool, `std::terminate` may happen on thread exit. Azat Khuzhin •  
(#4485 #4505 (alexey-milovidov •

Now it's possible to create ReplicatedMergeTree\* tables with comments on columns without defaults and tables with •  
(columns codecs without comments and defaults. Also fix comparison of codecs. #4523 (alesapin •

(Fixed crash on JOIN with array or tuple. #4552 (Artem Zuikov •

(Fixed crash in clickhouse-copier with the message ThreadStatus not created . #4540 (Artem Zuikov •

(Fixed hangup on server shutdown if distributed DDLs were used. #4472 (Alex Zatelepin •

Incorrect column numbers were printed in error message about text format parsing for columns with number greater •  
(than 10. #4484 (alexey-milovidov •

### BUILD/TESTING/PACKAGING IMPROVEMENTS

(Fixed build with AVX enabled. #4527 (alexey-milovidov •

Enable extended accounting and IO accounting based on good known version instead of kernel under which it is •  
(compiled. #4541 (nvartolomei •

(Allow to skip setting of `core_dump.size_limit`, warning instead of throw if limit set fail#4473 (proller •

(Removed the `inline` tags of `void readBinary(...)` in `Field.cpp` . Also merged redundant namespace DB blocks. #4530 (hcz •

## ClickHouse release 19.3.5, 2019-02-21

### BUG FIXES

(Fixed bug with large http insert queries processing. #4454 (alesapin •

Fixed backward incompatibility with old versions due to wrong implementation of `send_logs_level` setting. #4445 •  
((alexey-milovidov •

(Fixed backward incompatibility of table function `remote` introduced with column comments. #4446 (alexey-milovidov •

## ClickHouse release 19.3.4, 2019-02-16

### IMPROVEMENTS

Table index size is not accounted for memory limits when doing `ATTACH TABLE` query. Avoided the possibility that a table cannot be attached after being detached. #4396 (alexey-milovidov)

Slightly raised up the limit on max string and array size received from ZooKeeper. It allows to continue to work with increased size of `CLIENT_JVMFLAGS=-Djute.maxbuffer=...` on ZooKeeper. #4398 (alexey-milovidov)

(Allow to repair abandoned replica even if it already has huge number of nodes in its queue) #4399 (alexey-milovidov)  
(Add one required argument to `SET index` (max stored rows number). #4386 (Nikita Vasilev)

#### BUG FIXES

(Fixed `WITH ROLLUP` result for group by single LowCardinality key. #4384 (Nikolai Kochetov)

(Fixed bug in the set index (dropping a granule if it contains more than `max_rows` rows). #4386 (Nikita Vasilev)  
(A lot of FreeBSD build fixes. #4397 (proller))

(Fixed aliases substitution in queries with subquery containing same alias (issue #4110). #4351 (Artem Zuikov))

#### BUILD/TESTING/PACKAGING IMPROVEMENTS

(Add ability to run `clickhouse-server` for stateless tests in docker image. #4347 (Vasily Nemkov))

### ClickHouse release 19.3.3, 2019-02-13

#### NEW FEATURES

Added the `KILL MUTATION` statement that allows removing mutations that are for some reasons stuck. Added `latest_failed_part`, `latest_fail_time`, `latest_fail_reason` fields to the `system.mutations` table for easier troubleshooting. #4287 ((Alex Zatelepin))

(Added aggregate function `entropy` which computes Shannon entropy. #4238 (Quid37))

Added ability to send queries `INSERT INTO tbl VALUES (....)` to server without splitting on query and data parts. #4301 ((alesapin))

(Generic implementation of `arrayWithConstant` function was added. #4322 (alexey-milovidov))

(Implemented `NOT BETWEEN` comparison operator. #4228 (Dmitry Naumov))

Implement `sumMapFiltered` in order to be able to limit the number of keys for which values will be summed by `sumMap`. #4129 (Léo Ercolanelli)

(Added support of `Nullable` types in `mysql` table function. #4198 (Emmanuel Donin de Rosière))

(Support for arbitrary constant expressions in `LIMIT` clause. #4246 (k3box))

Added `topKWeighted` aggregate function that takes additional argument with (`unsigned integer`) weight. #4245 (Andrew Golman)

`StorageJoin` now supports `join_any_take_last_row` setting that allows overwriting existing values of the same key. #3973 (Amos Bird)

(Added function `toStartOfInterval`. #4304 (Vitaly Baranov))

(Added `RowBinaryWithNamesAndTypes` format. #4200 (Oleg V. Kozlyuk))

(Added `IPv4` and `IPv6` data types. More effective implementations of `IPv*` functions. #3669 (Vasily Nemkov))

(Added function `toStartOfTenMinutes()`. #4298 (Vitaly Baranov))

(Added `Protobuf` output format. #4005 #4158 (Vitaly Baranov))

(Added brotli support for HTTP interface for data import (INSERTs). #4235 (Mikhail))

(Added hints while user make typo in function name or type in command line client. #4239 (Danila Kutenin))

(Added `Query-Id` to Server's HTTP Response header. #4231 (Mikhail))

#### EXPERIMENTAL FEATURES

(Added `minmax` and `set` data skipping indices for MergeTree table engines family. #4143 (Nikita Vasilev) •  
(Added conversion of CROSS JOIN to INNER JOIN if possible. #4221 #4266 (Artem Zuikov) •

#### BUG FIXES

(Fixed `Not found column` for duplicate columns in JOIN ON section. #4279 (Artem Zuikov) •  
(Make `START REPLICATED SENDS` command start replicated sends. #4229 (nvartolomei) •  
(Fixed aggregate functions execution with `Array(LowCardinality)` arguments. #4055 (KochetovNicolai) •  
Fixed wrong behaviour when doing `INSERT ... SELECT ... FROM file(...)` query and file has `CSVWithNames` or  
(`TSVWithNames` format and the first data row is missing. #4297 (alexey-milovidov) •  
(Fixed crash on dictionary reload if dictionary not available. This bug was appeared in 19.1.6. #4188 (proller) •  
(Fixed `ALL JOIN` with duplicates in right table. #4184 (Artem Zuikov) •  
Fixed segmentation fault with `use_uncompressed_cache=1` and exception with wrong uncompressed size. This bug was  
(appeared in 19.1.6. #4186 (alesapin) •  
(Fixed `compile_expressions` bug with comparison of big (more than `int16`) dates. #4341 (alesapin) •  
(Fixed infinite loop when selecting from table function `numbers(0)`. #4280 (alexey-milovidov) •  
(Temporarily disable predicate optimization for `ORDER BY`. #3890 (Winter Zhang) •  
Fixed illegal instruction error when using `base64` functions on old CPUs. This error has been reproduced only when  
(ClickHouse was compiled with `gcc-8`. #4275 (alexey-milovidov) •  
Fixed `No message received` error when interacting with PostgreSQL ODBC Driver through TLS connection. Also fixes  
(segfault when using MySQL ODBC Driver. #4170 (alexey-milovidov) •  
Fixed incorrect result when `Date` and `DateTime` arguments are used in branches of conditional operator (function `if`).  
(Added generic case for function `if`. #4243 (alexey-milovidov) •  
(ClickHouse dictionaries now load within `clickhouse` process. #4166 (alexey-milovidov) •  
Fixed deadlock when `SELECT` from a table with `File` engine was retried after `No such file or directory` error. #4161 •  
((alexey-milovidov)  
(Fixed race condition when selecting from `system.tables` may give `table doesn't exist` error. #4313 (alexey-milovidov) •  
clickhouse-client can segfault on exit while loading data for command line suggestions if it was run in interactive mode.  
(#4317 (alexey-milovidov) •  
Fixed a bug when the execution of mutations containing `IN` operators was producing incorrect results. #4099 (Alex Zatelepin)  
(Zatelepin) •  
Fixed error: if there is a database with `Dictionary` engine, all dictionaries forced to load at server startup, and if there is  
(a dictionary with ClickHouse source from localhost, the dictionary cannot load. #4255 (alexey-milovidov) •  
(Fixed error when system logs are tried to create again at server shutdown. #4254 (alexey-milovidov) •  
(Correctly return the right type and properly handle locks in `joinGet` function. #4153 (Amos Bird) •  
(Added `sumMapWithOverflow` function. #4151 (Léo Ercolanelli) •  
(Fixed segfault with `allow_experimental_multiple_joins_emulation`. 52de2c (Artem Zuikov) •  
(Fixed bug with incorrect `Date` and `DateTime` comparison. #4237 (valexey) •  
Fixed fuzz test under undefined behavior sanitizer: added parameter type check for `quantile*Weighted` family of  
functions. #4145 (alexey-milovidov) •  
(Fixed rare race condition when removing of old data parts can fail with `File not found` error. #4378 (alexey-milovidov) •  
(Fix install package with missing `/etc/clickhouse-server/config.xml`. #4343 (proller) •

(Debian package: correct /etc/clickhouse-server/preprocessed link according to config. #4205 (proller) •  
(Various build fixes for FreeBSD. #4225 (proller) •  
(Added ability to create, fill and drop tables in perftest. #4220 (alesapin) •  
(Added a script to check for duplicate includes. #4326 (alexey-milovidov) •  
(Added ability to run queries by index in performance test. #4264 (alesapin) •  
(Package with debug symbols is suggested to be installed. #4274 (alexey-milovidov) •  
(Refactoring of performance-test. Better logging and signals handling. #4171 (alesapin) •  
(Added docs to anonymized Yandex.Metrika datasets. #4164 (alesapin) •  
(Added tool for converting an old month-partitioned part to the custom-partitioned format. #4195 (Alex Zatelepin) •  
(Added docs about two datasets in s3. #4144 (alesapin) •  
Added script which creates changelog from pull requests description. #4169 #4173 (KochetovNicolai) •  
((KochetovNicolai)  
(Added puppet module for Clickhouse. #4182 (Maxim Fedotov) •  
(Added docs for a group of undocumented functions. #4168 (Winter Zhang) •  
(ARM build fixes. #4210#4306 #4291 (proller) (proller) •  
(Dictionary tests now able to run from ctest . #4189 (proller) •  
(Now /etc/ssl is used as default directory with SSL certificates. #4167 (alexey-milovidov) •  
(Added checking SSE and AVX instruction at start. #4234 (lgr) •  
(Init script will wait server until start. #4281 (proller) •

#### BACKWARD INCOMPATIBLE CHANGES

Removed allow\_experimental\_low\_cardinality\_type setting. LowCardinality data types are production ready. #4323 •  
((alexey-milovidov)  
Reduce mark cache size and uncompressed cache size accordingly to available memory amount. #4240 (Lopatin) •  
Konstantin  
Added keyword INDEX in CREATE TABLE query. A column with name index must be quoted with backticks or double quotes: `index` . #4143 (Nikita Vasilev) •  
sumMap now promote result type instead of overflow. The old sumMap behavior can be obtained by using  
( sumMapWithOverflow function. #4151 (Léo Ercolanelli) •

#### PERFORMANCE IMPROVEMENTS

( std::sort replaced by pdqsort for queries without LIMIT . #4236 (Evgenii Pravda) •  
Now server reuse threads from global thread pool. This affects performance in some corner cases #4150 (alexey- milovidov) •

#### IMPROVEMENTS

(Implemented AIO support for FreeBSD. #4305 (urgordeadbeef) •  
( SELECT \* FROM a JOIN b USING a, b now return a and b columns only from the left table. #4141 (Artem Zuikov) •  
(Allow -C option of client to work as -c option. #4232 (syominsergey) •  
(Now option --password used without value requires password from stdin. #4230 (BSD\_Conqueror) •  
Added highlighting of unescaped metacharacters in string literals that contain LIKE expressions or regexps. #4327 •  
((alexey-milovidov)  
(Added cancelling of HTTP read only queries if client socket goes away. #4213 (nvartolomei) •

(Now server reports progress to keep client connections alive. #4215 (Ivan •  
Slightly better message with reason for OPTIMIZE query with `optimize_throw_if_noop` setting enabled. #4294 (alexey- •  
(milovidov  
(Added support of `--version` option for clickhouse server. #4251 (Lopatin Konstantin •  
(Added `--help/-h` option to `clickhouse-server`. #4233 (Yuriy Baranov •  
(Added support for scalar subqueries with aggregate function state result. #4348 (Nikolai Kochetov •  
(Improved server shutdown time and ALTERs waiting time. #4372 (alexey-milovidov •  
Added info about the `replicated_can_become_leader` setting to `system.replicas` and add logging if the replica won't try •  
(to become leader. #4379 (Alex Zatelepin

## ClickHouse release 19.1

### ClickHouse release 19.1.14, 2019-03-14

Fixed error Column ... queried more than once that may happen if the setting `asterisk_left_columns_only` is set to 1 in case •  
of using `GLOBAL JOIN` with `SELECT *` (rare case). The issue does not exist in 19.3 and newer. #6bac7d8d (Artem  
(Zuikov

### ClickHouse release 19.1.13, 2019-03-12

. This release contains exactly the same set of patches as 19.3.7

### ClickHouse release 19.1.10, 2019-03-03

. This release contains exactly the same set of patches as 19.3.6

## ClickHouse release 19.1

### ClickHouse release 19.1.9, 2019-02-21

#### BUG FIXES

Fixed backward incompatibility with old versions due to wrong implementation of `send_logs_level` setting. #4445 •  
(alexey-milovidov

(Fixed backward incompatibility of table function `remote` introduced with column comments. #4446 (alexey-milovidov •

### ClickHouse release 19.1.8, 2019-02-16

#### BUG FIXES

(Fix install package with missing `/etc/clickhouse-server/config.xml`. #4343 (proller •

## ClickHouse release 19.1

### ClickHouse release 19.1.7, 2019-02-15

#### BUG FIXES

(Correctly return the right type and properly handle locks in `joinGet` function. #4153 (Amos Bird •

(Fixed error when system logs are tried to create again at server shutdown. #4254 (alexey-milovidov •

Fixed error: if there is a database with `Dictionary` engine, all dictionaries forced to load at server startup, and if there is •  
(a dictionary with ClickHouse source from localhost, the dictionary cannot load. #4255 (alexey-milovidov

Fixed a bug when the execution of mutations containing `IN` operators was producing incorrect results. #4099 (Alex •

clickhouse-client can segfault on exit while loading data for command line suggestions if it was run in interactive mode. •  
(Fixed race condition when selecting from system.tables may give table doesn't exist error. #4313 (alexey-milovidov) •  
Fixed deadlock when SELECT from a table with File engine was retried after No such file or directory error. #4161 •  
((alexey-milovidov  
Fixed an issue: local ClickHouse dictionaries are loaded via TCP, but should load within process #4166 (alexey- •  
(milovidov  
Fixed No message received error when interacting with PostgreSQL ODBC Driver through TLS connection. Also fixes •  
(segfault when using MySQL ODBC Driver. #4170 (alexey-milovidov  
(Temporarily disable predicate optimization for ORDER BY . #3890 (Winter Zhang •  
(Fixed infinite loop when selecting from table function numbers(0) . #4280 (alexey-milovidov •  
(Fixed compile\_expressions bug with comparison of big (more than int16) dates. #4341 (alesapin •  
(Fixed segmentation fault with uncompressed\_cache=1 and exception with wrong uncompressed size. #4186 (alesapin •  
(Added support for ALL JOIN with duplicates in right table. #4184 (Artem Zuikov •  
Fixed wrong behaviour when doing INSERT ... SELECT ... FROM file(...) query and file has CSVWithNames or •  
( TSVWithNames format and the first data row is missing. #4297 (alexey-milovidov  
(Fixed aggregate functions execution with Array(LowCardinality) arguments. #4055 (KochetovNicolai •  
(Debian package: correct /etc/clickhouse-server/preprocessed link according to config. #4205 (proller •  
Fixed fuzz test under undefined behavior sanitizer: added parameter type check for quantile\*Weighted family of •  
functions. #4145 (alexey-milovidov  
(Make START REPLICATED SENDS command start replicated sends. #4229 (nvartolomei •  
(Fixed Not found column for duplicate columns in JOIN ON section. #4279 (Artem Zuikov •  
(Now /etc/ssl is used as default directory with SSL certificates. #4167 (alexey-milovidov •  
(Fixed crash on dictionary reload if dictionary not available. #4188 (proller •  
(Fixed bug with incorrect Date and DateTime comparison. #4237 (valexey •  
Fixed incorrect result when Date and DateTime arguments are used in branches of conditional operator (function if). •  
(Added generic case for function if . #4243 (alexey-milovidov

**ClickHouse release 19.1.6, 2019-01-24****NEW FEATURES**

(Custom per column compression codecs for tables. #3899 #4111 (alesapin, Winter Zhang, Anatoly •  
(Added compression codec Delta . #4052 (alesapin •  
(Allow to ALTER compression codecs. #4054 (alesapin •  
Added functions left , right , trim , ltrim , rtrim , timestampadd , timestampsub for SQL standard compatibility. #3826 (Ivan •  
(Blinkov  
(Support for write in HDFS tables and hdfs table function. #4084 (alesapin •  
Added functions to search for multiple constant strings from big haystack: multiPosition , multiSearch , firstMatch also •  
(with -UTF8 , -CaseInsensitive , and -CaseInsensitiveUTF8 variants. #4053 (Danila Kutenin  
Pruning of unused shards if SELECT query filters by sharding key (setting optimize\_skip\_unused\_shards ). #3851 (Gleb •  
(Kanterov, Ivan  
(Allow Kafka engine to ignore some number of parsing errors per block. #4094 (Ivan •

Added support for `CatBoost` multiclass models evaluation. Function `modelEvaluate` returns tuple with per-class raw predictions for multiclass models. `libcatboostmodel.so` should be built with #607. #3959 (KochetovNicolai) •  
(Added functions `filesystemAvailable`, `filesystemFree`, `filesystemCapacity`. #4097 (Boris Granveaud) •  
(Added hashing functions `xxHash64` and `xxHash32`. #3905 (filimonov) •  
Added `gccMurmurHash` hashing function (GCC flavoured Murmur hash) which uses the same hash seed as `gcc` #4000 •  
((sundyli)  
(Added hashing functions `javaHash`, `hiveHash`. #3811 (shangshujie365) •  
(Added table function `remoteSecure`. Function works as `remote`, but uses secure connection. #4088 (proller) •

## EXPERIMENTAL FEATURES

(Added multiple JOINs emulation (allow\_experimental\_multiple\_joins\_emulation setting). #3946 (Artem Zuikov) •

## BUG FIXES

(Make `compiled_expression_cache_size` setting limited by default to lower memory consumption. #4041 (alesapin) •

Fix a bug that led to hangups in threads that perform ALTERs of Replicated tables and in the thread that updates configuration from ZooKeeper. #2947 #3891 #3934 (Alex Zatelepin)

Fixed a race condition when executing a distributed ALTER task. The race condition led to more than one replica (trying to execute the task and all replicas except one failing with a ZooKeeper error. #3904 (Alex Zatelepin)

Fix a bug when `from_zk` config elements weren't refreshed after a request to ZooKeeper timed out. #2947 #3947 (Alex Zatelepin)

(Fix bug with wrong prefix for IPv4 subnet masks. #3945 (alesapin) •

Fixed crash (`std::terminate`) in rare cases when a new thread cannot be created due to exhausted resources #3956 •  
((alexey-milovidov)

Fix bug when in `remote` table function execution when wrong restrictions were used for in `getStructureOfRemoteTable`. (#4009 (alesapin)

Fix a leak of netlink sockets. They were placed in a pool where they were never deleted and new sockets were (created at the start of a new thread when all current sockets were in use. #4017 (Alex Zatelepin)

Fix bug with closing `/proc/self/fd` directory earlier than all fds were read from `/proc` after forking `odbc-bridge` (subprocess. #4120 (alesapin)

(Fixed String to UInt monotonic conversion in case of usage String in primary key #3870 (Winter Zhang) •

(Fixed error in calculation of integer conversion function monotonicity. #3921 (alexey-milovidov) •

Fixed segfault in `arrayEnumerateUniq`, `arrayEnumerateDense` functions in case of some invalid arguments. #3909 •  
((alexey-milovidov)

(Fix UB in `StorageMerge`. #3910 (Amos Bird) •

(Fixed segfault in functions `addDays`, `subtractDays`. #3913 (alexey-milovidov) •

Fixed error: functions `round`, `floor`, `trunc`, `ceil` may return bogus result when executed on integer argument and large (negative scale. #3914 (alexey-milovidov)

(Fixed a bug induced by 'kill query sync' which leads to a core dump. #3916 (muVulDeePecker) •

(Fix bug with long delay after empty replication queue. #3928 #3932 (alesapin) •

Fixed excessive memory usage in case of inserting into table with `LowCardinality` primary key. #3955 (KochetovNicolai) •  
(

(Fixed `LowCardinality` serialization for `Native` format in case of empty arrays. #3907 #4011 (KochetovNicolai) •

(Fixed incorrect result while using `distinct by` single `LowCardinality` numeric column. #3895 #4012 (KochetovNicolai) •

Fixed specialized aggregation with `LowCardinality` key (in case when `compile` setting is enabled). #3886 •

((KochetovNicolai

(Fix user and password forwarding for replicated tables queries. #3957 (alesapin) (小路 •

Fixed very rare race condition that can happen when listing tables in Dictionary database while reloading dictionaries. •

(#3970 (alexey-milovidov

(Fixed incorrect result when HAVING was used with ROLLUP or CUBE. #3756 #3837 (Sam Chou •

(Fixed column aliases for query with JOIN ON syntax and distributed tables. #3980 (Winter Zhang •

Fixed error in internal implementation of quantileTDigest (found by Artem Vakhrushev). This error never happens in •

ClickHouse and was relevant only for those who use ClickHouse codebase as a library directly. #3935 (alexey-  
(milovidov

## IMPROVEMENTS

Support for IF NOT EXISTS in ALTER TABLE ADD COLUMN statements along with IF EXISTS in •

( DROP/MODIFY/CLEAR/COMMENT COLUMN . #3900 (Boris Granveaud

Function parseDateTimeBestEffort : support for formats DD.MM.YYYY , DD.MM.YY , DD-MM-YYYY , DD-Mon-YYYY , •

( DD/Month/YYYY and similar. #3922 (alexey-milovidov

( CapnProtoInputStream now support jagged structures. #4063 (Odin Hultgren Van Der Horst •

Usability improvement: added a check that server process is started from the data directory's owner. Do not allow to •

(start server from root if the data belongs to non-root user. #3785 (sergey-v-galtsev

(Better logic of checking required columns during analysis of queries with JOINs. #3930 (Artem Zuikov •

Decreased the number of connections in case of large number of Distributed tables in a single server #3726 (Winter •

(Zhang

(Supported totals row for WITH TOTALS query for ODBC driver. #3836 (Maksim Koritckiy •

(Allowed to use Enum s as integers inside if function. #3875 (Ivan •

Added low\_cardinality\_allow\_in\_native\_format setting. If disabled, do not use LowCardinality type in Native format. #3879 •

((KochetovNicolai

(Removed some redundant objects from compiled expressions cache to lower memory usage. #4042 (alesapin •

(Add check that SET send\_logs\_level = 'value' query accept appropriate value. #3873 (Sabyanin Maxim •

(Fixed data type check in type conversion functions. #3896 (Winter Zhang •

## PERFORMANCE IMPROVEMENTS

Add a MergeTree setting use\_minimalistic\_part\_header\_in\_zookeeper . If enabled, Replicated tables will store compact •

part metadata in a single part znode. This can dramatically reduce ZooKeeper snapshot size (especially if the tables

have a lot of columns). Note that after enabling this setting you will not be able to downgrade to a version that doesn't

(support it. #3960 (Alex Zatelepin

Add an DFA-based implementation for functions sequenceMatch and sequenceCount in case pattern doesn't contain •

(time. #4004 (Léo Ercolanelli

(Performance improvement for integer numbers serialization. #3968 (Amos Bird •

Zero left padding PODArray so that -1 element is always valid and zeroed. It's used for branchless calculation of •

(offsets. #3920 (Amos Bird

(Reverted jemalloc version which lead to performance degradation. #4018 (alexey-milovidov •

## BACKWARD INCOMPATIBLE CHANGES

Removed undocumented feature ALTER MODIFY PRIMARY KEY because it was superseded by the ALTER MODIFY •

(ORDER BY command. #3887 (Alex Zatelepin

(Removed function shardByHash . #3833 (alexey-milovidov •

(Forbid using scalar subqueries with result of type AggregateFunction . #3865 (ivan •

## BUILD/TESTING/PACKAGING IMPROVEMENTS

(Added support for PowerPC ( ppc64le ) build. #4132 (Danila Kutenin •

(Stateful functional tests are run on public available dataset.#3969 (alexey-milovidov •

Fixed error when the server cannot start with the bash: /usr/bin/clickhouse-extract-from-config: Operation not permitted •  
(message within Docker or systemd-nspawn. #4136 (alexey-milovidov

(Updated rdkafka library to v1.0.0-RC5. Used cppkafka instead of raw C interface.#4025 (ivan •

(Updated mariadb-client library. Fixed one of issues found by UBSan.#3924 (alexey-milovidov •

(Some fixes for UBSan builds. #3926 #3021 #3948 (alexey-milovidov •

.Added per-commit runs of tests with UBSan build •

.Added per-commit runs of PVS-Studio static analyzer •

(Fixed bugs found by PVS-Studio. #4013 (alexey-milovidov •

(Fixed glibc compatibility issues. #4100 (alexey-milovidov •

(Move Docker images to 18.10 and add compatibility file for glibc >= 2.28#3965 (alesapin •

(Add env variable if user don't want to chown directories in server Docker image#3967 (alesapin •

(Enabled most of the warnings from -Weverything in clang. Enabled -Wpedantic . #3986 (alexey-milovidov •

(Added a few more warnings that are available only in clang 8#3993 (alexey-milovidov •

(Link to libLLVM rather than to individual LLVM libs when using shared linking.#3989 (Orivej Desh •

(Added sanitizer variables for test images. #4072 (alesapin •

clickhouse-server debian package will recommend libcap2-bin package to use setcap tool for setting capabilities. This •

(is optional. #4093 (alexey-milovidov

(Improved compilation time, fixed includes. #3898 (proller •

(Added performance tests for hash functions. #3918 (filimonov •

(Fixed cyclic library dependences. #3958 (proller •

(Improved compilation with low available memory. #4030 (proller •

(Added test script to reproduce performance degradation in jemalloc . #4036 (alexey-milovidov •

(Fixed misspells in comments and string literals under dbms . #4122 (maiha •

(Fixed typos in comments. #4089 (Evgenii Pravda •

## ClickHouse release 18.16

### ClickHouse release 18.16.1, 2018-12-21

#### :BUG FIXES

Fixed an error that led to problems with updating dictionaries with the ODBC source#3825, #3829 •

JIT compilation of aggregate functions now works with LowCardinality columns.#3838 •

#### :IMPROVEMENTS

Added the low\_cardinality\_allow\_in\_native\_format setting (enabled by default). When disabled, LowCardinality columns •  
will be converted to ordinary columns for SELECT queries and ordinary columns will be expected for INSERT queries.

#3879

#### :BUILD IMPROVEMENTS

:NEW FEATURES

DEFAULT expressions are evaluated for missing fields when loading data in semi-structured input formats •  
( JSONEachRow , TSKV ). The feature is enabled with the insert\_sample\_with\_metadata setting. #3555

The ALTER TABLE query now has the MODIFY ORDER BY action for changing the sorting key when adding or •  
removing a table column. This is useful for tables in the MergeTree family that perform additional tasks when merging  
based on this sorting key, such as SummingMergeTree , AggregatingMergeTree , and so on. #3581 #3755

For tables in the MergeTree family, now you can specify a different sorting key (ORDER BY) and index (PRIMARY •  
KEY ). The sorting key can be longer than the index. #3581

Added the hdfs table function and the HDFS table engine for importing and exporting data to HDFS. chenxing-xc •

Added functions for working with base64: base64Encode , base64Decode , tryBase64Decode . Alexander Krasheninnikov •

Now you can use a parameter to configure the precision of the uniqCombined aggregate function (select the number of •  
HyperLogLog cells). #3406

Added the system.contributors table that contains the names of everyone who made commits in ClickHouse. #3452 •

Added the ability to omit the partition for the ALTER TABLE ... FREEZE query in order to back up all partitions at once. •  
#3514

Added dictGet and dictGetOrDefault functions that don't require specifying the type of return value. The type is •  
determined automatically from the dictionary description. Amos Bird

Now you can specify comments for a column in the table description and change it using ALTER . #3377 •

Reading is supported for Join type tables with simple keys. Amos Bird •

Now you can specify the options join\_use\_nulls , max\_rows\_in\_join , max\_bytes\_in\_join , and join\_overflow\_mode when •  
creating a Join type table. Amos Bird

Added the joinGet function that allows you to use a Join type table like a dictionary. Amos Bird •

Added the partition\_key , sorting\_key , primary\_key , and sampling\_key columns to the system.tables table in order to •  
provide information about table keys. #3609

Added the is\_in\_partition\_key , is\_in\_sorting\_key , is\_in\_primary\_key , and is\_in\_sampling\_key columns to the •  
system.columns table. #3609

Added the min\_time and max\_time columns to the system.parts table. These columns are populated when the •  
partitioning key is an expression consisting of DateTime columns. Emmanuel Donin de Rosière

:BUG FIXES

Fixes and performance improvements for the LowCardinality data type. GROUP BY using LowCardinality(Nullable(...)) . •  
Getting the values of extremes . Processing high-order functions. LEFT ARRAY JOIN . Distributed GROUP BY .  
Functions that return Array . Execution of ORDER BY . Writing to Distributed tables (nicelulu). Backward compatibility  
for INSERT queries from old clients that implement the Native protocol. Support for LowCardinality for JOIN . Improved  
performance when working in a single stream. #3823 #3803 #3799 #3769 #3744 #3681 #3651 #3649 #3641 #3632  
#3568 #3523 #3518

Fixed how the select\_sequential\_consistency option works. Previously, when this setting was enabled, an incomplete •  
result was sometimes returned after beginning to write to a new partition. #2863

Databases are correctly specified when executing DDL ON CLUSTER queries and ALTER UPDATE/DELETE . #3772 •  
#3460

Databases are correctly specified for subqueries inside a VIEW. #3521 •

Fixed a bug in PREWHERE with FINAL for VersionedCollapsingMergeTree . 7167bfd7 •

Now you can use `KILL QUERY` to cancel queries that have not started yet because they are waiting for the table to be •  
locked. #3517

Corrected date and time calculations if the clocks were moved back at midnight (this happens in Iran, and happened •  
in Moscow from 1981 to 1983). Previously, this led to the time being reset a day earlier than necessary, and also  
caused incorrect formatting of the date and time in text format. #3819

Fixed bugs in some cases of `VIEW` and subqueries that omit the database. Winter Zhang •

Fixed a race condition when simultaneously reading from a `MATERIALIZED VIEW` and deleting a `MATERIALIZED VIEW` •  
due to not locking the internal `MATERIALIZED VIEW`. #3404 #3694

Fixed the error `Lock handler cannot be nullptr`. #3689 •

Fixed query processing when the `compile_expressions` option is enabled (it's enabled by default). Nondeterministic •  
constant expressions like the `now` function are no longer unfolded. #3457

.Fixed a crash when specifying a non-constant scale argument in `toDecimal32/64/128` functions •

Fixed an error when trying to insert an array with `NULL` elements in the `Values` format into a column of type `Array` •  
without `Nullable` (if `input_format_values_interpret_expressions = 1`). #3487 #3503

Fixed continuous error logging in `DDLWorker` if ZooKeeper is not available. 8f50c620 •

Fixed the return type for `quantile*` functions from `Date` and `DateTime` types of arguments. #3580 •

Fixed the `WITH` clause if it specifies a simple alias without expressions. #3570 •

Fixed processing of queries with named sub-queries and qualified column names when •  
`enable_optimize_predicate_expression` is enabled. Winter Zhang

Fixed the error `Attempt to attach to nullptr thread group` when working with materialized views. Marek Vavruša •

Fixed a crash when passing certain incorrect arguments to the `arrayReverse` function. 73e3a7b6 •

Fixed the buffer overflow in the `extractURLParameter` function. Improved performance. Added correct processing of •  
strings containing zero bytes. 141e9799

Fixed buffer overflow in the `lowerUTF8` and `upperUTF8` functions. Removed the ability to execute these functions over •  
`FixedSize` type arguments. #3662

Fixed a rare race condition when deleting `MergeTree` tables. #3680 •

Fixed a race condition when reading from `Buffer` tables and simultaneously performing `ALTER` or `DROP` on the target •  
tables. #3719

Fixed a segfault if the `max_temporary_non_const_columns` limit was exceeded. #3788 •

## :IMPROVEMENTS

The server does not write the processed configuration files to the `/etc/clickhouse-server/` directory. Instead, it saves •  
them in the `preprocessed_configs` directory inside `path`. This means that the `/etc/clickhouse-server/` directory doesn't  
have write access for the `clickhouse` user, which improves security. #2443

The `min_merge_bytes_to_use_direct_io` option is set to 10 GiB by default. A merge that forms large parts of tables from •  
the `MergeTree` family will be performed in `O_DIRECT` mode, which prevents excessive page cache eviction. #3504

Accelerated server start when there is a very large number of tables. #3398 •

Added a connection pool and HTTP `Keep-Alive` for connections between replicas. #3594 •

If the query syntax is invalid, the `400 Bad Request` code is returned in the `HTTP` interface (500 was returned •  
previously). 31bc680a

The `join_default_strictness` option is set to `ALL` by default for compatibility. 120e2cbe •

Removed logging to `stderr` from the `re2` library for invalid or complex regular expressions. #3723 •

Added for the `Kafka` table engine: checks for subscriptions before beginning to read from Kafka; the •  
`kafka_max_block_size` setting for the table. Marek Vavruša

- The `cityHash64`, `farmHash64`, `metroHash64`, `sipHash64`, `halfMD5`, `murmurHash2_32`, `murmurHash2_64`, `murmurHash3_32`, and `murmurHash3_64` functions now work for any number of arguments and for arguments in the form of tuples. [#3451](#) [#3519](#)
  - The `arrayReverse` function now works with any types of arrays. [#73e3a7b6](#)
  - Added an optional parameter: the slot size for the `timeSlots` function. [Kirill Shvakov](#)
  - For `FULL` and `RIGHT JOIN`, the `max_block_size` setting is used for a stream of non-joined data from the right table. [Amos Bird](#)
  - Added the `--secure` command line parameter in `clickhouse-benchmark` and `clickhouse-performance-test` to enable TLS. [#3688](#) [#3690](#)
  - Type conversion when the structure of a `Buffer` type table does not match the structure of the destination table. [Vitaly Baranov](#)
  - Added the `tcp_keep_alive_timeout` option to enable keep-alive packets after inactivity for the specified time interval. [#3441](#)
  - Removed unnecessary quoting of values for the partition key in the `system.parts` table if it consists of a single column. [#3652](#)
  - The modulo function works for `Date` and `DateTime` data types. [#3385](#)
  - Added synonyms for the `POWER`, `LN`, `LCASE`, `UCASE`, `REPLACE`, `LOCATE`, `SUBSTR`, and `MID` functions. [#3774](#)
  - [#3763](#) Some function names are case-insensitive for compatibility with the SQL standard. Added syntactic sugar `SUBSTRING(expr FROM start FOR length)` for compatibility with SQL. [#3804](#)
  - Added the ability to `mlock` memory pages corresponding to `clickhouse-server` executable code to prevent it from being forced out of memory. This feature is disabled by default. [#3553](#)
  - Improved performance when reading from `O_DIRECT` (with the `min_bytes_to_use_direct_io` option enabled). [#3405](#)
  - Improved performance of the `dictGet...OrDefault` function for a constant key argument and a non-constant default argument. [Amos Bird](#)
  - The `firstSignificantSubdomain` function now processes the domains `gov`, `mil`, and `edu`. [Igor Hatarist](#) Improved performance. [#3628](#)
  - Ability to specify custom environment variables for starting `clickhouse-server` using the SYS-V init.d script by defining `CLICKHOUSE_PROGRAM_ENV` in `/etc/default/clickhouse`. [Pavlo Bashynskyi](#)
  - Correct return code for the `clickhouse-server` init script. [#3516](#)
  - The `system.metrics` table now has the `VersionInteger` metric, and `system.build_options` has the added line `VERSION_INTEGER`, which contains the numeric form of the ClickHouse version, such as `18016000`. [#3644](#)
  - Removed the ability to compare the `Date` type with a number to avoid potential errors like `date = 2018-12-17`, where quotes around the date are omitted by mistake. [#3687](#)
  - Fixed the behavior of stateful functions like `rowNumberInAllBlocks`. They previously output a result that was one number larger due to starting during query analysis. [Amos Bird](#)
  - If the `force_restore_data` file can't be deleted, an error message is displayed. [Amos Bird](#)
- :BUILD IMPROVEMENTS
- Updated the `jemalloc` library, which fixes a potential memory leak. [Amos Bird](#)
  - Profiling with `jemalloc` is enabled by default in order to debug builds. [#2cc82f5c](#)
  - Added the ability to run integration tests when only `Docker` is installed on the system. [#3650](#)
  - Added the fuzz expression test in `SELECT` queries. [#3442](#)
  - Added a stress test for commits, which performs functional tests in parallel and in random order to detect more race conditions. [#3438](#)

Improved the method for starting clickhouse-server in a Docker image. [Elghazal Ahmed](#) •  
For a Docker image, added support for initializing databases using files in the `/docker-entrypoint-initdb.d` directory. •  
[Konstantin Lebedev](#)  
Fixes for builds on ARM. [#3709](#) •  
:BACKWARD INCOMPATIBLE CHANGES  
Removed the ability to compare the `Date` type with a number. Instead of `toDate('2018-12-18') = 17883`, you must use •  
explicit type conversion `= toDate(17883)` [#3687](#)

## ClickHouse release 18.14

### ClickHouse release 18.14.19, 2018-12-19

:BUG FIXES

Fixed an error that led to problems with updating dictionaries with the ODBC source. [#3825](#), [#3829](#) •  
Databases are correctly specified when executing DDL ON CLUSTER queries. [#3460](#) •  
Fixed a segfault if the `max_temporary_non_const_columns` limit was exceeded. [#3788](#) •

:BUILD IMPROVEMENTS

.Fixes for builds on ARM •

### ClickHouse release 18.14.18, 2018-12-04

:BUG FIXES

Fixed error in `dictGet...` function for dictionaries of type `range`, if one of the arguments is constant and other is not. •  
[#3751](#)

Fixed error that caused messages `netlink: ...: attribute type 1 has an invalid length` to be printed in Linux kernel log, that •  
was happening only on fresh enough versions of Linux kernel. [#3749](#)

Fixed segfault in function `empty` for argument of `FixedSize` type. [Daniel, Dao Quang Minh](#) •

Fixed excessive memory allocation when using large value of `max_query_size` setting (a memory chunk of •  
`max_query_size` bytes was preallocated at once). [#3720](#)

:BUILD CHANGES

Fixed build with LLVM/Clang libraries of version 7 from the OS packages (these libraries are used for runtime query •  
compilation). [#3582](#)

### ClickHouse release 18.14.17, 2018-11-30

:BUG FIXES

Fixed cases when the ODBC bridge process did not terminate with the main server process. [#3642](#) •

Fixed synchronous insertion into the `Distributed` table with a columns list that differs from the column list of the remote •  
table. [#3673](#)

Fixed a rare race condition that can lead to a crash when dropping a MergeTree table. [#3643](#) •

Fixed a query deadlock in case when query thread creation fails with the `Resource temporarily unavailable` error. [#3643](#) •

Fixed parsing of the `ENGINE` clause when the `CREATE AS table` syntax was used and the `ENGINE` clause was •  
specified before the `AS table` (the error resulted in ignoring the specified engine). [#3692](#)

### ClickHouse release 18.14.15, 2018-11-21

:BUG FIXES

The size of memory chunk was overestimated while deserializing the column of type `Array(String)` that leads to • "Memory limit exceeded" errors. The issue appeared in version 18.12.13. #3589

### ClickHouse release 18.14.14, 2018-11-20

:BUG FIXES

Fixed `ON CLUSTER` queries when cluster configured as secure (flag `<secure>`). #3599 •

:BUILD CHANGES

Fixed problems (llvm-7 from system, macos) #3582 •

### ClickHouse release 18.14.13, 2018-11-08

:BUG FIXES

Fixed the Block structure mismatch in MergingSorted stream error. #3162 •

Fixed `ON CLUSTER` queries in case when secure connections were turned on in the cluster config (the `<secure>` flag). • #3465

Fixed an error in queries that used `SAMPLE`, `PREWHERE` and alias columns. #3543 •

Fixed a rare `unknown compression method` error when the `min_bytes_to_use_direct_io` setting was enabled. #3544 •

:PERFORMANCE IMPROVEMENTS

Fixed performance regression of queries with `GROUP BY` of columns of `UInt16` or `Date` type when executing on AMD • EPYC processors. Igor Lapko

Fixed performance regression of queries that process long strings. #3530 •

:BUILD IMPROVEMENTS

Improvements for simplifying the Arcadia build. #3475, #3535 •

### ClickHouse release 18.14.12, 2018-11-02

:BUG FIXES

Fixed a crash on joining two unnamed subqueries. #3505 •

Fixed generating incorrect queries (with an empty `WHERE` clause) when querying external databases. hotid •

Fixed using an incorrect timeout value in ODBC dictionaries. Marek Vavruša •

### ClickHouse release 18.14.11, 2018-10-29

:BUG FIXES

Fixed the error Block structure mismatch in UNION stream: different number of columns in `LIMIT` queries. #2156 •

Fixed errors when merging data in tables containing arrays inside Nested structures. #3397 •

Fixed incorrect query results if the `merge_tree_uniform_read_distribution` setting is disabled (it is enabled by default). • #3429

Fixed an error on inserts to a Distributed table in Native format. #3411 •

### ClickHouse release 18.14.10, 2018-10-23

The `compile_expressions` setting (JIT compilation of expressions) is disabled by default. #3410 •

.The `enable_optimize_predicate_expression` setting is disabled by default •

## :NEW FEATURES

The `WITH CUBE` modifier for `GROUP BY` (the alternative syntax `GROUP BY CUBE(...)` is also available). #3172 •

Added the `formatDateTime` function. **Alexandr Krasheninnikov** •

Added the `JDBC` table engine and `jdbc` table function (requires installing `clickhouse-jdbc-bridge`). **Alexandr Krasheninnikov** •

Added functions for working with the ISO week number: `toISOWeek`, `toISOYear`, `toStartOfISOYear`, and `toDayOfYear`. #3146 •

Now you can use `Nullable` columns for `MySQL` and `ODBC` tables. #3362 •

Nested data structures can be read as nested objects in `JSONEachRow` format. Added the `input_format_import_nested_json` setting. **Veloman Yunkan** •

Parallel processing is available for many `MATERIALIZED VIEW`s when inserting data. See the `parallel_view_processing` setting. **Marek Vavruša** •

Added the `SYSTEM FLUSH LOGS` query (forced log flushes to system tables such as `query_log`) #3321 •

Now you can use pre-defined database and table macros when declaring Replicated tables. #3251 •

Added the ability to read `Decimal` type values in engineering notation (indicating powers of ten). #3153 •

## :EXPERIMENTAL FEATURES

Optimization of the `GROUP BY` clause for `LowCardinality` data types. #3138 •

Optimized calculation of expressions for `LowCardinality` data types. #3200 •

## :IMPROVEMENTS

Significantly reduced memory consumption for queries with `ORDER BY` and `LIMIT`. See the `max_bytes_before_remerge_sort` setting. #3205 •

In the absence of `JOIN` (`LEFT`, `INNER`, ...), `INNER JOIN` is assumed. #3147 •

Qualified asterisks work correctly in queries with `JOIN`. **Winter Zhang** •

The `ODBC` table engine correctly chooses the method for quoting identifiers in the SQL dialect of a remote database. #3101 • **Alexandr Krasheninnikov**

.The `compile_expressions` setting (JIT compilation of expressions) is enabled by default •

Fixed behavior for simultaneous `DROP DATABASE/TABLE IF EXISTS` and `CREATE DATABASE/TABLE IF NOT EXISTS`. Previously, a `CREATE DATABASE ... IF NOT EXISTS` query could return the error message "File ... already exists", and the `CREATE TABLE ... IF NOT EXISTS` and `DROP TABLE IF EXISTS` queries could return `Table ... is creating or attaching right now`. #3101 •

`LIKE` and `IN` expressions with a constant right half are passed to the remote server when querying from `MySQL` or `ODBC` tables. #3182 •

Comparisons with constant expressions in a `WHERE` clause are passed to the remote server when querying from `MySQL` and `ODBC` tables. Previously, only comparisons with constants were passed. #3182 •

.Correct calculation of row width in the terminal for `Pretty` formats, including strings with hieroglyphs. **Amos Bird** •

. `ON CLUSTER` can be specified for `ALTER UPDATE` queries •

Improved performance for reading data in `JSONEachRow` format. #3332 •

Added synonyms for the `LENGTH` and `CHARACTER_LENGTH` functions for compatibility. The `CONCAT` function is no longer case-sensitive. #3306 •

Added the `TIMESTAMP` synonym for the `DateTime` type. #3390 •

There is always space reserved for query\_id in the server logs, even if the log line is not related to a query. This makes it easier to parse server text logs with third-party tools •

Memory consumption by a query is logged when it exceeds the next level of an integer number of gigabytes #3205 •  
Added compatibility mode for the case when the client library that uses the Native protocol sends fewer columns by mistake than the server expects for the INSERT query. This scenario was possible when using the clickhouse-cpp library. Previously, this scenario caused the server to crash. #3171 •

In a user-defined WHERE expression in clickhouse-copier , you can now use a partition\_key alias (for additional filtering by source table partition). This is useful if the partitioning scheme changes during copying, but only changes slightly. #3166 •

The workflow of the Kafka engine has been moved to a background thread pool in order to automatically reduce the speed of data reading at high loads. Marek Vavruša •

Support for reading Tuple and Nested values of structures like struct in the Cap'n'Proto format . Marek Vavruša •

The list of top-level domains for the firstSignificantSubdomain function now includes the domain biz . decaseal •

In the configuration of external dictionaries, null\_value is interpreted as the value of the default data type. #3330 •

Support for the intDiv and intDivOrZero functions for Decimal . b48402e8 •

Support for the Date , DateTime , UUID , and Decimal types as a key for the sumMap aggregate function. #3281 •

Support for the Decimal data type in external dictionaries. #3324 •

Support for the Decimal data type in SummingMergeTree tables. #3348 •

Added specializations for UUID in if . #3366 •

Reduced the number of open and close system calls when reading from a MergeTree table . #3283 •

A TRUNCATE TABLE query can be executed on any replica (the query is passed to the leader replica). Kirill Shvakov •

#### :BUG FIXES

Fixed an issue with Dictionary tables for range\_hashed dictionaries. This error occurred in version 18.12.17. #1702 •

Fixed an error when loading range\_hashed dictionaries (the message Unsupported type Nullable (...) ). This error occurred in version 18.12.17. #3362 •

Fixed errors in the pointInPolygon function due to the accumulation of inaccurate calculations for polygons with a large number of vertices located close to each other. #3331 #3341 •

If after merging data parts, the checksum for the resulting part differs from the result of the same merge in another replica, the result of the merge is deleted and the data part is downloaded from the other replica (this is the correct behavior). But after downloading the data part, it couldn't be added to the working set because of an error that the part already exists (because the data part was deleted with some delay after the merge). This led to cyclical attempts to download the same data. #3194 •

Fixed incorrect calculation of total memory consumption by queries (because of incorrect calculation, the max\_memory\_usage\_for\_all\_queries setting worked incorrectly and the MemoryTracking metric had an incorrect value). This error occurred in version 18.12.13. Marek Vavruša •

Fixed the functionality of CREATE TABLE ... ON CLUSTER ... AS SELECT ... This error occurred in version 18.12.13. #3247 •

Fixed unnecessary preparation of data structures for JOIN s on the server that initiates the query if the JOIN is only performed on remote servers. #3340 •

Fixed bugs in the Kafka engine: deadlocks after exceptions when starting to read data, and locks upon completion . Marek Vavruša •

For Kafka tables, the optional schema parameter was not passed (the schema of the Cap'n'Proto format). Vojtech Splichal •

If the ensemble of ZooKeeper servers has servers that accept the connection but then immediately close it instead of responding to the handshake, ClickHouse chooses to connect another server. Previously, this produced the error

Cannot read all data. Bytes read: 0. Bytes expected: 4. and the server couldn't start. [#8218cf3a](#)

If the ensemble of ZooKeeper servers contains servers for which the DNS query returns an error, these servers are ignored. [#17b8e209](#)

Fixed type conversion between `Date` and `DateTime` when inserting data in the `VALUES` format (if `input_format_values_interpret_expressions = 1`). Previously, the conversion was performed between the numerical value of the number of days in Unix Epoch time and the Unix timestamp, which led to unexpected results. [#3229](#)

Corrected type conversion between `Decimal` and integer numbers. [#3211](#)

Fixed errors in the `enable_optimize_predicate_expression` setting. [Winter Zhang](#)

Fixed a parsing error in CSV format with floating-point numbers if a non-default CSV separator is used, such as; [#3155](#)

Fixed the `arrayCumSumNonNegative` function (it does not accumulate negative values if the accumulator is less than zero). [Aleksey Studnev](#)

Fixed how `Merge` tables work on top of `Distributed` tables when using `PREWHERE`. [#3165](#)

.Bug fixes in the `ALTER UPDATE` query

Fixed bugs in the `odbc` table function that appeared in version 18.12. [#3197](#)

Fixed the operation of aggregate functions with `StateArray` combinator. [#3188](#)

Fixed a crash when dividing a `Decimal` value by zero. [#69dd6609](#)

Fixed output of types for operations using `Decimal` and integer arguments. [#3224](#)

Fixed the segfault during `GROUP BY` on `Decimal128`. [#3359ba06](#)

The `log_query_threads` setting (logging information about each thread of query execution) now takes effect only if the `log_queries` option (logging information about queries) is set to 1. Since the `log_query_threads` option is enabled by default, information about threads was previously logged even if query logging was disabled. [#3241](#)

Fixed an error in the distributed operation of the `quantiles` aggregate function (the error message `Not found column quantile...`). [#292a8855](#)

Fixed the compatibility problem when working on a cluster of version 18.12.17 servers and older servers at the same time. For distributed queries with `GROUP BY` keys of both fixed and non-fixed length, if there was a large amount of data to aggregate, the returned data was not always fully aggregated (two different rows contained the same aggregation keys). [#3254](#)

Fixed handling of substitutions in `clickhouse-performance-test`, if the query contains only part of the substitutions declared in the test. [#3263](#)

Fixed an error when using `FINAL` with `PREWHERE`. [#3298](#)

Fixed an error when using `PREWHERE` over columns that were added during `ALTER`. [#3298](#)

Added a check for the absence of `arrayJoin` for `DEFAULT` and `MATERIALIZED` expressions. Previously, `arrayJoin` led to an error when inserting data. [#3337](#)

Added a check for the absence of `arrayJoin` in a `PREWHERE` clause. Previously, this led to messages like `Size ... doesn't match` or `Unknown compression method` when executing queries. [#3357](#)

Fixed segfault that could occur in rare cases after optimization that replaced AND chains from equality evaluations with the corresponding IN expression. [liuyimin-bytedance](#)

Minor corrections to `clickhouse-benchmark`: previously, client information was not sent to the server; now the number of queries executed is calculated more accurately when shutting down and for limiting the number of iterations. [#3351](#)  
[#3352](#)

Removed the `allow_experimental_decimal_type` option. The `Decimal` data type is available for default use. #3329 •

## ClickHouse release 18.12

### ClickHouse release 18.12.17, 2018-09-16

#### :NEW FEATURES

`invalidate_query` (the ability to specify a query to check whether an external dictionary needs to be updated) is implemented for the `clickhouse` source. #3126 •

Added the ability to use `UInt*`, `Int*`, and `DateTime` data types (along with the `Date` type) as a `range_hashed` external dictionary key that defines the boundaries of ranges. Now `NULL` can be used to designate an open range. Vasily Nemkov •

The `Decimal` type now supports `var*` and `stddev*` aggregate functions. #3129 •

The `Decimal` type now supports mathematical functions (`exp`, `sin` and so on.) #3129 •

The `system.part_log` table now has the `partition_id` column. #3089 •

#### :BUG FIXES

`Merge` now works correctly on Distributed tables. Winter Zhang •

Fixed incompatibility (unnecessary dependency on the `glibc` version) that made it impossible to run ClickHouse on Ubuntu Precise and older versions. The incompatibility arose in version 18.12.13. #3130 •

Fixed errors in the `enable_optimize_predicate_expression` setting. Winter Zhang •

Fixed a minor issue with backwards compatibility that appeared when working with a cluster of replicas on versions earlier than 18.12.13 and simultaneously creating a new replica of a table on a server with a newer version (shown in the message `Can not clone replica, because the ... updated to new ClickHouse version`, which is logical, but shouldn't happen). #3122 •

#### :BACKWARD INCOMPATIBLE CHANGES

The `enable_optimize_predicate_expression` option is enabled by default (which is rather optimistic). If query analysis errors occur that are related to searching for the column names, set `enable_optimize_predicate_expression` to 0. Winter Zhang •

### ClickHouse release 18.12.14, 2018-09-13

#### :NEW FEATURES

Added support for `ALTER UPDATE` queries. #3035 •

Added the `allow_ddl` option, which restricts the user's access to DDL queries. #3104 •

Added the `min_merge_bytes_to_use_direct_io` option for `MergeTree` engines, which allows you to set a threshold for the total size of the merge (when above the threshold, data part files will be handled using O\_DIRECT). #3117 •

The `system.merges` system table now contains the `partition_id` column. #3099 •

#### :IMPROVEMENTS

If a data part remains unchanged during mutation, it isn't downloaded by replicas. #3103 •

Autocomplete is available for names of settings when working with `clickhouse-client`. #3106 •

#### :BUG FIXES

Added a check for the sizes of arrays that are elements of `Nested` type fields when inserting. #3118 •

Fixed an error updating external dictionaries with the `ODBC` source and `hashed` storage. This error occurred in .version 18.12.13 •

Fixed a crash when creating a temporary table from a query with an IN condition. Winter Zhang •  
Fixed an error in aggregate functions for arrays that can have NULL elements. Winter Zhang •

## ClickHouse release 18.12.13, 2018-09-10

### :NEW FEATURES

Added the DECIMAL(digits, scale) data type ( Decimal32(scale) , Decimal64(scale) , Decimal128(scale) ). To enable it, use the setting allow\_experimental\_decimal\_type . #2846 #2970 #3008 #3047 •

New WITH ROLLUP modifier for GROUP BY (alternative syntax: GROUP BY ROLLUP(...)). #2948 •

In queries with JOIN, the star character expands to a list of columns in all tables, in compliance with the SQL standard. You can restore the old behavior by setting asterisk\_left\_columns\_only to 1 on the user configuration level.

Winter Zhang

Added support for JOIN with table functions. Winter Zhang •

Autocomplete by pressing Tab in clickhouse-client. Sergey Shcherbin •

Ctrl+C in clickhouse-client clears a query that was entered. #2877 •

Added the join\_default\_strictness setting (values: " ", 'any' , 'all' ). This allows you to not specify ANY or ALL for JOIN . #2982 •

Each line of the server log related to query processing shows the query ID#2482 •

Now you can get query execution logs in clickhouse-client (use the send\_logs\_level setting). With distributed query processing, logs are cascaded from all the servers. #2482 •

The system.query\_log and system.processes ( SHOW PROCESSLIST ) tables now have information about all changed settings when you run a query (the nested structure of the Settings data). Added the log\_query\_settings setting. #2482 •

The system.query\_log and system.processes tables now show information about the number of threads that are participating in query execution (see the thread\_numbers column). #2482 •

Added ProfileEvents counters that measure the time spent on reading and writing over the network and reading and writing to disk, the number of network errors, and the time spent waiting when network bandwidth is limited. #2482 •

Added ProfileEvents counters that contain the system metrics from rusage (you can use them to get information about CPU usage in userspace and the kernel, page faults, and context switches), as well as taskstats metrics (use these to obtain information about I/O wait time, CPU wait time, and the amount of data read and recorded, both with and without page cache). #2482 •

The ProfileEvents counters are applied globally and for each query, as well as for each query execution thread, which allows you to profile resource consumption by query in detail. #2482 •

Added the system.query\_thread\_log table, which contains information about each query execution thread. Added the log\_query\_threads setting. #2482 •

The system.metrics and system.events tables now have built-in documentation. #3016 •

Added the arrayEnumerateDense function. Amos Bird •

Added the arrayCumSumNonNegative and arrayDifference functions. Aleksey Studnev •

Added the retention aggregate function. Sundy Li •

Now you can add (merge) states of aggregate functions by using the plus operator, and multiply the states of aggregate functions by a nonnegative constant. #3062 #3034 •

Tables in the MergeTree family now have the virtual column \_partition\_id . #3089 •

### :EXPERIMENTAL FEATURES

Added the LowCardinality(T) data type. This data type automatically creates a local dictionary of values and allows data processing without unpacking the dictionary. #2830 •

Added a cache of JIT-compiled functions and a counter for the number of uses before compiling. To JIT compile expressions, enable the `compile_expressions` setting. #2990 #3077

#### :IMPROVEMENTS

Fixed the problem with unlimited accumulation of the replication log when there are abandoned replicas. Added an effective recovery mode for replicas with a long lag.

Improved performance of `GROUP BY` with multiple aggregation fields when one of them is string and the others are fixed length.

Improved performance when using `PREWHERE` and with implicit transfer of expressions in `PREWHERE`.

Improved parsing performance for text formats (CSV, TSV). Amos Bird #2980

Improved performance of reading strings and arrays in binary formats. Amos Bird

Increased performance and reduced memory consumption for queries to `system.tables` and `system.columns` when there is a very large number of tables on a single server. #2953

Fixed a performance problem in the case of a large stream of queries that result in an error (the `_dl_addr` function is visible in `perf top`, but the server isn't using much CPU). #2938

Conditions are cast into the View (when `enable_optimize_predicate_expression` is enabled). Winter Zhang

Improvements to the functionality for the `UUID` data type. #3074 #2985

The `UUID` data type is supported in The-Alchemist dictionaries. #2822

The `visitParamExtractRaw` function works correctly with nested structures. Winter Zhang

When the `input_format_skip_unknown_fields` setting is enabled, object fields in `JSONEachRow` format are skipped correctly. BlahGeek

For a `CASE` expression with conditions, you can now omit `ELSE`, which is equivalent to `ELSE NULL`. #2920

The operation timeout can now be configured when working with ZooKeeper. urykhy

You can specify an offset for `LIMIT n, m` as `LIMIT n OFFSET m`. #2840

You can use the `SELECT TOP n` syntax as an alternative for `LIMIT`. #2840

Increased the size of the queue to write to system tables, so the `SystemLog` parameter `queue is full` error doesn't happen as often

The `windowFunnel` aggregate function now supports events that meet multiple conditions. Amos Bird

Duplicate columns can be used in a `USING` clause for `JOIN`. #3006

Pretty formats now have a limit on column alignment by width. Use the `output_format_pretty_max_column_pad_width` setting. If a value is wider, it will still be displayed in its entirety, but the other cells in the table will not be too wide. #3003

The `odbc` table function now allows you to specify the database/schema name. Amos Bird

Added the ability to use a username specified in the `clickhouse-client` config file. Vladimir Kozbin

The `ZooKeeperExceptions` counter has been split into three counters: `ZooKeeperUserExceptions`, `ZooKeeperHardwareExceptions`, and `ZooKeeperOtherExceptions`. `ALTER DELETE` queries work for materialized views

Added randomization when running the cleanup thread periodically for `ReplicatedMergeTree` tables in order to avoid periodic load spikes when there are a very large number of `ReplicatedMergeTree` tables

Support for `ATTACH TABLE ... ON CLUSTER` queries. #3025

#### :BUG FIXES

Fixed an issue with `Dictionary` tables (throws the `Size of offsets doesn't match size of column` or `Unknown compression method` exception). This bug appeared in version 18.10.3. #2913

Fixed a bug when merging `CollapsingMergeTree` tables if one of the data parts is empty (these parts are formed during •  
merge or `ALTER DELETE` if all data was deleted), and the vertical algorithm was used for the merge. #3049

Fixed a race condition during `DROP` or `TRUNCATE` for `Memory` tables with a simultaneous `SELECT`, which could •  
lead to server crashes. This bug appeared in version 1.1.54388. #3038

Fixed the possibility of data loss when inserting in `Replicated` tables if the `Session` is expired error is returned (data loss •  
can be detected by the `ReplicatedDataLoss` metric). This error occurred in version 1.1.54378. #2939 #2949 #2964

Fixed a segfault during `JOIN ... ON`. #3000 •

Fixed the error searching column names when the `WHERE` expression consists entirely of a qualified column name, •  
such as `WHERE table.column`. #2994

Fixed the "Not found column" error that occurred when executing distributed queries if a single column consisting of •  
an `IN` expression with a subquery is requested from a remote server. #3087

Fixed the `Block structure mismatch in UNION stream: different number of columns` error that occurred for distributed queries if •  
one of the shards is local and the other is not, and optimization of the move to `PREWHERE` is triggered. #2226 #3037  
#3055 #3065 #3073 #3090 #3093

Fixed the `pointInPolygon` function for certain cases of non-convex polygons. #2910 •

Fixed the incorrect result when comparing `nan` with integers. #3024 •

Fixed an error in the `zlib-ng` library that could lead to segfault in rare cases. #2854 •

Fixed a memory leak when inserting into a table with `AggregateFunction` columns, if the state of the aggregate function •  
is not simple (allocates memory separately), and if a single insertion request results in multiple small blocks. #3084

.Fixed a race condition when creating and deleting the same `Buffer` or `MergeTree` table simultaneously •

Fixed the possibility of a segfault when comparing tuples made up of certain non-trivial types, such as tuples #2989 •

Fixed the possibility of a segfault when running certain `ON CLUSTER` queries. Winter Zhang •

Fixed an error in the `arrayDistinct` function for `Nullable` array elements. #2845 #2937 •

The `enable_optimize_predicate_expression` option now correctly supports cases with `SELECT *`. Winter Zhang •

Fixed the segfault when re-initializing the ZooKeeper session. #2917 •

.Fixed potential blocking when working with ZooKeeper •

.Fixed incorrect code for adding nested data structures in a `SummingMergeTree` •

When allocating memory for states of aggregate functions, alignment is correctly taken into account, which makes it •  
possible to use operations that require alignment when implementing states of aggregate functions. chenxing-xc

#### :SECURITY FIX

Safe use of ODBC data sources. Interaction with ODBC drivers uses a separate `clickhouse-odbc-bridge` process. •

Errors in third-party ODBC drivers no longer cause problems with server stability or vulnerabilities. #2828 #2879  
#2886 #2893 #2921

Fixed incorrect validation of the file path in the `catBoostPool` table function. #2894 •

The contents of system tables (`tables`, `databases`, `parts`, `columns`, `parts_columns`, `merges`, `mutations`, `replicas`, and •  
`replication_queue`) are filtered according to the user's configured access to databases (`allow_databases`). Winter Zhang

#### :BACKWARD INCOMPATIBLE CHANGES

In queries with `JOIN`, the star character expands to a list of columns in all tables, in compliance with the SQL •  
.standard. You can restore the old behavior by setting `asterisk_left_columns_only` to 1 on the user configuration level

#### :BUILD CHANGES

.Most integration tests can now be run by commit •

.Code style checks can also be run by commit •

The `memcpy` implementation is chosen correctly when building on CentOS7/Fedora. Etienne Champetier •

When using clang to build, some warnings from `-Weverything` have been added, in addition to the regular `-Wall`-`-Wextra` • `-Werror`. #2957

.Debugging the build uses the `jemalloc debug` option •

The interface of the library for interacting with ZooKeeper is declared abstract.[#2950](#) •

ClickHouse release 18.10

ClickHouse release 18.10.3, 2018-08-13

## NEW FEATURES

HTTPS can be used for replication. #2760 •

Added the functions `murmurHash2_64`, `murmurHash3_32`, `murmurHash3_64`, and `murmurHash3_128` in addition to the existing `murmurHash2_32`. #2791

Support for Nullable types in the ClickHouse ODBC driver (ODBCDriver2 output format). #2834 • .Support for UUID in the key columns •

## IMPROVEMENTS

Clusters can be removed without restarting the server when they are deleted from the config files #2777 •

External dictionaries can be removed without restarting the server when they are removed from config files #2779 •

Added `SETTINGS` support for the Kafka table engine. [Alexander Marshalov](#) •

Improvements for the `UUID` data type (not yet complete). #2618 •

Support for empty parts after merges in the `SummingMergeTree`, `CollapsingMergeTree` and `VersionedCollapsingMergeTree` engines. #2815

Old records of completed mutations are deleted (ALTER DELETE). #2784 •

Added the system.merge\_tree settings table. Kirill Shvakov •

The system.tables table now has dependency columns: dependencies database and dependencies table. Winter Zhang •

Added the max partition size to drop config option. #2782 •

Added the output format json escape forward slashes option. [Alexander Bocharov](#) •

Added the max fetch partition retries count setting. #2831 •

Added the `prefer_localhost_replica` setting for disabling the preference for a local replica and going to a local replica without inter-process interaction. #2832

The `quantileExact` aggregate function returns `nan` in the case of aggregation on an empty `Float32` or `Float64` set. • Sundy Li

## **:BUG FIXES**

Removed unnecessary escaping of the connection string parameters for ODBC, which made it impossible to establish a connection. This error occurred in version 18.6.0

Fixed the logic for processing REPLACE PARTITION commands in the replication queue. If there are two REPLACE commands for the same partition, the incorrect logic could cause one of them to remain in the replication queue and not be executed. #2814

Fixed a merge bug when all data parts were empty (parts that were formed from a merge or from ALTER DELETE if all data was deleted). This bug appeared in version 18.1.0. #2930

Fixed an error for concurrent Set or Join. Amos Bird •

Fixed the Block structure mismatch in UNION stream: different number of columns error that occurred for UNION ALL queries.

inside a sub-query if one of the `SELECT` queries contains duplicate column names. [Winter Zhang](#)

- .Fixed a memory leak if an exception occurred when connecting to a MySQL server •
- .Fixed incorrect clickhouse-client response code in case of a query error •
- Fixed incorrect behavior of materialized views containing `DISTINCT`. [#2795](#) •

#### BACKWARD INCOMPATIBLE CHANGES

- .Removed support for `CHECK TABLE` queries for Distributed tables •

#### :BUILD CHANGES

The allocator has been replaced: `jemalloc` is now used instead of `tcmalloc`. In some scenarios, this increases speed • up to 20%. However, there are queries that have slowed by up to 20%. Memory consumption has been reduced by approximately 10% in some scenarios, with improved stability. With highly competitive loads, CPU usage in userspace and in system shows just a slight increase. [#2773](#)

Use of `libressl` from a submodule. [#1983](#) [#2807](#) •

Use of `unixodbc` from a submodule. [#2789](#) •

Use of `mariadb-connector-c` from a submodule. [#2785](#) •

Added functional test files to the repository that depend on the availability of test data (for the time being, without the • .(test data itself

## ClickHouse release 18.6

### ClickHouse release 18.6.0, 2018-08-02

#### :NEW FEATURES

Added support for ON expressions for the JOIN ON syntax:`JOIN ON Expr([table.]column ...) = Expr([table.]column, ...)` [AND •  
`Expr([table.]column, ...) = Expr([table.]column, ...) ...]`] The expression must be a chain of equalities joined by the AND operator. Each side of the equality can be an arbitrary expression over the columns of one of the tables. The use of fully qualified column names is supported (`table.name`, `database.table.name`, `table_alias.name`, `subquery_alias.name`) for the right table. [#2742](#)

HTTPS can be enabled for replication. [#2760](#) •

#### :IMPROVEMENTS

The server passes the patch component of its version to the client. Data about the patch version component is in •  
`system.processes` and `query_log`. [#2646](#)

## ClickHouse release 18.5

### ClickHouse release 18.5.1, 2018-07-31

#### :NEW FEATURES

.Added the hash function `murmurHash2_32` [#2756](#) •

#### :IMPROVEMENTS

.Now you can use the `from_env` [#2741](#) attribute to set values in config files from environment variables •

.Added case-insensitive versions of the `coalesce`, `ifNull`, and `nullIf` functions [#2752](#) •

#### :BUG FIXES

.Fixed a possible bug when starting a replica[#2759](#) •

## ClickHouse release 18.4

### ClickHouse release 18.4.0, 2018-07-28

#### :NEW FEATURES

Added system tables: `formats`, `data_type_families`, `aggregate_function_combinators`, `table_functions`, `table_engines`, •  
. collations #2721

.Added the ability to use a table function instead of a table as an argument of a remote or cluster table function #2708 •  
.Support for HTTP Basic authentication in the replication protocol #2727 •  
.The `has` function now allows searching for a numeric value in an array of `Enum` values Maxim Khrisanfov •  
.Support for adding arbitrary message separators when reading from Kafka Amos Bird •

#### :IMPROVEMENTS

The `ALTER TABLE t DELETE WHERE` query does not rewrite data parts that were not affected by the `WHERE` condition •  
. #2694

The `use_minimalistic_checksums_in_zookeeper` option for `ReplicatedMergeTree` tables is enabled by default. This setting •  
.was added in version 1.1.54378, 2018-04-16. Versions that are older than 1.1.54378 can no longer be installed  
.Support for running `KILL` and `OPTIMIZE` queries that specify `ON CLUSTER` Winter Zhang •

#### :BUG FIXES

Fixed the error `Column ... is not under an aggregate function and not in GROUP BY` for aggregation with an `IN` expression. •  
(This bug appeared in version 18.1.0. (bddd780b  
.Fixed a bug in the `windowFunnel` aggregate function Winter Zhang •  
(Fixed a bug in the `anyHeavy` aggregate function (a2101df2 •  
.Fixed server crash when using the `countArray()` aggregate function •

#### :BACKWARD INCOMPATIBLE CHANGES

Parameters for `Kafka` engine was changed from `Kafka(kafka_broker_list, kafka_topic_list, kafka_group_name, kafka_format[, kafka_schema, kafka_num_consumers])` to `Kafka(kafka_broker_list, kafka_topic_list, kafka_group_name, kafka_format[, kafka_row_delimiter, kafka_schema, kafka_num_consumers])`. If your tables use `kafka_schema` or `kafka_num_consumers` parameters, you have to manually edit the metadata files `path/metadata/database/table.sql` and add `kafka_row_delimiter` parameter with " value

## ClickHouse release 18.1

### ClickHouse release 18.1.0, 2018-07-23

#### :NEW FEATURES

.(Support for the `ALTER TABLE t DELETE WHERE` query for non-replicated `MergeTree` tables #2634 •  
.Support for arbitrary types for the `uniq*` family of aggregate functions #2010 •  
.Support for arbitrary types in comparison operators #2026 •

The `users.xml` file allows setting a subnet mask in the format `10.0.0.1/255.255.255.0`. This is necessary for using masks •  
.for IPv6 networks with zeros in the middle (#2637  
.Added the `arrayDistinct` function (#2670 •  
.The `SummingMergeTree` engine can now work with `AggregateFunction` type columns Constantin S. Pan •

#### :IMPROVEMENTS

Changed the numbering scheme for release versions. Now the first part contains the year of release (A.D., Moscow timezone, minus 2000), the second part contains the number for major changes (increases for most releases), and the third part is the patch version. Releases are still backward compatible, unless otherwise stated in the changelog

.(Faster conversions of floating-point numbers to a string [Amos Bird](#) •

If some rows were skipped during an insert due to parsing errors (this is possible with the `input_allow_errors_num` and `input_allow_errors_ratio` settings enabled), the number of skipped rows is now written to the server log [Leonardo Cecchi](#) •

#### :BUG FIXES

.(Fixed the TRUNCATE command for temporary tables [Amos Bird](#) •

Fixed a rare deadlock in the ZooKeeper client library that occurred when there was a network error while reading the response ([c315200](#)) •

.(Fixed an error during a CAST to Nullable types [#1322](#) •

Fixed the incorrect result of the `maxIntersection()` function when the boundaries of intervals coincided [Michael Furmur](#) •  
•

.(Fixed incorrect transformation of the OR expression chain in a function argument [chenxing-xc](#) •

.(Fixed performance degradation for queries containing `IN (subquery)` expressions inside another subquery [#2571](#) •

Fixed incompatibility between servers with different versions in distributed queries that use a `CAST` function that isn't (in uppercase letters) [\(fe8c4d6](#) •

.(Added missing quoting of identifiers for queries to an external DBMS [#2635](#) •

#### :BACKWARD INCOMPATIBLE CHANGES

Converting a string containing the number zero to `DateTime` does not work. Example: `SELECT toDate('0')`. This is also the reason that `DateTime DEFAULT '0'` does not work in tables, as well as `<null_value>0</null_value>` in dictionaries.

.Solution: replace 0 with 0000-00-00 00:00:00

## ClickHouse release 1.1

### ClickHouse release 1.1.54394, 2018-07-12

#### :NEW FEATURES

.(Added the `histogram` aggregate function [Mikhail Surin](#) •

.(Now `OPTIMIZE TABLE ... FINAL` can be used without specifying partitions for `ReplicatedMergeTree` [Amos Bird](#) •

#### :BUG FIXES

Fixed a problem with a very small timeout for sockets (one second) for reading and writing when sending and downloading replicated data, which made it impossible to download larger parts if there is a load on the network or .disk (it resulted in cyclical attempts to download parts). This error occurred in version 1.1.54388

.Fixed issues when using chroot in ZooKeeper if you inserted duplicate data blocks in the table •

.(The `has` function now works correctly for an array with Nullable elements [#2115](#) •

The `system.tables` table now works correctly when used in distributed queries. The `metadata_modification_time` and `engine_full` columns are now non-virtual. Fixed an error that occurred if only these columns were queried from the .table

.(Fixed how an empty `TinyLog` table works after inserting an empty data block [#2563](#) •

.The `system.zookeeper` table works if the value of the node in ZooKeeper is NULL •

### ClickHouse release 1.1.54390, 2018-07-06

## :NEW FEATURES

Queries can be sent in `multipart/form-data` format (in the `query` field), which is useful if external data is also sent for •  
.(query processing ([Olga Hvostikova](#))

Added the ability to enable or disable processing single or double quotes when reading data in CSV format. You can •  
.configure this in the `format_csv_allow_single_quotes` and `format_csv_allow_double_quotes` settings ([Amos Bird](#))

Now `OPTIMIZE TABLE ... FINAL` can be used without specifying the partition for non-replicated variants of MergeTree •  
.(([Amos Bird](#))

## :IMPROVEMENTS

Improved performance, reduced memory consumption, and correct memory consumption tracking with use of the IN •  
.operator when a table index could be used ([#2584](#))

Removed redundant checking of checksums when adding a data part. This is important when there are a large •  
.number of replicas, because in these cases the total number of checks was equal to  $N^2$

.(Added support for `Array(Tuple(...))` arguments for the `arrayEnumerateUniq` function ([#2573](#)) •  
.Added `Nullable` support for the `runningDifference` function ([#2594](#)) •

.(Improved query analysis performance when there is a very large number of expressions ([#2572](#)) •

Faster selection of data parts for merging in `ReplicatedMergeTree` tables. Faster recovery of the ZooKeeper session •  
.(([#2597](#))

The `format_version.txt` file for `MergeTree` tables is re-created if it is missing, which makes sense if ClickHouse is •  
.launched after copying the directory structure without files ([Ciprian Hacman](#))

## :BUG FIXES

Fixed a bug when working with ZooKeeper that could make it impossible to recover the session and readonly states •  
.of tables before restarting the server

Fixed a bug when working with ZooKeeper that could result in old nodes not being deleted if the session is •  
.interrupted

Fixed an error in the `quantileTDigest` function for `Float` arguments (this bug was introduced in version 1.1.54388) •  
.(([Mikhail Surin](#))

Fixed a bug in the index for `MergeTree` tables if the primary key column is located inside the function for converting •  
.types between signed and unsigned integers of the same size ([#2603](#))

.(Fixed segfault if `macros` are used but they aren't in the config file ([#2570](#)) •

.(Fixed switching to the default database when reconnecting the client ([#2583](#)) •

.Fixed a bug that occurred when the `use_index_for_in_with_subqueries` setting was disabled •

## :SECURITY FIX

.(Sending files is no longer possible when connected to MySQL (`LOAD DATA LOCAL INFILE`) •

## ClickHouse release 1.1.54388, 2018-06-28

## :NEW FEATURES

Support for the `ALTER TABLE t DELETE WHERE` query for replicated tables. Added the `system.mutations` table to track •  
.progress of this type of queries

.Support for the `ALTER TABLE t [REPLACE|ATTACH] PARTITION` query for \*`MergeTree` tables •  
(Support for the `TRUNCATE TABLE` query ([Winter Zhang](#)) •

Several new `SYSTEM` queries for replicated tables (`RESTART REPLICAS`, `SYNC REPLICA`, `[STOP|START]` •  
.([MERGES|FETCHES|SENDS REPLICATED|REPLICATION QUEUES

.(Added the ability to write to a table with the MySQL engine and the corresponding table functions [sundy-li](#) •  
.(Added the `url()` table function and the `URL` table engine ([Alexander Sapin](#) •  
.(Added the `windowFunnel` aggregate function ([sundy-li](#) •  
.(`New` `startsWith` and `endsWith` functions for strings ([Vadim Plakhtinsky](#) •  
.(`The` `numbers()` table function now allows you to specify the offset ([Winter Zhang](#) •  
.The password to `clickhouse-client` can be entered interactively •  
.(`Server logs can now be sent to syslog` ([Alexander Krasheninnikov](#) •  
.(`Support for logging in dictionaries with a shared library source` ([Alexander Sapin](#) •  
(`Support for custom CSV delimiters` ([Ivan Zhukov](#) •  
Added the `date_time_input_format` setting. If you switch this setting to '`best_effort`' , `DateTime` values will be read in a •  
.wide range of formats  
Added the `clickhouse-obfuscator` utility for data obfuscation. Usage example: publishing data used in performance •  
.tests

#### :EXPERIMENTAL FEATURES

(`Added the ability to calculate and arguments only where they are needed` ([Anastasia Tsarkova](#) •  
.(`JIT compilation to native code is now available for some expressions` ([pyos](#) •

#### :BUG FIXES

.Duplicates no longer appear for a query with `DISTINCT` and `ORDER BY` •  
.Queries with `ARRAY JOIN` and `arrayFilter` no longer return an incorrect result •  
.(`Fixed an error when reading an array column from a Nested structure` ([#2066](#) •  
. (...) `Fixed an error when analyzing queries with a HAVING clause like``HAVING tuple IN` •  
.Fixed an error when analyzing queries with recursive aliases •  
.(`Fixed an error when reading from ReplacingMergeTree with a condition in PREWHERE that filters all rows` ([#2525](#) •  
.User profile settings were not applied when using sessions in the HTTP interface •  
.Fixed how settings are applied from the command line parameters in `clickhouse-local` •  
.The ZooKeeper client library now uses the session timeout received from the server •  
.Fixed a bug in the ZooKeeper client library when the client waited for the server response longer than the timeout •  
.(`Fixed pruning of parts for queries with conditions on partition key columns` ([#2342](#) •  
.(`Merges are now possible after CLEAR COLUMN IN PARTITION` ([#2315](#) •  
.(`Type mapping in the ODBC table function has been fixed` ([sundy-li](#) •  
.(`Type comparisons have been fixed for` `DateTime` `with and without the time zone` ([Alexander Bocharov](#) •  
.Fixed syntactic parsing and formatting of the `CAST` operator •  
.(`Fixed insertion into a materialized view for the Distributed table engine` ([Babacar Diassé](#) •  
.(`Fixed a race condition when writing data from the Kafka engine to materialized views` ([Yangkuan Liu](#) •  
.Fixed SSRF in the `remote()` table function •  
.(`Fixed exit behavior of` `clickhouse-client` `in multiline mode` ([#2510](#) •

#### :IMPROVEMENTS

Background tasks in replicated tables are now performed in a thread pool instead of in separate threads ([Silvia](#) •  
.([Caragea](#)

- .Improved LZ4 compression performance •
- .Faster analysis for queries with a large number of JOINs and sub-queries •
- .The DNS cache is now updated automatically when there are too many network errors •
- Table inserts no longer occur if the insert into one of the materialized views is not possible because it has too many parts •
- .Corrected the discrepancy in the event counters Query , SelectQuery , and InsertQuery •
- .Expressions like tuple IN (SELECT tuple) are allowed if the tuple types match •
- .A server with replicated tables can start even if you haven't configured ZooKeeper •
- .(When calculating the number of available CPU cores, limits on cgroups are now taken into account [Atri Sharma](#) •
- .(Added chown for config directories in the systemd config file [Mikhail Shiryaev](#) •

#### :BUILD CHANGES

- .The gcc8 compiler can be used for builds •
- .Added the ability to build llvm from submodule •
- .The version of the librdkafka library has been updated to v0.11.4 •
- .Added the ability to use the system libcpuid library. The library version has been updated to 0.4.0 •
  - .(Fixed the build using the vectorclass library [Babacar Diassé](#) •
  - .(Cmake now generates files for ninja by default (like when using -G Ninja •
  - .(Added the ability to use the libtinfo library instead of libtermcap [Georgy Kondratiev](#) •
  - .(Fixed a header file conflict in Fedora Rawhide [#2520](#) •

#### :BACKWARD INCOMPATIBLE CHANGES

- .Removed escaping in Vertical and Pretty\* formats and deleted the VerticalRaw format •

If servers with version 1.1.54388 (or newer) and servers with an older version are used simultaneously in a distributed query and the query has the cast(x, 'Type') expression without the AS keyword and doesn't have the word cast in uppercase, an exception will be thrown with a message like Not found column cast(0, 'UInt8') in block . Solution: Update the server on the entire cluster

### ClickHouse release 1.1.54385, 2018-06-01

#### :BUG FIXES

- .Fixed an error that in some cases caused ZooKeeper operations to block •

### ClickHouse release 1.1.54383, 2018-05-22

#### :BUG FIXES

- .Fixed a slowdown of replication queue if a table has many replicas •

### ClickHouse release 1.1.54381, 2018-05-14

#### :BUG FIXES

- .Fixed a nodes leak in ZooKeeper when ClickHouse loses connection to ZooKeeper server •

### ClickHouse release 1.1.54380, 2018-04-21

#### :NEW FEATURES

- Added the table function file(path, format, structure) . An example reading bytes from /dev/urandom : In -s /dev/urandom ."/var/lib/clickhouse/user\_files/random``clickhouse-client -q "SELECT \* FROM file('random', 'RowBinary', 'd UInt8') LIMIT 10 •

## :IMPROVEMENTS

Subqueries can be wrapped in () brackets to enhance query readability. For example:(SELECT 1) UNION ALL (SELECT  
•  
.1)

.Simple SELECT queries from the system.processes table are not included in the max\_concurrent\_queries limit •

## :BUG FIXES

.Fixed incorrect behavior of the IN operator when select from MATERIALIZED VIEW •

. (...) Fixed incorrect filtering by partition index in expressions likepartition\_key\_column IN •

.Fixed inability to execute OPTIMIZE query on non-leader replica if REANAME was performed on the table •

.Fixed the authorization error when executing OPTIMIZE or ALTER queries on a non-leader replica •

.Fixed freezing of KILL QUERY •

Fixed an error in ZooKeeper client library which led to loss of watches, freezing of distributed DDL queue, and •

.slowdowns in the replication queue if a non-empty chroot prefix is used in the ZooKeeper configuration •

## :BACKWARD INCOMPATIBLE CHANGES

Removed support for expressions like (a, b) IN (SELECT (a, b)) (you can use the equivalent expression(a, b) IN •  
. (SELECT a, b)). In previous releases, these expressions led to undetermined WHERE filtering or caused errors •

## ClickHouse release 1.1.54378, 2018-04-16

## :NEW FEATURES

.Logging level can be changed without restarting the server •

.Added the SHOW CREATE DATABASE query •

.(The query\_id can be passed to clickhouse-client (elBroom •

.New setting: max\_network\_bandwidth\_for\_all\_users •

.Added support for ALTER TABLE ... PARTITION ... for MATERIALIZED VIEW •

.Added information about the size of data parts in uncompressed form in the system table •

Server-to-server encryption support for distributed tables (<secure>1</secure> in the replica config in •  
. ( <<remote\_servers

Configuration of the table level for the ReplicatedMergeTree family in order to minimize the amount of data stored in •  
Zookeeper: : use\_minimalistic\_checksums\_in\_zookeeper = 1

Configuration of the clickhouse-client prompt. By default, server names are now output to the prompt. The server's •  
.display name can be changed. It's also sent in the X-ClickHouse-Display-Name HTTP header (Kirill Shvakov

(Multiple comma-separated topics can be specified for the Kafka engine (Tobias Adamson •

When a query is stopped by KILL QUERY or replace\_running\_query , the client receives the Query was canceled •  
.exception instead of an incomplete result

## :IMPROVEMENTS

. ALTER TABLE ... DROP/DETACH PARTITION queries are run at the front of the replication queue •

. SELECT ... FINAL and OPTIMIZE ... FINAL can be used even when the table has a single data part •

.(A query\_log table is recreated on the fly if it was deleted manually (Kirill Shvakov •

.(The lengthUTF8 function runs faster (zhang2014 •

Improved performance of synchronous inserts in Distributed tables ( insert\_distributed\_sync = 1 ) when there is a very •  
.large number of shards

The server accepts the `send_timeout` and `receive_timeout` settings from the client and applies them when connecting to the client (they are applied in reverse order: the server socket's `send_timeout` is set to the `receive_timeout` value .(received from the client, and vice versa

.More robust crash recovery for asynchronous insertion into Distributed tables •

.(The return type of the `countEqual` function changed from `UInt32` to `UInt64` (谢磊 •

#### :BUG FIXES

.Fixed an error with `IN` when the left side of the expression is `Nullable` •

Correct results are now returned when using tuples with `IN` when some of the tuple components are in the table .`index`

.The `max_execution_time` limit now works correctly with distributed queries •

.Fixed errors when calculating the size of composite columns in the `system.columns` table •

.Fixed an error when creating a temporary table `CREATE TEMPORARY TABLE IF NOT EXISTS` •

(Fixed errors in `StorageKafka` (##2075) •

.Fixed server crashes from invalid arguments of certain aggregate functions •

Fixed the error that prevented the `DETACH DATABASE` query from stopping background tasks for `ReplicatedMergeTree` .`tables`

.( Too many parts state is less likely to happen when inserting into aggregated materialized views (##2084) •

Corrected recursive handling of substitutions in the config if a substitution must be followed by another substitution on .the same level

.Corrected the syntax in the metadata file when creating a `VIEW` that uses a query with `UNION ALL` •

. `SummingMergeTree` now works correctly for summation of nested data structures with a composite key •

.Fixed the possibility of a race condition when choosing the leader for `ReplicatedMergeTree` tables •

#### :BUILD CHANGES

.The build supports `ninja` instead of `make` and uses `ninja` by default for building releases •

Renamed packages: `clickhouse-server-base` in `clickhouse-common-static` ; `clickhouse-server-common` in `clickhouse-server` ; `clickhouse-common-dbg` in `clickhouse-common-static-dbg` . To install, use `clickhouse-server` `clickhouse-client` . Packages with .the old names will still load in the repositories for backward compatibility

#### :BACKWARD INCOMPATIBLE CHANGES

Removed the special interpretation of an `IN` expression if an array is specified on the left side. Previously, the expression `arr IN (set)` was interpreted as "at least one `arr` element belongs to the `set`". To get the same behavior in . (the new version, write `arrayExists(x -> x IN (set), arr`

Disabled the incorrect use of the socket option `SO_REUSEPORT` , which was incorrectly enabled by default in the Poco library. Note that on Linux there is no longer any reason to simultaneously specify the addresses `::` and `0.0.0.0` for listen – use just `::` , which allows listening to the connection both over IPv4 and IPv6 (with the default kernel config settings). You can also revert to the behavior from previous versions by specifying . `<listen_reuse_port>1</listen_reuse_port>` in the config

**ClickHouse release 1.1.54370, 2018-03-16**

#### :NEW FEATURES

.Added the `system.macros` table and auto updating of macros when the config file is changed •

.Added the `SYSTEM RELOAD CONFIG` query •

Added the `maxIntersections(left_col, right_col)` aggregate function, which returns the maximum number of simultaneously •

intersecting intervals `[left; right]`. The `maxIntersectionsPosition(left, right)` function returns the beginning of the "maximum" interval. (Michael Furmur)

#### :IMPROVEMENTS

When inserting data in a `Replicated` table, fewer requests are made to ZooKeeper (and most of the user-level errors have disappeared from the ZooKeeper log).

Added the ability to create aliases for data sets. Example: WITH (1, 2, 3) AS set SELECT number IN set FROM system.numbers LIMIT 10

#### :BUG FIXES

.Fixed the `Illegal PREWHERE` error when reading from Merge tables for Distributed tables.

.Added fixes that allow you to start clickhouse-server in IPv4-only Docker containers.

.Fixed a race condition when reading from system.parts\_columns tables.

Removed double buffering during a synchronous insert to a `Distributed` table, which could have caused the connection to timeout.

.Fixed a bug that caused excessively long waits for an unavailable replica before beginning a `SELECT` query.

.Fixed incorrect dates in the `system.parts` table.

Fixed a bug that made it impossible to insert data in a `Replicated` table if `chroot` was non-empty in the configuration of the ZooKeeper cluster.

.Fixed the vertical merging algorithm for an empty `ORDER BY` table.

Restored the ability to use dictionaries in queries to remote tables, even if these dictionaries are not present on the requestor server. This functionality was lost in release 1.1.54362

Restored the behavior for queries like `SELECT * FROM remote('server2', default.table) WHERE col IN (SELECT col2 FROM default.table)` when the right side of the `IN` should use a remote `default.table` instead of a local one. This behavior was broken in version 1.1.54358

.Removed extraneous error-level logging of Not found column ... in block.

### Clickhouse Release 1.1.54362, 2018-03-11

#### :NEW FEATURES

Aggregation without `GROUP BY` for an empty set (such as `SELECT count(*) FROM table WHERE 0`) now returns a result with one row with null values for aggregate functions, in compliance with the SQL standard. To restore the old behavior (return an empty result), set `empty_result_for_aggregation_by_empty_set` to 1

Added type conversion for `UNION ALL`. Different alias names are allowed in `SELECT` positions in `UNION ALL`, in compliance with the SQL standard.

Arbitrary expressions are supported in `LIMIT BY` clauses. Previously, it was only possible to use columns resulting from `SELECT`.

An index of `MergeTree` tables is used when `IN` is applied to a tuple of expressions from the columns of the primary key. Example: `WHERE (UserID, EventDate) IN ((123, '2000-01-01'), ...)` (Anastasiya Tsarkova). (Added the `clickhouse-copier` tool for copying between clusters and resharding data (beta).

Added consistent hashing functions: `yandexConsistentHash`, `jumpConsistentHash`, `sumburConsistentHash`. They can be used as a sharding key in order to reduce the amount of network traffic during subsequent reshardings.

.Added functions: `arrayAny`, `arrayAll`, `hasAny`, `hasAll`, `arrayIntersect`, `arrayResize`. (Added the `arrayCumSum` function (Javi Santana).

Added the `parseDateTimeBestEffort`, `parseDateTimeBestEffortOrZero`, and `parseDateTimeBestEffortOrNull` functions to read the `DateTime` from a string containing text in a wide variety of possible formats.

Data can be partially reloaded from external dictionaries during updating (load just the records in which the value of .(the specified field greater than in the previous download) (Arsen Hakobyan •

Added the `cluster` table function. Example: `cluster(cluster_name, db, table)` . The `remote` table function can accept the .`cluster` name as the first argument, if it is specified as an identifier •

.The `remote` and `cluster` table functions can be used in `INSERT` queries •

Added the `create_table_query` and `engine_full` virtual columns to the `system.tables` table . The `metadata_modification_time` •  
.column is virtual

Added the `data_path` and `metadata_path` columns to `system.tables` and `system.databases` tables, and added the `path` •  
.column to the `system.parts` and `system.parts_columns` tables

.Added additional information about merges in the `system.part_log` table •

.(An arbitrary partitioning key can be used for the `system.query_log` table (Kirill Shvakov •

The `SHOW TABLES` query now also shows temporary tables. Added temporary tables and the `is_temporary` column to •  
.(`system.tables` (zhang2014 •

.(Added `DROP TEMPORARY TABLE` and `EXISTS TEMPORARY TABLE` queries (zhang2014 •

.(Support for `SHOW CREATE TABLE` for temporary tables (zhang2014 •

.Added the `system_profile` configuration parameter for the settings used by internal processes •

.(Support for loading `object_id` as an attribute in MongoDB dictionaries (Pavel Litvinenko •

Reading `null` as the default value when loading data for an external dictionary with the MongoDB source (Pavel •  
.Litvinenko

.Reading `DateTime` values in the `Values` format from a Unix timestamp without single quotes •

.Failover is supported in `remote` table functions for cases when some of the replicas are missing the requested table •

Configuration settings can be overridden in the command line when you run `clickhouse-server` . Example: `clickhouse- •  
.server -- --logger.level=information`

Implemented the `empty` function from a `FixedString` argument: the function returns 1 if the string consists entirely of •  
.(`null` bytes (zhang2014 •

Added the `listen_try` configuration parameter for listening to at least one of the listen addresses without quitting, if •  
.some of the addresses can't be listened to (useful for systems with disabled support for IPv4 or IPv6 •

.Added the `VersionedCollapsingMergeTree` table engine •

.Support for rows and arbitrary numeric types for the `library` dictionary source •

.(`MergeTree` tables can be used without a primary key (you need to specify `ORDER BY tuple` •

.A `Nullable` type can be `CAST` to a non-`Nullable` type if the argument is not `NONE` •

. `RENAME TABLE` can be performed for `VIEW` •

.Added the `throwIf` function •

Added the `odbc_default_field_size` option, which allows you to extend the maximum size of the value loaded from an •  
.(`ODBC` source (by default, it is 1024 •

.The `system.processes` table and `SHOW PROCESSLIST` now have the `is_cancelled` and `peak_memory_usage` columns •

:IMPROVEMENTS

Limits and quotas on the result are no longer applied to intermediate data for `INSERT SELECT` queries or for `SELECT` •  
.subqueries

.Fewer false triggers of `force_restore_data` when checking the status of Replicated tables when the server starts •

.Added the `allow_distributed_ddl` option •

.Nondeterministic functions are not allowed in expressions for `MergeTree` table keys •

- .Files with substitutions from `config.d` directories are loaded in alphabetical order •
  - Improved performance of the `arrayElement` function in the case of a constant multidimensional array with an empty [array as one of the elements. Example: `[[1], []][x`] •
  - The server starts faster now when using configuration files with very large substitutions (for instance, very large lists •  
.of IP networks)
  - When running a query, table valued functions run once. Previously, `remote` and `mysql` table valued functions •  
.performed the same query twice to retrieve the table structure from a remote server •  
.The `MkDocs` documentation generator is used •
  - When you try to delete a table column that `DEFAULT / MATERIALIZED` expressions of other columns depend on, an •  
.exception is thrown (zhang2014)
  - Added the ability to parse an empty line in text formats as the number 0 for `Float` data types. This feature was •  
.previously available but was lost in release 1.1.54342
  - `Enum` values can be used in `min`, `max`, `sum` and some other functions. In these cases, it uses the corresponding •  
.numeric values. This feature was previously available but was lost in the release 1.1.54337
  - .Added `max_expanded_ast_elements` to restrict the size of the AST after recursively expanding aliases •
- :BUG FIXES
- Fixed cases when unnecessary columns were removed from subqueries in error, or not removed from subqueries •  
.containing `UNION ALL` •  
.Fixed a bug in merges for `ReplacingMergeTree` tables •  
.•(Fixed synchronous insertions in `Distributed` tables (`insert_distributed_sync = 1`) •  
.Fixed segfault for certain uses of `FULL` and `RIGHT JOIN` with duplicate columns in subqueries •  
.Fixed segfault for certain uses of `replace_running_query` and `KILL QUERY` •  
.Fixed the order of the `source` and `last_exception` columns in the `system.dictionaries` table •  
.Fixed a bug when the `DROP DATABASE` query did not delete the file with metadata •  
.Fixed the `DROP DATABASE` query for `Dictionary` databases •
  - Fixed the low precision of `uniqHLL12` and `uniqCombined` functions for cardinalities greater than 100 million items (Alex •  
.Bocharov)
  - Fixed the calculation of implicit default values when necessary to simultaneously calculate default explicit expressions •  
.•(in `INSERT` queries (zhang2014) •  
.•(Fixed a rare case when a query to a `MergeTree` table couldn't finish (chenxing-xc) •  
.•(Fixed a crash that occurred when running a `CHECK` query for `Distributed` tables if all shards are local (chenxing.xc) •  
.•(Fixed a slight performance regression with functions that use regular expressions •  
.•(Fixed a performance regression when creating multidimensional arrays from complex expressions •  
.•(Fixed a bug that could cause an extra `FORMAT` section to appear in an `.sql` file with metadata •  
.Fixed a bug that caused the `max_table_size_to_drop` limit to apply when trying to delete a `MATERIALIZED VIEW` looking •  
.at an explicitly specified table
  - Fixed incompatibility with old clients (old clients were sometimes sent data with `theDateTime('timezone')` type, which •  
.they do not understand)
  - Fixed a bug when reading `Nested` column elements of structures that were added using `ALTER` but that are empty for •  
.the old partitions, when the conditions for these columns moved to `PREWHERE` •  
.•(Fixed a bug when filtering tables by virtual `_table` columns in queries to `Merge` tables •  
.•(Fixed a bug when using `ALIAS` columns in `Distributed` tables •

- .Fixed a bug that made dynamic compilation impossible for queries with aggregate functions from the `quantile` family •
- Fixed a race condition in the query execution pipeline that occurred in very rare cases when using `Merge` tables with •  
.a large number of tables, and when using `GLOBAL` subqueries
- Fixed a crash when passing arrays of different sizes to an `arrayReduce` function when using aggregate functions from •  
.multiple arguments
- .Prohibited the use of queries with `UNION ALL` in a `MATERIALIZED VIEW` •
- Fixed an error during initialization of the `part_log` system table when the server starts (by default, `part_log` is •  
.disabled)

#### :BACKWARD INCOMPATIBLE CHANGES

- .Removed the `distributed_ddl_allow_replicated_alter` option. This behavior is enabled by default •
- Removed the `strict_insert_defaults` setting. If you were using this functionality, write to `clickhouse-feedback@yandex` •  
.team.com
- .Removed the `UnsortedMergeTree` engine •

### **Clickhouse Release 1.1.54343, 2018-02-05**

- Added macros support for defining cluster names in distributed DDL queries and constructors of Distributed tables: •  
. ('CREATE TABLE distr ON CLUSTER '{cluster}' (...) ENGINE = Distributed('{cluster}', 'db', 'table')
- .Now queries like `SELECT ... FROM table WHERE expr IN (subquery)` are processed using the `table` index •
- Improved processing of duplicates when inserting to Replicated tables, so they no longer slow down execution of the •  
.replication queue

### **Clickhouse Release 1.1.54342, 2018-01-22**

:This release contains bug fixes for the previous release 1.1.54337

- Fixed a regression in 1.1.54337: if the default user has readonly access, then the server refuses to start up with the •  
.message `Cannot create database in readonly mode`
- Fixed a regression in 1.1.54337: on systems with `systemd`, logs are always written to `syslog` regardless of the •  
.configuration; the `watchdog` script still uses `init.d`
- .Fixed a regression in 1.1.54337: wrong default configuration in the Docker image •
- Fixed nondeterministic behavior of `GraphiteMergeTree` (you can see it in log messages) Data after merge is not byte- •  
.identical to the data on another replicas
- Fixed a bug that may lead to inconsistent merges after `OPTIMIZE` query to Replicated tables (you may see it in log •  
.messages `Part ... intersects the previous part`)
- .(Buffer tables now work correctly when `MATERIALIZED` columns are present in the destination table (by zhang2014) •  
.Fixed a bug in implementation of `NUL` •

### **Clickhouse Release 1.1.54337, 2018-01-18**

#### :NEW FEATURES

- .Added support for storage of multi-dimensional arrays and tuples (`Tuple` data type) in tables •
- Support for table functions for `DESCRIBE` and `INSERT` queries. Added support for subqueries in `DESCRIBE` . •  
Examples: `DESC TABLE remote('host', default.hits) ; DESC TABLE (SELECT 1) ; INSERT INTO TABLE FUNCTION remote('host',`  
. `default.hits)` . Support for `INSERT INTO TABLE` in addition to `INSERT INTO`
- Improved support for time zones. The `DateTime` data type can be annotated with the `timezone` that is used for parsing •  
and formatting in text formats. Example: `DateTime('Europe/Moscow')` . When timezones are specified in functions for  
. `DateTime` arguments, the return type will track the timezone, and the value will be displayed as expected

Added the functions `toTimeZone`, `timeDiff`, `toQuarter`, `toRelativeQuarterNum`. The `toRelativeHour` / `Minute` / `Second` .functions can take a value of type `Date` as an argument. The `now` function name is case-sensitive (Added the `toStartOfFifteenMinutes` function (Kirill Shvakov))

Added the clickhouse format tool for formatting queries •

.Added the clickhouse format tool for formatting queries •

Added the `format_schema_path` configuration parameter (Marek Vavruša). It is used for specifying a schema in Cap'n • .Proto format. Schema files can be located only in the specified directory

Added support for config substitutions (incl and conf.d) for configuration of external dictionaries and models (Pavel Yakunin).

.(Added a column with documentation for the system.settings table (Kirill Shvakov •

.Added the system.parts\_columns table with information about column sizes in each data part of MergeTree tables •

Added the system.models table with information about loaded CatBoost machine learning models

Added the `mysql` and `odbc` table function and corresponding MySQL and ODBC table engines for accessing remote databases. This functionality is in the beta stage.

Removed restrictions on various combinations of aggregate function combinators. For example, you can use `• .avgForEachIf` as well as `avgIfsForEach` aggregate functions, which have different behaviors

- The -ForEach aggregate function combinator is extended for the case of aggregate functions of multiple arguments

Added support for aggregate functions of Nullable arguments even for cases when the function returns a non- Nullable .result (added with the contribution of Silviu Caragea). Example: groupArray , groupUniqArray , topK

• (Added the `max_client_network_bandwidth` for clickhouse-client) (Kirill Sivakov)

Users with the `readonly = 2` setting are allowed to work with TEMPORARY tables (CREATE, DROP, INSERT...). (Kirill .(Shvakov)

Added support for using multiple consumers with the Kafka engine. Extended configuration options for Kafka (Marek Vavruša).

.Added the IntExp3 and IntExp4 functions •

.Added the sumKahan aggregate function •

.Added the `to ^ Number` or `Null` functions, where `^ Number` is a numeric type •

.(Added support for WITH clauses for an INSERT SELECT query (author: zhang2014 •

Added settings: `http_connection_timeout`, `http_send_timeout`, `http_receive_timeout`. In particular, these settings are used for downloading data parts for replication. Changing these settings allows for faster failover if the network is overloaded.

.(Added support for ALTER for tables of type Null (Anastasiya Tsarkova •

. The `reinterpretAsString` function is extended for all data types that are stored contiguously in memory •

.Added the --silent option for the clickhouse-local tool. It suppresses printing query execution info in stderr •

Added support for reading values of type `Date` from text in a format where the month and/or day of the month is .(specified using a single digit instead of two digits (Amos Bird

## PERFORMANCE OPTIMIZATIONS

Improved performance of aggregate functions `min`, `max`, `any`, `anyLast`, `anyHeavy`, `argMin`, `argMax` from string •  
arguments

.Improved performance of the functions `isInfinite`, `isFinite`, `isNaN`, `roundToExp2` •

• Improved performance of parsing and formatting Date and DateTime type values in text format

- .Improved performance and precision of parsing floating point numbers •
  - Lowered memory usage for `JOIN` in the case when the left and right parts have columns with identical names that are •
    - . not contained in `USING`
  - Improved performance of aggregate functions `varSamp`, `varPop`, `stddevSamp`, `stddevPop`, `covarSamp`, `covarPop`, `corr` •
 by reducing computational stability. The old functions are available under the names `varSampStable`, `varPopStable`, •
    - . `stddevSampStable`, `stddevPopStable`, `covarSampStable`, `covarPopStable`, `corrStable`
- :BUG FIXES
- Fixed data deduplication after running a `DROP` or `DETACH PARTITION` query. In the previous version, dropping a •
 .partition and inserting the same data again was not working because inserted blocks were considered duplicates
  - Fixed a bug that could lead to incorrect interpretation of the `WHERE` clause for `CREATE MATERIALIZED VIEW` queries •
    - . with `POPULATE`
  - .Fixed a bug in using the `root_path` parameter in the `zookeeper_servers` configuration •
    - . Fixed unexpected results of passing the `Date` argument to `toStartOfDay` •
  - Fixed the `addMonths` and `subtractMonths` functions and the arithmetic for `INTERVAL n MONTH` in cases when the result •
 .has the previous year
  - Added missing support for the `UUID` data type for `DISTINCT`, `JOIN`, and `uniq` aggregate functions and external •
 .dictionaries (Evgeniy Ivanov). Support for `UUID` is still incomplete
    - .Fixed `SummingMergeTree` behavior in cases when the rows summed to zero •
      - .(Various fixes for the Kafka engine (Marek Vavruša •
        - .(Fixed incorrect behavior of the `Join` table engine (Amos Bird •
          - .Fixed incorrect allocator behavior under FreeBSD and OS X •
            - .The `extractAll` function now supports empty matches •
              - . Fixed an error that blocked usage of `libressl` instead of `openssl` •
    - .Fixed the `CREATE TABLE AS SELECT` query from temporary tables •
  - Fixed non-atomicity of updating the replication queue. This could lead to replicas being out of sync until the server •
 .restarts
    - .(Fixed possible overflow in `gcd`, `lcm` and `modulo` (% operator) (Maks Skorokhod •
      - .( preprocessed files are now created after changing `umask` (`umask` can be changed in the config- •
        - .Fixed a bug in the background check of parts (`MergeTreePartChecker`) when using a custom partition key •
          - .Fixed parsing of tuples (values of the `Tuple` data type) in text formats •
    - .Improved error messages about incompatible types passed to `multilf`, `array` and some other functions •
  - Redesigned support for `Nullable` types. Fixed bugs that may lead to a server crash. Fixed almost all other bugs •
 related to `NULL` support: incorrect type conversions in `INSERT SELECT`, insufficient support for `Nullable` in `HAVING` •
 .and `PREWHERE`, `join_use_nulls` mode, `Nullable` types as arguments of `OR` operator, etc
  - Fixed various bugs related to internal semantics of data types. Examples: unnecessary summing of `Enum` type fields •
    - .in `SummingMergeTree`; alignment of `Enum` types in `Pretty` formats, etc
    - .Stricter checks for allowed combinations of composite columns •
  - .Fixed the overflow when specifying a very large parameter for the `FixedSizeString` data type •
    - .Fixed a bug in the `topK` aggregate function in a generic case •
  - Added the missing check for equality of array sizes in arguments of n-ary variants of aggregate functions with an- •
 .Array combinator
    - .(Fixed a bug in `--pager` for `clickhouse-client` (author: ks1322 •

.Fixed the precision of the `exp10` function •

.Fixed the behavior of the `visitParamExtract` function for better compliance with documentation •

.Fixed the crash when incorrect data types are specified •

.Fixed the behavior of `DISTINCT` in the case when all columns are constants •

Fixed query formatting in the case of using the `tupleElement` function with a complex constant expression as the tuple •  
.element index

.Fixed a bug in `Dictionary` tables for `range_hashed` dictionaries •

.(Fixed a bug that leads to excessive rows in the result of `FULL` and `RIGHT JOIN` (Amos Bird •

.Fixed a server crash when creating and removing temporary files in `config.d` directories during config reload •

.Fixed the `SYSTEM DROP DNS CACHE` query: the cache was flushed but addresses of cluster nodes were not updated •

Fixed the behavior of `MATERIALIZED VIEW` after executing `DETACH TABLE` for the table under the view (Marek •  
.Vavruša

#### :BUILD IMPROVEMENTS

The `pbuilder` tool is used for builds. The build process is almost completely independent of the build host •  
.environment

A single build is used for different OS versions. Packages and binaries have been made compatible with a wide range •  
.of Linux systems

.Added the `clickhouse-test` package. It can be used to run functional tests •

.The source tarball can now be published to the repository. It can be used to reproduce the build without using GitHub •

Added limited integration with Travis CI. Due to limits on build time in Travis, only the debug build is tested and a •  
.limited subset of tests are run

.Added support for `Cap'n'Proto` in the default build •

.Changed the format of documentation sources from `Restricted Text` to `Markdown` •

Added support for `systemd` (Vladimir Smirnov). It is disabled by default due to incompatibility with some OS images •  
.and can be enabled manually

For dynamic code generation, `clang` and `lld` are embedded into the `clickhouse` binary. They can also be invoked as •  
. `clickhouse clang` and `clickhouse lld`

Removed usage of GNU extensions from the code. Enabled the `-Wextra` option. When building with `clang` the default •  
.++is `libc++` instead of `libstdc`

.Extracted `clickhouse_parsers` and `clickhouse_common_io` libraries to speed up builds of various tools •

#### :BACKWARD INCOMPATIBLE CHANGES

The format for marks in `Log` type tables that contain `Nullable` columns was changed in a backward incompatible way. •

If you have these tables, you should convert them to the `TinyLog` type before starting up the new server version. To do this, replace `ENGINE = Log` with `ENGINE = TinyLog` in the corresponding `.sql` file in the `metadata` directory. If your .table doesn't have `Nullable` columns or if the type of your table is not `Log`, then you don't need to do anything

.Removed the `experimental_allow_extended_storage_definition_syntax` setting. Now this feature is enabled by default •

.The `runningIncome` function was renamed to `runningDifferenceStartingWithFirstValue` to avoid confusion •

Removed the `FROM ARRAY JOIN arr` syntax when `ARRAY JOIN` is specified directly after `FROM` with no table (Amos •  
.Bird)

.Removed the `BlockTabSeparated` format that was used solely for demonstration purposes •

Changed the state format for aggregate functions `varSamp` , `varPop` , `stddevSamp` , `stddevPop` , `covarSamp` , `covarPop` , •  
`corr` . If you have stored states of these aggregate functions in tables (using the `AggregateFunction` data type or

.materialized views with corresponding states), please write to clickhouse-feedback@yandex-team.com

In previous server versions there was an undocumented feature: if an aggregate function depends on parameters, you can still specify it without parameters in the AggregateFunction data type. Example: AggregateFunction(quantiles, UInt64) instead of AggregateFunction(quantiles(0.5, 0.9), UInt64). This feature was lost. Although it was undocumented, we plan to support it again in future releases.

.Enum data types cannot be used in min/max aggregate functions. This ability will be returned in the next release.

#### :PLEASE NOTE WHEN UPGRADING

When doing a rolling update on a cluster, at the point when some of the replicas are running the old version of ClickHouse and some are running the new version, replication is temporarily stopped and the message unknown .parameter 'shard' appears in the log. Replication will continue after all replicas of the cluster are updated.

If different versions of ClickHouse are running on the cluster servers, it is possible that distributed queries using the following functions will have incorrect results: varSamp , varPop , stddevSamp , stddevPop , covarSamp , covarPop , corr . You should update all cluster nodes

### ClickHouse release 1.1.54327, 2017-12-21

:This release contains bug fixes for the previous release 1.1.54318

Fixed bug with possible race condition in replication that could lead to data loss. This issue affects versions 1.1.54310 and 1.1.54318. If you use one of these versions with Replicated tables, the update is strongly recommended. This issue shows in logs in Warning messages like Part ... from own log doesn't exist. The issue is relevant even if you don't see these messages in logs

### ClickHouse release 1.1.54318, 2017-11-30

:This release contains bug fixes for the previous release 1.1.54310

Fixed incorrect row deletions during merges in the SummingMergeTree engine  
Fixed a memory leak in unreplicated MergeTree engines  
Fixed performance degradation with frequent inserts in MergeTree engines  
Fixed an issue that was causing the replication queue to stop running  
Fixed rotation and archiving of server logs

### ClickHouse release 1.1.54310, 2017-11-01

#### :NEW FEATURES

.Custom partitioning key for the MergeTree family of table engines  
.Kafka table engine  
.Added support for loading **CatBoost** models and applying them to data stored in ClickHouse  
.Added support for time zones with non-integer offsets from UTC  
.Added support for arithmetic operations with time intervals  
.The range of values for the Date and DateTime types is extended to the year 2105  
Added the CREATE MATERIALIZED VIEW x TO y query (specifies an existing table for storing the data of a materialized view)  
.Added the ATTACH TABLE query without arguments  
The processing logic for Nested columns with names ending in -Map in a SummingMergeTree table was extracted to the sumMap aggregate function. You can now specify such columns explicitly  
.Max size of the IP trie dictionary is increased to 128M entries

- .Added the getSizeOfEnumType function •
- .Added the sumWithOverflow aggregate function •
- .Added support for the Cap'n Proto input format •
- .You can now customize compression level when using the zstd algorithm •

:BACKWARD INCOMPATIBLE CHANGES

- .Creation of temporary tables with an engine other than Memory is not allowed •
- .Explicit creation of tables with the View or MaterializedView engine is not allowed •
- .During table creation, a new check verifies that the sampling key expression is included in the primary key •

:BUG FIXES

- .Fixed hangups when synchronously inserting into a Distributed table •
- .Fixed nonatomic adding and removing of parts in Replicated tables •
- .Data inserted into a materialized view is not subjected to unnecessary deduplication •
- Executing a query to a Distributed table for which the local replica is lagging and remote replicas are unavailable does •  
not result in an error anymore
- .Users don't need access permissions to the default database to create temporary tables anymore •
- .Fixed crashing when specifying the Array type without arguments •
- .Fixed hangups when the disk volume containing server logs is full •
- .Fixed an overflow in the toRelativeWeekNum function for the first week of the Unix epoch •

:BUILD IMPROVEMENTS

- .Several third-party libraries (notably Poco) were updated and converted to git submodules •

**ClickHouse release 1.1.54304, 2017-10-19**

:NEW FEATURES

- .( TLS support in the native protocol (to enable, set `tcp_ssl_port` in `config.xml`) •

:BUG FIXES

- . ALTER for replicated tables now tries to start running as soon as possible •
- .Fixed crashing when reading data with the setting `preferred_block_size_bytes=0` •  
Fixed crashes of `clickhouse-client` when pressing Page Down •
- Correct interpretation of certain complex queries with GLOBAL IN and UNION ALL •  
. FREEZE PARTITION always works atomically now •
- .Empty POST requests now return a response with code 411 •
- .((Fixed interpretation errors for expressions like `CAST(1 AS Nullable(UInt8` •
- .Fixed an error when reading `Array(Nullable(String))` columns from MergeTree tables •  
Fixed crashing when parsing queries like `SELECT dummy AS dummy, dummy AS b` •  
Users are updated correctly with invalid `users.xml` •
- .Correct handling when an executable dictionary returns a non-zero response code •

**ClickHouse release 1.1.54292, 2017-09-20**

:NEW FEATURES

.Added the `pointInPolygon` function for working with coordinates on a coordinate plane •  
.Added the `sumMap` aggregate function for calculating the sum of arrays, similar to `SummingMergeTree` •  
Added the `trunc` function. Improved performance of the rounding functions (`round`, `floor`, `ceil`, `roundToExp2`) and •  
corrected the logic of how they work. Changed the logic of the `roundToExp2` function for fractions and negative  
.numbers  
The ClickHouse executable file is now less dependent on the libc version. The same ClickHouse executable file can •  
run on a wide variety of Linux systems. There is still a dependency when using compiled queries (with the setting  
.(`compile = 1` , which is not used by default  
.Reduced the time needed for dynamic compilation of queries •

#### :BUG FIXES

.Fixed an error that sometimes produced `part ... intersects previous part` messages and weakened replica consistency •  
.Fixed an error that caused the server to lock up if ZooKeeper was unavailable during shutdown •  
.Removed excessive logging when restoring replicas •  
.Fixed an error in the UNION ALL implementation •  
.Fixed an error in the concat function that occurred if the first column in a block has the Array type •  
.Progress is now displayed correctly in the system.merges table •

### ClickHouse release 1.1.54289, 2017-09-13

#### :NEW FEATURES

SYSTEM queries for server administration: `SYSTEM RELOAD DICTIONARY` , `SYSTEM RELOAD DICTIONARIES` , `SYSTEM` •  
.DROP DNS CACHE , `SYSTEM SHUTDOWN` , `SYSTEM KILL`  
Added functions for working with arrays: `concat` , `arraySlice` , `arrayPushBack` , `arrayPushFront` , `arrayPopBack` , •  
. `arrayPopFront`  
Added `root` and `identity` parameters for the ZooKeeper configuration. This allows you to isolate individual users on •  
.the same ZooKeeper cluster  
Added aggregate functions `groupBitAnd` , `groupBitOr` , and `groupBitXor` (for compatibility, they are also available under •  
.the names `BIT_AND` , `BIT_OR` , and `BIT_XOR`  
.External dictionaries can be loaded from MySQL by specifying a socket in the filesystem •  
. (External dictionaries can be loaded from MySQL over SSL (`ssl_cert` , `ssl_key` , `ssl_ca` parameters •  
.Added the `max_network_bandwidth_for_user` setting to restrict the overall bandwidth use for queries per user •  
.Support for `DROP TABLE` for temporary tables •  
.Support for reading `DateTime` values in Unix timestamp format from the `CSV` and `JSONEachRow` formats •  
. (Lagging replicas in distributed queries are now excluded by default (the default threshold is 5 minutes •  
.FIFO locking is used during ALTER: an ALTER query isn't blocked indefinitely for continuously running queries •  
.Option to set `umask` in the config file •  
. Improved performance for queries with `DISTINCT` •

#### :BUG FIXES

Improved the process for deleting old nodes in ZooKeeper. Previously, old nodes sometimes didn't get deleted if there •  
.there were very frequent inserts, which caused the server to be slow to shut down, among other things  
.Fixed randomization when choosing hosts for the connection to ZooKeeper •  
.Fixed the exclusion of lagging replicas in distributed queries if the replica is localhost •

Fixed an error where a data part in a ReplicatedMergeTree table could be broken after running ALTER MODIFY on an element in a Nested structure •  
."Fixed an error that could cause SELECT queries to "hang" •  
.Improvements to distributed DDL queries •  
. <Fixed the query CREATE TABLE ... AS <materialized view •  
.Resolved the deadlock in the ALTER ... CLEAR COLUMN IN PARTITION query for Buffer tables •  
Fixed the invalid default value for Enum s (0 instead of the minimum) when using the JSONEachRow and TSKV formats •  
.Resolved the appearance of zombie processes when using a dictionary with an executable source •  
.Fixed segfault for the HEAD query •

#### :IMPROVED WORKFLOW FOR DEVELOPING AND ASSEMBLING CLICKHOUSE

.You can use pbuilder to build ClickHouse •  
.You can use libc++ instead of libstdc++ for builds on Linux •  
.Added instructions for using static code analysis tools: Coverage , clang-tidy , cppcheck •

#### :PLEASE NOTE WHEN UPGRADING

There is now a higher default value for the MergeTree setting max\_bytes\_to\_merge\_at\_max\_space\_in\_pool (the maximum total size of data parts to merge, in bytes): it has increased from 100 GiB to 150 GiB. This might result in large merges running after the server upgrade, which could cause an increased load on the disk subsystem. If the free space available on the server is less than twice the total amount of the merges that are running, this will cause all other merges to stop running, including merges of small data parts. As a result, INSERT queries will fail with the message "Merges are processing significantly slower than inserts." Use the SELECT \* FROM system.merges query to monitor the situation. You can also check the DiskSpaceReservedForMerge metric in the system.metrics table, or in Graphite. You don't need to do anything to fix this, since the issue will resolve itself once the large merges finish. If you find this unacceptable, you can restore the previous value for the max\_bytes\_to\_merge\_at\_max\_space\_in\_pool setting. To do this, go to the section in config.xml, set  
`<merge_tree><max_bytes_to_merge_at_max_space_in_pool>107374182400</max_bytes_to_merge_at_max_space_in_pool>`  
.and restart the server

### ClickHouse release 1.1.54284, 2017-08-29

.This is a bugfix release for the previous 1.1.54282 release. It fixes leaks in the parts directory in ZooKeeper •

### ClickHouse release 1.1.54282, 2017-08-23

:This release contains bug fixes for the previous release 1.1.54276

.Fixed DB::Exception: Assertion violation: !\_path.empty() when inserting into a Distributed table •  
.;"Fixed parsing when inserting in RowBinary format if input data starts with •  
.().Errors during runtime compilation of certain aggregate functions (e.g.groupArray •

### Clickhouse Release 1.1.54276, 2017-08-16

#### :NEW FEATURES

Added an optional WITH section for a SELECT query. Example query: WITH 1+1 AS a SELECT a, a\*a •  
INSERT can be performed synchronously in a Distributed table: OK is returned only after all the data is saved on all •  
.the shards. This is activated by the setting insert\_distributed\_sync=1 •  
.Added the UUID data type for working with 16-byte identifiers •

- .Added aliases of CHAR, FLOAT and other types for compatibility with the Tableau •
- .Added the functions toYYYYMM, toYYYYMMDD, and toYYYYMMDDhhmmss for converting time into numbers •
  - .You can use IP addresses (together with the hostname) to identify servers for clustered DDL queries •
  - .(Added support for non-constant arguments and negative offsets in the function substring(str, pos, len) •
- Added the max\_size parameter for the groupArray(max\_size)(column) aggregate function, and optimized its •
  - .performance

#### :MAIN CHANGES

- .(Security improvements: all server files are created with 0640 permissions (can be changed via config parameter •
  - .Improved error messages for queries with invalid syntax •
- Significantly reduced memory consumption and improved performance when merging large sections of MergeTree •
  - .data
  - .Significantly increased the performance of data merges for the ReplacingMergeTree engine •
- Improved performance for asynchronous inserts from a Distributed table by combining multiple source inserts. To •
  - .enable this functionality, use the setting distributed\_directory\_monitor\_batch\_inserts=1

#### :BACKWARD INCOMPATIBLE CHANGES

- .Changed the binary format of aggregate states of groupArray(array\_column) functions for arrays •

#### :COMPLETE LIST OF CHANGES

- .Added the output\_format\_json\_quote\_denormals setting, which enables outputting nan and inf values in JSON format •
  - .Optimized stream allocation when reading from a Distributed table •
  - .Settings can be configured in readonly mode if the value doesn't change •
- Added the ability to retrieve non-integer granules of the MergeTree engine in order to meet restrictions on the block •
  - .size specified in the preferred\_block\_size\_bytes setting. The purpose is to reduce the consumption of RAM and •
    - .increase cache locality when processing queries from tables with large columns
- .Efficient use of indexes that contain expressions like toStartOfHour(x) for conditions like toStartOfHour(x) op constexpr •
  - :(Added new settings for MergeTree engines (the merge\_tree section in config.xml •
  - replicated\_deduplication\_window\_seconds sets the number of seconds allowed for deduplicating inserts in •
    - .Replicated tables
  - .cleanup\_delay\_period sets how often to start cleanup to remove outdated data •
  - .(replicated\_can\_become\_leader can prevent a replica from becoming the leader (and assigning merges •
    - .Accelerated cleanup to remove outdated data from ZooKeeper •
- Multiple improvements and fixes for clustered DDL queries. Of particular interest is the new setting •
  - distributed\_ddl\_task\_timeout, which limits the time to wait for a response from the servers in the cluster. If a ddl request has not been performed on all hosts, a response will contain a timeout error and a request will be executed in •
    - .an async mode
    - .Improved display of stack traces in the server logs •
    - .Added the "none" value for the compression method •
    - .You can use multiple dictionaries\_config sections in config.xml •
    - .It is possible to connect to MySQL through a socket in the file system •
  - .The system.parts table has a new column with information about the size of marks, in bytes •

#### :BUG FIXES

.Distributed tables using a Merge table now work correctly for a SELECT query with a condition on the `_table` field •  
.Fixed a rare race condition in ReplicatedMergeTree when checking data parts •  
.Fixed possible freezing on "leader election" when starting a server •  
The `max_replica_delay_for_distributed_queries` setting was ignored when using a local replica of the data source. •  
.This has been fixed  
Fixed incorrect behavior of `ALTER TABLE CLEAR COLUMN IN PARTITION` when attempting to clean a non-existing •  
.column  
.Fixed an exception in the multilf function when using empty arrays or strings •  
.Fixed excessive memory allocations when deserializing Native format •  
.Fixed incorrect auto-update of Trie dictionaries •  
.Fixed an exception when running queries with a GROUP BY clause from a Merge table when using SAMPLE •  
.Fixed a crash of GROUP BY when using `distributed_aggregation_memory_efficient=1` •  
.Now you can specify the database.table in the right side of IN and JOIN •  
.Too many threads were used for parallel aggregation. This has been fixed •  
.Fixed how the "if" function works with `FixedString` arguments •  
.SELECT worked incorrectly from a Distributed table for shards with a weight of 0. This has been fixed •  
.Running `CREATE VIEW IF EXISTS` no longer causes crashes •  
.Fixed incorrect behavior when `input_format_skip_unknown_fields=1` is set and there are negative numbers •  
.Fixed an infinite loop in the `dictGetHierarchy()` function if there is some invalid data in the dictionary •  
Fixed Syntax error: unexpected (...) errors when running distributed queries with subqueries in an IN or JOIN clause and •  
.Merge tables  
.Fixed an incorrect interpretation of a SELECT query from Dictionary tables •  
.Fixed the "Cannot mremap" error when using arrays in IN and JOIN clauses with more than 2 billion elements •  
.Fixed the failover for dictionaries with MySQL as the source •

:IMPROVED WORKFLOW FOR DEVELOPING AND ASSEMBLING CLICKHOUSE

.Builds can be assembled in Arcadia •  
.You can use gcc 7 to compile ClickHouse •  
.Parallel builds using ccache+distcc are faster now •

**ClickHouse release 1.1.54245, 2017-07-04**

:NEW FEATURES

(Distributed DDL (for example, `CREATE TABLE ON CLUSTER` •  
.The replicated query `ALTER TABLE CLEAR COLUMN IN PARTITION` •  
.The engine for Dictionary tables (access to dictionary data in the form of a table •  
Dictionary database engine (this type of database automatically has Dictionary tables available for all the connected •  
.external dictionaries  
.You can check for updates to the dictionary by sending a request to the source •  
.Qualified column names •  
.Quoting identifiers using double quotation marks •  
.Sessions in the HTTP interface •  
.The `OPTIMIZE` query for a Replicated table can run not only on the leader •

:BACKWARD INCOMPATIBLE CHANGES

.Removed SET GLOBAL •

:MINOR CHANGES

.Now after an alert is triggered, the log prints the full stack trace •

.(Relaxed the verification of the number of damaged/extra data parts at startup (there were too many false positives •

:BUG FIXES

.Fixed a bad connection "sticking" when inserting into a Distributed table •

.GLOBAL IN now works for a query from a Merge table that looks at a Distributed table •

.The incorrect number of cores was detected on a Google Compute Engine virtual machine. This has been fixed •

.Changes in how an executable source of cached external dictionaries works •

.Fixed the comparison of strings containing null characters •

.Fixed the comparison of Float32 primary key fields with constants •

.Previously, an incorrect estimate of the size of a field could lead to overly large allocations •

.Fixed a crash when querying a Nullable column added to a table using ALTER •

.Fixed a crash when sorting by a Nullable column, if the number of rows is less than LIMIT •

.Fixed an ORDER BY subquery consisting of only constant values •

.Previously, a Replicated table could remain in the invalid state after a failed DROP TABLE •

.Aliases for scalar subqueries with empty results are no longer lost •

.Now a query that used compilation does not fail with an error if the .so file gets damaged •

Fixed in ClickHouse Release 19.14.3.3, 2019-09-10

**CVE-2019-15024**

An attacker having write access to ZooKeeper and who is able to run a custom server available from the network where ClickHouse runs, can create a custom-built malicious server that will act as a ClickHouse replica and register it in ZooKeeper. When another replica will fetch data part from the malicious replica, it can force clickhouse-server to write to .arbitrary path on filesystem

Credits: Eldar Zaitov of Yandex Information Security Team

**CVE-2019-16535**

An OOB read, OOB write and integer underflow in decompression algorithms can be used to achieve RCE or DoS via .native protocol

Credits: Eldar Zaitov of Yandex Information Security Team

**CVE-2019-16536**

.Stack overflow leading to DoS can be triggered by malicious authenticated client

Credits: Eldar Zaitov of Yandex Information Security Team

Fixed in ClickHouse Release 19.13.6.1, 2019-09-20

**CVE-2019-18657**

.Table function `url` had the vulnerability allowed the attacker to inject arbitrary HTTP headers in the request

Credits: [Nikita Tikhomirov](#)

Fixed in ClickHouse Release 18.12.13, 2018-09-10

**CVE-2018-14672**

.Functions for loading CatBoost models allowed path traversal and reading arbitrary files through error messages

Credits: Andrey Krasichkov of Yandex Information Security Team

Fixed in ClickHouse Release 18.10.3, 2018-08-13

**CVE-2018-14671**

unixODBC allowed loading arbitrary shared objects from the file system which led to a Remote Code Execution .vulnerability

Credits: Andrey Krasichkov and Evgeny Sidorov of Yandex Information Security Team

Fixed in ClickHouse Release 1.1.54388, 2018-06-28

**CVE-2018-14668**

remote" table function allowed arbitrary symbols in "user", "password" and "default\_database" fields which led to Cross" .Protocol Request Forgery Attacks

Credits: Andrey Krasichkov of Yandex Information Security Team

Fixed in ClickHouse Release 1.1.54390, 2018-07-06

**CVE-2018-14669**

ClickHouse MySQL client had "LOAD DATA LOCAL INFILE" functionality enabled that allowed a malicious MySQL .database read arbitrary files from the connected ClickHouse server

Credits: Andrey Krasichkov and Evgeny Sidorov of Yandex Information Security Team

Fixed in ClickHouse Release 1.1.54131, 2017-01-10

**CVE-2018-14670**

.Incorrect configuration in deb package could lead to unauthorized use of the database

(Credits: the UK's National Cyber Security Centre (NCSC