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NOSQL FOR POSTGRESQL

BEST PRACTICES

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➔ Jsonb internals and performance-related factors

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- ➔ Tricky queries

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- ➔ Benchmarks

- ➔ Jsonb internals and performance-related factors
- ➔ Tricky queries
- ➔ Benchmarks
- ➔ How to shoot yourself in the foot

Internals

Performance-related factors

Performance-related factors

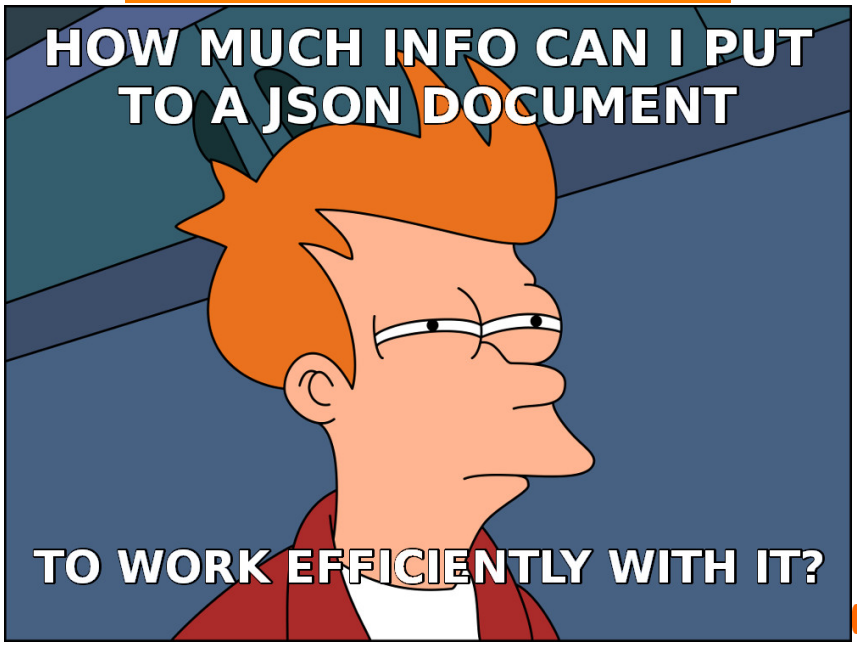
➔ On-disk representation

Performance-related factors

- ➔ On-disk representation
- ➔ In-memory representation

Performance-related factors

- ➔ On-disk representation
- ➔ In-memory representation
- ➔ Indexing support


HOW MUCH INFO CAN I PUT TO A JSON DOCUMENT
TO WORK EFFICIENTLY WITH IT?

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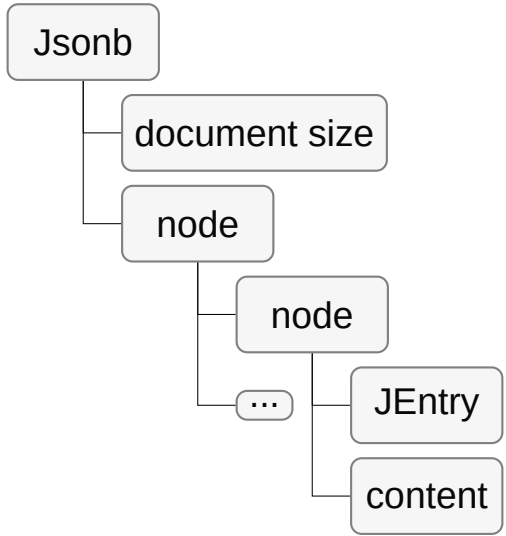

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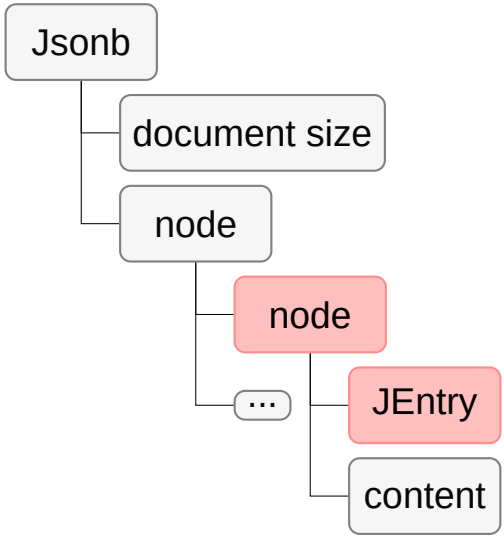

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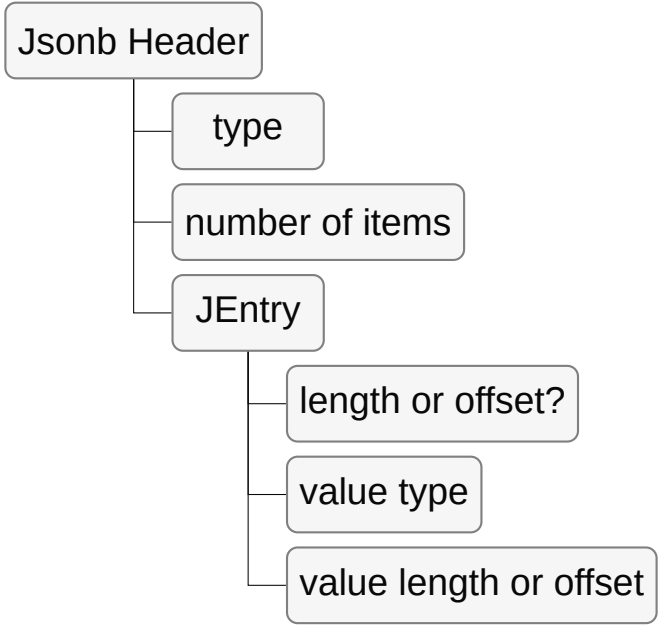
Jsonb Header
type
number of items
JEntry
length or offset?
value type
value length or offset

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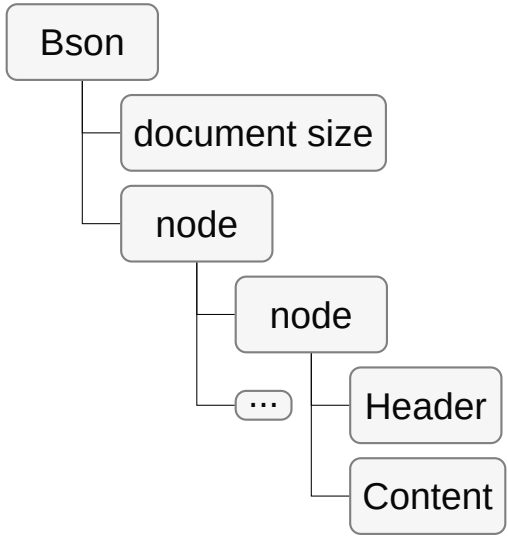
JB_OFFSET_STRIDE

- JEntry may contains a value lenght or offset
- Offset = access speed
- Length = compressibility
- Every **JB_OFFSET_STRIDE**’th JEntry contains an offset
- Rest of them contain length



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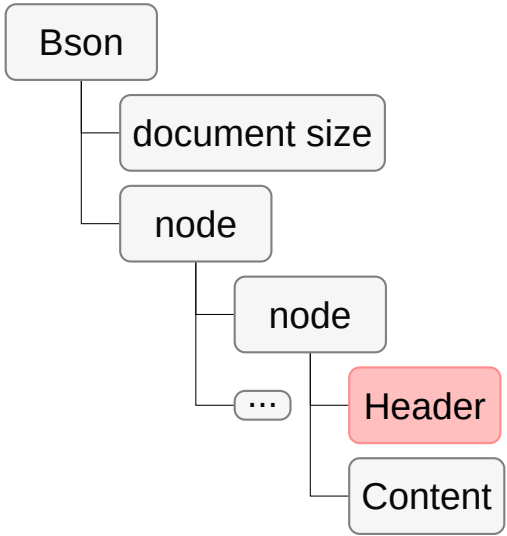

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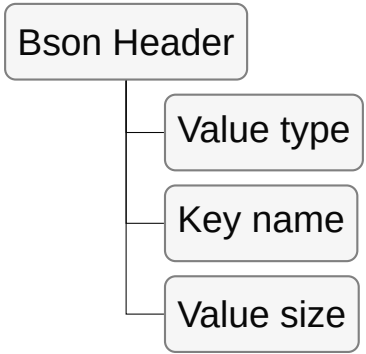
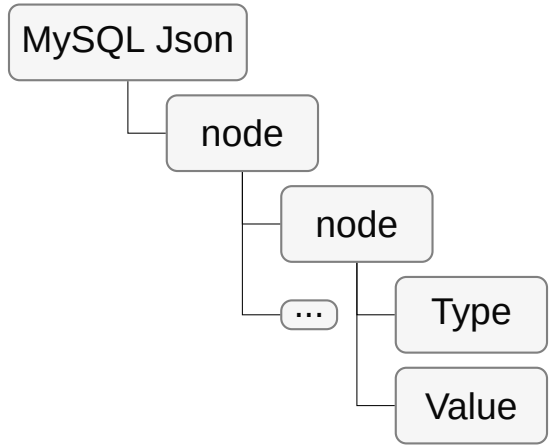
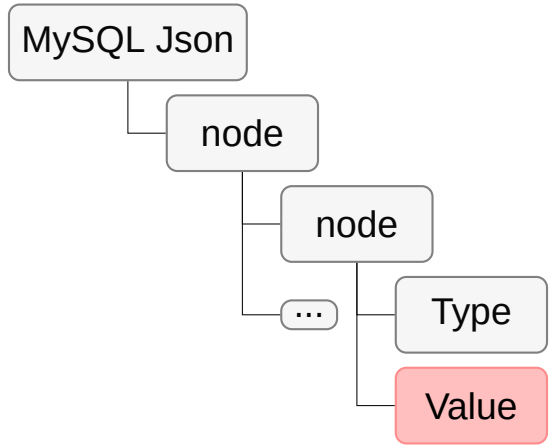


zalando



zalando



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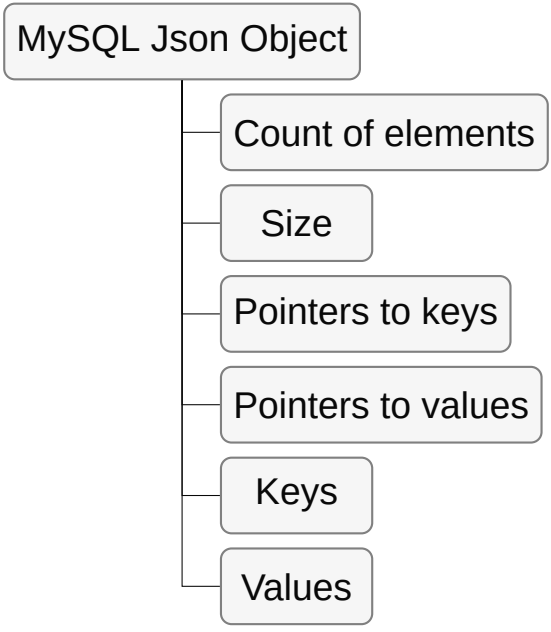
MySQL Json Object
Count of elements
Size
Pointers to keys
Pointers to values
Keys
Values

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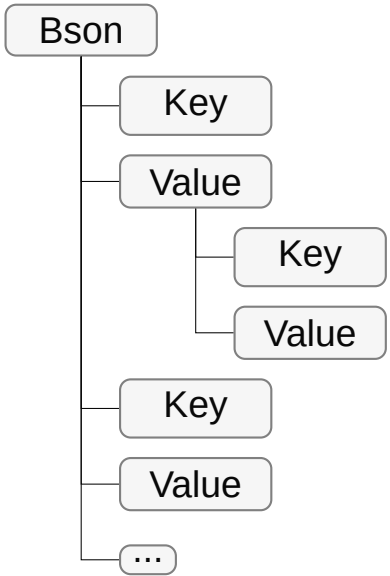
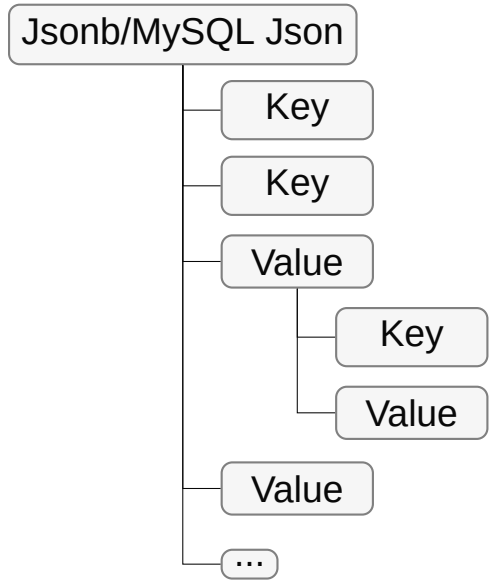

Bson
Key
Value
Key
Value
Key
Value
…


Jsonb/MySQL Json
Key
Key
Value
Key
Value
Value
…

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```
{"a": 3, "b": "xyz"}
```

```
select pg_relation_filepath(oid),
relpages from pg_class
where relname = 'table_name';

 pg_relation_filepath | relpages
----------------------+----------
 base/40960/325477    |        0
(1 row)
```

```
\x10\x03\x00\x00\x00ab\x00\x00\x00\x00\x00\x00\x80\x03\x00xyz\x00\x00\x00\x00
```

```
bson.dumps({"a": 3, "b": u"xyz"})
```

```
\x17\x00\x00\x00\x10a\x00\x03\x00\x00\x00\x02b\x00\x04\x00\x00\x00xyz\x00\x00
```


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$ hexdump -C database/table.ibd

```
\x00\x02\x00\x18\x00\x12\x00\x01\x00\x13\x00\x01\x00\x05\x03\x00\x0c\x14\x00ab\x03xyz\x00
```


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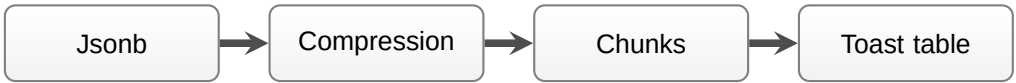
TOAST



- ➔ TOAST_TUPLE_THRESHOLD bytes (normally 2 kB)
- ➔ PostgreSQL and MySQL use LZ variation
- ➔ MongoDB uses snappy block compression

Alignment

Variable-length portion is aligned to a 4-byte

```
insert into test
values('{"a": "aa", "b": 1}');
```

```
abaa\x20\x00\x00\x00\x00\x80\x01\x00
```

```
insert into test
values('{"a": 1, "b": "aa"}');
```

```
\x00\x00ab\x00\x00\x20\x00\x00\x00\x00\x80\x01\x00aa
```

In-memory representation

- ➔ Tree-like representation (JsonbValue, Document, Json_dom)
- ➔ Little bit more expensive but more convenient to work with
- ➔ Mostly in use to modify data (except MySQL)
- ➔ Most of the read operations use on-disk representation

Indexing support

- ➔ Postgresql – single path, multiple paths, entire document
- ➔ MongoDB – single path, multiple paths
- ➔ MySQL – virtual columns, single path, multiple paths

PG indexing details

- ➔ jsonb_path
- ➔ jsonb_path_ops

Queries

Pitfalls

- ➔ No Json path out of the box (jsquery, SQL/JSON)
- ➔ Queries with an array somewhere in the middle
- ➔ Iterating through document
- ➔ Update inside document

```
[{
    "items": [
        {"id": 1, "value": "aaa"},
        {"id": 2, "value": "bbb"}
    ]
}, {
    "items": [
        {"id": 3, "value": "aaa"},
        {"id": 4, "value": "bbb"}
    ]
}]
```

```
WITH items AS (
    SELECT jsonb_array_elements(data→'items')
    AS item FROM test
)
SELECT * FROM items
WHERE item-»'value' = 'aaa';
```

```
item
————————
 {"id": 1, "value": "aaa"}
 {"id": 3, "value": "aaa"}
(2 rows)
```

```
{
    "items": {
        "item1": {"status": true},
        "item2": {"status": true},
        "item3": {"status": false}
    }
}
```

```
WITH items AS (
    SELECT jsonb_each(data→'items')
    AS item FROM test
)
SELECT (item).key FROM items
WHERE (item).value-»'status' = 'true';
```

```
key
——-
item1
item2
(2 rows)
```

Benchmarks


GREAT PERFORMANCE

AWS EC2

m4.xlarge instance

separate instance (database and generator)

16GB memory, 4 core 2.3GHz

Ubuntu 16.04

Same VPC and placement group

AMI that supports HVM virtualization type

at least 4 rounds of benchmark

PostgreSQL 9.6.3

MySQL 5.7.9/8.0

MongoDB 3.4.4

YCSB 0.13

10^6 rows and operations

AWS EC2

Configuration

shared_buffers
effective_cache_size
max_wal_size
innodb_buffer_pool_size
innodb_log_file_size
write concern level (journaled or transaction_sync)
checkpoint
eviction

Document types

“simple” document
10 key/value pairs (100 characters)

“large” document
100 key/value pairs (200 characters)

“complex” document
100 keys, 3 nesting levels (100 characters)

Select, GIN

”simple” document

jsonb_path_ops

where data @> ’{”key”: ”value”}’::jsonb

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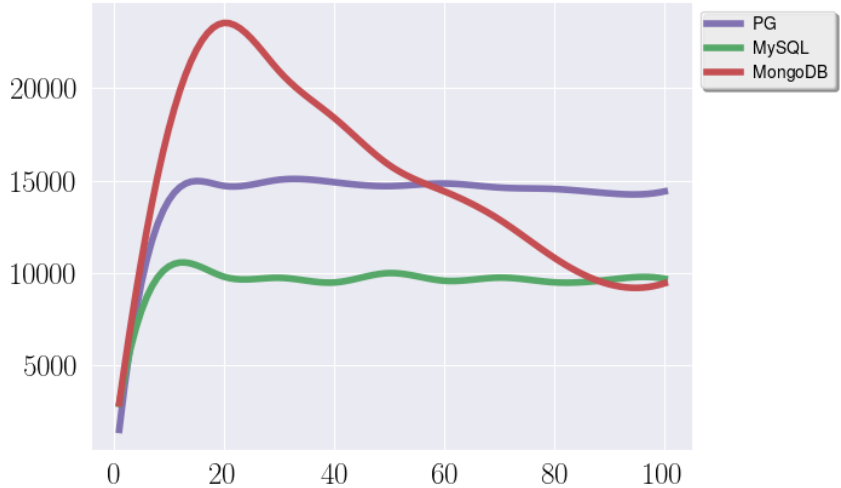
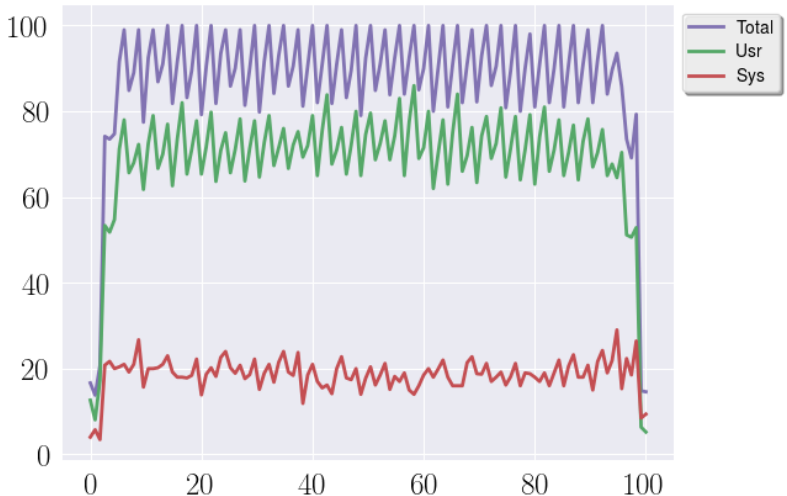
Throughput (ops/sec)

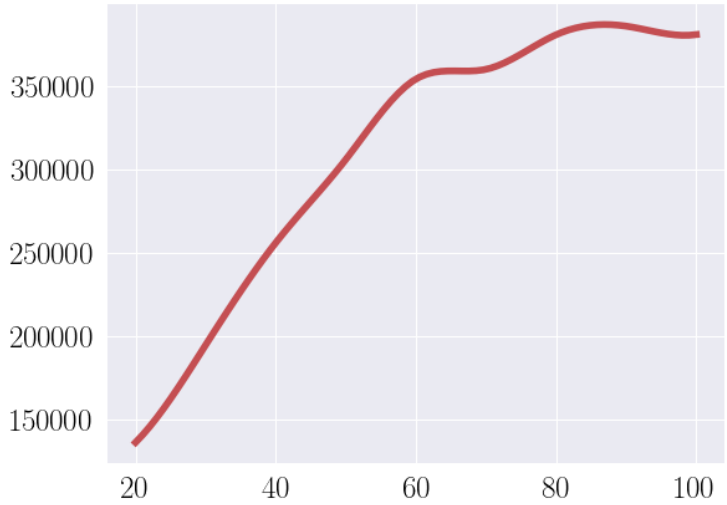


zalando

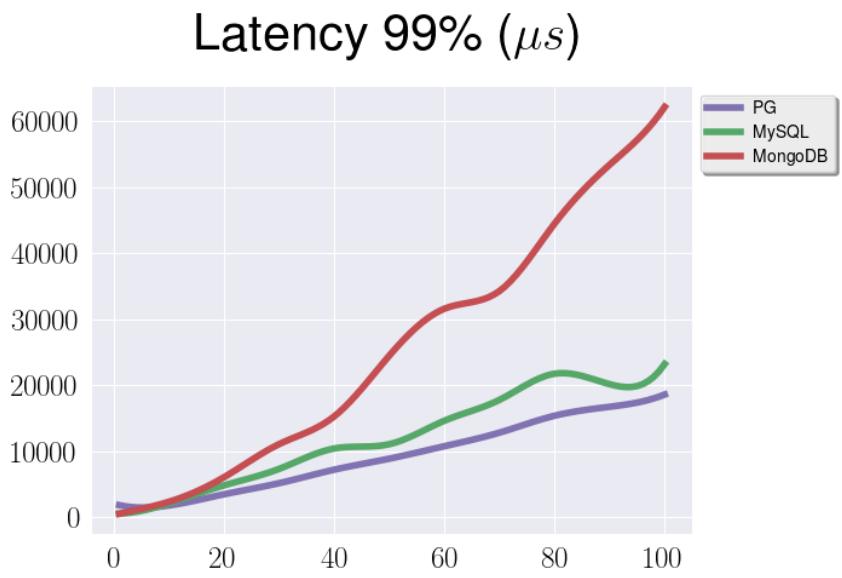


zalando

CPU migrations (MongoDB)



zalando


Latency 99% (μs)
60000
50000
40000
30000
20000
10000
0
0
20
40
60
80
100
PG
MySQL
MongoDB

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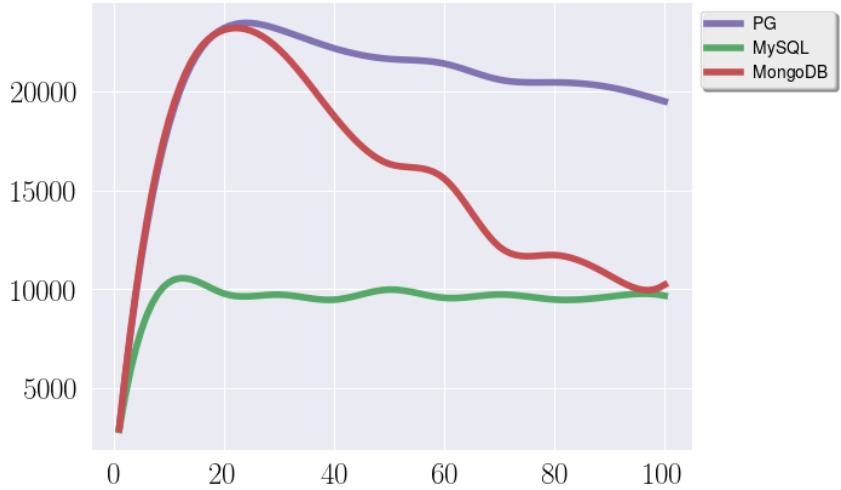
Select, BTree

”simple” document

btree

Throughput (ops/sec)



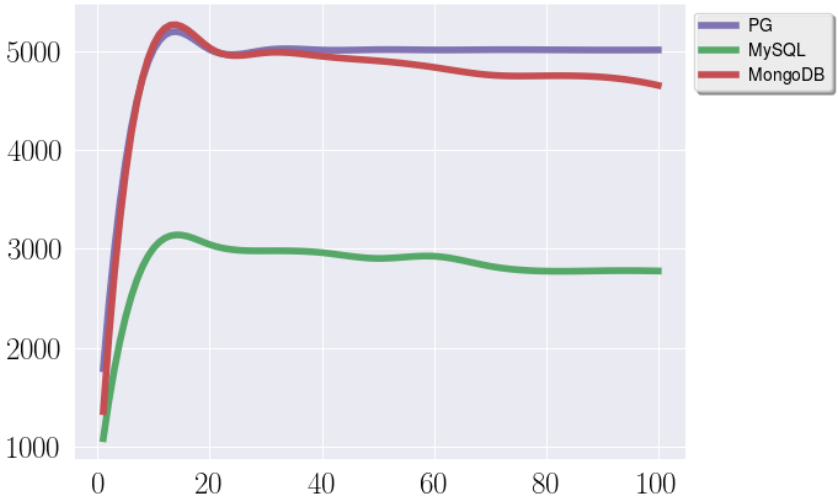
zalando

Select, BTree

”complex” document

btree

Throughput (ops/sec)



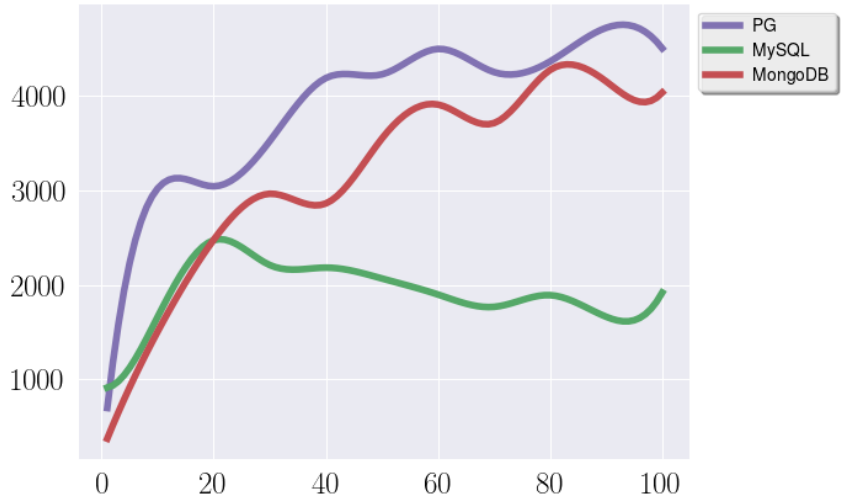
zalando

Insert

”simple” document

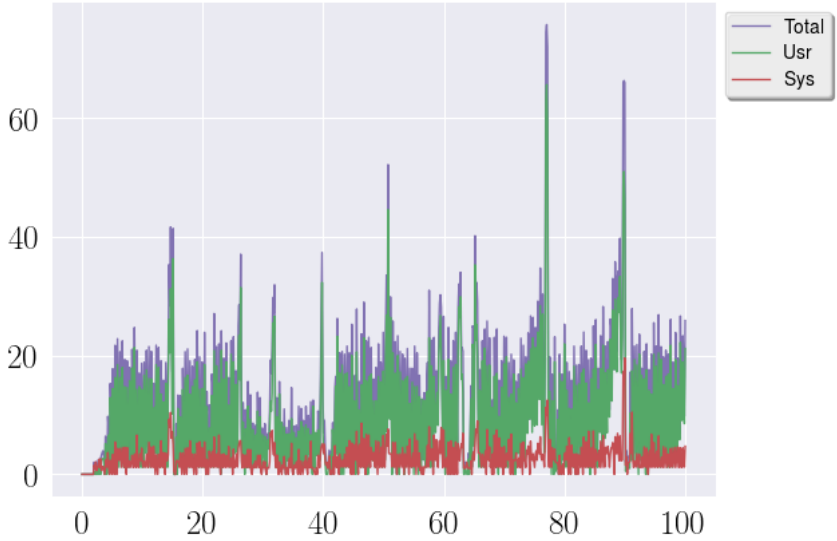
journaled

Throughput (ops/sec)



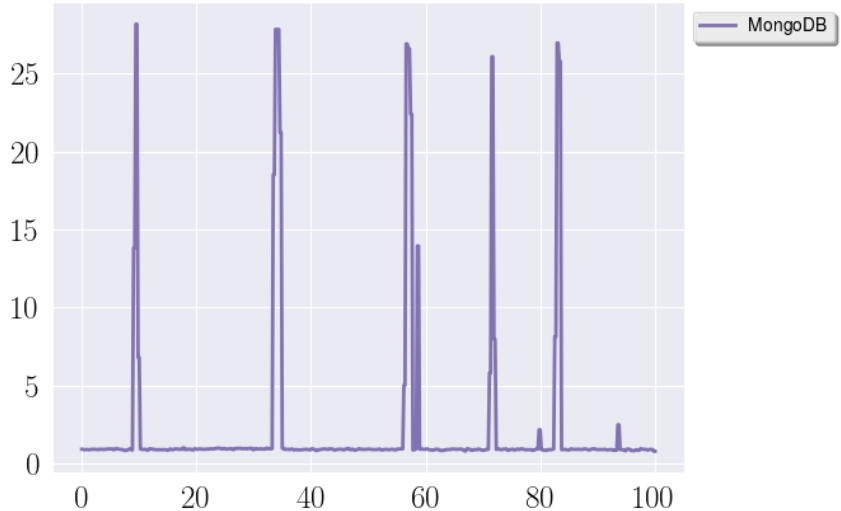
zalando

CPU%



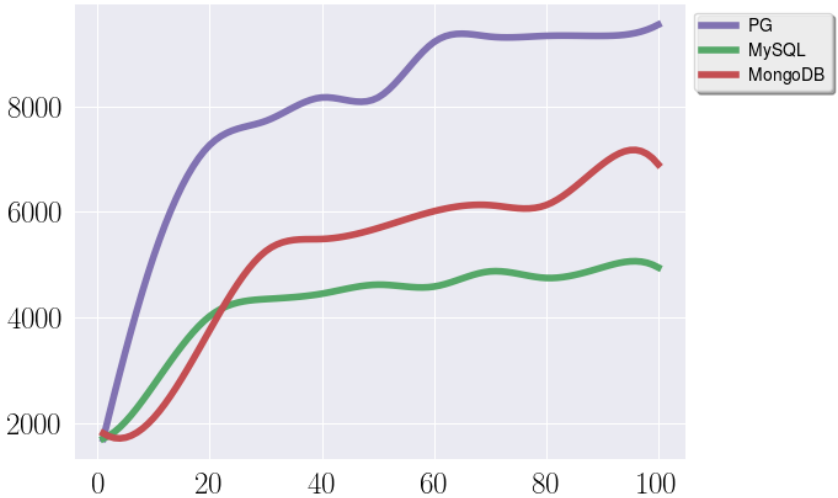
zalando

IO queue size



zalando

Throughput (ops/sec)



zalando

Update 50%, Select 50%

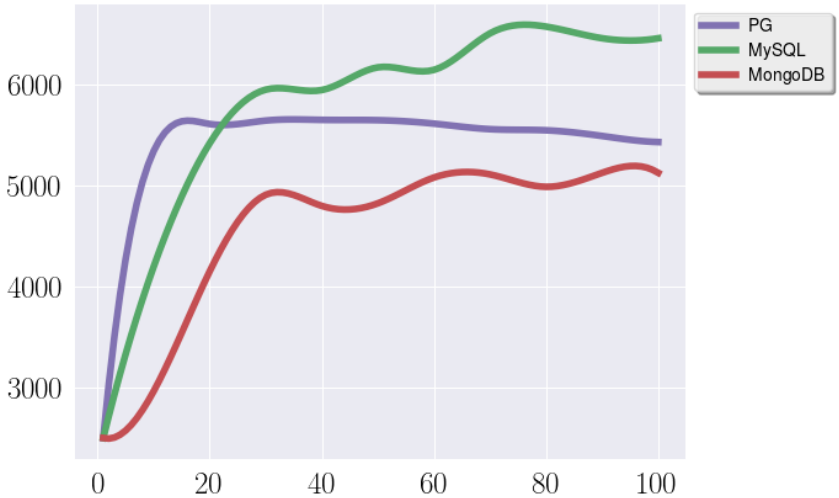
”simple” document

Update one field

journaled

max wal size 1GB

Throughput (ops/sec)



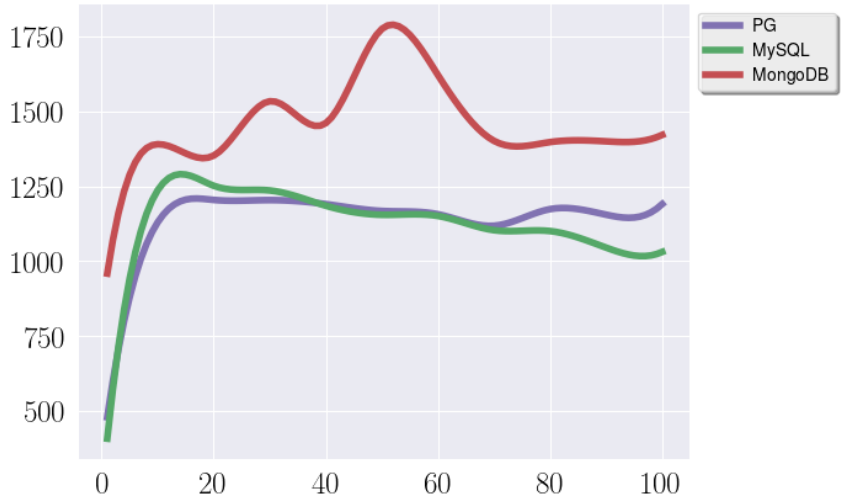
zalando

Update 50%, Select 50%

”large” document

Update one field

Throughput (ops/sec)



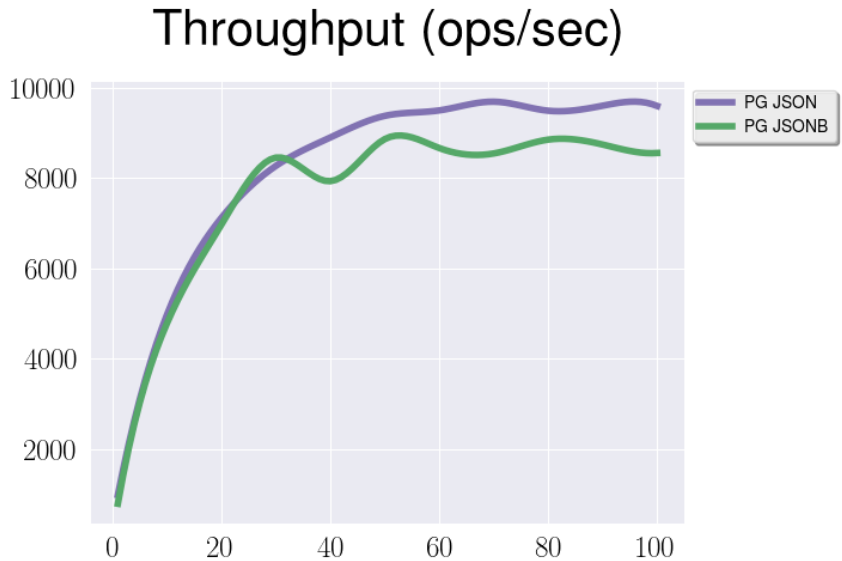
zalando

JSON vs JSONB

”simple” document

btree

insert


Throughput (ops/sec)
10000
8000
6000
4000
2000
0
20
40
60
80
100
PG JSON
PG JSONB

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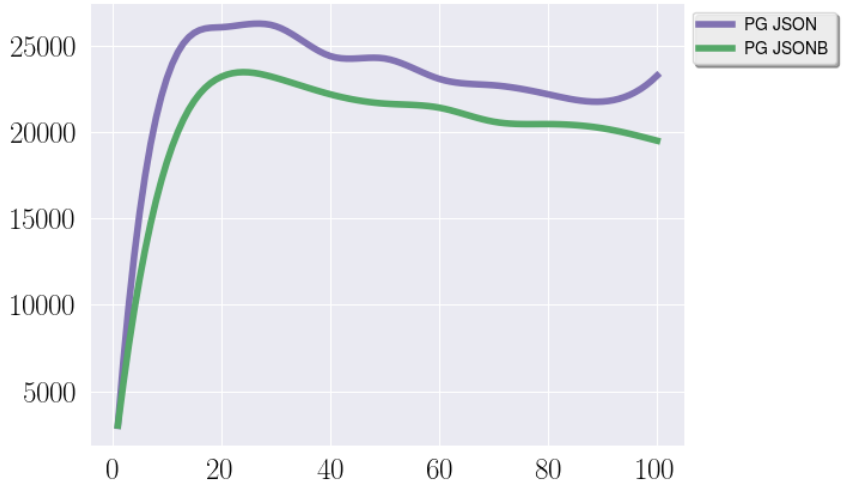
JSON vs JSONB

”simple” document

btree

select

Throughput (ops/sec)



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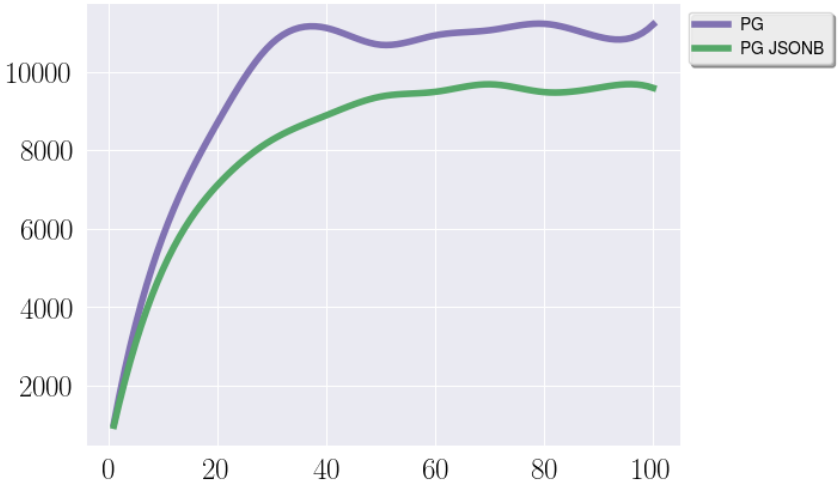
SQL vs JSONB

”simple” document

btree

insert

Throughput (ops/sec)



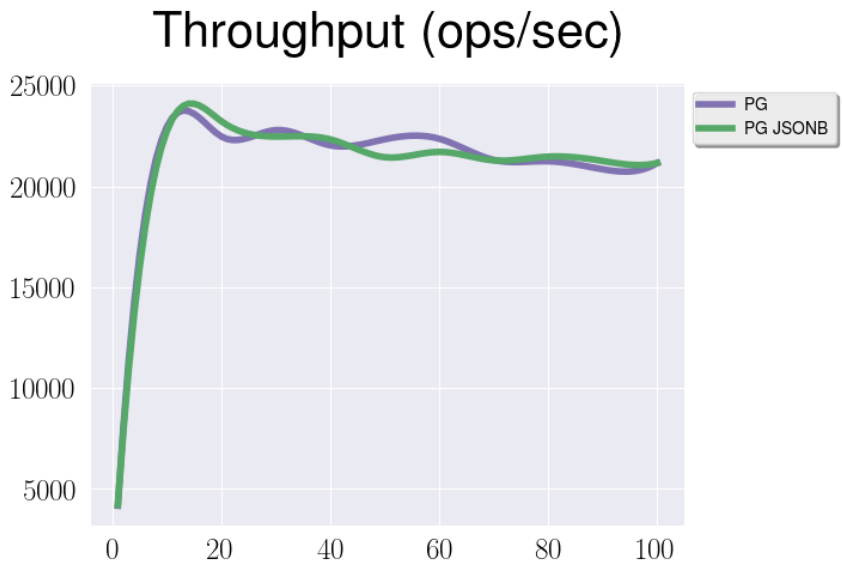
zalando

SQL vs JSONB

”simple” document

btree

select


Throughput (ops/sec)
25000
20000
15000
10000
5000
0
20
40
60
80
100
PG
PG JSONB

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How to bring it down acci-dentally?

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- ➔ Update one field of a document
- ➔ DETOAST of a document
  (select, constraints, procedures etc.)
- ➔ Reindex of an entire document

Document slice

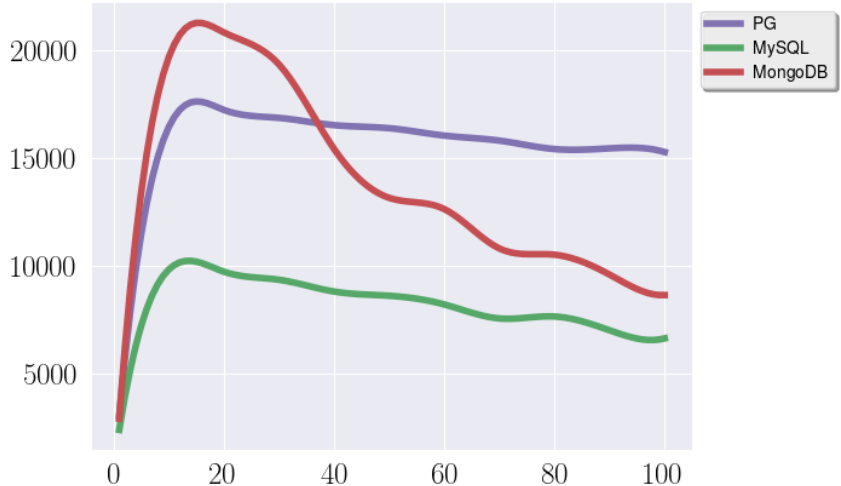
”large” document

One field from a document

```
select data→'key1'→'key2' from table;

select data→'key1', data→'key2' from table;
```

Throughput (ops/sec)



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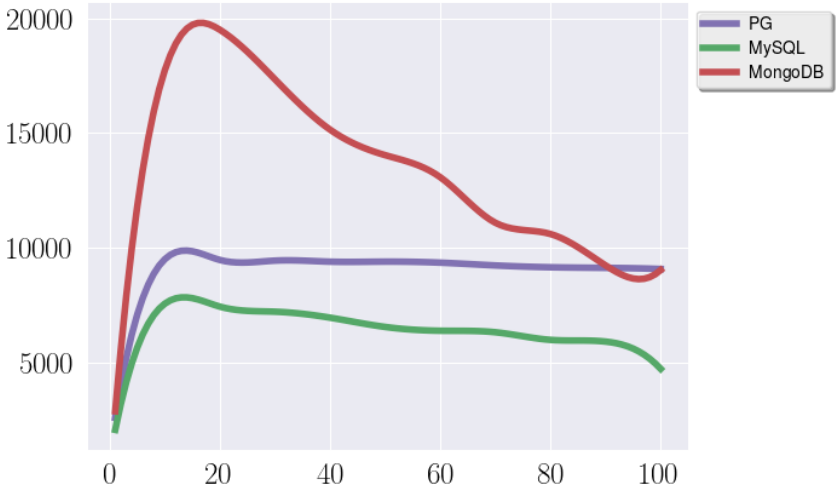
Document slice

”large” document

10 fields from a document

Throughput (ops/sec)



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Document slice

```
create type test as ("a" text, "b" text);
insert into test_jsonb
values('{"a": 1, "b": 2, "c": 3}');
select q.* from test_jsonb,
jsonb_populate_record(NULL::test, data) as q;
 a | b
---+---
 1 | 2
(1 row)
```


SET STORAGE EXTERNAL

TOAST_TUPLE_THRESHOLD

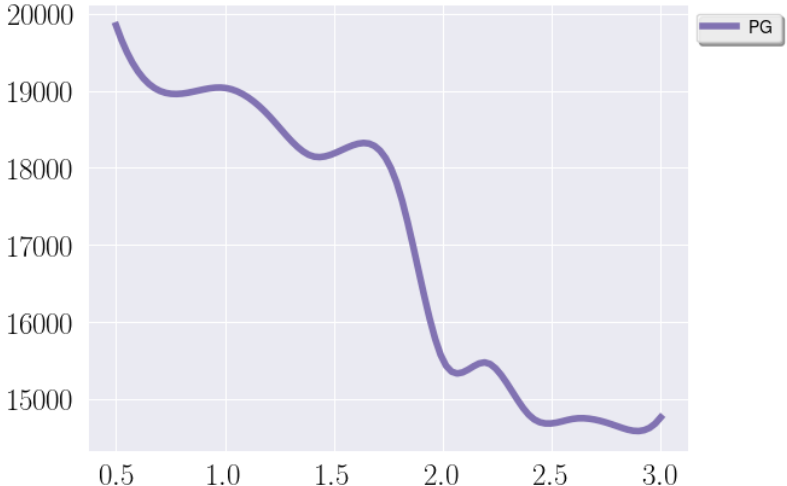
”simple” document

40 threads

different document size

select

Throughput, 40 clients



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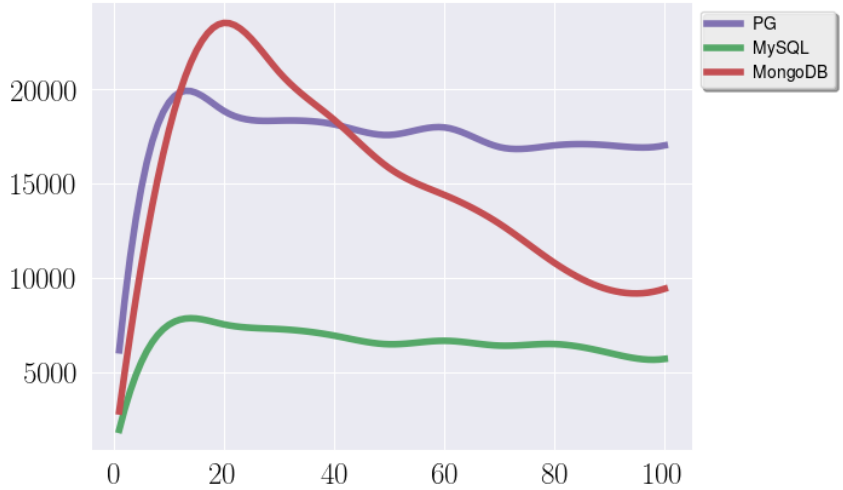
Select, GIN

”simple” document

jsonb_path_ops

where data @> jsonb_build_object(’key’, ’value’)

Throughput (ops/sec)



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➔ Jsonb is more that good for many use cases

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- ➔ Benchmarks above are only ”hints”

- ➔ Jsonb is more that good for many use cases
- ➔ Benchmarks above are only ”hints”
- ➔ You need your own tests

Questions?

 github.com/erthalion

 @erthalion

 9erthalion6 at gmail dot com

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```
[{
    "items": [
        {"id": 3, "value": "ccc"},
        {"id": 4, "value": "ddd"}
    ]
}, {
    "items": [
        {"id": 1, "value": "aaa"},
        {"id": 2, "value": "bbb"}
    ]
}]
```

```
UPDATE test
SET data = jsonb_set(data, '{items}',
(SELECT
    jsonb_agg(
        CASE WHEN item->'value' = 'aaa'
        THEN jsonb_set(item, '{value}', '"NEW"')
        ELSE item END
    )
    FROM (SELECT
        jsonb_array_elements(data->'items')
        AS item) q));
```

Scalability

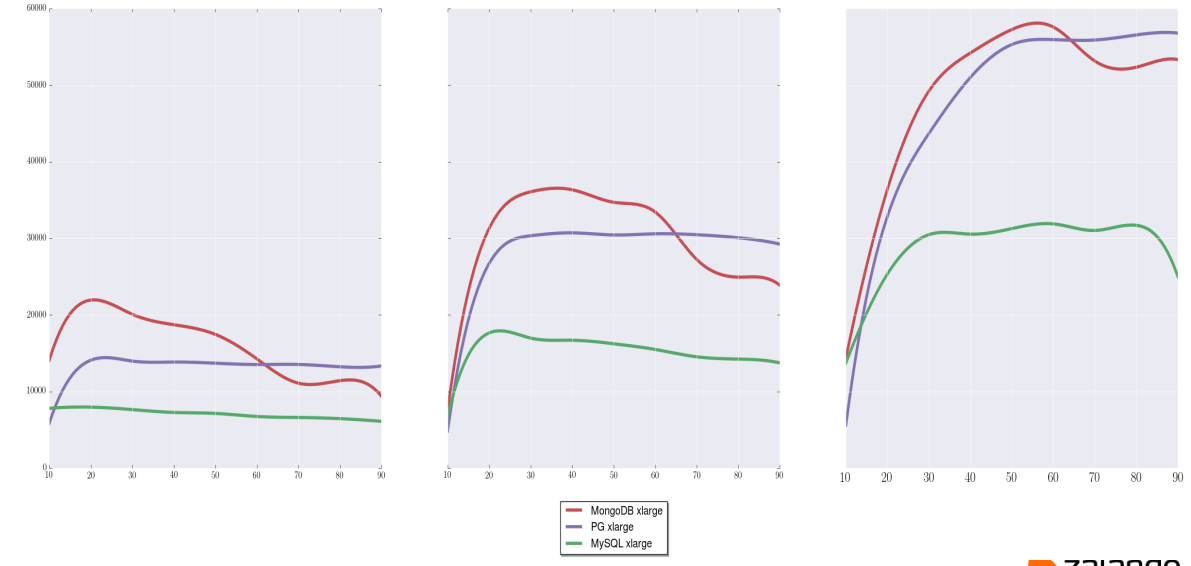
”simple” document

m4.large

m4.xlarge

m4.2xlarge

Throughput (ops/sec)



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