



# The Neo4j Cypher Manual v4.2

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*This is the Cypher manual for Neo4j version 4.2, authored by the Neo4j Team.*

This manual covers the following areas:

- [Introduction](#) — Introducing the Cypher query language.
- [Syntax](#) — Learn Cypher query syntax.
- [Clauses](#) — Reference of Cypher query clauses.
- [Functions](#) — Reference of Cypher query functions.
- [Administration](#) — Working with databases, indexes, constraints and security in Cypher.
- [Query tuning](#) — Learn to analyze queries and tune them for performance.
- [Execution plans](#) — Cypher execution plans and operators.
- [Deprecations, additions and compatibility](#) — An overview of language developments across versions.
- [Glossary of keywords](#) — A glossary of Cypher keywords, with links to other parts of the Cypher manual.
- [Cypher styleguide](#) — A guide to the recommended style for writing Cypher queries.

*Who should read this?*

This manual is written for the developer of a Neo4j client application.

# Chapter 1. Introduction

This section provides an introduction to the Cypher query language.

- [What is Cypher?](#)
- [Neo4j databases and graphs](#)
- [Querying, updating and administering](#)
- [Transactions](#)
- [Result uniqueness](#)

## 1.1. What is Cypher?

Cypher is a declarative graph query language that allows for expressive and efficient [querying](#), [updating](#) and [administering](#) of the graph. It is designed to be suitable for both developers and operations professionals. Cypher is designed to be simple, yet powerful; highly complicated database queries can be easily expressed, enabling you to focus on your domain, instead of getting lost in database access.

Cypher is inspired by a number of different approaches and builds on established practices for expressive querying. Many of the keywords, such as `WHERE` and `ORDER BY`, are inspired by [SQL](#). Pattern matching borrows expression approaches from [SPARQL](#). Some of the list semantics are borrowed from languages such as Haskell and Python. Cypher's constructs, based on English prose and neat iconography, make queries easy, both to write and to read.

### Structure

Cypher borrows its structure from SQL — queries are built up using various clauses.

Clauses are chained together, and they feed intermediate result sets between each other. For example, the matching variables from one `MATCH` clause will be the context that the next clause exists in.

The query language is comprised of several distinct clauses. These are discussed in more detail in the chapter on [Clauses](#).

The following are a few examples of clauses used to read from the graph:

- `MATCH`: The graph pattern to match. This is the most common way to get data from the graph.
- `WHERE`: Not a clause in its own right, but rather part of `MATCH`, `OPTIONAL MATCH` and `WITH`. Adds constraints to a pattern, or filters the intermediate result passing through `WITH`.
- `RETURN`: What to return.

Let's see `MATCH` and `RETURN` in action.

Let's create a simple example graph with the following query:

```
CREATE (john:Person {name: 'John'})
CREATE (joe:Person {name: 'Joe'})
CREATE (steve:Person {name: 'Steve'})
CREATE (sara:Person {name: 'Sara'})
CREATE (maria:Person {name: 'Maria'})
CREATE (john)-[:FRIEND]->(joe)-[:FRIEND]->(steve)
CREATE (john)-[:FRIEND]->(sara)-[:FRIEND]->(maria)
```

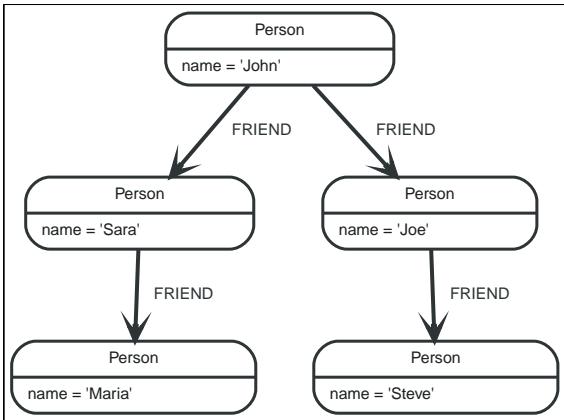


Figure 1. Example Graph

For example, here is a query which finds a user called '**John**' and '**John's**' friends (though not his direct friends) before returning both '**John**' and any friends-of-friends that are found.

```

MATCH (john {name: 'John'})-[:FRIEND]->()-[:FRIEND]->(fof)
RETURN john.name, fof.name

```

Resulting in:

john.name	fof.name
"John"	"Maria"
"John"	"Steve"

2 rows

Next up we will add filtering to set more parts in motion:

We take a list of user names and find all nodes with names from this list, match their friends and return only those followed users who have a 'name' property starting with 'S'.

```

MATCH (user)-[:FRIEND]->(follower)
WHERE user.name IN ['Joe', 'John', 'Sara', 'Maria', 'Steve'] AND follower.name =~ 'S.*'
RETURN user.name, follower.name

```

Resulting in:

user.name	follower.name
"Joe"	"Steve"
"John"	"Sara"

2 rows

And these are examples of clauses that are used to update the graph:

- **CREATE** (and **DELETE**): Create (and delete) nodes and relationships.
- **SET** (and **REMOVE**): Set values to properties and add labels on nodes using **SET** and use **REMOVE** to remove them.
- **MERGE**: Match existing or create new nodes and patterns. This is especially useful together with unique constraints.

## 1.2. Neo4j databases and graphs

*This section describes databases and graphs in Neo4j.*

Cypher queries are executed against a Neo4j database, but normally apply to specific graphs. It is important to understand the meaning of these terms and exactly when a graph is not a database.

### *DBMS*

A Neo4j Database Management System is capable of containing and managing multiple graphs contained in databases. Client applications will connect to the DBMS and open sessions against it. A client session provides access to any graph in the DBMS.

### *Graph*

This is a data model within a database. Normally there is only one graph within each database, and many [administrative](#) commands that refer to a specific graph do so using the database name.

Cypher queries executed in a session may declare which graph they apply to, or use a default, given by the session.

In Neo4j Fabric it is possible to refer to multiple graphs within the same query.

### *Database*

A database is a storage and retrieval mechanism for collecting data in a defined space on disk and in memory.

Most of the time Cypher queries are [reading or updating queries](#) which are run against a graph. There are, however, [administrative](#) commands that apply to a database, or to the entire DBMS. Such commands cannot be run in a session connected to a normal user database, but instead need to be run within a session connected to the special *system* database.

More on this requirement is described in the chapter on [Administration](#).

### 1.2.1. The system database and the default database

All Neo4j servers will contain a built-in database called `system` which behaves differently than all other databases. This database stores system data and you can not perform graph queries against it.

A fresh installation of Neo4j will include two databases:

- `system` - the system database described above, containing meta-data on the DBMS and security configuration.
- `neo4j` - the default database, named using the config option `dbms.default_database=neo4j`.

### 1.2.2. Different editions of Neo4j

Neo4j has two editions, a commercial Enterprise Edition with additional performance and administrative features, and an open-source Community Edition. Cypher works almost identically between the two editions, and as such most of this manual will not differentiate between them. In the few cases where there is a difference in Cypher language support or behaviour between editions, these are highlighted as described below in [Limited Support Features](#).

However it is worth listing up-front the key areas that are not supported in the open-source edition:

Feature	Enterprise	Community
<a href="#">Multi-database</a>	Any number of user databases	Only <code>system</code> and one user database

Feature	Enterprise	Community
Role-based security	User, Role and Privilege management for flexible access control and sub-graph access control.	Multi-user management. All users have full access rights.
Constraints	Existence constraints and multi-property NODE KEY constraints.	Only single property uniqueness constraints

### 1.2.3. Limited Support Features

Some elements of Cypher do not work in all deployments of Neo4j, and we use specific markers to highlight these cases:

Marker	Description	Example
<code>deprecated</code>	This feature is deprecated and will be removed in a future version	<code>DROP INDEX ON :Label(property)</code>
<code>enterprise-only</code>	This feature only works in the enterprise edition of Neo4j	<code>CREATE DATABASE foo</code>
<code>fabric</code>	This feature only works in a fabric deployment of Neo4j.	<code>USE fabric.graph(0)</code>

## 1.3. Querying, updating and administering

*This section describes using Cypher for both querying and updating your graph, as well as administering graphs and databases.*

In the [introduction](#) we described the common case of using Cypher to perform read-only queries of the graph. However, it is also possible to use Cypher to perform updates to the graph, import data into the graph, and perform administrative actions on graphs, databases and the entire DBMS.

All these various options are described in more detail in later sections, but it is worth summarizing a few key points first.

### 1.3.1. The structure of administrative queries

Cypher administrative queries cannot be combined with normal reading and writing queries. Each administrative query will perform either an update action to the `system` or a read of status information from the `system`. Some administrative commands make changes to a specific database, and will therefore be possible to run only when connected to the database of interest. Others make changes to the state of the entire DBMS and can only be run against the special `system` database. All administrative queries are described in more detail in the section on [Administration](#).

### 1.3.2. The structure of update queries

If you read from the graph and then update the graph, your query implicitly has two parts — the reading is the first part, and the writing is the second part.



A Cypher query part can either read and match on the graph, or make updates on it, not both simultaneously.

If your query only performs reads, Cypher will not actually match the pattern until you ask for the results. In an updating query, the semantics are that *all* the reading will be done before any writing is performed.

The only pattern where the query parts are implicit is when you first read and then write — any other order and you have to be explicit about your query parts. The parts are separated using the `WITH` statement. `WITH` is like an event horizon — it's a barrier between a plan and the finished execution of that plan.

When you want to filter using aggregated data, you have to chain together two reading query parts — the first one does the aggregating, and the second filters on the results coming from the first one.

```
MATCH (n {name: 'John'})-[:FRIEND]-(friend)
WITH n, count(friend) AS friendsCount
WHERE friendsCount > 3
RETURN n, friendsCount
```

Using `WITH`, you specify how you want the aggregation to happen, and that the aggregation has to be finished before Cypher can start filtering.

Here's an example of updating the graph, writing the aggregated data to the graph:

```
MATCH (n {name: 'John'})-[:FRIEND]-(friend)
WITH n, count(friend) AS friendsCount
SET n.friendsCount = friendsCount
RETURN n.friendsCount
```

You can chain together as many query parts as the available memory permits.

### 1.3.3. Returning data

Any query can return data. If a query only reads, it has to return data. If a read-query doesn't return any data, it serves no purpose, and is therefore not a valid Cypher query. Queries that update the graph don't have to return anything, but they can.

After all the parts of the query comes one final `RETURN` clause. `RETURN` is not part of any query part — it is a period symbol at the end of a query. The `RETURN` clause has three sub-clauses that come with it: `SKIP/LIMIT` and `ORDER BY`.

If you return nodes or relationships from a query that has just deleted them — beware, you are holding a pointer that is no longer valid.

## 1.4. Transactions

*This section describes how Cypher queries work with database transactions.*

All Cypher statements are explicitly run within a transaction. For read-only queries, the transaction will always succeed. For updating queries it is possible that a failure can occur for some reason, for example if the query attempts to violate a constraint, in which case the entire transaction is rolled back, and no changes are made to the graph. Every statement is executed within the context of the transaction, and nothing will be persisted to disk until that transaction is successfully committed.

In short, an updating query will always either fully succeed, or not succeed at all.

While it is not possible to run a Cypher query outside a transaction, it is possible to run multiple queries within a single transaction using the following sequence of operations:

1. Open a transaction,
2. Run multiple updating Cypher queries.

### 3. Commit all of them in one go.

Note that the transaction will hold the changes in memory until the whole query, or whole set of queries, has finished executing. A query that makes a large number of updates will consequently use large amounts of memory. For memory configuration in Neo4j, see the [Neo4j Operations Manual](#)  $\square$  [Memory configuration](#).

For examples of the API's used to start and commit transactions, refer to the API specific documentation:

- For information on using transactions with a Neo4j driver, see the [Neo4j Driver manual](#)  $\square$  [The session API](#).
- For information on using transactions over the HTTP API, see the [HTTP API documentation](#)  $\square$  [Using the HTTP API](#).
- For information on using transactions within the embedded Core API, see the [Java Reference](#)  $\square$  [Executing Cypher queries from Java](#).

When writing procedures or using Neo4j embedded, remember that all iterators returned from an execution result should be either fully exhausted or closed. This ensures that the resources bound to them are properly released.

#### 1.4.1. DBMS Transactions

Beginning a transaction while connected to a DBMS will start a DBMS-level transaction. A DBMS-level transaction is a container for database transactions.

A database transaction is started when the first query to a specific database is issued. Database transactions opened inside a DBMS-level transaction are committed or rolled back when the DBMS-level transaction is committed or rolled back.

For an example of how queries to multiple databases can be issued in one transaction, see [Driver Manual](#)  $\square$  [Databases and execution context](#).

DBMS transactions have the following limitations:

- Only one database can be written to in a DBMS transaction
- Cypher operations fall into the following main categories:
  - $\square$  Operations on graphs.
  - $\square$  Schema commands.
  - $\square$  Administration commands.

It is not possible to combine any of these workloads in a single DBMS transaction.

## 1.5. Cypher Result Uniqueness

While pattern matching, Neo4j Cypher makes sure to not include matches where the same graph relationship is found multiple times in a single path matching a particular pattern. This is called *relationship isomorphism* and is a very effective way of reducing the result set size and preventing infinite traversals. To understand this better, let's consider a few alternative options for uniqueness:

- *homomorphism*
  - $\square$  No uniqueness checks are made. If the query is looking for paths of length `n` and the graph is composed of only two nodes `a` and `b`, connected by one relationship, a path of length `n` will be returned repeating the two nodes over and over. For example `MATCH p=()-[*5]-() RETURN nodes(p)` could return `[a,b,a,b,a,b]` as well as `[b,a,b,a,b,a]`.

- *node isomorphism*

- The same node cannot be returned more than once in the same result record. In the above two-node example, only paths of length 1 can be found. The path [a,b,a] would be filtered out because of duplication of node b, as would any other paths longer than length 1.

- *relationship isomorphism*

- The same relationship cannot be returned more than once in the same result record. In the above two-node example, only paths of length 1 can be found. The single relationship between a and b can only exist once in the path result.

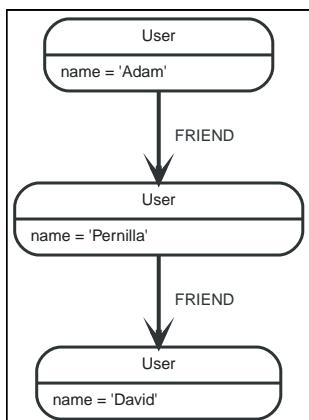
As can be seen in the above examples, in the case of variable length pattern expressions, it is particularly important to have a uniqueness check, or an infinite number of result records could be found.

Cypher makes use of *relationship isomorphism*. For example: looking for a user's friends of friends should not return said user.

To demonstrate this, let's create a few nodes and relationships:

```
CREATE (adam:User { name: 'Adam' }),(pernilla:User { name: 'Pernilla' }),(david:User { name: 'David' }),
(adam)-[:FRIEND]->(pernilla),(pernilla)-[:FRIEND]->(david)
```

Which gives us the following graph:



Now let's look for friends of friends of Adam:

```
MATCH (user:User { name: 'Adam' })-[r1:FRIEND]-()-[r2:FRIEND]-(friend_of_a_friend)
RETURN friend_of_a_friend.name AS fofName
```

fofName
"David"

1 row

In this query, Cypher makes sure to not return matches where the pattern relationships r1 and r2 point to the same graph relationship.

This is however not always desired. If the query should return the user, it is possible to spread the matching over multiple **MATCH** clauses, like so:

```
MATCH (user:User { name: 'Adam' })-[r1:FRIEND]-(friend)
MATCH (friend)-[r2:FRIEND]-(friend_of_a_friend)
RETURN friend_of_a_friend.name AS fofName
```

```
+-----+
| fofName |
+-----+
| "David" |
| "Adam"   |
+-----+
2 rows
```

Note that while the following query looks similar to the previous one, it is actually equivalent to the one before.

```
MATCH (user:User { name: 'Adam' })-[r1:FRIEND]-(friend),(friend)-[r2:FRIEND]-(friend_of_a_friend)
RETURN friend_of_a_friend.name AS fofName
```

Here, the **MATCH** clause has a single pattern with two paths, while the previous query has two distinct patterns.

```
+-----+
| fofName |
+-----+
| "David" |
+-----+
1 row
```

# Chapter 2. Syntax

This section describes the syntax of the Cypher query language.

- [Values and types](#)
- [Naming rules and recommendations](#)
- [Expressions](#)
  - [Expressions in general](#)
  - [Note on string literals](#)
  - [CASE Expressions](#)
- [Variables](#)
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  - [Ordering and comparison of values](#)
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  - [Patterns for nodes](#)
  - [Patterns for related nodes](#)

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## 2.1. Values and types

Cypher provides first class support for a number of data types.

These fall into several categories which will be described in detail in the following subsections:

- Property types
- Structural types
- Composite types

### 2.1.1. Property types

- Can be returned from Cypher queries
- Can be used as [parameters](#)
- Can be stored as properties
- Can be constructed with [Cypher literals](#)

Property types comprise:

- Number, an abstract type, which has the subtypes *Integer* and *Float*
- String
- Boolean
- The spatial type *Point*
- Temporal types: *Date*, *Time*, *LocalTime*, *DateTime*, *LocalDateTime* and *Duration*

The adjective *numeric*, when used in the context of describing Cypher functions or expressions, indicates that any type of Number applies (Integer or Float).

Homogeneous lists of simple types can also be stored as properties, although lists in general (see [Composite types](#)) cannot be stored.

Cypher also provides pass-through support for byte arrays, which can be stored as property values. Byte arrays are *not* considered a first class data type by Cypher, so do not have a literal representation.

### *Sorting of special characters*

Strings that contain characters that do not belong to the [Basic Multilingual Plane](#) ([BMP](#)) can have inconsistent or non-deterministic ordering in Neo4j. BMP is a subset of all characters defined in Unicode. Expressed simply, it contains all common characters from all common languages.



The most significant characters *not* in BMP are those belonging to the [Supplementary Multilingual Plane](#) or the [Supplementary Ideographic Plane](#). Examples are:

- Historic scripts and symbols and notation used within certain fields such as: Egyptian hieroglyphs, modern musical notation, mathematical alphanumerics.
- Emojis and other pictographic sets.
- Game symbols for playing cards, Mah Jongg, and dominoes.
- CJK Ideograph that were not included in earlier character encoding standards.

## 2.1.2. Structural types

- Can be returned from Cypher queries
- Cannot be used as [parameters](#)
- Cannot be stored as properties
- Cannot be constructed with [Cypher literals](#)

Structural types comprise:

- Nodes, comprising:
  - Id
  - Label(s)
  - Map (of properties)
- Relationships, comprising:
  - Id
  - Type
  - Map (of properties)
  - Id of the start and end nodes
- Paths
  - An alternating sequence of nodes and relationships



Nodes, relationships, and paths are returned as a result of pattern matching.



Labels are not values but are a form of pattern syntax.

## 2.1.3. Composite types

- Can be returned from Cypher queries
- Can be used as [parameters](#)
- Cannot be stored as properties
- Can be constructed with [Cypher literals](#)

Composite types comprise:

- **Lists** are heterogeneous, ordered collections of values, each of which has any property, structural or composite type.
- **Maps** are heterogeneous, unordered collections of (key, value) pairs, where:
  - the key is a String
  - the value has any property, structural or composite type



Composite values can also contain `null`.

Special care must be taken when using `null` (see [Working with null](#)).

## 2.2. Naming rules and recommendations

This section describes rules and recommendations for the naming of node labels, relationship types, property names, [variables](#), indexes and constraints.

### 2.2.1. Naming rules

- Alphabetic characters:
  - Names should begin with an alphabetic character.
  - This includes "non-English" characters, such as å, ä, ö, ü etc.
- Numbers:
  - Names should not begin with a number.
  - To illustrate, `1first` is not allowed, whereas `first1` is allowed.
- Symbols:
  - Names should not contain symbols, except for underscore, as in `my_variable`, or \$ as the first character to denote a [parameter](#), as given by `$myParam`.
- Length:
  - Can be very long, up to `65535` ( $2^{16} - 1$ ) or `65534` characters, depending on the version of Neo4j.
- Case-sensitive:
  - Names are case-sensitive and thus, `:PERSON`, `:Person` and `:person` are three different labels, and `n` and `N` are two different variables.
- Whitespace characters:
  - Leading and trailing whitespace characters will be removed automatically. For example, `MATCH ( a ) RETURN a` is equivalent to `MATCH (a) RETURN a`.



Non-alphabetic characters, including numbers, symbols and whitespace characters, **can** be used in names, but **must** be escaped using backticks. For example: ``^n``, ``1first``, ``$n``, and ``my variable has spaces``. Database names are an exception and may include dots without the need for escaping. For example: naming a database `foo.bar.baz` is perfectly valid.

## 2.2.2. Scoping and namespace rules

- Node labels, relationship types and property names may re-use names.
  - The following query — with `a` for the label, type and property name — is valid: `CREATE (a:a {a: 'a'})-[r:a]-(b:a {a: 'a'})`.
- Variables for nodes and relationships must not re-use names within the same query scope.
  - The following query is not valid as the node and relationship both have the name `a`: `CREATE (a)-[a]-(b)`.

## 2.2.3. Recommendations

Here are the recommended naming conventions:

Node labels	Camel-case, beginning with an upper-case character	<code>:VehicleOwner</code> rather than <code>:vehicle_owner</code> etc.
Relationship types	Upper-case, using underscore to separate words	<code>:OWNS_VEHICLE</code> rather than <code>:ownsVehicle</code> etc.

## 2.3. Expressions

- [Expressions in general](#)
- [Note on string literals](#)
- [CASE expressions](#)
  - Simple CASE form: comparing an expression against multiple values
  - Generic CASE form: allowing for multiple conditionals to be expressed
  - Distinguishing between when to use the simple and generic CASE forms

### 2.3.1. Expressions in general



Most expressions in Cypher evaluate to `null` if any of their inner expressions are `null`. Notable exceptions are the operators `IS NULL` and `IS NOT NULL`.

An expression in Cypher can be:

- A decimal (integer or float) literal: `13`, `-40000`, `3.14`, `6.022E23`.
- A hexadecimal integer literal (starting with `0x`): `0x13af`, `0xFC3A9`, `-0x66eff`.
- An octal integer literal (starting with `0o` or `0`): `0o1372`, `02127`, `-0o5671`.
- A string literal: `'Hello'`, `"World"`.
- A boolean literal: `true`, `false`, `TRUE`, `FALSE`.
- A variable: `n`, `x`, `rel`, `myFancyVariable`, `'A name with weird stuff in it[]!'`.
- A property: `n.prop`, `x.prop`, `rel.thisProperty`, `myFancyVariable.'(weird property name)'`.
- A dynamic property: `n["prop"]`, `rel[n.city + n.zip]`, `map[coll[0]]`.
- A parameter: `$param`, `$0`
- A list of expressions: `['a', 'b'], [1, 2, 3], ['a', 2, n.property, $param], [ ]`.
- A function call: `length(p)`, `nodes(p)`.
- An aggregate function: `avg(x.prop)`, `count(*)`.

- A path-pattern: `(a)-->()<--(b)`.
- An operator application: `1 + 2` and `3 < 4`.
- A predicate expression is an expression that returns true or false: `a.prop = 'Hello', length(p) > 10, exists(a.name)`.
- An existential subquery is an expression that returns true or false: `EXISTS { MATCH (n)-[r]-(p) WHERE p.name = 'Sven' }`.
- A regular expression: `a.name =~ 'Tim.*'`
- A case-sensitive string matching expression: `a.surname STARTS WITH 'Sven', a.surname ENDS WITH 'son' or a.surname CONTAINS 'son'`
- A `CASE` expression.

### 2.3.2. Note on string literals

String literals can contain the following escape sequences:

Escape sequence	Character
<code>\t</code>	Tab
<code>\b</code>	Backspace
<code>\n</code>	Newline
<code>\r</code>	Carriage return
<code>\f</code>	Form feed
<code>\'</code>	Single quote
<code>\"</code>	Double quote
<code>\\"</code>	Backslash
<code>\uxxxx</code>	Unicode UTF-16 code point (4 hex digits must follow the <code>\u</code> )
<code>\Uxxxxxxxxx</code>	Unicode UTF-32 code point (8 hex digits must follow the <code>\U</code> )

### 2.3.3. `CASE` expressions

Generic conditional expressions may be expressed using the well-known `CASE` construct. Two variants of `CASE` exist within Cypher: the simple form, which allows an expression to be compared against multiple values, and the generic form, which allows multiple conditional statements to be expressed.

The following graph is used for the examples below:

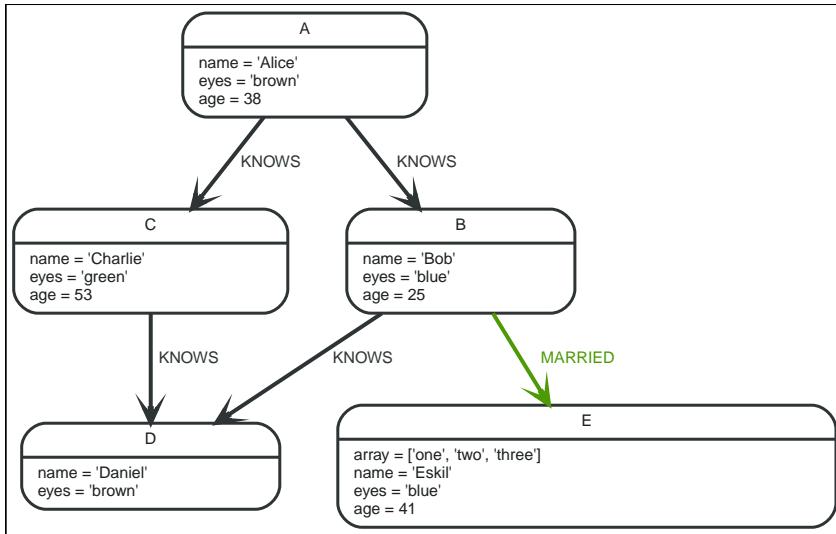


Figure 2. Graph

Simple **CASE** form: comparing an expression against multiple values

The expression is calculated, and compared in order with the **WHEN** clauses until a match is found. If no match is found, the expression in the **ELSE** clause is returned. However, if there is no **ELSE** case and no match is found, **null** will be returned.

**Syntax:**

```
CASE test
  WHEN value THEN result
  [WHEN ...]
  [ELSE default]
END
```

**Arguments:**

Name	Description
test	A valid expression.
value	An expression whose result will be compared to <b>test</b> .
result	This is the expression returned as output if <b>value</b> matches <b>test</b> .
default	If no match is found, <b>default</b> is returned.

**Query**

```
MATCH (n)
RETURN
CASE n.eyes
WHEN 'blue'
THEN 1
WHEN 'brown'
THEN 2
ELSE 3 END AS result
```

Table 1. Result

result
2
1

result
3
2
1
5 rows

Generic **CASE** form: allowing for multiple conditionals to be expressed

The predicates are evaluated in order until a **true** value is found, and the result value is used. If no match is found, the expression in the **ELSE** clause is returned. However, if there is no **ELSE** case and no match is found, **null** will be returned.

#### Syntax:

```
CASE
WHEN predicate THEN result
  [WHEN ...]
  [ELSE default]
END
```

#### Arguments:

Name	Description
<b>predicate</b>	A predicate that is tested to find a valid alternative.
<b>result</b>	This is the expression returned as output if <b>predicate</b> evaluates to <b>true</b> .
<b>default</b>	If no match is found, <b>default</b> is returned.

#### Query

```
MATCH (n)
RETURN
CASE
WHEN n.eyes = 'blue'
THEN 1
WHEN n.age < 40
THEN 2
ELSE 3 END AS result
```

Table 2. Result

result
2
1
3
3
1
5 rows

Distinguishing between when to use the simple and generic **CASE** forms

Owing to the close similarity between the syntax of the two forms, sometimes it may not be clear at the outset as to which form to use. We illustrate this scenario by means of the following query, in

which there is an expectation that `age_10_years_ago` is `-1` if `n.age` is `null`:

### Query

```
MATCH (n)
RETURN n.name,
CASE n.age
WHEN n.age IS NULL THEN -1
ELSE n.age - 10 END AS age_10_years_ago
```

However, as this query is written using the simple `CASE` form, instead of `age_10_years_ago` being `-1` for the node named `Daniel`, it is `null`. This is because a comparison is made between `n.age` and `n.age IS NULL`. As `n.age IS NULL` is a boolean value, and `n.age` is an integer value, the `WHEN n.age IS NULL THEN -1` branch is never taken. This results in the `ELSE n.age - 10` branch being taken instead, returning `null`.

Table 3. Result

n.name	age_10_years_ago
"Alice"	28
"Bob"	15
"Charlie"	43
"Daniel"	<null>
"Eskil"	31
5 rows	

The corrected query, behaving as expected, is given by the following generic `CASE` form:

### Query

```
MATCH (n)
RETURN n.name,
CASE
WHEN n.age IS NULL THEN -1
ELSE n.age - 10 END AS age_10_years_ago
```

We now see that the `age_10_years_ago` correctly returns `-1` for the node named `Daniel`.

Table 4. Result

n.name	age_10_years_ago
"Alice"	28
"Bob"	15
"Charlie"	43
"Daniel"	-1
"Eskil"	31
5 rows	

## 2.4. Variables

When you reference parts of a pattern or a query, you do so by naming them. The names you give the different parts are called variables.

In this example:

```
MATCH (n)-->(b)
RETURN b
```

The variables are `n` and `b`.

Information regarding the naming of variables may be found [here](#).



*Variables are only visible in the same query part*

Variables are not carried over to subsequent queries. If multiple query parts are chained together using `WITH`, variables have to be listed in the `WITH` clause to be carried over to the next part. For more information see [WITH](#).

## 2.5. Reserved keywords

We provide here a listing of reserved words, grouped by the categories from which they are drawn, all of which have a special meaning in Cypher. In addition to this, we list a number of words that are reserved for future use.

These reserved words are not permitted to be used as identifiers in the following contexts:

- Variables
- Function names
- Parameters

If any reserved keyword is escaped — i.e. is encapsulated by backticks ` , such as `AND` — it would become a valid identifier in the above contexts.

### 2.5.1. Clauses

- `CALL`
- `CREATE`
- `DELETE`
- `DETACH`
- `EXISTS`
- `FOREACH`
- `LOAD`
- `MATCH`
- `MERGE`
- `OPTIONAL`
- `REMOVE`
- `RETURN`
- `SET`
- `START`
- `UNION`
- `UNWIND`
- `WITH`

## 2.5.2. Subclauses

- LIMIT
- ORDER
- SKIP
- WHERE
- YIELD

## 2.5.3. Modifiers

- ASC
- ASCENDING
- ASSERT
- BY
- CSV
- DESC
- DESCENDING
- ON

## 2.5.4. Expressions

- ALL
- CASE
- ELSE
- END
- THEN
- WHEN

## 2.5.5. Operators

- AND
- AS
- CONTAINS
- DISTINCT
- ENDS
- IN
- IS
- NOT
- OR
- STARTS
- XOR

## 2.5.6. Schema

- `CONSTRAINT`
- `CREATE`
- `DROP`
- `EXISTS`
- `INDEX`
- `NODE`
- `KEY`
- `UNIQUE`

## 2.5.7. Hints

- `INDEX`
- `JOIN`
- `PERIODIC`
- `COMMIT`
- `SCAN`
- `USING`

## 2.5.8. Literals

- `false`
- `null`
- `true`

## 2.5.9. Reserved for future use

- `ADD`
- `DO`
- `FOR`
- `MANDATORY`
- `OF`
- `REQUIRE`
- `SCALAR`

## 2.6. Parameters

- [Introduction](#)
- [String literal](#)
- [Regular expression](#)
- [Case-sensitive string pattern matching](#)
- [Create node with properties](#)
- [Create multiple nodes with properties](#)

- [Setting all properties on a node](#)
- [SKIP and LIMIT](#)
- [Node id](#)
- [Multiple node ids](#)
- [Calling procedures](#)

## 2.6.1. Introduction

Cypher supports querying with parameters. This means developers don't have to resort to string building to create a query. Additionally, parameters make caching of execution plans much easier for Cypher, thus leading to faster query execution times.

Parameters can be used for:

- literals and expressions
- node and relationship ids

Parameters cannot be used for the following constructs, as these form part of the query structure that is compiled into a query plan:

- property keys; so, `MATCH (n) WHERE n.$param = 'something'` is invalid
- relationship types
- labels

Parameters may consist of letters and numbers, and any combination of these, but cannot start with a number or a currency symbol.

Setting parameters when running a query is dependent on the client environment. For example:

- To set a parameter in Cypher Shell use `:param name 'Joe'`. For more information refer to [Operations Manual](#) □ [Cypher Shell - Query Parameters](#).
- For Neo4j Browser use the same syntax as Cypher Shell, `:param name 'Joe'`.
- When using drivers, the syntax is dependent on the language choice. See the examples in [Driver Manual](#) □ [Transactions](#).
- For usage via the Neo4j HTTP API, see the [HTTP API documentation](#).

We provide below a comprehensive list of examples of parameter usage. In these examples, parameters are given in JSON; the exact manner in which they are to be submitted depends upon the driver being used.



The old parameter syntax `{param}` was deprecated in Neo4j 3.0 and removed entirely in Neo4j 4.0. Using it will result in a syntax error. However, it is still possible to use it, with warnings, if you prefix the query with `CYPHER 3.5`. See [Cypher Compatibility](#) for further information.

## 2.6.2. String literal

### Parameters

```
{
  "name" : "Johan"
}
```

## Query

```
MATCH (n:Person)
WHERE n.name = $name
RETURN n
```

You can use parameters in this syntax as well:

## Parameters

```
{
  "name" : "Johan"
}
```

## Query

```
MATCH (n:Person { name: $name })
RETURN n
```

## 2.6.3. Regular expression

### Parameters

```
{
  "regex" : ".*h.*"
}
```

## Query

```
MATCH (n:Person)
WHERE n.name =~ $regex
RETURN n.name
```

## 2.6.4. Case-sensitive string pattern matching

### Parameters

```
{
  "name" : "Michael"
}
```

## Query

```
MATCH (n:Person)
WHERE n.name STARTS WITH $name
RETURN n.name
```

## 2.6.5. Create node with properties

### Parameters

```
{
  "props" : {
    "name" : "Andy",
    "position" : "Developer"
  }
}
```

## Query

```
CREATE ($props)
```

## 2.6.6. Create multiple nodes with properties

### Parameters

```
{
  "props" : [ {
    "awesome" : true,
    "name" : "Andy",
    "position" : "Developer"
  }, {
    "children" : 3,
    "name" : "Michael",
    "position" : "Developer"
  } ]
}
```

## Query

```
UNWIND $props AS properties
CREATE (n:Person)
SET n = properties
RETURN n
```

## 2.6.7. Setting all properties on a node

Note that this will replace all the current properties.

### Parameters

```
{
  "props" : {
    "name" : "Andy",
    "position" : "Developer"
  }
}
```

## Query

```
MATCH (n:Person)
WHERE n.name='Michaela'
SET n = $props
```

## 2.6.8. SKIP and LIMIT

### Parameters

```
{
  "s" : 1,
  "l" : 1
}
```

## Query

```
MATCH (n:Person)
RETURN n.name
SKIP $s
LIMIT $l
```

## 2.6.9. Node id

### Parameters

```
{  
  "id" : 0  
}
```

### Query

```
MATCH (n)  
WHERE id(n)= $id  
RETURN n.name
```

## 2.6.10. Multiple node ids

### Parameters

```
{  
  "ids" : [ 0, 1, 2 ]  
}
```

### Query

```
MATCH (n)  
WHERE id(n) IN $ids  
RETURN n.name
```

## 2.6.11. Calling procedures

### Parameters

```
{  
  "indexname" : "My index"  
}
```

### Query

```
CALL db.resampleIndex($indexname)
```

## 2.7. Operators

- Operators at a glance
- Aggregation operators
  - Using the DISTINCT operator
- Property operators
  - Statically accessing a property of a node or relationship using the . operator
  - Filtering on a dynamically-computed property key using the [] operator
  - Replacing all properties of a node or relationship using the = operator
  - Mutating specific properties of a node or relationship using the += operator
- Mathematical operators
  - Using the exponentiation operator ^

- Using the unary minus operator -
- Comparison operators
  - Comparing two numbers
  - Using STARTS WITH to filter names
- Boolean operators
  - Using boolean operators to filter numbers
- String operators
  - Using a regular expression with =~ to filter words
- Temporal operators
  - Adding and subtracting a Duration to or from a temporal instant
  - Adding and subtracting a Duration to or from another Duration
  - Multiplying and dividing a Duration with or by a number
- Map operators
  - Statically accessing the value of a nested map by key using the . operator"
  - Dynamically accessing the value of a map by key using the [] operator and a parameter
  - Using IN with [] on a nested list
- List operators
  - Concatenating two lists using +
  - Using IN to check if a number is in a list
  - Using IN for more complex list membership operations
  - Accessing elements in a list using the [] operator
  - Dynamically accessing an element in a list using the [] operator and a parameter
- Equality and comparison of values
- Ordering and comparison of values
- Chaining comparison operations

## 2.7.1. Operators at a glance

Aggregation operators	DISTINCT
Property operators	. for static property access, [] for dynamic property access, = for replacing all properties, += for mutating specific properties
Mathematical operators	+, -, *, /, %, ^
Comparison operators	=, <>, <, >, <=, >=, IS NULL, IS NOT NULL
String-specific comparison operators	STARTS WITH, ENDS WITH, CONTAINS
Boolean operators	AND, OR, XOR, NOT
String operators	+ for concatenation, =~ for regex matching
Temporal operators	+ and - for operations between durations and temporal instants/durations, * and / for operations between durations and numbers
Map operators	. for static value access by key, [] for dynamic value access by key

## 2.7.2. Aggregation operators

The aggregation operators comprise:

- remove duplicates values: **DISTINCT**

### Using the **DISTINCT** operator

Retrieve the unique eye colors from **Person** nodes.

#### *Query*

```
CREATE (a:Person { name: 'Anne', eyeColor: 'blue' }),(b:Person { name: 'Bill', eyeColor: 'brown' })
      ,(c:Person { name: 'Carol', eyeColor: 'blue' })
WITH [a, b, c] AS ps
UNWIND ps AS p
RETURN DISTINCT p.eyeColor
```

Even though both '**Anne**' and '**Carol**' have blue eyes, '**blue**' is only returned once.

*Table 5. Result*

p.eyeColor
"blue"
"brown"
2 rows, Nodes created: 3 Properties set: 6 Labels added: 3

**DISTINCT** is commonly used in conjunction with [aggregating functions](#).

## 2.7.3. Property operators

The property operators pertain to a node or a relationship, and comprise:

- statically access the property of a node or relationship using the dot operator: `.`
- dynamically access the property of a node or relationship using the subscript operator: `[]`
- property replacement `=` for replacing all properties of a node or relationship
- property mutation operator `+=` for setting specific properties of a node or relationship

Statically accessing a property of a node or relationship using the `.` operator

#### *Query*

```
CREATE (a:Person { name: 'Jane', livesIn: 'London' }),(b:Person { name: 'Tom', livesIn: 'Copenhagen' })
WITH a, b
MATCH (p:Person)
RETURN p.name
```

*Table 6. Result*

p.name
"Jane"
"Tom"
2 rows, Nodes created: 2
Properties set: 4
Labels added: 2

Filtering on a dynamically-computed property key using the `[]` operator

#### Query

```
CREATE (a:Restaurant { name: 'Hungry Jo', rating_hygiene: 10, rating_food: 7 }), (b:Restaurant { name: 'Buttercup Tea Rooms', rating_hygiene: 5, rating_food: 6 }), (c1:Category { name: 'hygiene' }), (c2:Category { name: 'food' })
WITH a, b, c1, c2
MATCH (restaurant:Restaurant), (category:Category)
WHERE restaurant["rating_" + category.name] > 6
RETURN DISTINCT restaurant.name
```

Table 7. Result

restaurant.name
"Hungry Jo"
1 row, Nodes created: 4
Properties set: 8
Labels added: 4

See [Basic usage](#) for more details on dynamic property access.



The behavior of the `[]` operator with respect to `null` is detailed [here](#).

Replacing all properties of a node or relationship using the `=` operator

#### Query

```
CREATE (a:Person { name: 'Jane', age: 20 })
WITH a
MATCH (p:Person { name: 'Jane' })
SET p = { name: 'Ellen', livesIn: 'London' }
RETURN p.name, p.age, p.livesIn
```

All the existing properties on the node are replaced by those provided in the map; i.e. the `name` property is updated from `Jane` to `Ellen`, the `age` property is deleted, and the `livesIn` property is added.

Table 8. Result

p.name	p.age	p.livesIn
"Ellen"	<null>	"London"
1 row, Nodes created: 1		
Properties set: 5		
Labels added: 1		

See [Replace all properties using a map and =](#) for more details on using the property replacement operator `=`.

Mutating specific properties of a node or relationship using the `+ =` operator

### Query

```
CREATE (a:Person { name: 'Jane', age: 20 })
WITH a
MATCH (p:Person { name: 'Jane' })
SET p += { name: 'Ellen', livesIn: 'London' }
RETURN p.name, p.age, p.livesIn
```

The properties on the node are updated as follows by those provided in the map: the `name` property is updated from `Jane` to `Ellen`, the `age` property is left untouched, and the `livesIn` property is added.

Table 9. Result

p.name	p.age	p.livesIn
"Ellen"	20	"London"
1 row, Nodes created: 1		
Properties set: 4		
Labels added: 1		

See [Mutate specific properties using a map and `+ =`](#) for more details on using the property mutation operator `+ =`.

## 2.7.4. Mathematical operators

The mathematical operators comprise:

- addition: `+`
- subtraction or unary minus: `-`
- multiplication: `*`
- division: `/`
- modulo division: `%`
- exponentiation: `^`

Using the exponentiation operator `^`

### Query

```
WITH 2 AS number, 3 AS exponent
RETURN number ^ exponent AS result
```

Table 10. Result

result
8.0
1 row

Using the unary minus operator `-`

### Query

```
WITH -3 AS a, 4 AS b
RETURN b - a AS result
```

Table 11. Result

result
7
1 row

## 2.7.5. Comparison operators

The comparison operators comprise:

- equality: `=`
- inequality: `<>`
- less than: `<`
- greater than: `>`
- less than or equal to: `<=`
- greater than or equal to: `>=`
- `IS NULL`
- `IS NOT NULL`

String-specific comparison operators comprise:

- `STARTS WITH`: perform case-sensitive prefix searching on strings
- `ENDS WITH`: perform case-sensitive suffix searching on strings
- `CONTAINS`: perform case-sensitive inclusion searching in strings

Comparing two numbers

Query

```
WITH 4 AS one, 3 AS two
RETURN one > two AS result
```

Table 12. Result

result
true
1 row

See [Equality and comparison of values](#) for more details on the behavior of comparison operators, and [Using ranges](#) for more examples showing how these may be used.

Using `STARTS WITH` to filter names

Query

```
WITH ['John', 'Mark', 'Jonathan', 'Bill'] AS somenames
UNWIND somenames AS names
WITH names AS candidate
WHERE candidate STARTS WITH 'Jo'
RETURN candidate
```

Table 13. Result

candidate
"John"
"Jonathan"
2 rows

[String matching](#) contains more information regarding the string-specific comparison operators as well as additional examples illustrating the usage thereof.

## 2.7.6. Boolean operators

The boolean operators — also known as logical operators — comprise:

- conjunction: `AND`
- disjunction: `OR`,
- exclusive disjunction: `XOR`
- negation: `NOT`

Here is the truth table for `AND`, `OR`, `XOR` and `NOT`.

a	b	a AND b	a OR b	a XOR b	NOT a
false	false	false	false	false	true
false	null	false	null	null	true
false	true	false	true	true	true
true	false	false	true	true	false
true	null	null	true	null	false
true	true	true	true	false	false
null	false	false	null	null	null
null	null	null	null	null	null
null	true	null	true	null	null

Using boolean operators to filter numbers

*Query*

```
WITH [2, 4, 7, 9, 12] AS numberlist
UNWIND numberlist AS number
WITH number
WHERE number = 4 OR (number > 6 AND number < 10)
RETURN number
```

Table 14. Result

number
4
7
9
3 rows

## 2.7.7. String operators

The string operators comprise:

- concatenating strings: `+`
- matching a regular expression: `=~`

Using a regular expression with `=~` to filter words

*Query*

```
WITH ['mouse', 'chair', 'door', 'house'] AS wordlist
UNWIND wordlist AS word
WITH word
WHERE word =~ '.*ous.*'
RETURN word
```

*Table 15. Result*

word
"mouse"
"house"
2 rows

Further information and examples regarding the use of regular expressions in filtering can be found in [Regular expressions](#). In addition, refer to [String-specific comparison operators comprise](#): for details on string-specific comparison operators.

## 2.7.8. Temporal operators

Temporal operators comprise:

- adding a *Duration* to either a *temporal instant* or another *Duration*: `+`
- subtracting a *Duration* from either a *temporal instant* or another *Duration*: `-`
- multiplying a *Duration* with a number: `*`
- dividing a *Duration* by a number: `/`

The following table shows — for each combination of operation and operand type — the type of the value returned from the application of each temporal operator:

Operator	Left-hand operand	Right-hand operand	Type of result
<code>+</code>	Temporal instant	<i>Duration</i>	The type of the temporal instant
<code>+</code>	<i>Duration</i>	Temporal instant	The type of the temporal instant
<code>-</code>	Temporal instant	<i>Duration</i>	The type of the temporal instant
<code>+</code>	<i>Duration</i>	<i>Duration</i>	<i>Duration</i>
<code>-</code>	<i>Duration</i>	<i>Duration</i>	<i>Duration</i>
<code>*</code>	<i>Duration</i>	<i>Number</i>	<i>Duration</i>
<code>*</code>	<i>Number</i>	<i>Duration</i>	<i>Duration</i>
<code>/</code>	<i>Duration</i>	<i>Number</i>	<i>Duration</i>

## Adding and subtracting a *Duration* to or from a temporal instant

### Query

```
WITH localdatetime({ year:1984, month:10, day:11, hour:12, minute:31, second:14 }) AS aDateTime,
duration({ years: 12, nanoseconds: 2 }) AS aDuration
RETURN aDateTime + aDuration, aDateTime - aDuration
```

Table 16. Result

aDateTime + aDuration	aDateTime - aDuration
1996-10-11T12:31:14.000000002	1972-10-11T12:31:13.999999998
1 row	

Components of a *Duration* that do not apply to the temporal instant are ignored. For example, when adding a *Duration* to a *Date*, the *hours*, *minutes*, *seconds* and *nanoseconds* of the *Duration* are ignored (*Time* behaves in an analogous manner):

### Query

```
WITH date({ year:1984, month:10, day:11 }) AS aDate, duration({ years: 12, nanoseconds: 2 }) AS aDuration
RETURN aDate + aDuration, aDate - aDuration
```

Table 17. Result

aDate + aDuration	aDate - aDuration
1996-10-11	1972-10-11
1 row	

Adding two durations to a temporal instant is not an associative operation. This is because non-existing dates are truncated to the nearest existing date:

### Query

```
RETURN (date("2011-01-31") + duration("P1M")) + duration("P12M") AS date1, date("2011-01-31") + (duration("P1M") + duration("P12M")) AS date2
```

Table 18. Result

date1	date2
2012-02-28	2012-02-29
1 row	

## Adding and subtracting a *Duration* to or from another *Duration*

### Query

```
WITH duration({ years: 12, months: 5, days: 14, hours: 16, minutes: 12, seconds: 70, nanoseconds: 1 }) AS duration1,
duration({ months:1, days: -14, hours: 16, minutes: -12, seconds: 70 }) AS duration2
RETURN duration1, duration2, duration1 + duration2, duration1 - duration2
```

Table 19. Result

duration1	duration2	duration1 + duration2	duration1 - duration2
P12Y5M14DT16H13M10.000000001S	P1M-14DT15H49M10S	P12Y6MT32H2M20.000000001S	P12Y4M28DT24M0.000000001S

duration1	duration2	duration1 + duration2	duration1 - duration2
1 row			

Multiplying and dividing a *Duration* with or by a number

These operations are interpreted simply as component-wise operations with overflow to smaller units based on an average length of units in the case of division (and multiplication with fractions).

#### Query

```
WITH duration({ days: 14, minutes: 12, seconds: 70, nanoseconds: 1 }) AS aDuration
RETURN aDuration, aDuration * 2, aDuration / 3
```

Table 20. Result

aDuration	aDuration * 2	aDuration / 3
P14DT13M10.00000001S	P28DT26M20.00000002S	P4DT16H4M23.33333333S
1 row		

## 2.7.9. Map operators

The map operators comprise:

- statically access the value of a map by key using the dot operator: `.`
- dynamically access the value of a map by key using the subscript operator: `[]`



The behavior of the `[]` operator with respect to `null` is detailed in [The `\[\]` operator and `null`](#).

Statically accessing the value of a nested map by key using the `.` operator

#### Query

```
WITH { person: { name: 'Anne', age: 25 }} AS p
RETURN p.person.name
```

Table 21. Result

p.person.name
"Anne"
1 row

Dynamically accessing the value of a map by key using the `[]` operator and a parameter

A parameter may be used to specify the key of the value to access:

#### Parameters

```
{
  "myKey" : "name"
}
```

## Query

```
WITH { name: 'Anne', age: 25 } AS a
RETURN a[$myKey] AS result
```

Table 22. Result

result
"Anne"
1 row

More details on maps can be found in [Maps](#).

## 2.7.10. List operators

The list operators comprise:

- concatenating lists  $l_1$  and  $l_2$ :  $[l_1] + [l_2]$
- checking if an element  $e$  exists in a list  $l$ :  $e \text{ IN } [l]$
- dynamically accessing an element(s) in a list using the subscript operator:  $[]$



The behavior of the `IN` and `[]` operators with respect to `null` is detailed [here](#).

Concatenating two lists using `+`

## Query

```
RETURN [1,2,3,4,5]+[6,7] AS myList
```

Table 23. Result

myList
[1,2,3,4,5,6,7]
1 row

Using `IN` to check if a number is in a list

## Query

```
WITH [2, 3, 4, 5] AS numberlist
UNWIND numberlist AS number
WITH number
WHERE number IN [2, 3, 8]
RETURN number
```

Table 24. Result

number
2
3
2 rows

## Using IN for more complex list membership operations

The general rule is that the `IN` operator will evaluate to `true` if the list given as the right-hand operand contains an element which has the same *type and contents (or value)* as the left-hand operand. Lists are only comparable to other lists, and elements of a list `innerList` are compared pairwise in ascending order from the first element in `innerList` to the last element in `innerList`.

The following query checks whether or not the list `[2, 1]` is an element of the list `[1, [2, 1], 3]`:

### Query

```
RETURN [2, 1] IN [1,[2, 1], 3] AS inList
```

The query evaluates to `true` as the right-hand list contains, as an element, the list `[1, 2]` which is of the same type (a list) and contains the same contents (the numbers `2` and `1` in the given order) as the left-hand operand. If the left-hand operator had been `[1, 2]` instead of `[2, 1]`, the query would have returned `false`.

Table 25. Result

inList
<code>true</code>
1 row

At first glance, the contents of the left-hand operand and the right-hand operand *appear* to be the same in the following query:

### Query

```
RETURN [1, 2] IN [1, 2] AS inList
```

However, `IN` evaluates to `false` as the right-hand operand does not contain an element that is of the same *type* — i.e. a *list* — as the left-hand-operand.

Table 26. Result

inList
<code>false</code>
1 row

The following query can be used to ascertain whether or not a list — obtained from, say, the `labels()` function — contains at least one element that is also present in another list:

```
MATCH (n)
WHERE size([label IN labels(n) WHERE label IN ['Person', 'Employee'] | 1]) > 0
RETURN count(n)
```

As long as `labels(n)` returns either `Person` or `Employee` (or both), the query will return a value greater than zero.

## Accessing elements in a list using the `[]` operator

### Query

```
WITH ['Anne', 'John', 'Bill', 'Diane', 'Eve'] AS names
RETURN names[1..3] AS result
```

The square brackets will extract the elements from the start index 1, and up to (but excluding) the end index 3.

Table 27. Result

result
["John", "Bill"]
1 row

Dynamically accessing an element in a list using the [] operator and a parameter

A parameter may be used to specify the index of the element to access:

Parameters

```
{  
  "myIndex" : 1  
}
```

Query

```
WITH ['Anne', 'John', 'Bill', 'Diane', 'Eve'] AS names  
RETURN names[$myIndex] AS result
```

Table 28. Result

result
"John"
1 row

Using IN with [] on a nested list

IN can be used in conjunction with [] to test whether an element exists in a nested list:

Parameters

```
{  
  "myIndex" : 1  
}
```

Query

```
WITH [[1, 2, 3]] AS l  
RETURN 3 IN l[0] AS result
```

Table 29. Result

result
true
1 row

More details on lists can be found in [Lists in general](#).

## 2.7.11. Equality and comparison of values

### Equality

Cypher supports comparing values (see [Values and types](#)) by equality using the `=` and `<>` operators.

Values of the same type are only equal if they are the same identical value (e.g. `3 = 3` and `"x" <> "xy"`).

Maps are only equal if they map exactly the same keys to equal values and lists are only equal if they contain the same sequence of equal values (e.g. `[3, 4] = [1+2, 8/2]`).

Values of different types are considered as equal according to the following rules:

- Paths are treated as lists of alternating nodes and relationships and are equal to all lists that contain that very same sequence of nodes and relationships.
- Testing any value against `null` with both the `=` and the `<>` operators always is `null`. This includes `null = null` and `null <> null`. The only way to reliably test if a value `v` is `null` is by using the special `v IS NULL`, or `v IS NOT NULL` equality operators.

All other combinations of types of values cannot be compared with each other. Especially, nodes, relationships, and literal maps are incomparable with each other.

It is an error to compare values that cannot be compared.

## 2.7.12. Ordering and comparison of values

The comparison operators `<=`, `<` (for ascending) and `>=`, `>` (for descending) are used to compare values for ordering. The following points give some details on how the comparison is performed.

- Numerical values are compared for ordering using numerical order (e.g. `3 < 4` is true).
- The special value `java.lang.Double.NaN` is regarded as being larger than all other numbers.
- String values are compared for ordering using lexicographic order (e.g. `"x" < "xy"`).
- Boolean values are compared for ordering such that `false < true`.
- **Comparison of spatial values:**
  - Point values can only be compared within the same Coordinate Reference System (CRS) — otherwise, the result will be `null`.
  - For two points `a` and `b` within the same CRS, `a` is considered to be greater than `b` if `a.x > b.x` and `a.y > b.y` (and `a.z > b.z` for 3D points).
  - `a` is considered less than `b` if `a.x < b.x` and `a.y < b.y` (and `a.z < b.z` for 3D points).
  - If none of the above is true, the points are considered incomparable and any comparison operator between them will return `null`.
- **Ordering of spatial values:**
  - `ORDER BY` requires all values to be orderable.
  - Points are ordered after arrays and before temporal types.
  - Points of different CRS are ordered by the CRS code (the value of SRID field). For the currently supported set of [Coordinate Reference Systems](#) this means the order: 4326, 4979, 7302, 9157
  - Points of the same CRS are ordered by each coordinate value in turn, `x` first, then `y` and finally `z`.
  - Note that this order is different to the order returned by the spatial index, which will be the

order of the space filling curve.

- **Comparison** of temporal values:

- **Temporal instant values** are comparable within the same type. An instant is considered less than another instant if it occurs before that instant in time, and it is considered greater than if it occurs after.
- Instant values that occur at the same point in time — but that have a different time zone — are not considered equal, and must therefore be ordered in some predictable way. Cypher prescribes that, after the primary order of point in time, instant values be ordered by effective time zone offset, from west (negative offset from UTC) to east (positive offset from UTC). This has the effect that times that represent the same point in time will be ordered with the time with the earliest local time first. If two instant values represent the same point in time, and have the same time zone offset, but a different named time zone (this is possible for *DateTime* only, since *Time* only has an offset), these values are not considered equal, and ordered by the time zone identifier, alphabetically, as its third ordering component.
- **Duration** values cannot be compared, since the length of a *day*, *month* or *year* is not known without knowing which *day*, *month* or *year* it is. Since *Duration* values are not comparable, the result of applying a comparison operator between two *Duration* values is `null`. If the type, point in time, offset, and time zone name are all equal, then the values are equal, and any difference in order is impossible to observe.

- **Ordering** of temporal values:

- **ORDER BY** requires all values to be orderable.
- Temporal instances are ordered after spatial instances and before strings.
- Comparable values should be ordered in the same order as implied by their comparison order.
- Temporal instant values are first ordered by type, and then by comparison order within the type.
- Since no complete comparison order can be defined for *Duration* values, we define an order for **ORDER BY** specifically for *Duration*:
  - *Duration* values are ordered by normalising all components as if all years were `365.2425` days long (`PT8765H49M12S`), all months were `30.436875` (`1/12` year) days long (`PT730H29M06S`), and all days were 24 hours long [1: The `365.2425` days per year comes from the frequency of leap years. A leap year occurs on a year with an ordinal number divisible by `4`, that is not divisible by `100`, unless it divisible by `400`. This means that over `400` years there are  $((365 * 4 + 1) * 25 - 1) * 4 + 1 = 146097$  days, which means an average of `365.2425` days per year.].
- Comparing for ordering when one argument is `null` (e.g. `null < 3` is `null`).

### 2.7.13. Chaining comparison operations

Comparisons can be chained arbitrarily, e.g., `x < y <= z` is equivalent to `x < y AND y <= z`.

Formally, if `a, b, c, ..., y, z` are expressions and `op1, op2, ..., opN` are comparison operators, then `a op1 b op2 c ... y opN z` is equivalent to `a op1 b AND b op2 c AND ... y opN z`.

Note that `a op1 b op2 c` does not imply any kind of comparison between `a` and `c`, so that, e.g., `x < y > z` is perfectly legal (although perhaps not elegant).

The example:

```
MATCH (n) WHERE 21 < n.age <= 30 RETURN n
```

is equivalent to

```
MATCH (n) WHERE 21 < n.age AND n.age <= 30 RETURN n
```

Thus it will match all nodes where the age is between 21 and 30.

This syntax extends to all equality and inequality comparisons, as well as extending to chains longer than three.

For example:

```
a < b = c <= d <> e
```

Is equivalent to:

```
a < b AND b = c AND c <= d AND d <> e
```

For other comparison operators, see [Comparison operators](#).

## 2.8. Comments

To add comments to your queries, use double slash. Examples:

```
MATCH (n) RETURN n //This is an end of line comment
```

```
MATCH (n)
//This is a whole line comment
RETURN n
```

```
MATCH (n) WHERE n.property = '//This is NOT a comment' RETURN n
```

## 2.9. Patterns

- [Introduction](#)
- [Patterns for nodes](#)
- [Patterns for related nodes](#)
- [Patterns for labels](#)
- [Specifying properties](#)
- [Patterns for relationships](#)
- [Variable-length pattern matching](#)
- [Assigning to path variables](#)

### 2.9.1. Introduction

Patterns and pattern-matching are at the very heart of Cypher, so being effective with Cypher requires a good understanding of patterns.

Using patterns, you describe the shape of the data you're looking for. For example, in the `MATCH` clause you describe the shape with a pattern, and Cypher will figure out how to get that data for you.

The pattern describes the data using a form that is very similar to how one typically draws the shape of property graph data on a whiteboard: usually as circles (representing nodes) and arrows between them to represent relationships.

Patterns appear in multiple places in Cypher: in `MATCH`, `CREATE` and `MERGE` clauses, and in pattern expressions. Each of these is described in more detail in:

- [MATCH](#)
- [OPTIONAL MATCH](#)
- [CREATE](#)
- [MERGE](#)
- [Using path patterns in WHERE](#)

## 2.9.2. Patterns for nodes

The very simplest 'shape' that can be described in a pattern is a node. A node is described using a pair of parentheses, and is typically given a name. For example:

(a)

This simple pattern describes a single node, and names that node using the variable `a`.

## 2.9.3. Patterns for related nodes

A more powerful construct is a pattern that describes multiple nodes and relationships between them. Cypher patterns describe relationships by employing an arrow between two nodes. For example:

(a)-->(b)

This pattern describes a very simple data shape: two nodes, and a single relationship from one to the other. In this example, the two nodes are both named as `a` and `b` respectively, and the relationship is 'directed': it goes from `a` to `b`.

This manner of describing nodes and relationships can be extended to cover an arbitrary number of nodes and the relationships between them, for example:

(a)-->(b)<--(c)

Such a series of connected nodes and relationships is called a "path".

Note that the naming of the nodes in these patterns is only necessary should one need to refer to the same node again, either later in the pattern or elsewhere in the Cypher query. If this is not necessary, then the name may be omitted, as follows:

(a)-->()<--(c)

## 2.9.4. Patterns for labels

In addition to simply describing the shape of a node in the pattern, one can also describe attributes. The most simple attribute that can be described in the pattern is a label that the node must have. For example:

```
(a:User)-->(b)
```

One can also describe a node that has multiple labels:

```
(a:User:Admin)-->(b)
```

## 2.9.5. Specifying properties

Nodes and relationships are the fundamental structures in a graph. Neo4j uses properties on both of these to allow for far richer models.

Properties can be expressed in patterns using a map-construct: curly brackets surrounding a number of key-expression pairs, separated by commas. E.g. a node with two properties on it would look like:

```
(a {name: 'Andy', sport: 'Brazilian Ju-Jitsu'})
```

A relationship with expectations on it is given by:

```
(a)-[{:blocked: false}]->(b)
```

When properties appear in patterns, they add an additional constraint to the shape of the data. In the case of a **CREATE** clause, the properties will be set in the newly-created nodes and relationships. In the case of a **MERGE** clause, the properties will be used as additional constraints on the shape any existing data must have (the specified properties must exactly match any existing data in the graph). If no matching data is found, then **MERGE** behaves like **CREATE** and the properties will be set in the newly created nodes and relationships.

Note that patterns supplied to **CREATE** may use a single parameter to specify properties, e.g: **CREATE (node \$paramName)**. This is not possible with patterns used in other clauses, as Cypher needs to know the property names at the time the query is compiled, so that matching can be done effectively.

## 2.9.6. Patterns for relationships

The simplest way to describe a relationship is by using the arrow between two nodes, as in the previous examples. Using this technique, you can describe that the relationship should exist and the directionality of it. If you don't care about the direction of the relationship, the arrow head can be omitted, as exemplified by:

```
(a)--(b)
```

As with nodes, relationships may also be given names. In this case, a pair of square brackets is used to break up the arrow and the variable is placed between. For example:

```
(a)-[r]->(b)
```

Much like labels on nodes, relationships can have types. To describe a relationship with a specific type, you can specify this as follows:

```
(a)-[r:REL_TYPE]->(b)
```

Unlike labels, relationships can only have one type. But if we'd like to describe some data such that

the relationship could have any one of a set of types, then they can all be listed in the pattern, separating them with the pipe symbol | like this:

```
(a)-[r:TYPE1 | TYPE2]->(b)
```

Note that this form of pattern can only be used to describe existing data (ie. when using a pattern with `MATCH` or as an expression). It will not work with `CREATE` or `MERGE`, since it's not possible to create a relationship with multiple types.

As with nodes, the name of the relationship can always be omitted, as exemplified by:

```
(a)-[:REL_TYPE]->(b)
```

## 2.9.7. Variable-length pattern matching

Variable length pattern matching in versions 2.1.x and earlier does not enforce relationship uniqueness for patterns described within a single `MATCH` clause. This means that a query such as the following: `MATCH (a)-[r]->(b), p = (a)-[]->(c) RETURN *, relationships(p) AS rs` may include r as part of the rs set. This behavior has changed in versions 2.2.0 and later, in such a way that r will be excluded from the result set, as this better adheres to the rules of relationship uniqueness as documented here [Cypher Result Uniqueness](#). If you have a query pattern that needs to retrace relationships rather than ignoring them as the relationship uniqueness rules normally dictate, you can accomplish this using multiple match clauses, as follows: `MATCH (a)-[r]->(b) MATCH p = (a)-[]->(c) RETURN *, relationships(p)`. This will work in all versions of Neo4j that support the `MATCH` clause, namely 2.0.0 and later.



Rather than describing a long path using a sequence of many node and relationship descriptions in a pattern, many relationships (and the intermediate nodes) can be described by specifying a length in the relationship description of a pattern. For example:

```
(a)-[*2]->(b)
```

This describes a graph of three nodes and two relationships, all in one path (a path of length 2). This is equivalent to:

```
(a)-->()->(b)
```

A range of lengths can also be specified: such relationship patterns are called 'variable length relationships'. For example:

```
(a)-[*3..5]->(b)
```

This is a minimum length of 3, and a maximum of 5. It describes a graph of either 4 nodes and 3 relationships, 5 nodes and 4 relationships or 6 nodes and 5 relationships, all connected together in a single path.

Either bound can be omitted. For example, to describe paths of length 3 or more, use:

```
(a)-[*3..]->(b)
```

To describe paths of length 5 or less, use:

```
(a)-[*..5]->(b)
```

Both bounds can be omitted, allowing paths of any length to be described:

```
(a)-[*]->(b)
```

As a simple example, let's take the graph and query below:

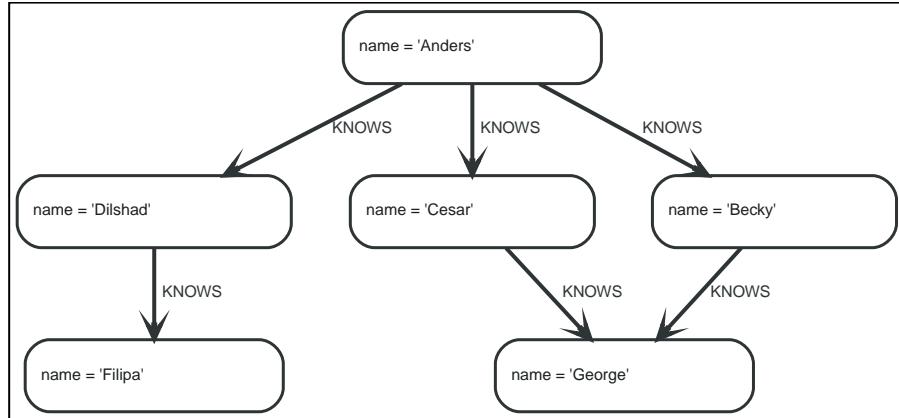


Figure 3. Graph

### Query

```
MATCH (me)-[:KNOWS*1..2]-(remote_friend)
WHERE me.name = 'Filipa'
RETURN remote_friend.name
```

Table 30. Result

remote_friend.name
"Dilshad"
"Anders"
2 rows

This query finds data in the graph which has a shape that fits the pattern: specifically a node (with the name property 'Filipa') and then the KNOWS related nodes, one or two hops away. This is a typical example of finding first and second degree friends.

Note that variable length relationships cannot be used with **CREATE** and **MERGE**.

### 2.9.8. Assigning to path variables

As described above, a series of connected nodes and relationships is called a "path". Cypher allows paths to be named using an identifier, as exemplified by:

```
p = (a)-[*3..5]->(b)
```

You can do this in **MATCH**, **CREATE** and **MERGE**, but not when using patterns as expressions.

## 2.10. Temporal (Date/Time) values

Cypher has built-in support for handling temporal values, and the underlying database supports storing these temporal values as properties on nodes and relationships.

- [Introduction](#)
- [Time zones](#)
- [Temporal instants](#)
  - [Specifying temporal instants](#)
    - [Specifying dates](#)
    - [Specifying times](#)
    - [Specifying time zones](#)
    - [Examples](#)
  - [Accessing components of temporal instants](#)
- [Durations](#)
  - [Specifying durations](#)
    - [Examples](#)
  - [Accessing components of durations](#)
- [Examples](#)
- [Temporal indexing](#)

Refer to [Temporal functions - instant types](#) for information regarding temporal *functions* allowing for the creation and manipulation of temporal values.



Refer to [Temporal operators](#) for information regarding temporal *operators*.

Refer to [Ordering and comparison of values](#) for information regarding the comparison and ordering of temporal values.

### 2.10.1. Introduction

The following table depicts the temporal value types and supported components:

Type	Date support	Time support	Time zone support
Date	X		
Time		X	X
LocalTime		X	
DateTime	X	X	X
LocalDateTime	X	X	
Duration	-	-	-

*Date*, *Time*, *LocalTime*, *DateTime* and *LocalDateTime* are *temporal instant* types. A temporal instant value expresses a point in time with varying degrees of precision.

By contrast, *Duration* is not a temporal instant type. A *Duration* represents a temporal amount, capturing the difference in time between two instants, and can be negative. Duration only captures the amount of time between two instants, and thus does not encapsulate a start time and end time.

## 2.10.2. Time zones

Time zones are represented either as an offset from UTC, or as a logical identifier of a *named time zone* (these are based on the [IANA time zone database](#)). In either case the time is stored as UTC internally, and the time zone offset is only applied when the time is presented. This means that temporal instants can be ordered without taking time zone into account. If, however, two times are identical in UTC, then they are ordered by timezone.

When creating a time using a named time zone, the offset from UTC is computed from the rules in the time zone database to create a time instant in UTC, and to ensure the named time zone is a valid one.

It is possible for time zone rules to change in the IANA time zone database. For example, there could be alterations to the rules for daylight savings time in a certain area. If this occurs after the creation of a temporal instant, the presented time could differ from the originally-entered time, insofar as the local timezone is concerned. However, the absolute time in UTC would remain the same.

There are three ways of specifying a time zone in Cypher:

- Specifying the offset from UTC in hours and minutes ([ISO 8601](#))
- Specifying a named time zone
- Specifying both the offset and the time zone name (with the requirement that these match)

The named time zone form uses the rules of the IANA time zone database to manage *daylight savings time* (DST).

The default time zone of the database can be configured using the configuration option `db.temporal.timezone`. This configuration option influences the creation of temporal types for the following functions:

- Getting the current date and time without specifying a time zone.
- Creating a temporal type from its components without specifying a time zone.
- Creating a temporal type by parsing a string without specifying a time zone.
- Creating a temporal type by combining or selecting values that do not have a time zone component, and without specifying a time zone.
- Truncating a temporal value that does not have a time zone component, and without specifying a time zone.

## 2.10.3. Temporal instants

### Specifying temporal instants

A temporal instant consists of three parts; the `date`, the `time`, and the `timezone`. These parts may then be combined to produce the various temporal value types. Literal characters are denoted in **bold**.

Temporal instant type	Composition of parts
<code>Date</code>	<code>&lt;date&gt;</code>
<code>Time</code>	<code>&lt;time&gt;&lt;timezone&gt;</code> or <code>T&lt;time&gt;&lt;timezone&gt;</code>
<code>LocalTime</code>	<code>&lt;time&gt;</code> or <code>T&lt;time&gt;</code>
<code>DateTime*</code>	<code>&lt;date&gt;T&lt;time&gt;&lt;timezone&gt;</code>
<code>LocalDateTime*</code>	<code>&lt;date&gt;T&lt;time&gt;</code>

\*When `date` and `time` are combined, `date` must be complete; i.e. fully identify a particular day.

## Specifying dates

Component	Format	Description
Year	YYYY	Specified with at least four digits (special rules apply in certain cases)
Month	MM	Specified with a double digit number from 01 to 12
Week	WW	Always prefixed with W and specified with a double digit number from 01 to 53
Quarter	Q	Always prefixed with Q and specified with a single digit number from 1 to 4
Day of the month	DD	Specified with a double digit number from 01 to 31
Day of the week	D	Specified with a single digit number from 1 to 7
Day of the quarter	DD	Specified with a double digit number from 01 to 92
Ordinal day of the year	DDD	Specified with a triple digit number from 001 to 366

If the year is before 0000 or after 9999, the following additional rules apply:

- must prefix any year before 0000
- + must prefix any year after 9999
- The year must be separated from the next component with the following characters:
  - if the next component is month or day of the year
  - Either - or W if the next component is week of the year
  - Q if the next component is quarter of the year

If the year component is prefixed with either - or +, and is separated from the next component, Year is allowed to contain up to nine digits. Thus, the allowed range of years is between -999,999,999 and +999,999,999. For all other cases, i.e. the year is between 0000 and 9999 (inclusive), Year must have exactly four digits (the year component is interpreted as a year of the Common Era (CE)).

The following formats are supported for specifying dates:

Format	Description	Example	Interpretation of example
YYYY-MM-DD	Calendar date: Year-Month-Day	2015-07-21	2015-07-21
YYYYMMDD	Calendar date: Year-Month-Day	20150721	2015-07-21
YYYY-MM	Calendar date: Year-Month	2015-07	2015-07-01
YYYYMM	Calendar date: Year-Month	201507	2015-07-01
YYYY-Www-D	Week date: Year-Week-Day	2015-W30-2	2015-07-21
YYYYWwwD	Week date: Year-Week-Day	2015W302	2015-07-21
YYYY-Www	Week date: Year-Week	2015-W30	2015-07-20

Format	Description	Example	Interpretation of example
YYYYWww	Week date: Year-Week	2015W30	2015-07-20
YYYY-Qq-DD	Quarter date: Year-Quarter-Day	2015-Q2-60	2015-05-30
YYYYQqDD	Quarter date: Year-Quarter-Day	2015Q260	2015-05-30
YYYY-Qq	Quarter date: Year-Quarter	2015-Q2	2015-04-01
YYYYQq	Quarter date: Year-Quarter	2015Q2	2015-04-01
YYYY-DDD	Ordinal date: Year-Day	2015-202	2015-07-21
YYYYDDD	Ordinal date: Year-Day	2015202	2015-07-21
YYYY	Year	2015	2015-01-01

The least significant components can be omitted. Cypher will assume omitted components to have their lowest possible value. For example, `2013-06` will be interpreted as being the same date as `2013-06-01`.

## Specifying times

Component	Format	Description
Hour	HH	Specified with a double digit number from <code>00</code> to <code>23</code>
Minute	MM	Specified with a double digit number from <code>00</code> to <code>59</code>
Second	SS	Specified with a double digit number from <code>00</code> to <code>59</code>
fraction	ssssssss	Specified with a number from <code>0</code> to <code>99999999</code> . It is not required to specify trailing zeros. <code>fraction</code> is an optional, sub-second component of <code>Second</code> . This can be separated from <code>Second</code> using either a full stop ( <code>.</code> ) or a comma ( <code>,</code> ). The <code>fraction</code> is in addition to the two digits of <code>Second</code> .

Cypher does not support leap seconds; [UTC-SLS](#) (*UTC with Smoothed Leap Seconds*) is used to manage the difference in time between UTC and TAI (*International Atomic Time*).

The following formats are supported for specifying times:

Format	Description	Example	Interpretation of example
HH:MM:SS.ssssssss	Hour:Minute:Second.fraction	21:40:32.142	21:40:32.142
HHMMSS.ssssssss	Hour:Minute:Second.fraction	214032.142	21:40:32.142
HH:MM:SS	Hour:Minute:Second	21:40:32	21:40:32.000
HHMMSS	Hour:Minute:Second	214032	21:40:32.000
HH:MM	Hour:Minute	21:40	21:40:00.000
HHMM	Hour:Minute	2140	21:40:00.000
HH	Hour	21	21:00:00.000

The least significant components can be omitted. For example, a time may be specified with **Hour** and **Minute**, leaving out **Second** and **fraction**. On the other hand, specifying a time with **Hour** and **Second**, while leaving out **Minute**, is not possible.

## Specifying time zones

The time zone is specified in one of the following ways:

- As an offset from UTC
- Using the **Z** shorthand for the UTC (**+00:00**) time zone

When specifying a time zone as an offset from UTC, the rules below apply:

- The time zone always starts with either a plus (+) or minus (-) sign.
  - Positive offsets, i.e. time zones beginning with +, denote time zones east of UTC.
  - Negative offsets, i.e. time zones beginning with -, denote time zones west of UTC.
- A double-digit hour offset follows the +/- sign.
- An optional double-digit minute offset follows the hour offset, optionally separated by a colon (:).
- The time zone of the International Date Line is denoted either by **+12:00** or **-12:00**, depending on country.

When creating values of the *DateTime* temporal instant type, the time zone may also be specified using a named time zone, using the names from the IANA time zone database. This may be provided either in addition to, or in place of the offset. The named time zone is given last and is enclosed in square brackets ([ ]). Should both the offset and the named time zone be provided, the offset must match the named time zone.

The following formats are supported for specifying time zones:

Format	Description	Example	Supported for <i>DateTime</i>	Supported for <i>Time</i>
<b>Z</b>	UTC	<b>Z</b>	X	X
<b>+HH:MM</b>	Hour:Minute	<b>+09:30</b>	X	X
<b>+HH:MM[ZoneName]</b>	Hour:Minute[ZoneName]	<b>+08:45[Australia/Eucla]</b>	X	
<b>+HHMM</b>	Hour:Minute	<b>+0100</b>	X	X
<b>+HHMM[ZoneName]</b>	Hour:Minute[ZoneName]	<b>+0200[Africa/Johannesburg]</b>	X	
<b>+HH</b>	Hour	<b>-08</b>	X	X
<b>+HH[ZoneName]</b>	Hour[ZoneName]	<b>+08[Asia/Singapore]</b>	X	
<b>[ZoneName]</b>	[ZoneName]	<b>[America/Regina]</b>	X	

## Examples

We show below examples of parsing temporal instant values using various formats. For more details, refer to [An overview of temporal instant type creation](#).

Parsing a *DateTime* using the *calendar date* format:

## Query

```
RETURN datetime('2015-06-24T12:50:35.556+0100') AS theDateTime
```

Table 31. Result

theDateTime
2015-06-24T12:50:35.556+01:00
1 row

Parsing a *LocalDateTime* using the *ordinal date* format:

## Query

```
RETURN localdatetime('2015185T19:32:24') AS theLocalDateTime
```

Table 32. Result

theLocalDateTime
2015-07-04T19:32:24
1 row

Parsing a *Date* using the *week date* format:

## Query

```
RETURN date('+2015-W13-4') AS theDate
```

Table 33. Result

theDate
2015-03-26
1 row

Parsing a *Time*:

## Query

```
RETURN time('125035.556+0100') AS theTime
```

Table 34. Result

theTime
12:50:35.556+01:00
1 row

Parsing a *LocalTime*:

## Query

```
RETURN localtime('12:50:35.556') AS theLocalTime
```

Table 35. Result

theLocalTime
12:50:35.556
1 row

## Accessing components of temporal instants

Components of temporal instant values can be accessed as properties.

*Table 36. Components of temporal instant values and where they are supported*

Component	Description	Type	Range/Format	Date	DateTime	LocalDateTime	Time	LocalTime
instant.year	The <a href="#">year</a> component represents the <a href="#">astronomical year number</a> of the instant [2: This is in accordance with the <a href="#">Gregorian calendar</a> ; i.e. years AD/CE start at year 1, and the year before that (year 1 BC/BCE) is 0, while year 2 BCE is -1 etc.]	Integer	At least 4 digits. For more information, see the rules for using the <a href="#">Year component</a>	X	X	X		
instant.quarter	The <a href="#">quarter-of-the-year</a> component	Integer	<a href="#">1 to 4</a>	X	X	X		
instant.month	The <a href="#">month-of-the-year</a> component	Integer	<a href="#">1 to 12</a>	X	X	X		
instant.week	The <a href="#">week-of-the-year</a> component [3: The <a href="#">first week of any year</a> is the week that contains the first Thursday of the year, and thus always contains January 4.]	Integer	<a href="#">1 to 53</a>	X	X	X		

Component	Description	Type	Range/Format	Date	DateTime	LocalDateTime	Time	LocalTime
instant.weekYear	The year that the week-of-year component belongs to [4: For dates from December 29, this could be the next year, and for dates until January 3 this could be the previous year, depending on how week 1 begins.]	Integer	At least 4 digits. For more information, see the <a href="#">rules for using the Year component</a>	X	X	X		
instant.dayOfQuarter	The day-of-the-quarter component	Integer	1 to 92	X	X	X		
instant.day	The day-of-the-month component	Integer	1 to 31	X	X	X		
instant.ordinalDay	The day-of-the-year component	Integer	1 to 366	X	X	X		
instant.dayOfWeek	The day-of-the-week component (the first day of the week is Monday)	Integer	1 to 7	X	X	X		
instant.hour	The hour component	Integer	0 to 23		X	X	X	X
instant.minute	The minute component	Integer	0 to 59		X	X	X	X
instant.second	The second component	Integer	0 to 60		X	X	X	X
instant.millisecond	The millisecond component	Integer	0 to 999		X	X	X	X
instant.microsecond	The microsecond component	Integer	0 to 999999		X	X	X	X
instant.nanosecond	The nanosecond component	Integer	0 to 999999999		X	X	X	X

Component	Description	Type	Range/Format	Date	DateTime	LocalDateTime	Time	LocalTime
instant.timezone	The <i>timezone</i> component	String	Depending on how the time zone was specified, this is either a time zone name or an offset from UTC in the format <code>±HHMM</code>		X		X	
instant.offset	The <i>timezone</i> offset	String	<code>±HHMM</code>		X		X	
instant.offsetMinutes	The <i>timezone</i> offset in minutes	Integer	<code>-1080</code> to <code>+1080</code>		X		X	
instant.offsetSeconds	The <i>timezone</i> offset in seconds	Integer	<code>-64800</code> to <code>+64800</code>		X		X	
instant.epochMillis	The number of milliseconds between <code>1970-01-01T00:00:00+0000</code> and the instant [5: <code>datetime().epochMillis</code> returns the equivalent value of the <code>timestamp()</code> function.]	Integer	Positive for instants after and negative for instants before <code>1970-01-01T00:00:00+0000</code>		X			
instant.epochSeconds	The number of seconds between <code>1970-01-01T00:00:00+0000</code> and the instant [6: For the nanosecond part of the epoch offset, the regular nanosecond component ( <code>instant.nanosecond</code> ) can be used.]	Integer	Positive for instants after and negative for instants before <code>1970-01-01T00:00:00+0000</code>		X			

The following query shows how to extract the components of a *Date* value:

### Query

```
WITH date({ year:1984, month:10, day:11 }) AS d
RETURN d.year, d.quarter, d.month, d.week, d.weekYear, d.day, d.ordinalDay, d.dayOfWeek, d.dayOfQuarter
```

Table 37. Result

d.year	d.quarter	d.month	d.week	d.weekYear	d.day	d.ordinalDay	d.dayOfWeek	d.dayOfQuarter
1984	4	10	41	1984	11	285	4	11
1 row								

The following query shows how to extract the components of a *DateTime* value:

#### Query

```
WITH datetime({ year:1984, month:11, day:11, hour:12, minute:31, second:14, nanosecond: 645876123,
  timezone:'Europe/Stockholm' }) AS d
RETURN d.year, d.quarter, d.month, d.week, d.weekYear, d.day, d.ordinalDay, d.dayOfWeek, d.dayOfQuarter,
  d.hour, d.minute, d.second, d.millisecond, d.microsecond, d.nanosecond, d.timezone, d.offset,
  d.offsetMinutes, d.epochSeconds, d.epochMillis
```

Table 38. Result

d.ye ar	d.qu arte r	d.m onth	d.w eek	d.w eek Year	d.da y	d.or dina lDay	d.da yOf Wee k	d.da yOf Qua ter	d.ho ur	d.mi nut	d.se con	d.mi llise con	d.mi cro ndo	d.na nos eco nd	d.ti mez one	d.off set	d.off set Min utes	d.ep och Seco nds	d.ep och Milli s
1984	4	11	45	1984	11	316	7	42	12	31	14	645	6458 76	6458 7612 3	"Eur ope/ Stoc khol m"	"+01 :00"	60	4690 2067 4	4690 2067 4645
1 row																			

## 2.10.4. Durations

### Specifying durations

A *Duration* represents a temporal amount, capturing the difference in time between two instants, and can be negative.

The specification of a *Duration* is prefixed with a **P**, and can use either a *unit-based form* or a *date-and-time-based form*:

- Unit-based form: **P[nY][nM][nW][nD][T[nH][nM][nS]]**
  - The square brackets ([]) denote an optional component (components with a zero value may be omitted).
  - The **n** denotes a numeric value which can be arbitrarily large.
  - The value of the last — and least significant — component may contain a decimal fraction.
  - Each component must be suffixed by a component identifier denoting the unit.
  - The unit-based form uses **M** as a suffix for both months and minutes. Therefore, time parts must always be preceded with **T**, even when no components of the date part are given.
- Date-and-time-based form: **P<date>T<time>**
  - Unlike the unit-based form, this form requires each component to be within the bounds of a valid *LocalDateTime*.

The following table lists the component identifiers for the unit-based form:

Component identifier	Description	Comments
Y	Years	
M	Months	Must be specified before T
W	Weeks	
D	Days	
H	Hours	
M	Minutes	Must be specified after T
S	Seconds	

## Examples

The following examples demonstrate various methods of parsing *Duration* values. For more details, refer to [Creating a Duration from a string](#).

Return a *Duration* of 14 days, 16 hours and 12 minutes:

### Query

```
RETURN duration('P14DT16H12M') AS theDuration
```

Table 39. Result

theDuration
P14DT16H12M
1 row

Return a *Duration* of 5 months, 1 day and 12 hours:

### Query

```
RETURN duration('P5M1.5D') AS theDuration
```

Table 40. Result

theDuration
P5M1DT12H
1 row

Return a *Duration* of 45 seconds:

### Query

```
RETURN duration('PT0.75M') AS theDuration
```

Table 41. Result

theDuration
PT45S
1 row

Return a *Duration* of 2 weeks, 3 days and 12 hours:

## Query

```
RETURN duration('P2.5W') AS theDuration
```

Table 42. Result

theDuration
P17DT12H
1 row

## Accessing components of durations

A *Duration* can have several components. These are categorized into the following groups:

Component group	Constituent components
Months	<i>Years, Quarters and Months</i>
Days	<i>Weeks and Days</i>
Seconds	<i>Hours, Minutes, Seconds, Milliseconds, Microseconds and Nanoseconds</i>

Within each group, the components can be converted without any loss:

- There are always *4 quarters* in *1 year*.
- There are always *12 months* in *1 year*.
- There are always *3 months* in *1 quarter*.
- There are always *7 days* in *1 week*.
- There are always *60 minutes* in *1 hour*.
- There are always *60 seconds* in *1 minute* (Cypher uses [UTC-SLS](#) when handling leap seconds).
- There are always *1000 milliseconds* in *1 second*.
- There are always *1000 microseconds* in *1 millisecond*.
- There are always *1000 nanoseconds* in *1 microsecond*.

Please note that:

- There are not always *24 hours* in *1 day*; when switching to/from daylight savings time, a *day* can have *23* or *25 hours*.
- There are not always the same number of *days* in a *month*.
- Due to leap years, there are not always the same number of *days* in a *year*.

Table 43. Components of Duration values and how they are truncated within their component group

Component	Component Group	Description	Type	Details
duration.years	Months	The total number of <i>years</i>	Integer	Each set of <i>4 quarters</i> is counted as <i>1 year</i> ; each set of <i>12 months</i> is counted as <i>1 year</i> .
duration.months	Months	The total number of <i>months</i>	Integer	Each <i>year</i> is counted as <i>12 months</i> ; each <i>quarter</i> is counted as <i>3 months</i> .

Component	Component Group	Description	Type	Details
duration.days	Days	The total number of <i>days</i>	Integer	Each <i>week</i> is counted as <b>7 days</b> .
duration.hours	Seconds	The total number of <i>hours</i>	Integer	Each set of <b>60 minutes</b> is counted as <b>1 hour</b> ; each set of <b>3600 seconds</b> is counted as <b>1 hour</b> .
duration.minutes	Seconds	The total number of <i>minutes</i>	Integer	Each <i>hour</i> is counted as <b>60 minutes</b> ; each set of <b>60 seconds</b> is counted as <b>1 minute</b> .
duration.seconds	Seconds	The total number of <i>seconds</i>	Integer	Each <i>hour</i> is counted as <b>3600 seconds</b> ; each <i>minute</i> is counted as <b>60 seconds</b> .
duration.milliseconds	Seconds	The total number of <i>milliseconds</i>	Integer	
duration.microseconds	Seconds	The total number of <i>microseconds</i>	Integer	
duration.nanoseconds	Seconds	The total number of <i>nanoseconds</i>	Integer	

It is also possible to access the smaller (less significant) components of a component group bounded by the largest (most significant) component of the group:

Component	Component Group	Description	Type
duration.monthsOfYear	Months	The number of <i>months</i> in the group that do not make a whole <i>year</i>	Integer
duration.minutesOfHour	Seconds	The total number of <i>minutes</i> in the group that do not make a whole <i>hour</i>	Integer
duration.secondsOfMinute	Seconds	The total number of <i>seconds</i> in the group that do not make a whole <i>minute</i>	Integer
duration.millisecondsOfSecond	Seconds	The total number of <i>milliseconds</i> in the group that do not make a whole <i>second</i>	Integer
duration.microsecondsOfSecond	Seconds	The total number of <i>microseconds</i> in the group that do not make a whole <i>second</i>	Integer
duration.nanosecondsOfSecond	Seconds	The total number of <i>nanoseconds</i> in the group that do not make a whole <i>second</i>	Integer

The following query shows how to extract the components of a *Duration* value:

### Query

```
WITH duration({ years: 1, months:4, days: 111, hours: 1, minutes: 1, seconds: 1, nanoseconds: 111111111 }) AS d
RETURN d.years, d.months, d.monthsOfYear, d.days, d.hours, d.minutes, d.minutesOfHour, d.seconds,
d.secondsOfMinute, d.milliseconds, d.millisecondsOfSecond, d.microseconds, d.microsecondsOfSecond,
d.nanoseconds, d.nanosecondsOfSecond
```

Table 44. Result

d.years	d.months	d.monthsOfYear	d.days	d.hours	d.minutes	d.minutesOfHour	d.seconds	d.secondsOfMinute	d.milliseconds	d.millisecondsOfSecond	d.microseconds	d.microsecondsOfSecond	d.nanoseconds	d.nanosecondsOfSecond
1	16	4	111	1	61	1	3661	1	3661111	111	3661111111	1111111111	36611111111111	111111111111111

1 row

## 2.10.5. Examples

The following examples illustrate the use of some of the temporal functions and operators. Refer to [Temporal functions - instant types](#) and [Temporal operators](#) for more details.

Create a *Duration* representing 1.5 days:

*Query*

```
RETURN duration({ days: 1, hours: 12 }) AS theDuration
```

Table 45. Result

theDuration
P1DT12H

1 row

Compute the *Duration* between two temporal instants:

*Query*

```
RETURN duration.between(date('1984-10-11'), date('2015-06-24')) AS theDuration
```

Table 46. Result

theDuration
P30Y8M13D

1 row

Compute the number of days between two *Date* values:

*Query*

```
RETURN duration.inDays(date('2014-10-11'), date('2015-08-06')) AS theDuration
```

Table 47. Result

theDuration
P299D

1 row

Get the first *Date* of the current year:

## Query

```
RETURN date.truncate('year') AS day
```

Table 48. Result

day
2020-01-01
1 row

Get the *Date* of the Thursday in the week of a specific date:

## Query

```
RETURN date.truncate('week', date('2019-10-01'), { dayOfWeek: 4 }) AS thursday
```

Table 49. Result

thursday
2019-10-03
1 row

Get the *Date* of the last day of the next month:

## Query

```
RETURN date.truncate('month', date() + duration('P2M')) - duration('P1D') AS lastDay
```

Table 50. Result

lastDay
2020-12-31
1 row

Add a *Duration* to a *Date*:

## Query

```
RETURN time('13:42:19') + duration({ days: 1, hours: 12 }) AS theTime
```

Table 51. Result

theTime
01:42:19Z
1 row

Add two *Duration* values:

## Query

```
RETURN duration({ days: 2, hours: 7 }) + duration({ months: 1, hours: 18 }) AS theDuration
```

Table 52. Result

theDuration
-------------

P1M2DT25H
-----------

1 row
-------

Multiply a *Duration* by a number:

*Query*

```
RETURN duration({ hours: 5, minutes: 21 })* 14 AS theDuration
```

Table 53. Result

theDuration
-------------

PT74H54M
----------

1 row
-------

Divide a *Duration* by a number:

*Query*

```
RETURN duration({ hours: 3, minutes: 16 })/ 2 AS theDuration
```

Table 54. Result

theDuration
-------------

PT1H38M
---------

1 row
-------

Examine whether two instants are less than one day apart:

*Query*

```
WITH datetime('2015-07-21T21:40:32.142+0100') AS date1, datetime('2015-07-21T17:12:56.333+0100') AS date2
RETURN
CASE
WHEN date1 < date2
THEN date1 + duration("P1D")> date2
ELSE date2 + duration("P1D")> date1 END AS lessThanOneDayApart
```

Table 55. Result

lessThanOneDayApart
---------------------

true
------

1 row
-------

Return the abbreviated name of the current month:

*Query*

```
RETURN ["Jan", "Feb", "Mar", "Apr", "May", "Jun", "Jul", "Aug", "Sep", "Oct", "Nov", "Dec"][date().month-1] AS month
```

Table 56. Result

month
-------

"Nov"
-------

month
-------

| 1 row |

## 2.10.6. Temporal indexing

All temporal types can be indexed, and thereby support exact lookups for equality predicates. Indexes for temporal instant types additionally support range lookups.

## 2.11. Lists

*Cypher has comprehensive support for lists.*

- [Lists in general](#)
- [List comprehension](#)
- [Pattern comprehension](#)



Information regarding operators such as list concatenation (+), element existence checking (IN) and access ([] ) can be found [here](#). The behavior of the IN and [] operators with respect to null is detailed [here](#).

### 2.11.1. Lists in general

A literal list is created by using brackets and separating the elements in the list with commas.

*Query*

```
RETURN [0, 1, 2, 3, 4, 5, 6, 7, 8, 9] AS list
```

*Table 57. Result*

list
------

| [0,1,2,3,4,5,6,7,8,9] |
| 1 row |

In our examples, we'll use the `range` function. It gives you a list containing all numbers between given start and end numbers. Range is inclusive in both ends.

To access individual elements in the list, we use the square brackets again. This will extract from the start index and up to but not including the end index.

*Query*

```
RETURN range(0, 10)[3]
```

*Table 58. Result*

range(0, 10)[3]
-----------------

| 3 |
| 1 row |

You can also use negative numbers, to start from the end of the list instead.

### Query

```
RETURN range(0, 10)[-3]
```

Table 59. Result

range(0, 10)[-3]
8
1 row

Finally, you can use ranges inside the brackets to return ranges of the list.

### Query

```
RETURN range(0, 10)[0..3]
```

Table 60. Result

range(0, 10)[0..3]
[0,1,2]
1 row

### Query

```
RETURN range(0, 10)[0..-5]
```

Table 61. Result

range(0, 10)[0..-5]
[0,1,2,3,4,5]
1 row

### Query

```
RETURN range(0, 10)[-5..]
```

Table 62. Result

range(0, 10)[-5..]
[6,7,8,9,10]
1 row

### Query

```
RETURN range(0, 10)[..4]
```

Table 63. Result

range(0, 10)[..4]
[0,1,2,3]
1 row



Out-of-bound slices are simply truncated, but out-of-bound single elements return `null`.

### Query

```
RETURN range(0, 10)[15]
```

Table 64. Result

range(0, 10)[15]
<null>
1 row

### Query

```
RETURN range(0, 10)[5..15]
```

Table 65. Result

range(0, 10)[5..15]
[5, 6, 7, 8, 9, 10]
1 row

You can get the `size` of a list as follows:

### Query

```
RETURN size(range(0, 10)[0..3])
```

Table 66. Result

size(range(0, 10)[0..3])
3
1 row

## 2.11.2. List comprehension

List comprehension is a syntactic construct available in Cypher for creating a list based on existing lists. It follows the form of the mathematical set-builder notation (set comprehension) instead of the use of map and filter functions.

### Query

```
RETURN [x IN range(0,10) WHERE x % 2 = 0 | x^3] AS result
```

Table 67. Result

result
[0.0, 8.0, 64.0, 216.0, 512.0, 1000.0]
1 row

Either the `WHERE` part, or the expression, can be omitted, if you only want to filter or map respectively.

## Query

```
RETURN [x IN range(0,10) WHERE x % 2 = 0] AS result
```

Table 68. Result

result
[0, 2, 4, 6, 8, 10]
1 row

## Query

```
RETURN [x IN range(0,10) | x^3] AS result
```

Table 69. Result

result
[0.0, 1.0, 8.0, 27.0, 64.0, 125.0, 216.0, 343.0, 512.0, 729.0, 1000.0]
1 row

## 2.11.3. Pattern comprehension

Pattern comprehension is a syntactic construct available in Cypher for creating a list based on matchings of a pattern. A pattern comprehension will match the specified pattern just like a normal `MATCH` clause, with predicates just like a normal `WHERE` clause, but will yield a custom projection as specified.

The following graph is used for the example below:

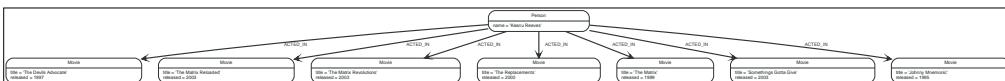


Figure 4. Graph

## Query

```
MATCH (a:Person { name: 'Keanu Reeves' })
RETURN [(a)-->(b) WHERE b:Movie | b.released] AS years
```

Table 70. Result

years
[1997, 2003, 2003, 2000, 1999, 2003, 1995]
1 row

The whole predicate, including the `WHERE` keyword, is optional and may be omitted.

## 2.12. Maps

This section describes how to use maps in Cyphers.

- Literal maps
- Map projection

## □ Examples of map projection

The following graph is used for the examples below:

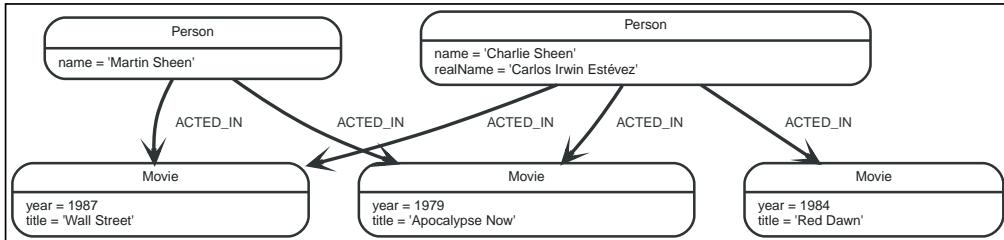


Figure 5. Graph



Information regarding property access operators such as `.` and `[]` can be found [here](#). The behavior of the `[]` operator with respect to `null` is detailed [here](#).

### 2.12.1. Literal maps

Cypher supports construction of maps. The key names in a map must be of type `String`. If returned through an [HTTP API call](#), a JSON object will be returned. If returned in Java, an object of type `java.util.Map<String, Object>` will be returned.

#### Query

```
RETURN { key: 'Value', listKey: [{ inner: 'Map1' }, { inner: 'Map2' }]}
```

Table 71. Result

{ key: 'Value', listKey: [{ inner: 'Map1' }, { inner: 'Map2' }]}  {listKey -> [{inner -> "Map1"}, {inner -> "Map2"}], key -> "Value"} 1 row
--

### 2.12.2. Map projection

Cypher supports a concept called "map projections". It allows for easily constructing map projections from nodes, relationships and other map values.

A map projection begins with the variable bound to the graph entity to be projected from, and contains a body of comma-separated map elements, enclosed by `{` and `}`.

```
map_variable {map_element, [ , ...n]}
```

A map element projects one or more key-value pairs to the map projection. There exist four different types of map projection elements:

- Property selector - Projects the property name as the key, and the value from the `map_variable` as the value for the projection.
- Literal entry - This is a key-value pair, with the value being arbitrary expression `key: <expression>`.
- Variable selector - Projects a variable, with the variable name as the key, and the value the variable is pointing to as the value of the projection. Its syntax is just the variable.
- All-properties selector - projects all key-value pairs from the `map_variable` value.

The following conditions apply:

- If the `map_variable` points to a `null` value, the whole map projection will evaluate to `null`.
- The key names in a map must be of type `String`.

## Examples of map projections

Find '**Charlie Sheen**' and return data about him and the movies he has acted in. This example shows an example of map projection with a literal entry, which in turn also uses map projection inside the aggregating `collect()`.

### Query

```
MATCH (actor:Person { name: 'Charlie Sheen' })-[:ACTED_IN]->(movie:Movie)
RETURN actor { .name, .realName, movies: collect(movie { .title, .year })}
```

*Table 72. Result*

<b>actor</b>
{movies -> [{year -> 1979, title -> "Apocalypse Now"}, {year -> 1984, title -> "Red Dawn"}, {year -> 1987, title -> "Wall Street"}], realName -> "Carlos Irwin Estévez", name -> "Charlie Sheen"}
1 row

Find all persons that have acted in movies, and show number for each. This example introduces an variable with the count, and uses a variable selector to project the value.

### Query

```
MATCH (actor:Person)-[:ACTED_IN]->(movie:Movie)
WITH actor, count(movie) AS nrOfMovies
RETURN actor { .name, nrOfMovies }
```

*Table 73. Result*

<b>actor</b>
{nrOfMovies -> 2, name -> "Martin Sheen"}
{nrOfMovies -> 3, name -> "Charlie Sheen"}
2 rows

Again, focusing on '**Charlie Sheen**', this time returning all properties from the node. Here we use an all-properties selector to project all the node properties, and additionally, explicitly project the property `age`. Since this property does not exist on the node, a `null` value is projected instead.

### Query

```
MATCH (actor:Person { name: 'Charlie Sheen' })
RETURN actor { .*, .age }
```

*Table 74. Result*

<b>actor</b>
{realName -> "Carlos Irwin Estévez", name -> "Charlie Sheen", age -> <null>}
1 row

## 2.13. Spatial values

Cypher has built-in support for handling spatial values (points), and the underlying database

*supports storing these point values as properties on nodes and relationships.*

- [Introduction](#)
- [Coordinate Reference Systems](#)
  - [Geographic coordinate reference systems](#)
  - [Cartesian coordinate reference systems](#)
- [Spatial instants](#)
  - [Creating points](#)
  - [Accessing components of points](#)
- [Spatial index](#)
- [Comparability and Orderability](#)

Refer to [Spatial functions](#) for information regarding spatial *functions* allowing for the creation and manipulation of spatial values.



Refer to [Ordering and comparison of values](#) for information regarding the comparison and ordering of spatial values.

### 2.13.1. Introduction

Neo4j supports only one type of spatial geometry, the *Point* with the following characteristics:

- Each point can have either 2 or 3 dimensions. This means it contains either 2 or 3 64-bit floating point values, which together are called the *Coordinate*.
- Each point will also be associated with a specific [Coordinate Reference System](#) (CRS) that determines the meaning of the values in the *Coordinate*.
- Instances of *Point* and lists of *Point* can be assigned to node and relationship properties.
- Nodes with *Point* or *List(Point)* properties can be indexed using a spatial index. This is true for all CRS (and for both 2D and 3D). There is no special syntax for creating spatial indexes, as it is supported using the existing [indexes](#).
- The [distance function](#) will work on points in all CRS and in both 2D and 3D but only if the two points have the same CRS (and therefore also same dimension).

### 2.13.2. Coordinate Reference Systems

Four Coordinate Reference Systems (CRS) are supported, each of which falls within one of two types: *geographic coordinates* modeling points on the earth, or *cartesian coordinates* modeling points in euclidean space:

- [Geographic coordinate reference systems](#)
  - WGS-84: longitude, latitude (x, y)
  - WGS-84-3D: longitude, latitude, height (x, y, z)
- [Cartesian coordinate reference systems](#)
  - Cartesian: x, y
  - Cartesian 3D: x, y, z

Data within different coordinate systems are entirely incomparable, and cannot be implicitly converted from one to the other. This is true even if they are both cartesian or both geographic. For example, if you search for 3D points using a 2D range, you will get no results. However, they can be

ordered, as discussed in more detail in the section on [Cypher ordering](#).

## Geographic coordinate reference systems

Two Geographic Coordinate Reference Systems (CRS) are supported, modeling points on the earth:

- [WGS 84 2D](#)

- A 2D geographic point in the *WGS 84* CRS is specified in one of two ways:

- *longitude* and *latitude* (if these are specified, and the *crs* is not, then the *crs* is assumed to be *WGS-84*)

- *x* and *y* (in this case the *crs* must be specified, or will be assumed to be *Cartesian*)

- Specifying this CRS can be done using either the name 'wgs-84' or the SRID 4326 as described in [Point\(WGS-84\)](#)

- [WGS 84 3D](#)

- A 3D geographic point in the *WGS 84* CRS is specified one of in two ways:

- *longitude*, *latitude* and either *height* or *z* (if these are specified, and the *crs* is not, then the *crs* is assumed to be *WGS-84-3D*)

- *x*, *y* and *z* (in this case the *crs* must be specified, or will be assumed to be *Cartesian-3D*)

- Specifying this CRS can be done using either the name 'wgs-84-3d' or the SRID 4979 as described in [Point\(WGS-84-3D\)](#)

The units of the *latitude* and *longitude* fields are in decimal degrees, and need to be specified as floating point numbers using Cypher literals. It is not possible to use any other format, like 'degrees, minutes, seconds'. The units of the *height* field are in meters. When geographic points are passed to the *distance* function, the result will always be in meters. If the coordinates are in any other format or unit than supported, it is necessary to explicitly convert them. For example, if the incoming *\$height* is a string field in kilometers, you would need to type *height:toFloat(\$height) \* 1000*. Likewise if the results of the *distance* function are expected to be returned in kilometers, an explicit conversion is required. For example: `RETURN distance(a,b) / 1000 AS km`. An example demonstrating conversion on incoming and outgoing values is:

### Query

```
WITH point({ latitude:toFloat('13.43'), longitude:toFloat('56.21') }) AS p1, point({  
    latitude:toFloat('13.10'), longitude:toFloat('56.41') }) AS p2  
RETURN toInteger(distance(p1,p2)/1000) AS km
```

Table 75. Result

km
42
1 row

## Cartesian coordinate reference systems

Two Cartesian Coordinate Reference Systems (CRS) are supported, modeling points in euclidean space:

- [Cartesian 2D](#)

- A 2D point in the *Cartesian* CRS is specified with a map containing *x* and *y* coordinate values

- Specifying this CRS can be done using either the name 'cartesian' or the SRID 7203 as described in [Point\(Cartesian\)](#)

- [Cartesian 3D](#)

- A 3D point in the *Cartesian* CRS is specified with a map containing `x`, `y` and `z` coordinate values
- Specifying this CRS can be done using either the name 'cartesian-3d' or the SRID 9157 as described in [Point\(Cartesian-3D\)](#)

The units of the `x`, `y` and `z` fields are unspecified and can mean anything the user intends them to mean. This also means that when two cartesian points are passed to the `distance` function, the resulting value will be in the same units as the original coordinates. This is true for both 2D and 3D points, as the *pythagoras* equation used is generalized to any number of dimensions. However, just as you cannot compare geographic points to cartesian points, you cannot calculate the distance between a 2D point and a 3D point. If you need to do that, explicitly transform the one type into the other. For example:

#### Query

```
WITH point({ x:3, y:0 }) AS p2d, point({ x:0, y:4, z:1 }) AS p3d
RETURN distance(p2d,p3d) AS bad, distance(p2d,point({ x:p3d.x, y:p3d.y })) AS good
```

*Table 76. Result*

bad	good
<null>	5.0
1 row	

### 2.13.3. Spatial instants

#### Creating points

All point types are created from two components:

- The *Coordinate* containing either 2 or 3 floating point values (64-bit)
- The Coordinate Reference System (or CRS) defining the meaning (and possibly units) of the values in the *Coordinate*

For most use cases it is not necessary to specify the CRS explicitly as it will be deduced from the keys used to specify the coordinate. Two rules are applied to deduce the CRS from the coordinate:

- Choice of keys:
  - If the coordinate is specified using the keys `latitude` and `longitude` the CRS will be assumed to be *Geographic* and therefore either `WGS-84` or `WGS-84-3D`.
  - If instead `x` and `y` are used, then the default CRS would be `Cartesian` or `Cartesian-3D`
- Number of dimensions:
  - If there are 2 dimensions in the coordinate, `x` & `y` or `longitude` & `latitude` the CRS will be a 2D CRS
  - If there is a third dimension in the coordinate, `z` or `height` the CRS will be a 3D CRS

All fields are provided to the `point` function in the form of a map of explicitly named arguments. We specifically do not support an ordered list of coordinate fields because of the contradictory conventions between geographic and cartesian coordinates, where geographic coordinates normally list `y` before `x` (`latitude` before `longitude`). See for example the following query which returns points created in each of the four supported CRS. Take particular note of the order and keys of the coordinates in the original `point` function calls, and how those values are displayed in the results:

## Query

```
RETURN point({ x:3, y:0 }) AS cartesian_2d, point({ x:0, y:4, z:1 }) AS cartesian_3d, point({ latitude: 12, longitude: 56 }) AS geo_2d, point({ latitude: 12, longitude: 56, height: 1000 }) AS geo_3d
```

Table 77. Result

cartesian_2d	cartesian_3d	geo_2d	geo_3d
point({x: 3.0, y: 0.0, crs: 'cartesian'})	point({x: 0.0, y: 4.0, z: 1.0, crs: 'cartesian-3d'})	point({x: 56.0, y: 12.0, crs: 'wgs-84'})	point({x: 56.0, y: 12.0, z: 1000.0, crs: 'wgs-84-3d'})
1 row			

For the geographic coordinates, it is important to note that the `latitude` value should always lie in the interval `[-90, 90]` and any other value outside this range will throw an exception. The `longitude` value should always lie in the interval `[-180, 180]` and any other value outside this range will be wrapped around to fit in this range. The `height` value and any cartesian coordinates are not explicitly restricted, and any value within the allowed range of the signed 64-bit floating point type will be accepted.

## Accessing components of points

Just as we construct points using a map syntax, we can also access components as properties of the instance.

Table 78. Components of point instances and where they are supported

Component	Description	Type	Range/Form at	WGS-84	WGS-84-3D	Cartesian	Cartesian-3D
<code>instant.x</code>	The first element of the <i>Coordinate</i>	Float	Number literal, range depends on CRS	X	X	X	X
<code>instant.y</code>	The second element of the <i>Coordinate</i>	Float	Number literal, range depends on CRS	X	X	X	X
<code>instant.z</code>	The third element of the <i>Coordinate</i>	Float	Number literal, range depends on CRS		X		X
<code>instant.latitude</code>	The second element of the <i>Coordinate</i> for geographic CRS, degrees North of the equator	Float	Number literal, <code>-90.0</code> to <code>90.0</code>	X	X		
<code>instant.longitude</code>	The first element of the <i>Coordinate</i> for geographic CRS, degrees East of the prime meridian	Float	Number literal, <code>-180.0</code> to <code>180.0</code>	X	X		

Component	Description	Type	Range/Form at	WGS-84	WGS-84-3D	Cartesian	Cartesian-3D
instant.height	The third element of the <i>Coordinate</i> for geographic CRS, meters above the ellipsoid defined by the datum (WGS-84)	Float	Number literal, range limited only by the underlying 64-bit floating point type		X		
instant.crs	The name of the CRS	String	One of wgs-84, wgs-84-3d, cartesian, cartesian-3d	X	X	X	X
instant.srid	The internal Neo4j ID for the CRS	Integer	One of 4326, 4979, 7203, 9157	X	X	X	X

The following query shows how to extract the components of a *Cartesian 2D* point value:

#### Query

```
WITH point({ x:3, y:4 }) AS p
RETURN p.x, p.y, p.crs, p.srid
```

Table 79. Result

p.x	p.y	p.crs	p.srid
3.0	4.0	"cartesian"	7203
1 row			

The following query shows how to extract the components of a *WGS-84 3D* point value:

#### Query

```
WITH point({ latitude:3, longitude:4, height: 4321 }) AS p
RETURN p.latitude, p.longitude, p.height, p.x, p.y, p.z, p.crs, p.srid
```

Table 80. Result

p.latitude	p.longitude	p.height	p.x	p.y	p.z	p.crs	p.srid
3.0	4.0	4321.0	4.0	3.0	4321.0	"wgs-84-3d"	4979
1 row							

### 2.13.4. Spatial index

If there is a [index](#) on a particular `:Label(property)` combination, and a spatial point is assigned to that property on a node with that label, the node will be indexed in a spatial index. For spatial indexing, Neo4j uses space filling curves in 2D or 3D over an underlying generalized B+Tree. Points will be stored in up to four different trees, one for each of the [four coordinate reference systems](#). This allows for both [equality](#) and [range](#) queries using exactly the same syntax and behaviour as for other property types. If two range predicates are used, which define minimum and maximum points, this will effectively result in a [bounding box query](#). In addition, queries using the [distance](#) function can, under the right conditions, also use the index, as described in the section '[Spatial distance searches](#)'.

## 2.13.5. Comparability and Orderability

Points with different CRS are not comparable. This means that any function operating on two points of different types will return `null`. This is true of the [distance function](#) as well as inequality comparisons. If these are used in a predicate, they will cause the associated [MATCH](#) to return no results.

### Query

```
WITH point({ x:3, y:0 }) AS p2d, point({ x:0, y:4, z:1 }) AS p3d
RETURN distance(p2d,p3d), p2d < p3d, p2d = p3d, p2d <> p3d, distance(p2d,point({ x:p3d.x, y:p3d.y }))
```

Table 81. Result

distance(p2d,p3d)	p2d < p3d	p2d = p3d	p2d <> p3d	distance(p2d,point({ x:p3d.x, y:p3d.y }))
<null>	<null>	false	true	5.0
1 row				

However, all types are orderable. The Point types will be ordered after Numbers and before Temporal types. Points with different CRS will be ordered by their SRID numbers. For the current set of four [CRS](#), this means the order is WGS84, WGS84-3D, Cartesian, Cartesian-3D.

### Query

```
UNWIND [point({ x:3, y:0 }), point({ x:0, y:4, z:1 }), point({ srid:4326, x:12, y:56 }), point({ srid:4979, x:12, y:56, z:1000 })] AS point
RETURN point
ORDER BY point
```

Table 82. Result

point
point({x: 12.0, y: 56.0, crs: 'wgs-84'})
point({x: 12.0, y: 56.0, z: 1000.0, crs: 'wgs-84-3d'})
point({x: 3.0, y: 0.0, crs: 'cartesian'})
point({x: 0.0, y: 4.0, z: 1.0, crs: 'cartesian-3d'})
4 rows

## 2.14. Working with `null`

- [Introduction to `null` in Cypher](#)
- [Logical operations with `null`](#)
- [The `IN` operator and `null`](#)
- [The `\[\]` operator and `null`](#)
- [Expressions that return `null`](#)

### 2.14.1. Introduction to `null` in Cypher

In Cypher, `null` is used to represent missing or undefined values. Conceptually, `null` means 'a missing unknown value' and it is treated somewhat differently from other values. For example getting a property from a node that does not have said property produces `null`. Most expressions that take `null` as input will produce `null`. This includes boolean expressions that are used as predicates in the [WHERE](#) clause. In this case, anything that is not `true` is interpreted as being false.

`null` is not equal to `null`. Not knowing two values does not imply that they are the same value. So the expression `null = null` yields `null` and not `true`.

## 2.14.2. Logical operations with `null`

The logical operators (`AND`, `OR`, `XOR`, `NOT`) treat `null` as the 'unknown' value of three-valued logic.

Here is the truth table for `AND`, `OR`, `XOR` and `NOT`.

a	b	a AND b	a OR b	a XOR b	NOT a
false	false	false	false	false	true
false	null	false	null	null	true
false	true	false	true	true	true
true	false	false	true	true	false
true	null	null	true	null	false
true	true	true	true	false	false
null	false	false	null	null	null
null	null	null	null	null	null
null	true	null	true	null	null

## 2.14.3. The `IN` operator and `null`

The `IN` operator follows similar logic. If Cypher knows that something exists in a list, the result will be `true`. Any list that contains a `null` and doesn't have a matching element will return `null`. Otherwise, the result will be `false`. Here is a table with examples:

Expression	Result
<code>2 IN [1, 2, 3]</code>	<code>true</code>
<code>2 IN [1, null, 3]</code>	<code>null</code>
<code>2 IN [1, 2, null]</code>	<code>true</code>
<code>2 IN [1]</code>	<code>false</code>
<code>2 IN []</code>	<code>false</code>
<code>null IN [1, 2, 3]</code>	<code>null</code>
<code>null IN [1, null, 3]</code>	<code>null</code>
<code>null IN []</code>	<code>false</code>

Using `all`, `any`, `none`, and `single` follows a similar rule. If the result can be calculated definitely, `true` or `false` is returned. Otherwise `null` is produced.

## 2.14.4. The `[]` operator and `null`

Accessing a list or a map with `null` will result in `null`:

Expression	Result
<code>[1, 2, 3][null]</code>	<code>null</code>
<code>[1, 2, 3, 4][null..2]</code>	<code>null</code>
<code>[1, 2, 3][1..null]</code>	<code>null</code>

Expression	Result
{age: 25}[]	null

Using parameters to pass in the bounds, such as `a[$lower..$upper]`, may result in a `null` for the lower or upper bound (or both). The following workaround will prevent this from happening by setting the absolute minimum and maximum bound values:

```
a[coalesce($lower,0)..coalesce($upper,size(a))]
```

## 2.14.5. Expressions that return `null`

- Getting a missing element from a list: `[][], head([])`
- Trying to access a property that does not exist on a node or relationship: `n.missingProperty`
- Comparisons when either side is `null`: `1 < null`
- Arithmetic expressions containing `null`: `1 + null`
- Function calls where any arguments are `null`: `sin(null)`

# Chapter 3. Clauses

This section contains information on all the clauses in the Cypher query language.

- [Reading clauses](#)
- [Projecting clauses](#)
- [Reading sub-clauses](#)
- [Reading hints](#)
- [Writing clauses](#)
- [Reading/Writing clauses](#)
- [Set operations](#)
- [Subquery clauses](#)
- [Multiple graphs](#)
- [Importing data](#)
- [Administration clauses](#)

## Reading clauses

These comprise clauses that read data from the database.

The flow of data within a Cypher query is an unordered sequence of maps with key-value pairs — a set of possible bindings between the variables in the query and values derived from the database. This set is refined and augmented by subsequent parts of the query.

Clause	Description
<a href="#">MATCH</a>	Specify the patterns to search for in the database.
<a href="#">OPTIONAL MATCH</a>	Specify the patterns to search for in the database while using <code>nulls</code> for missing parts of the pattern.

## Projecting clauses

These comprise clauses that define which expressions to return in the result set. The returned expressions may all be aliased using `AS`.

Clause	Description
<a href="#">RETURN ... [AS]</a>	Defines what to include in the query result set.
<a href="#">WITH ... [AS]</a>	Allows query parts to be chained together, piping the results from one to be used as starting points or criteria in the next.
<a href="#">UNWIND ... [AS]</a>	Expands a list into a sequence of rows.

## Reading sub-clauses

These comprise sub-clauses that must operate as part of reading clauses.

Sub-clause	Description
<a href="#">WHERE</a>	Adds constraints to the patterns in a <code>MATCH</code> or <code>OPTIONAL MATCH</code> clause or filters the results of a <code>WITH</code> clause.
<a href="#">WHERE EXISTS {...}</a>	An existential sub-query used to filter the results of a <code>MATCH</code> , <code>OPTIONAL MATCH</code> or <code>WITH</code> clause.

Sub-clause	Description
ORDER BY [ASC[ENDING]   DESC[ENDING]]	A sub-clause following RETURN or WITH, specifying that the output should be sorted in either ascending (the default) or descending order.
SKIP	Defines from which row to start including the rows in the output.
LIMIT	Constrains the number of rows in the output.

## Reading hints

These comprise clauses used to specify planner hints when tuning a query. More details regarding the usage of these — and query tuning in general — can be found in [Planner hints and the USING keyword](#).

Hint	Description
USING INDEX	Index hints are used to specify which index, if any, the planner should use as a starting point.
USING INDEX SEEK	Index seek hint instructs the planner to use an index seek for this clause.
USING SCAN	Scan hints are used to force the planner to do a label scan (followed by a filtering operation) instead of using an index.
USING JOIN	Join hints are used to enforce a join operation at specified points.

## Writing clauses

These comprise clauses that write the data to the database.

Clause	Description
CREATE	Create nodes and relationships.
DELETE	Delete nodes, relationships or paths. Any node to be deleted must also have all associated relationships explicitly deleted.
DETACH DELETE	Delete a node or set of nodes. All associated relationships will automatically be deleted.
SET	Update labels on nodes and properties on nodes and relationships.
REMOVE	Remove properties and labels from nodes and relationships.
FOREACH	Update data within a list, whether components of a path, or the result of aggregation.

## Reading/Writing clauses

These comprise clauses that both read data from and write data to the database.

Clause	Description
MERGE	Ensures that a pattern exists in the graph. Either the pattern already exists, or it needs to be created.
--- ON CREATE	Used in conjunction with MERGE, this write sub-clause specifies the actions to take if the pattern needs to be created.
--- ON MATCH	Used in conjunction with MERGE, this write sub-clause specifies the actions to take if the pattern already exists.

Clause	Description
<code>CALL [...YIELD]</code>	Invokes a procedure deployed in the database and return any results.

## Set operations

Clause	Description
<code>UNION</code>	Combines the result of multiple queries into a single result set. Duplicates are removed.
<code>UNION ALL</code>	Combines the result of multiple queries into a single result set. Duplicates are retained.

## Subquery clauses

Clause	Description
<code>CALL { ... }</code>	Evaluates a subquery, typically used for post-union processing or aggregations.

## Multiple graphs

Clause	Description
<code>USE</code>	Determines which graph a query, or query part, is executed against.

## Importing data

Clause	Description
<code>LOAD CSV</code>	Use when importing data from CSV files.
<code>--- USING PERIODIC COMMIT</code>	This query hint may be used to prevent an out-of-memory error from occurring when importing large amounts of data using <code>LOAD CSV</code> .

## Administration clauses

These comprise clauses used to manage databases, schema and security; further details can found in [Administration](#).

Clause	Description
<code>CREATE   DROP   START   STOP DATABASE</code>	Create, drop, start or stop a database.
<code>CREATE   DROP INDEX</code>	Create or drop an index on all nodes with a particular label and property.
<code>CREATE   DROP CONSTRAINT</code>	Create or drop a constraint pertaining to either a node label or relationship type, and a property.
<code>Users, roles, privileges</code>	Manage users, roles and privileges for database, graph and sub-graph access control.

## 3.1. MATCH

The `MATCH` clause is used to search for the pattern described in it.

- [Introduction](#)
- [Basic node finding](#)

- Get all nodes
- Get all nodes with a label
- Related nodes
- Match with labels
- Relationship basics
  - Outgoing relationships
  - Directed relationships and variable
  - Match on relationship type
  - Match on multiple relationship types
  - Match on relationship type and use a variable
- Relationships in depth
  - Relationship types with uncommon characters
  - Multiple relationships
  - Variable length relationships
  - Variable length relationships with multiple relationship types
  - Relationship variable in variable length relationships
  - Match with properties on a variable length path
  - Zero length paths
  - Named paths
  - Matching on a bound relationship
- Shortest path
  - Single shortest path
  - Single shortest path with predicates
  - All shortest paths
- Get node or relationship by id
  - Node by id
  - Relationship by id
  - Multiple nodes by id

### 3.1.1. Introduction

The **MATCH** clause allows you to specify the patterns Neo4j will search for in the database. This is the primary way of getting data into the current set of bindings. It is worth reading up more on the specification of the patterns themselves in [Patterns](#).

**MATCH** is often coupled to a **WHERE** part which adds restrictions, or predicates, to the **MATCH** patterns, making them more specific. The predicates are part of the pattern description, and should not be considered a filter applied only after the matching is done. *This means that WHERE should always be put together with the MATCH clause it belongs to.*

**MATCH** can occur at the beginning of the query or later, possibly after a **WITH**. If it is the first clause, nothing will have been bound yet, and Neo4j will design a search to find the results matching the clause and any associated predicates specified in any **WHERE** part. This could involve a scan of the database, a search for nodes having a certain label, or a search of an index to find starting points for the pattern matching. Nodes and relationships found by this search are available as *bound pattern elements*, and can be used for pattern matching of paths. They can also be used in any further **MATCH**

clauses, where Neo4j will use the known elements, and from there find further unknown elements.

Cypher is declarative, and so usually the query itself does not specify the algorithm to use to perform the search. Neo4j will automatically work out the best approach to finding start nodes and matching patterns. Predicates in `WHERE` parts can be evaluated before pattern matching, during pattern matching, or after finding matches. However, there are cases where you can influence the decisions taken by the query compiler. Read more about indexes in [Indexes for search performance](#), and more about specifying hints to force Neo4j to solve a query in a specific way in [Planner hints and the USING keyword](#).



To understand more about the patterns used in the `MATCH` clause, read [Patterns](#)

The following graph is used for the examples below:

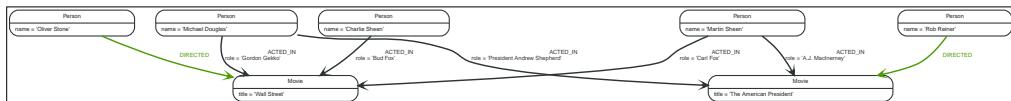


Figure 6. Graph

### 3.1.2. Basic node finding

#### Get all nodes

By just specifying a pattern with a single node and no labels, all nodes in the graph will be returned.

##### Query

```
MATCH (n)
RETURN n
```

Returns all the nodes in the database.

Table 83. Result

n
Node[0]{name: "Charlie Sheen"}
Node[1]{name: "Martin Sheen"}
Node[2]{name: "Michael Douglas"}
Node[3]{name: "Oliver Stone"}
Node[4]{name: "Rob Reiner"}
Node[5]{title: "Wall Street"}
Node[6]{title: "The American President"}
7 rows

#### Get all nodes with a label

Getting all nodes with a label on them is done with a single node pattern where the node has a label on it.

##### Query

```
MATCH (movie:Movie)
RETURN movie.title
```

Returns all the movies in the database.

Table 84. Result

movie.title
"Wall Street"
"The American President"
2 rows

## Related nodes

The symbol `--` means *related to*, without regard to type or direction of the relationship.

Query

```
MATCH (director { name: 'Oliver Stone' })--(movie)
RETURN movie.title
```

Returns all the movies directed by '**Oliver Stone**'.

Table 85. Result

movie.title
"Wall Street"
1 row

## Match with labels

To constrain your pattern with labels on nodes, you add it to your pattern nodes, using the label syntax.

Query

```
MATCH (:Person { name: 'Oliver Stone' })--(movie:Movie)
RETURN movie.title
```

Returns any nodes connected with the **Person 'Oliver'** that are labeled **Movie**.

Table 86. Result

movie.title
"Wall Street"
1 row

## 3.1.3. Relationship basics

### Outgoing relationships

When the direction of a relationship is of interest, it is shown by using `->` or `-<-`, like this:

Query

```
MATCH (:Person { name: 'Oliver Stone' })->(movie)
RETURN movie.title
```

Returns any nodes connected with the Person 'Oliver' by an outgoing relationship.

Table 87. Result

movie.title
"Wall Street"
1 row

## Directed relationships and variable

If a variable is required, either for filtering on properties of the relationship, or to return the relationship, this is how you introduce the variable.

Query

```
MATCH (:Person { name: 'Oliver Stone' })-[r]->(movie)
RETURN type(r)
```

Returns the type of each outgoing relationship from 'Oliver'.

Table 88. Result

type(r)
"DIRECTED"
1 row

## Match on relationship type

When you know the relationship type you want to match on, you can specify it by using a colon together with the relationship type.

Query

```
MATCH (wallstreet:Movie { title: 'Wall Street' })<[:-ACTED_IN]-(actor)
RETURN actor.name
```

Returns all actors that ACTED\_IN 'Wall Street'.

Table 89. Result

actor.name
"Michael Douglas"
"Martin Sheen"
"Charlie Sheen"
3 rows

## Match on multiple relationship types

To match on one of multiple types, you can specify this by chaining them together with the pipe symbol |.

Query

```
MATCH (wallstreet { title: 'Wall Street' })<[:-ACTED_IN|:DIRECTED]-(person)
RETURN person.name
```

Returns nodes with an `ACTED_IN` or `DIRECTED` relationship to 'Wall Street'.

Table 90. Result

person.name
"Oliver Stone"
"Michael Douglas"
"Martin Sheen"
"Charlie Sheen"
4 rows

Match on relationship type and use a variable

If you both want to introduce a variable to hold the relationship, and specify the relationship type you want, just add them both, like this:

Query

```
MATCH (wallstreet { title: 'Wall Street' })<-[r:ACTED_IN]-(actor)
RETURN r.role
```

Returns `ACTED_IN` roles for 'Wall Street'.

Table 91. Result

r.role
"Gordon Gekko"
"Carl Fox"
"Bud Fox"
3 rows

### 3.1.4. Relationships in depth



Inside a single pattern, relationships will only be matched once. You can read more about this in [Cypher Result Uniqueness](#).

Relationship types with uncommon characters

Sometimes your database will have types with non-letter characters, or with spaces in them. Use ``` (backtick) to quote these. To demonstrate this we can add an additional relationship between 'Charlie Sheen' and 'Rob Reiner':

Query

```
MATCH (charlie:Person { name: 'Charlie Sheen' }),(rob:Person { name: 'Rob Reiner' })
CREATE (rob)-[:`TYPE INCLUDING A SPACE`->(charlie)
```

Which leads to the following graph:

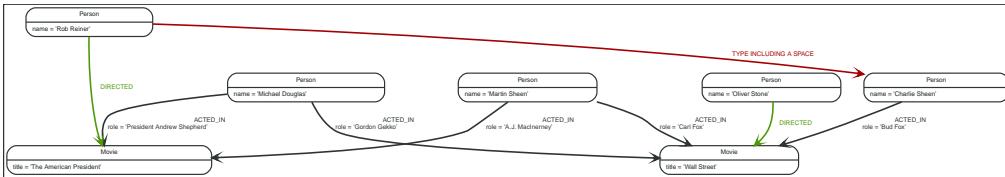


Figure 7. Graph

### Query

```
MATCH (n { name: 'Rob Reiner' })-[r: `TYPE INCLUDING A SPACE`]->()
RETURN type(r)
```

Returns a relationship type with spaces in it.

### Table 92. Result

type(r)
"TYPE INCLUDING A SPACE"
1 row

### Multiple relationships

Relationships can be expressed by using multiple statements in the form of `( )--( )`, or they can be strung together, like this:

### Query

```
MATCH (charlie { name: 'Charlie Sheen' })-[:ACTED_IN]->(movie)<-[:DIRECTED]-(director)
RETURN movie.title, director.name
```

Returns the movie '**Charlie Sheen**' acted in and its director.

### Table 93. Result

movie.title	director.name
"Wall Street"	"Oliver Stone"
1 row	

### Variable length relationships

Nodes that are a variable number of relationship node hops away can be found using the following syntax: `-[:TYPE*minHops..maxHops]->`. `minHops` and `maxHops` are optional and default to 1 and infinity respectively. When no bounds are given the dots may be omitted. The dots may also be omitted when setting only one bound and this implies a fixed length pattern.

### Query

```
MATCH (charlie { name: 'Charlie Sheen' })-[:ACTED_IN*1..3]->(movie:Movie)
RETURN movie.title
```

Returns all movies related to '**Charlie Sheen**' by 1 to 3 hops.

### Table 94. Result

movie.title
"Wall Street"

movie.title
"The American President"
"The American President"
3 rows

## Variable length relationships with multiple relationship types

Variable length relationships can be combined with multiple relationship types. In this case the `*minHops..maxHops` applies to all relationship types as well as any combination of them.

### Query

```
MATCH (charlie { name: 'Charlie Sheen' })-[:ACTED_IN|DIRECTED*2]-(person:Person)
RETURN person.name
```

Returns all people related to '**Charlie Sheen**' by 2 hops with any combination of the relationship types **ACTED\_IN** and **DIRECTED**.

*Table 95. Result*

person.name
"Oliver Stone"
"Michael Douglas"
"Martin Sheen"
3 rows

## Relationship variable in variable length relationships

When the connection between two nodes is of variable length, the list of relationships comprising the connection can be returned using the following syntax:

### Query

```
MATCH p =(actor { name: 'Charlie Sheen' })-[:ACTED_IN*2]-(co_actor)
RETURN relationships(p)
```

Returns a list of relationships.

*Table 96. Result*

relationships(p)
[:ACTED_IN[0]{role:"Bud Fox"}, :ACTED_IN[2]{role:"Gordon Gekko"}]
[:ACTED_IN[0]{role:"Bud Fox"}, :ACTED_IN[1]{role:"Carl Fox"}]
2 rows

## Match with properties on a variable length path

A variable length relationship with properties defined on it means that all relationships in the path must have the property set to the given value. In this query, there are two paths between '**Charlie Sheen**' and his father '**Martin Sheen**'. One of them includes a '**blocked**' relationship and the other doesn't. In this case we first alter the original graph by using the following query to add **BLOCKED** and **UNBLOCKED** relationships:

## Query

```
MATCH (charlie:Person { name: 'Charlie Sheen' }), (martin:Person { name: 'Martin Sheen' })
CREATE (charlie)-[:X { blocked: FALSE }]->(:UNBLOCKED)<-[:X { blocked: FALSE }]->(martin)
CREATE (charlie)-[:X { blocked: TRUE }]->(:BLOCKED)<-[:X { blocked: FALSE }]->(martin)
```

This means that we are starting out with the following graph:



Figure 8. Graph

## Query

```
MATCH p = (charlie:Person)-[* { blocked:false }]->(martin:Person)
WHERE charlie.name = 'Charlie Sheen' AND martin.name = 'Martin Sheen'
RETURN p
```

Returns the paths between '**Charlie Sheen**' and '**Martin Sheen**' where all relationships have the **blocked** property set to **false**.

Table 97. Result

p
(0)-[X,7]->(7)<-[X,8]-(1)
1 row

## Zero length paths

Using variable length paths that have the lower bound zero means that two variables can point to the same node. If the path length between two nodes is zero, they are by definition the same node. Note that when matching zero length paths the result may contain a match even when matching on a relationship type not in use.

## Query

```
MATCH (wallstreet:Movie { title: 'Wall Street' })-[*0..1]-(x)
RETURN x
```

Returns the movie itself as well as actors and directors one relationship away

Table 98. Result

x
Node[5]{title:"Wall Street"}
Node[3]{name:"Oliver Stone"}
Node[2]{name:"Michael Douglas"}
Node[1]{name:"Martin Sheen"}
Node[0]{name:"Charlie Sheen"}
5 rows

## Named paths

If you want to return or filter on a path in your pattern graph, you can introduce a named path.

## Query

```
MATCH p = (michael { name: 'Michael Douglas' })-->()
RETURN p
```

Returns the two paths starting from 'Michael Douglas'

Table 99. Result

p
(2)-[ACTED_IN,2]->(5)
(2)-[ACTED_IN,5]->(6)
2 rows

Matching on a bound relationship

When your pattern contains a bound relationship, and that relationship pattern doesn't specify direction, Cypher will try to match the relationship in both directions.

## Query

```
MATCH (a)-[r]-(b)
WHERE id(r)= 0
RETURN a,b
```

This returns the two connected nodes, once as the start node, and once as the end node

Table 100. Result

a	b
Node[0]{name:"Charlie Sheen"}	Node[5]{title:"Wall Street"}
Node[5]{title:"Wall Street"}	Node[0]{name:"Charlie Sheen"}
2 rows	

## 3.1.5. Shortest path

Single shortest path

Finding a single shortest path between two nodes is as easy as using the `shortestPath` function. It's done like this:

## Query

```
MATCH (martin:Person { name: 'Martin Sheen' }),(oliver:Person { name: 'Oliver Stone' }), p =
shortestPath((martin)-[*..15]-(oliver))
RETURN p
```

This means: find a single shortest path between two nodes, as long as the path is max 15 relationships long. Within the parentheses you define a single link of a path — the starting node, the connecting relationship and the end node. Characteristics describing the relationship like relationship type, max hops and direction are all used when finding the shortest path. If there is a `WHERE` clause following the match of a `shortestPath`, relevant predicates will be included in the `shortestPath`. If the predicate is a `none()` or `all()` on the relationship elements of the path, it will be used during the search to improve performance (see [Shortest path planning](#)).

Table 101. Result

p

(1)-[ACTED\_IN,1]->(5)<-[DIRECTED,3]-(3)

1 row

## Single shortest path with predicates

Predicates used in the `WHERE` clause that apply to the shortest path pattern are evaluated before deciding what the shortest matching path is.

### Query

```
MATCH (charlie:Person { name: 'Charlie Sheen' }),(martin:Person { name: 'Martin Sheen' }), p =  
shortestPath((charlie)-[*]-(martin))  
WHERE NONE (r IN relationships(p) WHERE type(r)= 'FATHER')  
RETURN p
```

This query will find the shortest path between '**Charlie Sheen**' and '**Martin Sheen**', and the `WHERE` predicate will ensure that we don't consider the father/son relationship between the two.

Table 102. Result

p

(0)-[ACTED\_IN,0]->(5)<-[ACTED\_IN,1]-(1)

1 row

## All shortest paths

Finds all the shortest paths between two nodes.

### Query

```
MATCH (martin:Person { name: 'Martin Sheen' }),(michael:Person { name: 'Michael Douglas' }), p =  
allShortestPaths((martin)-[*]-(michael))  
RETURN p
```

Finds the two shortest paths between '**Martin Sheen**' and '**Michael Douglas**'.

Table 103. Result

p

(1)-[ACTED\_IN,1]->(5)<-[ACTED\_IN,2]-(2)

(1)-[ACTED\_IN,4]->(6)<-[ACTED\_IN,5]-(2)

2 rows

## 3.1.6. Get node or relationship by id

### Node by id

Searching for nodes by id can be done with the `id()` function in a predicate.



Neo4j reuses its internal ids when nodes and relationships are deleted. This means that applications using, and relying on internal Neo4j ids, are brittle or at risk of making mistakes. It is therefore recommended to rather use application-generated ids.

## Query

```
MATCH (n)
WHERE id(n)= 0
RETURN n
```

The corresponding node is returned.

Table 104. Result

n
Node[0]{name:"Charlie Sheen"}
1 row

## Relationship by id

Search for relationships by id can be done with the `id()` function in a predicate.

This is not recommended practice. See [Node by id](#) for more information on the use of Neo4j ids.

## Query

```
MATCH ()-[r]->()
WHERE id(r)= 0
RETURN r
```

The relationship with id `0` is returned.

Table 105. Result

r
:ACTED_IN[0]{role:"Bud Fox"}
1 row

## Multiple nodes by id

Multiple nodes are selected by specifying them in an IN clause.

## Query

```
MATCH (n)
WHERE id(n) IN [0, 3, 5]
RETURN n
```

This returns the nodes listed in the IN expression.

Table 106. Result

n
Node[0]{name:"Charlie Sheen"}
Node[3]{name:"Oliver Stone"}
Node[5]{title:"Wall Street"}
3 rows

## 3.2. OPTIONAL MATCH

The `OPTIONAL MATCH` clause is used to search for the pattern described in it, while using `null` for missing parts of the pattern.

- Introduction
- Optional relationships
- Properties on optional elements
- Optional typed and named relationship

### 3.2.1. Introduction

`OPTIONAL MATCH` matches patterns against your graph database, just like `MATCH` does. The difference is that if no matches are found, `OPTIONAL MATCH` will use a `null` for missing parts of the pattern. `OPTIONAL MATCH` could be considered the Cypher equivalent of the outer join in SQL.

Either the whole pattern is matched, or nothing is matched. Remember that `WHERE` is part of the pattern description, and the predicates will be considered while looking for matches, not after. This matters especially in the case of multiple (`OPTIONAL`) `MATCH` clauses, where it is crucial to put `WHERE` together with the `MATCH` it belongs to.



To understand the patterns used in the `OPTIONAL MATCH` clause, read [Patterns](#).

The following graph is used for the examples below:

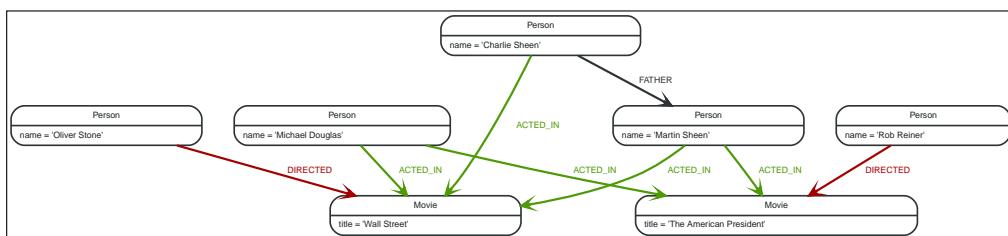


Figure 9. Graph

### 3.2.2. Optional relationships

If a relationship is optional, use the `OPTIONAL MATCH` clause. This is similar to how a SQL outer join works. If the relationship is there, it is returned. If it's not, `null` is returned in its place.

#### Query

```
MATCH (a:Movie { title: 'Wall Street' })
OPTIONAL MATCH (a)-->(x)
RETURN x
```

Returns `null`, since the node has no outgoing relationships.

Table 107. Result

x
<null>
1 row

### 3.2.3. Properties on optional elements

Returning a property from an optional element that is `null` will also return `null`.

#### Query

```
MATCH (a:Movie { title: 'Wall Street' })
OPTIONAL MATCH (a)-->(x)
RETURN x, x.name
```

Returns the element x (`null` in this query), and `null` as its name.

Table 108. Result

x	x.name
<null>	<null>
1 row	

### 3.2.4. Optional typed and named relationship

Just as with a normal relationship, you can decide which variable it goes into, and what relationship type you need.

#### Query

```
MATCH (a:Movie { title: 'Wall Street' })
OPTIONAL MATCH (a)-[r:ACTS_IN]->()
RETURN a.title, r
```

This returns the title of the node, '**Wall Street**', and, since the node has no outgoing `ACTS_IN` relationships, `null` is returned for the relationship denoted by `r`.

Table 109. Result

a.title	r
"Wall Street"	<null>
1 row	

## 3.3. RETURN

The `RETURN` clause defines what to include in the query result set.

- [Introduction](#)
- [Return nodes](#)
- [Return relationships](#)
- [Return property](#)
- [Return all elements](#)
- [Variable with uncommon characters](#)
- [Column alias](#)
- [Optional properties](#)
- [Other expressions](#)

- Unique results

### 3.3.1. Introduction

In the `RETURN` part of your query, you define which parts of the pattern you are interested in. It can be nodes, relationships, or properties on these.



If what you actually want is the value of a property, make sure to not return the full node/relationship. This will improve performance.

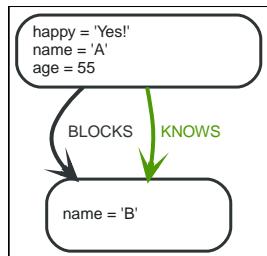


Figure 10. Graph

### 3.3.2. Return nodes

To return a node, list it in the `RETURN` statement.

#### Query

```

MATCH (n { name: 'B' })
RETURN n
  
```

The example will return the node.

#### Table 110. Result

n
Node[1]{name: "B"}
1 row

### 3.3.3. Return relationships

To return a relationship, just include it in the `RETURN` list.

#### Query

```

MATCH (n { name: 'A' })-[r:KNOWS]->(c)
RETURN r
  
```

The relationship is returned by the example.

#### Table 111. Result

r
:KNOWS[0]{}
1 row

### 3.3.4. Return property

To return a property, use the dot separator, like this:

#### Query

```
MATCH (n { name: 'A' })
RETURN n.name
```

The value of the property `name` gets returned.

Table 112. Result

n.name
"A"
1 row

### 3.3.5. Return all elements

When you want to return all nodes, relationships and paths found in a query, you can use the `*` symbol.

#### Query

```
MATCH p =(a { name: 'A' })-[r]->(b)
RETURN *
```

This returns the two nodes, the relationship and the path used in the query.

Table 113. Result

a	b	p	r
Node[0]{happy:"Yes!",name:"A",age:55}	Node[1]{name:"B"}	(0)-[BLOCKS,1]->(1)	:BLOCKS[1]{}
Node[0]{happy:"Yes!",name:"A",age:55}	Node[1]{name:"B"}	(0)-[KNOWS,0]->(1)	:KNOWS[0]{}
2 rows			

### 3.3.6. Variable with uncommon characters

To introduce a placeholder that is made up of characters that are not contained in the English alphabet, you can use the ``` to enclose the variable, like this:

#### Query

```
MATCH (`This isn't a common variable`)
WHERE `This isn't a common variable`.name = 'A'
RETURN `This isn't a common variable`.happy
```

The node with name "A" is returned.

Table 114. Result

`This isn't a common variable`.happy
"Yes!"
1 row

### 3.3.7. Column alias

If the name of the column should be different from the expression used, you can rename it by using `AS <new name>`.

#### Query

```
MATCH (a { name: 'A' })
RETURN a.age AS SomethingTotallyDifferent
```

Returns the age property of a node, but renames the column.

Table 115. Result

SomethingTotallyDifferent
55
1 row

### 3.3.8. Optional properties

If a property might or might not be there, you can still select it as usual. It will be treated as `null` if it is missing.

#### Query

```
MATCH (n)
RETURN n.age
```

This example returns the age when the node has that property, or `null` if the property is not there.

Table 116. Result

n.age
55
<null>
2 rows

### 3.3.9. Other expressions

Any expression can be used as a return item — literals, predicates, properties, functions, and everything else.

#### Query

```
MATCH (a { name: 'A' })
RETURN a.age > 30, "I'm a literal",(a)-->()
```

Returns a predicate, a literal and function call with a pattern expression parameter.

Table 117. Result

a.age > 30	"I'm a literal"	(a)-->()
true	"I'm a literal"	[(0)-[BLOCKS,1]->(1),(0)-[KNOWS,0]->(1)]
1 row		

### 3.3.10. Unique results

`DISTINCT` retrieves only unique rows depending on the columns that have been selected to output.

#### Query

```
MATCH (a { name: 'A' })-->(b)  
RETURN DISTINCT b
```

The node named "B" is returned by the query, but only once.

Table 118. Result

b
Node[1]{name: "B"}
1 row

## 3.4. WITH

The `WITH` clause allows query parts to be chained together, piping the results from one to be used as starting points or criteria in the next.



It is important to note that `WITH` affects variables in scope. Any variables not included in the `WITH` clause are not carried over to the rest of the query.

- [Introduction](#)
- [Filter on aggregate function results](#)
- [Sort results before using collect on them](#)
- [Limit branching of a path search](#)

### 3.4.1. Introduction

Using `WITH`, you can manipulate the output before it is passed on to the following query parts. The manipulations can be of the shape and/or number of entries in the result set.

One common usage of `WITH` is to limit the number of entries that are then passed on to other `MATCH` clauses. By combining `ORDER BY` and `LIMIT`, it's possible to get the top X entries by some criteria, and then bring in additional data from the graph.

Another use is to filter on aggregated values. `WITH` is used to introduce aggregates which can then be used in predicates in `WHERE`. These aggregate expressions create new bindings in the results. `WITH` can also, like `RETURN`, alias expressions that are introduced into the results using the aliases as the binding name.

`WITH` is also used to separate reading from updating of the graph. Every part of a query must be either read-only or write-only. When going from a writing part to a reading part, the switch must be done with a `WITH` clause.

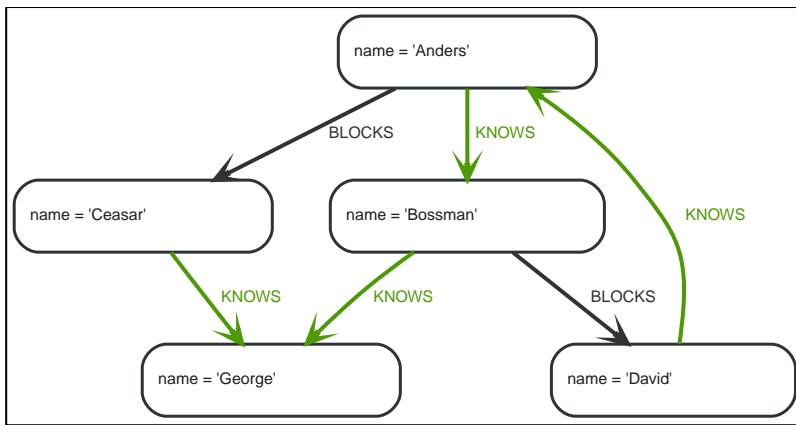


Figure 11. Graph

### 3.4.2. Filter on aggregate function results

Aggregated results have to pass through a **WITH** clause to be able to filter on.

#### Query

```

MATCH (david { name: 'David' })--(otherPerson)-->()
WITH otherPerson, count(*) AS foaf
WHERE foaf > 1
RETURN otherPerson.name

```

The name of the person connected to '**David**' with at least more than one outgoing relationship will be returned by the query.

#### Table 119. Result

otherPerson.name
"Anders"
1 row

### 3.4.3. Sort results before using collect on them

You can sort your results before passing them to collect, thus sorting the resulting list.

#### Query

```

MATCH (n)
WITH n
ORDER BY n.name DESC LIMIT 3
RETURN collect(n.name)

```

A list of the names of people in reverse order, limited to 3, is returned in a list.

#### Table 120. Result

collect(n.name)
["George", "David", "Ceasar"]
1 row

### 3.4.4. Limit branching of a path search

You can match paths, limit to a certain number, and then match again using those paths as a base, as

well as any number of similar limited searches.

### Query

```
MATCH (n { name: 'Anders' })--(m)
WITH m
ORDER BY m.name DESC LIMIT 1
MATCH (m)--(o)
RETURN o.name
```

Starting at '**Anders**', find all matching nodes, order by name descending and get the top result, then find all the nodes connected to that top result, and return their names.

Table 121. Result

o.name
" <b>Anders</b> "
" <b>Bossman</b> "
2 rows

## 3.5. UNWIND

**UNWIND** expands a list into a sequence of rows.

- [Introduction](#)
- [Unwinding a list](#)
- [Creating a distinct list](#)
- [Using \*\*UNWIND\*\* with any expression returning a list](#)
- [Using \*\*UNWIND\*\* with a list of lists](#)
- [Using \*\*UNWIND\*\* with an empty list](#)
- [Using \*\*UNWIND\*\* with an expression that is not a list](#)
- [Creating nodes from a list parameter](#)

### 3.5.1. Introduction

With **UNWIND**, you can transform any list back into individual rows. These lists can be parameters that were passed in, previously **collect**-ed result or other list expressions.

One common usage of unwind is to create distinct lists. Another is to create data from parameter lists that are provided to the query.

**UNWIND** requires you to specify a new name for the inner values.

### 3.5.2. Unwinding a list

We want to transform the literal list into rows named **x** and return them.

### Query

```
UNWIND [1, 2, 3, NULL ] AS x
RETURN x, 'val' AS y
```

Each value of the original list — including `null` — is returned as an individual row.

Table 122. Result

x	y
1	"val"
2	"val"
3	"val"
<null>	"val"
4 rows	

### 3.5.3. Creating a distinct list

We want to transform a list of duplicates into a set using `DISTINCT`.

Query

```
WITH [1, 1, 2, 2] AS coll
UNWIND coll AS x
WITH DISTINCT x
RETURN collect(x) AS setOfVals
```

Each value of the original list is unwound and passed through `DISTINCT` to create a unique set.

Table 123. Result

setOfVals
[1, 2]
1 row

### 3.5.4. Using `UNWIND` with any expression returning a list

Any expression that returns a list may be used with `UNWIND`.

Query

```
WITH [1, 2] AS a,[3, 4] AS b
UNWIND (a + b) AS x
RETURN x
```

The two lists —  $a$  and  $b$  — are concatenated to form a new list, which is then operated upon by `UNWIND`.

Table 124. Result

x
1
2
3
4
4 rows

### 3.5.5. Using UNWIND with a list of lists

Multiple `UNWIND` clauses can be chained to unwind nested list elements.

#### Query

```
WITH [[1, 2], [3, 4], 5] AS nested
UNWIND nested AS x
UNWIND x AS y
RETURN y
```

The first `UNWIND` results in three rows for `x`, each of which contains an element of the original list (two of which are also lists); namely, `[1, 2]`, `[3, 4]` and `5`. The second `UNWIND` then operates on each of these rows in turn, resulting in five rows for `y`.

Table 125. Result

y
1
2
3
4
5
5 rows

### 3.5.6. Using UNWIND with an empty list

Using an empty list with `UNWIND` will produce no rows, irrespective of whether or not any rows existed beforehand, or whether or not other values are being projected.

Essentially, `UNWIND []` reduces the number of rows to zero, and thus causes the query to cease its execution, returning no results. This has value in cases such as `UNWIND v`, where `v` is a variable from an earlier clause that may or may not be an empty list — when it is an empty list, this will behave just as a `MATCH` that has no results.

#### Query

```
UNWIND [] AS empty
RETURN empty, 'literal_that_is_not_returned'
```

Table 126. Result

(empty result)
0 rows

To avoid inadvertently using `UNWIND` on an empty list, `CASE` may be used to replace an empty list with a `null`:

```
WITH [] AS list
UNWIND
CASE
  WHEN list = []
    THEN [null]
  ELSE list
END AS emptylist
RETURN emptylist
```

### 3.5.7. Using UNWIND with an expression that is not a list

Using `UNWIND` on an expression that does not return a list, will return the same result as using `UNWIND` on a list that just contains that expression. As an example, `UNWIND 5` is effectively equivalent to `UNWIND[5]`. The exception to this is when the expression returns `null` — this will reduce the number of rows to zero, causing it to cease its execution and return no results.

#### Query

```
UNWIND NULL AS x
RETURN x, 'some_literal'
```

Table 127. Result

(empty result)
0 rows

### 3.5.8. Creating nodes from a list parameter

Create a number of nodes and relationships from a parameter-list without using `FOREACH`.

#### Parameters

```
{
  "events" : [ {
    "year" : 2014,
    "id" : 1
  }, {
    "year" : 2014,
    "id" : 2
  } ]
}
```

#### Query

```
UNWIND $events AS event
MERGE (y:Year { year: event.year })
MERGE (y)-[:IN]-(e:Event { id: event.id })
RETURN e.id AS x
ORDER BY x
```

Each value of the original list is unwound and passed through `MERGE` to find or create the nodes and relationships.

Table 128. Result

x
1
2

2 rows, Nodes created: 3  
Relationships created: 2  
Properties set: 3  
Labels added: 3

## 3.6. WHERE

`WHERE` adds constraints to the patterns in a `MATCH` or `OPTIONAL MATCH` clause or filters the results of a `WITH` clause.

- Introduction
- Basic usage
  - Boolean operations
  - Filter on node label
  - Filter on node property
  - Filter on relationship property
  - Filter on dynamically-computed property
  - Property existence checking
- String matching
  - Prefix string search using `STARTS WITH`
  - Suffix string search using `ENDS WITH`
  - Substring search using `CONTAINS`
  - String matching negation
- Regular expressions
  - Matching using regular expressions
  - Escaping in regular expressions
  - Case-insensitive regular expressions
- Using path patterns in `WHERE`
  - Filter on patterns
  - Filter on patterns using `NOT`
  - Filter on patterns with properties
  - Filter on relationship type
- Using existential subqueries in `WHERE`
  - Simple existential subquery
  - Existential subquery with `WHERE` clause
  - Nesting existential subqueries
- Lists
  - `IN` operator
- Missing properties and values
  - Default to `false` if property is missing
  - Default to `true` if property is missing
  - Filter on `null`
- Using ranges
  - Simple range
  - Composite range

### 3.6.1. Introduction

`WHERE` is not a clause in its own right — rather, it's part of `MATCH`, `OPTIONAL MATCH` and `WITH`.

In the case of `WITH`, `WHERE` simply filters the results.

For `MATCH` and `OPTIONAL MATCH` on the other hand, `WHERE` adds constraints to the patterns described. *It should not be seen as a filter after the matching is finished.*



In the case of multiple `MATCH / OPTIONAL MATCH` clauses, the predicate in `WHERE` is always a part of the patterns in the directly preceding `MATCH / OPTIONAL MATCH`. Both results and performance may be impacted if the `WHERE` is put inside the wrong `MATCH` clause.



**Indexes** may be used to optimize queries using `WHERE` in a variety of cases.

The following graph is used for the examples below:

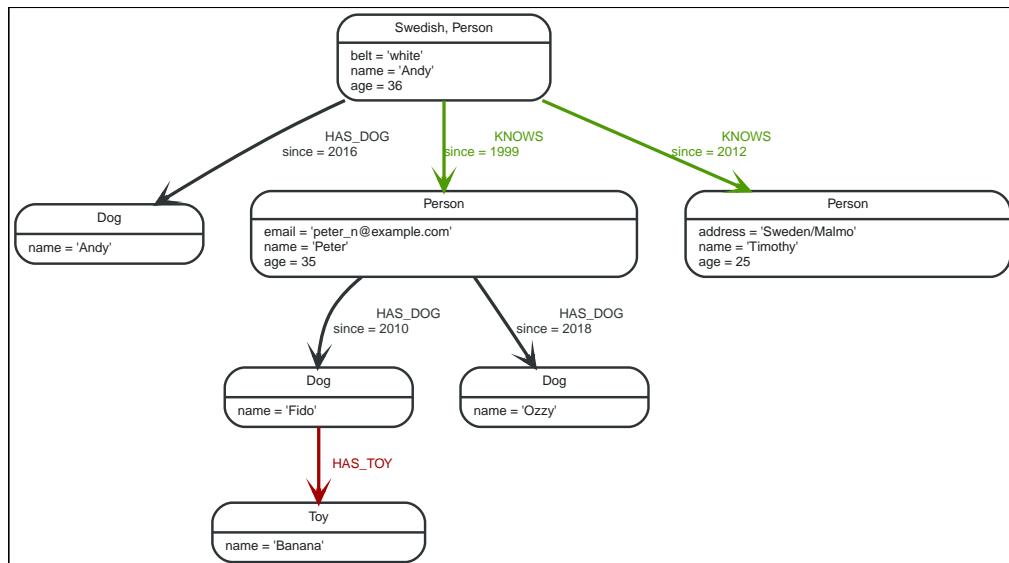


Figure 12. Graph

### 3.6.2. Basic usage

#### Boolean operations

You can use the boolean operators `AND`, `OR`, `XOR` and `NOT`. See [Working with null](#) for more information on how this works with `null`.

#### Query

```

MATCH (n:Person)
WHERE n.name = 'Peter' XOR (n.age < 30 AND n.name = 'Timothy') OR NOT (n.name = 'Timothy' OR n.name = 'Peter')
RETURN n.name, n.age
  
```

Table 129. Result

n.name	n.age
"Andy"	36
"Timothy"	25
"Peter"	35
3 rows	

## Filter on node label

To filter nodes by label, write a label predicate after the `WHERE` keyword using `WHERE n:foo`.

### Query

```
MATCH (n)
WHERE n:Swedish
RETURN n.name, n.age
```

The name and age for the 'Andy' node will be returned.

Table 130. Result

n.name	n.age
"Andy"	36
1 row	

## Filter on node property

To filter on a node property, write your clause after the `WHERE` keyword.

### Query

```
MATCH (n:Person)
WHERE n.age < 30
RETURN n.name, n.age
```

The name and age values for the 'Timothy' node are returned because he is less than 30 years of age.

Table 131. Result

n.name	n.age
"Timothy"	25
1 row	

## Filter on relationship property

To filter on a relationship property, write your clause after the `WHERE` keyword.

### Query

```
MATCH (n:Person)-[k:KNOWS]->(f)
WHERE k.since < 2000
RETURN f.name, f.age, f.email
```

The name, age and email values for the 'Peter' node are returned because Andy has known him since before 2000.

Table 132. Result

f.name	f.age	f.email
"Peter"	35	"peter_n@example.com"
1 row		

## Filter on dynamically-computed node property

To filter on a property using a dynamically computed name, use square bracket syntax.

### Query

```
WITH 'AGE' AS propname
MATCH (n:Person)
WHERE n[toLower(propname)] < 30
RETURN n.name, n.age
```

The name and age values for the 'Timothy' node are returned because he is less than 30 years of age.

Table 133. Result

n.name	n.age
"Timothy"	25
1 row	

## Property existence checking

Use the `exists()` function to only include nodes or relationships in which a property exists.

### Query

```
MATCH (n:Person)
WHERE EXISTS (n.belt)
RETURN n.name, n.belt
```

The name and belt for the 'Andy' node are returned because he is the only one with a `belt` property.



The `has()` function has been superseded by `exists()` and has been removed.

Table 134. Result

n.name	n.belt
"Andy"	"white"
1 row	

## 3.6.3. String matching

The prefix and suffix of a string can be matched using `STARTS WITH` and `ENDS WITH`. To undertake a substring search - i.e. match regardless of location within a string - use `CONTAINS`. The matching is *case-sensitive*. Attempting to use these operators on values which are not strings will return `null`.

### Prefix string search using `STARTS WITH`

The `STARTS WITH` operator is used to perform case-sensitive matching on the beginning of a string.

### Query

```
MATCH (n:Person)
WHERE n.name STARTS WITH 'Pet'
RETURN n.name, n.age
```

The name and age for the 'Peter' node are returned because his name starts with 'Pet'.

Table 135. Result

n.name	n.age
"Peter"	35
1 row	

## Suffix string search using ENDS WITH

The ENDS WITH operator is used to perform case-sensitive matching on the ending of a string.

### Query

```
MATCH (n:Person)
WHERE n.name ENDS WITH 'ter'
RETURN n.name, n.age
```

The name and age for the 'Peter' node are returned because his name ends with 'ter'.

Table 136. Result

n.name	n.age
"Peter"	35
1 row	

## Substring search using CONTAINS

The CONTAINS operator is used to perform case-sensitive matching regardless of location within a string.

### Query

```
MATCH (n:Person)
WHERE n.name CONTAINS 'ete'
RETURN n.name, n.age
```

The name and age for the 'Peter' node are returned because his name contains with 'ete'.

Table 137. Result

n.name	n.age
"Peter"	35
1 row	

## String matching negation

Use the NOT keyword to exclude all matches on given string from your result:

### Query

```
MATCH (n:Person)
WHERE NOT n.name ENDS WITH 'y'
RETURN n.name, n.age
```

The name and age for the 'Peter' node are returned because his name does not end with 'y'.

Table 138. Result

n.name	n.age
"Peter"	35
1 row	

### 3.6.4. Regular expressions

Cypher supports filtering using regular expressions. The regular expression syntax is inherited from [the Java regular expressions](#). This includes support for flags that change how strings are matched, including case-insensitive (?i), multiline (?m) and dotall (?s). Flags are given at the beginning of the regular expression, for example `MATCH (n) WHERE n.name =~ '(?i)Lon.*' RETURN n` will return nodes with name 'London' or with name 'LonDoN'.

#### Matching using regular expressions

You can match on regular expressions by using `=~ 'regexp'`, like this:

##### Query

```
MATCH (n:Person)
WHERE n.name =~ 'Tim.*'
RETURN n.name, n.age
```

The name and age for the 'Timothy' node are returned because his name starts with 'Tim'.

*Table 139. Result*

n.name	n.age
"Timothy"	25
1 row	

#### Escaping in regular expressions

Characters like `.` or `*` have special meaning in a regular expression. To use these as ordinary characters, without special meaning, escape them.

##### Query

```
MATCH (n:Person)
WHERE n.email =~ '.*\\\\.com'
RETURN n.name, n.age, n.email
```

The name, age and email for the 'Peter' node are returned because his email ends with `'.com'`.

*Table 140. Result*

n.name	n.age	n.email
"Peter"	35	"peter_n@example.com"
1 row		

#### Case-insensitive regular expressions

By pre-pending a regular expression with `(?i)`, the whole expression becomes case-insensitive.

## Query

```
MATCH (n:Person)
WHERE n.name =~ '(?i)AND.*'
RETURN n.name, n.age
```

The name and age for the 'Andy' node are returned because his name starts with 'AND' irrespective of casing.

Table 141. Result

n.name	n.age
"Andy"	36
1 row	

## 3.6.5. Using path patterns in WHERE

### Filter on patterns

Patterns are expressions in Cypher, expressions that return a list of paths. List expressions are also predicates — an empty list represents `false`, and a non-empty represents `true`.

So, patterns are not only expressions, they are also predicates. The only limitation to your pattern is that you must be able to express it in a single path. You cannot use commas between multiple paths like you do in `MATCH`. You can achieve the same effect by combining multiple patterns with `AND`.

Note that you cannot introduce new variables here. Although it might look very similar to the `MATCH` patterns, the `WHERE` clause is all about eliminating matched paths. `MATCH (a)-[]>(b)` is very different from `WHERE (a)-[]>(b)`. The first will produce a path for every path it can find between `a` and `b`, whereas the latter will eliminate any matched paths where `a` and `b` do not have a directed relationship chain between them.

## Query

```
MATCH (timothy:Person { name: 'Timothy' }),(other:Person)
WHERE other.name IN ['Andy', 'Peter'] AND (timothy)-->(other)
RETURN other.name, other.age
```

The name and age for nodes that have an outgoing relationship to the 'Timothy' node are returned.

Table 142. Result

other.name	other.age
"Andy"	36
1 row	

### Filter on patterns using NOT

The `NOT` operator can be used to exclude a pattern.

## Query

```
MATCH (person:Person),(peter:Person { name: 'Peter' })
WHERE NOT (person)-->(peter)
RETURN person.name, person.age
```

Name and age values for nodes that do not have an outgoing relationship to the 'Peter' node are

returned.

Table 143. Result

person.name	person.age
"Timothy"	25
"Peter"	35
2 rows	

Filter on patterns with properties

You can also add properties to your patterns:

Query

```
MATCH (n:Person)
WHERE (n)-[:KNOWS]-({ name: 'Timothy' })
RETURN n.name, n.age
```

Finds all name and age values for nodes that have a **KNOWS** relationship to a node with the name 'Timothy'.

Table 144. Result

n.name	n.age
"Andy"	36
1 row	

Filter on relationship type

You can put the exact relationship type in the **MATCH** pattern, but sometimes you want to be able to do more advanced filtering on the type. You can use the special property **type** to compare the type with something else. In this example, the query does a regular expression comparison with the name of the relationship type.

Query

```
MATCH (n:Person)-[r]->()
WHERE n.name='Andy' AND type(r)=~ 'K.*'
RETURN type(r), r.since
```

This returns all relationships having a type whose name starts with 'K'.

Table 145. Result

type(r)	r.since
"KNOWS"	1999
"KNOWS"	2012
2 rows	

An existential subquery can be used to find out if a specified pattern exists at least once in the data. It can be used in the same way as a path pattern but it allows you to use **MATCH** and **WHERE** clauses internally. A subquery has a scope, as indicated by the opening and closing braces, { and }. Any variable that is defined in the outside scope can be referenced inside the subquery's own scope. Variables introduced inside the subquery are not part of the outside scope and therefore can't be accessed on the outside. If the subquery evaluates even once to anything that is not null, the whole

expression will become true. This also means that the system only needs to calculate the first occurrence where the subquery evaluates to something that is not null and can skip the rest of the work.

## Syntax:

```
EXISTS {  
    MATCH [Pattern]  
    WHERE [Expression]  
}
```

It is worth noting that the `MATCH` keyword can be omitted in subqueries and that the `WHERE` clause is optional.

### 3.6.6. Using existential subqueries in `WHERE`

#### Simple existential subquery

Variables introduced by the outside scope can be used in the inner `MATCH` clause. The following example shows this:

##### Query

```
MATCH (person:Person)  
WHERE EXISTS {  
    MATCH (person)-[:HAS_DOG]->(:Dog)  
}  
RETURN person.name as name
```

Table 146. Result

name
"Andy"
"Peter"
2 rows

#### Existential subquery with `WHERE` clause

A `WHERE` clause can be used in conjunction to the `MATCH`. Variables introduced by the `MATCH` clause and the outside scope can be used in this scope.

##### Query

```
MATCH (person:Person)  
WHERE EXISTS {  
    MATCH (person)-[:HAS_DOG]->(dog :Dog)  
    WHERE person.name = dog.name  
}  
RETURN person.name as name
```

Table 147. Result

name
"Andy"
1 row

## Nesting existential subqueries

Existential subqueries can be nested like the following example shows. The nesting also affects the scopes. That means that it is possible to access all variables from inside the subquery which are either on the outside scope or defined in the very same subquery.

### Query

```
MATCH (person:Person)
WHERE EXISTS {
    MATCH (person)-[:HAS_DOG]->(dog:Dog)
    WHERE EXISTS {
        MATCH (dog)-[:HAS_TOY]->(toy:Toy)
        WHERE toy.name = 'Banana'
    }
}
RETURN person.name as name
```

Table 148. Result

name
"Peter"
1 row

## 3.6.7. Lists

### IN operator

To check if an element exists in a list, you can use the `IN` operator.

### Query

```
MATCH (a:Person)
WHERE a.name IN ['Peter', 'Timothy']
RETURN a.name, a.age
```

This query shows how to check if a property exists in a literal list.

Table 149. Result

a.name	a.age
"Timothy"	25
"Peter"	35
2 rows	

## 3.6.8. Missing properties and values

Default to `false` if property is missing

As missing properties evaluate to `null`, the comparison in the example will evaluate to `false` for nodes without the `belt` property.

### Query

```
MATCH (n:Person)
WHERE n.belt = 'white'
RETURN n.name, n.age, n.belt
```

Only the name, age and belt values of nodes with white belts are returned.

Table 150. Result

n.name	n.age	n.belt
"Andy"	36	"white"
1 row		

Default to `true` if property is missing

If you want to compare a property on a node or relationship, but only if it exists, you can compare the property against both the value you are looking for and `null`, like:

Query

```
MATCH (n:Person)
WHERE n.belt = 'white' OR n.belt IS NULL RETURN n.name, n.age, n.belt
ORDER BY n.name
```

This returns all values for all nodes, even those without the belt property.

Table 151. Result

n.name	n.age	n.belt
"Andy"	36	"white"
"Peter"	35	<null>
"Timothy"	25	<null>
3 rows		

Filter on `null`

Sometimes you might want to test if a value or a variable is `null`. This is done just like SQL does it, using `IS NULL`. Also like SQL, the negative is `IS NOT NULL`, although `NOT(IS NULL x)` also works.

Query

```
MATCH (person:Person)
WHERE person.name = 'Peter' AND person.belt IS NULL RETURN person.name, person.age, person.belt
```

The name and age values for nodes that have name 'Peter' but no belt property are returned.

Table 152. Result

person.name	person.age	person.belt
"Peter"	35	<null>
1 row		

### 3.6.9. Using ranges

Simple range

To check for an element being inside a specific range, use the inequality operators `<`, `<=`, `>=`, `>`.

## Query

```
MATCH (a:Person)
WHERE a.name >= 'Peter'
RETURN a.name, a.age
```

The name and age values of nodes having a name property lexicographically greater than or equal to 'Peter' are returned.

Table 153. Result

a.name	a.age
"Timothy"	25
"Peter"	35
2 rows	

## Composite range

Several inequalities can be used to construct a range.

## Query

```
MATCH (a:Person)
WHERE a.name > 'Andy' AND a.name < 'Timothy'
RETURN a.name, a.age
```

The name and age values of nodes having a name property lexicographically between 'Andy' and 'Timothy' are returned.

Table 154. Result

a.name	a.age
"Peter"	35
1 row	

## 3.7. ORDER BY

`ORDER BY` is a sub-clause following `RETURN` or `WITH`, and it specifies that the output should be sorted and how.

- [Introduction](#)
- [Order nodes by property](#)
- [Order nodes by multiple properties](#)
- [Order nodes in descending order](#)
- [Ordering `null`](#)
- [Ordering in a `WITH` clause](#)

### 3.7.1. Introduction

Note that you cannot sort on nodes or relationships, just on properties on these. `ORDER BY` relies on comparisons to sort the output, see [Ordering and comparison of values](#).

In terms of scope of variables, `ORDER BY` follows special rules, depending on if the projecting `RETURN` or `WITH` clause is either aggregating or `DISTINCT`. If it is an aggregating or `DISTINCT` projection, only the variables available in the projection are available. If the projection does not alter the output cardinality (which aggregation and `DISTINCT` do), variables available from before the projecting clause are also available. When the projection clause shadows already existing variables, only the new variables are available.

Lastly, it is not allowed to use aggregating expressions in the `ORDER BY` sub-clause if they are not also listed in the projecting clause. This last rule is to make sure that `ORDER BY` does not change the results, only the order of them.

The performance of Cypher queries using `ORDER BY` on node properties can be influenced by the existence and use of an index for finding the nodes. If the index can provide the nodes in the order requested in the query, Cypher can avoid the use of an expensive `Sort` operation. Read more about this capability in [The use of indexes](#).

The following graph is used for the examples below:

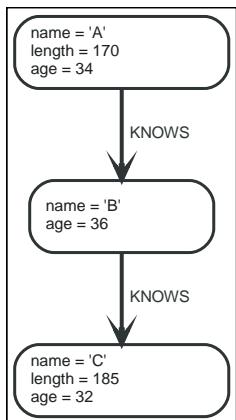


Figure 13. Graph



Strings that contain special characters can have inconsistent or non-deterministic ordering in Neo4j. For details, see [Sorting of special characters](#).

### 3.7.2. Order nodes by property

`ORDER BY` is used to sort the output.

#### Query

```

MATCH (n)
RETURN n.name, n.age
ORDER BY n.name
  
```

The nodes are returned, sorted by their name.

Table 155. Result

n.name	n.age
"A"	34
"B"	36
"C"	32
3 rows	

### 3.7.3. Order nodes by multiple properties

You can order by multiple properties by stating each variable in the `ORDER BY` clause. Cypher will sort the result by the first variable listed, and for equals values, go to the next property in the `ORDER BY` clause, and so on.

#### Query

```
MATCH (n)
RETURN n.name, n.age
ORDER BY n.age, n.name
```

This returns the nodes, sorted first by their age, and then by their name.

Table 156. Result

n.name	n.age
"C"	32
"A"	34
"B"	36
3 rows	

### 3.7.4. Order nodes in descending order

By adding `DESC[ENDING]` after the variable to sort on, the sort will be done in reverse order.

#### Query

```
MATCH (n)
RETURN n.name, n.age
ORDER BY n.name DESC
```

The example returns the nodes, sorted by their name in reverse order.

Table 157. Result

n.name	n.age
"C"	32
"B"	36
"A"	34
3 rows	

### 3.7.5. Ordering `null`

When sorting the result set, `null` will always come at the end of the result set for ascending sorting, and first when doing descending sort.

#### Query

```
MATCH (n)
RETURN n.length, n.name, n.age
ORDER BY n.length
```

The nodes are returned sorted by the length property, with a node without that property last.

Table 158. Result

n.length	n.name	n.age
170	"A"	34
185	"C"	32
<null>	"B"	36
3 rows		

### 3.7.6. Ordering in a WITH clause

When `ORDER BY` is present on a `WITH` clause, the immediately following clause will receive records in the specified order. The order is not guaranteed to be retained after the following clause, unless that also has an `ORDER BY` subclause. The ordering guarantee can be useful to exploit by operations which depend on the order in which they consume values. For example, this can be used to control the order of items in the list produced by the `collect()` aggregating function. The `MERGE` and `SET` clauses also have ordering dependencies which can be controlled this way.

#### Query

```
MATCH (n)
WITH n
ORDER BY n.age
RETURN collect(n.name) AS names
```

The list of names built from the `collect` aggregating function contains the names in order of the `age` property.

Table 159. Result

names
["C", "A", "B"]
1 row

## 3.8. SKIP

`SKIP` defines from which row to start including the rows in the output.

- [Introduction](#)
- [Skip first three rows](#)
- [Return middle two rows](#)
- [Using an expression with SKIP to return a subset of the rows](#)

### 3.8.1. Introduction

By using `SKIP`, the result set will get trimmed from the top. Please note that no guarantees are made on the order of the result unless the query specifies the `ORDER BY` clause. `SKIP` accepts any expression that evaluates to a positive integer — however the expression cannot refer to nodes or relationships.

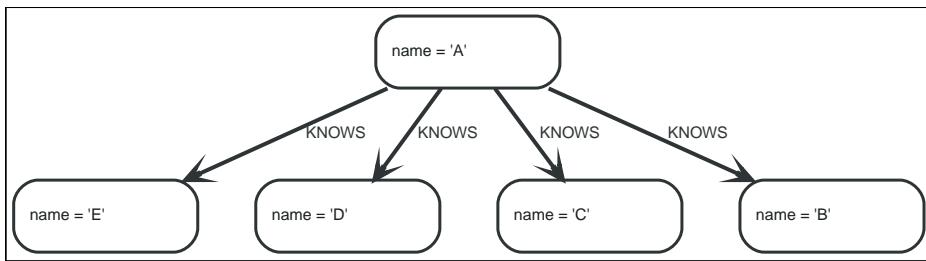


Figure 14. Graph

### 3.8.2. Skip first three rows

To return a subset of the result, starting from the fourth result, use the following syntax:

#### Query

```

MATCH (n)
RETURN n.name
ORDER BY n.name
SKIP 3

```

The first three nodes are skipped, and only the last two are returned in the result.

Table 160. Result

n.name
"D"
"E"
2 rows

### 3.8.3. Return middle two rows

To return a subset of the result, starting from somewhere in the middle, use this syntax:

#### Query

```

MATCH (n)
RETURN n.name
ORDER BY n.name
SKIP 1
LIMIT 2

```

Two nodes from the middle are returned.

Table 161. Result

n.name
"B"
"C"
2 rows

### 3.8.4. Using an expression with **SKIP** to return a subset of the rows

Skip accepts any expression that evaluates to a positive integer as long as it is not referring to any external variables:

## Query

```
MATCH (n)
RETURN n.name
ORDER BY n.name
SKIP toInteger(3*rand())+ 1
```

The first three nodes are skipped, and only the last two are returned in the result.

Table 162. Result

n.name
"C"
"D"
"E"
3 rows

## 3.9. LIMIT

**LIMIT** constrains the number of rows in the output.

- [Introduction](#)
- [Return a subset of the rows](#)
- [Using an expression with LIMIT to return a subset of the rows](#)

### 3.9.1. Introduction

**LIMIT** accepts any expression that evaluates to a positive integer — however the expression cannot refer to nodes or relationships.

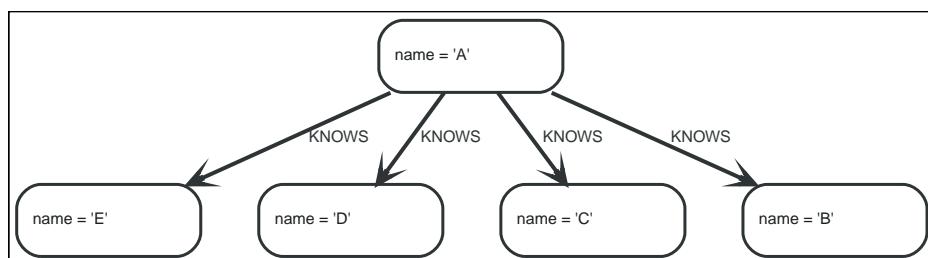


Figure 15. Graph

### 3.9.2. Return a subset of the rows

To return a subset of the result, starting from the top, use this syntax:

## Query

```
MATCH (n)
RETURN n.name
ORDER BY n.name
LIMIT 3
```

The top three items are returned by the example query.

Table 163. Result

n.name
"A"
"B"
"C"
3 rows

### 3.9.3. Using an expression with **LIMIT** to return a subset of the rows

Limit accepts any expression that evaluates to a positive integer as long as it is not referring to any external variables:

#### Query

```
MATCH (n)
RETURN n.name
ORDER BY n.name
LIMIT toInteger(3 * rand())+ 1
```

Returns one to three top items.

*Table 164. Result*

n.name
"A"
"B"
2 rows

## 3.10. CREATE

*The **CREATE** clause is used to create nodes and relationships.*

- [Create nodes](#)
  - [Create single node](#)
  - [Create multiple nodes](#)
  - [Create a node with a label](#)
  - [Create a node with multiple labels](#)
  - [Create node and add labels and properties](#)
  - [Return created node](#)
- [Create relationships](#)
  - [Create a relationship between two nodes](#)
  - [Create a relationship and set properties](#)
- [Create a full path](#)
- [Use parameters with \*\*CREATE\*\*](#)
  - [Create node with a parameter for the properties](#)
  - [Create multiple nodes with a parameter for their properties](#)



In the `CREATE` clause, patterns are used extensively. Read [Patterns](#) for an introduction.

### 3.10.1. Create nodes

#### Create single node

Creating a single node is done by issuing the following query:

*Query*

```
CREATE (n)
```

0 rows, Nodes created: 1

#### Create multiple nodes

Creating multiple nodes is done by separating them with a comma.

*Query*

```
CREATE (n),(m)
```

*Table 165. Result*

(empty result)
0 rows, Nodes created: 2

#### Create a node with a label

To add a label when creating a node, use the syntax below:

*Query*

```
CREATE (n:Person)
```

0 rows, Nodes created: 1, Labels added: 1

#### Create a node with multiple labels

To add labels when creating a node, use the syntax below. In this case, we add two labels.

*Query*

```
CREATE (n:Person:Swedish)
```

0 rows, Nodes created: 1, Labels added: 2

#### Create node and add labels and properties

When creating a new node with labels, you can add properties at the same time.

## Query

```
CREATE (n:Person { name: 'Andy', title: 'Developer' })
```

0 rows, Nodes created: 1, Properties set: 2, Labels added: 1

Return created node

Creating a single node is done by issuing the following query:

## Query

```
CREATE (a { name: 'Andy' })
RETURN a.name
```

The newly-created node is returned.

Table 166. Result

a.name
"Andy"

1 row, Nodes created: 1  
Properties set: 1

## 3.10.2. Create relationships

Create a relationship between two nodes

To create a relationship between two nodes, we first get the two nodes. Once the nodes are loaded, we simply create a relationship between them.

## Query

```
MATCH (a:Person),(b:Person)
WHERE a.name = 'A' AND b.name = 'B'
CREATE (a)-[r:RELTYPE]->(b)
RETURN type(r)
```

The created relationship is returned by the query.

Table 167. Result

type(r)
"RELTYPE"

1 row, Relationships created: 1

Create a relationship and set properties

Setting properties on relationships is done in a similar manner to how it's done when creating nodes. Note that the values can be any expression.

## Query

```
MATCH (a:Person),(b:Person)
WHERE a.name = 'A' AND b.name = 'B'
CREATE (a)-[r:RELTYPE { name: a.name + '<->' + b.name }]->(b)
RETURN type(r), r.name
```

The newly-created relationship is returned by the example query.

Table 168. Result

type(r)	r.name
"RELTYPE"	"A<->B"
1 row, Relationships created: 1 Properties set: 1	

### 3.10.3. Create a full path

When you use `CREATE` and a pattern, all parts of the pattern that are not already in scope at this time will be created.

Query

```
CREATE p =(andy { name:'Andy' })-[:WORKS_AT]->(neo)<-[:WORKS_AT]-(michael { name: 'Michael' })
RETURN p
```

This query creates three nodes and two relationships in one go, assigns it to a path variable, and returns it.

Table 169. Result

p
(2)-[WORKS_AT, 0]->(3)<-[:WORKS_AT, 1]-(4)
1 row, Nodes created: 3 Relationships created: 2 Properties set: 2

### 3.10.4. Use parameters with `CREATE`

Create node with a parameter for the properties

You can also create a graph entity from a map. All the key/value pairs in the map will be set as properties on the created relationship or node. In this case we add a `Person` label to the node as well.

Parameters

```
{
  "props" : {
    "name" : "Andy",
    "position" : "Developer"
  }
}
```

Query

```
CREATE (n:Person $props)
RETURN n
```

Table 170. Result

n
Node[2]{name: "Andy", position: "Developer"}

n

1 row, Nodes created: 1  
Properties set: 2  
Labels added: 1

Create multiple nodes with a parameter for their properties

By providing Cypher an array of maps, it will create a node for each map.

#### Parameters

```
{  
  "props" : [ {  
    "name" : "Andy",  
    "position" : "Developer"  
  }, {  
    "name" : "Michael",  
    "position" : "Developer"  
  } ]  
}
```

#### Query

```
UNWIND $props AS map  
CREATE (n)  
SET n = map
```

Table 171. Result

(empty result)

0 rows, Nodes created: 2  
Properties set: 4

## 3.11. DELETE

The [DELETE clause](#) is used to delete nodes, relationships or paths.

- [Introduction](#)
- [Delete a single node](#)
- [Delete all nodes and relationships](#)
- [Delete a node with all its relationships](#)
- [Delete relationships only](#)

### 3.11.1. Introduction

For removing properties and labels, see [REMOVE](#). Remember that you cannot delete a node without also deleting relationships that start or end on said node. Either explicitly delete the relationships, or use [DETACH DELETE](#).

The examples start out with the following database:

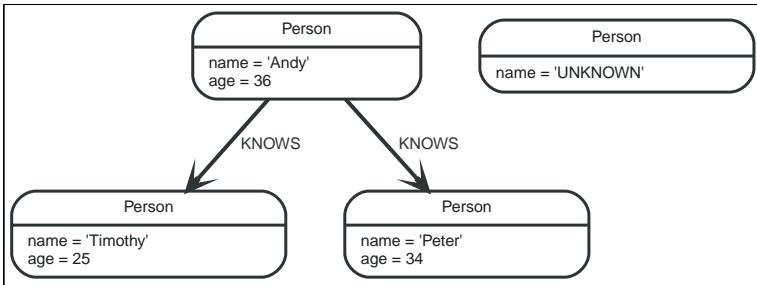


Figure 16. Graph

### 3.11.2. Delete single node

To delete a node, use the **DELETE** clause.

*Query*

```
MATCH (n:Person { name: 'UNKNOWN' })
DELETE n
```

Table 172. Result

(empty result)
----------------

0 rows, Nodes deleted: 1
--------------------------

### 3.11.3. Delete all nodes and relationships

This query isn't for deleting large amounts of data, but is useful when experimenting with small example data sets.

*Query*

```
MATCH (n)
DETACH DELETE n
```

Table 173. Result

(empty result)
----------------

0 rows, Nodes deleted: 4 Relationships deleted: 2
--

### 3.11.4. Delete a node with all its relationships

When you want to delete a node and any relationship going to or from it, use **DETACH DELETE**.

*Query*

```
MATCH (n { name: 'Andy' })
DETACH DELETE n
```

Table 174. Result

(empty result)
----------------

0 rows, Nodes deleted: 1 Relationships deleted: 2
--



For `DETACH DELETE` for users with restricted security privileges, see [Operations Manual](#) □ [Fine-grained access control](#).

### 3.11.5. Delete relationships only

It is also possible to delete relationships only, leaving the node(s) otherwise unaffected.

#### Query

```
MATCH (n { name: 'Andy' })-[r:KNOWS]->()
DELETE r
```

This deletes all outgoing `KNOWS` relationships from the node with the name '`Andy`'.

Table 175. Result

(empty result)
0 rows, Relationships deleted: 2

## 3.12. SET

The `SET` clause is used to update labels on nodes and properties on nodes and relationships.

- [Introduction](#)
- [Set a property](#)
- [Update a property](#)
- [Remove a property](#)
- [Copy properties between nodes and relationships](#)
- [Replace all properties using a map and `=`](#)
- [Remove all properties using an empty map and `=`](#)
- [Mutate specific properties using a map and `+=`](#)
- [Set multiple properties using one `SET` clause](#)
- [Set a property using a parameter](#)
- [Set all properties using a parameter](#)
- [Set a label on a node](#)
- [Set multiple labels on a node](#)

### 3.12.1. Introduction

`SET` can be used with a map — provided as a literal, a parameter, or a node or relationship — to set properties.



Setting labels on a node is an idempotent operation — nothing will occur if an attempt is made to set a label on a node that already has that label. The query statistics will state whether any updates actually took place.

The examples use this graph as a starting point:

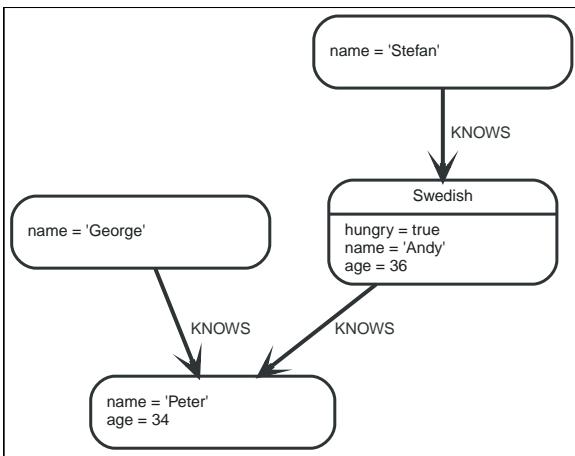


Figure 17. Graph

### 3.12.2. Set a property

Use **SET** to set a property on a node or relationship:

#### Query

```

MATCH (n { name: 'Andy' })
SET n.surname = 'Taylor'
RETURN n.name, n.surname

```

The newly-changed node is returned by the query.

Table 176. Result

n.name	n.surname
"Andy"	"Taylor"
1 row, Properties set: 1	

It is possible to set a property on a node or relationship using more complex expressions. For instance, in contrast to specifying the node directly, the following query shows how to set a property for a node selected by an expression:

#### Query

```

MATCH (n { name: 'Andy' })
SET (
CASE
WHEN n.age = 36
THEN n.END ).worksIn = 'Malmo'
RETURN n.name, n.worksIn

```

Table 177. Result

n.name	n.worksIn
"Andy"	"Malmo"
1 row, Properties set: 1	

No action will be taken if the node expression evaluates to **null**, as shown in this example:

## Query

```
MATCH (n { name: 'Andy' })
SET (
CASE
WHEN n.age = 55
THEN n END ).worksIn = 'Malmo'
RETURN n.name, n.worksIn
```

As no node matches the `CASE` expression, the expression returns a `null`. As a consequence, no updates occur, and therefore no `worksIn` property is set.

Table 178. Result

n.name	n.worksIn
"Andy"	<null>
1 row	

### 3.12.3. Update a property

`SET` can be used to update a property on a node or relationship. This query forces a change of type in the `age` property:

## Query

```
MATCH (n { name: 'Andy' })
SET n.age = toString(n.age)
RETURN n.name, n.age
```

The `age` property has been converted to the string '`'36'`'.

Table 179. Result

n.name	n.age
"Andy"	"36"
1 row, Properties set: 1	

### 3.12.4. Remove a property

Although `REMOVE` is normally used to remove a property, it's sometimes convenient to do it using the `SET` command. A case in point is if the property is provided by a parameter.

## Query

```
MATCH (n { name: 'Andy' })
SET n.name = NULL RETURN n.name, n.age
```

The `name` property is now missing.

Table 180. Result

n.name	n.age
<null>	36
1 row, Properties set: 1	

### 3.12.5. Copy properties between nodes and relationships

`SET` can be used to copy all properties from one node or relationship to another. This will remove *all* other properties on the node or relationship being copied to.

#### Query

```
MATCH (at { name: 'Andy' }), (pn { name: 'Peter' })
SET at = pn
RETURN at.name, at.age, at.hungry, pn.name, pn.age
```

The '**Andy**' node has had all its properties replaced by the properties of the '**Peter**' node.

Table 181. Result

at.name	at.age	at.hungry	pn.name	pn.age
"Peter"	34	<null>	"Peter"	34
1 row, Properties set: 3				

### 3.12.6. Replace all properties using a map and `=`

The property replacement operator `=` can be used with `SET` to replace all existing properties on a node or relationship with those provided by a map:

#### Query

```
MATCH (p { name: 'Peter' })
SET p = { name: 'Peter Smith', position: 'Entrepreneur' }
RETURN p.name, p.age, p.position
```

This query updated the `name` property from **Peter** to **Peter Smith**, deleted the `age` property, and added the `position` property to the '**Peter**' node.

Table 182. Result

p.name	p.age	p.position
"Peter Smith"	<null>	"Entrepreneur"
1 row, Properties set: 3		

### 3.12.7. Remove all properties using an empty map and `=`

All existing properties can be removed from a node or relationship by using `SET` with `=` and an empty map as the right operand:

#### Query

```
MATCH (p { name: 'Peter' })
SET p = {}
RETURN p.name, p.age
```

This query removed all the existing properties — namely, `name` and `age` — from the '**Peter**' node.

Table 183. Result

p.name	p.age
<null>	<null>

p.name	p.age
1 row, Properties set: 2	

### 3.12.8. Mutate specific properties using a map and `+ =`

The property mutation operator `+ =` can be used with `SET` to mutate properties from a map in a fine-grained fashion:

- Any properties in the map that are not on the node or relationship will be *added*.
- Any properties not in the map that are on the node or relationship will be left as is.
- Any properties that are in both the map and the node or relationship will be *replaced* in the node or relationship. However, if any property in the map is `null`, it will be *removed* from the node or relationship.

#### Query

```
MATCH (p { name: 'Peter' })
SET p += { age: 38, hungry: TRUE , position: 'Entrepreneur' }
RETURN p.name, p.age, p.hungry, p.position
```

This query left the `name` property unchanged, updated the `age` property from `34` to `38`, and added the `hungry` and `position` properties to the '`Peter`' node.

Table 184. Result

p.name	p.age	p.hungry	p.position
"Peter"	38	true	"Entrepreneur"
1 row, Properties set: 3			

In contrast to the property replacement operator `=`, providing an empty map as the right operand to `+ =` will not remove any existing properties from a node or relationship. In line with the semantics detailed above, passing in an empty map with `+ =` will have no effect:

#### Query

```
MATCH (p { name: 'Peter' })
SET p += { }
RETURN p.name, p.age
```

Table 185. Result

p.name	p.age
"Peter"	34
1 row	

### 3.12.9. Set multiple properties using one `SET` clause

Set multiple properties at once by separating them with a comma:

#### Query

```
MATCH (n { name: 'Andy' })
SET n.position = 'Developer', n.surname = 'Taylor'
```

Table 186. Result

```
(empty result)
```

```
0 rows, Properties set: 2
```

### 3.12.10. Set a property using a parameter

Use a parameter to set the value of a property:

*Parameters*

```
{
  "surname" : "Taylor"
}
```

*Query*

```
MATCH (n { name: 'Andy' })
SET n.surname = $surname
RETURN n.name, n.surname
```

A `surname` property has been added to the 'Andy' node.

*Table 187. Result*

n.name	n.surname
"Andy"	"Taylor"

1 row, Properties set: 1

### 3.12.11. Set all properties using a parameter

This will replace all existing properties on the node with the new set provided by the parameter.

*Parameters*

```
{
  "props" : {
    "name" : "Andy",
    "position" : "Developer"
  }
}
```

*Query*

```
MATCH (n { name: 'Andy' })
SET n = $props
RETURN n.name, n.position, n.age, n.hungry
```

The 'Andy' node has had all its properties replaced by the properties in the `props` parameter.

*Table 188. Result*

n.name	n.position	n.age	n.hungry
"Andy"	"Developer"	<null>	<null>

1 row, Properties set: 4

### 3.12.12. Set a label on a node

Use **SET** to set a label on a node:

*Query*

```
MATCH (n { name: 'Stefan' })
SET n:German
RETURN n.name, labels(n) AS labels
```

The newly-labeled node is returned by the query.

*Table 189. Result*

n.name	labels
"Stefan"	["German"]
1 row, Labels added: 1	

### 3.12.13. Set multiple labels on a node

Set multiple labels on a node with **SET** and use **:** to separate the different labels:

*Query*

```
MATCH (n { name: 'George' })
SET n:Swedish:Bossmann
RETURN n.name, labels(n) AS labels
```

The newly-labeled node is returned by the query.

*Table 190. Result*

n.name	labels
"George"	["Swedish", "Bossmann"]
1 row, Labels added: 2	

## 3.13. REMOVE

The **REMOVE** clause is used to remove properties from nodes and relationships, and to remove labels from nodes.

- [Introduction](#)
- [Remove a property](#)
- [Remove all properties](#)
- [Remove a label from a node](#)
- [Remove multiple labels from a node](#)

### 3.13.1. Introduction

For deleting nodes and relationships, see [DELETE](#).



Removing labels from a node is an idempotent operation: if you try to remove a label from a node that does not have that label on it, nothing happens. The query statistics will tell you if something needed to be done or not.

The examples use the following database:

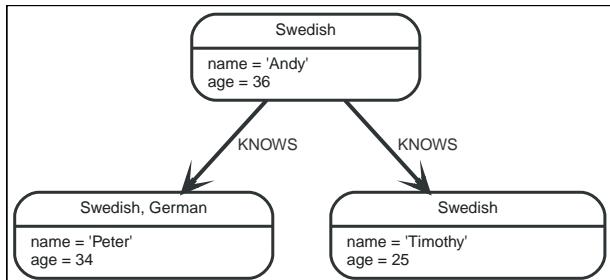


Figure 18. Graph

### 3.13.2. Remove a property

Neo4j doesn't allow storing `null` in properties. Instead, if no value exists, the property is just not there. So, `REMOVE` is used to remove a property value from a node or a relationship.

Query

```
MATCH (a { name: 'Andy' })
REMOVE a.age
RETURN a.name, a.age
```

The node is returned, and no property `age` exists on it.

Table 191. Result

a.name	a.age
"Andy"	<null>
1 row, Properties set: 1	

### 3.13.3. Remove all properties

`REMOVE` cannot be used to remove all existing properties from a node or relationship. Instead, using `SET with = and an empty map as the right operand` will clear all properties from the node or relationship.

### 3.13.4. Remove a label from a node

To remove labels, you use `REMOVE`.

Query

```
MATCH (n { name: 'Peter' })
REMOVE n:German
RETURN n.name, labels(n)
```

Table 192. Result

n.name	labels(n)
"Peter"	["Swedish"]

n.name	labels(n)
1 row, Labels removed: 1	

### 3.13.5. Remove multiple labels from a node

To remove multiple labels, you use [REMOVE](#).

#### Query

```
MATCH (n { name: 'Peter' })
REMOVE n:German:Swedish
RETURN n.name, labels(n)
```

Table 193. Result

n.name	labels(n)
"Peter"	[]
1 row, Labels removed: 2	

## 3.14. FOREACH

The [FOREACH](#) clause is used to update data within a list, whether components of a path, or result of aggregation.

- [Introduction](#)
- [Mark all nodes along a path](#)

### 3.14.1. Introduction

Lists and paths are key concepts in Cypher. [FOREACH](#) can be used to update data, such as executing update commands on elements in a path, or on a list created by aggregation.

The variable context within the [FOREACH](#) parenthesis is separate from the one outside it. This means that if you [CREATE](#) a node variable within a [FOREACH](#), you will *not* be able to use it outside of the foreach statement, unless you match to find it.

Within the [FOREACH](#) parentheses, you can do any of the updating commands — [CREATE](#), [MERGE](#), [DELETE](#), and [FOREACH](#).

If you want to execute an additional [MATCH](#) for each element in a list then [UNWIND](#) (see [UNWIND](#)) would be a more appropriate command.

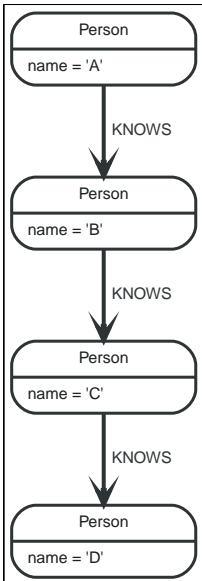


Figure 19. Graph

### 3.14.2. Mark all nodes along a path

This query will set the property `marked` to true on all nodes along a path.

#### Query

```

MATCH p =(begin)-[*]->(END )
WHERE begin.name = 'A' AND END .name = 'D'
FOREACH (n IN nodes(p)| SET n.marked = TRUE )

```

0 rows, Properties set: 4

## 3.15. MERGE

The `MERGE` clause ensures that a pattern exists in the graph. Either the pattern already exists, or it needs to be created.

- [Introduction](#)
- [Merge nodes](#)
  - Merge single node with a label
  - Merge single node with properties
  - Merge single node specifying both label and property
  - Merge single node derived from an existing node property
- [Use ON CREATE and ON MATCH](#)
  - Merge with `ON CREATE`
  - Merge with `ON MATCH`
  - Merge with `ON CREATE` and `ON MATCH`
  - Merge with `ON MATCH` setting multiple properties
- [Merge relationships](#)
  - Merge on a relationship

- Merge on multiple relationships
- Merge on an undirected relationship
- Merge on a relationship between two existing nodes
- Merge on a relationship between an existing node and a merged node derived from a node property
- Using unique constraints with **MERGE**
  - Merge using unique constraints creates a new node if no node is found
  - Merge using unique constraints matches an existing node
  - Merge with unique constraints and partial matches
  - Merge with unique constraints and conflicting matches
- Using map parameters with **MERGE**

### 3.15.1. Introduction

**MERGE** either matches existing nodes and binds them, or it creates new data and binds that. It's like a combination of **MATCH** and **CREATE** that additionally allows you to specify what happens if the data was matched or created.

For example, you can specify that the graph must contain a node for a user with a certain name. If there isn't a node with the correct name, a new node will be created and its name property set.



For performance reasons, creating a schema index on the label or property is highly recommended when using **MERGE**. See [Indexes for search performance](#) for more information.

When using **MERGE** on full patterns, the behavior is that either the whole pattern matches, or the whole pattern is created. **MERGE** will not partially use existing patterns — it's all or nothing. If partial matches are needed, this can be accomplished by splitting a pattern up into multiple **MERGE** clauses.

As with **MATCH**, **MERGE** can match multiple occurrences of a pattern. If there are multiple matches, they will all be passed on to later stages of the query.

The last part of **MERGE** is the **ON CREATE** and **ON MATCH**. These allow a query to express additional changes to the properties of a node or relationship, depending on if the element was **MATCH**-ed in the database or if it was **CREATE**-ed.

The following graph is used for the examples below:

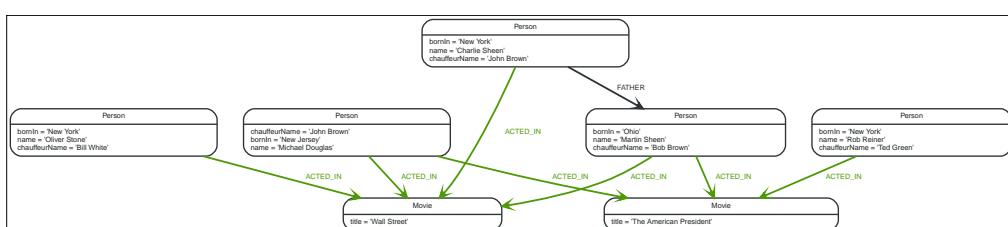


Figure 20. Graph

### 3.15.2. Merge nodes

Merge single node with a label

Merging a single node with the given label.

## Query

```
MERGE (robert:Critic)
RETURN robert, labels(robert)
```

A new node is created because there are no nodes labeled **Critic** in the database.

Table 194. Result

robert	labels(robert)
Node[7]{}	["Critic"]
1 row, Nodes created: 1 Labels added: 1	

Merge single node with properties

Merging a single node with properties where not all properties match any existing node.

## Query

```
MERGE (charlie { name: 'Charlie Sheen', age: 10 })
RETURN charlie
```

A new node with the name '**Charlie Sheen**' will be created since not all properties matched the existing '**Charlie Sheen**' node.

Table 195. Result

charlie
Node[7]{name:"Charlie Sheen",age:10}
1 row, Nodes created: 1 Properties set: 2

Merge single node specifying both label and property

Merging a single node with both label and property matching an existing node.

## Query

```
MERGE (michael:Person { name: 'Michael Douglas' })
RETURN michael.name, michael.bornIn
```

'**Michael Douglas**' will be matched and the **name** and **bornIn** properties returned.

Table 196. Result

michael.name	michael.bornIn
"Michael Douglas"	"New Jersey"
1 row	

As mentioned previously, **MERGE** queries can greatly benefit from schema indexes. In this example, the following would significantly improve the performance of the **MERGE** clause: `CREATE INDEX PersonIndex FOR (n:Person) ON (n.name)`

## Merge single node derived from an existing node property

For some property 'p' in each bound node in a set of nodes, a single new node is created for each unique value for 'p'.

### Query

```
MATCH (person:Person)
MERGE (city:City { name: person.bornIn })
RETURN person.name, person.bornIn, city
```

Three nodes labeled **City** are created, each of which contains a **name** property with the value of '**New York**', '**Ohio**', and '**New Jersey**', respectively. Note that even though the **MATCH** clause results in three bound nodes having the value '**New York**' for the **bornIn** property, only a single '**New York**' node (i.e. a **City** node with a name of '**New York**') is created. As the '**New York**' node is not matched for the first bound node, it is created. However, the newly-created '**New York**' node is matched and bound for the second and third bound nodes.

Table 197. Result

person.name	person.bornIn	city
"Charlie Sheen"	"New York"	Node[7]{name: "New York"}
"Martin Sheen"	"Ohio"	Node[8]{name: "Ohio"}
"Michael Douglas"	"New Jersey"	Node[9]{name: "New Jersey"}
"Oliver Stone"	"New York"	Node[7]{name: "New York"}
"Rob Reiner"	"New York"	Node[7]{name: "New York"}

5 rows, Nodes created: 3  
Properties set: 3  
Labels added: 3

## 3.15.3. Use **ON CREATE** and **ON MATCH**

### Merge with **ON CREATE**

Merge a node and set properties if the node needs to be created.

### Query

```
MERGE (keanu:Person { name: 'Keanu Reeves' })
ON CREATE SET keanu.created = timestamp()
RETURN keanu.name, keanu.created
```

The query creates the '**keanu**' node and sets a timestamp on creation time.

Table 198. Result

keanu.name	keanu.created
"Keanu Reeves"	1605610521901

1 row, Nodes created: 1  
Properties set: 2  
Labels added: 1

### Merge with **ON MATCH**

Merging nodes and setting properties on found nodes.

## Query

```
MERGE (person:Person)
ON MATCH SET person.found = TRUE RETURN person.name, person.found
```

The query finds all the **Person** nodes, sets a property on them, and returns them.

Table 199. Result

person.name	person.found
"Charlie Sheen"	true
"Martin Sheen"	true
"Michael Douglas"	true
"Oliver Stone"	true
"Rob Reiner"	true
5 rows, Properties set: 5	

## Merge with **ON CREATE** and **ON MATCH**

### Query

```
MERGE (keanu:Person { name: 'Keanu Reeves' })
ON CREATE SET keanu.created = timestamp()
ON MATCH SET keanu.lastSeen = timestamp()
RETURN keanu.name, keanu.created, keanu.lastSeen
```

The query creates the '**keanu**' node, and sets a timestamp on creation time. If '**keanu**' had already existed, a different property would have been set.

Table 200. Result

keanu.name	keanu.created	keanu.lastSeen
"Keanu Reeves"	1605610524293	<null>
1 row, Nodes created: 1 Properties set: 2 Labels added: 1		

## Merge with **ON MATCH** setting multiple properties

If multiple properties should be set, simply separate them with commas.

### Query

```
MERGE (person:Person)
ON MATCH SET person.found = TRUE , person.lastAccessed = timestamp()
RETURN person.name, person.found, person.lastAccessed
```

Table 201. Result

person.name	person.found	person.lastAccessed
"Charlie Sheen"	true	1605610525489
"Martin Sheen"	true	1605610525489
"Michael Douglas"	true	1605610525489
"Oliver Stone"	true	1605610525489

person.name	person.found	person.lastAccessed
"Rob Reiner"	true	1605610525489
5 rows, Properties set: 10		

### 3.15.4. Merge relationships

Merge on a relationship

`MERGE` can be used to match or create a relationship.

*Query*

```
MATCH (charlie:Person { name: 'Charlie Sheen' }),(wallStreet:Movie { title: 'Wall Street' })
MERGE (charlie)-[r:ACTED_IN]->(wallStreet)
RETURN charlie.name, type(r), wallStreet.title
```

'Charlie Sheen' had already been marked as acting in 'Wall Street', so the existing relationship is found and returned. Note that in order to match or create a relationship when using `MERGE`, at least one bound node must be specified, which is done via the `MATCH` clause in the above example.

*Table 202. Result*

charlie.name	type(r)	wallStreet.title
"Charlie Sheen"	"ACTED_IN"	"Wall Street"
1 row		

Merge on multiple relationships

*Query*

```
MATCH (oliver:Person { name: 'Oliver Stone' }),(reiner:Person { name: 'Rob Reiner' })
MERGE (oliver)-[:DIRECTED]->(movie:Movie)<-[ACTED_IN]-(reiner)
RETURN movie
```

In our example graph, 'Oliver Stone' and 'Rob Reiner' have never worked together. When we try to `MERGE` a "movie between them, Neo4j will not use any of the existing movies already connected to either person. Instead, a new 'movie' node is created.

*Table 203. Result*

movie
Node[7]{}
1 row, Nodes created: 1 Relationships created: 2 Labels added: 1

Merge on an undirected relationship

`MERGE` can also be used with an undirected relationship. When it needs to create a new one, it will pick a direction.

*Query*

```
MATCH (charlie:Person { name: 'Charlie Sheen' }),(oliver:Person { name: 'Oliver Stone' })
MERGE (charlie)-[r:KNOWS]-(oliver)
RETURN r
```

As '**Charlie Sheen**' and '**Oliver Stone**' do not know each other this **MERGE** query will create a **KNOWS** relationship between them. The direction of the created relationship is arbitrary.

Table 204. Result

r
:KNOWS[8]{}
1 row, Relationships created: 1

Merge on a relationship between two existing nodes

**MERGE** can be used in conjunction with preceding **MATCH** and **MERGE** clauses to create a relationship between two bound nodes 'm' and 'n', where 'm' is returned by **MATCH** and 'n' is created or matched by the earlier **MERGE**.

Query

```
MATCH (person:Person)
MERGE (city:City { name: person.bornIn })
MERGE (person)-[r:BORN_IN]->(city)
RETURN person.name, person.bornIn, city
```

This builds on the example from [Merge single node derived from an existing node property](#). The second **MERGE** creates a **BORN\_IN** relationship between each person and a city corresponding to the value of the person's **bornIn** property. '**Charlie Sheen**', '**Rob Reiner**' and '**Oliver Stone**' all have a **BORN\_IN** relationship to the 'same' **City** node ('**New York**').

Table 205. Result

person.name	person.bornIn	city
"Charlie Sheen"	"New York"	Node[7]{name: "New York"}
"Martin Sheen"	"Ohio"	Node[8]{name: "Ohio"}
"Michael Douglas"	"New Jersey"	Node[9]{name: "New Jersey"}
"Oliver Stone"	"New York"	Node[7]{name: "New York"}
"Rob Reiner"	"New York"	Node[7]{name: "New York"}

5 rows, Nodes created: 3  
Relationships created: 5  
Properties set: 3  
Labels added: 3

Merge on a relationship between an existing node and a merged node derived from a node property

**MERGE** can be used to simultaneously create both a new node 'n' and a relationship between a bound node 'm' and 'n'.

Query

```
MATCH (person:Person)
MERGE (person)-[r:HAS_CHAUFFEUR]->(chauffeur:Chauffeur { name: person.chauffeurName })
RETURN person.name, person.chauffeurName, chauffeur
```

As **MERGE** found no matches — in our example graph, there are no nodes labeled with **Chauffeur** and no **HAS\_CHAUFFEUR** relationships — **MERGE** creates five nodes labeled with **Chauffeur**, each of which contains a **name** property whose value corresponds to each matched **Person** node's **chauffeurName** property value. **MERGE** also creates a **HAS\_CHAUFFEUR** relationship between each **Person** node and the

newly-created corresponding `Chauffeur` node. As '**Charlie Sheen**' and '**Michael Douglas**' both have a chauffeur with the same name — '**John Brown**' — a new node is created in each case, resulting in 'two' `Chauffeur` nodes having a `name` of '**John Brown**', correctly denoting the fact that even though the `name` property may be identical, these are two separate people. This is in contrast to the example shown above in [Merge on a relationship between two existing nodes](#), where we used the first `MERGE` to bind the `City` nodes to prevent them from being recreated (and thus duplicated) in the second `MERGE`.

*Table 206. Result*

person.name	person.chauffeurName	chauffeur
"Charlie Sheen"	"John Brown"	Node[7]{name: "John Brown"}
"Martin Sheen"	"Bob Brown"	Node[8]{name: "Bob Brown"}
"Michael Douglas"	"John Brown"	Node[9]{name: "John Brown"}
"Oliver Stone"	"Bill White"	Node[10]{name: "Bill White"}
"Rob Reiner"	"Ted Green"	Node[11]{name: "Ted Green"}

5 rows, Nodes created: 5  
Relationships created: 5  
Properties set: 5  
Labels added: 5

### 3.15.5. Using unique constraints with `MERGE`

Cypher prevents getting conflicting results from `MERGE` when using patterns that involve unique constraints. In this case, there must be at most one node that matches that pattern.

For example, given two unique constraints on `:Person(id)` and `:Person(ssn)`, a query such as `MERGE (n:Person {id: 12, ssn: 437})` will fail, if there are two different nodes (one with `id` 12 and one with `ssn` 437) or if there is only one node with only one of the properties. In other words, there must be exactly one node that matches the pattern, or no matching nodes.

Note that the following examples assume the existence of unique constraints that have been created using:

```
CREATE CONSTRAINT ON (n:Person) ASSERT n.name IS UNIQUE;
CREATE CONSTRAINT ON (n:Person) ASSERT n.role IS UNIQUE;
```

Merge using unique constraints creates a new node if no node is found

Merge using unique constraints creates a new node if no node is found.

#### Query

```
MERGE (laurence:Person { name: 'Laurence Fishburne' })
RETURN laurence.name
```

The query creates the '`laurence`' node. If '`laurence`' had already existed, `MERGE` would just match the existing node.

*Table 207. Result*

laurence.name
"Laurence Fishburne"
1 row, Nodes created: 1 Properties set: 1 Labels added: 1

Merge using unique constraints matches an existing node

Merge using unique constraints matches an existing node.

*Query*

```
MERGE (oliver:Person { name: 'Oliver Stone' })
RETURN oliver.name, oliver.bornIn
```

The 'oliver' node already exists, so **MERGE** just matches it.

*Table 208. Result*

oliver.name	oliver.bornIn
"Oliver Stone"	"New York"
1 row	

Merge with unique constraints and partial matches

Merge using unique constraints fails when finding partial matches.

*Query*

```
MERGE (michael:Person { name: 'Michael Douglas', role: 'Gordon Gekko' })
RETURN michael
```

While there is a matching unique 'michael' node with the name '**Michael Douglas**', there is no unique node with the role of '**Gordon Gekko**' and **MERGE** fails to match.

*Error message*

```
Merge did not find a matching node michael and can not create a new node due to
conflicts with existing unique nodes
```

If we want to give Michael Douglas the role of Gordon Gekko, we can use the **SET** clause instead:

*Query*

```
MERGE (michael:Person { name: 'Michael Douglas' })
SET michael.role = 'Gordon Gekko'
```

Merge with unique constraints and conflicting matches

Merge using unique constraints fails when finding conflicting matches.

*Query*

```
MERGE (oliver:Person { name: 'Oliver Stone', role: 'Gordon Gekko' })
RETURN oliver
```

While there is a matching unique 'oliver' node with the name '**Oliver Stone**', there is also another unique node with the role of '**Gordon Gekko**' and **MERGE** fails to match.

*Error message*

```
Merge did not find a matching node oliver and can not create a new node due to
conflicts with existing unique nodes
```

## Using map parameters with MERGE

MERGE does not support map parameters the same way CREATE does. To use map parameters with MERGE, it is necessary to explicitly use the expected properties, such as in the following example. For more information on parameters, see [Parameters](#).

### Parameters

```
{  
  "param" : {  
    "name" : "Keanu Reeves",  
    "role" : "Neo"  
  }  
}
```

### Query

```
MERGE (person:Person { name: $param.name, role: $param.role })  
RETURN person.name, person.role
```

Table 209. Result

person.name	person.role
"Keanu Reeves"	"Neo"
1 row, Nodes created: 1	
Properties set: 2	
Labels added: 1	

## 3.16. CALL {} (subquery)

The `CALL {}` clause evaluates a subquery that returns some values.

- [Introduction](#)
- [Importing variables into subqueries](#)
- [Post-union processing](#)
- [Aggregation and side-effects](#)
- [Aggregation on imported variables](#)

### 3.16.1. Introduction

CALL allows to execute subqueries, i.e. queries inside of other queries. Subqueries allow you to compose queries, which is especially useful when working with UNION or aggregations.



The `CALL` clause is also used for calling procedures. For descriptions of the `CALL` clause in this context, refer to [CALL procedure](#).

A subquery is evaluated for each incoming input row and may produce an arbitrary number of output rows. Every output row is then combined with the input row to build the result of the subquery. That means that a subquery will influence the number of rows. If the subquery does not return any rows, there will be no rows available after the subquery.

There are restrictions on what queries are allowed as subqueries and how they interact with the enclosing query:

- A subquery must end with a **RETURN** clause.
- A subquery can only refer to variables from the enclosing query if they are explicitly imported.
- A subquery cannot return variables with the same names as variables in the enclosing query.
- All variables that are returned from a subquery are afterwards available in the enclosing query.

The following graph is used for the examples below:

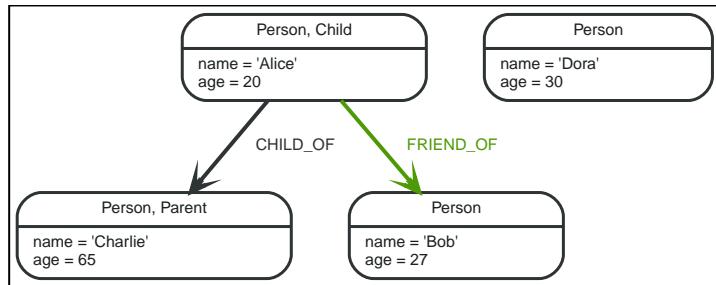


Figure 21. Graph

### 3.16.2. Importing variables into subqueries

Variables are imported into a subquery using an importing **WITH** clause. As the subquery is evaluated for each incoming input row, the imported variables get bound to the corresponding values from the input row in each evaluation.

#### Query

```

UNWIND [0, 1, 2] AS x
CALL {
  WITH x
  RETURN x * 10 AS y
}
RETURN x, y
  
```

Table 210. Result

x	y
0	0
1	10
2	20
3 rows	

An importing **WITH** clause must:

- Consist only of simple references to outside variables - e.g. **WITH x, y, z**. Aliasing or expressions are not supported in importing **WITH** clauses - e.g. **WITH a AS b** or **WITH a+1 AS b**.
- Be the first clause of a subquery (or the second clause, if directly following a **USE** clause).

### 3.16.3. Post-union processing

Subqueries can be used to process the results of a **UNION** query further. This example query finds the youngest and the oldest person in the database and orders them by name.

## Query

```
CALL {
  MATCH (p:Person) RETURN p ORDER BY p.age ASC LIMIT 1
  UNION
  MATCH (p:Person) RETURN p ORDER BY p.age DESC LIMIT 1
}
RETURN p.name, p.age ORDER BY p.name
```

Table 211. Result

p.name	p.age
"Alice"	20
"Charlie"	65
2 rows	

If different parts of a result should be matched differently, with some aggregation over the whole results, subqueries need to be used. This example query finds friends and/or parents for each person. Subsequently the number of friends and parents are counted together.

## Query

```
MATCH (p:Person)
CALL {
  WITH p OPTIONAL MATCH (p)-[:FRIEND_OF]->(other:Person) RETURN other
  UNION
  WITH p OPTIONAL MATCH (p)-[:CHILD_OF]->(other:Parent) RETURN other
}
RETURN DISTINCT p.name, count(other)
```

Table 212. Result

p.name	count(other)
"Alice"	2
"Bob"	0
"Charlie"	0
"Dora"	0
4 rows	

### 3.16.4. Aggregation and side-effects

Subqueries can be useful to do aggregations for each row and to isolate side-effects. This example query creates five [Clone](#) nodes for each existing person. The aggregation ensures that cardinality is not changed by the subquery. Without this, the result would be five times as many rows.

## Query

```
MATCH (p:Person)
CALL {
  UNWIND range(1, 5) AS i
  CREATE (c:Clone)
  RETURN count(c) AS numberofClones
}
RETURN p.name, numberofClones
```

Table 213. Result

p.name	numberofClones
"Alice"	5

p.name	numberOfClones
"Bob"	5
"Charlie"	5
"Dora"	5
4 rows, Nodes created: 20	
Labels added: 20	

### 3.16.5. Aggregation on imported variables

Aggregations in subqueries are scoped to the subquery evaluation, also for imported variables. The following example counts the number of younger persons for each person in the graph:

#### Query

```

MATCH (p:Person)
CALL {
    WITH p
    MATCH (other:Person) WHERE other.age < p.age
    RETURN count(other) AS youngerPersonsCount
}
RETURN p.name, youngerPersonsCount

```

Table 214. Result

p.name	youngerPersonsCount
"Alice"	0
"Bob"	1
"Charlie"	3
"Dora"	2
4 rows	

### 3.17. CALL procedure

The `CALL` clause is used to call a procedure deployed in the database.

- [Introduction](#)
- [Call a procedure using `CALL`](#)
- [View the signature for a procedure](#)
- [Call a procedure using a quoted namespace and name](#)
- [Call a procedure with literal arguments](#)
- [Call a procedure with parameter arguments](#)
- [Call a procedure with mixed literal and parameter arguments](#)
- [Call a procedure with literal and default arguments](#)
- [Call a procedure within a complex query using `CALL...YIELD`](#)
- [Call a procedure and filter its results](#)
- [Call a procedure within a complex query and rename its outputs](#)

### 3.17.1. Introduction

Procedures are called using the `CALL` clause.



The `CALL` clause is also used to evaluate a subquery. For descriptions of the `CALL` clause in this context, refer to [CALL {} \(subquery\)](#).

Each procedure call needs to specify all required procedure arguments. This may be done either explicitly, by using a comma-separated list wrapped in parentheses after the procedure name, or implicitly by using available query parameters as procedure call arguments. The latter form is available only in a so-called standalone procedure call, when the whole query consists of a single `CALL` clause.

Most procedures return a stream of records with a fixed set of result fields, similar to how running a Cypher query returns a stream of records. The `YIELD` sub-clause is used to explicitly select which of the available result fields are returned as newly-bound variables from the procedure call to the user or for further processing by the remaining query. Thus, in order to be able to use `YIELD`, the names (and types) of the output parameters need be known in advance. Each yielded result field may optionally be renamed using aliasing (i.e. `resultFieldName AS newName`). All new variables bound by a procedure call are added to the set of variables already bound in the current scope. It is an error if a procedure call tries to rebind a previously bound variable (i.e. a procedure call cannot shadow a variable that was previously bound in the current scope).

This section explains how to determine a procedure's input parameters (needed for `CALL`) and output parameters (needed for `YIELD`).

Inside a larger query, the records returned from a procedure call with an explicit `YIELD` may be further filtered using a `WHERE` sub-clause followed by a predicate (similar to `WITH ... WHERE ...`).

If the called procedure declares at least one result field, `YIELD` may generally not be omitted. However `YIELD` may always be omitted in a standalone procedure call. In this case, all result fields are yielded as newly-bound variables from the procedure call to the user.

Neo4j supports the notion of `VOID` procedures. A `VOID` procedure is a procedure that does not declare any result fields and returns no result records and that has explicitly been declared as `VOID`. Calling a `VOID` procedure may only have a side effect and thus does neither allow nor require the use of `YIELD`. Calling a `VOID` procedure in the middle of a larger query will simply pass on each input record (i.e. it acts like `WITH *` in terms of the record stream).



Neo4j comes with a number of built-in procedures. For a list of these, see [Operations Manual □ Procedures](#).

Users can also develop custom procedures and deploy to the database. See [Java Reference □ Procedures and functions](#) for details.

### 3.17.2. Call a procedure using `CALL`

This calls the built-in procedure `db.labels`, which lists all labels used in the database.

*Query*

```
CALL db.labels
```

*Table 215. Result*

label
"User"
"Administrator"
2 rows

### 3.17.3. View the signature for a procedure

To `CALL` a procedure, its input parameters need to be known, and to use `YIELD`, its output parameters need to be known. The built-in procedure `dbms.procedures` returns the name, signature and description for all procedures. The following query can be used to return the signature for a particular procedure:

#### Query

```
CALL dbms.procedures() YIELD name, signature
WHERE name='dbms.listConfig'
RETURN signature
```

We can see that the `dbms.listConfig` has one input parameter, `searchString`, and three output parameters, `name`, `description` and `value`.

Table 216. Result

signature
"dbms.listConfig(searchString = :: STRING?) :: (name :: STRING?, description :: STRING?, value :: STRING?, dynamic :: BOOLEAN?)"
1 row

### 3.17.4. Call a procedure using a quoted namespace and name

This calls the built-in procedure `db.labels`, which lists all labels used in the database.

#### Query

```
CALL `db`.`labels`
```

### 3.17.5. Call a procedure with literal arguments

This calls the example procedure `dbms.security.createUser` using literal arguments. The arguments are written out directly in the statement text.

#### Query

```
CALL dbms.security.createUser('johnsmith', 'h6u4%kr', FALSE )
```

Since our example procedure does not return any result, the result is empty.

### 3.17.6. Call a procedure with parameter arguments

This calls the example procedure `dbms.security.createUser` using parameters as arguments. Each procedure argument is taken to be the value of a corresponding statement parameter with the same name (or null if no such parameter has been given).

#### Parameters

```
{  
  "username" : "johnsmith",  
  "password" : "h6u4%kr",  
  "requirePasswordChange" : false  
}
```

#### Query

```
CALL dbms.security.createUser
```

Since our example procedure does not return any result, the result is empty.

### 3.17.7. Call a procedure with mixed literal and parameter arguments

This calls the example procedure `dbms.security.createUser` using both literal and parameter arguments.

#### Parameters

```
{  
  "password" : "h6u4%kr"  
}
```

#### Query

```
CALL dbms.security.createUser('username', $password, 'requirePasswordChange')
```

Since our example procedure does not return any result, the result is empty.

### 3.17.8. Call a procedure with literal and default arguments

This calls the example procedure `dbms.security.createUser` using literal arguments. That is, arguments that are written out directly in the statement text, and a trailing default argument that is provided by the procedure itself.

#### Query

```
CALL dbms.security.createUser('johnsmith', 'h6u4%kr')
```

Since our example procedure does not return any result, the result is empty.

### 3.17.9. Call a procedure within a complex query using `CALL YIELD`

This calls the built-in procedure `db.labels` to count all labels used in the database.

#### Query

```
CALL db.labels() YIELD label  
RETURN count(label) AS numLabels
```

Since the procedure call is part of a larger query, all outputs must be named explicitly.

### 3.17.10. Call a procedure and filter its results

This calls the built-in procedure `db.labels` to count all in-use labels in the database that contain the word 'User'.

*Query*

```
CALL db.labels() YIELD label
WHERE label CONTAINS 'User'
RETURN count(label) AS numLabels
```

Since the procedure call is part of a larger query, all outputs must be named explicitly.

### 3.17.11. Call a procedure within a complex query and rename its outputs

This calls the built-in procedure `db.propertyKeys` as part of counting the number of nodes per property key that is currently used in the database.

*Query*

```
CALL db.propertyKeys() YIELD propertyKey AS prop
MATCH (n)
WHERE n[prop] IS NOT NULL RETURN prop, count(n) AS numNodes
```

Since the procedure call is part of a larger query, all outputs must be named explicitly.

## 3.18. UNION

*The `UNION` clause is used to combine the result of multiple queries.*

- [Introduction](#)
- [Combine two queries and retain duplicates](#)
- [Combine two queries and remove duplicates](#)

### 3.18.1. Introduction

`UNION` combines the results of two or more queries into a single result set that includes all the rows that belong to all queries in the union.

The number and the names of the columns must be identical in all queries combined by using `UNION`.

To keep all the result rows, use `UNION ALL`. Using just `UNION` will combine and remove duplicates from the result set.

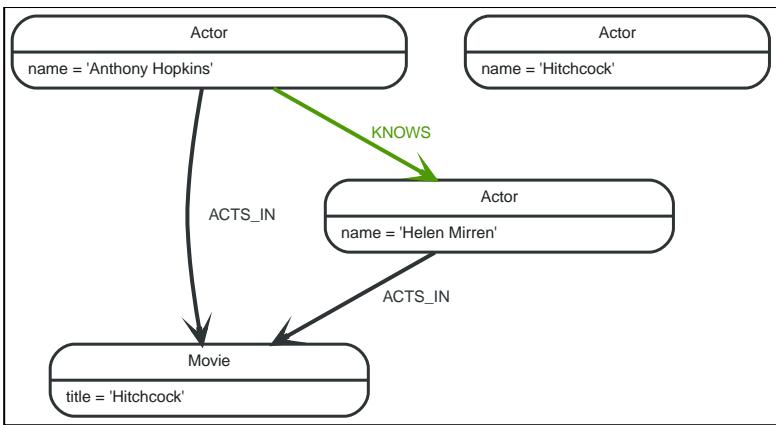


Figure 22. Graph

### 3.18.2. Combine two queries and retain duplicates

Combining the results from two queries is done using `UNION ALL`.

#### Query

```
MATCH (n:Actor)
RETURN n.name AS name
UNION ALL MATCH (n:Movie)
RETURN n.title AS name
```

The combined result is returned, including duplicates.

Table 217. Result

name
"Anthony Hopkins"
"Helen Mirren"
"Hitchcock"
"Hitchcock"
4 rows

### 3.18.3. Combine two queries and remove duplicates

By not including `ALL` in the `UNION`, duplicates are removed from the combined result set

#### Query

```
MATCH (n:Actor)
RETURN n.name AS name
UNION
MATCH (n:Movie)
RETURN n.title AS name
```

The combined result is returned, without duplicates.

Table 218. Result

name
"Anthony Hopkins"
"Helen Mirren"

name
"Hitchcock"
3 rows

## 3.19. USE

The **USE** clause determines which graph a query, or query part, is executed against.

- [Introduction](#)
- [Syntax](#)
- [Examples](#)
  - [Query remote graph by name](#)
  - [Query remote graph by graph ID](#)

### 3.19.1. Introduction

The **USE** clause determines which graph a query, or query part, is executed against. It is supported for queries and schema commands.



The **USE** clause can not be used together with the **PERIODIC COMMIT clause**.

### 3.19.2. Syntax

The **USE** clause can only appear as the prefix of schema commands, or as the first clause of queries:

```
USE <graph>
<other clauses>
```

Where **<graph>** refers to the name of a database in the DBMS.

#### Fabric syntax

When running queries against a Fabric database, the **USE** clause can also appear as the first clause of:

- Union parts:

```
USE <graph>
<other clauses>
UNION
USE <graph>
<other clauses>
```

- Subqueries:

```
CALL {
  USE <graph>
  <other clauses>
}
```

In subqueries, a **USE** clause may appear as the second clause, if directly following an [importing](#)

## WITH clause

When executing queries against a Fabric database, in addition to referring to databases in the DBMS, the <graph> may also refer to a graph mounted through the Fabric configuration. For more information, see [Operations Manual □ Fabric](#).

### 3.19.3. Examples

#### Query a graph by name

In this example we assume that your DBMS contains a database named `myDatabase`:

*Query.*

```
USE myDatabase
MATCH (n) RETURN n
```

#### Query a Fabric graph by name

In this example we assume that we have configured a Fabric database called `exampleFabricSetup`. The graph that we wish to query is named `exampleDatabaseName`:

*Query.*

```
USE exampleFabricSetup.exampleDatabaseName
MATCH (n) RETURN n
```

#### Query a Fabric graph by graph ID

This examples continues with a Fabric database called `exampleFabricSetup`.

The graph we wish to query is configured with the graph id `0`, which is why we can refer to it using the built-in function `graph()` with the argument `0`:

*Query.*

```
USE exampleFabricSetup.graph(0)
MATCH (n) RETURN n
```

## 3.20. LOAD CSV

`LOAD CSV` is used to import data from CSV files.

- [Introduction](#)
- [CSV file format](#)
- [Import data from a CSV file](#)
- [Import data from a CSV file containing headers](#)
- [Import data from a CSV file with a custom field delimiter](#)
- [Importing large amounts of data](#)
- [Setting the rate of periodic commits](#)
- [Import data containing escaped characters](#)

- Using `linenumber()` with `LOAD CSV`
- Using `file()` with `LOAD CSV`

### 3.20.1. Introduction

- The URL of the CSV file is specified by using `FROM` followed by an arbitrary expression evaluating to the URL in question.
- It is required to specify a variable for the CSV data using `AS`.
- CSV files can be stored on the database server and are then accessible using a `file:/// URL`. Alternatively, `LOAD CSV` also supports accessing CSV files via `HTTPS`, `HTTP`, and `FTP`.
- `LOAD CSV` supports resources compressed with `gzip` and `Deflate`. Additionally `LOAD CSV` supports locally stored CSV files compressed with `ZIP`.
- `LOAD CSV` will follow `HTTP` redirects but for security reasons it will not follow redirects that changes the protocol, for example if the redirect is going from `HTTPS` to `HTTP`.
- `LOAD CSV` is often used in conjunction with the query hint `PERIODIC COMMIT`; more information on this may be found in `PERIODIC COMMIT query hint`.

*Configuration settings for file URLs*

#### `dbms.security.allow_csv_import_from_file_urls`

This setting determines if Cypher will allow the use of `file:/// URLs` when loading data using `LOAD CSV`. Such URLs identify files on the filesystem of the database server. Default is `true`. Setting `dbms.security.allow_csv_import_from_file_urls=false` will completely disable access to the file system for `LOAD CSV`.

#### `dbms.directories.import`

Sets the root directory for `file:/// URLs` used with the Cypher `LOAD CSV` clause. This should be set to a single directory relative to the Neo4j installation path on the database server. All requests to load from `file:/// URLs` will then be relative to the specified directory. The default value set in the config settings is `import`. This is a security measure which prevents the database from accessing files outside the standard `import directory`, similar to how a Unix `chroot` operates. Setting this to an empty field will allow access to all files within the Neo4j installation folder. Commenting out this setting will disable the security feature, allowing all files in the local system to be imported. This is definitely not recommended.

File URLs will be resolved relative to the `dbms.directories.import` directory. For example, a file URL will typically look like `file:///myfile.csv` or `file:///myproject/myfile.csv`.

- If `dbms.directories.import` is set to the default value `import`, using the above URLs in `LOAD CSV` would read from `<NEO4J_HOME>/import/myfile.csv` and `<NEO4J_HOME>/import/myproject/myfile.csv` respectively.
- If it is set to `/data/csv`, using the above URLs in `LOAD CSV` would read from `<NEO4J_HOME>/data/csv/myfile.csv` and `<NEO4J_HOME>/data/csv/myproject/myfile.csv` respectively.

See the examples below for further details.

### 3.20.2. CSV file format

The CSV file to use with `LOAD CSV` must have the following characteristics:

- the character encoding is `UTF-8`;
- the end line termination is system dependent, e.g., it is `\n` on unix or `\r\n` on windows;
- the default field terminator is `,`;

- the field terminator character can be change by using the option `FIELDTERMINATOR` available in the `LOAD CSV` command;
- quoted strings are allowed in the CSV file and the quotes are dropped when reading the data;
- the character for string quotation is double quote `"`;
- if `dbms.import.csv.legacy_quoteEscaping` is set to the default value of `true`, `\` is used as an escape character;
- a double quote must be in a quoted string and escaped, either with the escape character or a second double quote.

### 3.20.3. Import data from a CSV file

To import data from a CSV file into Neo4j, you can use `LOAD CSV` to get the data into your query. Then you write it to your database using the normal updating clauses of Cypher.

*artists.csv*

```
1,ABBA,1992
2,Roxette,1986
3,Europe,1979
4,The Cardigans,1992
```

#### Query

```
LOAD CSV FROM 'https://neo4j.com/docs/cypher-manual/4.2/csv/artists.csv' AS line
CREATE (:Artist { name: line[1], year: toInteger(line[2])})
```

A new node with the `Artist` label is created for each row in the CSV file. In addition, two columns from the CSV file are set as properties on the nodes.

#### Result

```
+-----+
| No data returned. |
+-----+
Nodes created: 4
Properties set: 8
Labels added: 4
```

### 3.20.4. Import data from a CSV file containing headers

When your CSV file has headers, you can view each row in the file as a map instead of as an array of strings.

*artists-with-headers.csv*

```
Id,Name,Year
1,ABBA,1992
2,Roxette,1986
3,Europe,1979
4,The Cardigans,1992
```

#### Query

```
LOAD CSV WITH HEADERS FROM 'https://neo4j.com/docs/cypher-manual/4.2/csv/artists-with-headers.csv' AS line
CREATE (:Artist { name: line.Name, year: toInteger(line.Year)})
```

This time, the file starts with a single row containing column names. Indicate this using `WITH HEADERS`

and you can access specific fields by their corresponding column name.

### Result

```
+-----+
| No data returned. |
+-----+
Nodes created: 4
Properties set: 8
Labels added: 4
```

## 3.20.5. Import data from a CSV file with a custom field delimiter

Sometimes, your CSV file has other field delimiters than commas. You can specify which delimiter your file uses, using `FIELDTERMINATOR`. Hexadecimal representation of the unicode character encoding can be used if prepended by `\u`. The encoding must be written with four digits. For example, `\u002C` is equivalent to `,`.

### `artists-fieldterminator.csv`

```
1;ABBA;1992
2;Roxette;1986
3;Europe;1979
4;The Cardigans;1992
```

### Query

```
LOAD CSV FROM 'https://neo4j.com/docs/cypher-manual/4.2/csv/artists-fieldterminator.csv' AS line
FIELDTERMINATOR ';'
CREATE (:Artist { name: line[1], year: toInteger(line[2])})
```

As values in this file are separated by a semicolon, a custom `FIELDTERMINATOR` is specified in the `LOAD CSV` clause.

### Result

```
+-----+
| No data returned. |
+-----+
Nodes created: 4
Properties set: 8
Labels added: 4
```

## 3.20.6. Importing large amounts of data

If the CSV file contains a significant number of rows (approaching hundreds of thousands or millions), `USING PERIODIC COMMIT` can be used to instruct Neo4j to perform a commit after a number of rows. This reduces the memory overhead of the transaction state. By default, the commit will happen every 1000 rows. For more information, see `PERIODIC COMMIT query hint`.

Note: The `USE clause` can not be used together with the `PERIODIC COMMIT` clause.

### Query

```
USING PERIODIC COMMIT
LOAD CSV FROM 'https://neo4j.com/docs/cypher-manual/4.2/csv/artists.csv' AS line
CREATE (:Artist { name: line[1], year: toInteger(line[2])})
```

## Result

```
+-----+  
| No data returned. |  
+-----+  
Nodes created: 4  
Properties set: 8  
Labels added: 4
```

## 3.20.7. Setting the rate of periodic commits

You can set the number of rows as in the example, where it is set to 500 rows.

## Query

```
USING PERIODIC COMMIT 500  
LOAD CSV FROM 'https://neo4j.com/docs/cypher-manual/4.2/csv/artists.csv' AS line  
CREATE (:Artist { name: line[1], year: toInteger(line[2])})
```

## Result

```
+-----+  
| No data returned. |  
+-----+  
Nodes created: 4  
Properties set: 8  
Labels added: 4
```

## 3.20.8. Import data containing escaped characters

In this example, we both have additional quotes around the values, as well as escaped quotes inside one value.

*artists-with-escaped-char.csv*

```
"1", "The ""Symbol""", "1992"
```

## Query

```
LOAD CSV FROM 'https://neo4j.com/docs/cypher-manual/4.2/csv/artists-with-escaped-char.csv' AS line  
CREATE (a:Artist { name: line[1], year: toInteger(line[2])})  
RETURN a.name AS name, a.year AS year, size(a.name) AS size
```

Note that strings are wrapped in quotes in the output here. You can see that when comparing to the length of the string in this case!

## Result

```
+-----+  
| name      | year | size |  
+-----+  
| "The \"Symbol\"" | 1992 | 12  |  
+-----+  
1 row  
Nodes created: 1  
Properties set: 2  
Labels added: 1
```

### 3.20.9. Using linenumber() with LOAD CSV

For certain scenarios, like debugging a problem with a csv file, it may be useful to get the current line number that `LOAD CSV` is operating on. The `linenumber()` function provides exactly that or `null` if called without a `LOAD CSV` context.

*artists.csv*

```
1,ABBA,1992
2,Roxette,1986
3,Europe,1979
4,The Cardigans,1992
```

*Query*

```
LOAD CSV FROM 'https://neo4j.com/docs/cypher-manual/4.2/csv/artists.csv' AS line
RETURN linenumber() AS number, line
```

*Result*

number	line
1	["1", "ABBA", "1992"]
2	["2", "Roxette", "1986"]
3	["3", "Europe", "1979"]
4	["4", "The Cardigans", "1992"]

4 rows

### 3.20.10. Using file() with LOAD CSV

For certain scenarios, like debugging a problem with a csv file, it may be useful to get the absolute path of the file that `LOAD CSV` is operating on. The `file()` function provides exactly that or `null` if called without a `LOAD CSV` context.

*artists.csv*

```
1,ABBA,1992
2,Roxette,1986
3,Europe,1979
4,The Cardigans,1992
```

*Query*

```
LOAD CSV FROM 'https://neo4j.com/docs/cypher-manual/4.2/csv/artists.csv' AS line
RETURN DISTINCT file() AS path
```

Since `LOAD CSV` can temporary download a file to process it, it is important to note that `file()` will always return the path on disk. This is why you see different URLs in this example. If `LOAD CSV` is invoked with a `file:///` URL that points to your disk `file()` will return that same path.

## *Result*

```
+-----+  
| path  
|  
+-----+  
| "/opt/teamcity-agent/work/1a0193e4fce41a56/cypher/cypher-docs/target/docs/dev/ql/load-csv/csv-  
files/artists.csv" |  
+-----+  
-----+  
1 row
```

# Chapter 4. Functions

This section contains information on all functions in the Cypher query language.

- Predicate functions [[Summary](#) | [Detail](#)]
- Scalar functions [[Summary](#) | [Detail](#)]
- Aggregating functions [[Summary](#) | [Detail](#)]
- List functions [[Summary](#) | [Detail](#)]
- Mathematical functions - numeric [[Summary](#) | [Detail](#)]
- Mathematical functions - logarithmic [[Summary](#) | [Detail](#)]
- Mathematical functions - trigonometric [[Summary](#) | [Detail](#)]
- String functions [[Summary](#) | [Detail](#)]
- Temporal functions - instant types [[Summary](#) | [Detail](#)]
- Temporal functions - duration [[Summary](#) | [Detail](#)]
- Spatial functions [[Summary](#) | [Detail](#)]
- User-defined functions [[Summary](#) | [Detail](#)]
- LOAD CSV functions [[Summary](#) | [Detail](#)]

Related information may be found in [Operators](#).

## *Please note*

- Functions in Cypher return `null` if an input parameter is `null`.
- Functions taking a string as input all operate on *Unicode characters* rather than on a standard `char[]`. For example, the `size()` function applied to any *Unicode character* will return 1, even if the character does not fit in the 16 bits of one `char`.

## Predicate functions

These functions return either true or false for the given arguments.

Function	Description
<code>all()</code>	Tests whether the predicate holds for all elements in a list.
<code>any()</code>	Tests whether the predicate holds for at least one element in a list.
<code>exists()</code>	Returns true if a match for the pattern exists in the graph, or if the specified property exists in the node, relationship or map.
<code>none()</code>	Returns true if the predicate holds for no element in a list.
<code>single()</code>	Returns true if the predicate holds for exactly one of the elements in a list.

## Scalar functions

These functions return a single value.

Function	Description
<code>coalesce()</code>	Returns the first non- <code>null</code> value in a list of expressions.
<code>endNode()</code>	Returns the end node of a relationship.

Function	Description
<code>head()</code>	Returns the first element in a list.
<code>id()</code>	Returns the id of a relationship or node.
<code>last()</code>	Returns the last element in a list.
<code>length()</code>	Returns the length of a path.
<code>properties()</code>	Returns a map containing all the properties of a node or relationship.
<code>randomUUID()</code>	Returns a string value corresponding to a randomly-generated UUID.
<code>size()</code>	Returns the number of items in a list.
<code>size() applied to pattern expression</code>	Returns the number of paths matching the pattern expression.
<code>size() applied to string</code>	Returns the number of Unicode characters in a string.
<code>startNode()</code>	Returns the start node of a relationship.
<code>timestamp()</code>	Returns the difference, measured in milliseconds, between the current time and midnight, January 1, 1970 UTC.
<code>toBoolean()</code>	Converts a string value to a boolean value.
<code>toFloat()</code>	Converts an integer or string value to a floating point number.
<code>toInteger()</code>	Converts a floating point or string value to an integer value.
<code>type()</code>	Returns the string representation of the relationship type.

## Aggregating functions

These functions take multiple values as arguments, and calculate and return an aggregated value from them.

Function	Description
<code>avg() - Numeric values</code>	Returns the average of a set of numeric values.
<code>avg() - Durations</code>	Returns the average of a set of Durations.
<code>collect()</code>	Returns a list containing the values returned by an expression.
<code>count()</code>	Returns the number of values or rows.
<code>max()</code>	Returns the maximum value in a set of values.
<code>min()</code>	Returns the minimum value in a set of values.
<code>percentileCont()</code>	Returns the percentile of a value over a group using linear interpolation.
<code>percentileDisc()</code>	Returns the nearest value to the given percentile over a group using a rounding method.
<code>stDev()</code>	Returns the standard deviation for the given value over a group for a sample of a population.
<code>stDevP()</code>	Returns the standard deviation for the given value over a group for an entire population.
<code>sum() - Numeric values</code>	Returns the sum of a set of numeric values.
<code>sum() - Durations</code>	Returns the sum of a set of Durations.

## List functions

These functions return lists of other values. Further details and examples of lists may be found in [Lists](#).

Function	Description
<a href="#">keys()</a>	Returns a list containing the string representations for all the property names of a node, relationship, or map.
<a href="#">labels()</a>	Returns a list containing the string representations for all the labels of a node.
<a href="#">nodes()</a>	Returns a list containing all the nodes in a path.
<a href="#">range()</a>	Returns a list comprising all integer values within a specified range.
<a href="#">reduce()</a>	Runs an expression against individual elements of a list, storing the result of the expression in an accumulator.
<a href="#">relationships()</a>	Returns a list containing all the relationships in a path.
<a href="#">reverse()</a>	Returns a list in which the order of all elements in the original list have been reversed.
<a href="#">tail()</a>	Returns all but the first element in a list.

## Mathematical functions - numeric

These functions all operate on numerical expressions only, and will return an error if used on any other values.

Function	Description
<a href="#">abs()</a>	Returns the absolute value of a number.
<a href="#">ceil()</a>	Returns the smallest floating point number that is greater than or equal to a number and equal to a mathematical integer.
<a href="#">floor()</a>	Returns the largest floating point number that is less than or equal to a number and equal to a mathematical integer.
<a href="#">rand()</a>	Returns a random floating point number in the range from 0 (inclusive) to 1 (exclusive); i.e. $[0, 1)$ .
<a href="#">round()</a>	Returns the value of the given number rounded to the nearest integer, with half-way values always rounded up.
<a href="#">round(), with precision</a>	Returns the value of the given number rounded with the specified precision, with half-values always being rounded up.
<a href="#">round(), with precision and rounding mode</a>	Returns the value of the given number rounded with the specified precision and the specified rounding mode.
<a href="#">sign()</a>	Returns the signum of a number: $0$ if the number is $0$ , $-1$ for any negative number, and $1$ for any positive number.

## Mathematical functions - logarithmic

These functions all operate on numerical expressions only, and will return an error if used on any other values.

Function	Description
<a href="#">e()</a>	Returns the base of the natural logarithm, $e$ .
<a href="#">exp()</a>	Returns $e^n$ , where $e$ is the base of the natural logarithm, and $n$ is the value of the argument expression.
<a href="#">log()</a>	Returns the natural logarithm of a number.
<a href="#">log10()</a>	Returns the common logarithm (base 10) of a number.

Function	Description
<a href="#">sqrt()</a>	Returns the square root of a number.

## Mathematical functions - trigonometric

These functions all operate on numerical expressions only, and will return an error if used on any other values.

All trigonometric functions operate on radians, unless otherwise specified.

Function	Description
<a href="#">acos()</a>	Returns the arccosine of a number in radians.
<a href="#">asin()</a>	Returns the arcsine of a number in radians.
<a href="#">atan()</a>	Returns the arctangent of a number in radians.
<a href="#">atan2()</a>	Returns the arctangent2 of a set of coordinates in radians.
<a href="#">cos()</a>	Returns the cosine of a number.
<a href="#">cot()</a>	Returns the cotangent of a number.
<a href="#">degrees()</a>	Converts radians to degrees.
<a href="#">haversin()</a>	Returns half the versine of a number.
<a href="#">pi()</a>	Returns the mathematical constant <i>pi</i> .
<a href="#">radians()</a>	Converts degrees to radians.
<a href="#">sin()</a>	Returns the sine of a number.
<a href="#">tan()</a>	Returns the tangent of a number.

## String functions

These functions are used to manipulate strings or to create a string representation of another value.

Function	Description
<a href="#">left()</a>	Returns a string containing the specified number of leftmost characters of the original string.
<a href="#">lTrim()</a>	Returns the original string with leading whitespace removed.
<a href="#">replace()</a>	Returns a string in which all occurrences of a specified string in the original string have been replaced by another (specified) string.
<a href="#">reverse()</a>	Returns a string in which the order of all characters in the original string have been reversed.
<a href="#">right()</a>	Returns a string containing the specified number of rightmost characters of the original string.
<a href="#">rTrim()</a>	Returns the original string with trailing whitespace removed.
<a href="#">split()</a>	Returns a list of strings resulting from the splitting of the original string around matches of the given delimiter.
<a href="#">substring()</a>	Returns a substring of the original string, beginning with a 0-based index start and length.
<a href="#">toLowerCase()</a>	Returns the original string in lowercase.
<a href="#">toString()</a>	Converts an integer, float, boolean or temporal type (i.e. Date, Time, LocalTime, DateTime, LocalDateTime or Duration) value to a string.

Function	Description
<code>toUpper()</code>	Returns the original string in uppercase.
<code>trim()</code>	Returns the original string with leading and trailing whitespace removed.

## Temporal functions - instant types

Values of the [temporal types](#) — *Date*, *Time*, *LocalTime*, *DateTime*, and *LocalDateTime* — can be created manipulated using the following functions:

Function	Description
<code>date()</code>	Returns the current <i>Date</i> .
<code>date.transaction()</code>	Returns the current <i>Date</i> using the <code>transaction</code> clock.
<code>date.statement()</code>	Returns the current <i>Date</i> using the <code>statement</code> clock.
<code>date.realtime()</code>	Returns the current <i>Date</i> using the <code>realtime</code> clock.
<code>date({year [, month, day]})</code>	Returns a calendar (Year-Month-Day) <i>Date</i> .
<code>date({year [, week, dayOfWeek]})</code>	Returns a week (Year-Week-Day) <i>Date</i> .
<code>date({year [, quarter, dayOfQuarter]})</code>	Returns a quarter (Year-Quarter-Day) <i>Date</i> .
<code>date({year [, ordinalDay]})</code>	Returns an ordinal (Year-Day) <i>Date</i> .
<code>date(string)</code>	Returns a <i>Date</i> by parsing a string.
<code>date({map})</code>	Returns a <i>Date</i> from a map of another temporal value's components.
<code>date.truncate()</code>	Returns a <i>Date</i> obtained by truncating a value at a specific component boundary. <a href="#">Truncation summary</a> .
<code>datetime()</code>	Returns the current <i>DateTime</i> .
<code>datetime.transaction()</code>	Returns the current <i>DateTime</i> using the <code>transaction</code> clock.
<code>datetime.statement()</code>	Returns the current <i>DateTime</i> using the <code>statement</code> clock.
<code>datetime.realtime()</code>	Returns the current <i>DateTime</i> using the <code>realtime</code> clock.
<code>datetime({year [, month, day, ...]})</code>	Returns a calendar (Year-Month-Day) <i>DateTime</i> .
<code>datetime({year [, week, dayOfWeek, ...]})</code>	Returns a week (Year-Week-Day) <i>DateTime</i> .
<code>datetime({year [, quarter, dayOfQuarter, ...]})</code>	Returns a quarter (Year-Quarter-Day) <i>DateTime</i> .
<code>datetime({year [, ordinalDay, ...]})</code>	Returns an ordinal (Year-Day) <i>DateTime</i> .
<code>datetime(string)</code>	Returns a <i>DateTime</i> by parsing a string.
<code>datetime({map})</code>	Returns a <i>DateTime</i> from a map of another temporal value's components.
<code>datetime({epochSeconds})</code>	Returns a <i>DateTime</i> from a timestamp.
<code>datetime.truncate()</code>	Returns a <i>DateTime</i> obtained by truncating a value at a specific component boundary. <a href="#">Truncation summary</a> .
<code>localdatetime()</code>	Returns the current <i>LocalDateTime</i> .
<code>localdatetime.transaction()</code>	Returns the current <i>LocalDateTime</i> using the <code>transaction</code> clock.
<code>localdatetime.statement()</code>	Returns the current <i>LocalDateTime</i> using the <code>statement</code> clock.
<code>localdatetime.realtime()</code>	Returns the current <i>LocalDateTime</i> using the <code>realtime</code> clock.
<code>localdatetime({year [, month, day, ...]})</code>	Returns a calendar (Year-Month-Day) <i>LocalDateTime</i> .

Function	Description
localdatetime({year [, week, dayOfWeek, ...]})	Returns a week (Year-Week-Day) <i>LocalDateTime</i> .
localdatetime({year [, quarter, dayOfQuarter, ...]})	Returns a quarter (Year-Quarter-Day) <i>DateTime</i> .
localdatetime({year [, ordinalDay, ...]})	Returns an ordinal (Year-Day) <i>LocalDateTime</i> .
localdatetime(string)	Returns a <i>LocalDateTime</i> by parsing a string.
localdatetime({map})	Returns a <i>LocalDateTime</i> from a map of another temporal value's components.
localdatetime.truncate()	Returns a <i>LocalDateTime</i> obtained by truncating a value at a specific component boundary. <a href="#">Truncation summary</a> .
localtime()	Returns the current <i>LocalTime</i> .
localtime.transaction()	Returns the current <i>LocalTime</i> using the <code>transaction</code> clock.
localtime.statement()	Returns the current <i>LocalTime</i> using the <code>statement</code> clock.
localtime.realtime()	Returns the current <i>LocalTime</i> using the <code>realtime</code> clock.
localtime({hour [, minute, second, ...]})	Returns a <i>LocalTime</i> with the specified component values.
localtime(string)	Returns a <i>LocalTime</i> by parsing a string.
localtime({time [, hour, ...]})	Returns a <i>LocalTime</i> from a map of another temporal value's components.
localtime.truncate()	Returns a <i>LocalTime</i> obtained by truncating a value at a specific component boundary. <a href="#">Truncation summary</a> .
time()	Returns the current <i>Time</i> .
time.transaction()	Returns the current <i>Time</i> using the <code>transaction</code> clock.
time.statement()	Returns the current <i>Time</i> using the <code>statement</code> clock.
time.realtime()	Returns the current <i>Time</i> using the <code>realtime</code> clock.
time({hour [, minute, ...]})	Returns a <i>Time</i> with the specified component values.
time(string)	Returns a <i>Time</i> by parsing a string.
time({time [, hour, ..., timezone]})	Returns a <i>Time</i> from a map of another temporal value's components.
time.truncate()	Returns a <i>Time</i> obtained by truncating a value at a specific component boundary. <a href="#">Truncation summary</a> .

## Temporal functions - duration

Duration values of the [temporal types](#) can be created manipulated using the following functions:

Function	Description
duration({map})	Returns a <i>Duration</i> from a map of its components.
duration(string)	Returns a <i>Duration</i> by parsing a string.
duration.between()	Returns a <i>Duration</i> equal to the difference between two given instants.
duration.inMonths()	Returns a <i>Duration</i> equal to the difference in whole months, quarters or years between two given instants.
duration.inDays()	Returns a <i>Duration</i> equal to the difference in whole days or weeks between two given instants.
duration.inSeconds()	Returns a <i>Duration</i> equal to the difference in seconds and fractions of seconds, or minutes or hours, between two given instants.

## Spatial functions

These functions are used to specify 2D or 3D points in a geographic or cartesian Coordinate Reference System and to calculate the geodesic distance between two points.

Function	Description
<a href="#">distance()</a>	Returns a floating point number representing the geodesic distance between any two points in the same CRS.
<a href="#">point() - Cartesian 2D</a>	Returns a 2D point object, given two coordinate values in the Cartesian coordinate system.
<a href="#">point() - Cartesian 3D</a>	Returns a 3D point object, given three coordinate values in the Cartesian coordinate system.
<a href="#">point() - WGS 84 2D</a>	Returns a 2D point object, given two coordinate values in the WGS 84 geographic coordinate system.
<a href="#">point() - WGS 84 3D</a>	Returns a 3D point object, given three coordinate values in the WGS 84 geographic coordinate system.

## User-defined functions

User-defined functions are written in Java, deployed into the database and are called in the same way as any other Cypher function. There are two main types of functions that can be developed and used:

Type	Description	Usage	Developing
Scalar	For each row the function takes parameters and returns a result	<a href="#">Using UDF</a>	<a href="#">Extending Neo4j (UDF)</a>
Aggregating	Consumes many rows and produces an aggregated result	<a href="#">Using aggregating UDF</a>	<a href="#">Extending Neo4j (Aggregating UDF)</a>

## LOAD CSV functions

LOAD CSV functions can be used to get information about the file that is processed by [LOAD CSV](#).

Function	Description
<a href="#">linenumber()</a>	Returns the line number that <a href="#">LOAD CSV</a> is currently using.
<a href="#">file()</a>	Returns the absolute path of the file that <a href="#">LOAD CSV</a> is using.

## 4.1. Predicate functions

*Predicates are boolean functions that return true or false for a given set of non-null input. They are most commonly used to filter out paths in the WHERE part of a query.*

Functions:

- [all\(\)](#)
- [any\(\)](#)
- [exists\(\)](#)
- [none\(\)](#)
- [single\(\)](#)

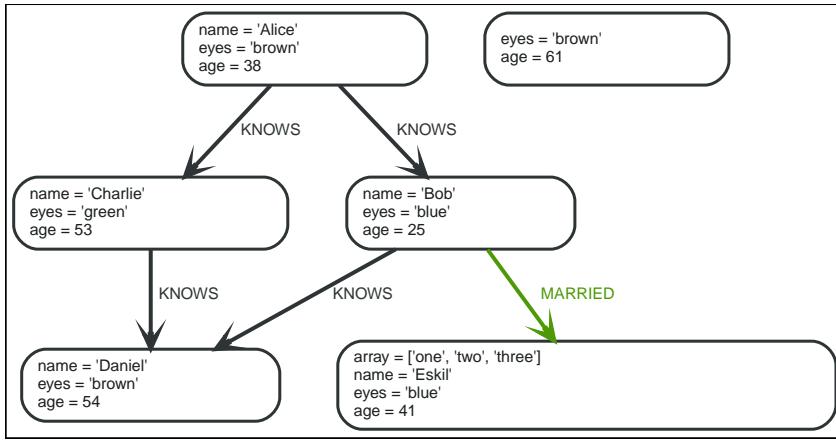


Figure 23. Graph

#### 4.1.1. all()

`all()` returns true if the predicate holds for all elements in the given list. `null` is returned if the list is `null` or all of its elements are `null`.

**Syntax:** `all(variable IN list WHERE predicate)`

**Returns:**

A Boolean.

**Arguments:**

Name	Description
<code>list</code>	An expression that returns a list. A single element cannot be explicitly passed as a literal in the cypher statement. However, an implicit conversion will happen for a single elements when passing node properties during cypher execution.
<code>variable</code>	This is the variable that can be used from within the predicate.
<code>predicate</code>	A predicate that is tested against all items in the list.

**Query**

```
MATCH p =(a)-[*1..3]->(b)
WHERE a.name = 'Alice' AND b.name = 'Daniel' AND ALL (x IN nodes(p) WHERE x.age > 30)
RETURN p
```

All nodes in the returned paths will have an `age` property of at least '30'.

Table 219. Result

<code>p</code>
<code>(0)-[KNOWS,1]-&gt;(2)-[KNOWS,3]-&gt;(3)</code>
1 row

#### 4.1.2. any()

`any()` returns true if the predicate holds for at least one element in the given list. `null` is returned if the list is `null` or all of its elements are `null`.

**Syntax:** `any(variable IN list WHERE predicate)`

**Returns:**

A Boolean.

**Arguments:**

Name	Description
<code>list</code>	An expression that returns a list. A single element cannot be explicitly passed as a literal in the cypher statement. However, an implicit conversion will happen for a single elements when passing node properties during cypher execution.
<code>variable</code>	This is the variable that can be used from within the predicate.
<code>predicate</code>	A predicate that is tested against all items in the list.

**Query**

```
MATCH (a)
WHERE a.name = 'Eskil' AND ANY (x IN a.array WHERE x = 'one')
RETURN a.name, a.array
```

All nodes in the returned paths have at least one 'one' value set in the array property named `array`.

*Table 220. Result*

a.name	a.array
"Eskil"	["one", "two", "three"]
1 row	

### 4.1.3. exists()

`exists()` returns true if a match for the given pattern exists in the graph, or if the specified property exists in the node, relationship or map. `null` is returned if the input argument is `null`.

**Syntax:** `exists(pattern-or-property)`

**Returns:**

A Boolean.

**Arguments:**

Name	Description
<code>pattern-or-property</code>	A pattern or a property (in the form 'variable.prop').

**Query**

```
MATCH (n)
WHERE EXISTS (n.name)
RETURN n.name AS name, EXISTS ((n)-[:MARRIED]->()) AS is_married
```

The names of all nodes with the `name` property are returned, along with a boolean `true / false` indicating if they are married.

Table 221. Result

name	is_married
"Alice"	false
"Bob"	true
"Charlie"	false
"Daniel"	false
"Eskil"	false
5 rows	

## Query

```

MATCH (a),(b)
WHERE EXISTS (a.name) AND NOT EXISTS (b.name)
OPTIONAL MATCH (c:DoesNotExist)
RETURN a.name AS a_name, b.name AS b_name, EXISTS (b.name) AS b_has_name, c.name AS c_name, EXISTS
(c.name) AS c_has_name
ORDER BY a_name, b_name, c_name
LIMIT 1

```

Three nodes are returned: one with a name property, one without a name property, and one that does not exist (e.g., is `null`). This query exemplifies the behavior of `exists()` when operating on `null` nodes.

Table 222. Result

a_name	b_name	b_has_name	c_name	c_has_name
"Alice"	<null>	false	<null>	<null>
1 row				

## 4.1.4. none()

`none()` returns true if the predicate holds for no element in the given list. `null` is returned if the list is `null` or all of its elements are `null`.

**Syntax:** `none(variable IN list WHERE predicate)`

**Returns:**

A Boolean.

## Arguments:

Name	Description
<code>list</code>	An expression that returns a list. A single element cannot be explicitly passed as a literal in the cypher statement. However, an implicit conversion will happen for a single elements when passing node properties during cypher execution.
<code>variable</code>	This is the variable that can be used from within the predicate.
<code>predicate</code>	A predicate that is tested against all items in the list.

## Query

```
MATCH p =(n)-[*1..3]->(b)
WHERE n.name = 'Alice' AND NONE (x IN nodes(p) WHERE x.age = 25)
RETURN p
```

No node in the returned paths has an `age` property set to '25'.

Table 223. Result

p
(0)-[KNOWS,1]->(2)
(0)-[KNOWS,1]->(2)-[KNOWS,3]->(3)
2 rows

## 4.1.5. single()

`single()` returns true if the predicate holds for exactly one of the elements in the given list. `null` is returned if the list is `null` or all of its elements are `null`.

**Syntax:** `single(variable IN list WHERE predicate)`

**Returns:**

A Boolean.

**Arguments:**

Name	Description
<code>list</code>	An expression that returns a list.
<code>variable</code>	This is the variable that can be used from within the predicate.
<code>predicate</code>	A predicate that is tested against all items in the list.

## Query

```
MATCH p =(n)-->(b)
WHERE n.name = 'Alice' AND SINGLE (var IN nodes(p) WHERE var.eyes = 'blue')
RETURN p
```

Exactly one node in every returned path has the `eyes` property set to 'blue'.

Table 224. Result

p
(0)-[KNOWS,0]->(1)
1 row

## 4.2. Scalar functions

*Scalar functions return a single value.*



The `length()` and `size()` functions are quite similar, and so it is important to take note of the difference. `length()` only works for `paths`, while `size()` only works for the three types: `strings`, `lists` and `pattern expressions`.

Functions:

- `coalesce()`
- `endNode()`
- `head()`
- `id()`
- `last()`
- `length()`
- `properties()`
- `randomUUID()`
- `size()`
- Size of pattern expression
- Size of string
- `startNode()`
- `timestamp()`
- `toBoolean()`
- `toFloat()`
- `toInteger()`
- `type()`

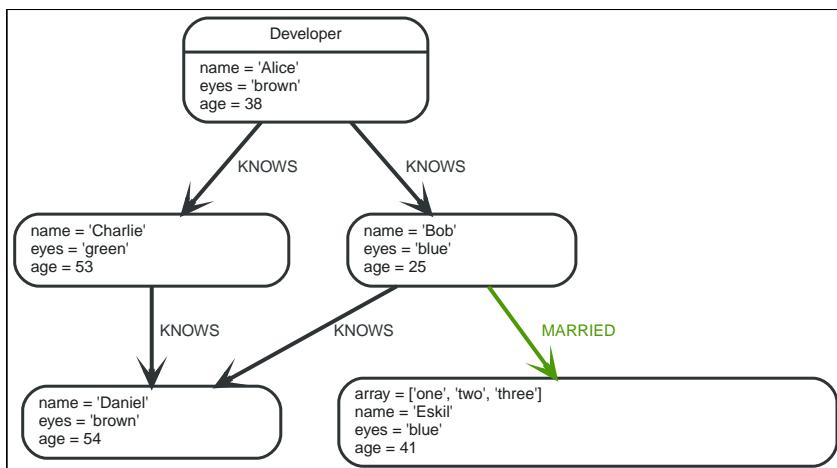


Figure 24. Graph

#### 4.2.1. `coalesce()`

`coalesce()` returns the first non-`null` value in the given list of expressions.

**Syntax:** `coalesce(expression [, expression]*)`

**Returns:**

The type of the value returned will be that of the first non-`null` expression.

## Arguments:

Name	Description
expression	An expression which may return <code>null</code> .

## Considerations:

`null` will be returned if all the arguments are `null`.

## Query

```
MATCH (a)
WHERE a.name = 'Alice'
RETURN coalesce(a.hairColor, a.eyes)
```

Table 225. Result

coalesce(a.hairColor, a.eyes)
"brown"
1 row

## 4.2.2. endNode()

`endNode()` returns the end node of a relationship.

Syntax: `endNode(relationship)`

## Returns:

A Node.

## Arguments:

Name	Description
relationship	An expression that returns a relationship.

## Considerations:

`endNode(null)` returns `null`.

## Query

```
MATCH (x:Developer)-[r]-()
RETURN endNode(r)
```

Table 226. Result

endNode(r)
Node[2]{name:"Charlie",eyes:"green",age:53}
Node[1]{name:"Bob",eyes:"blue",age:25}
2 rows

### 4.2.3. head()

`head()` returns the first element in a list.

**Syntax:** `head(list)`

**Returns:**

The type of the value returned will be that of the first element of `list`.

**Arguments:**

Name	Description
<code>list</code>	An expression that returns a list.

**Considerations:**

`head(null)` returns `null`.

If the first element in `list` is `null`, `head(list)` will return `null`.

**Query**

```
MATCH (a)
WHERE a.name = 'Eskil'
RETURN a.array, head(a.array)
```

The first element in the list is returned.

*Table 227. Result*

a.array	head(a.array)
<code>["one", "two", "three"]</code>	<code>"one"</code>
1 row	

### 4.2.4. id()

`id()` returns the id of a relationship or node.

**Syntax:** `id(expression)`

**Returns:**

An Integer.

**Arguments:**

Name	Description
<code>expression</code>	An expression that returns a node or a relationship.

**Considerations:**

`id(null)` returns `null`.

## Query

```
MATCH (a)
RETURN id(a)
```

The node id for each of the nodes is returned.

Table 228. Result

id(a)
0
1
2
3
4
5 rows

## 4.2.5. last()

`last()` returns the last element in a list.

**Syntax:** `last(expression)`

**Returns:**

The type of the value returned will be that of the last element of `list`.

**Arguments:**

Name	Description
<code>list</code>	An expression that returns a list.

**Considerations:**

`last(null)` returns `null`.

If the last element in `list` is `null`, `last(list)` will return `null`.

## Query

```
MATCH (a)
WHERE a.name = 'Eskil'
RETURN a.array, last(a.array)
```

The last element in the list is returned.

Table 229. Result

a.array	last(a.array)
<code>["one", "two", "three"]</code>	<code>"three"</code>
1 row	

## 4.2.6. length()

`length()` returns the length of a path.

**Syntax:** `length(path)`

**Returns:**

An Integer.

**Arguments:**

Name	Description
<code>path</code>	An expression that returns a path.

**Considerations:**

`length(null)` returns `null`.

**Query**

```
MATCH p =(a)-->(b)-->(c)
WHERE a.name = 'Alice'
RETURN length(p)
```

The length of the path `p` is returned.

*Table 230. Result*

length( <code>p</code> )
2
2
2
3 rows

## 4.2.7. properties()

`properties()` returns a map containing all the properties of a node or relationship. If the argument is already a map, it is returned unchanged.

**Syntax:** `properties(expression)`

**Returns:**

A Map.

**Arguments:**

Name	Description
<code>expression</code>	An expression that returns a node, a relationship, or a map.

**Considerations:**

```
properties(null) returns null.
```

## Query

```
CREATE (p:Person { name: 'Stefan', city: 'Berlin' })
RETURN properties(p)
```

Table 231. Result

properties(p)
{city -> "Berlin", name -> "Stefan"}
1 row, Nodes created: 1 Properties set: 2 Labels added: 1

## 4.2.8. randomUUID()

`randomUUID()` returns a randomly-generated Universally Unique Identifier (UUID), also known as a Globally Unique Identifier (GUID). This is a 128-bit value with strong guarantees of uniqueness.

**Syntax:** `randomUUID()`

**Returns:**

A String.
-----------

## Query

```
RETURN randomUUID() AS uuid
```

Table 232. Result

uuid
"237505b4-a6cd-4397-a6d8-9043c0dfb492"
1 row

## 4.2.9. size()

`size()` returns the number of elements in a list.

**Syntax:** `size(list)`

**Returns:**

An Integer.
-------------

## Arguments:

Name	Description
<code>list</code>	An expression that returns a list.

## Considerations:

```
size(null) returns null.
```

## Query

```
RETURN size(['Alice', 'Bob'])
```

Table 233. Result

size(['Alice', 'Bob'])
2
1 row

The number of elements in the list is returned.

### 4.2.10. size() applied to pattern expression

This is the same `size()` method as described above, but instead of passing in a list directly, a pattern expression can be provided that can be used in a match query to provide a new set of results. These results are a *list* of paths. The size of the result is calculated, not the length of the expression itself.

**Syntax:** `size(pattern expression)`

**Arguments:**

Name	Description
<code>pattern expression</code>	A pattern expression that returns a list.

## Query

```
MATCH (a)
WHERE a.name = 'Alice'
RETURN size((a)-->()-->()) AS fofof
```

Table 234. Result

fofof
3
1 row

The number of paths matching the pattern expression is returned.

### 4.2.11. size() applied to string

`size()` returns the number of Unicode characters in a string.

**Syntax:** `size(string)`

**Returns:**

An Integer.
-------------

**Arguments:**

Name	Description
string	An expression that returns a string value.

### Considerations:

`size(null) returns null.`

### Query

```
MATCH (a)
WHERE size(a.name)> 6
RETURN size(a.name)
```

Table 235. Result

size(a.name)
7
1 row

The number of characters in the string 'Charlie' is returned.

### 4.2.12. startNode()

`startNode()` returns the start node of a relationship.

**Syntax:** `startNode(relationship)`

### Returns:

A Node.

### Arguments:

Name	Description
relationship	An expression that returns a relationship.

### Considerations:

`startNode(null) returns null.`

### Query

```
MATCH (x:Developer)-[r]-()
RETURN startNode(r)
```

Table 236. Result

startNode(r)
Node[0]{name:"Alice",eyes:"brown",age:38}
Node[0]{name:"Alice",eyes:"brown",age:38}
2 rows

## 4.2.13. timestamp()

`timestamp()` returns the difference, measured in milliseconds, between the current time and midnight, January 1, 1970 UTC. It is the equivalent of `datetime().epochMillis`.

**Syntax:** `timestamp()`

**Returns:**

An Integer.

**Considerations:**

`timestamp()` will return the same value during one entire query, even for long-running queries.

*Query*

```
RETURN timestamp()
```

The time in milliseconds is returned.

*Table 237. Result*

<code>timestamp()</code>
1605610965056
1 row

## 4.2.14. toBoolean()

`toBoolean()` converts a string value to a boolean value.

**Syntax:** `toBoolean(expression)`

**Returns:**

A Boolean.

**Arguments:**

Name	Description
<code>expression</code>	An expression that returns a boolean or string value.

**Considerations:**

`toBoolean(null)` returns `null`.

If `expression` is a boolean value, it will be returned unchanged.

If the parsing fails, `null` will be returned.

*Query*

```
RETURN toBoolean('TRUE'), toBoolean('not a boolean')
```

*Table 238. Result*

<code>toBoolean('TRUE')</code>	<code>toBoolean('not a boolean')</code>
<code>true</code>	<code>&lt;null&gt;</code>
1 row	

## 4.2.15. `toFloat()`

`toFloat()` converts an integer or string value to a floating point number.

**Syntax:** `toFloat(expression)`

**Returns:**

A Float.

**Arguments:**

Name	Description
<code>expression</code>	An expression that returns a numeric or string value.

**Considerations:**

`toFloat(null)` returns `null`.

If `expression` is a floating point number, it will be returned unchanged.

If the parsing fails, `null` will be returned.

**Query**

```
RETURN toFloat('11.5'), toFloat('not a number')
```

*Table 239. Result*

<code>toFloat('11.5')</code>	<code>toFloat('not a number')</code>
<code>11.5</code>	<code>&lt;null&gt;</code>
1 row	

## 4.2.16. `toInteger()`

`toInteger()` converts a floating point or string value to an integer value.

**Syntax:** `toInteger(expression)`

**Returns:**

An Integer.

**Arguments:**

Name	Description
<code>expression</code>	An expression that returns a numeric or string value.

**Considerations:**

`toInteger(null)` returns `null`.

If `expression` is an integer value, it will be returned unchanged.

If the parsing fails, `null` will be returned.

## Query

```
RETURN toInteger('42'), toInteger('not a number')
```

Table 240. Result

toInteger('42')	toInteger('not a number')
42	<null>
1 row	

## 4.2.17. type()

`type()` returns the string representation of the relationship type.

**Syntax:** `type(relationship)`

**Returns:**

A String.

**Arguments:**

Name	Description
<code>relationship</code>	An expression that returns a relationship.

**Considerations:**

`type(null)` returns `null`.

## Query

```
MATCH (n)-[r]->()
WHERE n.name = 'Alice'
RETURN type(r)
```

The relationship type of `r` is returned.

Table 241. Result

type(r)
"KNOWS"
"KNOWS"
2 rows

## 4.3. Aggregating functions

To calculate aggregated data, Cypher offers aggregation, analogous to SQL's `GROUP BY`.

Aggregating functions take a set of values and calculate an aggregated value over them. Examples are

`avg()` that calculates the average of multiple numeric values, or `min()` that finds the smallest numeric or string value in a set of values. When we say below that an aggregating function operates on a *set of values*, we mean these to be the result of the application of the inner expression (such as `n.age`) to all the records within the same aggregation group.

Aggregation can be computed over all the matching paths, or it can be further divided by introducing grouping keys. These are non-aggregate expressions, that are used to group the values going into the aggregate functions.

Assume we have the following return statement:

```
RETURN n, count(*)
```

We have two return expressions: `n`, and `count()`. The first, `n`, is not an aggregate function, and so it will be the grouping key. The latter, `count()` is an aggregate expression. The matching paths will be divided into different buckets, depending on the grouping key. The aggregate function will then be run on these buckets, calculating an aggregate value per bucket.

To use aggregations to sort the result set, the aggregation must be included in the `RETURN` to be used in the `ORDER BY`.

The `DISTINCT` operator works in conjunction with aggregation. It is used to make all values unique before running them through an aggregate function. More information about `DISTINCT` may be found [here](#).

Functions:

- `avg()` - Numeric values
- `avg()` - Durations
- `collect()`
- `count()`
- `max()`
- `min()`
- `percentileCont()`
- `percentileDisc()`
- `stDev()`
- `stDevP()`
- `sum()` - Numeric values
- `sum()` - Durations

The following graph is used for the examples below:

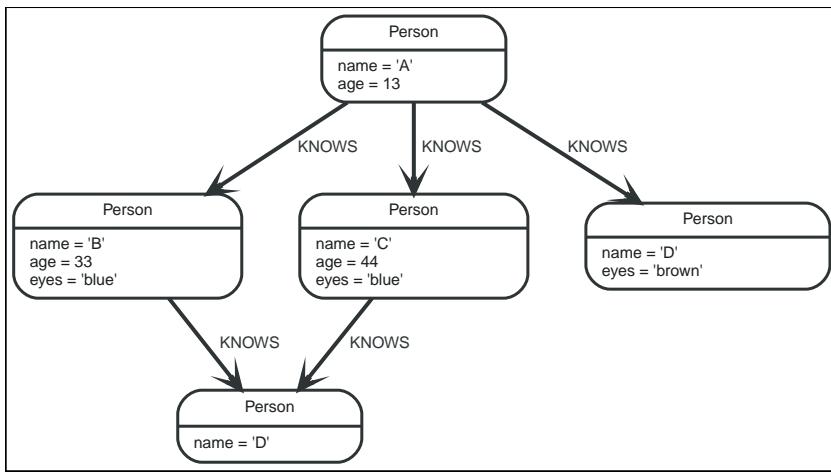


Figure 25. Graph

#### 4.3.1. avg() - Numeric values

`avg()` returns the average of a set of numeric values.

**Syntax:** `avg(expression)`

**Returns:**

Either an Integer or a Float, depending on the values returned by `expression` and whether or not the calculation overflows.

**Arguments:**

Name	Description
<code>expression</code>	An expression returning a set of numeric values.

**Considerations:**

Any `null` values are excluded from the calculation.

`avg(null)` returns `null`.

**Query**

```
MATCH (n:Person)
RETURN avg(n.age)
```

The average of all the values in the property `age` is returned.

**Table 242. Result**

<code>avg(n.age)</code>
30.0
1 row

#### 4.3.2. avg() - Durations

`avg()` returns the average of a set of Durations.

**Syntax:** `avg(expression)`

## Returns:

A Duration.

## Arguments:

Name	Description
expression	An expression returning a set of Durations.

## Considerations:

Any `null` values are excluded from the calculation.

`avg(null)` returns `null`.

## Query

```
UNWIND [duration('P2DT3H'), duration('PT1H45S')] AS dur  
RETURN avg(dur)
```

The average of the two supplied Durations is returned.

Table 243. Result

avg(dur)
P1DT2H22.5S
1 row

## 4.3.3. collect()

`collect()` returns a list containing the values returned by an expression. Using this function aggregates data by amalgamating multiple records or values into a single list.

Syntax: `collect(expression)`

## Returns:

A list containing heterogeneous elements; the types of the elements are determined by the values returned by `expression`.

## Arguments:

Name	Description
expression	An expression returning a set of values.

## Considerations:

Any `null` values are ignored and will not be added to the list.

`collect(null)` returns an empty list.

## Query

```
MATCH (n:Person)  
RETURN collect(n.age)
```

All the values are collected and returned in a single list.

Table 244. Result

collect(n.age)
[13,33,44]
1 row

### 4.3.4. count()

`count()` returns the number of values or rows, and appears in two variants:

- `count(*)` returns the number of matching rows, and
- `count(expr)` returns the number of non-`null` values returned by an expression.

**Syntax:** `count(expression)`

**Returns:**

An Integer.

**Arguments:**

Name	Description
<code>expression</code>	An expression.

**Considerations:**

`count(*)` includes rows returning `null`.

`count(expr)` ignores `null` values.

`count(null)` returns `0`.

Using `count(*)` to return the number of nodes

`count(*)` can be used to return the number of nodes; for example, the number of nodes connected to some node `n`.

**Query**

```
MATCH (n { name: 'A' })-->(x)
RETURN labels(n), n.age, count(*)
```

The labels and `age` property of the start node `n` and the number of nodes related to `n` are returned.

Table 245. Result

labels(n)	n.age	count(*)
["Person"]	13	3
1 row		

Using `count(*)` to group and count relationship types

`count(*)` can be used to group relationship types and return the number.

## Query

```
MATCH (n { name: 'A' })-[r]->()
RETURN type(r), count(*)
```

The relationship types and their group count are returned.

Table 246. Result

type(r)	count(*)
"KNOWS"	3
1 row	

Using `count(expression)` to return the number of values

Instead of simply returning the number of rows with `count(*)`, it may be more useful to return the actual number of values returned by an expression.

## Query

```
MATCH (n { name: 'A' })-->(x)
RETURN count(x)
```

The number of nodes connected to the start node is returned.

Table 247. Result

count(x)
3
1 row

Counting non-**null** values

`count(expression)` can be used to return the number of non-**null** values returned by the expression.

## Query

```
MATCH (n:Person)
RETURN count(n.age)
```

The number of :Person nodes having an `age` property is returned.

Table 248. Result

count(n.age)
3
1 row

Counting with and without duplicates

In this example we are trying to find all our friends of friends, and count them:

- The first aggregate function, `count(DISTINCT friend_of_friend)`, will only count a `friend_of_friend` once, as `DISTINCT` removes the duplicates.
- The second aggregate function, `count(friend_of_friend)`, will consider the same `friend_of_friend`

multiple times.

### Query

```
MATCH (me:Person)-->(friend:Person)-->(friend_of_friend:Person)
WHERE me.name = 'A'
RETURN count(DISTINCT friend_of_friend), count(friend_of_friend)
```

Both **B** and **C** know **D** and thus **D** will get counted twice when not using **DISTINCT**.

Table 249. Result

count(DISTINCT friend_of_friend)	count(friend_of_friend)
1	2
1 row	

### 4.3.5. max()

**max()** returns the maximum value in a set of values.

**Syntax:** `max(expression)`

**Returns:**

A [property type](#), or a list, depending on the values returned by `expression`.

**Arguments:**

Name	Description
<code>expression</code>	An expression returning a set containing any combination of <a href="#">property types</a> and lists thereof.

**Considerations:**

Any `null` values are excluded from the calculation.

In a mixed set, any numeric value is always considered to be higher than any string value, and any string value is always considered to be higher than any list.

Lists are compared in dictionary order, i.e. list elements are compared pairwise in ascending order from the start of the list to the end.

`max(null)` returns `null`.

### Query

```
UNWIND [1, 'a', NULL , 0.2, 'b', '1', '99'] AS val
RETURN max(val)
```

The highest of all the values in the mixed set — in this case, the numeric value `1` — is returned. Note that the (string) value `"99"`, which may *appear* at first glance to be the highest value in the list, is considered to be a lower value than `1` as the latter is a string.

Table 250. Result

max(val)
1
1 row

## Query

```
UNWIND [[1, 'a', 89],[1, 2]] AS val  
RETURN max(val)
```

The highest of all the lists in the set — in this case, the list [1, 2] — is returned, as the number 2 is considered to be a higher value than the string "a", even though the list [1, 'a', 89] contains more elements.

Table 251. Result

max(val)
[1, 2]
1 row

## Query

```
MATCH (n:Person)  
RETURN max(n.age)
```

The highest of all the values in the property age is returned.

Table 252. Result

max(n.age)
44
1 row

## 4.3.6. min()

min() returns the minimum value in a set of values.

**Syntax:** min(expression)

**Returns:**

A [property type](#), or a list, depending on the values returned by expression.

**Arguments:**

Name	Description
expression	An expression returning a set containing any combination of <a href="#">property types</a> and lists thereof.

**Considerations:**

Any null values are excluded from the calculation.

In a mixed set, any string value is always considered to be lower than any numeric value, and any list is always considered to be lower than any string.

Lists are compared in dictionary order, i.e. list elements are compared pairwise in ascending order from the start of the list to the end.

min(null) returns null.

## Query

```
UNWIND [1, 'a', NULL , 0.2, 'b', '1', '99'] AS val  
RETURN min(val)
```

The lowest of all the values in the mixed set — in this case, the string value "`1`" — is returned. Note that the (numeric) value `0.2`, which may *appear* at first glance to be the lowest value in the list, is considered to be a higher value than "`1`" as the latter is a string.

Table 253. Result

min(val)
<code>"1"</code>
1 row

## Query

```
UNWIND ['d',[1, 2],['a', 'c', 23]] AS val  
RETURN min(val)
```

The lowest of all the values in the set — in this case, the list `['a', 'c', 23]` — is returned, as (i) the two lists are considered to be lower values than the string "`d`", and (ii) the string "`a`" is considered to be a lower value than the numerical value `1`.

Table 254. Result

min(val)
<code>["a", "c", 23]</code>
1 row

## Query

```
MATCH (n:Person)  
RETURN min(n.age)
```

The lowest of all the values in the property `age` is returned.

Table 255. Result

min(n.age)
<code>13</code>
1 row

## 4.3.7. percentileCont()

`percentileCont()` returns the percentile of the given value over a group, with a percentile from 0.0 to 1.0. It uses a linear interpolation method, calculating a weighted average between two values if the desired percentile lies between them. For nearest values using a rounding method, see `percentileDisc`.

**Syntax:** `percentileCont(expression, percentile)`

**Returns:**

A Float.

## Arguments:

Name	Description
expression	A numeric expression.
percentile	A numeric value between 0.0 and 1.0

## Considerations:

Any `null` values are excluded from the calculation.

`percentileCont(null, percentile)` returns `null`.

## Query

```
MATCH (n:Person)
RETURN percentileCont(n.age, 0.4)
```

The 40th percentile of the values in the property `age` is returned, calculated with a weighted average. In this case, 0.4 is the median, or 40th percentile.

Table 256. Result

<code>percentileCont(n.age, 0.4)</code>
29.0
1 row

## 4.3.8. percentileDisc()

`percentileDisc()` returns the percentile of the given value over a group, with a percentile from 0.0 to 1.0. It uses a rounding method and calculates the nearest value to the percentile. For interpolated values, see `percentileCont`.

**Syntax:** `percentileDisc(expression, percentile)`

**Returns:**

Either an Integer or a Float, depending on the values returned by `expression` and whether or not the calculation overflows.

## Arguments:

Name	Description
expression	A numeric expression.
percentile	A numeric value between 0.0 and 1.0

## Considerations:

Any `null` values are excluded from the calculation.

`percentileDisc(null, percentile)` returns `null`.

## Query

```
MATCH (n:Person)
RETURN percentileDisc(n.age, 0.5)
```

The 50th percentile of the values in the property `age` is returned.

*Table 257. Result*

<code>percentileDisc(n.age, 0.5)</code>
33
1 row

## 4.3.9. `stDev()`

`stDev()` returns the standard deviation for the given value over a group. It uses a standard two-pass method, with  $N - 1$  as the denominator, and should be used when taking a sample of the population for an unbiased estimate. When the standard variation of the entire population is being calculated, `stdDevP` should be used.

**Syntax:** `stDev(expression)`

**Returns:**

A Float.

**Arguments:**

Name	Description
<code>expression</code>	A numeric expression.

**Considerations:**

Any `null` values are excluded from the calculation.

`stDev(null)` returns `0`.

**Query**

```
MATCH (n)
WHERE n.name IN ['A', 'B', 'C']
RETURN stDev(n.age)
```

The standard deviation of the values in the property `age` is returned.

*Table 258. Result*

<code>stDev(n.age)</code>
15.716233645501712
1 row

## 4.3.10. `stDevP()`

`stDevP()` returns the standard deviation for the given value over a group. It uses a standard two-pass method, with  $N$  as the denominator, and should be used when calculating the standard deviation for an entire population. When the standard variation of only a sample of the population is being calculated, `stDev` should be used.

**Syntax:** `stDevP(expression)`

**Returns:**

A Float.

#### Arguments:

Name	Description
expression	A numeric expression.

#### Considerations:

Any `null` values are excluded from the calculation.

`stDevP(null)` returns `0`.

#### Query

```
MATCH (n)
WHERE n.name IN ['A', 'B', 'C']
RETURN stDevP(n.age)
```

The population standard deviation of the values in the property `age` is returned.

#### Table 259. Result

`stDevP(n.age)`

12.832251036613439

1 row

### 4.3.11. sum() - Numeric values

`sum()` returns the sum of a set of numeric values.

**Syntax:** `sum(expression)`

**Returns:**

Either an Integer or a Float, depending on the values returned by `expression`.

#### Arguments:

Name	Description
expression	An expression returning a set of numeric values.

#### Considerations:

Any `null` values are excluded from the calculation.

`sum(null)` returns `0`.

#### Query

```
MATCH (n:Person)
RETURN sum(n.age)
```

The sum of all the values in the property `age` is returned.

#### Table 260. Result

```
sum(n.age)
```

```
90
```

```
1 row
```

### 4.3.12. sum() - Durations

`sum()` returns the sum of a set of Durations.

**Syntax:** `sum(expression)`

**Returns:**

```
A Duration.
```

**Arguments:**

Name	Description
<code>expression</code>	An expression returning a set of Durations.

**Considerations:**

```
Any null values are excluded from the calculation.
```

*Query*

```
UNWIND [duration('P2DT3H'), duration('PT1H45S')] AS dur
RETURN sum(dur)
```

The sum of the two supplied Durations is returned.

*Table 261. Result*

```
sum(dur)
```

```
P2DT4H45S
```

```
1 row
```

## 4.4. List functions

*List functions return lists of things — nodes in a path, and so on.*

Further details and examples of lists may be found in [Lists](#) and [List operators](#).

**Functions:**

- [keys\(\)](#)
- [labels\(\)](#)
- [nodes\(\)](#)
- [range\(\)](#)
- [reduce\(\)](#)
- [relationships\(\)](#)

- `reverse()`
- `tail()`

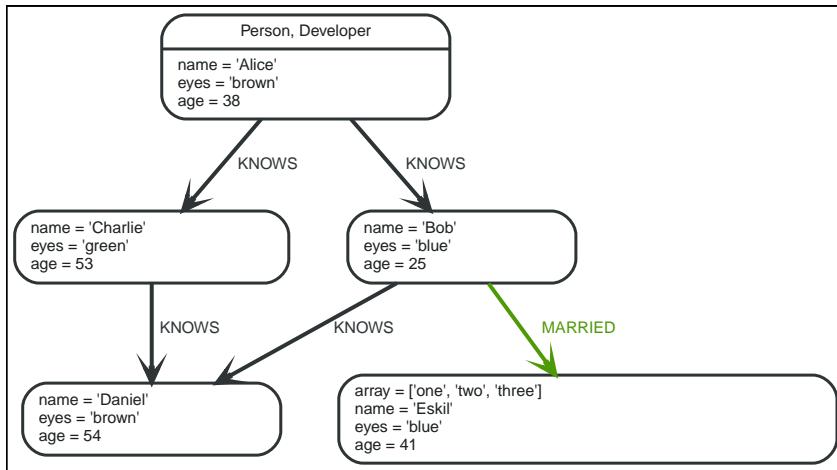


Figure 26. Graph

#### 4.4.1. `keys()`

`keys` returns a list containing the string representations for all the property names of a node, relationship, or map.

**Syntax:** `keys(expression)`

**Returns:**

A list containing String elements.

**Arguments:**

Name	Description
<code>expression</code>	An expression that returns a node, a relationship, or a map.

**Considerations:**

`keys(null)` returns `null`.

**Query**

```

MATCH (a)
WHERE a.name = 'Alice'
RETURN keys(a)
  
```

A list containing the names of all the properties on the node bound to `a` is returned.

Table 262. Result

<code>keys(a)</code>
<code>["name", "eyes", "age"]</code>
1 row

## 4.4.2. labels()

`labels` returns a list containing the string representations for all the labels of a node.

**Syntax:** `labels(node)`

**Returns:**

A list containing String elements.

**Arguments:**

Name	Description
<code>node</code>	An expression that returns a single node.

**Considerations:**

`labels(null)` returns `null`.

**Query**

```
MATCH (a)
WHERE a.name = 'Alice'
RETURN labels(a)
```

A list containing all the labels of the node bound to `a` is returned.

*Table 263. Result*

<code>labels(a)</code>
<code>["Person", "Developer"]</code>
1 row

## 4.4.3. nodes()

`nodes()` returns a list containing all the nodes in a path.

**Syntax:** `nodes(path)`

**Returns:**

A list containing Node elements.

**Arguments:**

Name	Description
<code>path</code>	An expression that returns a path.

**Considerations:**

`nodes(null)` returns `null`.

## Query

```
MATCH p =(a)-->(b)-->(c)
WHERE a.name = 'Alice' AND c.name = 'Eskil'
RETURN nodes(p)
```

A list containing all the nodes in the path `p` is returned.

Table 264. Result

nodes(p)
[Node[0]{name: "Alice", eyes: "brown", age: 38}, Node[1]{name: "Bob", eyes: "blue", age: 25}, Node[4]{array: ["one", "two", "three"], name: "Eskil", eyes: "blue", age: 41}]
1 row

## 4.4.4. range()

`range()` returns a list comprising all integer values within a range bounded by a start value `start` and end value `end`, where the difference `step` between any two consecutive values is constant; i.e. an arithmetic progression. To create ranges with decreasing integer values, use a negative value `step`. The range is inclusive for non-empty ranges, and the arithmetic progression will therefore always contain `start` and — depending on the values of `start`, `step` and `end` — `end`. The only exception where the range does not contain `start` are empty ranges. An empty range will be returned if the value `step` is negative and `start - end` is positive, or vice versa, e.g. `range(0, 5, -1)`.

**Syntax:** `range(start, end [, step])`

**Returns:**

A list of Integer elements.

### Arguments:

Name	Description
<code>start</code>	An expression that returns an integer value.
<code>end</code>	An expression that returns an integer value.
<code>step</code>	A numeric expression defining the difference between any two consecutive values, with a default of 1.

## Query

```
RETURN range(0, 10), range(2, 18, 3), range(0, 5, -1)
```

Three lists of numbers in the given ranges are returned.

Table 265. Result

range(0, 10)	range(2, 18, 3)	range(0, 5, -1)
[0,1,2,3,4,5,6,7,8,9,10]	[2,5,8,11,14,17]	[]
1 row		

## 4.4.5. reduce()

`reduce()` returns the value resulting from the application of an expression on each successive element in a list in conjunction with the result of the computation thus far. This function will iterate through

each element `e` in the given list, run the expression on `e` — taking into account the current partial result — and store the new partial result in the accumulator. This function is analogous to the `fold` or `reduce` method in functional languages such as Lisp and Scala.

**Syntax:** `reduce(accumulator = initial, variable IN list | expression)`

**Returns:**

The type of the value returned depends on the arguments provided, along with the semantics of `expression`.

**Arguments:**

Name	Description
<code>accumulator</code>	A variable that will hold the result and the partial results as the list is iterated.
<code>initial</code>	An expression that runs once to give a starting value to the accumulator.
<code>list</code>	An expression that returns a list.
<code>variable</code>	The closure will have a variable introduced in its context. We decide here which variable to use.
<code>expression</code>	This expression will run once per value in the list, and produce the result value.

**Query**

```
MATCH p =(a)-->(b)-->(c)
WHERE a.name = 'Alice' AND b.name = 'Bob' AND c.name = 'Daniel'
RETURN reduce(totalAge = 0, n IN nodes(p)| totalAge + n.age) AS reduction
```

The `age` property of all nodes in the path are summed and returned as a single value.

*Table 266. Result*

<code>reduction</code>
117
1 row

## 4.4.6. relationships()

`relationships()` returns a list containing all the relationships in a path.

**Syntax:** `relationships(path)`

**Returns:**

A list containing Relationship elements.

**Arguments:**

Name	Description
<code>path</code>	An expression that returns a path.

**Considerations:**

```
relationships(null) returns null.
```

## Query

```
MATCH p =(a)-->(b)-->(c)
WHERE a.name = 'Alice' AND c.name = 'Eskil'
RETURN relationships(p)
```

A list containing all the relationships in the path `p` is returned.

Table 267. Result

relationships(p)
------------------

[:KNOWS[0]{}, :MARRIED[4]{}]
------------------------------

1 row
-------

## 4.4.7. reverse()

`reverse()` returns a list in which the order of all elements in the original list have been reversed.

**Syntax:** `reverse(original)`

**Returns:**

A list containing homogeneous or heterogeneous elements; the types of the elements are determined by the elements within `original`.

**Arguments:**

Name	Description
<code>original</code>	An expression that returns a list.

**Considerations:**

Any `null` element in `original` is preserved.

## Query

```
WITH [4923, 'abc', 521, NULL , 487] AS ids
RETURN reverse(ids)
```

Table 268. Result

reverse(ids)
--------------

[487,<null>,521, "abc",4923]
------------------------------

1 row
-------

## 4.4.8. tail()

`tail()` returns a list `lresult` containing all the elements, excluding the first one, from a list `list`.

**Syntax:** `tail(list)`

**Returns:**

A list containing heterogeneous elements; the types of the elements are determined by the elements in `list`.

### Arguments:

Name	Description
<code>list</code>	An expression that returns a list.

### Query

```
MATCH (a)
WHERE a.name = 'Eskil'
RETURN a.array, tail(a.array)
```

The property named `array` and a list comprising all but the first element of the `array` property are returned.

Table 269. Result

a.array	tail(a.array)
<code>["one", "two", "three"]</code>	<code>["two", "three"]</code>
1 row	

## 4.5. Mathematical functions - numeric

*These functions all operate on numeric expressions only, and will return an error if used on any other values. See also [Mathematical operators](#).*

### Functions:

- [abs\(\)](#)
- [ceil\(\)](#)
- [floor\(\)](#)
- [rand\(\)](#)
- [round\(\)](#)
- [round\(\), with precision](#)
- [round\(\), with precision and rounding mode](#)
- [sign\(\)](#)

The following graph is used for the examples below:

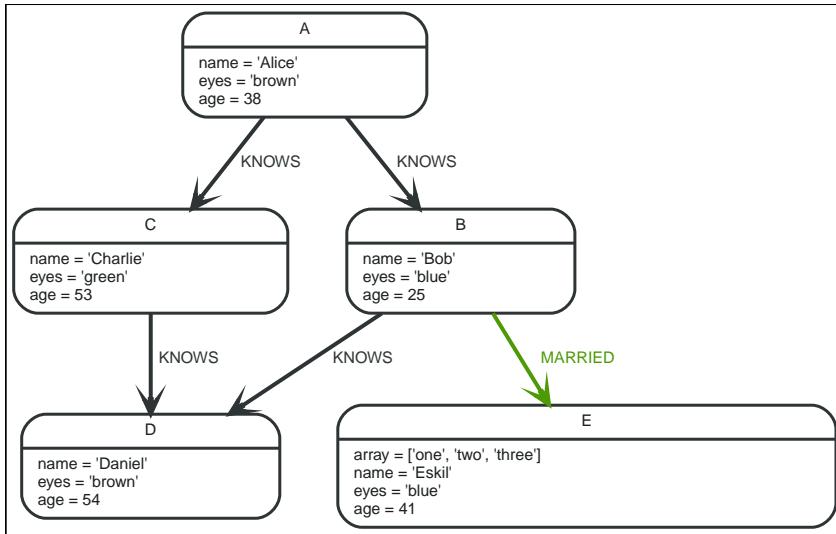


Figure 27. Graph

#### 4.5.1. abs()

`abs()` returns the absolute value of the given number.

**Syntax:** `abs(expression)`

**Returns:**

The type of the value returned will be that of `expression`.

**Arguments:**

Name	Description
<code>expression</code>	A numeric expression.

**Considerations:**

`abs(null)` returns `null`.

If `expression` is negative, `-(expression)` (i.e. the *negation* of `expression`) is returned.

**Query**

```

MATCH (a),(e)
WHERE a.name = 'Alice' AND e.name = 'Eskil'
RETURN a.age, e.age, abs(a.age - e.age)

```

The absolute value of the age difference is returned.

**Table 270. Result**

a.age	e.age	abs(a.age - e.age)
38	41	3
1 row		

#### 4.5.2. ceil()

`ceil()` returns the smallest floating point number that is greater than or equal to the given number and equal to a mathematical integer.

**Syntax:** `ceil(expression)`

**Returns:**

A Float.

**Arguments:**

Name	Description
<code>expression</code>	A numeric expression.

**Considerations:**

`ceil(null)` returns `null`.

**Query**

```
RETURN ceil(0.1)
```

The `ceil` of `0.1` is returned.

*Table 271. Result*

<code>ceil(0.1)</code>
<code>1.0</code>
1 row

### 4.5.3. `floor()`

`floor()` returns the largest floating point number that is less than or equal to the given number and equal to a mathematical integer.

**Syntax:** `floor(expression)`

**Returns:**

A Float.

**Arguments:**

Name	Description
<code>expression</code>	A numeric expression.

**Considerations:**

`floor(null)` returns `null`.

**Query**

```
RETURN floor(0.9)
```

The `floor` of `0.9` is returned.

*Table 272. Result*

```
floor(0.9)
```

```
0.0
```

```
1 row
```

## 4.5.4. rand()

`rand()` returns a random floating point number in the range from 0 (inclusive) to 1 (exclusive); i.e.  $[0, 1)$ . The numbers returned follow an approximate uniform distribution.

**Syntax:** `rand()`

**Returns:**

```
A Float.
```

*Query*

```
RETURN rand()
```

A random number is returned.

*Table 273. Result*

```
rand()
```

```
0.060768628280225334
```

```
1 row
```

## 4.5.5. round()

`round()` returns the value of the given number rounded to the nearest integer, with half-way values always rounded up.

**Syntax:** `round(expression)`

**Returns:**

```
A Float.
```

**Arguments:**

Name	Description
<code>expression</code>	A numeric expression to be rounded.

**Considerations:**

```
round(null) returns null.
```

*Query*

```
RETURN round(3.141592)
```

`3.0` is returned.

*Table 274. Result*

round(3.141592)
-----------------

3.0
-----

1 row
-------

## 4.5.6. round(), with precision

`round()` returns the value of the given number rounded with the specified precision, with half-values always being rounded up.

**Syntax:** `round(expression, precision)`

**Returns:**

A Float.
----------

**Arguments:**

Name	Description
<code>expression</code>	A numeric expression to be rounded.
<code>precision</code>	A numeric expression specifying precision.

**Considerations:**

<code>round(null)</code> returns <code>null</code> .
--

**Query**

RETURN round(3.141592, 3)
---------------------------

`3.142` is returned.

*Table 275. Result*

round(3.141592, 3)
--------------------

3.142
-------

1 row
-------

## 4.5.7. round(), with precision and rounding mode

`round()` returns the value of the given number rounded with the specified precision and the specified rounding mode.

**Syntax:** `round(expression, precision, mode)`

**Returns:**

A Float.
----------

**Arguments:**

Name	Description
expression	A numeric expression to be rounded.
precision	A numeric expression specifying precision.
mode	A string expression specifying rounding mode.

## Modes:

Mode	Description
CEILING	Round towards positive infinity.
DOWN	Round towards zero.
FLOOR	Round towards zero.
HALF_DOWN	Round towards closest value of given precision, with half-values always being rounded down.
HALF_EVEN	Round towards closest value of given precision, with half-values always being rounded to the even neighbor.
HALF_UP	Round towards closest value of given precision, with half-values always being rounded up.
UP	Round away from zero.

## Considerations:

`round(null)` returns `null`.

## Query

```
RETURN round(3.141592, 2, 'CEILING')
```

3.15 is returned.

Table 276. Result

round(3.141592, 2, 'CEILING')
3.15
1 row

## 4.5.8. sign()

`sign()` returns the signum of the given number: `0` if the number is `0`, `-1` for any negative number, and `1` for any positive number.

Syntax: `sign(expression)`

## Returns:

An Integer.

## Arguments:

Name	Description
expression	A numeric expression.

## Considerations:

```
sign(null) returns null.
```

### Query

```
RETURN sign(-17), sign(0.1)
```

The signs of `-17` and `0.1` are returned.

Table 277. Result

sign(-17)	sign(0.1)
-1	1
1 row	

## 4.6. Mathematical functions - logarithmic

These functions all operate on numeric expressions only, and will return an error if used on any other values. See also [Mathematical operators](#).

### Functions:

- [e\(\)](#)
- [exp\(\)](#)
- [log\(\)](#)
- [log10\(\)](#)
- [sqrt\(\)](#)

### 4.6.1. e()

`e()` returns the base of the natural logarithm, `e`.

Syntax: `e()`

### Returns:

```
A Float.
```

### Query

```
RETURN e()
```

The base of the natural logarithm, `e`, is returned.

Table 278. Result

e()
2.718281828459045
1 row

## 4.6.2. exp()

`exp()` returns  $e^n$ , where  $e$  is the base of the natural logarithm, and  $n$  is the value of the argument expression.

**Syntax:** `e(expression)`

**Returns:**

A Float.

**Arguments:**

Name	Description
<code>expression</code>	A numeric expression.

**Considerations:**

`exp(null)` returns `null`.

**Query**

```
RETURN exp(2)
```

$e$  to the power of  $2$  is returned.

*Table 279. Result*

<code>exp(2)</code>
<code>7.38905609893065</code>
1 row

## 4.6.3. log()

`log()` returns the natural logarithm of a number.

**Syntax:** `log(expression)`

**Returns:**

A Float.

**Arguments:**

Name	Description
<code>expression</code>	A numeric expression.

**Considerations:**

`log(null)` returns `null`.

`log(0)` returns `null`.

## Query

```
RETURN log(27)
```

The natural logarithm of 27 is returned.

*Table 280. Result*

log(27)
3.295836866004329
1 row

## 4.6.4. log10()

`log10()` returns the common logarithm (base 10) of a number.

**Syntax:** `log10(expression)`

**Returns:**

A Float.
----------

**Arguments:**

Name	Description
expression	A numeric expression.

**Considerations:**

<code>log10(null)</code> returns <code>null</code> .
--

<code>log10(0)</code> returns <code>null</code> .
---

## Query

```
RETURN log10(27)
```

The common logarithm of 27 is returned.

*Table 281. Result*

log10(27)
1.4313637641589874
1 row

## 4.6.5. sqrt()

`sqrt()` returns the square root of a number.

**Syntax:** `sqrt(expression)`

**Returns:**

A Float.
----------

## Arguments:

Name	Description
expression	A numeric expression.

## Considerations:

`sqrt(null)` returns `null`.

`sqrt(<any negative number>)` returns `null`

## Query

```
RETURN sqrt(256)
```

The square root of `256` is returned.

Table 282. Result

<code>sqrt(256)</code>
<code>16.0</code>
1 row

## 4.7. Mathematical functions - trigonometric

*These functions all operate on numeric expressions only, and will return an error if used on any other values. See also [Mathematical operators](#).*

### Functions:

- [acos\(\)](#)
- [asin\(\)](#)
- [atan\(\)](#)
- [atan2\(\)](#)
- [cos\(\)](#)
- [cot\(\)](#)
- [degrees\(\)](#)
- [haversin\(\)](#)
- Spherical distance using the `haversin()` function
- [pi\(\)](#)
- [radians\(\)](#)
- [sin\(\)](#)
- [tan\(\)](#)

### 4.7.1. acos()

`acos()` returns the arccosine of a number in radians.

**Syntax:** `acos(expression)`

## Returns:

A Float.

## Arguments:

Name	Description
expression	A numeric expression that represents the angle in radians.

## Considerations:

`acos(null)` returns `null`.

If `(expression < -1)` or `(expression > 1)`, then `(acos(expression))` returns `null`.

## Query

```
RETURN acos(0.5)
```

The arccosine of `0.5` is returned.

*Table 283. Result*

<code>acos(0.5)</code>
<code>1.0471975511965979</code>
1 row

## 4.7.2. asin()

`asin()` returns the arcsine of a number in radians.

**Syntax:** `asin(expression)`

## Returns:

A Float.

## Arguments:

Name	Description
expression	A numeric expression that represents the angle in radians.

## Considerations:

`asin(null)` returns `null`.

If `(expression < -1)` or `(expression > 1)`, then `(asin(expression))` returns `null`.

## Query

```
RETURN asin(0.5)
```

The arcsine of `0.5` is returned.

*Table 284. Result*

asin(0.5)
0.5235987755982989
1 row

## 4.7.3. atan()

`atan()` returns the arctangent of a number in radians.

**Syntax:** `atan(expression)`

**Returns:**

A Float.

**Arguments:**

Name	Description
<code>expression</code>	A numeric expression that represents the angle in radians.

**Considerations:**

`atan(null)` returns `null`.

**Query**

```
RETURN atan(0.5)
```

The arctangent of `0.5` is returned.

*Table 285. Result*

atan(0.5)
0.4636476090008061
1 row

## 4.7.4. atan2()

`atan2()` returns the arctangent2 of a set of coordinates in radians.

**Syntax:** `atan2(expression1, expression2)`

**Returns:**

A Float.

**Arguments:**

Name	Description
<code>expression1</code>	A numeric expression for y that represents the angle in radians.
<code>expression2</code>	A numeric expression for x that represents the angle in radians.

## Considerations:

`atan2(null, null)`, `atan2(null, expression2)` and `atan(expression1, null)` all return `null`.

## Query

```
RETURN atan2(0.5, 0.6)
```

The arctangent2 of `0.5` and `0.6` is returned.

Table 286. Result

<code>atan2(0.5, 0.6)</code>
<code>0.6947382761967033</code>
1 row

## 4.7.5. cos()

`cos()` returns the cosine of a number.

Syntax: `cos(expression)`

Returns:

A Float.

## Arguments:

Name	Description
<code>expression</code>	A numeric expression that represents the angle in radians.

## Considerations:

`cos(null)` returns `null`.

## Query

```
RETURN cos(0.5)
```

The cosine of `0.5` is returned.

Table 287. Result

<code>cos(0.5)</code>
<code>0.8775825618903728</code>
1 row

## 4.7.6. cot()

`cot()` returns the cotangent of a number.

Syntax: `cot(expression)`

Returns:

A Float.

### Arguments:

Name	Description
expression	A numeric expression that represents the angle in radians.

### Considerations:

`cot(null)` returns `null`.

`cot(0)` returns `null`.

### Query

```
RETURN cot(0.5)
```

The cotangent of `0.5` is returned.

Table 288. Result

<code>cot(0.5)</code>
<code>1.830487721712452</code>
1 row

## 4.7.7. degrees()

`degrees()` converts radians to degrees.

Syntax: `degrees(expression)`

### Returns:

A Float.

### Arguments:

Name	Description
expression	A numeric expression that represents the angle in radians.

### Considerations:

`degrees(null)` returns `null`.

### Query

```
RETURN degrees(3.14159)
```

The number of degrees in something close to  $\pi$  is returned.

Table 289. Result

<code>degrees(3.14159)</code>
<code>179.9998479605043</code>

```
degrees(3.14159)
```

1 row

## 4.7.8. haversin()

`haversin()` returns half the versine of a number.

**Syntax:** `haversin(expression)`

**Returns:**

A Float.

**Arguments:**

Name	Description
<code>expression</code>	A numeric expression that represents the angle in radians.

**Considerations:**

`haversin(null)` returns `null`.

**Query**

```
RETURN haversin(0.5)
```

The haversine of `0.5` is returned.

*Table 290. Result*

```
haversin(0.5)
```

```
0.06120871905481362
```

1 row

## 4.7.9. Spherical distance using the `haversin()` function

The `haversin()` function may be used to compute the distance on the surface of a sphere between two points (each given by their latitude and longitude). In this example the spherical distance (in km) between Berlin in Germany (at lat 52.5, lon 13.4) and San Mateo in California (at lat 37.5, lon -122.3) is calculated using an average earth radius of 6371 km.

**Query**

```
CREATE (ber:City { lat: 52.5, lon: 13.4 }),(sm:City { lat: 37.5, lon: -122.3 })
RETURN 2 * 6371 * asin(sqrt(haversin(radians(sm.lat - ber.lat))+ cos(radians(sm.lat))*cos(radians(ber.lat))*haversin(radians(sm.lon - ber.lon)))) AS dist
```

The estimated distance between 'Berlin' and 'San Mateo' is returned.

*Table 291. Result*

```
dist
```

```
9129.969740051658
```

## dist

1 row, Nodes created: 2  
Properties set: 4  
Labels added: 2

## 4.7.10. pi()

`pi()` returns the mathematical constant *pi*.

**Syntax:** `pi()`

**Returns:**

A Float.

*Query*

```
RETURN pi()
```

The constant *pi* is returned.

*Table 292. Result*

<code>pi()</code>
3.141592653589793
1 row

## 4.7.11. radians()

`radians()` converts degrees to radians.

**Syntax:** `radians(expression)`

**Returns:**

A Float.

**Arguments:**

Name	Description
<code>expression</code>	A numeric expression that represents the angle in degrees.

**Considerations:**

```
radians(null) returns null.
```

*Query*

```
RETURN radians(180)
```

The number of radians in `180` degrees is returned (*pi*).

*Table 293. Result*

radians(180)
3.141592653589793
1 row

## 4.7.12. sin()

`sin()` returns the sine of a number.

**Syntax:** `sin(expression)`

**Returns:**

A Float.

**Arguments:**

Name	Description
<code>expression</code>	A numeric expression that represents the angle in radians.

**Considerations:**

`sin(null)` returns `null`.

**Query**

```
RETURN sin(0.5)
```

The sine of `0.5` is returned.

*Table 294. Result*

<code>sin(0.5)</code>
0.479425538604203
1 row

## 4.7.13. tan()

`tan()` returns the tangent of a number.

**Syntax:** `tan(expression)`

**Returns:**

A Float.

**Arguments:**

Name	Description
<code>expression</code>	A numeric expression that represents the angle in radians.

**Considerations:**

```
tan(null) returns null.
```

## Query

```
RETURN tan(0.5)
```

The tangent of `0.5` is returned.

Table 295. Result

<code>tan(0.5)</code>
<code>0.5463024898437905</code>
1 row

## 4.8. String functions

These functions all operate on string expressions only, and will return an error if used on any other values. The exception to this rule is `toString()`, which also accepts numbers, booleans and temporal values (i.e. `Date`, `Time`, `LocalTime`, `DateTime`, `LocalDateTime` or `Duration` values).

Functions taking a string as input all operate on *Unicode characters* rather than on a standard `char[]`. For example, the `size()` function applied to any *Unicode character* will return 1, even if the character does not fit in the 16 bits of one `char`.



When `toString()` is applied to a temporal value, it returns a string representation suitable for parsing by the corresponding [temporal functions](#). This string will therefore be formatted according to the [ISO 8601](#) format.

See also [String operators](#).

Functions:

- [left\(\)](#)
- [lTrim\(\)](#)
- [replace\(\)](#)
- [reverse\(\)](#)
- [right\(\)](#)
- [rTrim\(\)](#)
- [split\(\)](#)
- [substring\(\)](#)
- [toLower\(\)](#)
- [toString\(\)](#)
- [toUpper\(\)](#)
- [trim\(\)](#)

## 4.8.1. left()

`left()` returns a string containing the specified number of leftmost characters of the original string.

**Syntax:** `left(original, length)`

**Returns:**

A String.

**Arguments:**

Name	Description
<code>original</code>	An expression that returns a string.
<code>n</code>	An expression that returns a positive integer.

**Considerations:**

`left(null, length)` and `left(null, null)` both return `null`

`left(original, null)` will raise an error.

If `length` is not a positive integer, an error is raised.

If `length` exceeds the size of `original`, `original` is returned.

**Query**

```
RETURN left('hello', 3)
```

*Table 296. Result*

<code>left('hello', 3)</code>
<code>"hel"</code>
1 row

## 4.8.2. ltrim()

`lTrim()` returns the original string with leading whitespace removed.

**Syntax:** `lTrim(original)`

**Returns:**

A String.

**Arguments:**

Name	Description
<code>original</code>	An expression that returns a string.

**Considerations:**

`lTrim(null)` returns `null`

## Query

```
RETURN lTrim('  hello')
```

Table 297. Result

lTrim(' hello')
"hello"
1 row

## 4.8.3. replace()

`replace()` returns a string in which all occurrences of a specified string in the original string have been replaced by another (specified) string.

**Syntax:** `replace(original, search, replace)`

**Returns:**

A String.
-----------

**Arguments:**

Name	Description
original	An expression that returns a string.
search	An expression that specifies the string to be replaced in <code>original</code> .
replace	An expression that specifies the replacement string.

**Considerations:**

If any argument is <code>null</code> , <code>null</code> will be returned.
--

If <code>search</code> is not found in <code>original</code> , <code>original</code> will be returned.
--

## Query

```
RETURN replace("hello", "l", "w")
```

Table 298. Result

replace("hello", "l", "w")
"hewwo"
1 row

## 4.8.4. reverse()

`reverse()` returns a string in which the order of all characters in the original string have been reversed.

**Syntax:** `reverse(original)`

**Returns:**

A String.

### Arguments:

Name	Description
original	An expression that returns a string.

### Considerations:

`reverse(null)` returns `null`.

### Query

```
RETURN reverse('anagram')
```

Table 299. Result

<code>reverse('anagram')</code>
"margana"
1 row

## 4.8.5. right()

`right()` returns a string containing the specified number of rightmost characters of the original string.

**Syntax:** `right(original, length)`

### Returns:

A String.

### Arguments:

Name	Description
original	An expression that returns a string.
n	An expression that returns a positive integer.

### Considerations:

`right(null, length)` and `right(null, null)` both return `null`

`right(original, null)` will raise an error.

If `length` is not a positive integer, an error is raised.

If `length` exceeds the size of `original`, `original` is returned.

### Query

```
RETURN right('hello', 3)
```

Table 300. Result

<code>right('hello', 3)</code>
"llo"

```
right('hello', 3)
```

1 row

## 4.8.6. rtrim()

`rTrim()` returns the original string with trailing whitespace removed.

**Syntax:** `rTrim(original)`

**Returns:**

A String.

**Arguments:**

Name	Description
<code>original</code>	An expression that returns a string.

**Considerations:**

`rTrim(null)` returns `null`

*Query*

```
RETURN rTrim('hello   ')
```

*Table 301. Result*

```
rTrim('hello ')
```

```
"hello"
```

1 row

## 4.8.7. split()

`split()` returns a list of strings resulting from the splitting of the original string around matches of the given delimiter.

**Syntax:** `split(original, splitDelimiter)`

**Returns:**

A list of Strings.

**Arguments:**

Name	Description
<code>original</code>	An expression that returns a string.
<code>splitDelimiter</code>	The string with which to split <code>original</code> .

**Considerations:**

`split(null, splitDelimiter)` and `split(original, null)` both return `null`

## Query

```
RETURN split('one,two', ',')
```

Table 302. Result

split('one,two', ',')
["one", "two"]
1 row

## 4.8.8. substring()

`substring()` returns a substring of the original string, beginning with a 0-based index start and length.

**Syntax:** `substring(original, start [, length])`

**Returns:**

A String.

**Arguments:**

Name	Description
<code>original</code>	An expression that returns a string.
<code>start</code>	An expression that returns a positive integer, denoting the position at which the substring will begin.
<code>length</code>	An expression that returns a positive integer, denoting how many characters of <code>original</code> will be returned.

**Considerations:**

<code>start</code> uses a zero-based index.
If <code>length</code> is omitted, the function returns the substring starting at the position given by <code>start</code> and extending to the end of <code>original</code> .
If <code>original</code> is <code>null</code> , <code>null</code> is returned.
If either <code>start</code> or <code>length</code> is <code>null</code> or a negative integer, an error is raised.
If <code>start</code> is <code>0</code> , the substring will start at the beginning of <code>original</code> .
If <code>length</code> is <code>0</code> , the empty string will be returned.

## Query

```
RETURN substring('hello', 1, 3), substring('hello', 2)
```

Table 303. Result

substring('hello', 1, 3)	substring('hello', 2)
"ell"	"llo"
1 row	

## 4.8.9. toLower()

`toLower()` returns the original string in lowercase.

**Syntax:** `toLowerCase(original)`

**Returns:**

A String.

**Arguments:**

Name	Description
<code>original</code>	An expression that returns a string.

**Considerations:**

`toLowerCase(null) returns null`

**Query**

```
RETURN toLower('HELLO')
```

*Table 304. Result*

<code>toLower('HELLO')</code>
"hello"
1 row

## 4.8.10. `toString()`

`toString()` converts an integer, float or boolean value to a string.

**Syntax:** `toString(expression)`

**Returns:**

A String.

**Arguments:**

Name	Description
<code>expression</code>	An expression that returns a number, a boolean, or a string.

**Considerations:**

`toString(null) returns null`

If `expression` is a string, it will be returned unchanged.

**Query**

```
RETURN toString(11.5), toString('already a string'), toString(TRUE ), toString(date({ year:1984, month:10, day:11 })) AS dateString, toString(datetime({ year:1984, month:10, day:11, hour:12, minute:31, second:14, millisecond: 341, timezone: 'Europe/Stockholm' })) AS datetimeString, toString(duration({ minutes: 12, seconds: -60 })) AS durationString
```

*Table 305. Result*

toString(11.5)	toString('already a string')	toString(TRUE )	dateString	datetimeString	durationString
"11.5"	"already a string"	"true"	"1984-10-11"	"1984-10-11T12:31:14.341+01:00[Europe/Stockholm]"	"PT11M"
1 row					

## 4.8.11. `toUpperCase()`

`toUpperCase()` returns the original string in uppercase.

**Syntax:** `toUpperCase(original)`

**Returns:**

A String.

**Arguments:**

Name	Description
<code>original</code>	An expression that returns a string.

**Considerations:**

`toUpperCase(null)` returns `null`

**Query**

```
RETURN toUpper('hello')
```

*Table 306. Result*

<code>toUpper('hello')</code>
"HELLO"
1 row

## 4.8.12. `trim()`

`trim()` returns the original string with leading and trailing whitespace removed.

**Syntax:** `trim(original)`

**Returns:**

A String.

**Arguments:**

Name	Description
<code>original</code>	An expression that returns a string.

**Considerations:**

```
trim(null) returns null
```

## Query

```
RETURN trim(' hello ')
```

Table 307. Result

trim(' hello ')
"hello"
1 row

## 4.9. Temporal functions - instant types

Cypher provides functions allowing for the creation and manipulation of values for each temporal type — *Date*, *Time*, *LocalTime*, *DateTime*, and *LocalDateTime*.



See also [Temporal \(Date/Time\) values](#) and [Temporal operators](#).

### Temporal instant types

- An overview of temporal instant type creation
- Controlling which clock to use
- Truncating temporal values

### Functions:

- [date\(\)](#)
  - Getting the current *Date*
  - Creating a calendar (Year-Month-Day) *Date*
  - Creating a week (Year-Week-Day) *Date*
  - Creating a quarter (Year-Quarter-Day) *Date*
  - Creating an ordinal (Year-Day) *Date*
  - Creating a *Date* from a string
  - Creating a *Date* using other temporal values as components
  - Truncating a *Date*
- [datetime\(\)](#)
  - Getting the current *DateTime*
  - Creating a calendar (Year-Month-Day) *DateTime*
  - Creating a week (Year-Week-Day) *DateTime*
  - Creating a quarter (Year-Quarter-Day) *DateTime*
  - Creating an ordinal (Year-Day) *DateTime*
  - Creating a *DateTime* from a string
  - Creating a *DateTime* using other temporal values as components
  - Creating a *DateTime* from a timestamp

- Truncating a *DateTime*
- `localdatetime()`
  - Getting the current *LocalDateTime*
  - Creating a calendar (Year-Month-Day) *LocalDateTime*
  - Creating a week (Year-Week-Day) *LocalDateTime*
  - Creating a quarter (Year-Quarter-Day) *DateTime*
  - Creating an ordinal (Year-Day) *LocalDateTime*
  - Creating a *LocalDateTime* from a string
  - Creating a *LocalDateTime* using other temporal values as components
  - Truncating a *LocalDateTime*
- `localtime()`
  - Getting the current *LocalTime*
  - Creating a *LocalTime*
  - Creating a *LocalTime* from a string
  - Creating a *LocalTime* using other temporal values as components
  - Truncating a *LocalTime*
- `time()`
  - Getting the current *Time*
  - Creating a *Time*
  - Creating a *Time* from a string
  - Creating a *Time* using other temporal values as components
  - Truncating a *Time*

#### 4.9.1. Temporal instant types

*An introduction to temporal instant types, including descriptions of creation functions, clocks, and truncation.*

An overview of temporal instant type creation

Each function bears the same name as the type, and construct the type they correspond to in one of four ways:

- Capturing the current time
- Composing the components of the type
- Parsing a string representation of the temporal value
- Selecting and composing components from another temporal value by
  - either combining temporal values (such as combining a *Date* with a *Time* to create a *DateTime*), or
  - selecting parts from a temporal value (such as selecting the *Date* from a *DateTime*); the *extractors* — groups of components which can be selected — are:
    - `date` — contains all components for a *Date* (conceptually *year*, *month* and *day*).
    - `time` — contains all components for a *Time* (*hour*, *minute*, *second*, and sub-seconds; namely

*millisecond*, *microsecond* and *nanosecond*). If the type being created and the type from which the time component is being selected both contain `timezone` (and a `timezone` is not explicitly specified) the `timezone` is also selected.

- `datetime` — selects all components, and is useful for overriding specific components. Analogously to `time`, if the type being created and the type from which the time component is being selected both contain `timezone` (and a `timezone` is not explicitly specified) the `timezone` is also selected.
- In effect, this allows for the *conversion* between different temporal types, and allowing for 'missing' components to be specified.

Table 308. Temporal instant type creation functions

Function	Date	Time	LocalTime	DateTime	LocalDateTime
Getting the current value	X	X	X	X	X
Creating a calendar-based (Year-Month-Day) value	X			X	X
Creating a week-based (Year-Week-Day) value	X			X	X
Creating a quarter-based (Year-Quarter-Day) value	X			X	X
Creating an ordinal (Year-Day) value	X			X	X
Creating a value from time components		X	X		
Creating a value from other temporal values using extractors (i.e. converting between different types)	X	X	X	X	X
Creating a value from a string	X	X	X	X	X
Creating a value from a timestamp				X	



All the temporal instant types — including those that do not contain time zone information support such as `Date`, `LocalTime` and `DateTime` — allow for a time zone to be specified for the functions that retrieve the current instant. This allows for the retrieval of the current instant in the specified time zone.

## Controlling which clock to use

The functions which create temporal instant values based on the current instant use the `statement` clock as default. However, there are three different clocks available for more fine-grained control:

- `transaction`: The same instant is produced for each invocation within the same transaction. A different time may be produced for different transactions.
- `statement`: The same instant is produced for each invocation within the same statement. A different time may be produced for different statements within the same transaction.

- **realtime**: The instant produced will be the live clock of the system.

The following table lists the different sub-functions for specifying the clock to be used when creating the current temporal instant value:

Type	default	transaction	statement	realtime
Date	date()	date.transaction()	date.statement()	date.realtime()
Time	time()	time.transaction()	time.statement()	time.realtime()
LocalTime	localtime()	localtime.transaction()	localtime.statement()	localtime.realtime()
DateTime	datetime()	datetime.transaction()	datetime.statement()	datetime.realtime()
LocalDateTime	localdatetime()	localdatetime.transaction()	localdatetime.statement()	localdatetime.realtime()

## Truncating temporal values

A temporal instant value can be created by truncating another temporal instant value at the nearest preceding point in time at a specified component boundary (namely, a *truncation unit*). A temporal instant value created in this way will have all components which are less significant than the specified truncation unit set to their default values.

It is possible to supplement the truncated value by providing a map containing components which are less significant than the truncation unit. This will have the effect of overriding the default values which would otherwise have been set for these less significant components.

The following truncation units are supported:

- **millennium**: Select the temporal instant corresponding to the *millenium* of the given instant.
- **century**: Select the temporal instant corresponding to the *century* of the given instant.
- **decade**: Select the temporal instant corresponding to the *decade* of the given instant.
- **year**: Select the temporal instant corresponding to the *year* of the given instant.
- **weekYear**: Select the temporal instant corresponding to the first day of the first week of the *week-year* of the given instant.
- **quarter**: Select the temporal instant corresponding to the *quarter of the year* of the given instant.
- **month**: Select the temporal instant corresponding to the *month* of the given instant.
- **week**: Select the temporal instant corresponding to the *week* of the given instant.
- **day**: Select the temporal instant corresponding to the *month* of the given instant.
- **hour**: Select the temporal instant corresponding to the *hour* of the given instant.
- **minute**: Select the temporal instant corresponding to the *minute* of the given instant.
- **second**: Select the temporal instant corresponding to the *second* of the given instant.
- **millisecond**: Select the temporal instant corresponding to the *millisecond* of the given instant.
- **microsecond**: Select the temporal instant corresponding to the *microsecond* of the given instant.

The following table lists the supported truncation units and the corresponding sub-functions:

Truncation unit	Date	Time	LocalTime	DateTime	LocalDateTime
millennium	date.truncate('millennium', input)			datetime.truncate('millennium', input)	localdatetime.truncate('millennium', input)

Truncation unit	Date	Time	LocalTime	DateTime	LocalDateTime
century	date.truncate('century', input)			datetime.truncate('century', input)	localdatetime.truncate('century', input)
decade	date.truncate('decade', input)			datetime.truncate('decade', input)	localdatetime.truncate('decade', input)
year	date.truncate('year', input)			datetime.truncate('year', input)	localdatetime.truncate('year', input)
weekYear	date.truncate('weekYear', input)			datetime.truncate('weekYear', input)	localdatetime.truncate('weekYear', input)
quarter	date.truncate('quarter', input)			datetime.truncate('quarter', input)	localdatetime.truncate('quarter', input)
month	date.truncate('month', input)			datetime.truncate('month', input)	localdatetime.truncate('month', input)
week	date.truncate('week', input)			datetime.truncate('week', input)	localdatetime.truncate('week', input)
day	date.truncate('day', input)	time.truncate('day', input)	localtime.truncate('day', input)	datetime.truncate('day', input)	localdatetime.truncate('day', input)
hour		time.truncate('hour', input)	localtime.truncate('hour', input)	datetime.truncate('hour', input)	localdatetime.truncate('hour', input)
minute		time.truncate('minute', input)	localtime.truncate('minute', input)	datetime.truncate('minute', input)	localdatetime.truncate('minute', input)
second		time.truncate('second', input)	localtime.truncate('second', input)	datetime.truncate('second', input)	localdatetime.truncate('second', input)
millisecond		time.truncate('millisecond', input)	localtime.truncate('millisecond', input)	datetime.truncate('millisecond', input)	localdatetime.truncate('millisecond', input)
microsecond		time.truncate('microsecond', input)	localtime.truncate('microsecond', input)	datetime.truncate('microsecond', input)	localdatetime.truncate('microsecond', input)

## 4.9.2. Date: `date()`

*Details for using the `date()` function.*

- Getting the current *Date*
- Creating a calendar (Year-Month-Day) *Date*
- Creating a week (Year-Week-Day) *Date*
- Creating a quarter (Year-Quarter-Day) *Date*
- Creating an ordinal (Year-Day) *Date*
- Creating a *Date* from a string
- Creating a *Date* using other temporal values as components
- Truncating a *Date*

## Getting the current Date

`date()` returns the current *Date* value. If no time zone parameter is specified, the local time zone will be used.

**Syntax:** `date([ {timezone} ])`

**Returns:**

A Date.

**Arguments:**

Name	Description
A single map consisting of the following:	
<code>timezone</code>	A string expression that represents the <a href="#">time zone</a>

**Considerations:**

If no parameters are provided, `date()` must be invoked (`date({})` is invalid).

**Query**

```
RETURN date() AS currentDate
```

The current date is returned.

*Table 309. Result*

currentDate
2020-11-17
1 row

**Query**

```
RETURN date({ timezone: 'America/Los Angeles' }) AS currentDateInLA
```

The current date in California is returned.

*Table 310. Result*

currentDateInLA
2020-11-17
1 row

`date.transaction()`

`date.transaction()` returns the current *Date* value using the `transaction` clock. This value will be the same for each invocation within the same transaction. However, a different value may be produced for different transactions.

**Syntax:** `date.transaction([ {timezone} ])`

**Returns:**

A Date.

### Arguments:

Name	Description
timezone	A string expression that represents the <a href="#">time zone</a>

### Query

```
RETURN date.transaction() AS currentDate
```

Table 311. Result

currentDate
2020-11-17
1 row

date.statement()

`date.statement()` returns the current *Date* value using the `statement` clock. This value will be the same for each invocation within the same statement. However, a different value may be produced for different statements within the same transaction.

**Syntax:** `date.statement([ {timezone} ])`

### Returns:

A Date.

### Arguments:

Name	Description
timezone	A string expression that represents the <a href="#">time zone</a>

### Query

```
RETURN date.statement() AS currentDate
```

Table 312. Result

currentDate
2020-11-17
1 row

date.realtime()

`date.realtime()` returns the current *Date* value using the `realtime` clock. This value will be the live clock of the system.

**Syntax:** `date.realtime([ {timezone} ])`

### Returns:

A Date.

## Arguments:

Name	Description
timezone	A string expression that represents the <a href="#">time zone</a>

## Query

```
RETURN date.realtime() AS currentDate
```

Table 313. Result

currentDate
2020-11-17
1 row

## Query

```
RETURN date.realtime('America/Los Angeles') AS currentDateInLA
```

Table 314. Result

currentDateInLA
2020-11-17
1 row

## Creating a calendar (Year-Month-Day) Date

`date()` returns a *Date* value with the specified *year*, *month* and *day* component values.

**Syntax:** `date({year [, month, day]})`

**Returns:**

A Date.

## Arguments:

Name	Description
A single map consisting of the following:	
year	An expression consisting of at <a href="#">least four digits</a> that specifies the year.
month	An integer between <a href="#">1</a> and <a href="#">12</a> that specifies the month.
day	An integer between <a href="#">1</a> and <a href="#">31</a> that specifies the day of the month.

## Considerations:

The *day of the month* component will default to [1](#) if `day` is omitted.

The *month* component will default to [1](#) if `month` is omitted.

If `month` is omitted, `day` must also be omitted.

## Query

```
UNWIND [
  date({year:1984, month:10, day:11}),
  date({year:1984, month:10}),
  date({year:1984})
] as theDate
RETURN theDate
```

Table 315. Result

theDate
1984-10-11
1984-10-01
1984-01-01
3 rows

## Creating a week (Year-Week-Day) Date

`date()` returns a *Date* value with the specified *year*, *week* and *dayOfWeek* component values.

**Syntax:** `date({year [, week, dayOfWeek]})`

**Returns:**

A Date.

### Arguments:

Name	Description
A single map consisting of the following:	
<code>year</code>	An expression consisting of at least four digits that specifies the year.
<code>week</code>	An integer between 1 and 53 that specifies the week.
<code>dayOfWeek</code>	An integer between 1 and 7 that specifies the day of the week.

### Considerations:

The *day of the week* component will default to 1 if `dayOfWeek` is omitted.

The *week* component will default to 1 if `week` is omitted.

If `week` is omitted, `dayOfWeek` must also be omitted.

## Query

```
UNWIND [
  date({year:1984, week:10, dayOfWeek:3}),
  date({year:1984, week:10}),
  date({year:1984})
] as theDate
RETURN theDate
```

Table 316. Result

theDate
1984-03-07
1984-03-05
1984-01-01
3 rows

## Creating a quarter (Year-Quarter-Day) Date

`date()` returns a *Date* value with the specified *year*, *quarter* and *dayOfQuarter* component values.

**Syntax:** `date({year [, quarter, dayOfQuarter]})`

**Returns:**

A Date.

### Arguments:

Name	Description
A single map consisting of the following:	
<code>year</code>	An expression consisting of at least four digits that specifies the year.
<code>quarter</code>	An integer between 1 and 4 that specifies the quarter.
<code>dayOfQuarter</code>	An integer between 1 and 92 that specifies the day of the quarter.

### Considerations:

The *day of the quarter* component will default to 1 if `dayOfQuarter` is omitted.

The *quarter* component will default to 1 if `quarter` is omitted.

If `quarter` is omitted, `dayOfQuarter` must also be omitted.

### Query

```
UNWIND [
    date({year:1984, quarter:3, dayOfQuarter: 45}),
    date({year:1984, quarter:3}),
    date({year:1984})
] as theDate
RETURN theDate
```

Table 317. Result

theDate
1984-08-14
1984-07-01
1984-01-01
3 rows

## Creating an ordinal (Year-Day) Date

`date()` returns a *Date* value with the specified *year* and *ordinalDay* component values.

**Syntax:** `date({year [, ordinalDay]})`

**Returns:**

A Date.

**Arguments:**

Name	Description
A single map consisting of the following:	
<code>year</code>	An expression consisting of at least four digits that specifies the year.
<code>ordinalDay</code>	An integer between 1 and 366 that specifies the ordinal day of the year.

**Considerations:**

The *ordinal day of the year* component will default to 1 if `ordinalDay` is omitted.

**Query**

```
UNWIND [
  date({year:1984, ordinalDay:202}),
  date({year:1984})
] as theDate
RETURN theDate
```

The date corresponding to 11 February 1984 is returned.

*Table 318. Result*

theDate
1984-07-20
1984-01-01
2 rows

Creating a *Date* from a string

`date()` returns the *Date* value obtained by parsing a string representation of a temporal value.

**Syntax:** `date(temporalValue)`

**Returns:**

A Date.

**Arguments:**

Name	Description
<code>temporalValue</code>	A string representing a temporal value.

**Considerations:**

`temporalValue` must comply with the format defined for [dates](#).

`temporalValue` must denote a valid date; i.e. a `temporalValue` denoting `30 February 2001` is invalid.

`date(null)` returns null.

## Query

```
UNWIND [
  date('2015-07-21'),
  date('2015-07'),
  date('201507'),
  date('2015-W30-2'),
  date('201502'),
  date('2015')
] as theDate
RETURN theDate
```

Table 319. Result

theDate
2015-07-21
2015-07-01
2015-07-01
2015-07-21
2015-07-21
2015-01-01
6 rows

Creating a *Date* using other temporal values as components

`date()` returns the *Date* value obtained by selecting and composing components from another temporal value. In essence, this allows a *DateTime* or *LocalDateTime* value to be converted to a *Date*, and for "missing" components to be provided.

**Syntax:** `date({date [, year, month, day, week, dayOfWeek, quarter, dayOfQuarter, ordinalDay]})`

**Returns:**

A Date.

**Arguments:**

Name	Description
A single map consisting of the following:	
<code>date</code>	A <i>Date</i> value.
<code>year</code>	An expression consisting of at least four digits that specifies the year.
<code>month</code>	An integer between 1 and 12 that specifies the month.
<code>day</code>	An integer between 1 and 31 that specifies the day of the month.
<code>week</code>	An integer between 1 and 53 that specifies the week.
<code>dayOfWeek</code>	An integer between 1 and 7 that specifies the day of the week.
<code>quarter</code>	An integer between 1 and 4 that specifies the quarter.

Name	Description
dayOfQuarter	An integer between 1 and 92 that specifies the day of the quarter.
ordinalDay	An integer between 1 and 366 that specifies the ordinal day of the year.

## Considerations:

If any of the optional parameters are provided, these will override the corresponding components of `date`.

`date(dd)` may be written instead of `date({date: dd})`.

## Query

```
UNWIND [
    date({year:1984, month:11, day:11}),
    localdatetime({year:1984, month:11, day:11, hour:12, minute:31, second:14}),
    datetime({year:1984, month:11, day:11, hour:12, timezone: '+01:00'})
] as dd
RETURN date({date: dd}) AS dateOnly,
       date({date: dd, day: 28}) AS dateDay
```

Table 320. Result

dateOnly	dateDay
1984-11-11	1984-11-28
1984-11-11	1984-11-28
1984-11-11	1984-11-28
3 rows	

## Truncating a Date

`date.truncate()` returns the *Date* value obtained by truncating a specified temporal instant value at the nearest preceding point in time at the specified component boundary (which is denoted by the truncation unit passed as a parameter to the function). In other words, the *Date* returned will have all components that are less significant than the specified truncation unit set to their default values.

It is possible to supplement the truncated value by providing a map containing components which are less significant than the truncation unit. This will have the effect of *overriding* the default values which would otherwise have been set for these less significant components. For example, `day` — with some value `x` — may be provided when the truncation unit is `year` in order to ensure the returned value has the `day` set to `x` instead of the default `day` (which is 1).

**Syntax:** `date.truncate(unit [, temporalInstantValue [, mapOfComponents ] ])`

**Returns:**

A Date.

## Arguments:

Name	Description
unit	A string expression evaluating to one of the following: {millennium, century, decade, year, weekYear, quarter, month, week, day}.
temporalInstantValue	An expression of one of the following types: {DateTime, LocalDateTime, Date}.

Name	Description
mapOfComponents	An expression evaluating to a map containing components less significant than <code>unit</code> .

## Considerations:

Any component that is provided in `mapOfComponents` must be less significant than `unit`; i.e. if `unit` is 'day', `mapOfComponents` cannot contain information pertaining to a *month*.

Any component that is not contained in `mapOfComponents` and which is less significant than `unit` will be set to its `minimal value`.

If `mapOfComponents` is not provided, all components of the returned value which are less significant than `unit` will be set to their default values.

If `temporalInstantValue` is not provided, it will be set to the current date, i.e. `date.truncate(unit)` is equivalent of `date.truncate(unit, date())`.

## Query

```
WITH datetime({year:2017, month:11, day:11, hour:12, minute:31, second:14, nanosecond: 645876123,
  timezone: '+01:00'}) AS d
RETURN date.truncate('millennium', d) AS truncMillenium,
       date.truncate('century', d) AS truncCentury,
       date.truncate('decade', d) AS truncDecade,
       date.truncate('year', d, {day:5}) AS truncYear,
       date.truncate('weekYear', d) AS truncWeekYear,
       date.truncate('quarter', d) AS truncQuarter,
       date.truncate('month', d) AS truncMonth,
       date.truncate('week', d, {dayOfWeek:2}) AS truncWeek,
       date.truncate('day', d) AS truncDay
```

Table 321. Result

truncMillenium	truncCentury	truncDecade	truncYear	truncWeekYear	truncQuarter	truncMonth	truncWeek	truncDay
2000-01-01	2000-01-01	2010-01-01	2017-01-05	2017-01-02	2017-10-01	2017-11-01	2017-11-07	2017-11-11
1 row								

## 4.9.3. DateTime: `datetime()`

Details for using the `datetime()` function.

- Getting the current *DateTime*
- Creating a calendar (Year-Month-Day) *DateTime*
- Creating a week (Year-Week-Day) *DateTime*
- Creating a quarter (Year-Quarter-Day) *DateTime*
- Creating an ordinal (Year-Day) *DateTime*
- Creating a *DateTime* from a string
- Creating a *DateTime* using other temporal values as components
- Creating a *DateTime* from a timestamp
- Truncating a *DateTime*

### Getting the current *DateTime*

`datetime()` returns the current *DateTime* value. If no time zone parameter is specified, the default time

zone will be used.

**Syntax:** `datetime([ {timezone} ])`

**Returns:**

A DateTime.

**Arguments:**

Name	Description
<code>A single map consisting of the following:</code>	
<code>timezone</code>	A string expression that represents the <a href="#">time zone</a>

**Considerations:**

If no parameters are provided, `datetime()` must be invoked (`datetime({})` is invalid).

**Query**

```
RETURN datetime() AS currentDateTime
```

The current date and time using the local time zone is returned.

*Table 322. Result*

<code>currentDateTime</code>
<code>2020-11-17T10:59:30.678Z</code>
1 row

**Query**

```
RETURN datetime({ timezone: 'America/Los Angeles' }) AS currentDateTimeInLA
```

The current date and time of day in California is returned.

*Table 323. Result*

<code>currentDateTimeInLA</code>
<code>2020-11-17T02:59:30.689-08:00[America/Los_Angeles]</code>
1 row

`datetime.transaction()`

`datetime.transaction()` returns the current *DateTime* value using the `transaction` clock. This value will be the same for each invocation within the same transaction. However, a different value may be produced for different transactions.

**Syntax:** `datetime.transaction([ {timezone} ])`

**Returns:**

A DateTime.

**Arguments:**

Name	Description
timezone	A string expression that represents the <a href="#">time zone</a>

## Query

```
RETURN datetime.transaction() AS currentDateTime
```

Table 324. Result

currentDateTime
2020-11-17T10:59:30.701Z
1 row

## Query

```
RETURN datetime.transaction('America/Los Angeles') AS currentDateTimeInLA
```

Table 325. Result

currentDateTimeInLA
2020-11-17T02:59:30.712-08:00[America/Los_Angeles]
1 row

datetime.statement()

`datetime.statement()` returns the current *Datetime* value using the `statement` clock. This value will be the same for each invocation within the same statement. However, a different value may be produced for different statements within the same transaction.

**Syntax:** `datetime.statement([ {timezone} ])`

**Returns:**

A DateTime.

**Arguments:**

Name	Description
timezone	A string expression that represents the <a href="#">time zone</a>

## Query

```
RETURN datetime.statement() AS currentDateTime
```

Table 326. Result

currentDateTime
2020-11-17T10:59:30.724Z
1 row

datetime.realtime()

`datetime.realtime()` returns the current *Datetime* value using the `realtime` clock. This value will be the

live clock of the system.

**Syntax:** `datetime.realtime([ {timezone} ])`

**Returns:**

A DateTime.

**Arguments:**

Name	Description
<code>timezone</code>	A string expression that represents the <a href="#">time zone</a>

**Query**

```
RETURN datetime.realtime() AS currentDateTime
```

*Table 327. Result*

<code>currentDateTime</code>
2020-11-17T10:59:30.754273Z
1 row

Creating a calendar (Year-Month-Day) *DateTime*

`datetime()` returns a *DateTime* value with the specified *year*, *month*, *day*, *hour*, *minute*, *second*, *millisecond*, *microsecond*, *nanosecond* and *timezone* component values.

**Syntax:** `datetime({year [, month, day, hour, minute, second, millisecond, microsecond, nanosecond, timezone]})`

**Returns:**

A DateTime.

**Arguments:**

Name	Description
A single map consisting of the following:	
<code>year</code>	An expression consisting of at <a href="#">least four digits</a> that specifies the year.
<code>month</code>	An integer between <code>1</code> and <code>12</code> that specifies the month.
<code>day</code>	An integer between <code>1</code> and <code>31</code> that specifies the day of the month.
<code>hour</code>	An integer between <code>0</code> and <code>23</code> that specifies the hour of the day.
<code>minute</code>	An integer between <code>0</code> and <code>59</code> that specifies the number of minutes.
<code>second</code>	An integer between <code>0</code> and <code>59</code> that specifies the number of seconds.
<code>millisecond</code>	An integer between <code>0</code> and <code>999</code> that specifies the number of milliseconds.

Name	Description
microsecond	An integer between <code>0</code> and <code>999,999</code> that specifies the number of microseconds.
nanosecond	An integer between <code>0</code> and <code>999,999,999</code> that specifies the number of nanoseconds.
timezone	An expression that specifies the time zone.

## Considerations:

The `month` component will default to `1` if `month` is omitted.

The `day of the month` component will default to `1` if `day` is omitted.

The `hour` component will default to `0` if `hour` is omitted.

The `minute` component will default to `0` if `minute` is omitted.

The `second` component will default to `0` if `second` is omitted.

Any missing `millisecond`, `microsecond` or `nanosecond` values will default to `0`.

The `timezone` component will default to the configured default time zone if `timezone` is omitted.

If `millisecond`, `microsecond` and `nanosecond` are given in combination (as part of the same set of parameters), the individual values must be in the range `0` to `999`.

The least significant components in the set `year`, `month`, `day`, `hour`, `minute`, and `second` may be omitted; i.e. it is possible to specify only `year`, `month` and `day`, but specifying `year`, `month`, `day` and `minute` is not permitted.

One or more of `millisecond`, `microsecond` and `nanosecond` can only be specified as long as `second` is also specified.

## Query

```
UNWIND [
    datetime({year:1984, month:10, day:11, hour:12, minute:31, second:14, millisecond: 123, microsecond: 456, nanosecond: 789}),
    datetime({year:1984, month:10, day:11, hour:12, minute:31, second:14, millisecond: 645, timezone: '+01:00'}),
    datetime({year:1984, month:10, day:11, hour:12, minute:31, second:14, nanosecond: 645876123, timezone: 'Europe/Stockholm'}),
    datetime({year:1984, month:10, day:11, hour:12, minute:31, second:14, timezone: '+01:00'}),
    datetime({year:1984, month:10, day:11, hour:12, minute:31, second:14}),
    datetime({year:1984, month:10, day:11, hour:12, minute:31, timezone: 'Europe/Stockholm'}),
    datetime({year:1984, month:10, day:11, hour:12, timezone: '+01:00'}),
    datetime({year:1984, month:10, day:11, timezone: 'Europe/Stockholm'})
] as theDate
RETURN theDate
```

Table 328. Result

theDate
1984-10-11T12:31:14.123456789Z
1984-10-11T12:31:14.645+01:00
1984-10-11T12:31:14.645876123+01:00[Europe/Stockholm]
1984-10-11T12:31:14+01:00
1984-10-11T12:31:14Z
1984-10-11T12:31+01:00[Europe/Stockholm]
1984-10-11T12:00+01:00
1984-10-11T00:00+01:00[Europe/Stockholm]
8 rows

## Creating a week (Year-Week-Day) *DateTime*

`datetime()` returns a *DateTime* value with the specified `year`, `week`, `dayOfWeek`, `hour`, `minute`, `second`, `millisecond`, `microsecond`, `nanosecond` and `timezone` component values.

**Syntax:** `datetime({year [, week, dayOfWeek, hour, minute, second, millisecond, microsecond, nanosecond, timezone]})`

**Returns:**

A *DateTime*.

### Arguments:

Name	Description
<code>A single map consisting of the following:</code>	
<code>year</code>	An expression consisting of at <a href="#">least four digits</a> that specifies the year.
<code>week</code>	An integer between <code>1</code> and <code>53</code> that specifies the week.
<code>dayOfWeek</code>	An integer between <code>1</code> and <code>7</code> that specifies the day of the week.
<code>hour</code>	An integer between <code>0</code> and <code>23</code> that specifies the hour of the day.
<code>minute</code>	An integer between <code>0</code> and <code>59</code> that specifies the number of minutes.
<code>second</code>	An integer between <code>0</code> and <code>59</code> that specifies the number of seconds.
<code>millisecond</code>	An integer between <code>0</code> and <code>999</code> that specifies the number of milliseconds.
<code>microsecond</code>	An integer between <code>0</code> and <code>999,999</code> that specifies the number of microseconds.
<code>nanosecond</code>	An integer between <code>0</code> and <code>999,999,999</code> that specifies the number of nanoseconds.
<code>timezone</code>	An expression that specifies the time zone.

### Considerations:

The `week` component will default to `1` if `week` is omitted.

The `day of the week` component will default to `1` if `dayOfWeek` is omitted.

The `hour` component will default to `0` if `hour` is omitted.

The `minute` component will default to `0` if `minute` is omitted.

The `second` component will default to `0` if `second` is omitted.

Any missing `millisecond`, `microsecond` or `nanosecond` values will default to `0`.

The `timezone` component will default to the configured default time zone if `timezone` is omitted.

If `millisecond`, `microsecond` and `nanosecond` are given in combination (as part of the same set of parameters), the individual values must be in the range `0` to `999`.

The least significant components in the set `year`, `week`, `dayOfWeek`, `hour`, `minute`, and `second` may be omitted; i.e. it is possible to specify only `year`, `week` and `dayOfWeek`, but specifying `year`, `week`, `dayOfWeek` and `minute` is not permitted.

One or more of `millisecond`, `microsecond` and `nanosecond` can only be specified as long as `second` is also specified.

## Query

```
UNWIND [
    datetime({year:1984, week:10, dayOfWeek:3, hour:12, minute:31, second:14, millisecond: 645}),
    datetime({year:1984, week:10, dayOfWeek:3, hour:12, minute:31, second:14, microsecond: 645876, timezone: '+01:00'}),
    datetime({year:1984, week:10, dayOfWeek:3, hour:12, minute:31, second:14, nanosecond: 645876123, timezone: 'Europe/Stockholm'}),
    datetime({year:1984, week:10, dayOfWeek:3, hour:12, minute:31, second:14, timezone: 'Europe/Stockholm'}),
    datetime({year:1984, week:10, dayOfWeek:3, hour:12, minute:31, second:14}),
    datetime({year:1984, week:10, dayOfWeek:3, hour:12, timezone: '+01:00'}),
    datetime({year:1984, week:10, dayOfWeek:3, timezone: 'Europe/Stockholm'})
] as theDate
RETURN theDate
```

Table 329. Result

theDate
1984-03-07T12:31:14.645Z
1984-03-07T12:31:14.645876+01:00
1984-03-07T12:31:14.645876123+01:00[Europe/Stockholm]
1984-03-07T12:31:14+01:00[Europe/Stockholm]
1984-03-07T12:31:14Z
1984-03-07T12:00+01:00
1984-03-07T00:00+01:00[Europe/Stockholm]
7 rows

## Creating a quarter (Year-Quarter-Day) *DateTime*

`datetime()` returns a *DateTime* value with the specified *year*, *quarter*, *dayOfQuarter*, *hour*, *minute*, *second*, *millisecond*, *microsecond*, *nanosecond* and *timezone* component values.

**Syntax:** `datetime({year [, quarter, dayOfQuarter, hour, minute, second, millisecond, microsecond, nanosecond, timezone]})`

**Returns:**

A *DateTime*.

## Arguments:

Name	Description
A single map consisting of the following:	
<code>year</code>	An expression consisting of at least four digits that specifies the year.
<code>quarter</code>	An integer between 1 and 4 that specifies the quarter.
<code>dayOfQuarter</code>	An integer between 1 and 92 that specifies the day of the quarter.
<code>hour</code>	An integer between 0 and 23 that specifies the hour of the day.
<code>minute</code>	An integer between 0 and 59 that specifies the number of minutes.
<code>second</code>	An integer between 0 and 59 that specifies the number of seconds.

Name	Description
millisecond	An integer between <code>0</code> and <code>999</code> that specifies the number of milliseconds.
microsecond	An integer between <code>0</code> and <code>999,999</code> that specifies the number of microseconds.
nanosecond	An integer between <code>0</code> and <code>999,999,999</code> that specifies the number of nanoseconds.
timezone	An expression that specifies the time zone.

## Considerations:

The <code>quarter</code> component will default to <code>1</code> if <code>quarter</code> is omitted.
The <code>day of the quarter</code> component will default to <code>1</code> if <code>dayOfQuarter</code> is omitted.
The <code>hour</code> component will default to <code>0</code> if <code>hour</code> is omitted.
The <code>minute</code> component will default to <code>0</code> if <code>minute</code> is omitted.
The <code>second</code> component will default to <code>0</code> if <code>second</code> is omitted.
Any missing <code>millisecond</code> , <code>microsecond</code> or <code>nanosecond</code> values will default to <code>0</code> .
The <code>timezone</code> component will default to the configured default time zone if <code>timezone</code> is omitted.
If <code>millisecond</code> , <code>microsecond</code> and <code>nanosecond</code> are given in combination (as part of the same set of parameters), the individual values must be in the range <code>0</code> to <code>999</code> .
The least significant components in the set <code>year</code> , <code>quarter</code> , <code>dayOfQuarter</code> , <code>hour</code> , <code>minute</code> , and <code>second</code> may be omitted; i.e. it is possible to specify only <code>year</code> , <code>quarter</code> and <code>dayOfQuarter</code> , but specifying <code>year</code> , <code>quarter</code> , <code>dayOfQuarter</code> and <code>minute</code> is not permitted.
One or more of <code>millisecond</code> , <code>microsecond</code> and <code>nanosecond</code> can only be specified as long as <code>second</code> is also specified.

## Query

```
UNWIND [
  datetime({year:1984, quarter:3, dayOfQuarter: 45, hour:12, minute:31, second:14, microsecond: 645876}),
  datetime({year:1984, quarter:3, dayOfQuarter: 45, hour:12, minute:31, second:14, timezone: '+01:00'}),
  datetime({year:1984, quarter:3, dayOfQuarter: 45, hour:12, timezone: 'Europe/Stockholm'}),
  datetime({year:1984, quarter:3, dayOfQuarter: 45})
] as theDate
RETURN theDate
```

Table 330. Result

theDate
1984-08-14T12:31:14.645876Z
1984-08-14T12:31:14+01:00
1984-08-14T12:00+02:00[Europe/Stockholm]
1984-08-14T00:00Z
4 rows

## Creating an ordinal (Year-Day) `DateTime`

`datetime()` returns a `DateTime` value with the specified `year`, `ordinalDay`, `hour`, `minute`, `second`, `millisecond`, `microsecond`, `nanosecond` and `timezone` component values.

**Syntax:** `datetime({year [, ordinalDay, hour, minute, second, millisecond, microsecond, nanosecond, timezone]})`

## Returns:

A DateTime.

## Arguments:

Name	Description
A single map consisting of the following:	
year	An expression consisting of at least four digits that specifies the year.
ordinalDay	An integer between 1 and 366 that specifies the ordinal day of the year.
hour	An integer between 0 and 23 that specifies the hour of the day.
minute	An integer between 0 and 59 that specifies the number of minutes.
second	An integer between 0 and 59 that specifies the number of seconds.
millisecond	An integer between 0 and 999 that specifies the number of milliseconds.
microsecond	An integer between 0 and 999,999 that specifies the number of microseconds.
nanosecond	An integer between 0 and 999,999,999 that specifies the number of nanoseconds.
timezone	An expression that specifies the time zone.

## Considerations:

The *ordinal day of the year* component will default to 1 if `ordinalDay` is omitted.

The *hour* component will default to 0 if `hour` is omitted.

The *minute* component will default to 0 if `minute` is omitted.

The *second* component will default to 0 if `second` is omitted.

Any missing `millisecond`, `microsecond` or `nanosecond` values will default to 0.

The *timezone* component will default to the configured default time zone if `timezone` is omitted.

If `millisecond`, `microsecond` and `nanosecond` are given in combination (as part of the same set of parameters), the individual values must be in the range 0 to 999.

The least significant components in the set `year`, `ordinalDay`, `hour`, `minute`, and `second` may be omitted; i.e. it is possible to specify only `year` and `ordinalDay`, but specifying `year`, `ordinalDay` and `minute` is not permitted.

One or more of `millisecond`, `microsecond` and `nanosecond` can only be specified as long as `second` is also specified.

## Query

```
UNWIND [
    datetime({year:1984, ordinalDay:202, hour:12, minute:31, second:14, millisecond: 645}),
    datetime({year:1984, ordinalDay:202, hour:12, minute:31, second:14, timezone: '+01:00'}),
    datetime({year:1984, ordinalDay:202, timezone: 'Europe/Stockholm'}),
    datetime({year:1984, ordinalDay:202})
] as theDate
RETURN theDate
```

Table 331. Result

theDate
1984-07-20T12:31:14.645Z
1984-07-20T12:31:14+01:00
1984-07-20T00:00+02:00[Europe/Stockholm]
1984-07-20T00:00Z
4 rows

## Creating a *DateTime* from a string

`datetime()` returns the *DateTime* value obtained by parsing a string representation of a temporal value.

**Syntax:** `datetime(temporalValue)`

**Returns:**

A *DateTime*.

### Arguments:

Name	Description
<code>temporalValue</code>	A string representing a temporal value.

### Considerations:

`temporalValue` must comply with the format defined for [dates](#), [times](#) and [time zones](#).

The *timezone* component will default to the configured default time zone if it is omitted.

`temporalValue` must denote a valid date and time; i.e. a `temporalValue` denoting `30 February 2001` is invalid.

`datetime(null)` returns null.

## Query

```
UNWIND [
    datetime('2015-07-21T21:40:32.142+0100'),
    datetime('2015-W30-2T214032.142Z'),
    datetime('2015T214032-0100'),
    datetime('20150721T21:40-01:30'),
    datetime('2015-W30T2140-02'),
    datetime('2015202T21+18:00'),
    datetime('2015-07-21T21:40:32.142[Europe/London]'),
    datetime('2015-07-21T21:40:32.142-04[America/New_York]')
] AS theDate
RETURN theDate
```

Table 332. Result

theDate
2015-07-21T21:40:32.142+01:00
2015-07-21T21:40:32.142Z
2015-01-01T21:40:32-01:00
2015-07-21T21:40-01:30
2015-07-20T21:40-02:00
2015-07-21T21:00+18:00

theDate
2015-07-21T21:40:32.142+01:00[Europe/London]
2015-07-21T21:40:32.142-04:00[America/New_York]
8 rows

Creating a *DateTime* using other temporal values as components

`datetime()` returns the *DateTime* value obtained by selecting and composing components from another temporal value. In essence, this allows a *Date*, *LocalDateTime*, *Time* or *LocalTime* value to be converted to a *DateTime*, and for "missing" components to be provided.

**Syntax:** `datetime({datetime [, year, ..., timezone]}) | datetime({date [, year, ..., timezone]}) | datetime({time [, year, ..., timezone]}) | datetime({date, time [, year, ..., timezone]})`

**Returns:**

A *DateTime*.

**Arguments:**

Name	Description
A single map consisting of the following:	
<code>datetime</code>	A <i>DateTime</i> value.
<code>date</code>	A <i>Date</i> value.
<code>time</code>	A <i>Time</i> value.
<code>year</code>	An expression consisting of at least four digits that specifies the year.
<code>month</code>	An integer between 1 and 12 that specifies the month.
<code>day</code>	An integer between 1 and 31 that specifies the day of the month.
<code>week</code>	An integer between 1 and 53 that specifies the week.
<code>dayOfWeek</code>	An integer between 1 and 7 that specifies the day of the week.
<code>quarter</code>	An integer between 1 and 4 that specifies the quarter.
<code>dayOfQuarter</code>	An integer between 1 and 92 that specifies the day of the quarter.
<code>ordinalDay</code>	An integer between 1 and 366 that specifies the ordinal day of the year.
<code>hour</code>	An integer between 0 and 23 that specifies the hour of the day.
<code>minute</code>	An integer between 0 and 59 that specifies the number of minutes.
<code>second</code>	An integer between 0 and 59 that specifies the number of seconds.
<code>millisecond</code>	An integer between 0 and 999 that specifies the number of milliseconds.
<code>microsecond</code>	An integer between 0 and 999,999 that specifies the number of microseconds.
<code>nanosecond</code>	An integer between 0 and 999,999,999 that specifies the number of nanoseconds.

Name	Description
timezone	An expression that specifies the time zone.

## Considerations:

If any of the optional parameters are provided, these will override the corresponding components of `datetime`, `date` and/or `time`.

`datetime(dd)` may be written instead of `datetime({datetime: dd})`.

Selecting a *Time* or *DateTime* value as the `time` component also selects its time zone. If a *LocalTime* or *LocalDateTime* is selected instead, the default time zone is used. In any case, the time zone can be overridden explicitly.

Selecting a *DateTime* as the `datetime` component and overwriting the time zone will adjust the local time to keep the same point in time.

Selecting a *DateTime* or *Time* as the `time` component and overwriting the time zone will adjust the local time to keep the same point in time.

The following query shows the various usages of `datetime({date [, year, ...], timezone})`

### Query

```
WITH date({year:1984, month:10, day:11}) AS dd
RETURN datetime({date:dd, hour: 10, minute: 10, second: 10}) AS dateHHMMSS,
       datetime({date:dd, hour: 10, minute: 10, second: 10, timezone:'+05:00'}) AS dateHHMMSSTimezone,
       datetime({date:dd, day: 28, hour: 10, minute: 10, second: 10}) AS dateDDHHMMSS,
       datetime({date:dd, day: 28, hour: 10, minute: 10, second: 10, timezone:'Pacific/Honolulu'}) AS
dateDDHMMSSSTimezone
```

Table 333. Result

dateHHMMSS	dateHHMMSSTimezone	dateDDHHMMSS	dateDDHMMSSSTimezone
1984-10-11T10:10:10Z	1984-10-11T10:10:10+05:00	1984-10-28T10:10:10Z	1984-10-28T10:10:10-10:00[Pacific/Honolulu]
1 row			

The following query shows the various usages of `datetime({time [, year, ...], timezone})`

### Query

```
WITH time({hour:12, minute:31, second:14, microsecond: 645876, timezone: '+01:00'}) AS tt
RETURN datetime({year:1984, month:10, day:11, time:tt}) AS YYYYMMDDTime,
       datetime({year:1984, month:10, day:11, time:tt, timezone:'+05:00'}) AS YYYYMMDDTimeTimezone,
       datetime({year:1984, month:10, day:11, time:tt, second: 42}) AS YYYYMMDDTimeSS,
       datetime({year:1984, month:10, day:11, time:tt, second: 42, timezone:'Pacific/Honolulu'}) AS
YYYYMMDDTimeSSTimezone
```

Table 334. Result

YYYYMMDDTime	YYYYMMDDTimeTimezone	YYYYMMDDTimeSS	YYYYMMDDTimeSSTimezone
1984-10-11T12:31:14.645876+01:00	1984-10-11T16:31:14.645876+05:00	1984-10-11T12:31:42.645876+01:00	1984-10-11T01:31:42.645876-10:00[Pacific/Honolulu]
1 row			

The following query shows the various usages of `datetime({date, time [, year, ...], timezone})`; i.e. combining a *Date* and a *Time* value to create a single *DateTime* value:

## Query

```
WITH date({year:1984, month:10, day:11}) AS dd,
      localtime({hour:12, minute:31, second:14, millisecond: 645}) AS tt
RETURN datetime({date:dd, time:tt}) as dateTime,
        datetime({date:dd, time:tt, timezone:'+05:00'}) AS dateTimeTimezone,
        datetime({date:dd, time:tt, day: 28, second: 42}) AS dateTimeDDSS,
        datetime({date:dd, time:tt, day: 28, second: 42, timezone:'Pacific/Honolulu'}) AS
dateTimeDDSTimezone
```

Table 335. Result

dateTime	dateTimeTimezone	dateTimeDDSS	dateTimeDDSTimezone
1984-10-11T12:31:14.645Z	1984-10-11T12:31:14.645+05:00	1984-10-28T12:31:42.645Z	1984-10-28T12:31:42.645-10:00[Pacific/Honolulu]
1 row			

The following query shows the various usages of `datetime({datetime [ , year, ..., timezone]})`

## Query

```
WITH datetime({year:1984, month:10, day:11, hour:12, timezone: 'Europe/Stockholm'}) AS dd
RETURN datetime({datetime:dd}) AS dateTime,
        datetime({datetime:dd, timezone:'+05:00'}) AS dateTimeTimezone,
        datetime({datetime:dd, day: 28, second: 42}) AS dateTimeDDSS,
        datetime({datetime:dd, day: 28, second: 42, timezone:'Pacific/Honolulu'}) AS
dateTimeDDSTimezone
```

Table 336. Result

dateTime	dateTimeTimezone	dateTimeDDSS	dateTimeDDSTimezone
1984-10-11T12:00+01:00[Europe/Stockholm]	1984-10-11T16:00+05:00	1984-10-28T12:00:42+01:00[Europe/Stockholm]	1984-10-28T01:00:42-10:00[Pacific/Honolulu]
1 row			

Creating a *DateTime* from a timestamp

`datetime()` returns the *DateTime* value at the specified number of *seconds* or *milliseconds* from the UNIX epoch in the UTC time zone.

Conversions to other temporal instant types from UNIX epoch representations can be achieved by transforming a *DateTime* value to one of these types.

**Syntax:** `datetime({ epochSeconds | epochMillis })`

**Returns:**

A *DateTime*.

**Arguments:**

Name	Description
A single map consisting of the following:	
epochSeconds	A numeric value representing the number of seconds from the UNIX epoch in the UTC time zone.
epochMillis	A numeric value representing the number of milliseconds from the UNIX epoch in the UTC time zone.

## Considerations:

`epochSeconds`/`epochMillis` may be used in conjunction with `nanosecond`

## Query

```
RETURN datetime({ epochSeconds:timestamp()/ 1000, nanosecond: 23 }) AS theDate
```

Table 337. Result

theDate

2020-11-17T10:59:31.00000023Z

1 row

## Query

```
RETURN datetime({ epochMillis: 424797300000 }) AS theDate
```

Table 338. Result

theDate

1983-06-18T15:15Z

1 row

## Truncating a *DateTime*

`datetime.truncate()` returns the *DateTime* value obtained by truncating a specified temporal instant value at the nearest preceding point in time at the specified component boundary (which is denoted by the truncation unit passed as a parameter to the function). In other words, the *DateTime* returned will have all components that are less significant than the specified truncation unit set to their default values.

It is possible to supplement the truncated value by providing a map containing components which are less significant than the truncation unit. This will have the effect of *overriding* the default values which would otherwise have been set for these less significant components. For example, `day` — with some value `x` — may be provided when the truncation unit is `year` in order to ensure the returned value has the `day` set to `x` instead of the default `day` (which is 1).

**Syntax:** `datetime.truncate(unit [, temporalInstantValue [, mapOfComponents ] ])`

**Returns:**

A *DateTime*.

## Arguments:

Name	Description
<code>unit</code>	A string expression evaluating to one of the following: <code>{millennium, century, decade, year, weekYear, quarter, month, week, day, hour, minute, second, millisecond, microsecond}</code> .
<code>temporalInstantValue</code>	An expression of one of the following types: <code>{DateTime, LocalDateTime, Date}</code> .
<code>mapOfComponents</code>	An expression evaluating to a map containing components less significant than <code>unit</code> . During truncation, a time zone can be attached or overridden using the key <code>timezone</code> .

## Considerations:

`temporalInstantValue` cannot be a `Date` value if `unit` is one of `{hour, minute, second, millisecond, microsecond}`.

The time zone of `temporalInstantValue` may be overridden; for example, `datetime.truncate('minute', input, {timezone: '+0200'})`.

If `temporalInstantValue` is one of `{Time, DateTime}` — a value with a time zone — and the time zone is overridden, no time conversion occurs.

If `temporalInstantValue` is one of `{LocalDateTime, Date}` — a value without a time zone — and the time zone is not overridden, the configured default time zone will be used.

Any component that is provided in `mapOfComponents` must be less significant than `unit`; i.e. if `unit` is 'day', `mapOfComponents` cannot contain information pertaining to a `month`.

Any component that is not contained in `mapOfComponents` and which is less significant than `unit` will be set to its `minimal value`.

If `mapOfComponents` is not provided, all components of the returned value which are less significant than `unit` will be set to their default values.

If `temporalInstantValue` is not provided, it will be set to the current date, time and timezone, i.e. `datetime.truncate(unit)` is equivalent of `datetime.truncate(unit, datetime())`.

## Query

```
WITH datetime({year:2017, month:11, day:11, hour:12, minute:31, second:14, nanosecond: 645876123, timezone: '+03:00'}) AS d
RETURN datetime.truncate('millennium', d, {timezone:'Europe/Stockholm'}) AS truncMillenium,
       datetime.truncate('year', d, {day:5}) AS truncYear,
       datetime.truncate('month', d) AS truncMonth,
       datetime.truncate('day', d, {millisecond:2}) AS truncDay,
       datetime.truncate('hour', d) AS truncHour,
       datetime.truncate('second', d) AS truncSecond
```

Table 339. Result

truncMillenium	truncYear	truncMonth	truncDay	truncHour	truncSecond
2000-01-01T00:00+01:00[Europe/Stockholm]	2017-01-05T00:00+03:00	2017-11-01T00:00+03:00	2017-11-11T00:00:00.002+03:00	2017-11-11T12:00+03:00	2017-11-11T12:31:14+03:00
1 row					

## 4.9.4. LocalDateTime: `localdatetime()`

Details for using the `localdatetime()` function.

- Getting the current `LocalDateTime`
- Creating a calendar (Year-Month-Day) `LocalDateTime`
- Creating a week (Year-Week-Day) `LocalDateTime`
- Creating a quarter (Year-Quarter-Day) `LocalDateTime`
- Creating an ordinal (Year-Day) `LocalDateTime`
- Creating a `LocalDateTime` from a string
- Creating a `LocalDateTime` using other temporal values as components
- Truncating a `LocalDateTime`

## Getting the current *LocalDateTime*

`localdatetime()` returns the current *LocalDateTime* value. If no time zone parameter is specified, the local time zone will be used.

**Syntax:** `localdatetime([ {timezone} ])`

**Returns:**

A *LocalDateTime*.

**Arguments:**

Name	Description
A single map consisting of the following:	
<code>timezone</code>	A string expression that represents the <a href="#">time zone</a>

**Considerations:**

If no parameters are provided, `localdatetime()` must be invoked (`localdatetime({})` is invalid).

**Query**

```
RETURN localdatetime() AS now
```

The current local date and time (i.e. in the local time zone) is returned.

*Table 340. Result*

<code>now</code>
2020-11-17T10:59:31.277
1 row

**Query**

```
RETURN localdatetime({ timezone: 'America/Los Angeles' }) AS now
```

The current local date and time in California is returned.

*Table 341. Result*

<code>now</code>
2020-11-17T02:59:31.290
1 row

`localdatetime.transaction()`

`localdatetime.transaction()` returns the current *LocalDateTime* value using the `transaction` clock. This value will be the same for each invocation within the same transaction. However, a different value may be produced for different transactions.

**Syntax:** `localdatetime.transaction([ {timezone} ])`

**Returns:**

A LocalDateTime.

### Arguments:

Name	Description
timezone	A string expression that represents the <a href="#">time zone</a>

### Query

```
RETURN localdatetime.transaction() AS now
```

Table 342. Result

now
2020-11-17T10:59:31.304
1 row

localdatetime.statement()

`localdatetime.statement()` returns the current *LocalDateTime* value using the `statement` clock. This value will be the same for each invocation within the same statement. However, a different value may be produced for different statements within the same transaction.

**Syntax:** `localdatetime.statement([ {timezone} ])`

### Returns:

A LocalDateTime.

### Arguments:

Name	Description
timezone	A string expression that represents the <a href="#">time zone</a>

### Query

```
RETURN localdatetime.statement() AS now
```

Table 343. Result

now
2020-11-17T10:59:31.316
1 row

localdatetime.realtime()

`localdatetime.realtime()` returns the current *LocalDateTime* value using the `realtime` clock. This value will be the live clock of the system.

**Syntax:** `localdatetime.realtime([ {timezone} ])`

### Returns:

A LocalDateTime.

## Arguments:

Name	Description
timezone	A string expression that represents the <a href="#">time zone</a>

## Query

```
RETURN localdatetime.realtime() AS now
```

Table 344. Result

now
2020-11-17T10:59:31.341799
1 row

## Query

```
RETURN localdatetime.realtime('America/Los Angeles') AS nowInLA
```

Table 345. Result

nowInLA
2020-11-17T02:59:31.355496
1 row

## Creating a calendar (Year-Month-Day) *LocalDateTime*

`localdatetime()` returns a *LocalDateTime* value with the specified *year*, *month*, *day*, *hour*, *minute*, *second*, *millisecond*, *microsecond* and *nanosecond* component values.

**Syntax:** `localdatetime({year [, month, day, hour, minute, second, millisecond, microsecond, nanosecond]})`

## Returns:

A *LocalDateTime*.

## Arguments:

Name	Description
A single map consisting of the following:	
year	An expression consisting of at <a href="#">least four digits</a> that specifies the year.
month	An integer between <code>1</code> and <code>12</code> that specifies the month.
day	An integer between <code>1</code> and <code>31</code> that specifies the day of the month.
hour	An integer between <code>0</code> and <code>23</code> that specifies the hour of the day.
minute	An integer between <code>0</code> and <code>59</code> that specifies the number of minutes.
second	An integer between <code>0</code> and <code>59</code> that specifies the number of seconds.

Name	Description
millisecond	An integer between <code>0</code> and <code>999</code> that specifies the number of milliseconds.
microsecond	An integer between <code>0</code> and <code>999,999</code> that specifies the number of microseconds.
nanosecond	An integer between <code>0</code> and <code>999,999,999</code> that specifies the number of nanoseconds.

## Considerations:

The `month` component will default to `1` if `month` is omitted.

The `day of the month` component will default to `1` if `day` is omitted.

The `hour` component will default to `0` if `hour` is omitted.

The `minute` component will default to `0` if `minute` is omitted.

The `second` component will default to `0` if `second` is omitted.

Any missing `millisecond`, `microsecond` or `nanosecond` values will default to `0`.

If `millisecond`, `microsecond` and `nanosecond` are given in combination (as part of the same set of parameters), the individual values must be in the range `0` to `999`.

The least significant components in the set `year`, `month`, `day`, `hour`, `minute`, and `second` may be omitted; i.e. it is possible to specify only `year`, `month` and `day`, but specifying `year`, `month`, `day` and `minute` is not permitted.

One or more of `millisecond`, `microsecond` and `nanosecond` can only be specified as long as `second` is also specified.

## Query

```
RETURN localdatetime({ year:1984, month:10, day:11, hour:12, minute:31, second:14, millisecond: 123,
microsecond: 456, nanosecond: 789 }) AS theDate
```

Table 346. Result

theDate
1984-10-11T12:31:14.123456789
1 row

## Creating a week (Year-Week-Day) `LocalDateTime`

`localdatetime()` returns a `LocalDateTime` value with the specified `year`, `week`, `dayOfWeek`, `hour`, `minute`, `second`, `millisecond`, `microsecond` and `nanosecond` component values.

**Syntax:** `localdatetime({year [, week, dayOfWeek, hour, minute, second, millisecond, microsecond, nanosecond]})`

## Returns:

A `LocalDateTime`.

## Arguments:

Name	Description
A single map consisting of the following:	
<code>year</code>	An expression consisting of at least four digits that specifies the year.

Name	Description
week	An integer between 1 and 53 that specifies the week.
dayOfWeek	An integer between 1 and 7 that specifies the day of the week.
hour	An integer between 0 and 23 that specifies the hour of the day.
minute	An integer between 0 and 59 that specifies the number of minutes.
second	An integer between 0 and 59 that specifies the number of seconds.
millisecond	An integer between 0 and 999 that specifies the number of milliseconds.
microsecond	An integer between 0 and 999,999 that specifies the number of microseconds.
nanosecond	An integer between 0 and 999,999,999 that specifies the number of nanoseconds.

## Considerations:

The `week` component will default to 1 if `week` is omitted.

The `day of the week` component will default to 1 if `dayOfWeek` is omitted.

The `hour` component will default to 0 if `hour` is omitted.

The `minute` component will default to 0 if `minute` is omitted.

The `second` component will default to 0 if `second` is omitted.

Any missing `millisecond`, `microsecond` or `nanosecond` values will default to 0.

If `millisecond`, `microsecond` and `nanosecond` are given in combination (as part of the same set of parameters), the individual values must be in the range 0 to 999.

The least significant components in the set `year`, `week`, `dayOfWeek`, `hour`, `minute`, and `second` may be omitted; i.e. it is possible to specify only `year`, `week` and `dayOfWeek`, but specifying `year`, `week`, `dayOfWeek` and `minute` is not permitted.

One or more of `millisecond`, `microsecond` and `nanosecond` can only be specified as long as `second` is also specified.

## Query

```
RETURN localdatetime({ year:1984, week:10, dayOfWeek:3, hour:12, minute:31, second:14, millisecond: 645 })
AS theDate
```

Table 347. Result

theDate
1984-03-07T12:31:14.645
1 row

## Creating a quarter (Year-Quarter-Day) `DateTime`

`localdatetime()` returns a `LocalDateTime` value with the specified `year`, `quarter`, `dayOfQuarter`, `hour`, `minute`, `second`, `millisecond`, `microsecond` and `nanosecond` component values.

**Syntax:** `localdatetime({year [, quarter, dayOfQuarter, hour, minute, second, millisecond, microsecond, nanosecond]})`

**Returns:**

A LocalDateTime.

## Arguments:

Name	Description
A single map consisting of the following:	
year	An expression consisting of at least four digits that specifies the year.
quarter	An integer between 1 and 4 that specifies the quarter.
dayOfQuarter	An integer between 1 and 92 that specifies the day of the quarter.
hour	An integer between 0 and 23 that specifies the hour of the day.
minute	An integer between 0 and 59 that specifies the number of minutes.
second	An integer between 0 and 59 that specifies the number of seconds.
millisecond	An integer between 0 and 999 that specifies the number of milliseconds.
microsecond	An integer between 0 and 999,999 that specifies the number of microseconds.
nanosecond	An integer between 0 and 999,999,999 that specifies the number of nanoseconds.

## Considerations:

The `quarter` component will default to 1 if `quarter` is omitted.

The `day of the quarter` component will default to 1 if `dayOfQuarter` is omitted.

The `hour` component will default to 0 if `hour` is omitted.

The `minute` component will default to 0 if `minute` is omitted.

The `second` component will default to 0 if `second` is omitted.

Any missing `millisecond`, `microsecond` or `nanosecond` values will default to 0.

If `millisecond`, `microsecond` and `nanosecond` are given in combination (as part of the same set of parameters), the individual values must be in the range 0 to 999.

The least significant components in the set `year`, `quarter`, `dayOfQuarter`, `hour`, `minute`, and `second` may be omitted; i.e. it is possible to specify only `year`, `quarter` and `dayOfQuarter`, but specifying `year`, `quarter`, `dayOfQuarter` and `minute` is not permitted.

One or more of `millisecond`, `microsecond` and `nanosecond` can only be specified as long as `second` is also specified.

## Query

```
RETURN localdatetime({ year:1984, quarter:3, dayOfQuarter: 45, hour:12, minute:31, second:14, nanosecond: 645876123 }) AS theDate
```

Table 348. Result

theDate
1984-08-14T12:31:14.645876123
1 row

## Creating an ordinal (Year-Day) *LocalDateTime*

`localdatetime()` returns a *LocalDateTime* value with the specified `year`, `ordinalDay`, `hour`, `minute`, `second`, `millisecond`, `microsecond` and `nanosecond` component values.

**Syntax:** `localdatetime({year [, ordinalDay, hour, minute, second, millisecond, microsecond, nanosecond]})`

**Returns:**

A *LocalDateTime*.

### Arguments:

Name	Description
<code>A single map consisting of the following:</code>	
<code>year</code>	An expression consisting of at <a href="#">least four digits</a> that specifies the year.
<code>ordinalDay</code>	An integer between <code>1</code> and <code>366</code> that specifies the ordinal day of the year.
<code>hour</code>	An integer between <code>0</code> and <code>23</code> that specifies the hour of the day.
<code>minute</code>	An integer between <code>0</code> and <code>59</code> that specifies the number of minutes.
<code>second</code>	An integer between <code>0</code> and <code>59</code> that specifies the number of seconds.
<code>millisecond</code>	An integer between <code>0</code> and <code>999</code> that specifies the number of milliseconds.
<code>microsecond</code>	An integer between <code>0</code> and <code>999,999</code> that specifies the number of microseconds.
<code>nanosecond</code>	An integer between <code>0</code> and <code>999,999,999</code> that specifies the number of nanoseconds.

### Considerations:

The `ordinal day of the year` component will default to `1` if `ordinalDay` is omitted.

The `hour` component will default to `0` if `hour` is omitted.

The `minute` component will default to `0` if `minute` is omitted.

The `second` component will default to `0` if `second` is omitted.

Any missing `millisecond`, `microsecond` or `nanosecond` values will default to `0`.

If `millisecond`, `microsecond` and `nanosecond` are given in combination (as part of the same set of parameters), the individual values must be in the range `0` to `999`.

The least significant components in the set `year`, `ordinalDay`, `hour`, `minute`, and `second` may be omitted; i.e. it is possible to specify only `year` and `ordinalDay`, but specifying `year`, `ordinalDay` and `minute` is not permitted.

One or more of `millisecond`, `microsecond` and `nanosecond` can only be specified as long as `second` is also specified.

### Query

```
RETURN localdatetime({ year:1984, ordinalDay:202, hour:12, minute:31, second:14, microsecond: 645876 }) AS  
theDate
```

### Table 349. Result

theDate
1984-07-20T12:31:14.645876
1 row

Creating a *LocalDateTime* from a string

`localdatetime()` returns the *LocalDateTime* value obtained by parsing a string representation of a temporal value.

**Syntax:** `localdatetime(temporalValue)`

**Returns:**

A *LocalDateTime*.

**Arguments:**

Name	Description
temporalValue	A string representing a temporal value.

**Considerations:**

`temporalValue` must comply with the format defined for [dates](#) and [times](#).

`temporalValue` must denote a valid date and time; i.e. a `temporalValue` denoting `30 February 2001` is invalid.

`localdatetime(null)` returns null.

**Query**

```
UNWIND [
    localdatetime('2015-07-21T21:40:32.142'),
    localdatetime('2015-W30-2T214032.142'),
    localdatetime('2015-202T21:40:32'),
    localdatetime('2015202T21')
] AS theDate
RETURN theDate
```

*Table 350. Result*

theDate
2015-07-21T21:40:32.142
2015-07-21T21:40:32.142
2015-07-21T21:40:32
2015-07-21T21:00
4 rows

Creating a *LocalDateTime* using other temporal values as components

`localdatetime()` returns the *LocalDateTime* value obtained by selecting and composing components from another temporal value. In essence, this allows a *Date*, *DateTime*, *Time* or *LocalTime* value to be converted to a *LocalDateTime*, and for "missing" components to be provided.

**Syntax:** `localdatetime({datetime [, year, ..., nanosecond]}) | localdatetime({date [, year, ..., nanosecond]}) | localdatetime({time [, year, ..., nanosecond]}) | localdatetime({date, time [, year, ..., nanosecond]})`

## Returns:

A LocalDateTime.

## Arguments:

Name	Description
A single map consisting of the following:	
<code>datetime</code>	A <i>DateTime</i> value.
<code>date</code>	A <i>Date</i> value.
<code>time</code>	A <i>Time</i> value.
<code>year</code>	An expression consisting of at least four digits that specifies the year.
<code>month</code>	An integer between 1 and 12 that specifies the month.
<code>day</code>	An integer between 1 and 31 that specifies the day of the month.
<code>week</code>	An integer between 1 and 53 that specifies the week.
<code>dayOfWeek</code>	An integer between 1 and 7 that specifies the day of the week.
<code>quarter</code>	An integer between 1 and 4 that specifies the quarter.
<code>dayOfQuarter</code>	An integer between 1 and 92 that specifies the day of the quarter.
<code>ordinalDay</code>	An integer between 1 and 366 that specifies the ordinal day of the year.
<code>hour</code>	An integer between 0 and 23 that specifies the hour of the day.
<code>minute</code>	An integer between 0 and 59 that specifies the number of minutes.
<code>second</code>	An integer between 0 and 59 that specifies the number of seconds.
<code>millisecond</code>	An integer between 0 and 999 that specifies the number of milliseconds.
<code>microsecond</code>	An integer between 0 and 999,999 that specifies the number of microseconds.
<code>nanosecond</code>	An integer between 0 and 999,999,999 that specifies the number of nanoseconds.

## Considerations:

If any of the optional parameters are provided, these will override the corresponding components of `datetime`, `date` and/or `time`.

`localdatetime(dd)` may be written instead of `localdatetime({datetime: dd})`.

The following query shows the various usages of `localdatetime({date [, year, ..., nanosecond]})`

### Query

```
WITH date({year:1984, month:10, day:11}) AS dd
RETURN localdatetime({date:dd, hour: 10, minute: 10, second: 10}) AS dateHHMMSS,
      localdatetime({date:dd, day: 28, hour: 10, minute: 10, second: 10}) AS dateDDHHMMSS
```

Table 351. Result

dateHHMMSS	dateDDHHMMSS
1984-10-11T10:10:10	1984-10-28T10:10:10
1 row	

The following query shows the various usages of `localdatetime({time [, year, ..., nanosecond]})`

#### Query

```
WITH time({hour:12, minute:31, second:14, microsecond: 645876, timezone: '+01:00'}) AS tt
RETURN localdatetime({year:1984, month:10, day:11, time:tt}) AS YYYYMMDDTime,
       localdatetime({year:1984, month:10, day:11, time:tt, second: 42}) AS YYYYMMDDTimeSS
```

Table 352. Result

YYYYMMDDTime	YYYYMMDDTimeSS
1984-10-11T12:31:14.645876	1984-10-11T12:31:42.645876
1 row	

The following query shows the various usages of `localdatetime({date, time [, year, ..., nanosecond]})`; i.e. combining a *Date* and a *Time* value to create a single *LocalDateTime* value:

#### Query

```
WITH date({year:1984, month:10, day:11}) AS dd,
      time({hour:12, minute:31, second:14, microsecond: 645876, timezone: '+01:00'}) AS tt
RETURN localdatetime({date:dd, time:tt}) AS dateTime,
       localdatetime({date:dd, time:tt, day: 28, second: 42}) AS dateTimeDDSS
```

Table 353. Result

dateTime	dateTimeDDSS
1984-10-11T12:31:14.645876	1984-10-28T12:31:42.645876
1 row	

The following query shows the various usages of `localdatetime({datetime [, year, ..., nanosecond]})`

#### Query

```
WITH datetime({year:1984, month:10, day:11, hour:12, timezone: '+01:00'}) as dd
RETURN localdatetime({datetime:dd}) as dateTime,
       localdatetime({datetime:dd, day: 28, second: 42}) as dateTimeDDSS
```

Table 354. Result

dateTime	dateTimeDDSS
1984-10-11T12:00	1984-10-28T12:00:42
1 row	

## Truncating a *LocalDateTime*

`localdatetime.truncate()` returns the *LocalDateTime* value obtained by truncating a specified temporal instant value at the nearest preceding point in time at the specified component boundary (which is denoted by the truncation unit passed as a parameter to the function). In other words, the *LocalDateTime* returned will have all components that are less significant than the specified truncation unit set to their default values.

It is possible to supplement the truncated value by providing a map containing components which are less significant than the truncation unit. This will have the effect of *overriding* the default values which would otherwise have been set for these less significant components. For example, `day` — with some value `x` — may be provided when the truncation unit is `year` in order to ensure the returned value has the `day` set to `x` instead of the default `day` (which is 1).

**Syntax:** `localdatetime.truncate(unit [, temporalInstantValue [, mapOfComponents] ])`

**Returns:**

A LocalDateTime.

**Arguments:**

Name	Description
<code>unit</code>	A string expression evaluating to one of the following: <code>{millennium, century, decade, year, weekYear, quarter, month, week, day, hour, minute, second, millisecond, microsecond}</code> .
<code>temporalInstantValue</code>	An expression of one of the following types: <code>{DateTime, LocalDateTime, Date}</code> .
<code>mapOfComponents</code>	An expression evaluating to a map containing components less significant than <code>unit</code> .

**Considerations:**

`temporalInstantValue` cannot be a `Date` value if `unit` is one of `{hour, minute, second, millisecond, microsecond}`.

Any component that is provided in `mapOfComponents` must be less significant than `unit`; i.e. if `unit` is 'day', `mapOfComponents` cannot contain information pertaining to a `month`.

Any component that is not contained in `mapOfComponents` and which is less significant than `unit` will be set to its `minimal value`.

If `mapOfComponents` is not provided, all components of the returned value which are less significant than `unit` will be set to their default values.

If `temporalInstantValue` is not provided, it will be set to the current date and time, i.e. `localdatetime.truncate(unit)` is equivalent of `localdatetime.truncate(unit, localdatetime())`.

**Query**

```
WITH localdatetime({year:2017, month:11, day:11, hour:12, minute:31, second:14, nanosecond: 645876123}) AS d
RETURN localdatetime.truncate('millennium', d) AS truncMillenium,
       localdatetime.truncate('year', d, {day:2}) AS truncYear,
       localdatetime.truncate('month', d) AS truncMonth,
       localdatetime.truncate('day', d) AS truncDay,
       localdatetime.truncate('hour', d, {nanosecond:2}) AS truncHour,
       localdatetime.truncate('second', d) AS truncSecond
```

*Table 355. Result*

truncMillenium	truncYear	truncMonth	truncDay	truncHour	truncSecond
2000-01-01T00:00	2017-01-02T00:00	2017-11-01T00:00	2017-11-11T00:00	2017-11-11T12:00:00.000000002	2017-11-11T12:31:14
1 row					

## 4.9.5. LocalTime: `localtime()`

*Details for using the `localtime()` function.*

- Getting the current *LocalTime*
- Creating a *LocalTime*
- Creating a *LocalTime* from a string
- Creating a *LocalTime* using other temporal values as components
- Truncating a *LocalTime*

## Getting the current *LocalTime*

`localtime()` returns the current *LocalTime* value. If no time zone parameter is specified, the local time zone will be used.

**Syntax:** `localtime([ {timezone} ])`

**Returns:**

A *LocalTime*.

**Arguments:**

Name	Description
A single map consisting of the following:	
<code>timezone</code>	A string expression that represents the <a href="#">time zone</a>

**Considerations:**

If no parameters are provided, `localtime()` must be invoked (`localtime({})` is invalid).

**Query**

```
RETURN localtime() AS now
```

The current local time (i.e. in the local time zone) is returned.

*Table 356. Result*

`now`

`10:59:31.646`

1 row

**Query**

```
RETURN localtime({ timezone: 'America/Los Angeles' }) AS nowInLA
```

The current local time in California is returned.

*Table 357. Result*

`nowInLA`

`02:59:31.660`

1 row

`localtime.transaction()`

`localtime.transaction()` returns the current *LocalTime* value using the `transaction` clock. This value will be the same for each invocation within the same transaction. However, a different value may be produced for different transactions.

**Syntax:** `localtime.transaction([ {timezone} ])`

**Returns:**

A LocalTime.

**Arguments:**

Name	Description
<code>timezone</code>	A string expression that represents the time zone

**Query**

```
RETURN localtime.transaction() AS now
```

*Table 358. Result*

<code>now</code>
10:59:31.677
1 row

`localtime.statement()`

`localtime.statement()` returns the current *LocalTime* value using the `statement` clock. This value will be the same for each invocation within the same statement. However, a different value may be produced for different statements within the same transaction.

**Syntax:** `localtime.statement([ {timezone} ])`

**Returns:**

A LocalTime.

**Arguments:**

Name	Description
<code>timezone</code>	A string expression that represents the time zone

**Query**

```
RETURN localtime.statement() AS now
```

*Table 359. Result*

<code>now</code>
10:59:31.691
1 row

## Query

```
RETURN localtime.statement('America/Los Angeles') AS nowInLA
```

Table 360. Result

nowInLA
02:59:31.704
1 row

localtime.realtime()

`localtime.realtime()` returns the current *LocalTime* value using the `realtime` clock. This value will be the live clock of the system.

**Syntax:** `localtime.realtime([ {timezone} ])`

**Returns:**

A LocalTime.

**Arguments:**

Name	Description
<code>timezone</code>	A string expression that represents the <a href="#">time zone</a>

## Query

```
RETURN localtime.realtime() AS now
```

Table 361. Result

now
10:59:31.733776
1 row

Creating a *LocalTime*

`localtime()` returns a *LocalTime* value with the specified *hour*, *minute*, *second*, *millisecond*, *microsecond* and *nanosecond* component values.

**Syntax:** `localtime({hour [, minute, second, millisecond, microsecond, nanosecond]})`

**Returns:**

A LocalTime.

**Arguments:**

Name	Description
A single map consisting of the following:	
<code>hour</code>	An integer between <code>0</code> and <code>23</code> that specifies the hour of the day.

Name	Description
minute	An integer between 0 and 59 that specifies the number of minutes.
second	An integer between 0 and 59 that specifies the number of seconds.
millisecond	An integer between 0 and 999 that specifies the number of milliseconds.
microsecond	An integer between 0 and 999,999 that specifies the number of microseconds.
nanosecond	An integer between 0 and 999,999,999 that specifies the number of nanoseconds.

## Considerations:

The `hour` component will default to 0 if `hour` is omitted.

The `minute` component will default to 0 if `minute` is omitted.

The `second` component will default to 0 if `second` is omitted.

Any missing `millisecond`, `microsecond` or `nanosecond` values will default to 0.

If `millisecond`, `microsecond` and `nanosecond` are given in combination (as part of the same set of parameters), the individual values must be in the range 0 to 999.

The least significant components in the set `hour`, `minute`, and `second` may be omitted; i.e. it is possible to specify only `hour` and `minute`, but specifying `hour` and `second` is not permitted.

One or more of `millisecond`, `microsecond` and `nanosecond` can only be specified as long as `second` is also specified.

## Query

```
UNWIND [
    localtime({hour:12, minute:31, second:14, nanosecond: 789, millisecond: 123, microsecond: 456}),
    localtime({hour:12, minute:31, second:14}),
    localtime({hour:12})
] as theTime
RETURN theTime
```

Table 362. Result

theTime
12:31:14.123456789
12:31:14
12:00
3 rows

## Creating a LocalTime from a string

`localtime()` returns the `LocalTime` value obtained by parsing a string representation of a temporal value.

**Syntax:** `localtime(temporalValue)`

**Returns:**

A LocalTime.

## Arguments:

Name	Description
temporalValue	A string representing a temporal value.

## Considerations:

- `temporalValue` must comply with the format defined for `times`.
- `temporalValue` must denote a valid time; i.e. a `temporalValue` denoting `13:46:64` is invalid.
- `localtime(null)` returns null.

## Query

```
UNWIND [
  localtime('21:40:32.142'),
  localtime('214032.142'),
  localtime('21:40'),
  localtime('21')
] AS theTime
RETURN theTime
```

Table 363. Result

theTime
21:40:32.142
21:40:32.142
21:40
21:00
4 rows

## Creating a *LocalTime* using other temporal values as components

`localtime()` returns the *LocalTime* value obtained by selecting and composing components from another temporal value. In essence, this allows a *DateTime*, *LocalDateTime* or *Time* value to be converted to a *LocalTime*, and for "missing" components to be provided.

**Syntax:** `localtime({time [, hour, ..., nanosecond]})`

## Returns:

A LocalTime.

## Arguments:

Name	Description
A single map consisting of the following:	
<code>time</code>	A <i>Time</i> value.
<code>hour</code>	An integer between <code>0</code> and <code>23</code> that specifies the hour of the day.
<code>minute</code>	An integer between <code>0</code> and <code>59</code> that specifies the number of minutes.
<code>second</code>	An integer between <code>0</code> and <code>59</code> that specifies the number of seconds.
<code>millisecond</code>	An integer between <code>0</code> and <code>999</code> that specifies the number of milliseconds.

Name	Description
microsecond	An integer between <code>0</code> and <code>999,999</code> that specifies the number of microseconds.
nanosecond	An integer between <code>0</code> and <code>999,999,999</code> that specifies the number of nanoseconds.

## Considerations:

If any of the optional parameters are provided, these will override the corresponding components of `time`.

`localtime(tt)` may be written instead of `localtime({time: tt})`.

## Query

```
WITH time({hour:12, minute:31, second:14, microsecond: 645876, timezone: '+01:00'}) AS tt
RETURN localtime({time:tt}) AS timeOnly,
       localtime({time:tt, second: 42}) AS timeSS
```

Table 364. Result

timeOnly	timeSS
12:31:14.645876	12:31:42.645876
1 row	

## Truncating a LocalTime

`localtime.truncate()` returns the *LocalTime* value obtained by truncating a specified temporal instant value at the nearest preceding point in time at the specified component boundary (which is denoted by the truncation unit passed as a parameter to the function). In other words, the *LocalTime* returned will have all components that are less significant than the specified truncation unit set to their default values.

It is possible to supplement the truncated value by providing a map containing components which are less significant than the truncation unit. This will have the effect of *overriding* the default values which would otherwise have been set for these less significant components. For example, `minute` — with some value `x` — may be provided when the truncation unit is `hour` in order to ensure the returned value has the `minute` set to `x` instead of the default `minute` (which is `1`).

**Syntax:** `localtime.truncate(unit [, temporalInstantValue [, mapOfComponents] ])`

**Returns:**

A *LocalTime*.

## Arguments:

Name	Description
<code>unit</code>	A string expression evaluating to one of the following: <code>{day, hour, minute, second, millisecond, microsecond}</code> .
<code>temporalInstantValue</code>	An expression of one of the following types: <code>{DateTime, LocalDateTime, Time, LocalTime}</code> .
<code>mapOfComponents</code>	An expression evaluating to a map containing components less significant than <code>unit</code> .

## Considerations:

Truncating time to day — i.e. `unit` is 'day' — is supported, and yields midnight at the start of the day (`00:00`), regardless of the value of `temporalInstantValue`. However, the time zone of `temporalInstantValue` is retained.

Any component that is provided in `mapOfComponents` must be less significant than `unit`; i.e. if `unit` is 'second', `mapOfComponents` cannot contain information pertaining to a *minute*.

Any component that is not contained in `mapOfComponents` and which is less significant than `unit` will be set to its `minimal value`.

If `mapOfComponents` is not provided, all components of the returned value which are less significant than `unit` will be set to their default values.

If `temporalInstantValue` is not provided, it will be set to the current time, i.e. `localtime.truncate(unit)` is equivalent of `localtime.truncate(unit, localtime())`.

## Query

```
WITH time({hour:12, minute:31, second:14, nanosecond: 645876123, timezone: '-01:00'}) AS t
RETURN localtime.truncate('day', t) AS truncDay,
       localtime.truncate('hour', t) AS truncHour,
       localtime.truncate('minute', t, {millisecond:2}) AS truncMinute,
       localtime.truncate('second', t) AS truncSecond,
       localtime.truncate('millisecond', t) AS truncMillisecond,
       localtime.truncate('microsecond', t) AS truncMicrosecond
```

Table 365. Result

truncDay	truncHour	truncMinute	truncSecond	truncMillisecond	truncMicrosecond
00:00	12:00	12:31:00.002	12:31:14	12:31:14.645	12:31:14.645876
1 row					

## 4.9.6. Time: `time()`

Details for using the `time()` function.

- Getting the current *Time*
- Creating a *Time*
- Creating a *Time* from a string
- Creating a *Time* using other temporal values as components
- Truncating a *Time*

### Getting the current *Time*

`time()` returns the current *Time* value. If no time zone parameter is specified, the local time zone will be used.

**Syntax:** `time([ {timezone} ])`

**Returns:**

A Time.

### Arguments:

Name	Description
A single map consisting of the following:	
<code>timezone</code>	A string expression that represents the <code>time zone</code>

## Considerations:

If no parameters are provided, `time()` must be invoked (`time({})` is invalid).

### Query

```
RETURN time() AS currentTime
```

The current time of day using the local time zone is returned.

Table 366. Result

currentTime
-------------

10:59:31.893Z
---------------

1 row
-------

### Query

```
RETURN time({ timezone: 'America/Los Angeles' }) AS currentTimeInLA
```

The current time of day in California is returned.

Table 367. Result

currentTimeInLA
-----------------

02:59:31.903-08:00
--------------------

1 row
-------

`time.transaction()`

`time.transaction()` returns the current *Time* value using the `transaction` clock. This value will be the same for each invocation within the same transaction. However, a different value may be produced for different transactions.

**Syntax:** `time.transaction([ {timezone} ])`

**Returns:**

A Time.

**Arguments:**

Name	Description
<code>timezone</code>	A string expression that represents the <a href="#">time zone</a>

### Query

```
RETURN time.transaction() AS currentTime
```

Table 368. Result

currentTime
-------------

10:59:31.914Z
---------------

1 row
-------

`time.statement()`

`time.statement()` returns the current *Time* value using the `statement` clock. This value will be the same for each invocation within the same statement. However, a different value may be produced for different statements within the same transaction.

**Syntax:** `time.statement([ {timezone} ])`

**Returns:**

A Time.

**Arguments:**

Name	Description
<code>timezone</code>	A string expression that represents the <a href="#">time zone</a>

**Query**

```
RETURN time.statement() AS currentTime
```

*Table 369. Result*

<code>currentTime</code>
<code>10:59:31.924Z</code>
1 row

**Query**

```
RETURN time.statement('America/Los Angeles') AS currentTimeInLA
```

*Table 370. Result*

<code>currentTimeInLA</code>
<code>02:59:31.933-08:00</code>
1 row

`time.realtime()`

`time.realtime()` returns the current *Time* value using the `realtime` clock. This value will be the live clock of the system.

**Syntax:** `time.realtime([ {timezone} ])`

**Returns:**

A Time.

**Arguments:**

Name	Description
<code>timezone</code>	A string expression that represents the <a href="#">time zone</a>

## Query

```
RETURN time.realtime() AS currentTime
```

Table 371. Result

currentTime
10:59:31.962160Z
1 row

## Creating a Time

`time()` returns a *Time* value with the specified *hour*, *minute*, *second*, *millisecond*, *microsecond*, *nanosecond* and *timezone* component values.

**Syntax:** `time({hour [, minute, second, millisecond, microsecond, nanosecond, timezone]})`

**Returns:**

A Time.

## Arguments:

Name	Description
A single map consisting of the following:	
hour	An integer between 0 and 23 that specifies the hour of the day.
minute	An integer between 0 and 59 that specifies the number of minutes.
second	An integer between 0 and 59 that specifies the number of seconds.
millisecond	An integer between 0 and 999 that specifies the number of milliseconds.
microsecond	An integer between 0 and 999,999 that specifies the number of microseconds.
nanosecond	An integer between 0 and 999,999,999 that specifies the number of nanoseconds.
timezone	An expression that specifies the time zone.

## Considerations:

The *hour* component will default to 0 if *hour* is omitted.

The *minute* component will default to 0 if *minute* is omitted.

The *second* component will default to 0 if *second* is omitted.

Any missing *millisecond*, *microsecond* or *nanosecond* values will default to 0.

The *timezone* component will default to the configured default time zone if *timezone* is omitted.

If *millisecond*, *microsecond* and *nanosecond* are given in combination (as part of the same set of parameters), the individual values must be in the range 0 to 999.

The least significant components in the set *hour*, *minute*, and *second* may be omitted; i.e. it is possible to specify only *hour* and *minute*, but specifying *hour* and *second* is not permitted.

One or more of *millisecond*, *microsecond* and *nanosecond* can only be specified as long as *second* is also specified.

## Query

```
UNWIND [
  time({hour:12, minute:31, second:14, millisecond: 123, microsecond: 456, nanosecond: 789}),
  time({hour:12, minute:31, second:14, nanosecond: 645876123}),
  time({hour:12, minute:31, second:14, microsecond: 645876, timezone: '+01:00'}),
  time({hour:12, minute:31, timezone: '+01:00'}),
  time({hour:12, timezone: '+01:00'})
] AS theTime
RETURN theTime
```

Table 372. Result

theTime
12:31:14.123456789Z
12:31:14.645876123Z
12:31:14.645876+01:00
12:31+01:00
12:00+01:00
5 rows

## Creating a *Time* from a string

`time()` returns the *Time* value obtained by parsing a string representation of a temporal value.

**Syntax:** `time(temporalValue)`

**Returns:**

A Time.

### Arguments:

Name	Description
<code>temporalValue</code>	A string representing a temporal value.

### Considerations:

`temporalValue` must comply with the format defined for [times](#) and [time zones](#).

The *timezone* component will default to the configured default time zone if it is omitted.

`temporalValue` must denote a valid time; i.e. a `temporalValue` denoting `15:67` is invalid.

`time(null)` returns null.

## Query

```
UNWIND [
  time('21:40:32.142+0100'),
  time('214032.142Z'),
  time('21:40:32+01:00'),
  time('214032-0100'),
  time('21:40-01:30'),
  time('2140-00:00'),
  time('2140-02'),
  time('22+18:00')
] AS theTime
RETURN theTime
```

Table 373. Result

theTime
21:40:32.142+01:00
21:40:32.142Z
21:40:32+01:00
21:40:32-01:00
21:40-01:30
21:40Z
21:40-02:00
22:00+18:00
8 rows

Creating a *Time* using other temporal values as components

`time()` returns the *Time* value obtained by selecting and composing components from another temporal value. In essence, this allows a *DateTime*, *LocalDateTime* or *LocalTime* value to be converted to a *Time*, and for "missing" components to be provided.

**Syntax:** `time({time [, hour, ..., timezone]})`

**Returns:**

A Time.
---------

**Arguments:**

Name	Description
A single map consisting of the following:	
<code>time</code>	A <i>Time</i> value.
<code>hour</code>	An integer between 0 and 23 that specifies the hour of the day.
<code>minute</code>	An integer between 0 and 59 that specifies the number of minutes.
<code>second</code>	An integer between 0 and 59 that specifies the number of seconds.
<code>millisecond</code>	An integer between 0 and 999 that specifies the number of milliseconds.
<code>microsecond</code>	An integer between 0 and 999,999 that specifies the number of microseconds.
<code>nanosecond</code>	An integer between 0 and 999,999,999 that specifies the number of nanoseconds.
<code>timezone</code>	An expression that specifies the time zone.

**Considerations:**

If any of the optional parameters are provided, these will override the corresponding components of <code>time</code> .
---

<code>time(tt)</code> may be written instead of <code>time({time: tt})</code> .
---

Selecting a <i>Time</i> or <i>DateTime</i> value as the <code>time</code> component also selects its time zone. If a <i>LocalTime</i> or <i>LocalDateTime</i> is selected instead, the default time zone is used. In any case, the time zone can be overridden explicitly.
--

Selecting a *DateTime* or *Time* as the `time` component and overwriting the time zone will adjust the local time to keep the same point in time.

## Query

```
WITH localtime({hour:12, minute:31, second:14, microsecond: 645876}) AS tt
RETURN time({time:tt}) AS timeOnly,
       time({time:tt, timezone:'+05:00'}) AS timeTimezone,
       time({time:tt, second: 42}) AS timeSS,
       time({time:tt, second: 42, timezone:'+05:00'}) AS timeSSTimezone
```

Table 374. Result

timeOnly	timeTimezone	timeSS	timeSSTimezone
12:31:14.645876	12:31:14.645876+05:00	12:31:42.645876Z	12:31:42.645876+05:00
1 row			

## Truncating a Time

`time.truncate()` returns the *Time* value obtained by truncating a specified temporal instant value at the nearest preceding point in time at the specified component boundary (which is denoted by the truncation unit passed as a parameter to the function). In other words, the *Time* returned will have all components that are less significant than the specified truncation unit set to their default values.

It is possible to supplement the truncated value by providing a map containing components which are less significant than the truncation unit. This will have the effect of *overriding* the default values which would otherwise have been set for these less significant components. For example, `minute` — with some value `x` — may be provided when the truncation unit is `hour` in order to ensure the returned value has the `minute` set to `x` instead of the default `minute` (which is `1`).

**Syntax:** `time.truncate(unit [, temporalInstantValue [, mapOfComponents ] ])`

**Returns:**

A *Time*.

## Arguments:

Name	Description
<code>unit</code>	A string expression evaluating to one of the following: { <code>day</code> , <code>hour</code> , <code>minute</code> , <code>second</code> , <code>millisecond</code> , <code>microsecond</code> }.
<code>temporalInstantValue</code>	An expression of one of the following types: { <code>DateTime</code> , <code>LocalDateTime</code> , <code>Time</code> , <code>LocalTime</code> }.
<code>mapOfComponents</code>	An expression evaluating to a map containing components less significant than <code>unit</code> . During truncation, a time zone can be attached or overridden using the key <code>timezone</code> .

## Considerations:

Truncating time to day — i.e. `unit` is 'day' — is supported, and yields midnight at the start of the day (`00:00`), regardless of the value of `temporalInstantValue`. However, the time zone of `temporalInstantValue` is retained.

The time zone of `temporalInstantValue` may be overridden; for example, `time.truncate('minute', input, {timezone:'+0200'})`.

If `temporalInstantValue` is one of {`Time`, `DateTime`} — a value with a time zone — and the time zone is overridden, no time conversion occurs.

If `temporalInstantValue` is one of {`LocalTime`, `LocalDateTime`, `Date`} — a value without a time zone — and the time zone is not overridden, the configured default time zone will be used.

Any component that is provided in <code>mapOfComponents</code> must be less significant than <code>unit</code> ; i.e. if <code>unit</code> is 'second', <code>mapOfComponents</code> cannot contain information pertaining to a <i>minute</i> .
Any component that is not contained in <code>mapOfComponents</code> and which is less significant than <code>unit</code> will be set to its <code>minimal value</code> .
If <code>mapOfComponents</code> is not provided, all components of the returned value which are less significant than <code>unit</code> will be set to their default values.
If <code>temporalInstantValue</code> is not provided, it will be set to the current time and timezone, i.e. <code>time.truncate(unit)</code> is equivalent of <code>time.truncate(unit, time())</code> .

## Query

```
WITH time({ hour:12, minute:31, second:14, nanosecond: 645876123, timezone: '-01:00' }) AS t
RETURN time.truncate('day', t) AS truncDay, time.truncate('hour', t) AS truncHour, time.truncate('minute',
t) AS truncMinute, time.truncate('second', t) AS truncSecond, time.truncate('millisecond', t, {
nanosecond:2 }) AS truncMillisecond, time.truncate('microsecond', t) AS truncMicrosecond
```

Table 375. Result

truncDay	truncHour	truncMinute	truncSecond	truncMillisecond	truncMicrosecond
00:00-01:00	12:00-01:00	12:31-01:00	12:31:14-01:00	12:31:14.6450000	12:31:14.645876-01:00
1 row					

## 4.10. Temporal functions - duration

Cypher provides functions allowing for the creation and manipulation of values for a Duration temporal type.



See also [Temporal \(Date/Time\) values](#) and [Temporal operators](#).

`duration()`:

- [Creating a Duration from duration components](#)
- [Creating a Duration from a string](#)
- [Computing the Duration between two temporal instants](#)

Information regarding specifying and accessing components of a *Duration* value can be found [here](#).

### 4.10.1. Creating a Duration from duration components

`duration()` can construct a *Duration* from a map of its components in the same way as the temporal instant types.

- `years`
- `quarters`
- `months`
- `weeks`
- `days`
- `hours`
- `minutes`

- `seconds`
- `milliseconds`
- `microseconds`
- `nanoseconds`

**Syntax:** `duration([ {years, quarters, months, weeks, days, hours, minutes, seconds, milliseconds, microseconds, nanoseconds} ])`

#### Returns:

A Duration.

#### Arguments:

Name	Description
<code>A single map consisting of the following:</code>	
<code>years</code>	A numeric expression.
<code>quarters</code>	A numeric expression.
<code>months</code>	A numeric expression.
<code>weeks</code>	A numeric expression.
<code>days</code>	A numeric expression.
<code>hours</code>	A numeric expression.
<code>minutes</code>	A numeric expression.
<code>seconds</code>	A numeric expression.
<code>milliseconds</code>	A numeric expression.
<code>microseconds</code>	A numeric expression.
<code>nanoseconds</code>	A numeric expression.

#### Considerations:

At least one parameter must be provided (`duration()` and `duration({})` are invalid).

There is no constraint on how many of the parameters are provided.

It is possible to have a *Duration* where the amount of a smaller unit (e.g. `seconds`) exceeds the threshold of a larger unit (e.g. `days`).

The values of the parameters may be expressed as decimal fractions.

The values of the parameters may be arbitrarily large.

The values of the parameters may be negative.

#### Query

```
UNWIND [
    duration({days: 14, hours:16, minutes: 12}),
    duration({months: 5, days: 1.5}),
    duration({months: 0.75}),
    duration({weeks: 2.5}),
    duration({minutes: 1.5, seconds: 1, milliseconds: 123, microseconds: 456, nanoseconds: 789}),
    duration({minutes: 1.5, seconds: 1, nanoseconds: 123456789})
] AS aDuration
RETURN aDuration
```

Table 376. Result

aDuration
P14DT16H12M
P5M1DT12H
P22DT19H51M49.5S
P17DT12H
PT1M31.123456789S
PT1M31.123456789S
6 rows

## 4.10.2. Creating a *Duration* from a string

`duration()` returns the *Duration* value obtained by parsing a string representation of a temporal amount.

**Syntax:** `duration(temporalAmount)`

**Returns:**

A Duration.

**Arguments:**

Name	Description
<code>temporalAmount</code>	A string representing a temporal amount.

**Considerations:**

`temporalAmount` must comply with either the [unit based form](#) or [date-and-time based form](#) defined for *Durations*.

**Query**

```
UNWIND [
    duration("P14DT16H12M"),
    duration("P5M1.5D"),
    duration("P0.75M"),
    duration("PT0.75M"),
    duration("P2012-02-02T14:37:21.545")
] AS aDuration
RETURN aDuration
```

*Table 377. Result*

aDuration
P14DT16H12M
P5M1DT12H
P22DT19H51M49.5S
PT45S
P2012Y2M2DT14H37M21.545S
5 rows

### 4.10.3. Computing the *Duration* between two temporal instants

`duration()` has sub-functions which compute the *logical difference* (in days, months, etc) between two temporal instant values:

- `duration.between(a, b)`: Computes the difference in multiple components between instant `a` and instant `b`. This captures month, days, seconds and sub-seconds differences separately.
- `duration.inMonths(a, b)`: Computes the difference in whole months (or quarters or years) between instant `a` and instant `b`. This captures the difference as the total number of months. Any difference smaller than a whole month is disregarded.
- `duration.inDays(a, b)`: Computes the difference in whole days (or weeks) between instant `a` and instant `b`. This captures the difference as the total number of days. Any difference smaller than a whole day is disregarded.
- `duration.inSeconds(a, b)`: Computes the difference in seconds (and fractions of seconds, or minutes or hours) between instant `a` and instant `b`. This captures the difference as the total number of seconds.

#### `duration.between()`

`duration.between()` returns the *Duration* value equal to the difference between the two given instants.

**Syntax:** `duration.between(instant1, instant2)`

**Returns:**

A Duration.

#### Arguments:

Name	Description
<code>instant<sub>1</sub></code>	An expression returning any temporal instant type ( <i>Date</i> etc) that represents the starting instant.
<code>instant<sub>2</sub></code>	An expression returning any temporal instant type ( <i>Date</i> etc) that represents the ending instant.

#### Considerations:

If `instant2` occurs earlier than `instant1`, the resulting *Duration* will be negative.

If `instant1` has a time component and `instant2` does not, the time component of `instant2` is assumed to be midnight, and vice versa.

If `instant1` has a time zone component and `instant2` does not, the time zone component of `instant2` is assumed to be the same as that of `instant1`, and vice versa.

If `instant1` has a date component and `instant2` does not, the date component of `instant2` is assumed to be the same as that of `instant1`, and vice versa.

## Query

```
UNWIND [
    duration.between(date("1984-10-11"), date("1985-11-25")),
    duration.between(date("1985-11-25"), date("1984-10-11")),
    duration.between(date("1984-10-11"), datetime("1984-10-12T21:40:32.142+0100")),
    duration.between(date("2015-06-24"), localtime("14:30")),
    duration.between(localtime("14:30"), time("16:30+0100")),
    duration.between(localdatetime("2015-07-21T21:40:32.142"), localdatetime("2016-07-21T21:45:22.142")),
    duration.between(datetime({year: 2017, month: 10, day: 29, hour: 0, timezone: 'Europe/Stockholm'}),
    datetime({year: 2017, month: 10, day: 29, hour: 0, timezone: 'Europe/London'}))
] AS aDuration
RETURN aDuration
```

Table 378. Result

aDuration
P1Y1M14D
P-1Y-1M-14D
P1DT21H40M32.142S
PT14H30M
PT2H
P1YT4M50S
PT1H
7 rows

duration.inMonths()

`duration.inMonths()` returns the *Duration* value equal to the difference in whole months, quarters or years between the two given instants.

**Syntax:** `duration.inMonths(instant1, instant2)`

**Returns:**

A Duration.

**Arguments:**

Name	Description
instant <sub>1</sub>	An expression returning any temporal instant type ( <i>Date</i> etc) that represents the starting instant.
instant <sub>2</sub>	An expression returning any temporal instant type ( <i>Date</i> etc) that represents the ending instant.

**Considerations:**

If `instant2` occurs earlier than `instant1`, the resulting *Duration* will be negative.

If `instant1` has a time component and `instant2` does not, the time component of `instant2` is assumed to be midnight, and vice versa.

If `instant1` has a time zone component and `instant2` does not, the time zone component of `instant2` is assumed to be the same as that of `instant1`, and vice versa.

If `instant1` has a date component and `instant2` does not, the date component of `instant2` is assumed to be the same as that of `instant1`, and vice versa.

Any difference smaller than a whole month is disregarded.

## Query

```
UNWIND [
    duration.inMonths(date("1984-10-11"), date("1985-11-25")),
    duration.inMonths(date("1985-11-25"), date("1984-10-11")),
    duration.inMonths(date("1984-10-11"), datetime("1984-10-12T21:40:32.142+0100")),
    duration.inMonths(date("2015-06-24"), localtime("14:30")),
    duration.inMonths(localdatetime("2015-07-21T21:40:32.142"), localdatetime("2016-07-21T21:45:22.142")),
    duration.inMonths(datetime({year: 2017, month: 10, day: 29, hour: 0, timezone: 'Europe/Stockholm'})),
    datetime({year: 2017, month: 10, day: 29, hour: 0, timezone: 'Europe/London'}))
] AS aDuration
RETURN aDuration
```

Table 379. Result

aDuration
P1Y1M
P-1Y-1M
PT0S
PT0S
P1Y
PT0S
6 rows

## duration.inDays()

`duration.inDays()` returns the *Duration* value equal to the difference in whole days or weeks between the two given instants.

**Syntax:** `duration.inDays(instant1, instant2)`

**Returns:**

A Duration.

## Arguments:

Name	Description
instant <sub>1</sub>	An expression returning any temporal instant type ( <i>Date</i> etc) that represents the starting instant.
instant <sub>2</sub>	An expression returning any temporal instant type ( <i>Date</i> etc) that represents the ending instant.

## Considerations:

If `instant2` occurs earlier than `instant1`, the resulting *Duration* will be negative.

If `instant1` has a time component and `instant2` does not, the time component of `instant2` is assumed to be midnight, and vice versa.

If `instant1` has a time zone component and `instant2` does not, the time zone component of `instant2` is assumed to be the same as that of `instant1`, and vice versa.

If `instant1` has a date component and `instant2` does not, the date component of `instant2` is assumed to be the same as that of `instant1`, and vice versa.

Any difference smaller than a whole day is disregarded.

## Query

```
UNWIND [
    duration.inDays(date("1984-10-11"), date("1985-11-25")),
    duration.inDays(date("1985-11-25"), date("1984-10-11")),
    duration.inDays(date("1984-10-11"), datetime("1984-10-12T21:40:32.142+0100")),
    duration.inDays(date("2015-06-24"), localtime("14:30")),
    duration.inDays(localdatetime("2015-07-21T21:40:32.142"), localdatetime("2016-07-21T21:45:22.142")),
    duration.inDays(datetime({year: 2017, month: 10, day: 29, hour: 0, timezone: 'Europe/Stockholm'}),
    datetime({year: 2017, month: 10, day: 29, hour: 0, timezone: 'Europe/London'}))
] AS aDuration
RETURN aDuration
```

Table 380. Result

aDuration
P410D
P-410D
P1D
PT0S
P366D
PT0S
6 rows

duration.inSeconds()

`duration.inSeconds()` returns the *Duration* value equal to the difference in seconds and fractions of seconds, or minutes or hours, between the two given instants.

**Syntax:** `duration.inSeconds(instant1, instant2)`

**Returns:**

A Duration.

**Arguments:**

Name	Description
instant <sub>1</sub>	An expression returning any temporal instant type ( <i>Date</i> etc) that represents the starting instant.
instant <sub>2</sub>	An expression returning any temporal instant type ( <i>Date</i> etc) that represents the ending instant.

**Considerations:**

If `instant2` occurs earlier than `instant1`, the resulting *Duration* will be negative.

If `instant1` has a time component and `instant2` does not, the time component of `instant2` is assumed to be midnight, and vice versa.

If `instant1` has a time zone component and `instant2` does not, the time zone component of `instant2` is assumed to be the same as that of `instant1`, and vice versa.

If `instant1` has a date component and `instant2` does not, the date component of `instant2` is assumed to be the same as that of `instant1`, and vice versa.

## Query

```
UNWIND [
    duration.inSeconds(date("1984-10-11"), date("1984-10-12")),
    duration.inSeconds(date("1984-10-12"), date("1984-10-11")),
    duration.inSeconds(date("1984-10-11"), datetime("1984-10-12T01:00:32.142+0100")),
    duration.inSeconds(date("2015-06-24"), localtime("14:30")),
    duration.inSeconds(datetime({year: 2017, month: 10, day: 29, hour: 0, timezone: 'Europe/Stockholm'}),
    datetime({year: 2017, month: 10, day: 29, hour: 0, timezone: 'Europe/London'}))
] AS aDuration
RETURN aDuration
```

Table 381. Result

aDuration
PT24H
PT-24H
PT25H32.142S
PT14H30M
PT1H
5 rows

## 4.11. Spatial functions

*These functions are used to specify 2D or 3D points in a Coordinate Reference System (CRS) and to calculate the geodesic distance between two points.*

Functions:

- [distance\(\)](#)
- [point\(\) - WGS 84 2D](#)
- [point\(\) - WGS 84 3D](#)
- [point\(\) - Cartesian 2D](#)
- [point\(\) - Cartesian 3D](#)

The following graph is used for some of the examples below.

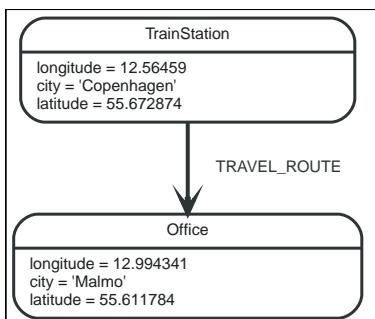


Figure 28. Graph

### 4.11.1. [distance\(\)](#)

[distance\(\)](#) returns a floating point number representing the geodesic distance between two points in the same Coordinate Reference System (CRS).

- If the points are in the *Cartesian CRS* (2D or 3D), then the units of the returned distance will be the same as the units of the points, calculated using Pythagoras' theorem.
- If the points are in the *WGS-84 CRS* (2D), then the units of the returned distance will be meters, based on the haversine formula over a spherical earth approximation.
- If the points are in the *WGS-84 CRS* (3D), then the units of the returned distance will be meters.
  - The distance is calculated in two steps.
    - First, a haversine formula over a spherical earth is used, at the average height of the two points.
    - To account for the difference in height, Pythagoras' theorem is used, combining the previously calculated spherical distance with the height difference.
  - This formula works well for points close to the earth's surface; for instance, it is well-suited for calculating the distance of an airplane flight. It is less suitable for greater heights, however, such as when calculating the distance between two satellites.

**Syntax:** `distance(point1, point2)`

**Returns:**

A Float.

**Arguments:**

Name	Description
<code>point1</code>	A point in either a geographic or cartesian coordinate system.
<code>point2</code>	A point in the same CRS as 'point1'.

**Considerations:**

`distance(null, null)`, `distance(null, point2)` and `distance(point1, null)` all return `null`.

Attempting to use points with different Coordinate Reference Systems (such as WGS 84 2D and WGS 84 3D) will return `null`.

**Query**

```
WITH point({ x: 2.3, y: 4.5, crs: 'cartesian' }) AS p1, point({ x: 1.1, y: 5.4, crs: 'cartesian' }) AS p2
RETURN distance(p1,p2) AS dist
```

The distance between two 2D points in the *Cartesian CRS* is returned.

*Table 382. Result*

<code>dist</code>
<code>1.5</code>
1 row

**Query**

```
WITH point({ longitude: 12.78, latitude: 56.7, height: 100 }) AS p1, point({ latitude: 56.71, longitude: 12.79, height: 100 }) AS p2
RETURN distance(p1,p2) AS dist
```

The distance between two 3D points in the *WGS 84 CRS* is returned.

Table 383. Result

dist
1269.9148706779097
1 row

Query

```
MATCH (t:TrainStation)-[:TRAVEL_ROUTE]->(o:Office)
WITH point({ longitude: t.longitude, latitude: t.latitude }) AS trainPoint, point({ longitude:
o.longitude, latitude: o.latitude }) AS officePoint
RETURN round(distance(trainPoint, officePoint)) AS travelDistance
```

The distance between the train station in Copenhagen and the Neo4j office in Malmo is returned.

Table 384. Result

travelDistance
27842.0
1 row

Query

```
RETURN distance(NULL , point({ longitude: 56.7, latitude: 12.78 })) AS d
```

If `null` is provided as one or both of the arguments, `null` is returned.

Table 385. Result

d
<null>
1 row

## 4.11.2. point() - WGS 84 2D

`point({longitude | x, latitude | y [, crs][, srid]})` returns a 2D point in the *WGS 84* CRS corresponding to the given coordinate values.

**Syntax:** `point({longitude | x, latitude | y [, crs][, srid]})`

**Returns:**

A 2D point in *WGS 84*.

### Arguments:

Name	Description
A single map consisting of the following:	
<code>longitude/x</code>	A numeric expression that represents the longitude/x value in decimal degrees
<code>latitude/y</code>	A numeric expression that represents the latitude/y value in decimal degrees
<code>crs</code>	The optional string 'WGS-84'
<code>srid</code>	The optional number 4326

## Considerations:

If any argument provided to `point()` is `null`, `null` will be returned.

If the coordinates are specified using `longitude` and `latitude`, the `crs` or `srid` fields are optional and inferred to be '`WGS-84`' (`srid=4326`).

If the coordinates are specified using `x` and `y`, then either the `crs` or `srid` field is required if a geographic CRS is desired.

## Query

```
RETURN point({ longitude: 56.7, latitude: 12.78 }) AS point
```

A 2D point with a `longitude` of `56.7` and a `latitude` of `12.78` in the `WGS 84` CRS is returned.

Table 386. Result

point
point({x: 56.7, y: 12.78, crs: 'wgs-84'})
1 row

## Query

```
RETURN point({ x: 2.3, y: 4.5, crs: 'WGS-84' }) AS point
```

`x` and `y` coordinates may be used in the `WGS 84` CRS instead of `longitude` and `latitude`, respectively, providing `crs` is set to '`WGS-84`', or `srid` is set to `4326`.

Table 387. Result

point
point({x: 2.3, y: 4.5, crs: 'wgs-84'})
1 row

## Query

```
MATCH (p:Office)
RETURN point({ longitude: p.longitude, latitude: p.latitude }) AS officePoint
```

A 2D point representing the coordinates of the city of Malmo in the `WGS 84` CRS is returned.

Table 388. Result

officePoint
point({x: 12.994341, y: 55.611784, crs: 'wgs-84'})
1 row

## Query

```
RETURN point(NULL ) AS p
```

If `null` is provided as the argument, `null` is returned.

Table 389. Result

p
<null>

p
1 row

### 4.11.3. point() - WGS 84 3D

`point({longitude | x, latitude | y, height | z, [, crs][, srid]})` returns a 3D point in the *WGS 84* CRS corresponding to the given coordinate values.

**Syntax:** `point({longitude | x, latitude | y, height | z, [, crs][, srid]})`

**Returns:**

A 3D point in *WGS 84*.

**Arguments:**

Name	Description
A single map consisting of the following:	
<code>longitude/x</code>	A numeric expression that represents the longitude/x value in decimal degrees
<code>latitude/y</code>	A numeric expression that represents the latitude/y value in decimal degrees
<code>height/z</code>	A numeric expression that represents the height/z value in meters
<code>crs</code>	The optional string 'WGS-84-3D'
<code>srid</code>	The optional number 4979

**Considerations:**

If any argument provided to `point()` is `null`, `null` will be returned.

If the `height/z` key and value is not provided, a 2D point in the *WGS 84* CRS will be returned.

If the coordinates are specified using `latitude` and `longitude`, the `crs` or `srid` fields are optional and inferred to be '`WGS-84-3D`' (`srid=4979`).

If the coordinates are specified using `x` and `y`, then either the `crs` or `srid` field is required if a geographic CRS is desired.

**Query**

```
RETURN point({ longitude: 56.7, latitude: 12.78, height: 8 }) AS point
```

A 3D point with a `longitude` of `56.7`, a `latitude` of `12.78` and a height of `8` meters in the *WGS 84* CRS is returned.

*Table 390. Result*

point
<code>point({x: 56.7, y: 12.78, z: 8.0, crs: 'wgs-84-3d'})</code>
1 row

### 4.11.4. point() - Cartesian 2D

`point({x, y [, crs][, srid]})` returns a 2D point in the *Cartesian* CRS corresponding to the given coordinate values.

**Syntax:** `point({x, y [, crs][, srid]})`

**Returns:**

A 2D point in *Cartesian*.

**Arguments:**

Name	Description
A single map consisting of the following:	
x	A numeric expression
y	A numeric expression
crs	The optional string 'cartesian'
srid	The optional number 7203

**Considerations:**

If any argument provided to `point()` is `null`, `null` will be returned.

The `crs` or `srid` fields are optional and default to the *Cartesian CRS* (which means `srid:7203`).

**Query**

```
RETURN point({ x: 2.3, y: 4.5 }) AS point
```

A 2D point with an `x` coordinate of `2.3` and a `y` coordinate of `4.5` in the *Cartesian CRS* is returned.

*Table 391. Result*

point
<code>point({x: 2.3, y: 4.5, crs: 'cartesian'})</code>
1 row

## 4.11.5. `point()` - Cartesian 3D

`point({x, y, z, [, crs][, srid]})` returns a 3D point in the *Cartesian CRS* corresponding to the given coordinate values.

**Syntax:** `point({x, y, z, [, crs][, srid]})`

**Returns:**

A 3D point in *Cartesian*.

**Arguments:**

Name	Description
A single map consisting of the following:	
x	A numeric expression
y	A numeric expression
z	A numeric expression
crs	The optional string 'cartesian-3D'

Name	Description
srid	The optional number 9157

## Considerations:

If any argument provided to `point()` is `null`, `null` will be returned.

If the `z` key and value is not provided, a 2D point in the *Cartesian* CRS will be returned.

The `crs` or `srid` fields are optional and default to the *3D Cartesian* CRS (which means `srid:9157`).

## Query

```
RETURN point({ x: 2.3, y: 4.5, z: 2 }) AS point
```

A 3D point with an `x` coordinate of `2.3`, a `y` coordinate of `4.5` and a `z` coordinate of `2` in the *Cartesian* CRS is returned.

Table 392. Result

point
<code>point({x: 2.3, y: 4.5, z: 2.0, crs: 'cartesian-3d'})</code>
1 row

## 4.12. User-defined functions

*User-defined functions are written in Java, deployed into the database and are called in the same way as any other Cypher function.*

There are two main types of functions that can be developed and used:

Type	Description	Usage	Developing
Scalar	For each row the function takes parameters and returns a result	<a href="#">Using UDF</a>	<a href="#">Extending Neo4j (UDF)</a>
Aggregating	Consumes many rows and produces an aggregated result	<a href="#">Using aggregating UDF</a>	<a href="#">Extending Neo4j (Aggregating UDF)</a>

### 4.12.1. User-defined scalar functions

For each incoming row the function takes parameters and returns a single result.

This example shows how you invoke a user-defined function called `join` from Cypher.

#### Call a user-defined function

This calls the user-defined function `org.neo4j.procedure.example.join()`.

## Query

```
MATCH (n:Member)
RETURN org.neo4j.function.example.join(collect(n.name)) AS members
```

Table 393. Result

members
"John,Paul,George,Ringo"
1 row

For developing and deploying user-defined functions in Neo4j, see [Extending Neo4j □ User-defined functions](#).

## 4.12.2. User-defined aggregation functions

Aggregating functions consume many rows and produces a single aggregated result.

This example shows how you invoke a user-defined aggregation function called `longestString` from Cypher.

Call a user-defined aggregation function

This calls the user-defined function `org.neo4j.function.example.longestString()`.

Query

```
MATCH (n:Member)
RETURN org.neo4j.function.example.longestString(n.name) AS member
```

Table 394. Result

member
"George"
1 row

## 4.13. LOAD CSV functions

*LOAD CSV functions can be used to get information about the file that is processed by `LOAD CSV`.*



The functions described on this page are only useful when run on a query that uses `LOAD CSV`. In all other contexts they will always return `null`.

Functions:

- `linenumber()`
- `file()`

### 4.13.1. `linenumber()`

`linenumber()` returns the line number that `LOAD CSV` is currently using.

Syntax: `linenumber()`

Returns:

An Integer.

## Considerations:

`null` will be returned if this function is called without a `LOAD CSV` context.

### 4.13.2. `file()`

`file()` returns the absolute path of the file that `LOAD CSV` is using.

**Syntax:** `file()`

#### Returns:

A String.

## Considerations:

`null` will be returned if this function is called without a `LOAD CSV` context.

# Chapter 5. Administration

*This chapter explains how to use Cypher to administer Neo4j databases, such as creating databases, managing indexes and constraints, and managing security.*

Neo4j supports the management of multiple databases within the same DBMS. The metadata for these databases, including the associated security model, is maintained in a special database called the `system` database. Most administrative commands must be executed against the `system` database because they involve editing the metadata for the entire system. This includes all commands related to managing multiple databases as well as all commands for defining the security model: users, roles and privileges. The administrative commands that are specific to the schema of an individual database are still executed against that specific database. These include index and constraint management commands.

- [Databases](#)
  - [Introduction](#)
  - [Listing databases](#)
  - [Creating databases](#)
  - [Stopping databases](#)
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- [Indexes for search performance](#)
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  - [Composite index limitations](#)
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- [Indexes for full-text search](#)
  - [Introduction](#)
  - [Procedures to manage full-text indexes](#)
  - [Create and configure full-text indexes](#)
  - [Query full-text indexes](#)
  - [Drop full-text indexes](#)
- [Constraints](#)
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  - [User and role management](#)
  - [Graph and sub-graph access control](#)
  - [Read privileges](#)
  - [Write privileges](#)

- Security of administration
- Known limitations of security

## 5.1. Databases

*This section explains how to use Cypher to manage Neo4j databases: creating, deleting, starting and stopping individual databases within a single server.*

- [Introduction](#)
- [Listing databases](#)
- [Creating databases](#)
- [Stopping databases](#)
- [Starting databases](#)
- [Deleting databases](#)
- [Waiting for completion](#)

### 5.1.1. Introduction

Neo4j supports the management of multiple databases within the same DBMS. The metadata for these databases, including the associated security model, is maintained in a special database called the `system` database. All multi-database administrative commands must be run against the `system` database. These administrative commands are automatically routed to the `system` database when connected to the DBMS over Bolt.

The syntax of the database management commands is as follows:

*Table 395. Command syntax*

Command	Syntax
Show Database	<pre>SHOW { DATABASE db   DATABASES   DEFAULT DATABASE } [YIELD { *   field1[, ...] } [ORDER BY field1[, ...]] [SKIP n] [LIMIT n]] [WHERE expression] [RETURN field1[, ...] [ORDER BY field1[, ...]] [SKIP n] [LIMIT n]]</pre>
Create Database	<pre>CREATE DATABASE name [IF NOT EXISTS] [WAIT [n [SEC[OND[S]]]] NOWAIT] CREATE [OR REPLACE] DATABASE name [WAIT [n [SEC[OND[S]]]] NOWAIT]</pre>
Stop Database	<pre>STOP DATABASE name [WAIT [n [SEC[OND[S]]]] NOWAIT]</pre>
Start Database	<pre>START DATABASE name [WAIT [n [SEC[OND[S]]]] NOWAIT]</pre>
Drop Database	<pre>DROP DATABASE name [IF EXISTS] [{DUMP DESTROY} [DATA]] [WAIT [n [SEC[OND[S]]]] NOWAIT]</pre>

## 5.1.2. Listing databases

There are three different commands for listing databases. Listing all databases, listing a particular database or listing the default database.

All available databases can be seen using the command `SHOW DATABASES`.

### Query

```
SHOW DATABASES
```

Table 396. Result

name	address	role	requestedStatus	currentStatus	error	default
"movies"	"localhost:7687"	"standalone"	"online"	"online"	" "	false
"neo4j"	"localhost:7687"	"standalone"	"online"	"online"	" "	true
"northwind-graph"	"localhost:7687"	"standalone"	"online"	"online"	" "	false
"system"	"localhost:7687"	"standalone"	"online"	"online"	" "	false
4 rows						

The number of databases can be seen using a `count()` aggregation with `YIELD` and `RETURN`.

### Query

```
SHOW DATABASES YIELD *
RETURN count(*) AS count
```

Table 397. Result

count
4
1 row

A particular database can be seen using the command `SHOW DATABASE name`.

### Query

```
SHOW DATABASE system
```

Table 398. Result

name	address	role	requestedStatus	currentStatus	error	default
"system"	"localhost:7687"	"standalone"	"online"	"online"	" "	false
1 row						

The default database can be seen using the command `SHOW DEFAULT DATABASE`.

## Query

```
SHOW DEFAULT DATABASE
```

Table 399. Result

name	address	role	requestedStatus	currentStatus	error
"neo4j"	"localhost:7687"	"standalone"	"online"	"online"	" "
1 row					

It is also possible to filter and sort the results by using `YIELD`, `ORDER BY` and `WHERE`.

## Query

```
SHOW DATABASES YIELD name, currentStatus, requestedStatus  
ORDER BY currentStatus  
WHERE name CONTAINS 'e'
```

In this example:

- The number of columns returned has been reduced with the `YIELD` clause.
- The order of the returned columns has been changed.
- The results have been filtered to only show database names containing 'e'.
- The results are ordered by the 'currentStatus' column using `ORDER BY`.

It is also possible to use `SKIP` and `LIMIT` to paginate the results.

Table 400. Result

name	currentStatus	requestedStatus
"movies"	"online"	"online"
"neo4j"	"online"	"online"
"system"	"online"	"online"
3 rows		



Note that for failed databases, the `currentStatus` and `requestedStatus` are different. This often implies an error, but **does not always**. For example, a database may take a while to transition from `offline` to `online` due to performing recovery. Or, during normal operation a database's `currentStatus` may be transiently different from its `requestedStatus` due to a necessary automatic process, such as one Neo4j instance copying store files from another. The possible statuses are `initial`, `online`, `offline`, `store copying` and `unknown`.

### 5.1.3. Creating databases

Databases can be created using `CREATE DATABASE`.

## Query

```
CREATE DATABASE customers
```

0 rows, System updates: 1

Database names are subject to the [standard Cypher restrictions on valid identifiers](#). The following naming rules apply:

- Database name length must be between 3 and 63 characters.
- The first character must be an ASCII alphabetic character.
- Subsequent characters can be ASCII alphabetic (`mydatabase`), numeric characters (`mydatabase2`), dots (`main.db`), and dashes (enclosed within backticks, e.g., `CREATE DATABASE `main-db``).
- Names cannot end with dots or dashes.
- Names that begin with an underscore or with the prefix `system` are reserved for internal use.



When a database has been created, it will show up in the listing provided by the command `SHOW DATABASES`.

### Query

```
SHOW DATABASES
```

Table 401. Result

name	address	role	requestedStatus	currentStatus	error	default
"customers"	"localhost:7687"	"standalone"	"online"	"online"	" "	false
"movies"	"localhost:7687"	"standalone"	"online"	"online"	" "	false
"neo4j"	"localhost:7687"	"standalone"	"online"	"online"	" "	true
"northwind-graph"	"localhost:7687"	"standalone"	"online"	"online"	" "	false
"system"	"localhost:7687"	"standalone"	"online"	"online"	" "	false

5 rows

This command is optionally idempotent, with the default behavior to throw an exception if the database already exists. Appending `IF NOT EXISTS` to the command will ensure that no exception is thrown and nothing happens should the database already exist. Adding `OR REPLACE` to the command will result in any existing database being deleted and a new one created.

### Query

```
CREATE DATABASE customers IF NOT EXISTS
```

### Query

```
CREATE OR REPLACE DATABASE customers
```

This is equivalent to running `DROP DATABASE customers IF EXISTS` followed by `CREATE DATABASE customers`.



The `IF NOT EXISTS` and `OR REPLACE` parts of this command cannot be used together.

## 5.1.4. Stopping databases

Databases can be stopped using the command `STOP DATABASE`.

*Query*

```
STOP DATABASE customers
```

0 rows, System updates: 1

The status of the stopped database can be seen using the command `SHOW DATABASE name`.

*Query*

```
SHOW DATABASE customers
```

*Table 402. Result*

name	address	role	requestedStatus	currentStatus	error	default
"customers"	"localhost:7687"	"standalone"	"offline"	"offline"	" "	false
1 row						

## 5.1.5. Starting databases

Databases can be started using the command `START DATABASE`.

*Query*

```
START DATABASE customers
```

0 rows, System updates: 1

The status of the started database can be seen using the command `SHOW DATABASE name`.

*Query*

```
SHOW DATABASE customers
```

*Table 403. Result*

name	address	role	requestedStatus	currentStatus	error	default
"customers"	"localhost:7687"	"standalone"	"online"	"online"	" "	false
1 row						

## 5.1.6. Deleting databases

Databases can be deleted using the command `DROP DATABASE`.

*Query*

```
DROP DATABASE customers
```

0 rows, System updates: 1

When a database has been deleted, it will no longer show up in the listing provided by the command `SHOW DATABASES`.

#### Query

```
SHOW DATABASES
```

Table 404. Result

name	address	role	requestedStatus	currentStatus	error	default
"movies"	"localhost:7687"	"standalone"	"online"	"online"	" "	false
"neo4j"	"localhost:7687"	"standalone"	"online"	"online"	" "	true
"northwind-graph"	"localhost:7687"	"standalone"	"online"	"online"	" "	false
"system"	"localhost:7687"	"standalone"	"online"	"online"	" "	false
4 rows						

This command is optionally idempotent, with the default behavior to throw an exception if the database does not exist. Appending `IF EXISTS` to the command will ensure that no exception is thrown and nothing happens should the database not exist.

#### Query

```
DROP DATABASE customers IF EXISTS
```

The `DROP DATABASE` command will remove a database entirely. However, you can request that a dump of the store files is produced first, and stored in the path configured using the `dbms.directories.dumps.root` setting (by default `<neo4j-home>/data/dumps`). This can be achieved by appending `DUMP DATA` to the command (or `DESTROY DATA` to explicitly request the default behaviour). These dumps are equivalent to those produced by `neo4j-admin dump` and can be similarly restored using `neo4j-admin load`.

#### Query

```
DROP DATABASE customers DUMP DATA
```

The options `IF EXISTS` and `DUMP DATA/ DESTROY DATA` can also be combined. An example could look like this:

#### Query

```
DROP DATABASE customers IF EXISTS DUMP DATA
```

### 5.1.7. Waiting for completion

Aside from `SHOW DATABASES`, the database management commands all accept an optional `WAIT/NOWAIT` clause. The `WAIT/NOWAIT` clause allows a user to specify whether to wait for the command to complete before returning. The options are:

- `WAIT n SECONDS` - Wait the specified number of seconds (n) for the command to complete before

returning.

- **WAIT** - Wait for the default period for the command to complete before returning.
- **NOWAIT** - Return immediately.

The default behaviour is **NOWAIT**, so if no clause is specified the command will return immediately whilst the action is performed in the background.

### Query

```
CREATE DATABASE slow WAIT 5 SECONDS
```

Table 405. Result

address	state	message	success
"localhost:7687"	"CaughtUp"	"caught up"	true
1 row			

The **success** column provides an aggregate status of whether or not the command is considered successful and thus every row will have the same value. The intention of this column is to make it easy to determine, for example in a script, whether or not the command completed successfully without timing out.



A command with a **WAIT** clause may be interrupted whilst it is waiting to complete. In this event the command will continue to execute in the background and will not be aborted.

## 5.2. Indexes for search performance

*This section explains how to manage indexes used for search performance.*

- [Introduction](#)
- [Syntax](#)
- [Composite index limitations](#)
- [Examples](#)
  - [Create a single-property index](#)
  - [Create a single-property index only if it does not already exist](#)
  - [Create a single-property index with specified index provider](#)
  - [Create a single-property index with specified index configuration](#)
  - [Create a composite index](#)
  - [Create a composite index with specified index provider and configuration](#)
  - [Drop an index](#)
  - [Drop a non-existing index](#)
  - [List indexes](#)
  - [Deprecated syntax](#)

This section describes how to manage indexes. For query performance purposes, it is important to also understand how the indexes are used by the Cypher planner. Refer to [Query tuning](#) for examples and in-depth discussions on how query plans result from different index and query scenarios. See

specifically [The use of indexes](#) for examples of how various index scenarios result in different query plans.

For information on index configuration and limitations, refer to [Operations Manual □ Index configuration](#).

## 5.2.1. Introduction

A database index is a redundant copy of some of the data in the database for the purpose of making searches of related data more efficient. This comes at the cost of additional storage space and slower writes, so deciding what to index and what not to index is an important and often non-trivial task.

Once an index has been created, it will be managed and kept up to date by the DBMS. Neo4j will automatically pick up and start using the index once it has been created and brought online.

Cypher enables the creation of indexes on one or more properties for all nodes that have a given label:

- An index that is created on a single property for any given label is called a *single-property index*.
- An index that is created on more than one property for any given label is called a *composite index*.

Differences in the usage patterns between composite and single-property indexes are described in [Composite index limitations](#).

The following is true for indexes:

- Best practice is to give the index a name when it is created. If the index is not explicitly named, it will get an auto-generated name.
- The index name must be unique among both indexes and constraints.
- Index creation is by default not idempotent, and an error will be thrown if you attempt to create the same index twice. Using the keyword `IF NOT EXISTS` makes the command idempotent, and no error will be thrown if you attempt to create the same index twice.

## 5.2.2. Syntax

*Table 406. Syntax for managing indexes*

Command	Description	Comment
<pre>CREATE [BTREE] INDEX [index_name] [IF NOT EXISTS] FOR (n:LabelName) ON (n.propertyName) [OPTIONS "{" option: value[,...] "}"]</pre>	Create a single-property index.	<p>Best practice is to give the index a name when it is created. If the index is not explicitly named, it will get an auto-generated name.</p> <p>The index name must be unique among both indexes and constraints.</p> <p>The command is optionally idempotent, with the default behavior to throw an error if you attempt to create the same index twice. With <b>IF NOT EXISTS</b>, no error is thrown and nothing happens should an index with the same name, schema or both already exist. It may still throw an error should a conflicting constraint exist.</p>
<pre>CREATE [BTREE] INDEX [index_name] [IF NOT EXISTS] FOR (n:LabelName) ON (n.propertyName_1,     n.propertyName_2,     ...     n.propertyName_n) [OPTIONS "{" option: value[,...] "}"]</pre>	Create a composite index.	<p>Index provider and configuration can be specified using the <b>OPTIONS</b> clause.</p>
<pre>DROP INDEX index_name [IF EXISTS]</pre>	Drop an index	<p>The command is optionally idempotent, with the default behavior to throw an error if you attempt to drop the same index twice. With <b>IF EXISTS</b>, no error is thrown and nothing happens should the index not exist.</p>
<pre>SHOW [ALL BTREE] INDEX[ES] [BRIEF VERBOSE [OUTPUT]]</pre>	List indexes in the database, either all or B-tree only.	
<pre>DROP INDEX ON :LabelName(propertyName)</pre>	Drop a single-property index without specifying a name.	
<pre>DROP INDEX ON :LabelName (n.propertyName_1,     n.propertyName_2,     ...     n.propertyName_n)</pre>	Drop a composite index without specifying a name.	This syntax is deprecated.

Planner hints and the **USING** keyword describes how to make the Cypher planner use specific indexes

(especially in cases where the planner would not necessarily have used them).

### 5.2.3. Composite index limitations

Like single-property indexes, composite indexes support all predicates:

- equality check: `n.prop = value`
- list membership check: `n.prop IN list`
- existence check: `exists(n.prop)`
- range search: `n.prop > value`
- prefix search: `STARTS WITH`
- suffix search: `ENDS WITH`
- substring search: `CONTAINS`

However, predicates might be planned as existence check and a filter. For most predicates, this can be avoided by following these restrictions:

- If there is any `equality check` and `list membership check` predicates, they need to be for the first properties defined by the index.
- There can be up to one `range search` or `prefix search` predicate.
- There can be any number of `existence check` predicates.
- Any predicate after a `range search`, `prefix search` or `existence check` predicate has to be an `existence check` predicate.

However, the `suffix search` and `substring search` predicates are always planned as existence check and a filter and any predicates following after will therefore also be planned as such.

For example, an index on `:Label(prop1,prop2,prop3,prop4,prop5,prop6)` and predicates:

```
WHERE n.prop1 = 'x' AND n.prop2 = 1 AND n.prop3 > 5 AND n.prop4 < 'e' AND n.prop5 = true AND exists(n.prop6)
```

will be planned as:

```
WHERE n.prop1 = 'x' AND n.prop2 = 1 AND n.prop3 > 5 AND exists(n.prop4) AND exists(n.prop5) AND exists(n.prop6)
```

with filters on `n.prop4 < 'e'` and `n.prop5 = true`, since `n.prop3` has a `range search` predicate.

And an index on `:Label(prop1,prop2)` with predicates:

```
WHERE n.prop1 ENDS WITH 'x' AND n.prop2 = false
```

will be planned as:

```
WHERE exists(n.prop1) AND exists(n.prop2)
```

with filters on `n.prop1 ENDS WITH 'x'` and `n.prop2 = false`, since `n.prop1` has a `suffix search` predicate.

Composite indexes require predicates on all properties indexed. If there are predicates on only a subset of the indexed properties, it will not be possible to use the composite index. To get this kind of fallback behavior, it is necessary to create additional indexes on the relevant sub-set of properties or on single properties.

## 5.2.4. Examples

### Create a single-property index

A named index on a single property for all nodes that have a particular label can be created with `CREATE INDEX index_name FOR (n:Label) ON (n.property)`. Note that the index is not immediately available, but will be created in the background.

#### Query

```
CREATE INDEX index_name FOR (n:Person)
ON (n.surname)
```

Note that the index name needs to be unique.

#### Result

```
+-----+
| No data returned. |
+-----+
Indexes added: 1
```

### Create a single-property index only if it does not already exist

If it is unknown if an index exists or not but we want to make sure it does, we add `IF NOT EXISTS`.

#### Query

```
CREATE INDEX index_name IF NOT EXISTS FOR (n:Person)
ON (n.surname)
```

Note that the index will not be created if there already exists an index with the same name, same schema or both.

#### Result

```
+-----+
| No data returned, and nothing was changed. |
+-----+
```

### Create a single-property index with specified index provider

To create a single property index with a specific index provider, the `OPTIONS` clause is used. Valid values for the index provider is `native-btree-1.0` and `lucene+native-3.0`, default if nothing is specified is `native-btree-1.0`.

#### Query

```
CREATE BTREE INDEX index_with_provider FOR (n:Label)
ON (n.prop1)OPTIONS { indexProvider: 'native-btree-1.0' }
```

Can be combined with specifying index configuration.

## Result

```
+-----+  
| No data returned. |  
+-----+  
Indexes added: 1
```

Create a single-property index with specified index configuration

To create a single property index with a specific index configuration, the `OPTIONS` clause is used. Valid configuration settings are `spatial.cartesian.min`, `spatial.cartesian.max`, `spatial.cartesian-3d.min`, `spatial.cartesian-3d.max`, `spatial.wgs-84.min`, `spatial.wgs-84.max`, `spatial.wgs-84-3d.min`, and `spatial.wgs-84-3d.max`. Non-specified settings get their respective default values.

## Query

```
CREATE BTREE INDEX index_with_config FOR (n:Label)  
ON (n.prop2)OPTIONS { indexConfig: { `spatial.cartesian.min`: [-100.0, -100.0],  
`spatial.cartesian.max`: [100.0, 100.0]}}
```

Can be combined with specifying index provider.

## Result

```
+-----+  
| No data returned. |  
+-----+  
Indexes added: 1
```

Create a composite index

A named index on multiple properties for all nodes that have a particular label — i.e. a composite index — can be created with `CREATE INDEX index_name FOR (n:Label) ON (n.prop1, ..., n.propN)`. Only nodes labeled with the specified label and which contain all the properties in the index definition will be added to the index. Note that the composite index is not immediately available, but will be created in the background. The following statement will create a named composite index on all nodes labeled with `Person` and which have both an `age` and `country` property:

## Query

```
CREATE INDEX index_name FOR (n:Person)  
ON (n.age, n.country)
```

Note that the index name needs to be unique.

## Result

```
+-----+  
| No data returned. |  
+-----+  
Indexes added: 1
```

Create a composite index with specified index provider and configuration

To create a composite index with a specific index provider and configuration, the `OPTIONS` clause is used. Valid values for the index provider is `native-btree-1.0` and `lucene+native-3.0`, default if nothing is specified is `native-btree-1.0`. Valid configuration settings are `spatial.cartesian.min`, `spatial.cartesian.max`, `spatial.cartesian-3d.min`, `spatial.cartesian-3d.max`, `spatial.wgs-84.min`, `spatial.wgs-84.max`, `spatial.wgs-84-3d.min`, and `spatial.wgs-84-3d.max`. Non-specified settings get

their respective default values.

### Query

```
CREATE INDEX index_with_options FOR (n:Label)
ON (n.prop1, n.prop2)OPTIONS { indexProvider: 'lucene+native-3.0',
    indexConfig: { `spatial.wgs-84.min`: [-100.0, -80.0], `spatial.wgs-84.max`: [100.0, 80.0]}}}
```

Specifying index provider and configuration can be done individually.

### Result

```
+-----+
| No data returned. |
+-----+
Indexes added: 1
```

## Drop an index

An index on all nodes that have a label and property/properties combination can be dropped using the name with the `DROP INDEX index_name` command. The name of the index can be found using the `SHOW INDEXES` command, given in the output column `name`.

### Query

```
DROP INDEX index_name
```

### Result

```
+-----+
| No data returned. |
+-----+
Indexes removed: 1
```

## Drop a non-existing index

If it is uncertain if an index exists and you want to drop it if it does but not get an error should it not, use:

### Query

```
DROP INDEX missing_index_name IF EXISTS
```

### Result

```
+-----+
| No data returned, and nothing was changed. |
+-----+
```

## List indexes

Listing all indexes can be done with `SHOW INDEXES`, which will produce a table with the following columns:

*Table 407. List indexes output*

Column	Description	Brief output	Verbose output
<code>id</code>	The id of the index.	+	+
<code>name</code>	Name of the index (explicitly set by the user or automatically assigned).	+	+
<code>state</code>	Current state of the index.	+	+
<code>populationPercent</code>	% of index population.	+	+
<code>uniqueness</code>	Tells if the index is only meant to allow one value per key.	+	+
<code>type</code>	The IndexType of this index ( <code>BTREE</code> or <code>FULLTEXT</code> ).	+	+
<code>entityType</code>	Type of entities this index represents (nodes or relationship).	+	+
<code>labelsOrTypes</code>	The labels or relationship types of this index.	+	+
<code>properties</code>	The properties of this index.	+	+
<code>indexProvider</code>	The index provider for this index.	+	+
<code>options</code>	The options passed to <code>CREATE</code> command.		+
<code>failureMessage</code>	The failure description of a failed index.		+
<code>createStatement</code>	Statement used to create the index.		+

## Options for listing indexes

The old built-in procedures for listing indexes, such as `db.indexes`, work as before and are not affected by the `SHOW INDEXES` privilege.

### Query

```
SHOW INDEXES
```

To show all columns, use `SHOW INDEXES VERBOSE`. To show only `BTREE` indexes, use `SHOW BTREE INDEXES`. One of the output columns from `SHOW INDEXES` is the name of the index. This can be used to drop the index with the `DROP INDEX` command.

## Result

id	name	state	populationPercent	uniqueness	type	entityType
labelsOrTypes	properties	indexProvider				
2	"index_58a1c03e"	"ONLINE"	100.0	"NONUNIQUE"	"BTREE"	"NODE"   ["Person"]
3	"index_d7c12ba3"	"ONLINE"	100.0	"NONUNIQUE"	"BTREE"	"NODE"   ["Person"]
1	"index_deeafdb2"	"ONLINE"	100.0	"NONUNIQUE"	"BTREE"	"NODE"   ["Person"]
	"firstname"	"native-btree-1.0"				

3 rows

## Deprecated syntax

### Drop a single-property index

An index on all nodes that have a label and single property combination can be dropped with `DROP INDEX ON :Label(property)`.

## Query

```
DROP INDEX ON :Person(firstname)
```

## Result

+-----+
No data returned.
+-----+

Indexes removed: 1

### Drop a composite index

A composite index on all nodes that have a label and multiple property combination can be dropped with `DROP INDEX ON :Label(prop1, ..., propN)`. The following statement will drop a composite index on all nodes labeled with `Person` and which have both an `age` and `country` property:

## Query

```
DROP INDEX ON :Person(age, country)
```

## Result

+-----+
No data returned.
+-----+

Indexes removed: 1

## 5.3. Indexes for full-text search

*This section describes how to use full-text indexes, to enable full-text search.*

- [Introduction](#)
- [Procedures to manage full-text indexes](#)

- [Create and configure full-text indexes](#)
- [Query full-text indexes](#)
- [Drop full-text indexes](#)

### 5.3.1. Introduction

Full-text indexes are powered by the [Apache Lucene](#) indexing and search library, and can be used to index nodes and relationships by string properties. A full-text index allows you to write queries that match within the *contents* of indexed string properties. For instance, the btree indexes described in previous sections can only do exact matching or prefix matches on strings. A full-text index will instead tokenize the indexed string values, so it can match *terms* anywhere within the strings. How the indexed strings are tokenized and broken into terms, is determined by what analyzer the full-text index is configured with. For instance, the *swedish* analyzer knows how to tokenize and stem Swedish words, and will avoid indexing Swedish stop words. The complete list of stop words for each analyzer is included in the result of the `db.index.fulltext.listAvailableAnalyzers` procedure.

Full-text indexes:

- support the indexing of both nodes and relationships.
- support configuring custom analyzers, including analyzers that are not included with Lucene itself.
- can be queried using the Lucene query language.
- can return the *score* for each result from a query.
- are kept up to date automatically, as nodes and relationships are added, removed, and modified.
- will automatically populate newly created indexes with the existing data in a store.
- can be checked by the consistency checker, and they can be rebuilt if there is a problem with them.
- are a projection of the store, and can only index nodes and relationships by the contents of their properties.
- can support any number of documents in a single index.
- are created, dropped, and updated transactionally, and is automatically replicated throughout a cluster.
- can be accessed via Cypher procedures.
- can be configured to be *eventually consistent*, in which index updating is moved from the commit path to a background thread. Using this feature, it is possible to work around the slow Lucene writes from the performance critical commit process, thus removing the main bottlenecks for Neo4j write performance.

At first sight, the construction of full-text indexes can seem similar to regular indexes. However there are some things that are interesting to note: In contrast to [btree indexes](#), a full-text index

- can be applied to more than one label.
- can be applied to relationship types (one or more).
- can be applied to more than one property at a time (similar to a [composite index](#)) but with an important difference: While a composite index applies only to entities that match the indexed label and *all* of the indexed properties, full-text index will index entities that have at least one of the indexed labels or relationship types, and at least one of the indexed properties.

For information on how to configure full-text indexes, refer to [Operations Manual □ Indexes to support full-text search](#).

### 5.3.2. Procedures to manage full-text indexes

Full-text indexes are managed through built-in procedures. The most common procedures are listed in the table below:

Usage	Procedure	Description
Create full-text node index	<code>db.index.fulltext.createNodeIndex</code>	Create a node fulltext index for the given labels and properties. The optional 'config' map parameter can be used to supply settings to the index. Supported settings are 'analyzer', for specifying what analyzer to use when indexing and querying. Use the <code>db.index.fulltext.listAvailableAnalyzers</code> procedure to see what options are available. And 'eventually_consistent' which can be set to 'true' to make this index eventually consistent, such that updates from committing transactions are applied in a background thread.
Create full-text relationship index	<code>db.index.fulltext.createRelationshipIndex</code>	Create a relationship fulltext index for the given relationship types and properties. The optional 'config' map parameter can be used to supply settings to the index. Supported settings are 'analyzer', for specifying what analyzer to use when indexing and querying. Use the <code>db.index.fulltext.listAvailableAnalyzers</code> procedure to see what options are available. And 'eventually_consistent' which can be set to 'true' to make this index eventually consistent, such that updates from committing transactions are applied in a background thread.
List available analyzers	<code>db.index.fulltext.listAvailableAnalyzers</code>	List the available analyzers that the full-text indexes can be configured with.
Use full-text node index	<code>db.index.fulltext.queryNodes</code>	Query the given full-text index. Returns the matching nodes and their Lucene query score, ordered by score.
Use full-text relationship index	<code>db.index.fulltext.queryRelationships</code>	Query the given full-text index. Returns the matching relationships and their Lucene query score, ordered by score.
Drop full-text index	<code>db.index.fulltext.drop</code>	Drop the specified index.
Eventually consistent indexes	<code>db.index.fulltext.awaitEventuallyConsistentIndexRefresh</code>	Wait for the updates from recently committed transactions to be applied to any eventually-consistent full-text indexes.

### 5.3.3. Create and configure full-text indexes

Full-text indexes are created with the `db.index.fulltext.createNodeIndex` and `db.index.fulltext.createRelationshipIndex` procedures. An index must be given a unique name when created, which is used to reference the specific index when querying or dropping it. A full-text index applies to a list of labels or a list of relationship types, for node and relationship indexes respectively, and then a list of property names.

For instance, if we have a movie with a title.

## Query

```
CREATE (:Movie { title: "The Matrix" })
RETURN m.title
```

Table 408. Result

m.title
"The Matrix"
1 row, Nodes created: 1 Properties set: 1 Labels added: 1

And we have a full-text index on the `title` and `description` properties of movies and books.

## Query

```
CALL db.index.fulltext.createNodeIndex("titlesAndDescriptions", ["Movie", "Book"], ["title", "description"])
```

Then our movie node from above will be included in the index, even though it only has one of the indexed labels, and only one of the indexed properties:

## Query

```
CALL db.index.fulltext.queryNodes("titlesAndDescriptions", "matrix") YIELD node, score
RETURN node.title, node.description, score
```

Table 409. Result

node.title	node.description	score
"The Matrix"	<null>	0.7799721956253052
1 row		

The same is true for full-text indexes on relationships. Though a relationship can only have one type, a relationship full-text index can index multiple types, and all relationships will be included that match one of the relationship types, and at least one of the indexed properties.

The `db.index.fulltext.createNodeIndex` and `db.index.fulltext.createRelationshipIndex` procedures take an optional fourth argument, called `config`. The `config` parameter is a map from string to string, and can be used to set index-specific configuration settings. The `analyzer` setting can be used to configure an index-specific analyzer. The possible values for the `analyzer` setting can be listed with the `db.index.fulltext.listAvailableAnalyzers` procedure. The `eventually_consistent` setting, if set to `"true"`, will put the index in an *eventually consistent* update mode. This means that updates will be applied in a background thread "as soon as possible", instead of during transaction commit like other indexes.

## Query

```
CALL db.index.fulltext.createRelationshipIndex("taggedByRelationshipIndex", ["TAGGED_AS"], ["taggedByUser"]),
{ analyzer: "url_or_email", eventually_consistent: "true" }
```

In this example, an eventually consistent relationship full-text index is created for the `TAGGED_AS` relationship type, and the `taggedByUser` property, and the index uses the `url_or_email` analyzer. This could, for instance, be a system where people are assigning tags to documents, and where the index on the `taggedByUser` property will allow them to quickly find all of the documents they have tagged. Had it not been for the relationship index, one would have had to add artificial connective nodes between the tags and the documents in the data model, just so these nodes could be indexed.

Table 410. Result

(empty result)
0 rows

### 5.3.4. Query full-text indexes

Full-text indexes will, in addition to any exact matches, also return *approximate* matches to a given query. Both the property values that are indexed, and the queries to the index, are processed through the analyzer such that the index can find that don't *exactly* matches. The `score` that is returned alongside each result entry, represents how well the index thinks that entry matches the given query. The results are always returned in *descending score order*, where the best matching result entry is put first. To illustrate, in the example below, we search our movie database for "Full Metal Jacket", and even though there is an exact match as the first result, we also get three other less interesting results:

Query

```
CALL db.index.fulltext.queryNodes("titlesAndDescriptions", "Full Metal Jacket") YIELD node, score  
RETURN node.title, score
```

Table 411. Result

node.title	score
"Full Metal Jacket"	1.411118507385254
"Full Moon High"	0.44524085521698
"Yellow Jacket"	0.3509605824947357
"The Jacket"	0.3509605824947357
4 rows	

Full-text indexes are powered by the [Apache Lucene](#) indexing and search library. This means that we can use Lucene's full-text query language to express what we wish to search for. For instance, if we are only interested in exact matches, then we can quote the string we are searching for.

Query

```
CALL db.index.fulltext.queryNodes("titlesAndDescriptions", "\"Full Metal Jacket\"") YIELD node, score  
RETURN node.title, score
```

When we put "Full Metal Jacket" in quotes, Lucene only gives us exact matches.

Table 412. Result

node.title	score
"Full Metal Jacket"	1.411118507385254
1 row	

Lucene also allows us to use logical operators, such as `AND` and `OR`, to search for terms:

Query

```
CALL db.index.fulltext.queryNodes("titlesAndDescriptions", 'full AND metal') YIELD node, score  
RETURN node.title, score
```

Only the "Full Metal Jacket" movie in our database has both the words "full" and "metal".

Table 413. Result

node.title	score
"Full Metal Jacket"	1.1113792657852173
1 row	

It is also possible to search for only specific properties, by putting the property name and a colon in front of the text being searched for.

#### Query

```
CALL db.index.fulltext.queryNodes("titlesAndDescriptions", 'description:"surreal adventure"') YIELD node,
      score
      RETURN node.title, node.description, score
```

Table 414. Result

node.title	node.description	score
"Metallica Through The Never"	"The movie follows the young roadie Trip through his surreal adventure with the band."	0.2615291476249695
1 row		

A complete description of the Lucene query syntax can be found in the [Lucene documentation](#).

### 5.3.5. Drop full-text indexes

A full-text node index is dropped by using the procedure `db.index.fulltext.drop`.

In the following example, we will drop the `taggedByRelationshipIndex` that we created previously:

#### Query

```
CALL db.index.fulltext.drop("taggedByRelationshipIndex")
```

Table 415. Result

(empty result)
0 rows

## 5.4. Constraints

*This section explains how to manage constraints used for ensuring data integrity.*

- [Introduction](#)
- [Syntax](#)
- [Examples](#)
  - [Unique node property constraints](#)
  - [Node property existence constraints](#)
  - [Relationship property existence constraints](#)
  - [Node key constraints](#)
  - [Drop a constraint by name](#)
  - [List constraints](#)

## 5.4.1. Introduction

The following constraint types are available:

### Unique node property constraints

Unique property constraints ensure that property values are unique for all nodes with a specific label. Unique constraints do not mean that all nodes have to have a unique value for the properties — nodes without the property are not subject to this rule.

### Node property existence constraints

Node property existence constraints ensure that a property exists for all nodes with a specific label. Queries that try to create new nodes of the specified label, but without this property, will fail. The same is true for queries that try to remove the mandatory property.

### Relationship property existence constraints

Property existence constraints ensure that a property exists for all relationships with a specific type. All queries that try to create relationships of the specified type, but without this property, will fail. The same is true for queries that try to remove the mandatory property.

### Node key constraints

Node key constraints ensure that, for a given label and set of properties:

- i. All the properties exist on all the nodes with that label.
- ii. The combination of the property values is unique.

Queries attempting to do any of the following will fail:

- Create new nodes without all the properties or where the combination of property values is not unique.
- Remove one of the mandatory properties.
- Update the properties so that the combination of property values is no longer unique.



Node key constraints, node property existence constraints and relationship property existence constraints are only available in Neo4j Enterprise Edition. Databases containing one of these constraint types cannot be opened using Neo4j Community Edition.

Creating a constraint has the following implications on indexes:

- Adding a unique property constraint on a property will also add a [single-property index](#) on that property, so such an index cannot be added separately.
- Adding a node key constraint for a set of properties will also add a [composite index](#) on those properties, so such an index cannot be added separately.
- Cypher will use these indexes for lookups just like other indexes. Refer to [Indexes for search performance](#) for more details on indexes.
- If a unique property constraint is dropped and the single-property index on the property is still required, the index will need to be created explicitly.
- If a node key constraint is dropped and the composite-property index on the properties is still required, the index will need to be created explicitly.

Additionally, the following is true for constraints:

- A given label can have multiple constraints, and unique and property existence constraints can be combined on the same property.
- Adding constraints is an atomic operation that can take a while — all existing data has to be scanned before Neo4j can turn the constraint 'on'.
- Best practice is to give the constraint a name when it is created. If the constraint is not explicitly named, it will get an auto-generated name.
- The constraint name must be unique among both indexes and constraints.
- Constraint creation is by default not idempotent, and an error will be thrown if you attempt to create the same constraint twice. Using the keyword **IF NOT EXISTS** makes the command idempotent, and no error will be thrown if you attempt to create the same constraint twice.

## 5.4.2. Syntax

*Table 416. Syntax for managing indexes*

Command	Description	Comment
<pre>CREATE CONSTRAINT [constraint_name] [IF NOT EXISTS] ON (n:LabelName) ASSERT n.propertyName IS UNIQUE [OPTIONS "{" option: value[,...] "}"]</pre>	Create a unique node property constraint.	Best practice is to give the constraint a name when it is created. If the constraint is not explicitly named, it will get an auto-generated name.
<pre>CREATE CONSTRAINT [constraint_name] [IF NOT EXISTS] ON (n:LabelName) ASSERT EXISTS (n.propertyName)</pre>	Create a node property existence constraint.	The constraint name must be unique among both indexes and constraints.
<pre>CREATE CONSTRAINT [constraint_name] [IF NOT EXISTS] ON ()-[R:RELATIONSHIP_TYPE]-() ASSERT EXISTS (R.propertyName)</pre>	Create a relationship property existence constraint.	The command is optionally idempotent, with the default behavior to throw an error if you attempt to create the same constraint twice. With <b>IF NOT EXISTS</b> , no error is thrown and nothing happens should a constraint with the same name or same schema and constraint type already exist. It may still throw an error should a conflicting index or constraint exist.
<pre>CREATE CONSTRAINT [constraint_name] [IF NOT EXISTS] ON (n:LabelName) ASSERT (n.propertyName_1, n.propertyName_2, ... n.propertyName_n) IS NODE KEY [OPTIONS "{" option: value[,...] "}"]</pre>	Create a node key constraint.	Index provider and configuration for the backing index can be specified using the <b>OPTIONS</b> clause.

Command	Description	Comment
DROP CONSTRAINT constraint_name [IF EXISTS]	Drop a constraint.	The command is optionally idempotent, with the default behavior to throw an error if you attempt to drop the same constraint twice. With <b>IF EXISTS</b> , no error is thrown and nothing happens should the constraint not exist.
SHOW [ALL UNIQUE NODE EXIST[S] RELATIONSHIP EXIST[S] EXIST[S] NODE KEY] CONSTRAINT[S] [BRIEF VERBOSE [OUTPUT]]	List constraints in the database, either all or filtered on type.	
DROP CONSTRAINT ON (n:LabelName) ASSERT n.propertyName IS UNIQUE	Drop a unique constraint without specifying a name.	
DROP CONSTRAINT ON (n:LabelName) ASSERT EXISTS (n.propertyName)	Drop an exists constraint without specifying a name.	
DROP CONSTRAINT ON ()-[R:RELATIONSHIP_TYPE]-() ASSERT EXISTS (R.propertyName)	Drop a relationship property existence constraint without specifying a name.	This syntax is deprecated.
DROP CONSTRAINT ON (n:LabelName) ASSERT (n.propertyName_1, n.propertyName_2, ... n.propertyName_n) IS NODE KEY	Drop a node key constraint without specifying a name.	

### 5.4.3. Examples

#### Unique node property constraints

Create a unique constraint

When creating a unique constraint, a name can be provided. The constraint ensures that your database will never contain more than one node with a specific label and one property value.

#### Query

```
CREATE CONSTRAINT constraint_name
ON (book:Book) ASSERT book.isbn IS UNIQUE
```

## Result

```
+-----+  
| No data returned. |  
+-----+  
Unique constraints added: 1
```

Create a unique constraint only if it does not already exist

If it is unknown if a constraint exists or not but we want to make sure it does, we add the `IF NOT EXISTS`. The uniqueness constraint ensures that your database will never contain more than one node with a specific label and one property value.

## Query

```
CREATE CONSTRAINT constraint_name IF NOT EXISTS ON (book:Book) ASSERT book.isbn IS UNIQUE
```

Note no constraint will be created if any other constraint with that name or another uniqueness constraint on the same schema already exists. Assuming no such constraints existed:

## Result

```
+-----+  
| No data returned. |  
+-----+  
Unique constraints added: 1
```

Create a unique constraint with specified index provider and configuration

To create a unique constraint with a specific index provider and configuration for the backing index, the `OPTIONS` clause is used. Valid values for the index provider is `native-btree-1.0` and `lucene+native-3.0`, default if nothing is specified is `native-btree-1.0`. Valid configuration settings are `spatial.cartesian.min`, `spatial.cartesian.max`, `spatial.cartesian-3d.min`, `spatial.cartesian-3d.max`, `spatial.wgs-84.min`, `spatial.wgs-84.max`, `spatial.wgs-84-3d.min`, and `spatial.wgs-84-3d.max`. Non-specified settings get their respective default values.

## Query

```
CREATE CONSTRAINT constraint_with_options  
ON (n:Label) ASSERT n.prop IS UNIQUE OPTIONS { indexProvider: 'lucene+native-3.0',  
indexConfig: { 'spatial.wgs-84.min': [-100.0, -80.0], 'spatial.wgs-84.max': [100.0, 80.0]}}
```

Specifying index provider and configuration can be done individually.

## Result

```
+-----+  
| No data returned. |  
+-----+  
Unique constraints added: 1
```

Create a node that complies with unique property constraints

Create a `Book` node with an `isbn` that isn't already in the database.

## Query

```
CREATE (book:Book { isbn: '1449356265', title: 'Graph Databases' })
```

## Result

```
+-----+
| No data returned. |
+-----+
Nodes created: 1
Properties set: 2
Labels added: 1
```

Create a node that violates a unique property constraint

Create a `Book` node with an `isbn` that is already used in the database.

## Query

```
CREATE (book:Book { isbn: '1449356265', title: 'Graph Databases' })
```

In this case the node isn't created in the graph.

## Error message

```
Node(0) already exists with label `Book` and property `isbn` = '1449356265'
```

Failure to create a unique property constraint due to conflicting nodes

Create a unique property constraint on the property `isbn` on nodes with the `Book` label when there are two nodes with the same `isbn`.

## Query

```
CREATE CONSTRAINT ON (book:Book) ASSERT book.isbn IS UNIQUE
```

In this case the constraint can't be created because it is violated by existing data. We may choose to use [Indexes for search performance](#) instead or remove the offending nodes and then re-apply the constraint.

## Error message

```
Unable to create Constraint( name='constraint_ca412c3d', type='UNIQUENESS',
schema=(:Book {isbn}) ):
Both Node(0) and Node(1) have the label `Book` and property `isbn` = '1449356265'
```

Node property existence constraints

Create a node property existence constraint

When creating a node property existence constraint, a name can be provided. The constraint ensures that all nodes with a certain label have a certain property.

## Query

```
CREATE CONSTRAINT constraint_name
ON (book:Book) ASSERT EXISTS (book.isbn)
```

## Result

```
+-----+  
| No data returned. |  
+-----+  
Property existence constraints added: 1
```

Create a node property existence constraint only if it does not already exist

If it is unknown if a constraint exists or not but we want to make sure it does, we add the `IF NOT EXISTS`. The node property existence constraint ensures that all nodes with a certain label have a certain property.

## Query

```
CREATE CONSTRAINT constraint_name IF NOT EXISTS ON (book:Book) ASSERT EXISTS (book.isbn)
```

Note no constraint will be created if any other constraint with that name or another node property existence constraint on the same schema already exists. Assuming a constraint with the name `constraint_name` already existed:

## Result

```
+-----+  
| No data returned, and nothing was changed. |  
+-----+
```

Create a node that complies with property existence constraints

Create a `Book` node with an `isbn` property.

## Query

```
CREATE (book:Book { isbn: '1449356265', title: 'Graph Databases' })
```

## Result

```
+-----+  
| No data returned. |  
+-----+  
Nodes created: 1  
Properties set: 2  
Labels added: 1
```

Create a node that violates a property existence constraint

Trying to create a `Book` node without an `isbn` property, given a property existence constraint on `:Book(isbn)`.

## Query

```
CREATE (book:Book { title: 'Graph Databases' })
```

In this case the node isn't created in the graph.

## Error message

```
Node(0) with label `Book` must have the property `isbn`
```

Removing an existence constrained node property

Trying to remove the `isbn` property from an existing node `book`, given a property existence constraint on `:Book(isbn)`.

#### Query

```
MATCH (book:Book { title: 'Graph Databases' })
REMOVE book.isbn
```

In this case the property is not removed.

#### Error message

```
Node(0) with label `Book` must have the property `isbn`
```

Failure to create a node property existence constraint due to existing node

Create a constraint on the property `isbn` on nodes with the `Book` label when there already exists a node without an `isbn`.

#### Query

```
CREATE CONSTRAINT ON (book:Book) ASSERT EXISTS (book.isbn)
```

In this case the constraint can't be created because it is violated by existing data. We may choose to remove the offending nodes and then re-apply the constraint.

#### Error message

```
Unable to create Constraint( type='NODE PROPERTY EXISTENCE', schema=(:Book
{isbn}) ):
Node(0) with label `Book` must have the property `isbn`
```

## Relationship property existence constraints

Create a relationship property existence constraint

When creating a relationship property existence constraint, a name can be provided. The constraint ensures all relationships with a certain type have a certain property.

#### Query

```
CREATE CONSTRAINT constraint_name
ON ()-[like:LIKED]-() ASSERT EXISTS (like.day)
```

#### Result

```
+-----+
| No data returned. |
+-----+
Property existence constraints added: 1
```

Create a relationship property existence constraint only if it does not already exist

If it is unknown if a constraint exists or not but we want to make sure it does, we add the `IF NOT EXISTS`. The relationship property existence constraint ensures all relationships with a certain type have a certain property.

## Query

```
CREATE CONSTRAINT constraint_name IF NOT EXISTS ON ()-[like:LIKED]-() ASSERT EXISTS (like.day)
```

Note no constraint will be created if any other constraint with that name or another relationship property existence constraint on the same schema already exists. Assuming a constraint with the name `constraint_name` already existed:

## Result

```
+-----+  
| No data returned, and nothing was changed. |  
+-----+
```

Create a relationship that complies with property existence constraints

Create a `LIKED` relationship with a `day` property.

## Query

```
CREATE (user:User)-[like:LIKED { day: 'yesterday' }]->(book:Book)
```

## Result

```
+-----+  
| No data returned. |  
+-----+  
Nodes created: 2  
Relationships created: 1  
Properties set: 1  
Labels added: 2
```

Create a relationship that violates a property existence constraint

Trying to create a `LIKED` relationship without a `day` property, given a property existence constraint `:LIKED(day)`.

## Query

```
CREATE (user:User)-[like:LIKED]->(book:Book)
```

In this case the relationship isn't created in the graph.

## Error message

```
Relationship(0) with type `LIKED` must have the property `day`
```

Removing an existence constrained relationship property

Trying to remove the `day` property from an existing relationship `like` of type `LIKED`, given a property existence constraint `:LIKED(day)`.

## Query

```
MATCH (user:User)-[like:LIKED]->(book:Book)  
REMOVE like.day
```

In this case the property is not removed.

## Error message

```
Relationship(0) with type `LIKED` must have the property `day`
```

Failure to create a relationship property existence constraint due to existing relationship

Create a constraint on the property `day` on relationships with the `LICKED` type when there already exists a relationship without a property named `day`.

## Query

```
CREATE CONSTRAINT ON ()-[like:LIKED]-() ASSERT EXISTS (like.day)
```

In this case the constraint can't be created because it is violated by existing data. We may choose to remove the offending relationships and then re-apply the constraint.

## Error message

```
Unable to create Constraint( type='RELATIONSHIP PROPERTY EXISTENCE' ,  
schema=-[:LIKED {day}]- ):  
Relationship(0) with type `LIKED` must have the property `day`
```

## Node key constraints

Create a node key constraint

When creating a node key constraint, a name can be provided. The constraint ensures that all nodes with a particular label have a set of defined properties whose combined value is unique and all properties in the set are present.

## Query

```
CREATE CONSTRAINT constraint_name  
ON (n:Person) ASSERT (n.firstname, n.surname) IS NODE KEY
```

## Result

```
+-----+  
| No data returned. |  
+-----+  
Node key constraints added: 1
```

Create a node key constraint only if it does not already exist

If it is unknown if a constraint exists or not but we want to make sure it does, we add the `IF NOT EXISTS`. The node key constraint ensures that all nodes with a particular label have a set of defined properties whose combined value is unique and all properties in the set are present.

## Query

```
CREATE CONSTRAINT constraint_name IF NOT EXISTS ON (n:Person) ASSERT (n.firstname,  
n.surname) IS NODE KEY
```

Note no constraint will be created if any other constraint with that name or another node key constraint on the same schema already exists. Assuming a node key constraint on `(:Person {firstname, surname})` already existed:

## *Result*

```
+-----+
| No data returned, and nothing was changed. |
+-----+
```

Create a node key constraint with specified index provider

To create a node key constraint with a specific index provider for the backing index, the **OPTIONS** clause is used. Valid values for the index provider is **native-btree-1.0** and **lucene+native-3.0**, default if nothing is specified is **native-btree-1.0**.

## *Query*

```
CREATE CONSTRAINT constraint_with_provider
ON (n:Label) ASSERT (n.prop1) IS NODE KEY OPTIONS { indexProvider: 'native-btree-1.0' }
```

Can be combined with specifying index configuration.

## *Result*

```
+-----+
| No data returned. |
+-----+
Node key constraints added: 1
```

Create a node key constraint with specified index configuration

To create a node key constraint with a specific index configuration for the backing index, the **OPTIONS** clause is used. Valid configuration settings are **spatial.cartesian.min**, **spatial.cartesian.max**, **spatial.cartesian-3d.min**, **spatial.cartesian-3d.max**, **spatial.wgs-84.min**, **spatial.wgs-84.max**, **spatial.wgs-84-3d.min**, and **spatial.wgs-84-3d.max**. Non-specified settings get their respective default values.

## *Query*

```
CREATE CONSTRAINT constraint_with_config
ON (n:Label) ASSERT (n.prop2) IS NODE KEY OPTIONS { indexConfig: { `spatial.cartesian.min`: [-100.0,
-100.0], `spatial.cartesian.max`: [100.0, 100.0] } }
```

Can be combined with specifying index provider.

## *Result*

```
+-----+
| No data returned. |
+-----+
Node key constraints added: 1
```

Create a node that complies with node key constraints

Create a **Person** node with both a **firstname** and **surname** property.

## *Query*

```
CREATE (p:Person { firstname: 'John', surname: 'Wood', age: 55 })
```

## Result

```
+-----+
| No data returned. |
+-----+
Nodes created: 1
Properties set: 3
Labels added: 1
```

Create a node that violates a node key constraint

Trying to create a `Person` node without a `surname` property, given a node key constraint on `:Person(firstname, surname)`, will fail.

## Query

```
CREATE (p:Person { firstname: 'Jane', age: 34 })
```

In this case the node isn't created in the graph.

## Error message

```
Node(0) with label `Person` must have the properties (firstname, surname)
```

Removing a `NODE KEY`-constrained property

Trying to remove the `surname` property from an existing node `Person`, given a `NODE KEY` constraint on `:Person(firstname, surname)`.

## Query

```
MATCH (p:Person { firstname: 'John', surname: 'Wood' })
REMOVE p.surname
```

In this case the property is not removed.

## Error message

```
Node(0) with label `Person` must have the properties (firstname, surname)
```

Failure to create a node key constraint due to existing node

Trying to create a node key constraint on the property `surname` on nodes with the `Person` label will fail when a node without a `surname` already exists in the database.

## Query

```
CREATE CONSTRAINT ON (n:Person) ASSERT (n.firstname, n.surname) IS NODE KEY
```

In this case the node key constraint can't be created because it is violated by existing data. We may choose to remove the offending nodes and then re-apply the constraint.

## Error message

```
Unable to create Constraint( type='NODE PROPERTY EXISTENCE', schema=(:Person
{firstname, surname}) ):
Node(0) with label `Person` must have the properties (firstname, surname)
```

## Drop a constraint by name

### Drop a constraint

A constraint can be dropped using the name with the `DROP CONSTRAINT constraint_name` command. It is the same command for unique property, property existence and node key constraints. The name of the constraint can be found using the `SHOW CONSTRAINTS` command, given in the output column `name`.

#### Query

```
DROP CONSTRAINT constraint_name
```

#### Result

```
+-----+
| No data returned. |
+-----+
Named constraints removed: 1
```

## Drop a non-existing constraint

If it is uncertain if any constraint with a given name exists and you want to drop it if it does but not get an error should it not, use `IF EXISTS`. It is the same command for unique property, property existence and node key constraints.

#### Query

```
DROP CONSTRAINT missing_constraint_name IF EXISTS
```

#### Result

```
+-----+
| No data returned, and nothing was changed. |
+-----+
```

## List constraints

### List constraints

Listing all constraints can be done with `SHOW CONSTRAINTS`, which will produce a table with the following columns:

*Table 417. List constraints output*

Column	Description	Brief output	Verbose output
<code>id</code>	The id of the constraint.	+	+
<code>name</code>	Name of the constraint (explicitly set by the user or automatically assigned).	+	+
<code>type</code>	The ConstraintType of this constraint ( <code>UNIQUENESS</code> , <code>NODE_PROPERTY_EXISTENCE</code> , <code>NODE_KEY</code> , or <code>RELATIONSHIP_PROPERTY_EXISTENCE</code> ).	+	+
<code>entityType</code>	Type of entities this constraint represents (nodes or relationship).	+	+

Column	Description	Brief output	Verbose output
<code>labelsOrTypes</code>	The labels or relationship types of this constraint.	+	+
<code>properties</code>	The properties of this constraint.	+	+
<code>ownedIndexId</code>	The id of the index associated to the constraint, or <code>null</code> if no index is associated with the constraint.	+	+
<code>options</code>	The options passed to <code>CREATE</code> command, for the index associated to the constraint, or <code>null</code> if no index is associated with the constraint.		+
<code>createStatement</code>	Statement used to create the constraint.		+

The old built-in procedures for listing constraints, such as `db.constraints`, work as before and are not affected by the `SHOW CONSTRAINTS` privilege.

### Query

```
SHOW CONSTRAINTS
```

To show all columns, use `SHOW CONSTRAINTS VERBOSE`. To show only one type of constraint use the filtering keyword, for example to show unique constraints, use `SHOW UNIQUE CONSTRAINTS`.

One of the output columns from `SHOW CONSTRAINTS` is the name of the constraint. This can be used to drop the constraint with the `DROP CONSTRAINT` command.

### Result

```
+-----+
| id | name          | type      | entityType | labelsOrTypes | properties | ownedIndexId |
+-----+
| 2  | "constraint_ca412c3d" | "UNIQUENESS" | "NODE"     | ["Book"]     | ["isbn"]    | 1            |
+-----+
1 row
```

## Deprecated syntax

Drop a unique constraint

By using `DROP CONSTRAINT`, you remove a constraint from the database.

### Query

```
DROP CONSTRAINT ON (book:Book) ASSERT book.isbn IS UNIQUE
```

### Result

```
+-----+
| No data returned. |
+-----+
Unique constraints removed: 1
```

Drop a node property existence constraint

By using `DROP CONSTRAINT`, you remove a constraint from the database.

#### Query

```
DROP CONSTRAINT ON (book:Book) ASSERT EXISTS (book.isbn)
```

#### Result

```
+-----+  
| No data returned. |  
+-----+  
Property existence constraints removed: 1
```

Drop a relationship property existence constraint

To remove a constraint from the database, use `DROP CONSTRAINT`.

#### Query

```
DROP CONSTRAINT ON ()-[like:LIKED]-() ASSERT EXISTS (like.day)
```

#### Result

```
+-----+  
| No data returned. |  
+-----+  
Property existence constraints removed: 1
```

Drop a node key constraint

Use `DROP CONSTRAINT` to remove a node key constraint from the database.

#### Query

```
DROP CONSTRAINT ON (n:Person) ASSERT (n.firstname, n.surname) IS NODE KEY
```

#### Result

```
+-----+  
| No data returned. |  
+-----+  
Node key constraints removed: 1
```

## 5.5. Security

*This section explains how to use Cypher to manage Neo4j role-based access control and fine-grained security.*

- [Introduction](#)
- [User and role management](#)
  - [User management](#)
  - [Listing current user](#)

- Listing users
  - Creating users
  - Modifying users
  - Changing the current user's password
  - Deleting users
- Role management
  - The PUBLIC role
  - Listing roles
  - Creating roles
  - Deleting roles
  - Assigning roles
  - Revoking roles
- Graph and sub-graph access control
  - The GRANT, DENY and REVOKE commands
  - Listing privileges
  - The REVOKE command
- Read privileges
  - The TRAVERSE privilege
  - The READ privilege
  - The MATCH privilege
- Write privileges
  - The CREATE privilege
  - The DELETE privilege
  - The SET LABEL privilege
  - The REMOVE LABEL privilege
  - The SET PROPERTY privilege
  - The MERGE privilege
  - The WRITE privilege
  - The ALL GRAPH PRIVILEGES privilege
- Security of administration
  - The admin role
  - Database administration
    - The database ACCESS privilege
    - The database START/STOP privileges
    - The INDEX MANAGEMENT privileges
    - The CONSTRAINT MANAGEMENT privileges
    - The NAME MANAGEMENT privileges
    - Granting ALL DATABASE PRIVILEGES
    - Granting TRANSACTION MANAGEMENT privileges

- DBMS administration
  - Creating custom roles with DBMS privileges
  - The dbms ROLE MANAGEMENT privileges
  - The dbms USER MANAGEMENT privileges
  - The dbms DATABASE MANAGEMENT privileges
  - The dbms PRIVILEGE MANAGEMENT privileges
  - The dbms EXECUTE privileges
  - Granting ALL DBMS PRIVILEGES
- Built-in roles
- Known limitations of security
  - Security and indexes
  - Security and labels
  - Security and count store operations

## 5.5.1. Introduction

*This section introduces the sections on how to manage Neo4j role-based access control and fine-grained security.*

Neo4j has a complex security model stored in the system graph, maintained in a special database called the `system` database. All administrative commands need to be executing against the `system` database. When connected to the DBMS over bolt, administrative commands are automatically routed to the `system` database. For more information on how to manage multiple databases, refer to the section on [administering databases](#).

Neo4j 3.1 introduced the concept of *role-based access control*. It was possible to create users and assign them to roles to control whether the users could read, write and administer the database. In Neo4j 4.0 this model was enhanced significantly with the addition of *privileges*, which are the underlying access-control rules by which the users rights are defined.

The original built-in roles still exist with almost the exact same access rights, but they are no-longer statically defined (see [Built-in roles](#)). Instead they are defined in terms of their underlying *privileges* and they can be modified by adding or removing these access rights.

In addition, any new roles created can be assigned any combination of *privileges* to create the specific access control desired. A major additional capability is *sub-graph* access control whereby read-access to the graph can be limited to specific combinations of label, relationship-type and property.

## 5.5.2. User and role management

*This section explains how to use Cypher to manage Neo4j role-based access control through users and roles.*

- User Management
  - Listing current user
  - Listing users
  - Creating users

- Modifying users
- Changing the current user's password
- Deleting users
- Role management
  - The **PUBLIC** role
  - Listing roles
  - Creating roles
  - Deleting roles
  - Assigning roles
  - Revoking roles

## User Management

Users can be created and managed using a set of Cypher administration commands executed against the **system** database.

When connected to the DBMS over bolt, administration commands are automatically routed to the **system** database.

*Table 418. User management command syntax*

Command	Description	Required privilege	Community Edition	Enterprise Edition
<pre>SHOW CURRENT USER [YIELD { *   field1[, ...] } [ORDER BY field1 [, ...]] [SKIP n] [LIMIT n] [WHERE expression] [RETURN field1[, ...] [ORDER BY field1 [, ...]] [SKIP n] [LIMIT n]]</pre>	List the current user.	None	+	+
<pre>SHOW USERS [YIELD { *   field1[, ...] } [ORDER BY field1 [, ...]] [SKIP n] [LIMIT n] [WHERE expression] [RETURN field1[, ...] [ORDER BY field1 [, ...]] [SKIP n] [LIMIT n]]</pre>	List all users.	SHOW USER	+	+
<pre>SHOW USER[S] [name1[, name2]] PRIVILEGE[S] [AS [REVOKE] COMMAND[S]] [YIELD { *   field1[, ...] } [ORDER BY field1 [, ...]] [SKIP n] [LIMIT n] [WHERE expression] [RETURN field1[, ...] [ORDER BY field1 [, ...]] [SKIP n] [LIMIT n]]</pre>	List the privileges granted to the specified users or the current user, if no user is specified.	SHOW PRIVILEGE and SHOW USER	-	+
<pre>CREATE USER name [IF NOT EXISTS] SET [PLAINTEXT   ENCRYPTED] PASSWORD password [[SET PASSWORD] CHANGE [NOT] REQUIRED] [SET STATUS {ACTIVE   SUSPENDED}]</pre>	Create a new user.	CREATE USER	+	+

Command	Description	Required privilege	Community Edition	Enterprise Edition
<code>CREATE OR REPLACE USER name   SET [PLAINTEXT   ENCRYPTED] PASSWORD password   [[SET PASSWORD] CHANGE [NOT] REQUIRED]   [SET STATUS {ACTIVE   SUSPENDED}]</code>	Create a new user.	<a href="#">CREATE USER</a> and <a href="#">DROP USER</a>	+	+
<code>ALTER USER name SET {   [PLAINTEXT   ENCRYPTED] PASSWORD password   [[SET PASSWORD] CHANGE [NOT] REQUIRED]   [SET STATUS {ACTIVE   SUSPENDED} ]     PASSWORD CHANGE [NOT] REQUIRED   [SET STATUS {ACTIVE   SUSPENDED}]     STATUS {ACTIVE   SUSPENDED}</code>	Modify the settings for an existing user.	<a href="#">SET PASSWORD</a> and/or <a href="#">SET USER STATUS</a>	+	+
<code>ALTER CURRENT USER SET PASSWORD FROM original TO password</code>	Change the current user's password.	None	+	+
<code>DROP USER name [IF EXISTS]</code>	Remove an existing user.	<a href="#">DROP USER</a>	+	+

## Listing current user

The currently logged-in user can be seen using `SHOW CURRENT USER` which will produce a table with four columns:

*Table 419. List users output*

Column	Description	Community Edition	Enterprise Edition
user	User name	+	+
roles	Roles granted to the user.	-	+
passwordChangeRequired	If <code>true</code> , the user must change their password at the next login.	+	+
suspended	If <code>true</code> , the user is currently suspended (cannot log in).	-	+

## Query

```
SHOW CURRENT USER
```

*Table 420. Result*

user	roles	passwordChangeRequired	suspended
"jake"	["PUBLIC"]	false	false
1 row			



This command is only supported for a logged-in user and will return an empty result if authorization has been disabled.

## Listing users

Available users can be seen using `SHOW USERS` which will produce a table of users with four columns:

*Table 421. List users output*

Column	Description	Community Edition	Enterprise Edition
user	User name	+	+
roles	Roles granted to the user.	-	+
passwordChangeRequired	If <code>true</code> , the user must change their password at the next login.	+	+
suspended	If <code>true</code> , the user is currently suspended (cannot log in).	-	+

## Query

```
SHOW USERS
```

*Table 422. Result*

user	roles	passwordChangeRequired	suspended
"neo4j"	["admin", "PUBLIC"]	true	false
1 row			

When first starting a Neo4j DBMS, there is always a single default user `neo4j` with administrative privileges. It is possible to set the initial password using `neo4j-admin set-initial-password`, otherwise it is necessary to change the password after first login.



The `SHOW USER name PRIVILEGES` command is described in [Listing privileges](#).

## Creating users

Users can be created using `CREATE USER`.

### Command syntax

```
CREATE [OR REPLACE] USER name [IF NOT EXISTS]
  SET [PLAINTEXT | ENCRYPTED] PASSWORD password
  [[SET PASSWORD] CHANGE [NOT] REQUIRED]
  [SET STATUS {ACTIVE | SUSPENDED}]
```

If the optional `SET PASSWORD CHANGE [NOT] REQUIRED` is omitted then the default is `CHANGE REQUIRED`. The default for `SET STATUS` is `ACTIVE`. The `password` can either be a string value or a string parameter. The optional `PLAINTEXT` in `SET PLAINTEXT PASSWORD` has the same behaviour as `SET PASSWORD`. The optional `ENCRYPTED` can be used to create a user when the plaintext password is unknown but the encrypted password is available (e.g. from a database backup). With `ENCRYPTED`, the password string is expected to be on the format `<encryption-version>, <hash>, <salt>`.

For example, we can create the user `jake` in a suspended state and the requirement to change his password.

#### Query

```
CREATE USER jake  
SET PASSWORD 'abc' CHANGE REQUIRED  
SET STATUS SUSPENDED
```

0 rows, System updates: 1



The `SET STATUS {ACTIVE | SUSPENDED}` part of the command is only available in Enterprise Edition.

The created user will appear on the list provided by `SHOW USERS`.

#### Query

```
SHOW USERS YIELD user, suspended, passwordChangeRequired, roles  
WHERE user = 'jake'
```

In this example we also:

- Reorder the columns using a `YIELD` clause
- Filter the results using a `WHERE` clause to show only the new user

Table 423. Result

user	suspended	passwordChangeRequired	roles
"jake"	true	true	["PUBLIC"]
1 row			

#### Query

```
SHOW USERS YIELD roles, user  
WHERE "PUBLIC" IN roles  
RETURN user AS publicUsers
```

It is also possible to add a `RETURN` clause to further manipulate the results after filtering. In this case it is used to filter out the roles column and rename the users column to `publicUsers`.

Table 424. Result

publicUsers
"jake"
"neo4j"
2 rows



In Neo4j Community Edition there are no roles, but all users have implied administrator privileges. In Neo4j Enterprise Edition all users are automatically assigned the `PUBLIC` role, giving them a base set of privileges.

The `CREATE USER` command is optionally idempotent, with the default behavior to throw an exception if the user already exists. Appending `IF NOT EXISTS` to the command will ensure that no exception is thrown and nothing happens should the user already exist. Adding `OR REPLACE` to the command will result in any existing user being deleted and a new one created.

#### Query

```
CREATE USER jake IF NOT EXISTS SET PASSWORD 'xyz'
```

0 rows

#### Query

```
CREATE OR REPLACE USER jake  
SET PLAINTEXT PASSWORD 'xyz'
```

0 rows, System updates: 2

This is equivalent to running `DROP USER jake IF EXISTS` followed by `CREATE USER jake SET PASSWORD 'xyz'`.



The `IF NOT EXISTS` and `OR REPLACE` parts of this command cannot be used together.

### Modifying users

Users can be modified using `ALTER USER`.

#### Command syntax

```
ALTER USER name SET {  
    [PLAINTEXT | ENCRYPTED] PASSWORD password  
    [[SET PASSWORD] CHANGE [NOT] REQUIRED]  
    [SET STATUS {ACTIVE | SUSPENDED} ] |  
    PASSWORD CHANGE [NOT] REQUIRED  
    [SET STATUS {ACTIVE | SUSPENDED} ] |  
    STATUS {ACTIVE | SUSPENDED}  
}
```

The `password` can either be a string value or a string parameter, and must not be identical to the old password. The optional `PLAINTEXT` in `SET PLAINTEXT PASSWORD` has the same behaviour as `SET PASSWORD`. The optional `ENCRYPTED` can be used to update a user's password when the plaintext password is unknown but the encrypted password is available (e.g. from a database backup). With `ENCRYPTED`, the password string is expected to be on the format `<encryption-version>, <hash>, <salt>`.

For example, we can modify the user `jake` with a new password and active status as well as remove the requirement to change his password.

#### Query

```
ALTER USER jake  
SET PASSWORD 'abc123' CHANGE NOT REQUIRED  
SET STATUS ACTIVE
```

0 rows, System updates: 1



When altering a user it is only necessary to specify the changes required. For example, leaving out the `CHANGE [NOT] REQUIRED` part of the query will leave that unchanged.



The `SET STATUS {ACTIVE | SUSPENDED}` part of the command is only available in Enterprise Edition.

The changes to the user will appear on the list provided by `SHOW USERS`.

#### Query

```
SHOW USERS
```

Table 425. Result

user	roles	passwordChangeRequired	suspended
"jake"	["PUBLIC"]	false	false
"neo4j"	["admin", "PUBLIC"]	true	false
2 rows			

Changing the current user's password

Users can change their own password using `ALTER CURRENT USER SET PASSWORD`. The old password is required in addition to the new one, and either or both can be a string value or a string parameter. When a user executes this command it will change their password as well as set the `CHANGE NOT REQUIRED` flag.

#### Query

```
ALTER CURRENT USER
SET PASSWORD FROM 'abc123' TO '123xyz'
```

0 rows, System updates: 1



This command only works for a logged in user and cannot be run with auth disabled.

Deleting users

Users can be deleted using `DROP USER`.

#### Query

```
DROP USER jake
```

0 rows, System updates: 1



Deleting a user will not automatically terminate associated connections, sessions, transactions, or queries.

When a user has been deleted, it will no longer appear on the list provided by `SHOW USERS`.

#### Query

```
SHOW USERS
```

Table 426. Result

user	roles	passwordChangeRequired	suspended
"neo4j"	["admin", "PUBLIC"]	true	false
1 row			

This command is optionally idempotent, with the default behavior to throw an exception if the user does not exist. Appending `IF EXISTS` to the command will ensure that no exception is thrown and nothing happens should the user not exist.

#### Query

```
DROP USER jake IF EXISTS
```

0 rows

## Role Management

Roles can be created and managed using a set of Cypher administration commands executed against the `system` database.

When connected to the DBMS over bolt, administration commands are automatically routed to the `system` database.

Table 427. Role management command syntax

Command	Description	Required privilege
<pre>SHOW [ALL POPULATED] ROLES     [YIELD { *   field1[, ...] } [ORDER BY         field1 [, ...]] [SKIP n] [LIMIT n]]     [WHERE expression]     [RETURN field1[, ...] [ORDER BY field1         [, ...]] [SKIP n] [LIMIT n]]</pre>	List roles.	<a href="#">SHOW ROLE</a>
<pre>SHOW [ALL POPULATED] ROLES WITH USERS     [YIELD { *   field1[, ...] } [ORDER BY         field1 [, ...]] [SKIP n] [LIMIT n]]     [WHERE expression]     [RETURN field1[, ...] [ORDER BY field1         [, ...]] [SKIP n] [LIMIT n]]</pre>	List roles and users assigned to them.	<a href="#">SHOW ROLE</a> and <a href="#">SHOW USER</a>
<pre>SHOW ROLE[S] name1[, name2] PRIVILEGE[S]     [AS [REVOKE] COMMAND[S]]     [YIELD { *   field1[, ...] } [ORDER BY         field1 [, ...]] [SKIP n] [LIMIT n]]     [WHERE expression]     [RETURN field1[, ...] [ORDER BY field1         [, ...]] [SKIP n] [LIMIT n]]</pre>	List the privileges granted to the specified roles.	<a href="#">SHOW ROLE PRIVILEGES</a>
<pre>CREATE ROLE name [IF NOT EXISTS] [AS COPY     OF name]</pre>	Create a new role.	<a href="#">CREATE ROLE</a>

Command	Description	Required privilege
CREATE OR REPLACE ROLE name [AS COPY OF name]	Create a new role.	CREATE ROLE and DROP ROLE
DROP ROLE name [IF EXISTS]	Remove a role.	DROP ROLE
GRANT ROLE name[, ...] TO user[, ...]	Assign roles to users.	ASSIGN ROLE

## The `PUBLIC` role

There exists a special built-in role, `PUBLIC`, which is assigned to all users. This role cannot be dropped or revoked from any user, but its privileges may be modified. By default, it is assigned the `ACCESS` privilege on the default database.

In contrast to the `PUBLIC` role, the other built-in roles can be granted, revoked, dropped and re-created.

## Listing roles

Available roles can be seen using `SHOW ROLES`.

### Query

```
SHOW ROLES
```

This is the same command as `SHOW ALL ROLES`. When first starting a Neo4j DBMS there are a number of built-in roles:

- `PUBLIC` - a role that all users have granted, by default it gives access to the default database
- `reader` - can perform traverse and read operations on all databases except `system`.
- `editor` - can perform traverse, read, and write operations on all databases except `system`, but cannot make new labels or relationship types.
- `publisher` - can do the same as `editor`, but also create new labels and relationship types.
- `architect` - can do the same as `publisher` as well as create and manage indexes and constraints.
- `admin` - can do the same as all the above, as well as manage databases, users, roles, and privileges.

More information about the built-in roles can be found in [Operations Manual □ Built-in roles](#)

*Table 428. Result*

role
"PUBLIC"
"admin"
"architect"
"editor"
"publisher"

role
"reader"
6 rows

There are multiple versions of this command, the default being `SHOW ALL ROLES`. To only show roles that are assigned to users, the command is `SHOW POPULATED ROLES`. To see which users are assigned to roles `WITH USERS` can be appended to the commands. This will give one result row for each user, so if a role is assigned to two users then it will show up twice in the result.

### Query

```
SHOW POPULATED ROLES
WITH USERS
```

The table of results will show information about the role and what database it belongs to.

*Table 429. Result*

role	member
"PUBLIC"	"neo4j"
"PUBLIC"	"jake"
"PUBLIC"	"user1"
"PUBLIC"	"user2"
"PUBLIC"	"user3"
"admin"	"neo4j"
6 rows	

It is also possible to filter and sort the results by using `YIELD`, `ORDER BY` and `WHERE`.

### Query

```
SHOW ROLES YIELD role
ORDER BY role
WHERE role ENDS WITH 'r'
```

In this example:

- The results have been filtered to only return the roles ending in 'r'.
- The results are ordered by the 'action' column using `ORDER BY`.

It is also possible to use `SKIP` and `LIMIT` to paginate the results.

*Table 430. Result*

role
"editor"
"publisher"
"reader"
3 rows



The `SHOW ROLE name PRIVILEGES` command is found in [Listing privileges](#).

## Creating roles

Roles can be created using `CREATE ROLE`.

### Query

```
CREATE ROLE myrole
```

0 rows, System updates: 1

The following naming rules apply:



- The first character must be an ASCII alphabetic character.
- Subsequent characters can be ASCII alphabetic, numeric characters, and underscore.

A role can also be copied, keeping its privileges, using `CREATE ROLE AS COPY OF`.

### Query

```
CREATE ROLE mysecondrole AS COPY OF myrole
```

0 rows, System updates: 1

The created roles will appear on the list provided by `SHOW ROLES`.

### Query

```
SHOW ROLES
```

*Table 431. Result*

role
"PUBLIC"
"admin"
"architect"
"editor"
"myrole"
"mysecondrole"
"publisher"
"reader"
8 rows

These command versions are optionally idempotent, with the default behavior to throw an exception if the role already exists. Appending `IF NOT EXISTS` to the command will ensure that no exception is thrown and nothing happens should the role already exist. Adding `OR REPLACE` to the command will result in any existing role being deleted and a new one created.

### Query

```
CREATE ROLE myrole IF NOT EXISTS
```

0 rows

## Query

```
CREATE OR REPLACE ROLE myrole
```

0 rows, System updates: 2

This is equivalent to running `DROP ROLE myrole IF EXISTS` followed by `CREATE ROLE myrole`.



The `IF NOT EXISTS` and `OR REPLACE` parts of this command cannot be used together.

Deleting roles

Roles can be deleted using `DROP ROLE` command.

## Query

```
DROP ROLE mysecondrole
```

0 rows, System updates: 1

When a role has been deleted, it will no longer appear on the list provided by `SHOW ROLES`.

## Query

```
SHOW ROLES
```

Table 432. Result

role
"PUBLIC"
"admin"
"architect"
"editor"
"publisher"
"reader"
6 rows

This command is optionally idempotent, with the default behavior to throw an exception if the role does not exist. Appending `IF EXISTS` to the command will ensure that no exception is thrown and nothing happens should the role not exist.

## Query

```
DROP ROLE mysecondrole IF EXISTS
```

0 rows

Assigning roles to users

Users can be given access rights by assigning them roles using `GRANT ROLE`.

### Query

```
GRANT ROLE myrole TO jake
```

0 rows, System updates: 1

The roles assigned to each user can be seen in the list provided by `SHOW USERS`.

### Query

```
SHOW USERS
```

*Table 433. Result*

user	roles	passwordChangeRequired	suspended
"jake"	["myrole", "PUBLIC"]	false	false
"neo4j"	["admin", "PUBLIC"]	true	false
"user1"	["PUBLIC"]	true	false
"user2"	["PUBLIC"]	true	false
"user3"	["PUBLIC"]	true	false
5 rows			

It is possible to assign multiple roles to multiple users in one command.

### Query

```
GRANT ROLES role1, role2 TO user1, user2, user3
```

0 rows, System updates: 6

### Query

```
SHOW USERS
```

*Table 434. Result*

user	roles	passwordChangeRequired	suspended
"jake"	["myrole", "PUBLIC"]	false	false
"neo4j"	["admin", "PUBLIC"]	true	false
"user1"	["role1", "role2", "PUBLIC"]	true	false
"user2"	["role1", "role2", "PUBLIC"]	true	false
"user3"	["role1", "role2", "PUBLIC"]	true	false
5 rows			

Revoking roles from users

Users can lose access rights by revoking roles from them using `REVOKE ROLE`.

### Query

```
REVOKE ROLE myrole FROM jake
```

0 rows, System updates: 1

The roles revoked from users can no longer be seen in the list provided by `SHOW USERS`.

### Query

```
SHOW USERS
```

Table 435. Result

user	roles	passwordChangeRequired	suspended
"jake"	["PUBLIC"]	false	false
"neo4j"	["admin", "PUBLIC"]	true	false
"user1"	["role1", "role2", "PUBLIC"]	true	false
"user2"	["role1", "role2", "PUBLIC"]	true	false
"user3"	["role1", "role2", "PUBLIC"]	true	false
5 rows			

It is possible to revoke multiple roles from multiple users in one command.

### Query

```
REVOKE ROLES role1, role2 FROM user1, user2, user3
```

0 rows, System updates: 6

## 5.5.3. Graph and sub-graph access control

*This section explains how to use Cypher to manage privileges for Neo4j role-based access control and fine-grained security.*

- [The GRANT, DENY and REVOKE commands](#)
- [Listing privileges](#)
- [The REVOKE command](#)

Privileges control the access rights to graph elements using a combined whitelist/blacklist mechanism. It is possible to grant access, or deny access, or a combination of the two. The user will be able to access the resource if they have a grant (whitelist) and do not have a deny (blacklist) relevant to that resource. All other combinations of `GRANT` and `DENY` will result in the matching path being inaccessible. What this means in practice depends on whether we are talking about a [read privilege](#) or a [write privilege](#).

- If a entity is not accessible due to [read privileges](#), the data will become invisible to attempts to read it. It will appear to the user as if they have a smaller database (smaller graph).
- If an entity is not accessible due to [write privileges](#), an error will occur on any attempt to write that data.



In this document we will often use the terms '*allows*' and '*enables*' in seemingly identical ways. However, there is a subtle difference. We will use '*enables*' to refer to the consequences of [read privileges](#) where a restriction will not cause an error, only a reduction in the apparent graph size. We will use '*allows*' to refer to the consequence of [write privileges](#) where a restriction can result in an error.



If a user was not also provided with the database **ACCESS** privilege then access to the entire database will be denied. Information about the database access privilege can be found in [The ACCESS privilege](#).

## The **GRANT**, **DENY** and **REVOKE** commands

The administrators can use Cypher commands to manage Neo4j graph administrative rights. The components of the graph privilege commands are:

- the command:
  - **GRANT** – gives privileges to roles.
  - **DENY** – denies privileges to roles.
  - **REVOKE** – removes granted or denied privilege from roles.
- *graph-privilege*
  - Can be either a [read privilege](#) or [write privilege](#).
- *name*
  - The graph or graphs to associate the privilege with. Because in \${neo4j.version} you can have only one graph per database, this command uses the database name to refer to that graph.
- If you delete a database and create a new one with the same name, the new one will *NOT* have the privileges assigned to the deleted graph.
  - It can be **\*** which means all graphs. Graphs created after this command execution will also be associated with these privileges.
- *entity*
  - The graph elements this privilege applies to:
    - **NODES** label (nodes with the specified label(s)).
    - **RELATIONSHIPS** type (relationships of the specific type(s)).
    - **ELEMENTS** label (both nodes and relationships).
  - The label or type can be **\*** which means all labels or types.
  - Multiple labels or types can be specified, comma-separated.
  - Defaults to **ELEMENTS \*** if omitted.
  - Some of the commands for write privileges do not allow an *entity* part, see [Write privileges](#) for details.
- *roles*
  - The role or roles to associate the privilege with, comma-separated.

Table 436. Privilege command syntax

Command	Description
<pre>GRANT graph-privilege ON {DEFAULT GRAPH   GRAPH[S] {name [, ...]   *}} [entity] TO role [, ...]</pre>	Grant a privilege to one or multiple roles.

Command	Description
DENY graph-privilege ON {DEFAULT GRAPH   GRAPH[S] {name [, ...]   *}} [entity] TO role [, ...]	Deny a privilege to one or multiple roles.
REVOKE GRANT graph-privilege ON {DEFAULT GRAPH   GRAPH[S] {name [, ...]   *}} [entity] FROM role [, ...]	Revoke a granted privilege from one or multiple roles.
REVOKE DENY graph-privilege ON {DEFAULT GRAPH   GRAPH[S] {name [, ...]   *}} [entity] FROM role [, ...]	Revoke a denied privilege from one or multiple roles.
REVOKE graph-privilege ON {DEFAULT GRAPH   GRAPH[S] {name [, ...]   *}} [entity] FROM role [, ...]	Revoke a granted or denied privilege from one or multiple roles.



**DENY** does NOT erase a granted privilege; they both exist. Use **REVOKE** if you want to remove a privilege.

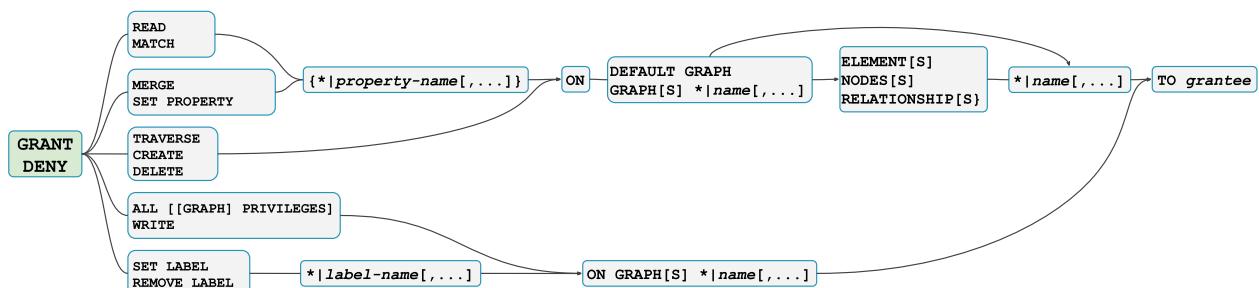


Figure 29. GRANT and DENY Syntax

## Listing privileges

Available privileges for all roles can be seen using **SHOW PRIVILEGES**.

### Command syntax

```
SHOW [ALL] PRIVILEGE[S] [AS [REVOKE] COMMAND[S]]
[YIELD { * | field1[, ...] } [ORDER BY field1 [, ...]] [SKIP n] [LIMIT n]]
[WHERE expression]
[RETURN field1[, ...] [ORDER BY field1 [, ...]] [SKIP n] [LIMIT n]]
```

### Query

```
SHOW PRIVILEGES
```

Lists all privileges for all roles. The table contains columns describing the privilege:

- access: whether the privilege is granted or denied (whitelist or blacklist)
- action: which type of privilege this is: traverse, read, match, write, a database privilege, a dbms privilege or admin

- resource: what type of scope this privilege applies to: the entire dbms, a database, a graph or sub-graph access
- graph: the specific database or graph this privilege applies to
- segment: for sub-graph access control, this describes the scope in terms of labels or relationship types
- role: the role the privilege is granted to

*Table 437. Result*

access	action	resource	graph	segment	role
"GRANTED"	"execute"	"database"	"*"	"FUNCTION(*)"	"PUBLIC"
"GRANTED"	"execute"	"database"	"*"	"PROCEDURE(*)"	"PUBLIC"
"GRANTED"	"access"	"database"	"DEFAULT"	"database"	"PUBLIC"
"GRANTED"	"match"	"all_properties"	"*"	"NODE(*)"	"admin"
"GRANTED"	"write"	"graph"	"*"	"NODE(*)"	"admin"
"GRANTED"	"match"	"all_properties"	"*"	"RELATIONSHIP(*)"	"admin"
"GRANTED"	"write"	"graph"	"*"	"RELATIONSHIP(*)"	"admin"
"GRANTED"	"access"	"database"	"*"	"database"	"admin"
"GRANTED"	"admin"	"database"	"*"	"database"	"admin"
"GRANTED"	"constraint"	"database"	"*"	"database"	"admin"
"GRANTED"	"index"	"database"	"*"	"database"	"admin"
"GRANTED"	"token"	"database"	"*"	"database"	"admin"
"GRANTED"	"match"	"all_properties"	"*"	"NODE(*)"	"architect"
"GRANTED"	"write"	"graph"	"*"	"NODE(*)"	"architect"
"GRANTED"	"match"	"all_properties"	"*"	"RELATIONSHIP(*)"	"architect"
"GRANTED"	"write"	"graph"	"*"	"RELATIONSHIP(*)"	"architect"
"GRANTED"	"access"	"database"	"*"	"database"	"architect"
"GRANTED"	"constraint"	"database"	"*"	"database"	"architect"
"GRANTED"	"index"	"database"	"*"	"database"	"architect"
"GRANTED"	"token"	"database"	"*"	"database"	"architect"
"GRANTED"	"match"	"all_properties"	"*"	"NODE(*)"	"editor"
"GRANTED"	"write"	"graph"	"*"	"NODE(*)"	"editor"
"GRANTED"	"match"	"all_properties"	"*"	"RELATIONSHIP(*)"	"editor"
"GRANTED"	"write"	"graph"	"*"	"RELATIONSHIP(*)"	"editor"
"GRANTED"	"access"	"database"	"*"	"database"	"editor"
"DENIED"	"access"	"database"	"neo4j"	"database"	"noAccessUsers"
"GRANTED"	"match"	"all_properties"	"*"	"NODE(*)"	"publisher"
"GRANTED"	"write"	"graph"	"*"	"NODE(*)"	"publisher"
"GRANTED"	"match"	"all_properties"	"*"	"RELATIONSHIP(*)"	"publisher"
"GRANTED"	"write"	"graph"	"*"	"RELATIONSHIP(*)"	"publisher"
"GRANTED"	"access"	"database"	"*"	"database"	"publisher"
"GRANTED"	"token"	"database"	"*"	"database"	"publisher"
"GRANTED"	"match"	"all_properties"	"*"	"NODE(*)"	"reader"

access	action	resource	graph	segment	role
"GRANTED"	"match"	"all_properties"	"*"	"RELATIONSHIP(*)"	"reader"
"GRANTED"	"access"	"database"	"*"	"database"	"reader"
"GRANTED"	"access"	"database"	"neo4j"	"database"	"regularUsers"
36 rows					

It is also possible to filter and sort the results by using `YIELD`, `ORDER BY` and `WHERE`.

### Query

```
SHOW PRIVILEGES YIELD role, access, action, segment
ORDER BY action
WHERE role = 'admin'
```

In this example:

- The number of columns returned has been reduced with the `YIELD` clause.
- The order of the returned columns has been changed.
- The results have been filtered to only return the 'admin' role using a `WHERE` clause.
- The results are ordered by the 'action' column using `ORDER BY`.

`SKIP` and `LIMIT` can also be used to paginate the results.

Table 438. Result

role	access	action	segment
"admin"	"GRANTED"	"access"	"database"
"admin"	"GRANTED"	"admin"	"database"
"admin"	"GRANTED"	"constraint"	"database"
"admin"	"GRANTED"	"index"	"database"
"admin"	"GRANTED"	"match"	"NODE(*)"
"admin"	"GRANTED"	"match"	"RELATIONSHIP(*)"
"admin"	"GRANTED"	"token"	"database"
"admin"	"GRANTED"	"write"	"NODE(*)"
"admin"	"GRANTED"	"write"	"RELATIONSHIP(*)"
9 rows			

`WHERE` can be used without `YIELD`

### Query

```
SHOW PRIVILEGES
WHERE graph <> '*'
```

In this example the `WHERE` clause is used to filter privileges down to those that target specific graphs only.

Table 439. Result

access	action	graph	resource	role	segment
"GRANTED"	"access"	"DEFAULT"	"database"	"PUBLIC"	"database"

access	action	graph	resource	role	segment
"DENIED"	"access"	"neo4j"	"database"	"noAccessUsers"	"database"
"GRANTED"	"access"	"neo4j"	"database"	"regularUsers"	"database"
3 rows					

Aggregations in the `RETURN` clause can be used to group privileges. In this case, by user and granted / denied.

### Query

```
SHOW PRIVILEGES YIELD *
RETURN role, access, collect([graph, resource, segment, action]) AS privileges
```

Table 440. Result

role	access	privileges
"PUBLIC"	"GRANTED"	[["*", "database", "FUNCTION(*)", "execute"], ["*", "database", "PROCEDURE(*)", "execute"], ["DEFAULT", "database", "database", "access"]]
"admin"	"GRANTED"	[["*", "all_properties", "NODE(*)", "match"], ["*", "graph", "NODE(*)", "write"], ["*", "all_properties", "RELATIONSHIP(*)", "match"], ["*", "graph", "RELATIONSHIP(*)", "write"], ["*", "database", "database", "access"], ["*", "database", "database", "admin"], ["*", "database", "database", "constraint"], ["*", "database", "index"], ["*", "database", "database", "token"]]
"architect"	"GRANTED"	[["*", "all_properties", "NODE(*)", "match"], ["*", "graph", "NODE(*)", "write"], ["*", "all_properties", "RELATIONSHIP(*)", "match"], ["*", "graph", "RELATIONSHIP(*)", "write"], ["*", "database", "database", "access"], ["*", "database", "database", "constraint"], ["*", "database", "index"], ["*", "database", "database", "token"]]
"editor"	"GRANTED"	[["*", "all_properties", "NODE(*)", "match"], ["*", "graph", "NODE(*)", "write"], ["*", "all_properties", "RELATIONSHIP(*)", "match"], ["*", "graph", "RELATIONSHIP(*)", "write"], ["*", "database", "database", "access"]]
"noAccessUsers"	"DENIED"	[["neo4j", "database", "database", "access"]]
"publisher"	"GRANTED"	[["*", "all_properties", "NODE(*)", "match"], ["*", "graph", "NODE(*)", "write"], ["*", "all_properties", "RELATIONSHIP(*)", "match"], ["*", "graph", "RELATIONSHIP(*)", "write"], ["*", "database", "database", "access"], ["*", "database", "database", "token"]]
"reader"	"GRANTED"	[["*", "all_properties", "NODE(*)", "match"], ["*", "all_properties", "RELATIONSHIP(*)", "match"], ["*", "database", "database", "access"]]
"regularUsers"	"GRANTED"	[["neo4j", "database", "database", "access"]]
8 rows		

The `RETURN` clause can also be used to order and paginate the results, which is useful when combined

with `YIELD` and `WHERE`. In this example the query returns privileges for display five-per-page, and skips the first five to display the second page.

### Query

```
SHOW PRIVILEGES YIELD *
RETURN *
ORDER BY role
SKIP 5
LIMIT 5
```

*Table 441. Result*

access	action	graph	resource	role	segment
"GRANTED"	"match"	"*"	"all_properties"	"admin"	"RELATIONSHIP(*)"
"GRANTED"	"write"	"*"	"graph"	"admin"	"RELATIONSHIP(*)"
"GRANTED"	"access"	"*"	"database"	"admin"	"database"
"GRANTED"	"admin"	"*"	"database"	"admin"	"database"
"GRANTED"	"constraint"	"*"	"database"	"admin"	"database"
5 rows					

Available privileges for specific roles can be seen using `SHOW ROLE name PRIVILEGES`.

### Command syntax

```
SHOW ROLE[S] role1[, role2] PRIVILEGE[S] [AS [REVOKE] COMMAND[S]]
[YIELD { * | field1[, ...] } [ORDER BY field1 [, ...]] [SKIP n] [LIMIT n]]
[WHERE expression]
[RETURN field1[, ...] [ORDER BY field1 [, ...]] [SKIP n] [LIMIT n]]
```

### Query

```
SHOW ROLE regularUsers PRIVILEGES
```

Lists all privileges for role 'regularUsers'

*Table 442. Result*

access	action	resource	graph	segment	role
"GRANTED"	"access"	"database"	"neo4j"	"database"	"regularUsers"
1 row					

### Query

```
SHOW ROLES regularUsers, noAccessUsers PRIVILEGES
```

Lists all privileges for roles 'regularUsers' and 'noAccessUsers'

*Table 443. Result*

access	action	resource	graph	segment	role
"DENIED"	"access"	"database"	"neo4j"	"database"	"noAccessUsers"
"GRANTED"	"access"	"database"	"neo4j"	"database"	"regularUsers"
2 rows					

Available privileges for roles can also be output as Cypher commands with the optional `AS COMMAND[S]`.

### Query

```
SHOW ROLE admin PRIVILEGES AS COMMANDS
```

Table 444. Result

command
"GRANT ACCESS ON DATABASE * TO `admin`"
"GRANT ALL DBMS PRIVILEGES ON DBMS TO `admin`"
"GRANT CONSTRAINT MANAGEMENT ON DATABASE * TO `admin`"
"GRANT INDEX MANAGEMENT ON DATABASE * TO `admin`"
"GRANT MATCH {*} ON GRAPH * NODE * TO `admin`"
"GRANT MATCH {*} ON GRAPH * RELATIONSHIP * TO `admin`"
"GRANT NAME MANAGEMENT ON DATABASE * TO `admin`"
"GRANT START ON DATABASE * TO `admin`"
"GRANT STOP ON DATABASE * TO `admin`"
"GRANT TRANSACTION MANAGEMENT (*) ON DATABASE * TO `admin`"
"GRANT WRITE ON GRAPH * TO `admin`"
11 rows

Like other `SHOW` commands, the output can also be processed using `YIELD` / `WHERE` / `RETURN`.

### Query

```
SHOW ROLE architect PRIVILEGES AS COMMANDS  
WHERE command CONTAINS 'MATCH'
```

Table 445. Result

command
"GRANT MATCH {*} ON GRAPH * NODE * TO `architect`"
"GRANT MATCH {*} ON GRAPH * RELATIONSHIP * TO `architect`"
2 rows

It is also possible to have privileges output as revoke commands. For more on revoke commands, please see [The REVOKE command](#).

### Query

```
SHOW ROLE reader PRIVILEGES AS REVOKE COMMANDS
```

Table 446. Result

command
"REVOKE GRANT ACCESS ON DATABASE * FROM `reader`"
"REVOKE GRANT MATCH {*} ON GRAPH * NODE * FROM `reader`"
"REVOKE GRANT MATCH {*} ON GRAPH * RELATIONSHIP * FROM `reader`"
3 rows

Available privileges for specific users can be seen using `SHOW USER name PRIVILEGES`.



Please note that if a non-native auth provider like LDAP is in use, `SHOW USER PRIVILEGES` will only work in a limited capacity; It is only possible for a user to show their own privileges. Other users' privileges cannot be listed when using a non-native auth provider.

### Command syntax

```
SHOW USER[S] [user1[, user2]] PRIVILEGE[S] [AS [REVOKE] COMMAND[S]]  
[YIELD { * | field1[, ...] } [ORDER BY field1 [, ...]] [SKIP n] [LIMIT n]]  
[WHERE expression]  
[RETURN field1[, ...] [ORDER BY field1 [, ...]] [SKIP n] [LIMIT n]]
```

### Query

```
SHOW USER jake PRIVILEGES
```

Lists all privileges for user 'jake'

Table 447. Result

access	action	resource	graph	segment	role	user
"GRANTED"	"execute"	"database"	"*"	"FUNCTION(*)"	"PUBLIC"	"jake"
"GRANTED"	"execute"	"database"	"*"	"PROCEDURE(*)"	"PUBLIC"	"jake"
"GRANTED"	"access"	"database"	"DEFAULT"	"database"	"PUBLIC"	"jake"
"GRANTED"	"access"	"database"	"neo4j"	"database"	"regularUsers"	"jake"
4 rows						

### Query

```
SHOW USERS jake, joe PRIVILEGES
```

Lists all privileges for users 'jake' and 'joe'

Table 448. Result

access	action	resource	graph	segment	role	user
"GRANTED"	"execute"	"database"	"*"	"FUNCTION(*)"	"PUBLIC"	"jake"
"GRANTED"	"execute"	"database"	"*"	"PROCEDURE(*)"	"PUBLIC"	"jake"
"GRANTED"	"access"	"database"	"DEFAULT"	"database"	"PUBLIC"	"jake"
"GRANTED"	"access"	"database"	"neo4j"	"database"	"regularUsers"	"jake"
"GRANTED"	"execute"	"database"	"*"	"FUNCTION(*)"	"PUBLIC"	"joe"
"GRANTED"	"execute"	"database"	"*"	"PROCEDURE(*)"	"PUBLIC"	"joe"
"GRANTED"	"access"	"database"	"DEFAULT"	"database"	"PUBLIC"	"joe"
"DENIED"	"access"	"database"	"neo4j"	"database"	"noAccessUsers"	"joe"
8 rows						

The same command can be used at all times to review available privileges for the current user. For this purpose, a shorter form of the the command also exists: `SHOW USER PRIVILEGES`.

## Query

```
SHOW USER PRIVILEGES
```

Available privileges for users can also be output as Cypher commands with the optional **AS COMMAND[S]**.



When showing *user* privileges as commands, the roles in the Cypher commands are replaced with a parameter. This can be used to quickly create new roles based on the privileges of specific users.

## Query

```
SHOW USER jake PRIVILEGES AS COMMANDS
```

Table 449. Result

command
"GRANT ACCESS ON DATABASE `neo4j` TO \$role"
"GRANT ACCESS ON DEFAULT DATABASE TO \$role"
"GRANT EXECUTE FUNCTION * ON DBMS TO \$role"
"GRANT EXECUTE PROCEDURE * ON DBMS TO \$role"
4 rows

Like other **SHOW** commands, the output can also be processed using **YIELD** / **WHERE** / **RETURN**. Additionally, just as with role privileges, it is also possible to show user privileges as revoke commands.

## Query

```
SHOW USER jake PRIVILEGES AS REVOKE COMMANDS  
WHERE command CONTAINS 'EXECUTE'
```

Table 450. Result

command
"REVOKE GRANT EXECUTE FUNCTION * ON DBMS FROM \$role"
"REVOKE GRANT EXECUTE PROCEDURE * ON DBMS FROM \$role"
2 rows

## The **REVOKE** command

Privileges that were granted or denied earlier can be revoked using the **REVOKE** command.

### Command syntax

```
REVOKE  
[ { GRANT | DENY } ] graph-privilege  
FROM role [, ...]
```

An example usage of the **REVOKE** command is given here:

## Query

```
REVOKE GRANT TRAVERSE  
ON DEFAULT GRAPH NODES Post FROM regularUsers
```

0 rows, System updates: 1

While it can be explicitly specified that revoke should remove a **GRANT** or **DENY**, it is also possible to revoke either one by not specifying at all as the next example demonstrates. Because of this, if there happen to be a **GRANT** and a **DENY** on the same privilege, it would remove both.

## Query

```
REVOKE TRAVERSE  
ON DEFAULT GRAPH NODES Payments FROM regularUsers
```

0 rows, System updates: 2

### 5.5.4. Read privileges

*This section explains how to use Cypher to manage read privileges on graphs.*

- [The TRAVERSE privilege](#)
- [The READ privilege](#)
- [The MATCH privilege](#)

There are three separate read privileges:

- **TRAVERSE** - enables the specified entities to be found.
- **READ {props}** - enables the specified properties on the found entities to be read.
- **MATCH {props}** - combines both **TRAVERSE** and **READ**, enabling an entity to be found and its properties read.

#### The **TRAVERSE** privilege

Users can be granted the right to find nodes and relationships using the **GRANT TRAVERSE** privilege.

#### Command syntax

```
GRANT TRAVERSE  
ON {DEFAULT GRAPH | GRAPH[S] {name [, ...] | *}}  
[  
    ELEMENT[S] { * | label-or-rel-type-name[,...] }  
    | NODE[S] { * | label-name[,...] }  
    | RELATIONSHIP[S] { * | rel-type-name[,...] }  
]  
TO role [, ...]
```

For example, we can enable the user **jake**, who has role 'regularUsers' to find all nodes with the label **Post**.

## Query

```
GRANT TRAVERSE  
ON GRAPH neo4j NODES Post TO regularUsers
```

0 rows, System updates: 1

The **TRAVERSE** privilege can also be denied.

#### Command syntax

```
DENY TRAVERSE
ON {DEFAULT GRAPH | GRAPH[S] {name [, ...] | *}}
[
    ELEMENT[S] { * | label-or-rel-type-name[,...] }
    | NODE[S] { * | label-name[,...] }
    | RELATIONSHIP[S] { * | rel-type-name[,...] }
]
TO role [, ...]
```

For example, we can disable the user **jake**, who has role 'regularUsers' from finding all nodes with the label **Payments**.

#### Query

```
DENY TRAVERSE
ON DEFAULT GRAPH NODES Payments TO regularUsers
```

0 rows, System updates: 1

### The **READ** privilege

Users can be granted the right to do property reads on nodes and relationships using the **GRANT READ** privilege. It is very important to note that users can only read properties on entities that they are enabled to find in the first place.

#### Command syntax

```
GRANT READ
"{" * | properties } ?>"
ON {DEFAULT GRAPH | GRAPH[S] {name [, ...] | *}}
[
    ELEMENT[S] { * | label-or-rel-type-name[,...] }
    | NODE[S] { * | label-name[,...] }
    | RELATIONSHIP[S] { * | rel-type-name[,...] }
]
TO role [, ...]
```

For example, we can enable the user **jake**, who has role 'regularUsers' to read all properties on nodes with the label **Post**. The **\*** implies that the ability to read all properties also extends to properties that might be added in the future.

#### Query

```
GRANT READ { * }
ON GRAPH neo4j NODES Post TO regularUsers
```

0 rows, System updates: 1



Granting property **READ** access does not imply that the entities with that property can be found. For example, if there is also a **DENY TRAVERSE** present on the same entity as a **GRANT READ**, the entity will not be found by a Cypher **MATCH** statement.

The **READ** privilege can also be denied.

## Command syntax

```
DENY READ
  "{" { * | properties } "}"
  ON {DEFAULT GRAPH | GRAPH[S] {name [, ...] | *}}
  [
    ELEMENT[S] { * | label-or-rel-type-name[,...] }
    | NODE[S] { * | label-name[,...] }
    | RELATIONSHIP[S] { * | rel-type-name[,...] }
  ]
  TO role [, ...]
```

Although we just granted the user 'jake' the right to read all properties, we may want to hide the `secret` property. The following example shows how to do that.

## Query

```
DENY READ { secret }
ON GRAPH neo4j NODES Post TO regularUsers
```

0 rows, System updates: 1

## The `MATCH` privilege

Users can be granted the right to find and do property reads on nodes and relationships using the `GRANT MATCH` privilege. This is semantically the same as having both `TRAVERSE` and `READ` privileges.

## Command syntax

```
GRANT MATCH
  "{" { * | properties } "}"
  ON {DEFAULT GRAPH | GRAPH[S] {name [, ...] | *}}
  [
    ELEMENT[S] { * | label-or-rel-type-name[,...] }
    | NODE[S] { * | label-name[,...] }
    | RELATIONSHIP[S] { * | rel-type-name[,...] }
  ]
  TO role [, ...]
```

For example if you want to grant the ability to read the properties `language` and `length` for nodes with the label `Message`, as well as the ability to find these nodes, to a role `regularUsers` you can use the following `GRANT MATCH` query.

## Query

```
GRANT
MATCH { language, length }
ON GRAPH neo4j NODES Message TO regularUsers
```

0 rows, System updates: 2

Like all other privileges, the `MATCH` privilege can also be denied.

## Command syntax

```
DENY MATCH
  "{" { * | properties } "}"
  ON {DEFAULT GRAPH | GRAPH[S] {name [, ...] | *}}
  [
    ELEMENT[S] { * | label-or-rel-type-name[,...] }
    | NODE[S] { * | label-name[,...] }
    | RELATIONSHIP[S] { * | rel-type-name[,...] }
  ]
  TO role [, ...]
```

Please note that the effect of denying a `MATCH` privilege depends on whether concrete property keys are specified or not. If you specify concrete property keys then `DENY MATCH` will only deny reading those properties. Finding the elements to traverse would still be enabled. If you specify instead then both traversal of the element and all property reads will be disabled. The following queries will show examples for this.

Denying to read the property 'content' on nodes with the label `Message` for the role `regularUsers` would look like the following query. Although not being able to read this specific property, nodes with that label can still be traversed (and, depending on other grants, other properties on it could still be read).

#### Query

```
DENY
MATCH { content }
ON GRAPH neo4j NODES Message TO regularUsers
```

0 rows, System updates: 1

The following query exemplifies how it would look like if you want to deny both reading all properties and traversing nodes labeled with `Account`.

#### Query

```
DENY
MATCH { * }
ON GRAPH neo4j NODES Account TO regularUsers
```

0 rows, System updates: 1

### 5.5.5. Write privileges

*This section explains how to use Cypher to manage write privileges on graphs.*

- The `CREATE` privilege
- The `DELETE` privilege
- The `SET LABEL` privilege
- The `REMOVE LABEL` privilege
- The `SET PROPERTY` privilege
- The `MERGE` privilege
- The `WRITE` privilege
- The `ALL GRAPH PRIVILEGES` privilege

Write privileges are defined for different parts of the graph:

- `CREATE` - allows creating nodes and relationships.
- `DELETE` - allows deleting nodes and relationships.
- `SET LABEL labels` - allows setting the specified node labels using the `SET` clause.
- `REMOVE LABEL labels` - allows removing the specified node labels using the `REMOVE` clause.
- `SET PROPERTY {props}` - allows setting properties on nodes and relationships.

There are also compound privileges which combine the above specific privileges:

- **MERGE** - allows match, create and set property to permit the **MERGE** command.
- **WRITE** - allows all write operations on an entire graph.
- **ALL GRAPH PRIVILEGES** - allows all read and write operation on an entire graph.

## The **CREATE** privilege

The **CREATE** privilege allows a user to create new node and relationship elements in a graph. See the Cypher **CREATE** clause.

### *Command syntax*

```
GRANT CREATE ON {DEFAULT GRAPH | GRAPH[S] { * | graph-name[,...] }}
  [
    ELEMENT[S] { * | label-or-rel-type-name[,...] }
    | NODE[S] { * | label-name[,...] }
    | RELATIONSHIP[S] { * | rel-type-name[,...] }
  ]
  TO grantee[,...]
```

For example, granting the ability to create elements on the graph `neo4j` to the role `regularUsers` would be achieved using:

### *Query*

```
GRANT
CREATE
ON GRAPH neo4j ELEMENTS * TO regularUsers
```

0 rows, System updates: 2

The **CREATE** privilege can also be denied.

### *Command syntax*

```
DENY CREATE ON {DEFAULT GRAPH | GRAPH[S] { * | graph-name[,...] }}
  [
    ELEMENT[S] { * | label-or-rel-type-name[,...] }
    | NODE[S] { * | label-name[,...] }
    | RELATIONSHIP[S] { * | rel-type-name[,...] }
  ]
  TO grantee[,...]
```

For example, denying the ability to create nodes with the label `foo` on all graphs to the role `regularUsers` would be achieved using:

### *Query*

```
DENY
CREATE
ON GRAPH * NODES foo TO regularUsers
```

0 rows, System updates: 1



If the user attempts to create nodes with a label that does not already exist in the database, then the user must also possess the **CREATE NEW LABEL** privilege. The same applies to new relationships - the **CREATE NEW RELATIONSHIP TYPE** privilege is required.

## The `DELETE` privilege

The `DELETE` privilege allows a user to delete node and relationship elements in a graph. See the Cypher `DELETE` clause.

### *Command syntax*

```
GRANT DELETE ON {DEFAULT GRAPH | GRAPH[S] { * | graph-name[,...] }}  
[  
    ELEMENT[S] { * | label-or-rel-type-name[,...] }  
    | NODE[S] { * | label-name[,...] }  
    | RELATIONSHIP[S] { * | rel-type-name[,...] }  
]  
TO grantee[,...]
```

For example, granting the ability to delete elements on the graph `neo4j` to the role `regularUsers` would be achieved using:

### *Query*

```
GRANT  
DELETE  
ON GRAPH neo4j ELEMENTS * TO regularUsers
```

0 rows, System updates: 2

The `DELETE` privilege can also be denied.

### *Command syntax*

```
DENY DELETE ON {DEFAULT GRAPH | GRAPH[S] { * | graph-name[,...] }}  
[  
    ELEMENT[S] { * | label-or-rel-type-name[,...] }  
    | NODE[S] { * | label-name[,...] }  
    | RELATIONSHIP[S] { * | rel-type-name[,...] }  
]  
TO grantee[,...]
```

For example, denying the ability to delete relationships with the relationship type `bar` on all graphs to the role `regularUsers` would be achieved using:

### *Query*

```
DENY  
DELETE  
ON GRAPH * RELATIONSHIPS bar TO regularUsers
```

0 rows, System updates: 1



Users with `DELETE` privilege, but restricted `TRAVERSE` privileges, will not be able to do `DETACH DELETE` in all cases. See [Operations Manual](#) [Fine-grained access control](#) for more info.

## The `SET LABEL` privilege

The `SET LABEL` privilege allows you to set labels on a node using the `SET` clause.

## *Command syntax*

```
GRANT SET LABEL {label [, ...] | *}
  ON {DEFAULT GRAPH | GRAPH[S] {name [, ...] | *}}
  TO role [, ...]
```

For example, granting the ability to set any label on nodes of the graph `neo4j` to the role `regularUsers` would be achieved using:

## *Query*

```
GRANT
SET LABEL *
ON GRAPH neo4j TO regularUsers
```

0 rows, System updates: 1



Unlike many of the other read and write privileges, it is not possible to restrict the `SET LABEL` privilege to specific ELEMENTS, NODES or RELATIONSHIPS.

The `SET LABEL` privilege can also be denied.

## *Command syntax*

```
DENY SET LABEL {label [, ...] | *}
  ON {DEFAULT GRAPH | GRAPH[S] {name [, ...] | *}}
  TO role [, ...]
```

For example, denying the ability to set the label `foo` on nodes of all graphs to the role `regularUsers` would be achieved using:

## *Query*

```
DENY
SET LABEL foo
ON GRAPH * TO regularUsers
```

0 rows, System updates: 1



If no instances of this label exist in the database, then the `CREATE NEW LABEL` privilege is also required.

The `REMOVE LABEL` privilege

The `REMOVE LABEL` privilege allows you to remove labels from a node using the `REMOVE` clause.

## *Command syntax*

```
GRANT REMOVE LABEL {label [, ...] | *}
  ON {DEFAULT GRAPH | GRAPH[S] {name [, ...] | *}}
  TO role [, ...]
```

For example, granting the ability to remove any label from nodes of the graph `neo4j` to the role `regularUsers` would be achieved using:

## Query

```
GRANT  
REMOVE LABEL *  
ON GRAPH neo4j TO regularUsers
```

0 rows, System updates: 1



Unlike many of the other read and write privileges, it is not possible to restrict the `REMOVE LABEL` privilege to specific ELEMENTS, NODES or RELATIONSHIPS.

The `REMOVE LABEL` privilege can also be denied.

### Command syntax

```
DENY REMOVE LABEL {label [, ...] | *}  
ON {DEFAULT GRAPH | GRAPH[S] {name [, ...] | *}}  
TO role [, ...]
```

For example, denying the ability to remove the label `foo` from nodes of all graphs to the role `regularUsers` would be achieved using:

## Query

```
DENY  
REMOVE LABEL foo  
ON GRAPH * TO regularUsers
```

0 rows, System updates: 1

## The `SET PROPERTY` privilege

The `SET PROPERTY` privilege allows a user to set a property on a node or relationship element in a graph using the [SET clause](#).

### Command syntax

```
GRANT SET PROPERTY "{" { * | property-name[,...] } "}"  
ON {DEFAULT GRAPH | GRAPH[S] { * | graph-name[,...] }}  
[  
    ELEMENT[S] { * | label-or-rel-type-name[,...] }  
    | NODE[S] { * | label-name[,...] }  
    | RELATIONSHIP[S] { * | rel-type-name[,...] }  
]  
TO grantee[,...]
```

For example, granting the ability to set any property on all elements of the graph `neo4j` to the role `regularUsers` would be achieved using:

## Query

```
GRANT  
SET PROPERTY { * }  
ON DEFAULT GRAPH ELEMENTS * TO regularUsers
```

0 rows, System updates: 2

The `SET PROPERTY` privilege can also be denied.

## Command syntax

```
DENY SET PROPERTY "{" { * | property-name[,...] } "}"
ON {DEFAULT GRAPH | GRAPH[S] { * | graph-name[,...] }}
[
    ELEMENT[S] { * | label-or-rel-type-name[,...] }
    | NODE[S] { * | label-name[,...] }
    | RELATIONSHIP[S] { * | rel-type-name[,...] }
]
TO grantee[,...]
```

For example, denying the ability to set the property `foo` on nodes with the label `bar` on all graphs to the role `regularUsers` would be achieved using:

### Query

```
DENY
SET PROPERTY { foo }
ON GRAPH * NODES bar TO regularUsers
```

0 rows, System updates: 1



If the user attempts to set a property with a property name that does not already exist in the database the user must also possess the [CREATE NEW PROPERTY NAME](#) privilege.

## The `MERGE` privilege

The `MERGE` privilege is a compound privilege that combines `TRAVERSE` and `READ` (i.e. `MATCH`) with `CREATE` and `SET PROPERTY`. This is intended to permit use of the [MERGE command](#) but is applicable to all reads and writes that require these privileges.

### Command syntax

```
GRANT MERGE "{" { * | property-name[,...] } "}"
ON {DEFAULT GRAPH | GRAPH[S] { * | graph-name[,...] }}
[
    ELEMENT[S] { * | label-or-rel-type-name[,...] }
    | NODE[S] { * | label-name[,...] }
    | RELATIONSHIP[S] { * | rel-type-name[,...] }
]
TO grantee[,...]
```

For example, granting `MERGE` on all elements of the graph `neo4j` to the role `regularUsers` would be achieved using:

### Query

```
GRANT
MERGE { * }
ON GRAPH neo4j ELEMENTS * TO regularUsers
```

0 rows, System updates: 2

It is not possible to deny the `MERGE` privilege. If it is desirable to prevent a user from creating elements and setting properties, use [DENY CREATE](#) or [DENY SET PROPERTY](#).



If the user attempts to create nodes with a label that does not already exist in the database the user must also possess the [CREATE NEW LABEL](#) privilege. The same applies to new relationships and properties - the [CREATE NEW RELATIONSHIP TYPE](#) or [CREATE NEW PROPERTY NAME](#) privileges are required.

## The `WRITE` privilege

The `WRITE` privilege allows the user to execute any write command on a graph.

### *Command syntax*

```
GRANT WRITE  
ON {DEFAULT GRAPH | GRAPH[S] {name [, ...] | *}}  
TO role [, ...]
```

For example, granting the ability to write on the graph `neo4j` to the role `regularUsers` would be achieved using:

### *Query*

```
GRANT WRITE  
ON GRAPH neo4j TO regularUsers
```

0 rows, System updates: 2



Unlike the more specific write commands, it is not possible to restrict `WRITE` privileges to specific ELEMENTS, NODES or RELATIONSHIPS. If it is desirable to prevent a user from writing to a subset of database objects, a `GRANT WRITE` can be combined with more specific `DENY` commands to target these elements.

The `WRITE` privilege can also be denied.

### *Command syntax*

```
DENY WRITE  
ON {DEFAULT GRAPH | GRAPH[S] {name [, ...] | *}}  
TO role [, ...]
```

For example, denying the ability to write on the graph `neo4j` to the role `regularUsers` would be achieved using:

### *Query*

```
DENY WRITE  
ON GRAPH neo4j TO regularUsers
```

0 rows, System updates: 2



Users with `WRITE` privilege but restricted `TRAVERSE` privileges will not be able to do `DETACH DELETE` in all cases. See [Operations Manual](#) □ [Fine-grained access control](#) for more info.

## `ALL GRAPH PRIVILEGES`

The `ALL GRAPH PRIVILEGES` privilege allows the user to execute any command on a graph.

## Command syntax

```
GRANT ALL [ [ GRAPH ] PRIVILEGES ]
  ON {DEFAULT GRAPH | GRAPH[S] {name [, ...] | *}}
  TO role [, ...]
```

For example, granting all graph privileges on the graph `neo4j` to the role `regularUsers` would be achieved using:

### Query

```
GRANT ALL GRAPH PRIVILEGES
ON GRAPH neo4j TO regularUsers
```

0 rows, System updates: 1



Unlike the more specific read and write commands, it is not possible to restrict `ALL GRAPH PRIVILEGES` privileges to specific ELEMENTS, NODES or RELATIONSHIPS. If it is desirable to prevent a user from reading or writing to a subset of database objects, a `GRANT ALL GRAPH PRIVILEGES` can be combined with more specific `DENY` commands to target these elements.

The `ALL GRAPH PRIVILEGES` privilege can also be denied.

## Command syntax

```
DENY ALL [ [ GRAPH ] PRIVILEGES ]
  ON {DEFAULT GRAPH | GRAPH[S] {name [, ...] | *}}
  TO role [, ...]
```

For example, denying all graph privileges on the graph `neo4j` to the role `regularUsers` would be achieved using:

### Query

```
DENY ALL GRAPH PRIVILEGES
ON GRAPH neo4j TO regularUsers
```

0 rows, System updates: 1

## 5.5.6. Security of administration

*This section explains how to use Cypher to manage Neo4j administrative privileges.*

All of the commands described in the enclosing [Administration](#) section require that the user executing the commands has the rights to do so. These privileges can be conferred either by granting the user the `admin` role, which enables all administrative rights, or by granting specific combinations of privileges.

- [The admin role](#)
- [Database administration](#)
  - [The database ACCESS privilege](#)
  - [The database START/STOP privileges](#)
  - [The INDEX MANAGEMENT privileges](#)

- The **CONSTRAINT MANAGEMENT** privileges
- The **NAME MANAGEMENT** privileges
- Granting **ALL DATABASE PRIVILEGES**
- Granting **TRANSACTION MANAGEMENT** privileges
- DBMS administration
  - Using a custom role to manage DBMS privileges
  - The **dbms ROLE MANAGEMENT** privileges
  - The **dbms USER MANAGEMENT** privileges
  - The **dbms DATABASE MANAGEMENT** privileges
  - The **dbms PRIVILEGE MANAGEMENT** privileges
  - The **dbms EXECUTE** privileges
    - The **dbms EXECUTE PROCEDURE** privileges
    - The **dbms EXECUTE BOOSTED PROCEDURE** privileges
    - The **dbms EXECUTE ADMIN PROCEDURES** privileges
    - The **dbms EXECUTE USER DEFINED FUNCTION** privileges
    - The **dbms EXECUTE BOOSTED USER DEFINED FUNCTION** privileges
    - Procedure and user defined function name-globbing
  - Granting **ALL DBMS PRIVILEGES**

## The **admin** role

The built-in role **admin** includes a number of privileges allowing users granted this role the ability to perform administrative tasks. These include the rights to perform the following classes of tasks:

- Manage **database security** for controlling the rights to perform actions on specific databases:
  - Manage access to a database and the right to start and stop a database
  - Manage **indexes** and **constraints**
  - Allow the creation of labels, relationship types or property names
  - Manage transactions
- Manage **DBMS security** for controlling the rights to perform actions on the entire system:
  - Manage **multiple databases**
  - Manage **users and roles**
  - Change configuration parameters
  - Manage sub-graph privileges
  - Manage procedure security

These rights are conferred using privileges that can be managed using **GRANT**, **DENY** and **REVOKE** commands.

### *Query*

```
SHOW ROLE admin PRIVILEGES
```

*Table 451. Result*

access	action	resource	graph	segment	role
"GRANTED"	"match"	"all_properties"	"*"	"NODE(*)"	"admin"
"GRANTED"	"write"	"graph"	"*"	"NODE(*)"	"admin"
"GRANTED"	"match"	"all_properties"	"*"	"RELATIONSHIP(*)"	"admin"
"GRANTED"	"write"	"graph"	"*"	"RELATIONSHIP(*)"	"admin"
"GRANTED"	"access"	"database"	"*"	"database"	"admin"
"GRANTED"	"admin"	"database"	"*"	"database"	"admin"
"GRANTED"	"constraint"	"database"	"*"	"database"	"admin"
"GRANTED"	"index"	"database"	"*"	"database"	"admin"
"GRANTED"	"token"	"database"	"*"	"database"	"admin"
9 rows					

If the built-in admin role has been altered or dropped, and needs to be restored to its original state, see [Operations Manual □ Password and user recovery](#).

## Database administration

The administrators can use the following Cypher commands to manage Neo4j database administrative rights. The components of the database privilege commands are:

- the command:
  - **GRANT** – gives privileges to roles.
  - **DENY** – denies privileges to roles.
  - **REVOKE** – removes granted or denied privilege from roles.
- *database-privilege*
  - **ACCESS** - allows access to a specific database.
  - **START** - allows the specified database to be started.
  - **STOP** - allows the specified database to be stopped.
  - **CREATE INDEX** - allows indexes to be created on the specified database.
  - **DROP INDEX** - allows indexes to be deleted on the specified database.
  - **SHOW INDEX** - allows indexes to be listed on the specified database.
  - **INDEX [MANAGEMENT]** - allows indexes to be created, deleted, and listed on the specified database.
  - **CREATE CONSTRAINT** - allows constraints to be created on the specified database.
  - **DROP CONSTRAINT** - allows constraints to be deleted on the specified database.
  - **SHOW CONSTRAINT** - allows constraints to be listed on the specified database.
  - **CONSTRAINT [MANAGEMENT]** - allows constraints to be created, deleted, and listed on the specified database.
  - **CREATE NEW [NODE] LABEL** - allows labels to be created so that future nodes can be assigned them.
  - **CREATE NEW [RELATIONSHIP] TYPE** - allows relationship types to be created, so that future relationships can be created with these types.
  - **CREATE NEW [PROPERTY] NAME** - allows property names to be created, so that nodes and relationships can have properties with these names assigned.

- **NAME [MANAGEMENT]** - allows all of the name management capabilities: node labels, relationship types, and property names.
- **ALL [[DATABASE] PRIVILEGES]** - allows access, index, constraint, and name management for the specified database.
- **SHOW TRANSACTION {\* | user[, ...]}** - allows listing transactions and queries for the specified users on the specified database.
- **TERMINATE TRANSACTION {\* | user[, ...]}** - allows ending transactions and queries for the specified users on the specified database.
- **TRANSACTION [MANAGEMENT] {\* | user[, ...]}** - allows listing and ending transactions and queries for the specified users on the specified database.

- *name*

- The database to associate the privilege with.



If you delete a database and create a new one with the same name, the new one will NOT have the privileges assigned to the deleted database.

- The *name* component can be **\***, which means all databases. Databases created after this command execution will also be associated with these privileges.
- The **DATABASE[S] name** part of the command can be replaced by **DEFAULT DATABASE**. If you restart the server and choose a new default database after this command execution, the new one will be associated with these privileges.

- *role[, ...]*

- The role or roles to associate the privilege with, comma-separated.

*Table 452. Privilege command syntax*

Command	Description
<code>GRANT database-privilege ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *}} TO role[, ...]</code>	Grant a privilege to one or multiple roles.
<code>DENY database-privilege ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *}} TO role[, ...]</code>	Deny a privilege to one or multiple roles.
<code>REVOKE GRANT database-privilege ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *}} FROM role[, ...]</code>	Revoke a granted privilege from one or multiple roles.
<code>REVOKE DENY database-privilege ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *}} FROM role[, ...]</code>	Revoke a denied privilege from one or multiple roles.
<code>REVOKE database-privilege ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *}} FROM role[, ...]</code>	Revoke a granted or denied privilege from one or multiple roles.



**DENY** does NOT erase a granted privilege; they both exist. Use **REVOKE** if you want to remove a privilege.

Table 453. Database management command syntax

Command	Description
GRANT ACCESS ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *} } TO role[, ...]	Grant the specified roles the privilege to access the default database, specific database(s), or all databases.
GRANT {START   STOP} ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *} } TO role[, ...]	Grant the specified roles the privilege to start and stop the default database, specific database(s), or all databases.
GRANT {CREATE   DROP   SHOW} INDEX[ES] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *} } TO role[, ...]	Grant the specified roles the privilege to create, delete, or show indexes on the default database, specific database(s), or all databases.
GRANT INDEX[ES] [MANAGEMENT] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *} } TO role[, ...]	Grant the specified roles the privilege to manage indexes on the default database, specific database(s), or all databases.
GRANT {CREATE   DROP   SHOW} CONSTRAINT[S] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *} } TO role[, ...]	Grant the specified roles the privilege to create, delete, or show constraints on the default database, specific database(s), or all databases.
GRANT CONSTRAINT[S] [MANAGEMENT] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *} } TO role[, ...]	Grant the specified roles the privilege to manage constraints on the default database, specific database(s), or all databases.
GRANT CREATE NEW [NODE] LABEL[S] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *} } TO role[, ...]	Grant the specified roles the privilege to create new node labels in the default database, specific database(s), or all databases.
GRANT CREATE NEW [RELATIONSHIP] TYPE[S] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *} } TO role[, ...]	Grant the specified roles the privilege to create new relationships types in the default database, specific database(s), or all databases.
GRANT CREATE NEW [PROPERTY] NAME[S] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *} } TO role[, ...]	Grant the specified roles the privilege to create new property names in the default database, specific database(s), or all databases.
GRANT NAME [MANAGEMENT] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *} } TO role[, ...]	Grant the specified roles the privilege to manage new labels, relationship types, and property names in the default database, specific database(s), or all databases.

Command	Description
<pre>GRANT ALL [[DATABASE] PRIVILEGES] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *}} TO role[, ...]</pre>	Grant the specified roles all privileges for the default database, specific database(s), or all databases.
<pre>GRANT {SHOW   TERMINATE} TRANSACTION[S] [(*   user[, ...])] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *}} TO role[, ...]</pre>	Grant the specified roles the privilege to list and end the transactions and queries of all users or a particular user(s) in the default database, specific database(s), or all databases.
<pre>GRANT TRANSACTION [MANAGEMENT] [(*   user[, ...])] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *}} TO role[, ...]</pre>	Grant the specified roles the privilege to manage the transactions and queries of all users or a particular user(s) in the default database, specific database(s), or all databases.

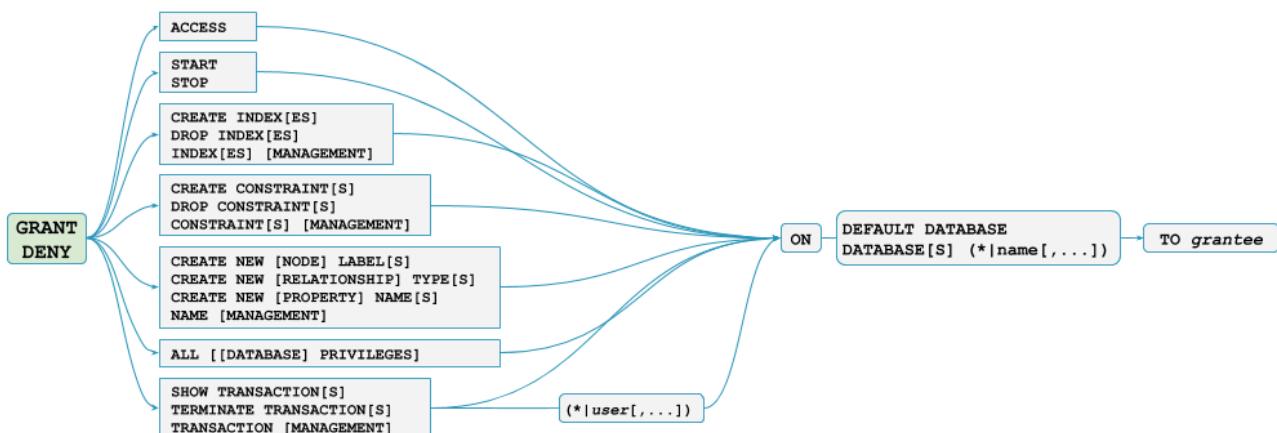


Figure 30. Syntax of GRANT and DENY Database Privileges

The database **ACCESS** privilege

The **ACCESS** privilege enables users to connect to a database. With **ACCESS** you can run calculations, for example, `RETURN 2*5 AS answer` or call functions `RETURN timestamp() AS time`.

#### Command syntax

```
GRANT ACCESS
ON {DEFAULT DATABASE \| DATABASE[S] {name [, ...] \| *}}
TO role [, ...]
```

For example, granting the ability to access the database `neo4j` to the role `regularUsers` is done using the following query.

#### Query

```
GRANT ACCESS
ON DATABASE neo4j TO regularUsers
```

0 rows, System updates: 1

The **ACCESS** privilege can also be denied.

### *Command syntax*

```
DENY ACCESS  
ON {DEFAULT DATABASE \| DATABASE[S] {name [, ...] \| *}}  
TO role [, ...]
```

For example, denying the ability to access to the database `neo4j` to the role `regularUsers` is done using the following query.

### *Query*

```
DENY ACCESS  
ON DATABASE neo4j TO regularUsers
```

0 rows, System updates: 1

The privileges granted can be seen using the `SHOW PRIVILEGES` command:

### *Query*

```
SHOW ROLE regularUsers PRIVILEGES
```

*Table 454. Result*

access	action	resource	graph	segment	role
"DENIED"	"access"	"database"	"neo4j"	"database"	"regularUsers"
"GRANTED"	"access"	"database"	"neo4j"	"database"	"regularUsers"
2 rows					

The database `START/STOP` privileges

The `START` privilege can be used to enable the ability to start a database.

### *Command syntax*

```
GRANT START  
ON {DEFAULT DATABASE \| DATABASE[S] {name [, ...] \| *}}  
TO role [, ...]
```

For example, granting the ability to start the database `neo4j` to the role `regularUsers` is done using the following query.

### *Query*

```
GRANT  
START  
ON DATABASE neo4j TO regularUsers
```

0 rows, System updates: 1

The `START` privilege can also be denied.

### *Command syntax*

```
DENY START  
ON {DEFAULT DATABASE \| DATABASE[S] {name [, ...] \| *}}  
TO role [, ...]
```

For example, denying the ability to start to the database `neo4j` to the role `regularUsers` is done using the following query.

#### Query

```
DENY  
START  
ON DATABASE system TO regularUsers
```

0 rows, System updates: 1

The `STOP` privilege can be used to enable the ability to stop a database.

#### Command syntax

```
GRANT STOP  
ON {DEFAULT DATABASE \| DATABASE[S] {name [, ...] \| *}}  
TO role [, ...]
```

For example, granting the ability to stop the database `neo4j` to the role `regularUsers` is done using the following query.

#### Query

```
GRANT STOP  
ON DATABASE neo4j TO regularUsers
```

0 rows, System updates: 1

The `STOP` privilege can also be denied.

#### Command syntax

```
DENY STOP  
ON {DEFAULT DATABASE \| DATABASE[S] {name [, ...] \| *}}  
TO role [, ...]
```

For example, denying the ability to stop to the database `neo4j` to the role `regularUsers` is done using the following query.

#### Query

```
DENY STOP  
ON DATABASE system TO regularUsers
```

0 rows, System updates: 1

The privileges granted can be seen using the `SHOW PRIVILEGES` command:

#### Query

```
SHOW ROLE regularUsers PRIVILEGES
```

Table 455. Result

access	action	resource	graph	segment	role
"DENIED"	"access"	"database"	"neo4j"	"database"	"regularUsers"
"GRANTED"	"access"	"database"	"neo4j"	"database"	"regularUsers"

access	action	resource	graph	segment	role
"GRANTED"	"start_database"	"database"	"neo4j"	"database"	"regularUsers"
"GRANTED"	"stop_database"	"database"	"neo4j"	"database"	"regularUsers"
"DENIED"	"start_database"	"database"	"system"	"database"	"regularUsers"
"DENIED"	"stop_database"	"database"	"system"	"database"	"regularUsers"
6 rows					



Note that `START` and `STOP` privileges are not included in the `ALL DATABASE PRIVILEGES`.

The `INDEX MANAGEMENT` privileges

Indexes can be created, deleted, or listed with the `CREATE INDEX`, `DROP INDEX`, and `SHOW INDEXES` commands. The privilege to do this can be granted with `GRANT CREATE INDEX`, `GRANT DROP INDEX`, and `GRANT SHOW INDEX` commands. The privilege to do all three can be granted with `GRANT INDEX MANAGEMENT` command.

*Table 456. Index management command syntax*

Command	Description
<pre>GRANT {CREATE   DROP   SHOW} INDEX[ES] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *}} TO role [, ...]</pre>	Enable the specified roles to create, delete, or show indexes in the default database, specific database(s), or all databases.
<pre>GRANT INDEX[ES] [MANAGEMENT] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *}} TO role [, ...]</pre>	Enable the specified roles to manage indexes in the default database, specific database(s), or all databases.

For example, granting the ability to create indexes on the database `neo4j` to the role `regularUsers` is done using the following query.

*Query*

```
GRANT
CREATE INDEX ON DATABASE neo4j TO regularUsers
```

0 rows, System updates: 1

The `SHOW INDEXES` privilege only affects the `SHOW INDEXES` command and not the old procedures for listing indexes, such as `db.indexes`.

The `CONSTRAINT MANAGEMENT` privileges

Constraints can be created, deleted, or listed with the `CREATE CONSTRAINT`, `DROP CONSTRAINT` and `SHOW CONSTRAINTS` commands. The privilege to do this can be granted with `GRANT CREATE CONSTRAINT`, `GRANT DROP CONSTRAINT`, `GRANT SHOW CONSTRAINT` commands. The privilege to do all three can be granted with `GRANT CONSTRAINT MANAGEMENT` command.

*Table 457. Constraint management command syntax*

Command	Description
<pre>GRANT {CREATE   DROP   SHOW} CONSTRAINT[S] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *}} TO role [, ...]</pre>	Enable the specified roles to create, delete, or show constraints on the default database, specific database(s), or all databases.
<pre>GRANT CONSTRAINT[S] [MANAGEMENT] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *}} TO role [, ...]</pre>	Enable the specified roles to manage constraints on the default database, specific database(s), or all databases.

For example, granting the ability to create constraints on the database `neo4j` to the role `regularUsers` is done using the following query.

#### Query

```
GRANT
CREATE CONSTRAINT ON DATABASE neo4j TO regularUsers
```

0 rows, System updates: 1

The `SHOW CONSTRAINTS` privilege only affects the `SHOW CONSTRAINTS` command and not the old procedures for listing constraints, such as `db.constraints`.

The `NAME MANAGEMENT` privileges

The right to create new labels, relationship types or property names is different from the right to create nodes, relationships or properties. The latter is managed using database `WRITE` privileges, while the former is managed using specific `GRANT/DENY CREATE NEW ...` commands for each type.

*Table 458. Label, relationship type and property name management command syntax*

Command	Description
<pre>GRANT CREATE NEW [NODE] LABEL[S] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *}} TO role [, ...]</pre>	Enable the specified roles to create new node labels in the default database, specific database(s), or all databases.
<pre>GRANT CREATE NEW [RELATIONSHIP] TYPE[S] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *}} TO role [, ...]</pre>	Enable the specified roles to create new relationship types in the default database, specific database(s), or all databases.
<pre>GRANT CREATE NEW [PROPERTY] NAME[S] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *}} TO role [, ...]</pre>	Enable the specified roles to create new property names in the default database, specific database(s), or all databases.
<pre>GRANT NAME [MANAGEMENT] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]   *}} TO role [, ...]</pre>	Enable the specified roles to create new labels, relationship types, and property names in the default database, specific database(s), or all databases.

For example, granting the ability to create new properties on nodes or relationships in the database `neo4j` to the role `regularUsers` is done using the following query.

## Query

```
GRANT  
CREATE NEW PROPERTY NAME  
ON DATABASE neo4j TO regularUsers
```

0 rows, System updates: 1

Granting **ALL DATABASE PRIVILEGES**

The right to access a database, create and drop indexes and constraints and create new labels, relationship types or property names can be achieved with a single command:

*Command syntax*

```
GRANT ALL [[DATABASE] PRIVILEGES]  
ON {DEFAULT DATABASE \| DATABASE[S] {name [, ...] \| *}}  
TO role[, ...]
```



Note that the privileges for starting and stopping all databases, and transaction management, are not included in the **ALL DATABASE PRIVILEGES** grant. These privileges are associated with administrators while other database privileges are of use to domain and application developers.

For example, granting the abilities above on the database `neo4j` to the role `databaseAdminUsers` is done using the following query.

## Query

```
GRANT ALL DATABASE PRIVILEGES  
ON DATABASE neo4j TO databaseAdminUsers
```

0 rows, System updates: 1

The privileges granted can be seen using the **SHOW PRIVILEGES** command:

## Query

```
SHOW ROLE databaseAdminUsers PRIVILEGES
```

*Table 459. Result*

access	action	resource	graph	segment	role
"GRANTED"	"database_actions" "	"database"	"neo4j"	"database"	"databaseAdminUsers"
1 row					

Granting **TRANSACTION MANAGEMENT** privileges

The right to run the procedures `dbms.listTransactions`, `dbms.listQueries`, `dbms.killQuery`, `dbms.killQueries`, `dbms.killTransaction` and `dbms.killTransactions` are managed through the **SHOW TRANSACTION** and **TERMINATE TRANSACTION** privileges.

*Table 460. Transaction management command syntax*

Command	Description
<pre>GRANT SHOW TRANSACTION[S] [(*   user[, ...])] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]  *}} TO role [, ...]</pre>	Enable the specified roles to list transactions and queries for user(s) or all users in the default database, specific database(s), or all databases.
<pre>GRANT TERMINATE TRANSACTION[S] [(*   user[, ...])] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]  *}} TO role [, ...]</pre>	Enable the specified roles to end running transactions and queries for user(s) or all users in the default database, specific database(s), or all databases.
<pre>GRANT TRANSACTION [MANAGEMENT] [(*   user[, ...])] ON {DEFAULT DATABASE   DATABASE[S] {name [, ...]  *}} TO role [, ...]</pre>	Enable the specified roles to manage transactions and queries for user(s) or all users in the default database, specific database(s), or all databases.



Note that the **TRANSACTION MANAGEMENT** privileges are not included in the **ALL DATABASE PRIVILEGES**.

For example, granting the ability to list transactions for user `jake` in the database `neo4j` to the role `regularUsers` is done using the following query.

### Query

```
GRANT SHOW TRANSACTION(jake)
ON DATABASE neo4j TO regularUsers
```

0 rows, System updates: 1

## DBMS administration

All DBMS privileges are relevant system-wide. Like user management, they do not belong to one specific database or graph. For more details on the differences between graphs, databases and the DBMS, refer to [Neo4j databases and graphs](#).

As [described above](#), the `admin` role has a number of built-in privileges. These include:

- Create and drop databases
- Change configuration parameters
- Manage transactions
- Manage users and roles
- Manage sub-graph privileges
- Manage procedure security

The easiest way to enable a user to perform these tasks is to grant them the `admin` role. All of these privileges are also assignable using Cypher commands. See the sections on [role management](#), [user management](#), [database management](#), [privilege management](#), [transaction management](#) and [procedure and user defined function security](#) for details. It is possible to make a custom role with a subset of these privileges.

### Using a custom role to manage DBMS privileges

If it is desired to have an administrator with a subset of privileges that includes all DBMS privileges,

but not all database privileges, this can be achieved by copying the `admin` role and revoking or denying some privileges.

First we copy the 'admin' role:

*Query*

```
CREATE ROLE usermanager AS COPY OF admin
```

0 rows, System updates: 2

Then we DENY ACCESS to normal databases:

*Query*

```
DENY ACCESS  
ON DATABASE * TO usermanager
```

0 rows, System updates: 1

And DENY START and STOP for normal databases:

*Query*

```
DENY  
START  
ON DATABASE * TO usermanager
```

0 rows, System updates: 1

*Query*

```
DENY STOP  
ON DATABASE * TO usermanager
```

0 rows, System updates: 1

And DENY index and constraint management:

*Query*

```
DENY INDEX MANAGEMENT  
ON DATABASE * TO usermanager
```

0 rows, System updates: 1

*Query*

```
DENY CONSTRAINT MANAGEMENT  
ON DATABASE * TO usermanager
```

0 rows, System updates: 1

And finally DENY label, relationship type and property name:

*Query*

```
DENY NAME MANAGEMENT  
ON DATABASE * TO usermanager
```

0 rows, System updates: 1

The resulting role should have privileges that only allow the DBMS capabilities, like user and role management:

### Query

```
SHOW ROLE usermanager PRIVILEGES
```

Lists all privileges for role 'usermanager'

Table 461. Result

access	action	resource	graph	segment	role
"GRANTED"	"match"	"all_properties"	"*"	"NODE(*)"	"usermanager"
"GRANTED"	"write"	"graph"	"*"	"NODE(*)"	"usermanager"
"GRANTED"	"match"	"all_properties"	"*"	"RELATIONSHIP(*)"	"usermanager"
"GRANTED"	"write"	"graph"	"*"	"RELATIONSHIP(*)"	"usermanager"
"DENIED"	"access"	"database"	"*"	"database"	"usermanager"
"GRANTED"	"access"	"database"	"*"	"database"	"usermanager"
"GRANTED"	"admin"	"database"	"*"	"database"	"usermanager"
"DENIED"	"constraint"	"database"	"*"	"database"	"usermanager"
"GRANTED"	"constraint"	"database"	"*"	"database"	"usermanager"
"DENIED"	"index"	"database"	"*"	"database"	"usermanager"
"GRANTED"	"index"	"database"	"*"	"database"	"usermanager"
"DENIED"	"start_database"	"database"	"*"	"database"	"usermanager"
"DENIED"	"stop_database"	"database"	"*"	"database"	"usermanager"
"DENIED"	"token"	"database"	"*"	"database"	"usermanager"
"GRANTED"	"token"	"database"	"*"	"database"	"usermanager"
15 rows					

The dbms **ROLE MANAGEMENT** privileges

The dbms privileges for role management are assignable using Cypher administrative commands. They can be granted, denied and revoked like other privileges.

Table 462. Role management privileges command syntax

Command	Description
<pre>GRANT CREATE ROLE ON DBMS TO role[, ...]</pre>	Enable the specified roles to create new roles.
<pre>GRANT DROP ROLE ON DBMS TO role[, ...]</pre>	Enable the specified roles to delete roles.

Command	Description
GRANT ASSIGN ROLE ON DBMS TO role[, ...]	Enable the specified roles to assign roles to users.
GRANT REMOVE ROLE ON DBMS TO role[, ...]	Enable the specified roles to remove roles from users.
GRANT SHOW ROLE ON DBMS TO role[, ...]	Enable the specified roles to list roles.
GRANT ROLE MANAGEMENT ON DBMS TO role[, ...]	Enable the specified roles to create, delete, assign, remove, and list roles.

The ability to add roles can be granted via the `CREATE ROLE` privilege. The following query shows an example of this:

#### Query

```
GRANT
CREATE ROLE
ON DBMS TO roleAdder
```

0 rows, System updates: 1

The resulting role should have privileges that only allow adding roles:

#### Query

```
SHOW ROLE roleAdder PRIVILEGES
```

Lists all privileges for role 'roleAdder'

Table 463. Result

access	action	resource	graph	segment	role
"GRANTED"	"create_role"	"database"	"*"	"database"	"roleAdder"
1 row					

The ability to delete roles can be granted via the `DROP ROLE` privilege. The following query shows an example of this:

#### Query

```
GRANT DROP ROLE
ON DBMS TO roleDropper
```

0 rows, System updates: 1

The resulting role should have privileges that only allow deleting roles:

#### Query

```
SHOW ROLE roleDropper PRIVILEGES
```

Lists all privileges for role 'roleDropper'

Table 464. Result

access	action	resource	graph	segment	role
"GRANTED"	"drop_role"	"database"	"*"	"database"	"roleDropper"
1 row					

The ability to assign roles to users can be granted via the `ASSIGN ROLE` privilege. The following query shows an example of this:

#### Query

```
GRANT ASSIGN ROLE  
ON DBMS TO roleAssigner
```

0 rows, System updates: 1

The resulting role should have privileges that only allow assigning/granting roles:

#### Query

```
SHOW ROLE roleAssigner PRIVILEGES
```

Lists all privileges for role 'roleAssigner'

Table 465. Result

access	action	resource	graph	segment	role
"GRANTED"	"assign_role"	"database"	"*"	"database"	"roleAssigner"
1 row					

The ability to remove roles from users can be granted via the `REMOVE ROLE` privilege. The following query shows an example of this:

#### Query

```
GRANT  
REMOVE ROLE  
ON DBMS TO roleRemover
```

0 rows, System updates: 1

The resulting role should have privileges that only allow removing/revoking roles:

#### Query

```
SHOW ROLE roleRemover PRIVILEGES
```

Lists all privileges for role 'roleRemover'

Table 466. Result

access	action	resource	graph	segment	role
"GRANTED"	"remove_role"	"database"	"*"	"database"	"roleRemover"
1 row					

The ability to show roles can be granted via the `SHOW ROLE` privilege. A user with this privilege is allowed to execute the `SHOW ROLES` and `SHOW POPULATED ROLES` administration commands. For the `SHOW ROLES WITH USERS` and `SHOW POPULATED ROLES WITH USERS` administration commands, both this privilege and the `SHOW USER` privilege are required. The following query shows an example of how to grant the `SHOW ROLE` privilege:

*Query*

```
GRANT SHOW ROLE
ON DBMS TO roleShower
```

0 rows, System updates: 1

The resulting role should have privileges that only allow showing roles:

*Query*

```
SHOW ROLE roleShower PRIVILEGES
```

Lists all privileges for role 'roleShower'

Table 467. Result

access	action	resource	graph	segment	role
"GRANTED"	"show_role"	"database"	"*"	"database"	"roleShower"
1 row					

All of the above mentioned privileges can be granted via the `ROLE MANAGEMENT` privilege. The following query shows an example of this:

*Query*

```
GRANT ROLE MANAGEMENT
ON DBMS TO roleManager
```

0 rows, System updates: 1

The resulting role should have all privileges to manage roles:

*Query*

```
SHOW ROLE roleManager PRIVILEGES
```

Lists all privileges for role 'roleManager'

Table 468. Result

access	action	resource	graph	segment	role
"GRANTED"	"role_management"	"database"	"*"	"database"	"roleManager"
1 row					

## The dbms **USER MANAGEMENT** privileges

The dbms privileges for user management are assignable using Cypher administrative commands. They can be granted, denied and revoked like other privileges.

*Table 469. User management privileges command syntax*

Command	Description
<pre>GRANT CREATE USER ON DBMS TO role[, ...]</pre>	Enable the specified roles to create new users.
<pre>GRANT DROP USER ON DBMS TO role[, ...]</pre>	Enable the specified roles to delete users.
<pre>GRANT ALTER USER ON DBMS TO role[, ...]</pre>	Enable the specified roles to modify users.
<pre>GRANT SET PASSWORD[S] ON DBMS TO role[, ...]</pre>	Enable the specified roles to modify users' passwords and whether those passwords must be changed upon first login.
<pre>GRANT SET USER STATUS ON DBMS TO role[, ...]</pre>	Enable the specified roles to modify the account status of users.
<pre>GRANT SHOW USER ON DBMS TO role[, ...]</pre>	Enable the specified roles to list users.
<pre>GRANT USER MANAGEMENT ON DBMS TO role[, ...]</pre>	Enable the specified roles to create, delete, modify, and list users.

The ability to add users can be granted via the **CREATE USER** privilege. The following query shows an example of this:

### Query

```
GRANT  
CREATE USER  
ON DBMS TO userAdder
```

0 rows, System updates: 1

The resulting role should have privileges that only allow adding users:

### Query

```
SHOW ROLE userAdder PRIVILEGES
```

Lists all privileges for role 'userAdder'

Table 470. Result

access	action	resource	graph	segment	role
"GRANTED"	"create_user"	"database"	"*"	"database"	"userAdder"
1 row					

The ability to delete users can be granted via the `DROP USER` privilege. The following query shows an example of this:

### Query

```
GRANT DROP USER  
ON DBMS TO userDropper
```

0 rows, System updates: 1

The resulting role should have privileges that only allow deleting users:

### Query

```
SHOW ROLE userDropper PRIVILEGES
```

Lists all privileges for role 'userDropper'

Table 471. Result

access	action	resource	graph	segment	role
"GRANTED"	"drop_user"	"database"	"*"	"database"	"userDropper"
1 row					

The ability to modify users can be granted via the `ALTER USER` privilege. The following query shows an example of this:

### Query

```
GRANT ALTER USER  
ON DBMS TO userModifier
```

0 rows, System updates: 1

The resulting role should have privileges that only allow modifying users:

### Query

```
SHOW ROLE userModifier PRIVILEGES
```

Lists all privileges for role 'userModifier'

Table 472. Result

access	action	resource	graph	segment	role
"GRANTED"	"alter_user"	"database"	"*"	"database"	"userModifier"
1 row					

A user that is granted `ALTER USER` is allowed to run the `ALTER USER` administration command with one or several of the `SET PASSWORD`, `SET PASSWORD CHANGE [NOT] REQUIRED` and `SET STATUS` parts:

#### Query

```
ALTER USER jake
SET PASSWORD 'secret'
SET STATUS SUSPENDED
```

0 rows, System updates: 1

The ability to modify users' passwords and whether those passwords must be changed upon first login can be granted via the `SET PASSWORDS` privilege. The following query shows an example of this:

#### Query

```
GRANT
SET PASSWORDS
ON DBMS TO passwordModifier
```

0 rows, System updates: 1

The resulting role should have privileges that only allow modifying users' passwords and whether those passwords must be changed upon first login:

#### Query

```
SHOW ROLE passwordModifier PRIVILEGES
```

Lists all privileges for role 'passwordModifier'

Table 473. Result

access	action	resource	graph	segment	role
"GRANTED"	"set_passwords"	"database"	"*"	"database"	"passwordModifier"
1 row					

A user that is granted `SET PASSWORDS` is allowed to run the `ALTER USER` administration command with one or both of the `SET PASSWORD` and `SET PASSWORD CHANGE [NOT] REQUIRED` parts:

#### Query

```
ALTER USER jake
SET PASSWORD 'abc123' CHANGE NOT REQUIRED
```

0 rows, System updates: 1

The ability to modify the account status of users can be granted via the `SET USER STATUS` privilege. The following query shows an example of this:

### Query

```
GRANT  
SET USER STATUS  
ON DBMS TO statusModifier
```

0 rows, System updates: 1

The resulting role should have privileges that only allow modifying the account status of users:

### Query

```
SHOW ROLE statusModifier PRIVILEGES
```

Lists all privileges for role 'statusModifier'

Table 474. Result

access	action	resource	graph	segment	role
"GRANTED"	"set_user_status"	"database"	"*"	"database"	"statusModifier"
1 row					

A user that is granted `SET USER STATUS` is allowed to run the `ALTER USER` administration command with only the `SET STATUS` part:

### Query

```
ALTER USER jake  
SET STATUS ACTIVE
```

0 rows, System updates: 1



Note that the combination of the `SET PASSWORDS` and the `SET USER STATUS` privilege actions is equivalent to the `ALTER USER` privilege action.

The ability to show users can be granted via the `SHOW USER` privilege. The following query shows an example of this:

### Query

```
GRANT SHOW USER  
ON DBMS TO userShower
```

0 rows, System updates: 1

The resulting role should have privileges that only allow showing users:

### Query

```
SHOW ROLE userShower PRIVILEGES
```

Lists all privileges for role 'userShower'

Table 475. Result

access	action	resource	graph	segment	role
"GRANTED"	"show_user"	"database"	"*"	"database"	"userShower"

access	action	resource	graph	segment	role
1 row					

All of the above mentioned privileges can be granted via the **USER MANAGEMENT** privilege. The following query shows an example of this:

#### Query

```
GRANT USER MANAGEMENT
ON DBMS TO userManager
```

0 rows, System updates: 1

The resulting role should have all privileges to manage users:

#### Query

```
SHOW ROLE userManager PRIVILEGES
```

Lists all privileges for role 'userManager'

*Table 476. Result*

access	action	resource	graph	segment	role
"GRANTED"	"user_management"	"database"	"*"	"database"	"userManager"
1 row					

The dbms **DATABASE MANAGEMENT** privileges

The dbms privileges for database management are assignable using Cypher administrative commands. They can be granted, denied and revoked like other privileges.

*Table 477. Database management privileges command syntax*

Command	Description
GRANT CREATE DATABASE ON DBMS TO role[, ...]	Enable the specified roles to create new databases.
GRANT DROP DATABASE ON DBMS TO role[, ...]	Enable the specified roles to delete databases.
GRANT DATABASE MANAGEMENT ON DBMS TO role[, ...]	Enable the specified roles to manage databases.

The ability to create databases can be granted via the **CREATE DATABASE** privilege. The following query shows an example of this:

## Query

```
GRANT  
CREATE DATABASE  
ON DBMS TO databaseAdder
```

0 rows, System updates: 1

The resulting role should have privileges that only allow creating databases:

## Query

```
SHOW ROLE databaseAdder PRIVILEGES
```

Lists all privileges for role 'databaseAdder'

*Table 478. Result*

access	action	resource	graph	segment	role
"GRANTED"	"create_database"	"database"	"*"	"database"	"databaseAdder"
1 row					

The ability to delete databases can be granted via the `DROP DATABASE` privilege. The following query shows an example of this:

## Query

```
GRANT DROP DATABASE  
ON DBMS TO databaseDropper
```

0 rows, System updates: 1

The resulting role should have privileges that only allow deleting databases:

## Query

```
SHOW ROLE databaseDropper PRIVILEGES
```

Lists all privileges for role 'databaseDropper'

*Table 479. Result*

access	action	resource	graph	segment	role
"GRANTED"	"drop_database"	"database"	"*"	"database"	"databaseDropper"
1 row					

Both of the above mentioned privileges can be granted via the `DATABASE MANAGEMENT` privilege. The following query shows an example of this:

## Query

```
GRANT DATABASE MANAGEMENT  
ON DBMS TO databaseManager
```

0 rows, System updates: 1

The resulting role should have all privileges to manage databases:

## Query

```
SHOW ROLE databaseManager PRIVILEGES
```

Lists all privileges for role 'databaseManager'

Table 480. Result

access	action	resource	graph	segment	role
"GRANTED"	"database_manager"	"database"	"*"	"database"	"databaseManager"
1 row					

The dbms **PRIVILEGE MANAGEMENT** privileges

The dbms privileges for privilege management are assignable using Cypher administrative commands. They can be granted, denied and revoked like other privileges.

Table 481. Privilege management privileges command syntax

Command	Description
GRANT SHOW PRIVILEGE ON DBMS TO role[, ...]	Enable the specified roles to list privileges.
GRANT ASSIGN PRIVILEGE ON DBMS TO role[, ...]	Enable the specified roles to assign privileges using the <b>GRANT</b> and <b>DENY</b> commands.
GRANT REMOVE PRIVILEGE ON DBMS TO role[, ...]	Enable the specified roles to remove privileges using the <b>REVOKE</b> command.
GRANT PRIVILEGE MANAGEMENT ON DBMS TO role[, ...]	Enable the specified roles to list, assign, and remove privileges.

The ability to list privileges can be granted via the **SHOW PRIVILEGE** privilege. A user with this privilege is allowed to execute the **SHOW PRIVILEGES** and **SHOW ROLE roleName PRIVILEGES** administration commands. For the **SHOW USER username PRIVILEGES** administration command, both this privilege and the **SHOW USER** privilege are required. The following query shows an example of how to grant the **SHOW PRIVILEGE** privilege:

## Query

```
GRANT SHOW PRIVILEGE  
ON DBMS TO privilegeShower
```

0 rows, System updates: 1

The resulting role should have privileges that only allow showing privileges:

## Query

```
SHOW ROLE privilegeShower PRIVILEGES
```

Lists all privileges for role 'privilegeShower'

Table 482. Result

access	action	resource	graph	segment	role
"GRANTED"	"show_privilege"	"database"	"*"	"database"	"privilegeShower"
1 row					

Note that no specific privileges are required for showing the current user's privileges using either `SHOW USER username PRIVILEGES`, or `SHOW USER PRIVILEGES`.



Please note that if a non-native auth provider like LDAP is in use, `SHOW USER PRIVILEGES` will only work in a limited capacity; It is only possible for a user to show their own privileges. Other users' privileges cannot be listed when using a non-native auth provider.

The ability to assign privileges to roles can be granted via the `ASSIGN PRIVILEGE` privilege. A user with this privilege is allowed to execute GRANT and DENY administration commands. The following query shows an example of how to grant this privilege:

## Query

```
GRANT ASSIGN PRIVILEGE  
ON DBMS TO privilegeAssigner
```

0 rows, System updates: 1

The resulting role should have privileges that only allow assigning privileges:

## Query

```
SHOW ROLE privilegeAssigner PRIVILEGES
```

Lists all privileges for role 'privilegeAssigner'

Table 483. Result

access	action	resource	graph	segment	role
"GRANTED"	"assign_privilege"	"database"	"*"	"database"	"privilegeAssigner"
1 row					

The ability to remove privileges from roles can be granted via the `REMOVE PRIVILEGE` privilege. A user with this privilege is allowed to execute REVOKE administration commands. The following query shows an example of how to grant this privilege:

## Query

```
GRANT  
REMOVE PRIVILEGE  
ON DBMS TO privilegeRemover
```

0 rows, System updates: 1

The resulting role should have privileges that only allow removing privileges:

#### Query

```
SHOW ROLE privilegeRemover PRIVILEGES
```

Lists all privileges for role 'privilegeRemover'

Table 484. Result

access	action	resource	graph	segment	role
"GRANTED"	"remove_privilege" "	"database"	"*"	"database"	"privilegeRemover" "
1 row					

All of the above mentioned privileges can be granted via the **PRIVILEGE MANAGEMENT** privilege. The following query shows an example of this:

#### Query

```
GRANT PRIVILEGE MANAGEMENT  
ON DBMS TO privilegeManager
```

0 rows, System updates: 1

The resulting role should have all privileges to manage privileges:

#### Query

```
SHOW ROLE privilegeManager PRIVILEGES
```

Lists all privileges for role 'privilegeManager'

Table 485. Result

access	action	resource	graph	segment	role
"GRANTED"	"privilege_management"	"database"	"*"	"database"	"privilegeManager" "
1 row					

The dbms **EXECUTE** privileges

The dbms privileges for procedure and user defined function execution are assignable using Cypher administrative commands. They can be granted, denied and revoked like other privileges.

Table 486. Execute privileges command syntax

Command	Description
<pre>GRANT EXECUTE PROCEDURE[S] name-globbing[,...] ON DBMS TO role[, ...]</pre>	Enable the specified roles to execute the given procedures.

Command	Description
<pre>GRANT EXECUTE BOOSTED PROCEDURE[S] name-globbing[,...] ON DBMS TO role[, ...]</pre>	Enable the specified roles to execute the given procedures with elevated privileges.
<pre>GRANT EXECUTE ADMIN[ISTRATOR] PROCEDURES ON DBMS TO role[, ...]</pre>	Enable the specified roles to execute procedures annotated with <code>@Admin</code> .
<pre>GRANT EXECUTE [USER [DEFINED]] FUNCTION[S] name- globbing[,...] ON DBMS TO role[, ...]</pre>	Enable the specified roles to execute the given user defined functions.
<pre>GRANT EXECUTE BOOSTED [USER [DEFINED]] FUNCTION[S] name- globbing[,...] ON DBMS TO role[, ...]</pre>	Enable the specified roles to execute the given user defined functions with elevated privileges.

The `EXECUTE BOOSTED` privileges replace the `dbms.security.procedures.default_allowed` and `dbms.security.procedures.roles` configuration parameters for procedures and user defined functions. The configuration parameters are still honoured as a set of temporary privileges. These cannot be revoked, but will be updated on each restart with the current configuration values.

The `EXECUTE PROCEDURE` privilege

The ability to execute a procedure can be granted via the `EXECUTE PROCEDURE` privilege. A user with this privilege is allowed to execute the procedures matched by the `name-globbing`. The following query shows an example of how to grant this privilege:

#### Query

```
GRANT EXECUTE PROCEDURE db.schema./*
ON DBMS TO procedureExecutor
```

0 rows, System updates: 1

Users with the role 'procedureExecutor' can then run any procedure in the `db.schema` namespace. The procedure will be run using the users own privileges.

The resulting role should have privileges that only allow executing procedures in the `db.schema` namespace:

#### Query

```
SHOW ROLE procedureExecutor PRIVILEGES
```

Lists all privileges for role 'procedureExecutor'

*Table 487. Result*

access	action	resource	graph	segment	role
"GRANTED"	"execute"	"database"	"*"	"PROCEDURE(db.schema.*)"	"procedureExecutor"
1 row					

If we want to allow executing all but a few procedures, we can grant `EXECUTE PROCEDURES *` and deny the unwanted procedures. For example, the following queries allows for executing all procedures except `dbms.killTransaction` and `dbms.killTransactions`:

#### Query

```
GRANT EXECUTE PROCEDURE *
ON DBMS TO deniedProcedureExecutor
```

0 rows, System updates: 1

#### Query

```
DENY EXECUTE PROCEDURE dbms.killTransaction*
ON DBMS TO deniedProcedureExecutor
```

0 rows, System updates: 1

The resulting role should have privileges that only allow executing all procedures except `dbms.killTransaction` and `dbms.killTransactions`:

#### Query

```
SHOW ROLE deniedProcedureExecutor PRIVILEGES
```

Lists all privileges for role 'deniedProcedureExecutor'

Table 488. Result

access	action	resource	graph	segment	role
"GRANTED"	"execute"	"database"	"*"	"PROCEDURE(*)"	"deniedProcedureExecutor"
"DENIED"	"execute"	"database"	"*"	"PROCEDURE(dbms.killTransaction*)"	"deniedProcedureExecutor"
2 rows					

The `EXECUTE BOOSTED PROCEDURE` privilege

The ability to execute a procedure with elevated privileges can be granted via the `EXECUTE BOOSTED PROCEDURE` privilege. A user with this privilege is allowed to execute the procedures matched by the `name-globbing` without the execution being restricted to their other privileges. The following query shows an example of how to grant this privilege:

#### Query

```
GRANT EXECUTE BOOSTED PROCEDURE db.labels, db.relationshipTypes
ON DBMS TO boostedProcedureExecutor
```

0 rows, System updates: 2

Users with the role 'boostedProcedureExecutor' can then run `db.labels` and `db.relationshipTypes` with full privileges, seeing everything in the graph not just the labels and types that the user has

`TRAVERSE` privilege on.

The resulting role should have privileges that only allow executing procedures `db.labels` and `db.relationshipTypes`, but with elevated execution:

#### Query

```
SHOW ROLE boostedProcedureExecutor PRIVILEGES
```

Lists all privileges for role 'boostedProcedureExecutor'

Table 489. Result

access	action	resource	graph	segment	role
"GRANTED"	"execute_boosted"	"database"	"*"	"PROCEDURE(db.labels)"	"boostedProcedureExecutor"
"GRANTED"	"execute_boosted"	"database"	"*"	"PROCEDURE(db.relationshipTypes)"	"boostedProcedureExecutor"
2 rows					

While granting `EXECUTE BOOSTED PROCEDURE` on its own allows the procedure to be both executed and given elevated privileges during the execution, the deny behaves slightly different and only denies the elevation and not the execution. However, having only a granted `EXECUTE BOOSTED PROCEDURE` and a deny `EXECUTE BOOSTED PROCEDURE` will deny the execution as well. This is explained through the examples below:

Example 1: Grant `EXECUTE PROCEDURE` and deny `EXECUTE BOOSTED PROCEDURE`

#### Query

```
GRANT EXECUTE PROCEDURE *
ON DBMS TO deniedBoostedProcedureExecutor1
```

0 rows, System updates: 1

#### Query

```
DENY EXECUTE BOOSTED PROCEDURE db.labels
ON DBMS TO deniedBoostedProcedureExecutor1
```

0 rows, System updates: 1

The resulting role should have privileges that allow executing all procedures using the users own privileges, as well as blocking `db.labels` from being elevated. The deny `EXECUTE BOOSTED PROCEDURE` does not block execution of `db.labels`.

#### Query

```
SHOW ROLE deniedBoostedProcedureExecutor1 PRIVILEGES
```

Lists all privileges for role 'deniedBoostedProcedureExecutor1'

Table 490. Result

access	action	resource	graph	segment	role
"GRANTED"	"execute"	"database"	"*"	"PROCEDURE(*)"	"deniedBoostedProcedureExecutor1"

access	action	resource	graph	segment	role
"DENIED"	"execute_boosted"	"database"	"*"	"PROCEDURE(db.labels)"	"deniedBoostedProcedureExecutor1"
2 rows					

Example 2: Grant EXECUTE BOOSTED PROCEDURE and deny EXECUTE PROCEDURE

Query

```
GRANT EXECUTE BOOSTED PROCEDURE *
ON DBMS TO deniedBoostedProcedureExecutor2
```

0 rows, System updates: 1

Query

```
DENY EXECUTE PROCEDURE db.labels
ON DBMS TO deniedBoostedProcedureExecutor2
```

0 rows, System updates: 1

The resulting role should have privileges that allow executing all procedures with elevated privileges except db.labels which is not allowed to execute at all:

Query

```
SHOW ROLE deniedBoostedProcedureExecutor2 PRIVILEGES
```

Lists all privileges for role 'deniedBoostedProcedureExecutor2'

Table 491. Result

access	action	resource	graph	segment	role
"GRANTED"	"execute_boosted"	"database"	"*"	"PROCEDURE(*)"	"deniedBoostedProcedureExecutor2"
"DENIED"	"execute"	"database"	"*"	"PROCEDURE(db.labels)"	"deniedBoostedProcedureExecutor2"
2 rows					

Example 3: Grant EXECUTE BOOSTED PROCEDURE and deny EXECUTE BOOSTED PROCEDURE

Query

```
GRANT EXECUTE BOOSTED PROCEDURE *
ON DBMS TO deniedBoostedProcedureExecutor3
```

0 rows, System updates: 1

Query

```
DENY EXECUTE BOOSTED PROCEDURE db.labels
ON DBMS TO deniedBoostedProcedureExecutor3
```

0 rows, System updates: 1

The resulting role should have privileges that allow executing all procedures with elevated privileges except db.labels which is not allowed to execute at all:

## Query

```
SHOW ROLE deniedBoostedProcedureExecutor3 PRIVILEGES
```

Lists all privileges for role 'deniedBoostedProcedureExecutor3'

Table 492. Result

access	action	resource	graph	segment	role
"GRANTED"	"execute_boosted"	"database"	"*"	"PROCEDURE(*)"	"deniedBoostedProcedureExecutor3"
"DENIED"	"execute_boosted"	"database"	"*"	"PROCEDURE(db.labels)"	"deniedBoostedProcedureExecutor3"
2 rows					

Example 4: Grant EXECUTE PROCEDURE and EXECUTE BOOSTED PROCEDURE and deny EXECUTE BOOSTED PROCEDURE

## Query

```
GRANT EXECUTE PROCEDURE db.labels  
ON DBMS TO deniedBoostedProcedureExecutor4
```

0 rows, System updates: 1

## Query

```
GRANT EXECUTE BOOSTED PROCEDURE *  
ON DBMS TO deniedBoostedProcedureExecutor4
```

0 rows, System updates: 1

## Query

```
DENY EXECUTE BOOSTED PROCEDURE db.labels  
ON DBMS TO deniedBoostedProcedureExecutor4
```

0 rows, System updates: 1

The resulting role should have privileges that allow executing all procedures with elevated privileges except `db.labels` which is only allowed to execute using the users own privileges:

## Query

```
SHOW ROLE deniedBoostedProcedureExecutor4 PRIVILEGES
```

Lists all privileges for role 'deniedBoostedProcedureExecutor4'

Table 493. Result

access	action	resource	graph	segment	role
"GRANTED"	"execute_boosted"	"database"	"*"	"PROCEDURE(*)"	"deniedBoostedProcedureExecutor4"
"GRANTED"	"execute"	"database"	"*"	"PROCEDURE(db.labels)"	"deniedBoostedProcedureExecutor4"
"DENIED"	"execute_boosted"	"database"	"*"	"PROCEDURE(db.labels)"	"deniedBoostedProcedureExecutor4"

access	action	resource	graph	segment	role
3 rows					

The `EXECUTE ADMIN PROCEDURES` privilege

The ability to execute admin procedures (annotated with `@Admin`) can be granted via the `EXECUTE ADMIN PROCEDURES` privilege. This privilege is equivalent with granting `the EXECUTE BOOSTED PROCEDURE privilege` on each of the admin procedures. Any new admin procedures that gets added are automatically included in this privilege. The following query shows an example of how to grant this privilege:

*Query*

```
GRANT EXECUTE ADMIN PROCEDURES
ON DBMS TO adminProcedureExecutor
```

0 rows, System updates: 1

Users with the role 'adminProcedureExecutor' can then run any admin procedure with elevated privileges.

The resulting role should have privileges that allows executing all admin procedures:

*Query*

```
SHOW ROLE adminProcedureExecutor PRIVILEGES
```

Lists all privileges for role 'adminProcedureExecutor'

*Table 494. Result*

access	action	resource	graph	segment	role
"GRANTED"	"execute_admin"	"database"	"*"	"database"	"adminProcedureExecutor"
1 row					

The `EXECUTE USER DEFINED FUNCTION` privilege

The ability to execute a user defined function (UDF) can be granted via the `EXECUTE USER DEFINED FUNCTION` privilege. A user with this privilege is allowed to execute the UDFs matched by the `name-globbing`. The following query shows an example of how to grant this privilege:

*Query*

```
GRANT EXECUTE FUNCTION apoc.coll./*
ON DBMS TO functionExecutor
```

0 rows, System updates: 1

Users with the role 'functionExecutor' can then run any UDF in the `apoc.coll` namespace. The function will be run using the users own privileges.

The resulting role should have privileges that only allow executing UDFs in the `apoc.coll` namespace:

*Query*

```
SHOW ROLE functionExecutor PRIVILEGES
```

Lists all privileges for role 'functionExecutor'

Table 495. Result

access	action	resource	graph	segment	role
"GRANTED"	"execute"	"database"	"*"	"FUNCTION(apoc.co 11.*)"	"functionExecutor "
1 row					

If we want to allow executing all but a few UDFs, we can grant `EXECUTE USER DEFINED FUNCTIONS *` and deny the unwanted functions. For example, the following queries allows for executing all UDFs except `apoc.any.property` and `apoc.any.properties`:

Query

```
GRANT EXECUTE FUNCTIONS *
ON DBMS TO deniedFunctionExecutor
```

0 rows, System updates: 1

Query

```
DENY EXECUTE FUNCTION apoc.any.prop*
ON DBMS TO deniedFunctionExecutor
```

0 rows, System updates: 1

The resulting role should have privileges that only allow executing all procedures except `apoc.any.property` and `apoc.any.properties`:

Query

```
SHOW ROLE deniedFunctionExecutor PRIVILEGES
```

Lists all privileges for role 'deniedFunctionExecutor'

Table 496. Result

access	action	resource	graph	segment	role
"GRANTED"	"execute"	"database"	"*"	"FUNCTION(*)"	"deniedFunctionEx ecutor"
"DENIED"	"execute"	"database"	"*"	"FUNCTION(apoc.an y.prop*)"	"deniedFunctionEx ecutor"
2 rows					

The `EXECUTE BOOSTED USER DEFINED FUNCTION` privilege

The ability to execute a user defined function (UDF) with elevated privileges can be granted via the `EXECUTE BOOSTED USER DEFINED FUNCTION` privilege. A user with this privilege is allowed to execute the UDFs matched by the `name-globbing` without the execution being restricted to their other privileges. The following query shows an example of how to grant this privilege:

Query

```
GRANT EXECUTE BOOSTED FUNCTION apoc.any.properties
ON DBMS TO boostedFunctionExecutor
```

0 rows, System updates: 1

Users with the role 'boostedFunctionExecutor' can then run `apoc.any.properties` with full privileges, seeing every property on the node/relationship not just the properties that the user has **READ** privilege on.

The resulting role should have privileges that only allow executing the UDF `apoc.any.properties`, but with elevated execution:

### Query

```
SHOW ROLE boostedFunctionExecutor PRIVILEGES
```

Lists all privileges for role 'boostedFunctionExecutor'

Table 497. Result

access	action	resource	graph	segment	role
"GRANTED"	"execute_boosted"	"database"	"*"	"FUNCTION(apoc.any.properties)"	"boostedFunctionExecutor"
1 row					

While granting `EXECUTE BOOSTED USER DEFINED FUNCTION` on its own allows the UDF to be both executed and given elevated privileges during the execution, the deny behaves slightly different and only denies the elevation and not the execution. However, having only a granted `EXECUTE BOOSTED USER DEFINED FUNCTION` and a deny `EXECUTE BOOSTED USER DEFINED FUNCTION` will deny the execution as well. This is the same behaviour as for `EXECUTE BOOSTED PROCEDURE`, for examples see [The EXECUTE BOOSTED PROCEDURE privilege](#)

Procedure and user defined function name-globbing

The name-globbing for procedure and user defined function names is a simplified version of globbing for filename expansions, only allowing two wildcard characters — `*` and `?`. They are used for multiple and single character matches, where `*` means 0 or more characters and `?` matches exactly one character.

The examples below only use procedures but the same rules apply to user defined function names. For the examples below, assume we have the following procedures:

- `mine.public.exampleProcedure`
- `mine.public.exampleProcedure1`
- `mine.public.exampleProcedure42`
- `mine.private.exampleProcedure`
- `mine.private.exampleProcedure1`
- `mine.private.exampleProcedure2`
- `your.exampleProcedure`

### Query

```
GRANT EXECUTE PROCEDURE *
ON DBMS TO globbing1
```

0 rows, System updates: 1

Users with the role 'globbing1' can then run procedures all the procedures.

### Query

```
GRANT EXECUTE PROCEDURE mine.*.exampleProcedure  
ON DBMS TO globbing2
```

0 rows, System updates: 1

Users with the role 'globbing2' can then run procedures `mine.public.exampleProcedure` and `mine.private.exampleProcedure`, but none of the others.

### Query

```
GRANT EXECUTE PROCEDURE mine.*.exampleProcedure?  
ON DBMS TO globbing3
```

0 rows, System updates: 1

Users with the role 'globbing3' can then run procedures `mine.public.exampleProcedure1`, `mine.private.exampleProcedure1` and `mine.private.exampleProcedure2`, but none of the others.

### Query

```
GRANT EXECUTE PROCEDURE *.exampleProcedure  
ON DBMS TO globbing4
```

0 rows, System updates: 1

Users with the role 'globbing4' can then run procedures `your.exampleProcedure`, `mine.public.exampleProcedure` and `mine.private.exampleProcedure`, but none of the others.

### Query

```
GRANT EXECUTE PROCEDURE mine.public.exampleProcedure*  
ON DBMS TO globbing5
```

0 rows, System updates: 1

Users with the role 'globbing5' can then run procedures `mine.public.exampleProcedure`, `mine.public.exampleProcedure1` and `mine.public.exampleProcedure42`, but none of the others.

## Granting ALL DBMS PRIVILEGES

The right to perform the following privileges can be achieved with a single command:

- create roles
- drop roles
- assign roles
- remove roles
- show roles
- create users
- alter users
- drop users
- show users
- create databases

- drop databases
- show privileges
- assign privileges
- remove privileges
- execute all procedures with elevated privileges

*Command syntax*

```
GRANT ALL [[DBMS] PRIVILEGES]
ON DBMS
TO role[, ...]
```

For example, granting the abilities above to the role `dbmsManager` is done using the following query.

*Query*

```
GRANT ALL DBMS PRIVILEGES
ON DBMS TO dbmsManager
```

0 rows, System updates: 1

The privileges granted can be seen using the `SHOW PRIVILEGES` command:

*Query*

```
SHOW ROLE dbmsManager PRIVILEGES
```

*Table 498. Result*

access	action	resource	graph	segment	role
"GRANTED"	"dbms_actions"	"database"	"*"	"database"	"dbmsManager"
1 row					

## 5.5.7. Built-in roles

*This section explains the default privileges of the built-in roles in Neo4j and how to recreate them if needed.*

All of the commands described in this chapter require that the user executing the commands has the rights to do so. The privileges listed in the following sections are the default set of privileges for each built-in role:

- [The PUBLIC role](#)
- [The reader role](#)
- [The editor role](#)
- [The publisher role](#)
- [The architect role](#)
- [The admin role](#)

## The **PUBLIC** role

All users are granted the **PUBLIC** role, and it can not be revoked or dropped. By default, it gives access to the default database and allows executing all procedures and user defined functions.

### Privileges of the **PUBLIC** role

#### Query

```
SHOW ROLE PUBLIC PRIVILEGES
```

Table 499. Result

access	action	resource	graph	segment	role
"GRANTED"	"execute"	"database"	"*"	"FUNCTION(*)"	"PUBLIC"
"GRANTED"	"execute"	"database"	"*"	"PROCEDURE(*)"	"PUBLIC"
"GRANTED"	"access"	"database"	"DEFAULT"	"database"	"PUBLIC"
3 rows					

### How to recreate the **PUBLIC** role

The **PUBLIC** role can not be dropped and thus there is no need to recreate the role itself. To restore the role to its original capabilities, two steps are needed. First, all **GRANT** or **DENY** privileges on this role should be revoked (see output of **SHOW ROLE PUBLIC PRIVILEGES** on what to revoke). Secondly, the following queries must be run:

#### Query

```
GRANT ACCESS  
ON DEFAULT DATABASE TO PUBLIC
```

0 rows, System updates: 1

#### Query

```
GRANT EXECUTE PROCEDURES *  
ON DBMS TO PUBLIC
```

0 rows, System updates: 1

#### Query

```
GRANT EXECUTE USER DEFINED FUNCTIONS *  
ON DBMS TO PUBLIC
```

0 rows, System updates: 1

The resulting **PUBLIC** role now has the same privileges as the original built-in **PUBLIC** role.

## The **reader** role

The **reader** role can perform read-only queries on all graphs except for the **system** database.

Privileges of the `reader` role

#### Query

```
SHOW ROLE reader PRIVILEGES
```

Table 500. Result

access	action	resource	graph	segment	role
"GRANTED"	"match"	"all_properties"	"*"	"NODE(*)"	"reader"
"GRANTED"	"match"	"all_properties"	"*"	"RELATIONSHIP(*)"	"reader"
"GRANTED"	"access"	"database"	"*"	"database"	"reader"
3 rows					

How to recreate the `reader` role

To restore the role to its original capabilities two steps are needed. First, if not already done, execute `DROP ROLE reader`. Secondly, the following queries must be run:

#### Query

```
CREATE ROLE reader
```

0 rows, System updates: 1

#### Query

```
GRANT ACCESS  
ON DATABASE * TO reader
```

0 rows, System updates: 1

#### Query

```
GRANT  
MATCH { * }  
ON GRAPH * TO reader
```

0 rows, System updates: 2

The resulting `reader` role now has the same privileges as the original built-in `reader` role.

The `editor` role

The `editor` role can perform read and write operations on all graphs except for the `system` database, but can not make new labels, property keys or relationship types.

Privileges of the `editor` role

#### Query

```
SHOW ROLE editor PRIVILEGES
```

Table 501. Result

access	action	resource	graph	segment	role
"GRANTED"	"match"	"all_properties"	"*"	"NODE(*)"	"editor"
"GRANTED"	"write"	"graph"	"*"	"NODE(*)"	"editor"
"GRANTED"	"match"	"all_properties"	"*"	"RELATIONSHIP(*)"	"editor"
"GRANTED"	"write"	"graph"	"*"	"RELATIONSHIP(*)"	"editor"
"GRANTED"	"access"	"database"	"*"	"database"	"editor"
5 rows					

How to recreate the `editor` role

To restore the role to its original capabilities two steps are needed. First, if not already done, execute `DROP ROLE editor`. Secondly, the following queries must be run:

*Query*

```
CREATE ROLE editor
```

0 rows, System updates: 1

*Query*

```
GRANT ACCESS
ON DATABASE * TO editor
```

0 rows, System updates: 1

*Query*

```
GRANT
MATCH { * }
ON GRAPH * TO editor
```

0 rows, System updates: 2

*Query*

```
GRANT WRITE
ON GRAPH * TO editor
```

0 rows, System updates: 2

The resulting `editor` role now has the same privileges as the original built-in `editor` role.

The `publisher` role

The `publisher` role can do the same as `editor`, but can also create new labels, property keys and relationship types.

Privileges of the `publisher` role

*Query*

```
SHOW ROLE publisher PRIVILEGES
```

Table 502. Result

access	action	resource	graph	segment	role
"GRANTED"	"match"	"all_properties"	"*"	"NODE(*)"	"publisher"
"GRANTED"	"write"	"graph"	"*"	"NODE(*)"	"publisher"
"GRANTED"	"match"	"all_properties"	"*"	"RELATIONSHIP(*)"	"publisher"
"GRANTED"	"write"	"graph"	"*"	"RELATIONSHIP(*)"	"publisher"
"GRANTED"	"access"	"database"	"*"	"database"	"publisher"
"GRANTED"	"token"	"database"	"*"	"database"	"publisher"
6 rows					

How to recreate the `publisher` role

To restore the role to its original capabilities two steps are needed. First, if not already done, execute `DROP ROLE publisher`. Secondly, the following queries must be run:

Query

```
CREATE ROLE publisher
```

0 rows, System updates: 1

Query

```
GRANT ACCESS
ON DATABASE * TO publisher
```

0 rows, System updates: 1

Query

```
GRANT
MATCH { * }
ON GRAPH * TO publisher
```

0 rows, System updates: 2

Query

```
GRANT WRITE
ON GRAPH * TO publisher
```

0 rows, System updates: 2

Query

```
GRANT NAME MANAGEMENT
ON DATABASE * TO publisher
```

0 rows, System updates: 1

The resulting `publisher` role now has the same privileges as the original built-in `publisher` role.

## The `architect` role

The `architect` role can do the same as the `publisher`, as well as create and manage indexes and constraints.

Privileges of the `architect` role

### Query

```
SHOW ROLE architect PRIVILEGES
```

Table 503. Result

access	action	resource	graph	segment	role
"GRANTED"	"match"	"all_properties"	"*"	"NODE(*)"	"architect"
"GRANTED"	"write"	"graph"	"*"	"NODE(*)"	"architect"
"GRANTED"	"match"	"all_properties"	"*"	"RELATIONSHIP(*)"	"architect"
"GRANTED"	"write"	"graph"	"*"	"RELATIONSHIP(*)"	"architect"
"GRANTED"	"access"	"database"	"*"	"database"	"architect"
"GRANTED"	"constraint"	"database"	"*"	"database"	"architect"
"GRANTED"	"index"	"database"	"*"	"database"	"architect"
"GRANTED"	"token"	"database"	"*"	"database"	"architect"
8 rows					

How to recreate the `architect` role

To restore the role to its original capabilities two steps are needed. First, if not already done, execute `DROP ROLE architect`. Secondly, the following queries must be run:

### Query

```
CREATE ROLE architect
```

0 rows, System updates: 1

### Query

```
GRANT ACCESS  
ON DATABASE * TO architect
```

0 rows, System updates: 1

### Query

```
GRANT  
MATCH { * }  
ON GRAPH * TO architect
```

0 rows, System updates: 2

### Query

```
GRANT WRITE  
ON GRAPH * TO architect
```

0 rows, System updates: 2

Query

```
GRANT NAME MANAGEMENT  
ON DATABASE * TO architect
```

0 rows, System updates: 1

Query

```
GRANT INDEX MANAGEMENT  
ON DATABASE * TO architect
```

0 rows, System updates: 1

Query

```
GRANT CONSTRAINT MANAGEMENT  
ON DATABASE * TO architect
```

0 rows, System updates: 1

The resulting `architect` role now has the same privileges as the original built-in `architect` role.

## The `admin` role

The `admin` role can do the same as the `architect`, as well as manage databases, users, roles and privileges.

### Privileges of the `admin` role

Query

```
SHOW ROLE admin PRIVILEGES
```

Table 504. Result

access	action	resource	graph	segment	role
"GRANTED"	"match"	"all_properties"	"*"	"NODE(*)"	"admin"
"GRANTED"	"write"	"graph"	"*"	"NODE(*)"	"admin"
"GRANTED"	"match"	"all_properties"	"*"	"RELATIONSHIP(*)"	"admin"
"GRANTED"	"write"	"graph"	"*"	"RELATIONSHIP(*)"	"admin"
"GRANTED"	"access"	"database"	"*"	"database"	"admin"
"GRANTED"	"admin"	"database"	"*"	"database"	"admin"
"GRANTED"	"constraint"	"database"	"*"	"database"	"admin"
"GRANTED"	"index"	"database"	"*"	"database"	"admin"
"GRANTED"	"token"	"database"	"*"	"database"	"admin"
9 rows					

### How to recreate the `admin` role

To restore the role to its original capabilities two steps are needed. First, if not already done, execute

`DROP ROLE admin.` Secondly, the following queries must be run in order to set up the privileges:

*Query*

```
CREATE ROLE admin
```

0 rows, System updates: 1

*Query*

```
GRANT ALL DBMS PRIVILEGES  
ON DBMS TO admin
```

0 rows, System updates: 1

*Query*

```
GRANT TRANSACTION MANAGEMENT  
ON DATABASE * TO admin
```

0 rows, System updates: 1

*Query*

```
GRANT  
START  
ON DATABASE * TO admin
```

0 rows, System updates: 1

*Query*

```
GRANT STOP  
ON DATABASE * TO admin
```

0 rows, System updates: 1

*Query*

```
GRANT  
MATCH { * }  
ON GRAPH * TO admin
```

0 rows, System updates: 2

*Query*

```
GRANT WRITE  
ON GRAPH * TO admin
```

0 rows, System updates: 2

*Query*

```
GRANT ALL ON DATABASE * TO admin
```

0 rows, System updates: 1

The queries above are enough to grant most of the full admin capabilities. Please note that the result of executing `SHOW ROLE admin PRIVILEGES` now appears to be slightly different from the privileges shown for the original built-in `admin` role. This does not make any functional difference.

### Query

```
SHOW ROLE admin PRIVILEGES
```

Table 505. Result

access	action	resource	graph	segment	role
"GRANTED"	"match"	"all_properties"	"*"	"NODE(*)"	"admin"
"GRANTED"	"write"	"graph"	"*"	"NODE(*)"	"admin"
"GRANTED"	"match"	"all_properties"	"*"	"RELATIONSHIP(*)"	"admin"
"GRANTED"	"write"	"graph"	"*"	"RELATIONSHIP(*)"	"admin"
"GRANTED"	"transaction_management"	"database"	"*"	"USER(*)"	"admin"
"GRANTED"	"database_actions"	"database"	"*"	"database"	"admin"
"GRANTED"	"dbms_actions"	"database"	"*"	"database"	"admin"
"GRANTED"	"start_database"	"database"	"*"	"database"	"admin"
"GRANTED"	"stop_database"	"database"	"*"	"database"	"admin"
9 rows					

Additional information about restoring the admin role can be found in the [Operations Manual □ Recover the admin role](#).

## 5.5.8. Known limitations of security

*This section explains known limitations and implications of Neo4js role-based access control security.*

### Security and indexes

As described in [Indexes for search performance](#), Neo4j 4.2 supports the creation and use of indexes to improve the performance of Cypher queries. The Neo4j security model will impact the results of queries (regardless if the indexes are used). When using non full-text Neo4j indexes, a Cypher query will always return the same results it would have if no index existed. This means that if the security model causes fewer results to be returned due to restricted read access in [Graph and sub-graph access control](#), the index will also return the same fewer results.

However, this rule is not fully obeyed by [Indexes for full-text search](#). These specific indexes are backed by Lucene internally. It is therefore not possible to know for certain whether a security violation occurred for each specific entry returned from the index. As a result, Neo4j will return zero results from full-text indexes if it is determined that any result might violate the security privileges active for that query.

Since full-text indexes are not automatically used by Cypher, this does not lead to the case where the same Cypher query would return different results simply because such an index got created. Users need to explicitly call procedures to use these indexes. The problem is only that if this behavior is not understood by the user, they might expect the full text index to return the same results that a different, but semantically similar, Cypher query does.

## Example with denied properties

Consider the following example. The database has nodes with labels `:User` and `:Person`, and these have properties `name` and `surname`. We have indexes on both properties:

```
CREATE INDEX singleProp FOR (n:User) FOR (n.name);
CREATE INDEX composite FOR (n:User) FOR (n.name, n.surname);
CALL db.index.fulltext.createNodeIndex("userNames", ["User", "Person"], ["name", "surname"]);
```



Full-text indexes support multiple labels. See [Indexes for full-text search](#) for more details on creating and using full-text indexes.

After creating these indexes, it would appear that the latter two indexes accomplish the same thing. However, this is not completely accurate. The composite and fulltext indexes behave in different ways and are focused on different use cases. A key difference is that full-text indexes are backed by Lucene, and will use the Lucene syntax for querying the index.

This has consequences for users restricted on the labels or properties involved in the indexes. Ideally, if the labels and properties in the index are denied, we can correctly return zero results from both native indexes and full-text indexes. However, there are borderline cases where this is not as simple.

Imagine the following nodes were added to the database:

```
CREATE (:User {name:'Sandy'});
CREATE (:User {name:'Mark', surname:'Andy'});
CREATE (:User {name:'Andy', surname:'Anderson'});
CREATE (:User:Person {name:'Mandy', surname:'Smith'});
CREATE (:User:Person {name:'Joe', surname:'Andy'});
```

Consider denying the label `:Person`.

```
DENY TRAVERSE Person ON GRAPH * TO users;
```

If the user runs a query that uses the native single property index on `name`:

```
MATCH (n:User) WHERE n.name CONTAINS 'ndy' RETURN n.name;
```

This query performs several checks:

- do a scan on the index to create a stream of results of nodes with the `name` property, which leads to five results
- filter the results to include only nodes where `n.name CONTAINS 'ndy'`, filtering out `Mark` and `Joe` so we have three results
- filter the results to exclude nodes that also have the denied label `:Person`, filtering out `Mandy` so we have two results

For the above dataset, we can see we will get two results and that only one of these has the `surname` property.

To use the native composite index on `name` and `surname`, the query needs to include a predicate on the `surname` property as well:

```
MATCH (n:User) WHERE n.name CONTAINS 'ndy' AND n.surname IS NOT NULL RETURN n.name;
```

This query performs several checks, almost identical to the single property index query:

- do a scan on the index to create a stream of results of nodes with the `name` and `surname` property, which leads to four results
- filter the results to include only nodes where `n.name CONTAINS 'ndy'`, filtering out `Mark` and `Joe` so we have two results
- filter the results to exclude nodes that also have the denied label `:Person`, filtering out `Mandy` so we only have one result

For the above dataset, we can see we will get one result.

What if we query this with the full-text index:

```
CALL db.index.fulltext.queryNodes("userNames", "ndy") YIELD node, score
RETURN node.name
```

The problem now is that we do not know if the results provided by the index were because of a match to the `name` or the `surname` property. The steps taken by the query engine would be:

- run a *Lucene* query on the full-text index to produce results containing `ndy` in either property, leading to five results.
- filter the results to exclude nodes that also have the label `:Person`, filtering out `Mandy` and `Joe` so we have three results.

This difference in results is due to the `OR` relationship between the two properties in the index creation.

Denying properties

Now consider denying access on properties, like the `surname` property:

```
DENY READ {surname} ON GRAPH * TO users;
```

Now we run the same queries again:

```
MATCH (n:User) WHERE n.name CONTAINS 'ndy' RETURN n.name;
```

This query operates exactly as before, returning the same two results, because nothing in this query relates to the denied property.

However, for the query targeting the composite index, things have changed.

```
MATCH (n:User) WHERE n.name CONTAINS 'ndy' AND n.surname IS NOT NULL RETURN n.name;
```

Since the `surname` property is denied, it will appear to always be `null` and the composite index empty. Therefore, the query returns no result.

Now consider the full-text index query:

```
CALL db.index.fulltext.queryNodes("userNames", "ndy") YIELD node, score
RETURN node.name
```

The problem remains, we do not know if the results provided by the index were because of a match

on the `name` or the `surname` property. Results from the `surname` now need to be excluded by the security rules, because they require that the user cannot see any `surname` properties. However, the security model is not able to introspect the *Lucene* query to know what it will actually do, whether it works only on the allowed `name` property, or also on the disallowed `surname` property. We know that the earlier query returned a match for `Joe Andy` which should now be filtered out. So, in order to never return results the user should not be able to see, we have to block all results. The steps taken by the query engine would be:

- Determine if the full-text index includes denied properties
- If yes, return an empty results stream, otherwise process as before

The query will therefore return zero results in this case, rather than simply returning the results `Andy` and `Sandy` which might be expected.

## Security and labels

### Traversing the graph with multi-labeled nodes

The general influence of access control privileges on graph traversal is described in detail in [Graph and sub-graph access control](#). The following section will only focus on nodes because of their ability to have multiple labels. Relationships can only ever have one type and thus they do not exhibit the behavior this section aims to clarify. While this section will not mention relationships further, the general function of the traverse privilege also applies to them.

For any node that is traversable, due to `GRANT TRAVERSE` or `GRANT MATCH`, the user can get information about the labels attached to the node by calling the built-in `labels()` function. In the case of nodes with multiple labels, this can seemingly result in labels being returned to which the user wasn't directly granted access to.

To give an illustrative example, imagine a graph with three nodes: one labeled `:A`, one labeled `:B` and one with `:A :B`. We also have a user with a role `custom` as defined by:

```
GRANT TRAVERSE ON GRAPH * NODES A TO custom;
```

If that user were to execute

```
MATCH (n:A) RETURN n, labels(n);
```

they would be returned two nodes: the node that was labeled with `:A` and the node with labels `:A :B`.

In contrast, executing

```
MATCH (n:B) RETURN n, labels(n);
```

will return only the one node that has both labels: `:A :B`. Even though `:B` was not allowed access for traversal, there is one node with that label accessible in the data because of the allowlisted label `:A` that is attached to the same node.

If a user is denied traverse on a label they will never get results from any node that has this label attached to it. Thus, the label name will never show up for them. For our example this can be done by executing:

```
DENY TRAVERSE ON GRAPH * NODES B TO custom;
```

## The query

```
MATCH (n:A) RETURN n, labels(n);
```

will now return the node only labeled with :A, while the query

```
MATCH (n:B) RETURN n, labels(n);
```

will now return no nodes.

## The db.labels() procedure

In contrast to the normal graph traversal described in the previous section, the built-in `db.labels()` procedure is not processing the data graph itself but the security rules defined on the system graph. That means:

- if a label is explicitly whitelisted (granted), it will be returned by this procedure.
- if a label is denied or isn't explicitly allowed it will not be returned by this procedure.

To reuse the example of the previous section: imagine a graph with three nodes: one labeled :A, one labeled :B and one with :A :B. We also have a user with a role `custom` as defined by:

```
GRANT TRAVERSE ON GRAPH * NODES A TO custom;
```

This means that only label :A is explicitly allowlisted. Thus, executing

```
CALL db.labels();
```

will only return label :A because that is the only label for which traversal was granted.

## Security and count store operations

The rules of a security model may impact some of the database operations. This comes down to necessary additional security checks that incur additional data accesses. Especially in regards to count store operations, as they are usually very fast lookups, the difference might be noticeable.

Let's look at the following security rules that set up a `restricted` and a `free` role as an example:

```
GRANT TRAVERSE ON GRAPH * NODES Person TO restricted;
DENY TRAVERSE ON GRAPH * NODES Customer TO restricted;
GRANT TRAVERSE ON GRAPH * ELEMENTS * TO free;
```

Now, let's look at what the database needs to do in order to execute the following query:

```
MATCH (n:Person) RETURN count(n);
```

For both roles the execution plan will look like this:

```
+-----+
| Operator          |
+-----+
| +ProduceResults   |
| |                   |
| +NodeCountFromCountStore |
+-----+
```

Internally however, very different operations need to be executed. The following table illustrates the difference.

User with <b>free role</b>	User with <b>restricted role</b>
<p>The database can access the count store and retrieve the total number of nodes with the label <code>:Person</code>.</p> <p>This is a very quick operation.</p>	<p>The database cannot just access the count store because it must make sure that only traversable nodes with the desired label <code>:Person</code> are counted. Due to this, each node with the <code>:Person</code> label needs to be accessed and examined to make sure that it does not also have a denylisted label, such as <code>:Customer</code>.</p> <p>Due to the additional data accesses that the security checks need to do, this operation will be slower compared to executing the query as an unrestricted user.</p>

# Chapter 6. Query tuning

*This section describes query tuning for the Cypher query language.*

Neo4j aims to execute queries as fast as possible.

However, when optimizing for maximum query execution performance, it may be helpful to rephrase queries using knowledge about the domain and the application.

The overall goal of manual query performance optimization is to ensure that only necessary data is retrieved from the graph. At the very least, data should get filtered out as early as possible in order to reduce the amount of work that has to be done in the later stages of query execution. This also applies to what gets returned: returning whole nodes and relationships ought to be avoided in favour of selecting and returning only the data that is needed. You should also make sure to set an upper limit on variable length patterns, so they don't cover larger portions of the dataset than needed.

Each Cypher query gets optimized and transformed into an [execution plan](#) by the Cypher query planner. To minimize the resources used for this, try to use parameters instead of literals when possible. This allows Cypher to re-use your queries instead of having to parse and build new execution plans.

To read more about the execution plan operators mentioned in this chapter, see [Execution plans](#).

- [Cypher query options](#)
  - [Cypher version](#)
  - [Cypher runtime](#)
  - [Cypher connect-components planner](#)
  - [Cypher update strategy](#)
  - [Cypher expression engine](#)
  - [Cypher operator engine](#)
  - [Cypher interpreted pipes fallback](#)
  - [Cypher replanning](#)
- [Profiling a query](#)
- [The use of indexes](#)
- [Basic query tuning example](#)
- [Advanced query tuning example](#)
  - [Introduction](#)
  - [The data set](#)
  - [Index-backed property-lookup](#)
  - [Index-backed order by](#)
- [Planner hints and the USING keyword](#)
  - [Introduction](#)
  - [Index hints](#)
  - [Scan hints](#)
  - [Join hints](#)
  - [PERIODIC COMMIT query hint](#)

## 6.1. Cypher query options

This section describes the query options available in Cypher.

Query execution can be fine-tuned through the use of query options. In order to use one or more of these options, the query must be prepended with **CYPHER**, followed by the query option(s), as exemplified thus: **CYPHER query-option [further-query-options] query**.

### 6.1.1. Cypher version

Occasionally, there is a requirement to use a previous version of the Cypher compiler when running a query. Here we detail the available versions:

Query option	Description	Default
3.5	This will force the query to use Neo4j Cypher 3.5.	
4.1	This will force the query to use Neo4j Cypher 4.1.	
4.2	This will force the query to use Neo4j Cypher 4.2. As this is the default version, it is not necessary to use this option explicitly.	X

In Neo4j 4.2, the support for Cypher 3.5 is provided only at the parser level. The consequence is that some underlying features available in Neo4j 3.5 are no longer available and will result in runtime errors.



Please refer to the discussion in [Cypher Compatibility](#) for more information on which features are affected.

### 6.1.2. Cypher runtime

Using the execution plan, the query is executed — and records returned — by the *Cypher runtime*. Depending on whether Neo4j Enterprise Edition or Neo4j Community Edition is used, there are three different runtimes available:

#### *Interpreted*

In this runtime, the operators in the execution plan are chained together in a tree, where each non-leaf operator feeds from one or two child operators. The tree thus comprises nested iterators, and the records are streamed in a pipelined manner from the top iterator, which pulls from the next iterator and so on.

#### *Slotted*

This is very similar to the interpreted runtime, except that there are additional optimizations regarding the way in which the records are streamed through the iterators. This results in improvements to both the performance and memory usage of the query. In effect, this can be thought of as the 'faster interpreted' runtime.

#### *Pipelined*

The pipelined runtime was introduced in Neo4j 4.0 as a replacement for the older compiled runtime used in the Neo4j 3.x versions. It combines some of the advantages of the compiled runtime in a new architecture that allows for support of a wider range of queries.

Algorithms are employed to intelligently group the operators in the execution plan in order to generate new combinations and orders of execution which are optimised for performance and

memory usage. While this should lead to superior performance in most cases (over both the interpreted and slotted runtimes), it is still under development and does not support all possible operators or queries (the slotted runtime covers all operators and queries).

Option	Description	Default
<code>runtim=interpreted</code>	This will force the query planner to use the interpreted runtime.	This is not used in Enterprise Edition unless explicitly asked for. It is the only option for all queries in Community Edition—it is not necessary to specify this option in Community Edition.
<code>runtim=slotted</code>	This will cause the query planner to use the slotted runtime.	This is the default option for all queries which are not supported by <code>runtim=pipelined</code> in Enterprise Edition.
<code>runtim=pipelined</code>	This will cause the query planner to use the pipelined runtime if it supports the query. If the pipelined runtime does not support the query, the planner will fall back to the slotted runtime.	This is the default option for some queries in Enterprise Edition.

In Enterprise Edition, the Cypher query planner selects the runtime, falling back to alternative runtimes as follows:

- Try the pipelined runtime first.
- If the pipelined runtime does not support the query, then fall back to use the slotted runtime.
- Finally, if the slotted runtime does not support the query, fall back to the interpreted runtime. The interpreted runtime supports all queries, and is the only option in Neo4j Community Edition.

### 6.1.3. Cypher planner

The Cypher planner takes a Cypher query and computes an execution plan that solves it. For any given query there is likely a number of execution plan candidates that each solve the query in a different way. The planner uses a search algorithm to find the execution plan with the lowest estimated execution cost.

This table describes the available planner options:

Query option	Description	Default
<code>planner=cost</code>	Use cost based planning with default limits on plan search space and time.	X
<code>planner=idp</code>	Synonym for <code>planner=cost</code> .	

Query option	Description	Default
<code>planner=dp</code>	<p>Use cost based planning without limits on plan search space and time to perform an exhaustive search for the best execution plan.</p> <p>Note that using this option may significantly increase the planning time of the query.</p>	

## 6.1.4. Cypher connect-components planner

One part of the Cypher planner is responsible for combining sub-plans for separate patterns into larger plans - a task referred to as *connecting components*.

This table describes the available query options for the connect-components planner:

Query option	Description	Default
<code>connectComponentsPlanner=greedy</code>	Use a greedy approach when combining sub-plans.	X
<code>connectComponentsPlanner=idp</code>	<p>Use the cost based IDP search algorithm when combining sub-plans.</p> <p>Note that using this option can significantly increase the planning time of the query.</p>	

## 6.1.5. Cypher update strategy

This option affects the eagerness of updating queries.

The possible values are:

Query option	Description	Default
<code>updateStrategy=default</code>	Update queries are executed eagerly when needed.	X
<code>updateStrategy=eager</code>	Update queries are always executed eagerly.	

## 6.1.6. Cypher expression engine

This option affects how the runtime evaluates expressions.

The possible values are:

Query option	Description	Default
<code>expressionEngine=default</code>	Compile expressions and use the compiled expression engine when needed.	X
<code>expressionEngine=interpreted</code>	Always use the <i>interpreted</i> expression engine.	
<code>expressionEngine=compiled</code>	Always compile expressions and use the <i>compiled</i> expression engine.  Cannot be used together with <code>runtime=interpreted</code> .	

### 6.1.7. Cypher operator engine

This query option affects whether the pipelined runtime attempts to generate compiled code for groups of operators.

The possible values are:

Query option	Description	Default
<code>operatorEngine=default</code>	Attempt to generate compiled operators when applicable.	X
<code>operatorEngine=interpreted</code>	Never attempt to generate compiled operators.	
<code>operatorEngine=compiled</code>	Always attempt to generate <i>compiled</i> operators.  Cannot be used together with <code>runtime=interpreted</code> or <code>runtime=slotted</code> .	

### 6.1.8. Cypher interpreted pipes fallback

This query option affects how the pipelined runtime behaves for operators it does not directly support.

The available options are:

Query option	Description	Default
<code>interpretedPipesFallback=default</code>	Equivalent to <code>interpretedPipesFallback=white listed_plans_only</code>	X

Query option	Description	Default
<code>interpretedPipesFallback=disabled</code>	If the plan contains any operators not supported by the pipelined runtime then another runtime is chosen to execute the entire plan.  Cannot be used together with <code>runtime=interpreted</code> or <code>runtime=slotted</code>	
<code>interpretedPipesFallback=whitelisted_plans_only</code>	Parts of the execution plan can be executed on another runtime. Only certain operators are allowed to execute on another runtime.  Cannot be used together with <code>runtime=interpreted</code> or <code>runtime=slotted</code> .	
<code>interpretedPipesFallback=all</code>	Parts of the execution plan may be executed on another runtime. Any operator is allowed to execute on another runtime. Queries with this option set might produce incorrect results, or fail.  Cannot be used together with <code>runtime=interpreted</code> or <code>runtime=slotted</code> .   This setting is experimental, and using it in a production environment is discouraged.	

## 6.1.9. Cypher replanning

Cypher replanning occurs in the following circumstances:

- When the query is not in the cache. This can either be when the server is first started or restarted, if the cache has recently been cleared, or if `dbms.query_cache_size` was exceeded.
- When the time has past the `cypher.min_replan_interval` value, and the database statistics have changed more than the `cypher.statistics_divergence_threshold` value.

There may be situations where [Cypher query planning](#) can occur at a non-ideal time. For example, when a query must be as fast as possible and a valid plan is already in place.



Replanning is not performed for all queries at once; it is performed in the same thread as running the query, and can block the query. However, replanning one query does not replan any other queries.

There are three different replan options available:

Option	Description	Default
<code>replan=default</code>	This is the planning and replanning option as described above.	X
<code>replan=force</code>	This will force a replan, even if the plan is valid according to the planning rules. Once the new plan is complete, it replaces the existing one in the query cache.	
<code>replan=skip</code>	If a valid plan already exists, it will be used even if the planning rules would normally dictate that it should be replanned.	

The replan option is prepended to queries. For example:

```
CYPHER replan=force MATCH ...
```

In a mixed workload, you can force replanning by using the Cypher `EXPLAIN` commands. This can be useful to schedule replanning of queries which are expensive to plan, at known times of low load. Using `EXPLAIN` will make sure the query is only planned, but not executed. For example:

```
CYPHER replan=force EXPLAIN MATCH ...
```

During times of known high load, `replan=skip` can be useful to not introduce unwanted latency spikes.

## 6.2. Profiling a query

There are two options to choose from when you want to analyze a query by looking at its execution plan:

### EXPLAIN

If you want to see the execution plan but not run the statement, prepend your Cypher statement with `EXPLAIN`. The statement will always return an empty result and make no changes to the database.

### PROFILE

If you want to run the statement and see which operators are doing most of the work, use `PROFILE`. This will run your statement and keep track of how many rows pass through each operator, and how much each operator needs to interact with the storage layer to retrieve the necessary data. Please note that *profiling your query uses more resources*, so you should not profile unless you are actively working on a query.

See [Execution plans](#) for a detailed explanation of each of the operators contained in an execution

plan.



Being explicit about what types and labels you expect relationships and nodes to have in your query helps Neo4j use the best possible statistical information, which leads to better execution plans. This means that when you know that a relationship can only be of a certain type, you should add that to the query. The same goes for labels, where declaring labels on both the start and end nodes of a relationship helps Neo4j find the best way to execute the statement.

## 6.3. The use of indexes

*This section describes the query plans when indexes are used in various scenarios.*

The task of tuning calls for different indexes depending on what the queries look like. Therefore, it is important to have a fundamental understanding of how the indexes operate. This section describes the query plans that result from different index scenarios.

Please refer to [Indexes for search performance](#) for instructions on how to create and maintain the indexes themselves.

### 6.3.1. A simple example

In the example below, the query will use a `Person(firstname)` index, if it exists.

#### Query

```
MATCH (person:Person { firstname: 'Andy' })
RETURN person
```

#### Query Plan

```
Compiler CYPHER 4.2
Planner COST
Runtime INTERPRETED
Runtime version 4.2

+-----+-----+
| Operator      | Details
+-----+-----+
| Hits | Page Cache Hits/Misses |
+-----+-----+
+-----+-----+
| +ProduceResults | person
0 |          0/0 |
| |
+-----+-----+
| +NodeIndexSeek | person:Person(firstname) WHERE firstname = $autostring_0 |
2 |          0/0 |
+-----+-----+
Total database accesses: 2, total allocated memory: 0
```

### 6.3.2. Equality check using `WHERE` (single-property index)

A query containing equality comparisons of a single indexed property in the `WHERE` clause is backed automatically by the index. It is also possible for a query with multiple `OR` predicates to use multiple indexes, if indexes exist on the properties. For example, if indexes exist on both `:Label(p1)` and

`:Label(p2), MATCH (n:Label) WHERE n.p1 = 1 OR n.p2 = 2 RETURN n` will use both indexes.

### Query

```
MATCH (person:Person)
WHERE person.firstname = 'Andy'
RETURN person
```

### Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime INTERPRETED

Runtime version 4.2

Operator		Details	Estimated Rows	Rows	DB
Hits	Page Cache Hits/Misses				
+ProduceResults	person			1	1
0	0/0				
	+-----+				
+NodeIndexSeek	person:Person(firstname) WHERE firstname = \$autostring_0			1	1
2	0/0				
	+-----+				

Total database accesses: 2, total allocated memory: 0

### 6.3.3. Equality check using `WHERE` (composite index)

A query containing equality comparisons for all the properties of a composite index will automatically be backed by the same index. However, the query does not need to have equality on all properties. It can have ranges and existence predicates as well. But in these cases rewrites might happen depending on which properties have which predicates, see [composite index limitations](#). The following query will use the composite index defined [earlier](#):

### Query

```
MATCH (n:Person)
WHERE n.age = 35 AND n.country = 'UK'
RETURN n
```

However, the query `MATCH (n:Person) WHERE n.age = 35 RETURN n` will not be backed by the composite index, as the query does not contain a predicate on the `country` property. It will only be backed by an index on the `Person` label and `age` property defined thus: `:Person(age)`; i.e. a single-property index.

### Result

```
+-----+
| n
+-----+
| Node[0]{country:"UK",highScore:54321,firstname:"John",surname:"Smith",name:"john",age:35} |
+-----+
1 row
```

### 6.3.4. Range comparisons using WHERE (single-property index)

Single-property indexes are also automatically used for inequality (range) comparisons of an indexed property in the `WHERE` clause.

#### Query

```
MATCH (person:Person)
WHERE person.firstname > 'B'
RETURN person
```

#### Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime INTERPRETED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows
DB Hits	Page Cache Hits/Misses		
+ProduceResults	person	1	1
0	0/0		
+NodeIndexSeekByRange	person:Person(firstname) WHERE firstname > \$autostring_0	1	1
2	0/0		

Total database accesses: 2, total allocated memory: 0

### 6.3.5. Range comparisons using WHERE (composite index)

Composite indexes are also automatically used for inequality (range) comparisons of indexed properties in the `WHERE` clause. Equality or list membership check predicates may precede the range predicate. However, predicates after the range predicate may be rewritten as an existence check predicate and a filter as described in [composite index limitations](#).

#### Query

```
MATCH (person:Person)
WHERE person.firstname > 'B' AND person.highScore > 10000
RETURN person
```

## Query Plan

```
Compiler CYPHER 4.2
```

```
Planner COST
```

```
Runtime INTERPRETED
```

```
Runtime version 4.2
```

Operator	Details		
Estimated Rows	Rows	DB Hits	Page Cache Hits/Misses
+ProduceResults	person		
	0	1	0   0/0
+Filter	cache[person.highScore] > \$autoint_1		
	0	1	0   0/0
+NodeIndexSeek	person:Person(firstname, highScore) WHERE firstname > \$autostring_0 AND exists(highScore), cache[per   son.highScore]	0   1   2	0/0

Total database accesses: 2, total allocated memory: 0

### 6.3.6. Multiple range comparisons using **WHERE** (single-property index)

When the **WHERE** clause contains multiple inequality (range) comparisons for the same property, these can be combined in a single index range seek.

#### Query

```
MATCH (person:Person)
WHERE 10000 < person.highScore < 20000
RETURN person
```

## Query Plan

```
Compiler CYPHER 4.2
```

```
Planner COST
```

```
Runtime INTERPRETED
```

```
Runtime version 4.2
```

Operator	Details			
Estimated Rows	Rows	DB Hits	Page Cache Hits/Misses	
+ProduceResults	1	1	0	0/0
+NodeIndexSeekByRange	1	1	2	0/0

```
Total database accesses: 2, total allocated memory: 0
```

### 6.3.7. Multiple range comparisons using WHERE (composite index)

When the `WHERE` clause contains multiple inequality (range) comparisons for the same property, these can be combined in a single index range seek. That single range seek created in the following query will then use the composite index `Person(highScore, name)` if it exists.

#### Query

```
MATCH (person:Person)
WHERE 10000 < person.highScore < 20000 AND EXISTS (person.name)
RETURN person
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime INTERPRETED

Runtime version 4.2

Operator Details			
Estimated Rows	Rows	DB Hits	Page Cache Hits/Misses
+-----	+-----	+-----	+-----
+ProduceResults   person	1   1   0	0/0	
+-----	+-----	+-----	+-----
+NodeIndexSeek   person:Person(highScore, name) WHERE highScore > \$autoint_0 AND highScore < \$autoint_1 AND exists(na   me)	1   1   2	0/0	
+-----	+-----	+-----	+-----

Total database accesses: 2, total allocated memory: 0

## 6.3.8. List membership check using IN (single-property index)

The `IN` predicate on `person.firstname` in the following query will use the single-property index `Person(firstname)` if it exists.

### Query

```
MATCH (person:Person)
WHERE person.firstname IN ['Andy', 'John']
RETURN person
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime INTERPRETED

Runtime version 4.2

Operator Details		Estimated Rows	Rows	DB
Hits	Page Cache Hits/Misses			
+-----	+-----	+-----	+-----	+-----
+ProduceResults   person	0   0/0	24   2		
+-----	+-----	+-----	+-----	+-----
+NodeIndexSeek   person:Person(firstname) WHERE firstname IN \$autolist_0	4   0/0	24   2		
+-----	+-----	+-----	+-----	+-----

Total database accesses: 4, total allocated memory: 0

### 6.3.9. List membership check using IN (composite index)

The `IN` predicates on `person.age` and `person.country` in the following query will use the composite index `Person(age, country)` if it exists.

#### Query

```
MATCH (person:Person)
WHERE person.age IN [10, 20, 35] AND person.country IN ['Sweden', 'USA', 'UK']
RETURN person
```

#### Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime INTERPRETED

Runtime version 4.2

Operator	Details
Estimated Rows	Rows
+ProduceResults	person
451	1
	0
	0/0
+NodeIndexSeek	person:Person(age, country) WHERE age IN \$autolist_0 AND country IN \$autolist_1
451	1
	10
	0/0

Total database accesses: 10, total allocated memory: 0

### 6.3.10. Prefix search using STARTS WITH (single-property index)

The `STARTS WITH` predicate on `person.firstname` in the following query will use the `Person(firstname)` index, if it exists.

#### Query

```
MATCH (person:Person)
WHERE person.firstname STARTS WITH 'And'
RETURN person
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime INTERPRETED

Runtime version 4.2

+-----+-----+-----+-----+				Estimated
Operator	Details	Rows	Rows   DB Hits   Page Cache Hits/Misses	
+ProduceResults	person	2	1   0   0/0	
+NodeIndexSeekByRange	person:Person(firstname) WHERE firstname STARTS WITH \$autostring_0	2	1   2   0/0	

Total database accesses: 2, total allocated memory: 0

### 6.3.11. Prefix search using `STARTS WITH` (composite index)

The `STARTS WITH` predicate on `person.firstname` in the following query will use the `Person(firstname, surname)` index, if it exists. Any (non-existence check) predicate on `person.surname` will be rewritten as existence check with a filter. However, if the predicate on `person.firstname` is a equality check then a `STARTS WITH` on `person.surname` would also use the index (without rewrites). More information about how the rewriting works can be found in [composite index limitations](#).

#### Query

```
MATCH (person:Person)
WHERE person.firstname STARTS WITH 'And' AND EXISTS (person.surname)
RETURN person
```

## Query Plan

```
Compiler CYPHER 4.2
Planner COST
Runtime INTERPRETED
Runtime version 4.2
+-----
+-----+
| Operator      | Details
| Estimated Rows | Rows | DB Hits | Page Cache Hits/Misses |
+-----+
+-----+
| +ProduceResults | person
|           1 |   1 |       0 |          0/0 |
| |
+-----+
+-----+
| +NodeIndexSeek | person:Person(firstname, surname) WHERE firstname STARTS WITH $autostring_0 AND
exists(surname) |           1 |   1 |       2 |          0/0 |
+-----+
+-----+
Total database accesses: 2, total allocated memory: 0
```

### 6.3.12. Suffix search using ENDS WITH (single-property index)

The `ENDS WITH` predicate on `person.firstname` in the following query will use the `Person(firstname)` index, if it exists. All values stored in the `Person(firstname)` index will be searched, and entries ending with 'hn' will be returned. This means that although the search will not be optimized to the extent of queries using `=`, `IN`, `>`, `<` or `STARTS WITH`, it is still faster than not using an index in the first place. Composite indexes are currently not able to support `ENDS WITH`.

#### Query

```
MATCH (person:Person)
WHERE person.firstname ENDS WITH 'hn'
RETURN person
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime INTERPRETED

Runtime version 4.2

Operator   Details   Estimated			
Rows	Rows	DB Hits	Page Cache Hits/Misses
+ProduceResults	person	0/0	
2	1	0	0/0
		+	
+NodeIndexEndsWithScan	person:Person(firstname) WHERE firstname ENDS WITH \$autostring_0	0/0	
2	1	2	0/0

Total database accesses: 2, total allocated memory: 0

### 6.3.13. Suffix search using ENDS WITH (composite index)

The `ENDS WITH` predicate on `person.surname` in the following query will use the `Person(surname,age)` index, if it exists. However, it will be rewritten as existence check and a filter due to the index not supporting actual suffix searches for composite indexes, this is still faster than not using an index in the first place. Any (non-existence check) predicate on `person.age` will also be rewritten as existence check with a filter. More information about how the rewriting works can be found in [composite index limitations](#).

#### Query

```
MATCH (person:Person)
WHERE person.surname ENDS WITH '300' AND EXISTS (person.age)
RETURN person
```

## Query Plan

```
Compiler CYPHER 4.2
```

```
Planner COST
```

```
Runtime INTERPRETED
```

```
Runtime version 4.2
```

Operator	Details		
Estimated Rows	Rows	DB Hits	Page Cache Hits/Misses
+ProduceResults	person		
	11	1	0 / 0
+Filter	cache[person.surname] ENDS WITH \$autostring_0		
	11	1	0 / 0
+NodeIndexScan	person:Person(surname, age) WHERE exists(surname) AND exists(age), cache[person.surname]		
	106	303	304 / 0 / 0

```
Total database accesses: 304, total allocated memory: 0
```

### 6.3.14. Substring search using `CONTAINS` (single-property index)

The `CONTAINS` predicate on `person.firstname` in the following query will use the `Person(firstname)` index, if it exists. All values stored in the `Person(firstname)` index will be searched, and entries containing '`h`' will be returned. This means that although the search will not be optimized to the extent of queries using `=`, `IN`, `>`, `<` or `STARTS WITH`, it is still faster than not using an index in the first place. Composite indexes are currently not able to support `CONTAINS`.

#### Query

```
MATCH (person:Person)
WHERE person.firstname CONTAINS 'h'
RETURN person
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime INTERPRETED

Runtime version 4.2

Rows	Rows	Operator   Details		Estimated
		DB Hits	Page Cache Hits/Misses	
2	1	0	0/0	
			+	
2	1	2	0/0	
			+	

Total database accesses: 2, total allocated memory: 0

### 6.3.15. Substring search using `CONTAINS` (composite index)

The `CONTAINS` predicate on `person.surname` in the following query will use the `Person(surname, age)` index, if it exists. However, it will be rewritten as existence check and a filter due to the index not supporting actual suffix searches for composite indexes, this is still faster than not using an index in the first place. Any (non-existence check) predicate on `person.age` will also be rewritten as existence check with a filter. More information about how the rewriting works can be found in [composite index limitations](#).

#### Query

```
MATCH (person:Person)
WHERE person.surname CONTAINS '300' AND EXISTS (person.age)
RETURN person
```

## Query Plan

```
Compiler CYPHER 4.2
```

```
Planner COST
```

```
Runtime INTERPRETED
```

```
Runtime version 4.2
```

Operator Details				
Estimated Rows	Rows	DB Hits	Page Cache Hits/Misses	
+-----				
+ProduceResults   person				
11   1   0   0/0				
+-----				
+Filter   cache[person.surname] CONTAINS \$autostring_0				
11   1   0   0/0				
+-----				
+NodeIndexScan   person:Person(surname, age) WHERE exists(surname) AND exists(age),				
cache[person.surname]   106   303   304   0/0				
+-----				

```
Total database accesses: 304, total allocated memory: 0
```

### 6.3.16. Existence check using `exists` (single-property index)

The `exists(p.firstname)` predicate in the following query will use the `Person(firstname)` index, if it exists.

#### Query

```
MATCH (p:Person)
WHERE EXISTS (p.firstname)
RETURN p
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime INTERPRETED

Runtime version 4.2

Operator	Details	Cache Hits/Misses	Estimated Rows	Rows	DB Hits	Page
+ProduceResults	p	0/0		2	2	0
+NodeIndexScan	p:Person(firstname) WHERE exists(firstname)	0/0		2	2	3

Total database accesses: 3, total allocated memory: 0

### 6.3.17. Existence check using `exists` (composite index)

The `exists(p.firstname)` and `exists(p.surname)` predicate in the following query will use the `Person(firstname, surname)` index, if it exists. Any (non-existence check) predicate on `person.surname` will be rewritten as existence check with a filter.

#### Query

```
MATCH (p:Person)
WHERE EXISTS (p.firstname) AND EXISTS (p.surname)
RETURN p
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime INTERPRETED

Runtime version 4.2

Operator	Details	Rows	Cache Hits/Misses	DB Hits	Page	Estimated
+ProduceResults	p	1	2	0	0/0	
+NodeIndexScan	p:Person(firstname, surname) WHERE exists(firstname) AND exists(surname)	1	2	3	0/0	

Total database accesses: 3, total allocated memory: 0

### 6.3.18. Spatial distance searches (single-property index)

If a property with point values is indexed, the index is used for spatial distance searches as well as for range queries.

#### Query

```
MATCH (p:Person)
WHERE distance(p.location, point({ x: 1, y: 2 })) < 2
RETURN p.location
```

#### Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime INTERPRETED

Runtime version 4.2

Operator	Details		
Estimated Rows	Rows	DB Hits	Page Cache Hits/Misses
+ProduceResults	0	9	0   0/0
+Projection	0	9	0   0/0
+Filter	0	9	0   0/0
+NodeIndexSeekByRange	p:Person(location)	0	9   10   0/0

Total database accesses: 10, total allocated memory: 0

### 6.3.19. Spatial distance searches (composite index)

If a property with point values is indexed, the index is used for spatial distance searches as well as for range queries. Any following (non-existence check) predicates (here on property `p.name` for index `:Person(place, name)`) will be rewritten as existence check with a filter.

#### Query

```
MATCH (p:Person)
WHERE distance(p.place, point({ x: 1, y: 2 })) < 2 AND EXISTS (p.name)
RETURN p.place
```

## Query Plan

```
Compiler CYPHER 4.2
Planner COST
Runtime INTERPRETED
Runtime version 4.2
+-----
+-----+
| Operator      | Details
| Estimated Rows | Rows | DB Hits | Page Cache Hits/Misses |
+-----+
+-----+
| +ProduceResults | `p.place` |
|       69 |   9 |     0 |           0/0 |
| |
+-----+
+-----+
| +Projection    | cache[p.place] AS `p.place` |
|       69 |   9 |     0 |           0/0 |
| |
+-----+
+-----+
| +Filter        | distance(cache[p.place], point({x: $autoint_0, y: $autoint_1})) < $autoint_2 |
|       69 |   9 |     0 |           0/0 |
| |
+-----+
+-----+
| +NodeIndexSeek | p:Person(place, name) WHERE distance(place, point($autoint_0, $autoint_1)) <
$autoint_2 AND exists(n |
|       69 |   9 |    10 |           0/0 |
|           | ame), cache[p.place]
|           | |
+-----+
+-----+
Total database accesses: 10, total allocated memory: 0
```

## 6.3.20. Spatial bounding box searches (single-property index)

The ability to do index seeks on bounded ranges works even with the 2D and 3D spatial `Point` types.

### Query

```
MATCH (person:Person)
WHERE point({ x: 1, y: 5 }) < person.location < point({ x: 2, y: 6 })
RETURN person
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime INTERPRETED

Runtime version 4.2

Operator	Details		
Estimated Rows	Rows	DB Hits	Page Cache Hits/Misses
+ProduceResults	person		
0	1	0	0/0
+NodeIndexSeekByRange	person:Person(location)	WHERE location > point({x: \$autoint_0, y: \$autoint_1}) AND location < point({x: \$autoint_2, y: \$autoint_3})	0/0
0	1	2	0/0
+Total			
Total database accesses:	2	total allocated memory:	0

### 6.3.21. Spatial bounding box searches (composite index)

The ability to do index seeks on bounded ranges works even with the 2D and 3D spatial `Point` types. Any following (non-existence check) predicates (here on property `p.firstname` for index `:Person(place,firstname)`) will be rewritten as existence check with a filter. For index `:Person(firstname,place)`, if the predicate on `firstname` is equality or list membership then the bounded range is handled as a range itself. If the predicate on `firstname` is anything else then the bounded range is rewritten to existence and filter.

#### Query

```
MATCH (person:Person)
WHERE point({ x: 1, y: 5 })< person.place < point({ x: 2, y: 6 })
      AND EXISTS (person.firstname)
RETURN person
```

## Query Plan

```
Compiler CYPHER 4.2
```

```
Planner COST
```

```
Runtime INTERPRETED
```

```
Runtime version 4.2
```

Operator	Details		
Estimated Rows	Rows	DB Hits	Page Cache Hits/Misses
+ProduceResults	person		
	0	1	0   0/0
+NodeIndexSeek	person:Person(place, firstname) WHERE place > point({x: \$autoint_0, y: \$autoint_1}) AND place < point({x: \$autoint_2, y: \$autoint_3}) AND exists(firstname)	0   1   2	0/0   t({x: \$autoint_2, y: \$autoint_3}) AND exists(firstname)

```
Total database accesses: 2, total allocated memory: 0
```

## 6.4. Basic query tuning example

We'll start with a basic example to help you get the hang of profiling queries. The following examples will use a movies data set.

Let's start by importing the data:

```
LOAD CSV WITH HEADERS FROM 'https://neo4j.com/docs/cypher-manual/4.2/csv/query-tuning/movies.csv' AS line
MERGE (m:Movie { title: line.title })
ON CREATE SET m.released = toInteger(line.released), m.tagline = line.tagline
```

```
LOAD CSV WITH HEADERS FROM 'https://neo4j.com/docs/cypher-manual/4.2/csv/query-tuning/actors.csv' AS line
MATCH (m:Movie { title: line.title })
MERGE (p:Person { name: line.name })
ON CREATE SET p.born = toInteger(line.born)
MERGE (p)-[:ACTED_IN { roles:split(line.roles, ',')}]->(m)
```

```
LOAD CSV WITH HEADERS FROM 'https://neo4j.com/docs/cypher-manual/4.2/csv/query-tuning/directors.csv' AS line
MATCH (m:Movie { title: line.title })
MERGE (p:Person { name: line.name })
ON CREATE SET p.born = toInteger(line.born)
MERGE (p)-[:DIRECTED]->(m)
```

Let's say we want to write a query to find '**Tom Hanks**'. The naive way of doing this would be to write the following:

```
MATCH (p { name: 'Tom Hanks' })
RETURN p
```

This query will find the '**Tom Hanks**' node but as the number of nodes in the database increase it will

become slower and slower. We can profile the query to find out why that is.

You can learn more about the options for profiling queries in [Profiling a query](#) but in this case we're going to prefix our query with **PROFILE**:

```
PROFILE
MATCH (p { name: 'Tom Hanks' })
RETURN p
```

Compiler CYPHER 4.2

Planner COST

Runtime INTERPRETED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Page Cache Hits/Misses
+ProduceResults	p	16	1	0	0/0
+Filter	p.name = \$autostring_0	16	1	163	0/0
+AllNodesScan	p	163	163	164	0/0

Total database accesses: 327, total allocated memory: 0

The first thing to keep in mind when reading execution plans is that you need to read from the bottom up.

In that vein, starting from the last row, the first thing we notice is that the value in the **Rows** column seems high given there is only one node with the name property 'Tom Hanks' in the database. If we look across to the **Operator** column we'll see that **AllNodesScan** has been used which means that the query planner scanned through all the nodes in the database.

This seems like an inefficient way of finding 'Tom Hanks' given that we are looking at many nodes that aren't even people and therefore aren't what we're looking for.

The solution to this problem is that whenever we're looking for a node we should specify a label to help the query planner narrow down the search space. For this query we'd need to add a **Person** label.

```
MATCH (p:Person { name: 'Tom Hanks' })
RETURN p
```

This query will be faster than the first one but as the number of people in our database increase we again notice that the query slows down.

Again we can profile the query to work out why:

```
PROFILE
MATCH (p:Person { name: 'Tom Hanks' })
RETURN p
```

```
Compiler CYPHER 4.2
```

```
Planner COST
```

```
Runtime INTERPRETED
```

```
Runtime version 4.2
```

Operator	Details	Estimated Rows	Rows	DB Hits	Page Cache Hits/Misses
+ProduceResults	p	13	1	0	0/0
+Filter	p.name = \$autostring_0	13	1	125	0/0
+NodeByLabelScan	p:Person	125	125	126	0/0

```
Total database accesses: 251, total allocated memory: 0
```

This time the `Rows` value on the last row has reduced so we're not scanning some nodes that we were before which is a good start. The `NodeByLabelScan` operator indicates that we achieved this by first doing a linear scan of all the `Person` nodes in the database.

Once we've done that we again scan through all those nodes using the `Filter` operator, comparing the name property of each one.

This might be acceptable in some cases but if we're going to be looking up people by name frequently then we'll see better performance if we create an index on the `name` property for the `Person` label:

```
CREATE INDEX FOR (p:Person)
ON (p.name)
```

Now if we run the query again it will run more quickly:

```
MATCH (p:Person { name: 'Tom Hanks' })
RETURN p
```

Let's profile the query to see why that is:

```
PROFILE
MATCH (p:Person { name: 'Tom Hanks' })
RETURN p
```

```
Compiler CYPHER 4.2
```

```
Planner COST
```

```
Runtime INTERPRETED
```

```
Runtime version 4.2
```

Operator	Details	Estimated Rows	Rows	DB Hits	Page
Cache Hits/Misses					
+ProduceResults	p		1	1	0
0/0					
+NodeIndexSeek	p:Person(name) WHERE name = \$autostring_0		1	1	2
0/0					

Total database accesses: 2, total allocated memory: 0

Our execution plan is down to a single row and uses the [Node Index Seek](#) operator which does an index seek (see [Indexes for search performance](#)) to find the appropriate node.

## 6.5. Advanced query tuning example

*This section describes some more subtle optimizations based on new native index capabilities*

- [Introduction](#)
- [The data set](#)
- [Index-backed property-lookup](#)
  - [Aggregating functions](#)
- [Index-backed order by](#)
  - [min\(\) and max\(\)](#)
  - [Restrictions](#)

### 6.5.1. Introduction

One of the most important and useful ways of optimizing Cypher queries involves creating appropriate indexes. This is described in more detail in [Indexes for search performance](#), and demonstrated in [Basic query tuning example](#). In summary, an index will be based on the combination of a [Label](#) and a [property](#). Any Cypher query that searches for nodes with a specific label and some predicate on the property (equality, range or existence) will be planned to use the index if the cost planner deems that to be the most efficient solution.

In order to benefit from enhancements provided by native indexes, it is useful to understand when *index-backed property lookup* and *index-backed order by* will come into play. In Neo4j 3.4 and earlier, the fact that the index contains the property value, and the results are returned in a specific order, was not used to improve the performance of any later part of the query that might depend on the property value or result order.

Let's explain how to use these features with a more advanced query tuning example.



If you are upgrading an existing store to 4.2.0, it may be necessary to drop and re-create existing indexes. For information on native index support and upgrade considerations regarding indexes, see [Operations Manual □ Indexes](#).

## 6.5.2. The data set

In this example we will demonstrate the impact native indexes can have on query performance under certain conditions. We'll use a movies dataset to illustrate this more advanced query tuning.

```
LOAD CSV WITH HEADERS FROM 'https://neo4j.com/docs/cypher-manual/4.2/csv/query-tuning/movies.csv' AS line
MERGE (m:Movie { title: line.title })
ON CREATE SET m.released = toInteger(line.released), m.tagline = line.tagline
```

```
LOAD CSV WITH HEADERS FROM 'https://neo4j.com/docs/cypher-manual/4.2/csv/query-tuning/actors.csv' AS line
MATCH (m:Movie { title: line.title })
MERGE (p:Person { name: line.name })
ON CREATE SET p.born = toInteger(line.born)
MERGE (p)-[:ACTED_IN { roles:split(line.roles, ';')}]->(m)
```

```
LOAD CSV WITH HEADERS FROM 'https://neo4j.com/docs/cypher-manual/4.2/csv/query-tuning/directors.csv' AS line
MATCH (m:Movie { title: line.title })
MERGE (p:Person { name: line.name })
ON CREATE SET p.born = toInteger(line.born)
MERGE (p)-[:DIRECTED]->(m)
```

```
CREATE INDEX FOR (p:Person)
ON (p.name)
```

```
CALL db.awaitIndexes
```

```
+-----+
| No data returned, and nothing was changed. |
+-----+
```

## 6.5.3. Index-backed property-lookup

Let's say we want to write a query to find persons with the name 'Tom' that acted in a movie.

```
MATCH (p:Person)-[:ACTED_IN]->(m:Movie)
WHERE p.name STARTS WITH 'Tom'
RETURN p.name, count(m)
```

```
+-----+
| p.name      | count(m) |
+-----+
| "Tom Cruise" | 3       |
| "Tom Hanks"   | 12      |
| "Tom Skerritt" | 1       |
+-----+
3 rows
```

We have asked the database to return all the actors with the first name 'Tom'. There are three of them: '*Tom Cruise*', '*Tom Skerritt*' and '*Tom Hanks*'. In previous versions of Neo4j, the final clause `RETURN p.name` would cause the database to take the node `p` and look up its properties and return the value of

the property `name`. With native indexes, however, we can leverage the fact that indexes store the property values. In this case, it means that the names can be looked up directly from the index. This allows Cypher to avoid the second call to the database to find the property, which can save time on very large queries.

If we profile the above query, we see that the `NodeIndexSeekByRange` in the `Details` column contains `cache[p.name]`, which means that `p.name` is retrieved from the index. We can also see that the `OrderedAggregation` has no `DB Hits`, which means it does not have to access the database again.

```
PROFILE
MATCH (p:Person)-[:ACTED_IN]->(m:Movie)
WHERE p.name STARTS WITH 'Tom'
RETURN p.name, count(m)
```

Compiler CYPHER 4.2

Planner COST

Runtime INTERPRETED

Runtime version 4.2

Operator	Details	Estimated				
Rows	Rows	DB Hits	Memory (Bytes)	Page Cache Hits/Misses	Ordered by	
+ProduceResults	`p.name`, `count(m)`			0/0	p.name ASC	
1   3   0						
+OrderedAggregation	cache[p.name] AS `p.name`, count(m) AS `count(m)`			0/0	p.name ASC	
1   3   0						
+Filter	m:Movie			0/0	p.name ASC	
1   16   16						
+Expand(All)	(p)-[anon_17:ACTED_IN]->(m)			0/0	p.name ASC	
1   16   20						
+NodeIndexSeekByRange	p:Person(name) WHERE name STARTS WITH \$autostring_0, cache[p.name]			0/0	p.name ASC	
1   4   5						

Total database accesses: 41, total allocated memory: 0

If we change the query, such that it can no longer use an index, we will see that there will be no `cache[p.name]` in the `Variables`, and that the `EagerAggregation` now has `DB Hits`, since it accesses the database again to retrieve the name.

```
PROFILE
MATCH (p:Person)-[:ACTED_IN]->(m:Movie)
RETURN p.name, count(m)
```

Compiler CYPHER 4.2

Planner COST

Runtime INTERPRETED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits
Memory (Bytes)	Page Cache Hits/Misses			
+ProduceResults	`p.name` , `count(m)`   0/0	13	102	0
+EagerAggregation	p.name AS `p.name` , count(m) AS `count(m)`   13280   0/0	13	102	172
+Filter	p:Person   0/0	172	172	172
+Expand(All)	(m)<-[anon_17:ACTED_IN]-(p)   0/0	172	172	210
+NodeByLabelScan	m:Movie   0/0	38	38	39

Total database accesses: 593, total allocated memory: 13280

For non-native indexes there will still be a second database access to retrieve those values.

Predicates that can be used to enable this optimization are:

- Existence (e.g. `WHERE exists(n.name)`)
- Equality (e.g. `WHERE n.name = 'Tom Hanks'`)
- Range (e.g. `WHERE n.uid > 1000 AND n.uid < 2000`)
- Prefix (e.g. `WHERE n.name STARTS WITH 'Tom'`)
- Suffix (e.g. `WHERE n.name ENDS WITH 'Hanks'`)
- Substring (e.g. `WHERE n.name CONTAINS 'a'`)
- Several predicates of the above types combined using `OR`, given that all of them are on the same property (e.g. `WHERE n.prop < 10 OR n.prop = 'infinity'`)



If there is an existence constraint on the property, no predicate is required to trigger the optimization. For example, `CREATE CONSTRAINT constraint_name ON (p:Person) ASSERT exists(p.name)`

## Aggregating functions

For all [built-in aggregating functions](#) in Cypher, the *index-backed property-lookup* optimization can be used even without a predicate. Consider this query which returns the number of distinct names of people in the movies dataset:

```

PROFILE
MATCH (p:Person)
RETURN count(DISTINCT p.name) AS numberOfNames

```

Compiler CYPHER 4.2

Planner COST

Runtime INTERPRETED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits
Memory (Bytes)	Page Cache Hits/Misses			
+ProduceResults	numberOfNames 0/0		1   1   0	
+EagerAggregation	count(DISTINCT cache[p.name]) AS numberOfNames 9856   0/0		1   1   0	
+NodeIndexScan	p:Person(name) WHERE exists(name), cache[p.name]   0/0	125   125   126		

Total database accesses: 126, total allocated memory: 9856

Note that the **NodeIndexScan** in the **Variables** column contains `cache[p.name]` and that the **EagerAggregation** has no **DB Hits**. In this case, the semantics of aggregating functions works like an implicit existence predicate because **Person** nodes without the property `name` will not affect the result of an aggregation.

#### 6.5.4. Index-backed order by

Now consider the following refinement to the query:

```

PROFILE
MATCH (p:Person)-[:ACTED_IN]->(m:Movie)
WHERE p.name STARTS WITH 'Tom'
RETURN p.name, count(m)
ORDER BY p.name

```

Compiler CYPHER 4.2

Planner COST

Runtime INTERPRETED

Runtime version 4.2

Operator	Details	Estimated
Rows	Rows	DB Hits
		Memory (Bytes)
		Page Cache Hits/Misses
		Ordered by
+ProduceResults	`p.name` , `count(m)`	
1   3   0		0/0   p.name ASC
+OrderedAggregation	cache[p.name] AS `p.name` , count(m) AS `count(m)`	
1   3   0	0	0/0   p.name ASC
+Filter	m:Movie	
1   16   16		0/0   p.name ASC
+Expand(All)	(p)-[anon_17:ACTED_IN]->(m)	
1   16   20		0/0   p.name ASC
+NodeIndexSeekByRange	p:Person(name) WHERE name STARTS WITH \$autostring_0 , cache[p.name]	
1   4   5		0/0   p.name ASC

Total database accesses: 41, total allocated memory: 0

We are asking for the results in ascending alphabetical order. The native index happens to store String properties in ascending alphabetical order, and Cypher knows this. In Neo4j 3.4 and earlier, Cypher would plan a `Sort` operation to sort the results, which means building a collection in memory and running a sort algorithm on it. For large result sets this can be expensive in terms of both memory and time. In Neo4j 3.5 and later, Cypher will recognize that the index already returns data in the correct order, and skip the `Sort` operation.

The `Order` column describes the order of rows after each operator. We see that the `Order` column contains `p.name ASC` from the index seek operation, meaning that the rows are ordered by `p.name` in ascending order.

*Index-backed order by* can also be used for queries that expect their results in descending order, but with slightly lower performance.



In cases where the Cypher planner is unable to remove the `Sort` operator, the planner can utilize knowledge of the `ORDER BY` clause to plan the `Sort` operator at a point in the plan with optimal cardinality.

## `min()` and `max()`

For the `min` and `max` functions, the *index-backed order by* optimization can be used to avoid aggregation and instead utilize the fact that the minimum/maximum value is the first/last one in a sorted index. Consider the following query which returns the first actor in alphabetical order:

```
PROFILE
MATCH (p:Person)-[:ACTED_IN]->(m:Movie)
RETURN min(p.name) AS name
```

```
+-----+
| name      |
+-----+
| "Aaron Sorkin" |
+-----+
1 row
```

Aggregations are usually using the [EagerAggregation](#) operation. This would mean scanning all nodes in the index to find the name that is first in alphabetic order. Instead, the query is planned with [Projection](#), followed by [Limit](#), followed by [Optional](#). This will simply pick the first value from the index.

```
Compiler CYPHER 4.2
Planner COST
Runtime INTERPRETED
Runtime version 4.2

+-----+-----+-----+-----+
+-----+-----+-----+-----+
| Operator      | Details          | Estimated Rows | Rows | DB Hits | Memory (Bytes) |
| Page Cache Hits/Misses |
+-----+-----+-----+-----+
+-----+-----+-----+-----+
| +ProduceResults | name           | 1 | 1 | 0 |           |
0/0 |
| |           +-----+-----+-----+-----+
+-----+-----+-----+-----+
| +EagerAggregation | min(p.name) AS name | 1 | 1 | 172 | 0 |
0/0 |
| |           +-----+-----+-----+-----+
+-----+-----+-----+-----+
| +Filter       | p:Person        | 172 | 172 | 172 |           |
0/0 |
| |           +-----+-----+-----+-----+
+-----+-----+-----+-----+
| +Expand(All)   | (m)<-[anon_17:ACTED_IN]-(p) | 172 | 172 | 210 |           |
0/0 |
| |           +-----+-----+-----+-----+
+-----+-----+-----+-----+
| +NodeByLabelScan | m:Movie         | 38 | 38 | 39 |           |
0/0 |
+-----+-----+-----+-----+
+-----+-----+-----+-----+
Total database accesses: 593, total allocated memory: 0
```

For large datasets, this can improve performance dramatically.

*Index-backed order by* can also be used for corresponding queries with the [max](#) function, but with slightly lower performance.

## Restrictions

The optimization can only work on native indexes. It does not work for predicates only querying for the spatial type [Point](#). Predicates that can be used to enable this optimization are:

- Existence (e.g. `WHERE exists(n.name)`)
- Equality (e.g. `WHERE n.name = 'Tom Hanks'`)
- Range (e.g. `WHERE n.uid > 1000 AND n.uid < 2000`)
- Prefix (e.g. `WHERE n.name STARTS WITH 'Tom'`)
- Suffix (e.g. `WHERE n.name ENDS WITH 'Hanks'`)
- Substring (e.g. `WHERE n.name CONTAINS 'a'`)

Predicates that will not work:

- Several predicates combined using `OR`
- Equality or range predicates querying for points (e.g. `WHERE n.place > point({ x: 1, y: 2 })`)
- Spatial distance predicates (e.g. `WHERE distance(n.place, point({ x: 1, y: 2 })) < 2`)

If there is an existence constraint on the property, no predicate is required to trigger the optimization. For example, `CREATE CONSTRAINT constraint_name ON (p:Person) ASSERT exists(p.name)`



As of Neo4j 4.2.0, predicates with parameters, such as `WHERE n.prop > $param`, can trigger *index-backed order by*. The only exception are queries with parameters of type `Point`.

## 6.6. Planner hints and the `USING` keyword

A *planner hint* is used to influence the decisions of the planner when building an execution plan for a query. Planner hints are specified in a query with the `USING` keyword.



Forcing planner behavior is an advanced feature, and should be used with caution by experienced developers and/or database administrators only, as it may cause queries to perform poorly.

- [Introduction](#)
- [Index hints](#)
- [Scan hints](#)
- [Join hints](#)
- [PERIODIC COMMIT query hint](#)

### 6.6.1. Introduction

When executing a query, Neo4j needs to decide where in the query graph to start matching. This is done by looking at the `MATCH` clause and the `WHERE` conditions and using that information to find useful indexes, or other starting points.

However, the selected index might not always be the best choice. Sometimes multiple indexes are possible candidates, and the query planner picks the suboptimal one from a performance point of view. Moreover, in some circumstances (albeit rarely) it is better not to use an index at all.

Neo4j can be forced to use a specific starting point through the `USING` keyword. This is called giving a planner hint. There are four types of planner hints: index hints, scan hints, join hints, and the `PERIODIC COMMIT` query hint.

The following graph is used for the examples below:

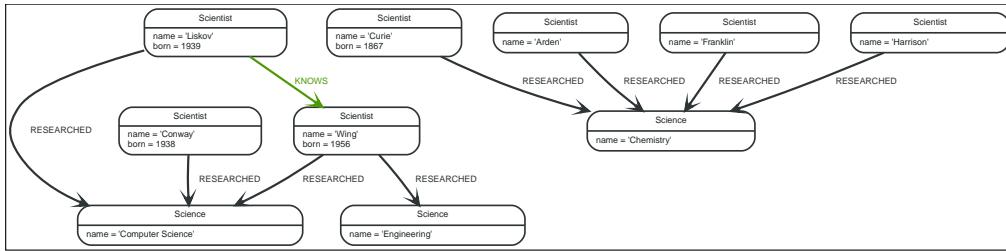


Figure 31. Graph

## Query

```

MATCH (liskov:Scientist { name:'Liskov' })-[:KNOWS]->(wing:Scientist)-[:RESEARCHED]->(cs:Science { name: 'Computer Science' })<-[:RESEARCHED]-(conway:Scientist { name: 'Conway' })
RETURN 1 AS column

```

The following query will be used in some of the examples on this page. It has intentionally been constructed in such a way that the statistical information will be inaccurate for the particular path that this query matches. For this reason, it can be improved by supplying planner hints.

## Query plan

Compiler CYPHER 4.2						
Planner COST						
Runtime PIPELINED						
Runtime version 4.2						
<hr/>						
<hr/>						
<hr/>						
<hr/>						
Operator   Details						
Estimated Rows   Rows   DB Hits   Memory (Bytes)   Page Cache Hits/Misses   Time (ms)   Other						
<hr/>						
<hr/>						
<hr/>						
+ProduceResults   column						
0   1   0     0/0   1.442   In Pipeline 5						
<hr/>						
<hr/>						
<hr/>						
+Projection   \$autoint_3 AS column						
0   1   0     0/0   0.065   In Pipeline 5						
<hr/>						
<hr/>						
<hr/>						
+NodeHashJoin   wing						
0   1   0   640     0.095   In Pipeline 5						
<hr/>						
<hr/>						
<hr/>						
+Filter   not anon_126 = anon_70						
0   2   0     0/0   0.299   In Pipeline 4						
<hr/>						
<hr/>						
<hr/>						
+NodeHashJoin   cs						
0   3   0   768     0/0   0.238   In Pipeline 4						
<hr/>						
<hr/>						

```

+-----+
| | +Expand(Into)      | (cs)-[anon_126:RESEARCHED]-(conway)
| |   0 |   1 |      5 |          984 |
| |   0/0 |     0.272 | In Pipeline 3
|
| | |
+-----+
| | +MultiNodeIndexSeek | cs:Science(name) WHERE name = $autostring_1, conway:Scientist(name) WHERE name
= $autostring_2 |           0 |   1 |      4 |          72 |
| |   2/0 |     0.394 | In Pipeline 2
|
| | |
+-----+
| | +Filter            | wing:Scientist
| |   0 |   3 |      3 |           |
| |   |           |           |           | Fused in
Pipeline 1 |
|
+-----+
| | +Expand(All)       | (cs)-[anon_70:RESEARCHED]-(wing)
| |   0 |   3 |      4 |           |
| |   |           |           |           | Fused in
Pipeline 1 |
|
+-----+
| | +NodeIndexSeek    | cs:Science(name) WHERE name = $autostring_1
| |   0 |   1 |      2 |          72 |
| |   |           |           |           | Fused in
Pipeline 1 |
|
+-----+
| | +Filter            | wing:Scientist
| |   0 |   1 |      1 |           |
| |   |           |           |           | Fused in
Pipeline 0 |
|
+-----+
| | +Expand(All)       | (liskov)-[anon_43:KNOWS]->(wing)
| |   0 |   1 |      3 |           |
| |   |           |           |           | Fused in
Pipeline 0 |
|
+-----+
| | +NodeIndexSeek    | liskov:Scientist(name) WHERE name = $autostring_0
| |   0 |   1 |      2 |          72 |
| |   |           |           |           | Fused in
Pipeline 0 |
|
+-----+

```

Total database accesses: 24, total allocated memory: 2160

## 6.6.2. Index hints

Index hints are used to specify which index, if any, the planner should use as a starting point. This can be beneficial in cases where the index statistics are not accurate for the specific values that the query at hand is known to use, which would result in the planner picking a non-optimal index. To supply an index hint, use `USING INDEX variable:Label(property)` or `USING INDEX SEEK variable:Label(property)` after the applicable `MATCH` clause.

It is possible to supply several index hints, but keep in mind that several starting points will require the use of a potentially expensive join later in the query plan.

## Query using an index hint

The query above will not naturally pick an index to solve the plan. This is because the graph is very small, and label scans are faster for small databases. In general, however, query performance is ranked by the dbhit metric, and we see that using an index is slightly better for this query.

### Query

```
MATCH (liskov:Scientist { name:'Liskov' })-[:KNOWS]->(wing:Scientist)-[:RESEARCHED]->(cs:Science {  
    name: 'Computer Science' })-<-[RESEARCHED]-(conway:Scientist { name: 'Conway' })  
USING INDEX liskov:Scientist(name)  
RETURN liskov.born AS column
```

Returns the year '**Barbara Liskov**' was born.

### Query plan

```
Compiler CYPHER 4.2  
Planner COST  
Runtime PIPELINED  
Runtime version 4.2  
  
+-----  
+-----  
+-----+-----+-----+-----+  
+-----| Operator | Details  
+-----| Estimated Rows | Rows | DB Hits | Memory (Bytes) | Page Cache Hits/Misses | Time (ms) | Other  
+-----| +ProduceResults | column  
      0 | 1 | 0 | | 0/0 | 0.066 | In Pipeline 5  
| |  
+-----  
+-----+-----+-----+-----+  
+-----| +Projection | liskov.born AS column  
      0 | 1 | 3 | | 1/0 | 0.065 | In Pipeline 5  
| |  
+-----  
+-----+-----+-----+-----+  
+-----| +NodeHashJoin | wing  
      0 | 1 | 0 | 640 | | 0.054 | In Pipeline 5  
| | \\\  
+-----  
+-----+-----+-----+-----+  
+-----| +Filter | not anon_126 = anon_70  
      0 | 2 | 0 | | 0/0 | 0.076 | In Pipeline 4  
| | |  
+-----  
+-----+-----+-----+-----+  
+-----| +NodeHashJoin | cs  
      0 | 3 | 0 | 768 | | 0/0 | 0.135 | In Pipeline 4  
| | | \\\  
+-----  
+-----+-----+-----+-----+  
+-----| +Expand(Into) | (cs)<-[anon_126:RESEARCHED]-(conway)  
      0 | 1 | 5 | 984 | | 0/0 | 0.139 | In Pipeline 3
```

```

| | |
+-----+
+-----+
| | | +MultiNodeIndexSeek | cs:Science(name) WHERE name = $autostring_1, conway:Scientist(name) WHERE name
= $autostring_2 | 0 | 1 | 4 | 72 | 2/0 | 7.698 |
In Pipeline 2 |
| | |
+-----+
+-----+
| | | +Filter | wing:Scientist
| | | 0 | 3 | 3 | | | Fused in
Pipeline 1 |
| | |
+-----+
+-----+
| | | +Expand(All) | (cs)<-[anon_70:RESEARCHED]-(wing)
| | | 0 | 3 | 4 | | | Fused in
Pipeline 1 |
| | |
+-----+
+-----+
| | | +NodeIndexSeek | cs:Science(name) WHERE name = $autostring_1
| | | 0 | 1 | 2 | 72 | | | Fused in
Pipeline 1 |
| |
+-----+
+-----+
| | | +Filter | wing:Scientist
| | | 0 | 1 | 1 | | | Fused in
Pipeline 0 |
| |
+-----+
+-----+
| | | +Expand(All) | (liskov)-[anon_43:KNOWS]->(wing)
| | | 0 | 1 | 3 | | | Fused in
Pipeline 0 |
| |
+-----+
+-----+
| | | +NodeIndexSeek | liskov:Scientist(name) WHERE name = $autostring_0
| | | 0 | 1 | 2 | 72 | | | Fused in
Pipeline 0 |
+-----+
+-----+
+-----+
+-----+
Total database accesses: 27, total allocated memory: 2160

```

## Query using an index seek hint

Similar to the index (scan) hint, but an index seek will be used rather than an index scan. Index seeks require no post filtering, they are most efficient when a relatively small number of nodes have the specified value on the queried property.

### Query

```

MATCH (liskov:Scientist { name:'Liskov' })-[:KNOWS]->(wing:Scientist)-[:RESEARCHED]->(cs:Science {
name:'Computer Science' })<-[:RESEARCHED]-(conway:Scientist { name: 'Conway' })
USING INDEX SEEK liskov:Scientist(name)
RETURN liskov.born AS column

```

Returns the year '**Barbara Liskov**' was born.

### Query plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator Details						
Estimated Rows	Rows	DB Hits	Memory (Bytes)	Page Cache Hits/Misses	Time (ms)	Other
+ProduceResults	1	0		0/0	0.069	In Pipeline 5
+Projection	1	3		1/0	0.059	In Pipeline 5
+NodeHashJoin	1	0	640		0.069	In Pipeline 5
+Filter	2	0		0/0	0.070	In Pipeline 4
+NodeHashJoin	3	0	768		0.116	In Pipeline 4
+Expand(Into)	1	5	984		0.111	In Pipeline 3
+MultiNodeIndexSeek	1	4	72	2/0	1.125	In Pipeline 2
+Filter	3	3				Fused in Pipeline 1
+Expand(All)	3	4				Fused in Pipeline 1

```

+-----+
| | +NodeIndexSeek      | cs:Science(name) WHERE name = $autostring_1
| |          0 |   1 |       2 |        72 |
| |           |           |           |           | Fused in
Pipeline 1 |
| |
+-----+
+-----+
| +Filter          | wing:Scientist
| |          0 |   1 |       1 |           |           | Fused in
Pipeline 0 |
| |
+-----+
+-----+
| +Expand(All)      | (liskov)-[anon_43:KNOWS]->(wing)
| |          0 |   1 |       3 |           |           | Fused in
Pipeline 0 |
| |
+-----+
+-----+
| +NodeIndexSeek      | liskov:Scientist(name) WHERE name = $autostring_0
| |          0 |   1 |       2 |        72 |
| |           |           |           |           | Fused in
Pipeline 0 |
+-----+
+-----+
+-----+
+-----+
Total database accesses: 27, total allocated memory: 2160

```

## Query using multiple index hints

Supplying one index hint changed the starting point of the query, but the plan is still linear, meaning it only has one starting point. If we give the planner yet another index hint, we force it to use two starting points, one at each end of the match. It will then join these two branches using a join operator.

### Query

```

MATCH (liskov:Scientist { name:'Liskov' })-[:KNOWS]->(wing:Scientist)-[:RESEARCHED]->(cs:Science {
name:'Computer Science' })<-[:RESEARCHED]-(conway:Scientist { name: 'Conway' })
USING INDEX liskov:Scientist(name)
USING INDEX conway:Scientist(name)
RETURN liskov.born AS column

```

Returns the year '**Barbara Liskov**' was born, using a slightly better plan.

### Query plan

```

Compiler CYPHER 4.2
Planner COST
Runtime PIPELINED
Runtime version 4.2
+-----+
+-----+
+-----+
| Operator      | Details
| Estimated Rows | Rows | DB Hits | Memory (Bytes) | Page Cache Hits/Misses | Time (ms) | Other
|               |
+-----+
+-----+
+-----+
| +ProduceResults | column

```

```

| 0 | 1 | 0 | | 0/0 | 0.055 | In Pipeline 5
| |
+-----+
| +Projection | liskov.born AS column
| 0 | 1 | 3 | | 1/0 | 0.032 | In Pipeline 5
| |
+-----+
| +NodeHashJoin | wing
| 0 | 1 | 0 | 640 | | 0.041 | In Pipeline 5
| |
| \|
+-----+
| +Filter | not anon_126 = anon_70
| 0 | 2 | 0 | | 0/0 | 0.149 | In Pipeline 4
| |
| |
+-----+
| +NodeHashJoin | cs
| 0 | 3 | 0 | 768 | | 0/0 | 0.115 | In Pipeline 4
| |
| |
+-----+
| +Expand(Into) | (cs)-[anon_126:RESEARCHED]-(conway)
| 0 | 1 | 5 | 984 | | 0/0 | 0.145 | In Pipeline 3
| |
| |
+-----+
| +MultiNodeIndexSeek | cs:Science(name) WHERE name = $autostring_1, conway:Scientist(name) WHERE name = $autostring_2 | 0 | 1 | 4 | 72 | | 2/0 | 0.774 | In Pipeline 2
| |
| |
+-----+
| +Filter | wing:Scientist
| 0 | 3 | 3 | | | | Fused in
Pipeline 1 |
| |
+-----+
| +Expand(All) | (cs)-[anon_70:RESEARCHED]-(wing)
| 0 | 3 | 4 | | | | Fused in
Pipeline 1 |
| |
+-----+
| +NodeIndexSeek | cs:Science(name) WHERE name = $autostring_1
| 0 | 1 | 2 | 72 | | | | Fused in
Pipeline 1 |
| |
+-----+
| +Filter | wing:Scientist
| 0 | 1 | 1 | | | | Fused in
Pipeline 0 |
| |
+-----+
| +Expand(All) | (liskov)-[anon_43:KNOWS]->(wing)
| 0 | 1 | 3 | | | | Fused in
Pipeline 0 |
| |

```

```

+-----+
| +NodeIndexSeek | liskov:Scientist(name) WHERE name = $autostring_0
|   0 |   1 |   2 |      72 |           | Fused in
Pipeline 0 |
+-----+
+-----+
| +NodeByLabelScan | s:Scientist
|   10 |    7 |     8 |      72 | Fused in
+-----+
Total database accesses: 27, total allocated memory: 2160

```

### 6.6.3. Scan hints

If your query matches large parts of an index, it might be faster to scan the label and filter out nodes that do not match. To do this, you can use `USING SCAN variable:Label` after the applicable `MATCH` clause. This will force Cypher to not use an index that could have been used, and instead do a label scan.

#### Hinting a label scan

If the best performance is to be had by scanning all nodes in a label and then filtering on that set, use `USING SCAN`.

#### Query

```

MATCH (s:Scientist)
USING SCAN s:Scientist
WHERE s.born < 1939
RETURN s.born AS column

```

Returns all scientists born before '1939'.

#### Query plan

```

Compiler CYPHER 4.2
Planner COST
Runtime PIPELINED
Runtime version 4.2

+-----+-----+-----+-----+
| Operator      | Details          | Estimated Rows | Rows | DB Hits | Memory (Bytes) | Other
|-----+-----+-----+-----+
| +ProduceResults | column          |                 3 |    2 |       0 |                   | Fused
in Pipeline 0 |
| |               +-----+-----+-----+
+-----+
| +Projection    | cache[s.born] AS column |                 3 |    2 |       0 |                   | Fused
in Pipeline 0 |
| |               +-----+-----+-----+
+-----+
| +Filter        | cache[s.born] < $autoint_0 |                 3 |    2 |      18 |                   | Fused
in Pipeline 0 |
| |               +-----+-----+-----+
+-----+
| +NodeByLabelScan | s:Scientist          |                10 |    7 |       8 |      72 | Fused
in Pipeline 0 |
+-----+
Total database accesses: 26, total allocated memory: 72

```

## 6.6.4. Join hints

Join hints are the most advanced type of hints, and are not used to find starting points for the query execution plan, but to enforce that joins are made at specified points. This implies that there has to be more than one starting point (leaf) in the plan, in order for the query to be able to join the two branches ascending from these leaves. Due to this nature, joins, and subsequently join hints, will force the planner to look for additional starting points, and in the case where there are no more good ones, potentially pick a very bad starting point. This will negatively affect query performance. In other cases, the hint might force the planner to pick a *seemingly* bad starting point, which in reality proves to be a very good one.

### Hinting a join on a single node

In the example above using multiple index hints, we saw that the planner chose to do a join on the `cs` node. This means that the relationship between `wing` and `cs` was traversed in the outgoing direction, which is better statistically because the pattern `(:RESEARCHED)->(:Science)` is more common than the pattern `(:Scientist)-[:RESEARCHED]->()`. However, in the actual graph, the `cs` node only has two such relationships, so expanding from it will be beneficial to expanding from the `wing` node. We can force the join to happen on `wing` instead with a join hint.

#### Query

```
MATCH (liskov:Scientist { name:'Liskov' })-[:KNOWS]->(wing:Scientist)-[:RESEARCHED]->(cs:Science { name:'Computer Science' })<-[:RESEARCHED]-(conway:Scientist { name: 'Conway' })
USING INDEX liskov:Scientist(name)
USING INDEX conway:Scientist(name)
USING JOIN ON wing
RETURN wing.born AS column
```

Returns the birth date of 'Jeanette Wing', using a slightly better plan.

#### Query plan

```
Compiler CYPHER 4.2
Planner COST
Runtime PIPELINED
Runtime version 4.2

+-----+
+-----+
+-----+-----+-----+-----+
| Operator          | Details
| Estimated Rows  | Rows | DB Hits | Memory (Bytes) | Page Cache Hits/Misses | Time (ms) | Other
|-----+
|-----+
| +ProduceResults   | column
|       0 |    1 |      0 |           |                   0/0 |     0.064 | In Pipeline 5
|
|-----+
|-----+
| +Projection        | wing.born AS column
|       0 |    1 |      3 |           |                   1/0 |     0.042 | In Pipeline 5
|
|-----+
|-----+
| +NodeHashJoin      | wing
|       0 |    1 |      0 |      640 |           |                   0.069 | In Pipeline 5
```

```

| | \
+-----+
+-----+-----+-----+
| | +Filter      | not anon_126 = anon_70
| |     0 |     2 |     0 |           |
| |           0/0 |    0.117 | In Pipeline 4
|
| | |
+-----+
+-----+-----+-----+
| | +NodeHashJoin | cs
| |     0 |     3 |     0 |           768 |
| |           0/0 |    1.009 | In Pipeline 4
|
| | | \
+-----+
+-----+-----+-----+
| | | +Expand(Into) | (cs)-[anon_126:RESEARCHED]-(conway)
| | |     0 |     1 |     5 |           984 |
| | |           0/0 |    0.233 | In Pipeline 3
|
| | | |
+-----+
+-----+-----+-----+
| | | +MultiNodeIndexSeek | cs:Science(name) WHERE name = $autostring_1, conway:Scientist(name) WHERE name
= $autostring_2 |           0 |     1 |     4 |           72 |
In Pipeline 2           2/0 |    0.478 |
| | |
+-----+
+-----+-----+-----+
| | +Filter      | wing:Scientist
| |     0 |     3 |     3 |           |
| |           |           |           | Fused in
Pipeline 1           |
| | |
+-----+
+-----+-----+-----+
| | +Expand(All) | (cs)-[anon_70:RESEARCHED]-(wing)
| |     0 |     3 |     4 |           |
| |           |           |           | Fused in
Pipeline 1           |
| | |
+-----+
+-----+-----+-----+
| | +NodeIndexSeek | cs:Science(name) WHERE name = $autostring_1
| |     0 |     1 |     2 |           72 |
| |           |           |           | Fused in
Pipeline 1           |
| |
+-----+
+-----+-----+-----+
| | +Filter      | wing:Scientist
| |     0 |     1 |     1 |           |
| |           |           |           | Fused in
Pipeline 0           |
| |
+-----+
+-----+-----+-----+
| | +Expand(All) | (liskov)-[anon_43:KNOWS]->(wing)
| |     0 |     1 |     3 |           |
| |           |           |           | Fused in
Pipeline 0           |
| |
+-----+
+-----+-----+-----+
| | +NodeIndexSeek | liskov:Scientist(name) WHERE name = $autostring_0
| |     0 |     1 |     2 |           72 |
| |           |           |           | Fused in
Pipeline 0           |
+-----+
+-----+-----+-----+

```

Total database accesses: 27, total allocated memory: 2160

## Hinting a join on multiple nodes

The query planner can be made to produce a join between several specific points. This requires the query to expand from the same node from several directions.

### Query

```
MATCH (liskov:Scientist { name:'Liskov' })-[:KNOWS]->(wing:Scientist { name:'Wing' })-[:RESEARCHED]-
>(cs:Science { name:'Computer Science' })<-[:RESEARCHED]-(liskov)
USING INDEX liskov:Scientist(name)
USING JOIN ON liskov, cs
RETURN wing.born AS column
```

Returns the birth date of 'Jeanette Wing'.

### Query plan

```
Compiler CYPHER 4.2
Planner COST
Runtime PIPELINED
Runtime version 4.2

+-----+
+-----+
+-----+-----+-----+-----+
+-----+
| Operator          | Details
| Estimated Rows | Rows | DB Hits | Memory (Bytes) | Page Cache Hits/Misses | Time (ms) | Other
|-----|
+-----+
+-----+-----+-----+-----+
+-----+
| +ProduceResults   | column
|      0 |    1 |      0 |           |           0/0 |     0.117 | In Pipeline 6
|-----|
| |
+-----+
+-----+-----+-----+-----+
+-----+
| +Projection       | wing.born AS column
|      0 |    1 |      3 |           |           0/0 |     0.037 | In Pipeline 6
|-----|
| |
+-----+
+-----+-----+-----+-----+
+-----+
| +Filter            | not anon_142 = anon_86
|      0 |    1 |      0 |           |           0/0 |     0.061 | In Pipeline 6
|-----|
| |
+-----+
+-----+-----+-----+-----+
+-----+
| +NodeHashJoin      | cs, liskov
|      0 |    1 |      0 |           720 |           0/0 |     0.189 | In Pipeline 6
|-----|
| | \
+-----+
+-----+-----+-----+-----+
+-----+
| | +NodeHashJoin    | wing
| |      0 |    1 |      0 |           652 |           0.074 | In Pipeline 5
| |
| | | \
+-----+
+-----+-----+-----+-----+
+-----+
| | | +Filter         | cache[cs.name] = $autostring_2 AND cs:Science
| | |      0 |    1 |      5 |           |           | Fused in
Pipeline 4 |
| | | |
```

```

+-----+
| | +Expand(All)      | (wing)-[anon_86:RESEARCHED]->(cs)
| |   0 |   2 |   4 |                                |           | Fused in
Pipeline 4 |
| | |
+-----+
| | +NodeIndexSeek   | wing:Scientist(name) WHERE name = $autostring_1
| |   0 |   1 |   2 |   72 |                                |           | Fused in
Pipeline 4 |
| | |
+-----+
| | +Expand(Into)    | (liskov)-[anon_43:KNOWS]->(wing)
| |   0 |   1 |   4 |   984 |   1/0 |   0.233 | In Pipeline 3
|
| | |
+-----+
| | +MultiNodeIndexSeek | liskov:Scientist(name) WHERE name = $autostring_0, wing:Scientist(name) WHERE
name = $autostring_1 |   0 |   1 |   4 |   72 |   2/0 |
0.368 | In Pipeline 2 |
| |
+-----+
| | +Expand(Into)    | (cs)<-[anon_142:RESEARCHED]-(liskov)
| |   0 |   1 |   5 |   984 |   2/0 |   0.151 | In Pipeline 1
|
| |
+-----+
| | +MultiNodeIndexSeek | cs:Science(name) WHERE name = $autostring_2, cache[cs.name],
| |   0 |   1 |   4 |   72 |   2/0 |   2.062 | In Pipeline 0
|
| |           | liskov:Scientist(name) WHERE name = $autostring_0, cache[cs.name]
| |           |   |   |   |           |           |
|
+-----+
+-----+
+-----+

```

Total database accesses: 31, total allocated memory: 1948

## 6.6.5. PERIODIC COMMIT query hint

Importing large amounts of data using `LOAD CSV` with a single Cypher query may fail due to memory constraints. This will manifest itself as an `OutOfMemoryError`.

For this situation *only*, Cypher provides the global `USING PERIODIC COMMIT` query hint for updating queries using `LOAD CSV`. If required, the limit for the number of rows per commit may be set as follows: `USING PERIODIC COMMIT 500`.

`PERIODIC COMMIT` will process the rows until the number of rows reaches a limit. Then the current transaction will be committed and replaced with a newly opened transaction. If no limit is set, a default value will be used.

See [Importing large amounts of data](#) in `LOAD CSV` for examples of `USING PERIODIC COMMIT` with and without setting the number of rows per commit.



Using `PERIODIC COMMIT` will prevent running out of memory when importing large amounts of data. However, it will also break transactional isolation and thus it should only be used where needed.



The `USE clause` can not be used together with the `PERIODIC COMMIT` clause.

# Chapter 7. Execution plans

This section describes the characteristics of query execution plans and provides details about each of the operators.

- [Introduction](#)
- [Execution plan operators](#)
- [Database hits \(DbHits\)](#)
- [Execution plan operators in detail](#)
- [Shortest path planning](#)



For information on replanning, see [Cypher replanning](#).

## 7.1. Introduction

The task of executing a query is decomposed into *operators*, each of which implements a specific piece of work. The operators are combined into a tree-like structure called an *execution plan*. Each operator in the execution plan is represented as a node in the tree. Each operator takes as input zero or more rows, and produces as output zero or more rows. This means that the output from one operator becomes the input for the next operator. Operators that join two branches in the tree combine input from two incoming streams and produce a single output.

### Evaluation model

Evaluation of the execution plan begins at the leaf nodes of the tree. Leaf nodes have no input rows and generally comprise operators such as scans and seeks. These operators obtain the data directly from the storage engine, thus incurring [database hits](#). Any rows produced by leaf nodes are then piped into their parent nodes, which in turn pipe their output rows to their parent nodes and so on, all the way up to the root node. The root node produces the final results of the query.

### Eager and lazy evaluation

In general, query evaluation is *lazy*: most operators pipe their output rows to their parent operators as soon as they are produced. This means that a child operator may not be fully exhausted before the parent operator starts consuming the input rows produced by the child.

However, some operators, such as those used for aggregation and sorting, need to aggregate all their rows before they can produce output. Such operators need to complete execution in its entirety before any rows are sent to their parents as input. These operators are called *eager* operators, and are denoted as such in [Execution plan operators at a glance](#). Eagerness can cause high memory usage and may therefore be the cause of query performance issues.

### Statistics

Each operator is annotated with statistics.

#### Rows

The number of rows that the operator produced. This is only available if the query was profiled.

#### EstimatedRows

This is the estimated number of rows that is expected to be produced by the operator. The estimate is an approximate number based on the available statistical information. The compiler uses this estimate to choose a suitable execution plan.

#### DbHits

Each operator will ask the Neo4j storage engine to do work such as retrieving or updating data. A *database hit* is an abstract unit of this storage engine work. The actions triggering a database hit are listed in [Database hits \(DbHits\)](#).

### Page Cache Hits, Page Cache Misses, Page Cache Hit Ratio

These metrics are only shown for some queries when using Neo4j Enterprise Edition. The page cache is used to cache data and avoid accessing disk, so having a high number of [hits](#) and a low number of [misses](#) will typically make the query run faster. Whenever several operators are fused together for more efficient execution we can no longer associate this metric with a given operator and then nothing will appear here.

### Time

[Time](#) is only shown for some operators when using the [pipelined](#) runtime. The number shown is the time in milliseconds it took to execute the given operator. Whenever several operators are fused together for more efficient execution we can no longer associate a duration with a given operator and then nothing will appear here.

To produce an efficient plan for a query, the Cypher query planner requires information about the Neo4j database. This information includes which indexes and constraints are available, as well as various statistics maintained by the database. The Cypher query planner uses this information to determine which access patterns will produce the best execution plan.

The statistical information maintained by Neo4j is:

1. The number of nodes having a certain label.
2. The number of relationships by type.
3. Selectivity per index.
4. The number of relationships by type, ending with or starting from a node with a specific label.

Information about how the statistics are kept up to date, as well as configuration options for managing query replanning and caching, can be found in the [Operations Manual](#) [Statistics and execution plans](#).

[Query tuning](#) describes how to tune Cypher queries. In particular, see [Profiling a query](#) for how to view the execution plan for a query and [Planner hints and the USING keyword](#) for how to use *hints* to influence the decisions of the planner when building an execution plan for a query.

For a deeper understanding of how each operator works, refer to [Execution plan operators at a glance](#) and the linked sections per operator. Please remember that the statistics of the particular database where the queries run will decide the plan used. There is no guarantee that a specific query will always be solved with the same plan.

## 7.2. Execution plan operators at a glance

This table comprises all the execution plan operators ordered lexicographically.

- *Leaf* operators, in most cases, locate the starting nodes and relationships required in order to execute the query.
- *Updating* operators are used in queries that update the graph.
- *Eager* operators [accumulate all their rows](#) before piping them to the next operator.

Name	Description	Leaf?	Updating?	Considerations
AllNodesScan	Reads all nodes from the node store.	Y		

Name	Description	Leaf?	Updating?	Considerations
AntiConditionalApply	Performs a nested loop. If a variable is <code>null</code> , the right-hand side will be executed.			
AntiSemiApply	Performs a nested loop. Tests for the absence of a pattern predicate.			
Apply	Performs a nested loop. Yields rows from both the left-hand and right-hand side operators.			
Argument	Indicates the variable to be used as an argument to the right-hand side of an <a href="#">Apply</a> operator.	Y		
AssertSameNode	Used to ensure that no unique constraints are violated.			
CacheProperties	Reads node or relationship properties and caches them.			
CartesianProduct	Produces a cartesian product of the inputs from the left-hand and right-hand operators.			
ConditionalApply	Performs a nested loop. If a variable is not <code>null</code> , the right-hand side will be executed.			
CreateIndex	Creates an index on a property for all nodes having a certain label.		Y	
CreateNodeKeyConstraint	Creates a node key constraint on a set of properties for all nodes having a certain label.		Y	
Create	Creates nodes and relationships.		Y	
CreateNodePropertyExistenceConstraint	Creates an existence constraint on a property for all nodes having a certain label.		Y	
CreateRelationshipPropertyExistenceConstraint	Creates an existence constraint on a property for all relationships of a certain type.		Y	
CreateUniqueConstraint	Creates a unique constraint on a property for all nodes having a certain label.		Y	
Delete	Deletes a node or relationship.		Y	
DetachDelete	Deletes a node and its relationships.		Y	

Name	Description	Leaf?	Updating?	Considerations
DirectedRelationshipByldSeek	Reads one or more relationships by id from the relationship store.	Y		
Distinct	Drops duplicate rows from the incoming stream of rows.			Eager
DoNothingIfExists(CONSTRAINT)	Checks if a constraint already exists, if it does then it stops the execution, if not it continues	Y		
DoNothingIfExists(INDEX)	Checks if an index already exists, if it does then it stops the execution, if not it continues	Y		
DropIndex (deprecated syntax)	Drops an index from a property for all nodes having a certain label.	Y	Y	Deprecated
DropIndex (new syntax)	Drops an index using its name.	Y	Y	
DropConstraint	Drops a constraint using its name.	Y	Y	
DropNodeKeyConstraint	Drops a node key constraint from a set of properties for all nodes having a certain label.	Y	Y	Deprecated
DropNodePropertyExistenceConstraint	Drops an existence constraint from a property for all nodes having a certain label.	Y	Y	Deprecated
DropRelationshipPropertyExistenceConstraint	Drops an existence constraint from a property for all relationships of a certain type.	Y	Y	Deprecated
DropResult	Produces zero rows when an expression is guaranteed to produce an empty result.			
DropUniqueConstraint	Drops a unique constraint from a property for all nodes having a certain label.	Y	Y	Deprecated
Eager	For isolation purposes, Eager ensures that operations affecting subsequent operations are executed fully for the whole dataset before continuing execution.			Eager
EagerAggregation	Evaluates a grouping expression.			Eager
EmptyResult	Eagerly loads all incoming data and discards it.			

Name	Description	Leaf?	Updating?	Considerations
EmptyRow	Returns a single row with no columns.	Y		
Expand(All)	Traverses incoming or outgoing relationships from a given node.			
Expand(Into)	Finds all relationships between two nodes.			
Filter	Filters each row coming from the child operator, only passing through rows that evaluate the predicates to <code>true</code> .			
Foreach	Performs a nested loop. Yields rows from the left-hand operator and discards rows from the right-hand operator.			
LetAntiSemiApply	Performs a nested loop. Tests for the absence of a pattern predicate in queries containing multiple pattern predicates.			
LetSelectOrSemiApply	Performs a nested loop. Tests for the presence of a pattern predicate that is combined with other predicates.			
LetSelectOrAntiSemiApply	Performs a nested loop. Tests for the absence of a pattern predicate that is combined with other predicates.			
LetSemiApply	Performs a nested loop. Tests for the presence of a pattern predicate in queries containing multiple pattern predicates.			
Limit	Returns the first 'n' rows from the incoming input.			
LoadCSV	Loads data from a CSV source into the query.	Y		
LockNodes	Locks the start and end node when creating a relationship.			
MergeCreateNode	Creates the node when failing to find the node.	Y	Y	
MergeCreateRelationship	Creates the relationship when failing to find the relationship.		Y	
NodeByIdSeek	Reads one or more nodes by id from the node store.	Y		

Name	Description	Leaf?	Updating?	Considerations
NodeByLabelScan	Fetches all nodes with a specific label from the node label index.	Y		
NodeCountFromCount Store	Uses the count store to answer questions about node counts.	Y		
NodeHashJoin	Executes a hash join on node ids.			Eager
NodeIndexContainsScan	Examines all values stored in an index, searching for entries containing a specific string.	Y		
NodeIndexEndsWithScan	Examines all values stored in an index, searching for entries ending in a specific string.	Y		
NodeIndexScan	Examines all values stored in an index, returning all nodes with a particular label having a specified property.	Y		
NodeIndexSeek	Finds nodes using an index seek.	Y		
NodeIndexSeekByRange	Finds nodes using an index seek where the value of the property matches the given prefix string.	Y		
NodeLeftOuterHashJoin	Executes a left outer hash join.			Eager
NodeRightOuterHashJoin	Executes a right outer hash join.			Eager
NodeUniqueIndexSeek	Finds nodes using an index seek within a unique index.	Y		
NodeUniqueIndexSeekByRange	Finds nodes using an index seek within a unique index where the value of the property matches the given prefix string.	Y		
OrderedAggregation	Like <a href="#">EagerAggregation</a> but relies on the ordering of incoming rows. Is not eager.			
OrderedDistinct	Like <a href="#">Distinct</a> but relies on the ordering of incoming rows.			
Optional	Yields a single row with all columns set to <a href="#">null</a> if no data is returned by its source.			

Name	Description	Leaf?	Updating?	Considerations
OptionalExpand(All)	Traverses relationships from a given node, producing a single row with the relationship and end node set to <code>null</code> if the predicates are not fulfilled.			
OptionalExpand(Into)	Traverses all relationships between two nodes, producing a single row with the relationship and end node set to <code>null</code> if no matching relationships are found (the start node will be the node with the smallest degree).			
PartialSort	Sorts a row by multiple columns if there is already an ordering.			
PartialTop	Returns the first 'n' rows sorted by multiple columns if there is already an ordering.			
ProcedureCall	Calls a procedure.			
ProduceResults	Prepares the result so that it is consumable by the user.			
ProjectEndpoints	Projects the start and end node of a relationship.			
Projection	Evaluates a set of expressions, producing a row with the results thereof.	Y		
RelationshipCountFromCountStore	Uses the count store to answer questions about relationship counts.	Y		
RemoveLabels	Deletes labels from a node.		Y	
RollUpApply	Performs a nested loop. Executes a pattern expression or pattern comprehension.			
SelectOrAntiSemiApply	Performs a nested loop. Tests for the absence of a pattern predicate if an expression predicate evaluates to <code>false</code> .			
SelectOrSemiApply	Performs a nested loop. Tests for the presence of a pattern predicate if an expression predicate evaluates to <code>false</code> .			

Name	Description	Leaf?	Updating?	Considerations
SemiApply	Performs a nested loop. Tests for the presence of a pattern predicate.			
SetLabels	Sets labels on a node.		Y	
SetNodePropertiesFromMap	Sets properties from a map on a node.		Y	
SetProperty	Sets a property on a node or relationship.		Y	
SetRelationshipPropertiesFromMap	Sets properties from a map on a relationship.		Y	
Skip	Skips 'n' rows from the incoming rows.			
Sort	Sorts rows by a provided key.			Eager
Top	Returns the first 'n' rows sorted by a provided key.			Eager
TriadicSelection	Solves triangular queries, such as the very common 'find my friend-of-friends that are not already my friend'.			
UndirectedRelationshipByidSeek	Reads one or more relationships by id from the relationship store.	Y		
Union	Concatenates the results from the right-hand operator with the results from the left-hand operator.			
Unwind	Returns one row per item in a list.			
ValueHashJoin	Executes a hash join on arbitrary values.			Eager
VarLengthExpand(All)	Traverses variable-length relationships from a given node.			
VarLengthExpand(Into)	Finds all variable-length relationships between two nodes.			
VarLengthExpand(Pruning)	Traverses variable-length relationships from a given node and only returns unique end nodes.			

## 7.3. Database hits (DbHits)

Each operator will send a request to the storage engine to do work such as retrieving or updating data. A *database hit* is an abstract unit of this storage engine work.

We list below all the actions that trigger one or more database hits:

- Create actions

- Create a node
  - Create a relationship
  - Create a new node label
  - Create a new relationship type
  - Create a new ID for property keys with the same name
- Delete actions
  - Delete a node
  - Delete a relationship
- Update actions
  - Set one or more labels on a node
  - Remove one or more labels from a node
- Node-specific actions
  - Get a node by its ID
  - Get the degree of a node
  - Determine whether a node is dense
  - Determine whether a label is set on a node
  - Get the labels of a node
  - Get a property of a node
  - Get an existing node label
  - Get the name of a label by its ID, or its ID by its name
- Relationship-specific actions
  - Get a relationship by its ID
  - Get a property of a relationship
  - Get an existing relationship type
  - Get a relationship type name by its ID, or its ID by its name
- General actions
  - Get the name of a property key by its ID, or its ID by the key name
  - Find a node or relationship through an index seek or index scan
  - Find a path in a variable-length expand
  - Find a shortest path
  - Ask the count store for a value
- Schema actions
  - Add an index
  - Drop an index
  - Get the reference of an index
  - Create a constraint
  - Drop a constraint
- Call a procedure
- Call a user-defined function



The presented value can vary slightly depending on the [Cypher runtime](#) that was used to execute the query. In the pipelined runtime the number of *database hits* will typically be higher since it uses a more accurate way of measuring.

## 7.4. Execution plan operators in detail

*All operators are listed here, grouped by the similarity of their characteristics.*

Certain operators are only used by a subset of the [runtimes](#) that Cypher can choose from. If that is the case, the example queries will be prefixed with an option to choose one of these runtimes.

### 7.4.1. All Nodes Scan

The [AllNodesScan](#) operator reads all nodes from the node store. The variable that will contain the nodes is seen in the arguments. Any query using this operator is likely to encounter performance problems on a non-trivial database.

#### Query

```
MATCH (n)
RETURN n
```

#### Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Memory (Bytes)	Other	
+ProduceResults	n	35	35	0			Fused in Pipeline 0
+AllNodesScan	n	35	35	36	72		Fused in Pipeline 0

Total database accesses: 36, total allocated memory: 72

### 7.4.2. Directed Relationship By Id Seek

The [DirectedRelationshipByIdSeek](#) operator reads one or more relationships by id from the relationship store, and produces both the relationship and the nodes on either side.

#### Query

```
MATCH (n1)-[r]->()
WHERE id(r)= 0
RETURN r, n1
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows
DB Hits	Memory (Bytes)	Other	
+ProduceResults	r, n1 0   Fused in Pipeline 0	1	1
+DirectedRelationshipByIdSeek	(n1)-[r]->(anon_17) WHERE id(r) = \$autoint_0   1   72   Fused in Pipeline 0	1	1

Total database accesses: 1, total allocated memory: 72

## 7.4.3. Node By Id Seek

The [NodeByIdSeek](#) operator reads one or more nodes by id from the node store.

### Query

```
MATCH (n)
WHERE id(n)= 0
RETURN n
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Memory (Bytes)	Other
+ProduceResults   n in Pipeline 0	1   1   0					Fused
+NodeByIdSeek   n WHERE id(n) = \$autoint_0   in Pipeline 0	1   1   1   72					Fused

Total database accesses: 1, total allocated memory: 72

## 7.4.4. Node By Label Scan

The [NodeByLabelScan](#) operator fetches all nodes with a specific label from the node label index.

## Query

```
MATCH (person:Person)
RETURN person
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Memory (Bytes)	Other
+ProduceResults	person	14	14	0		Fused in Pipeline
+NodeByLabelScan	person:Person	14	14	15	72	Fused in Pipeline

Total database accesses: 15, total allocated memory: 72

## 7.4.5. Node Index Seek

The [NodeIndexSeek](#) operator finds nodes using an index seek. The node variable and the index used is shown in the arguments of the operator. If the index is a unique index, the operator is instead called [NodeUniqueIndexSeek](#).

## Query

```
MATCH (location:Location { name: 'Malmo' })
RETURN location
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Memory (Bytes)	Other
+ProduceResults	location	0	1	0		
+NodeIndexSeek	location:Location(name) WHERE name = \$autostring_0	0	1	2	72	Fused in Pipeline

Total database accesses: 2, total allocated memory: 72

## 7.4.6. Node Unique Index Seek

The `NodeUniqueIndexSeek` operator finds nodes using an index seek within a unique index. The node variable and the index used is shown in the arguments of the operator. If the index is not unique, the operator is instead called `NodeIndexSeek`. If the index seek is used to solve a `MERGE` clause, it will also be marked with (`Locking`). This makes it clear that any nodes returned from the index will be locked in order to prevent concurrent conflicting updates.

### Query

```
MATCH (t:Team { name: 'Malmo' })
RETURN t
```

### Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits
Memory (Bytes)	Other			
+ProduceResults	t   Fused in Pipeline 0	0	0	0
+NodeUniqueIndexSeek	UNIQUE t:Team(name) WHERE name = \$autostring_0   72   Fused in Pipeline 0	0	0	1

Total database accesses: 1, total allocated memory: 72

## 7.4.7. Multi Node Index Seek

The `MultiNodeIndexSeek` operator finds nodes using multiple index seeks. It supports using multiple distinct indexes for different nodes in the query. The node variables and the indexes used are shown in the arguments of the operator.

The operator yields a cartesian product of all index seeks. For example, if the operator does two seeks and the first seek finds the nodes `a1`, `a2` and the second `b1`, `b2`, `b3`, the `MultiNodeIndexSeek` will yield the rows `(a1, b1)`, `(a1, b2)`, `(a1, b3)`, `(a2, b1)`, `(a2, b2)`, `(a2, b3)`.

### Query

```
CYPHER runtime=pipelined
MATCH (location:Location { name: 'Malmo' }),(person:Person { name: 'Bob' })
RETURN location, person
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details				
Estimated Rows	Rows	DB Hits	Memory (Bytes)	Page Cache Hits/Misses	Time (ms)
+ProduceResults	location, person				
0	1	0			2/0   0.197   In Pipeline 0
+MultiNodeIndexSeek	location:Location(name) WHERE name = \$autostring_0, person:Person(name) WHERE name = \$autostring_1	0	1	4	72   0/2   0.602
In Pipeline 0					

Total database accesses: 4, total allocated memory: 72

## 7.4.8. Node Index Seek By Range

The [NodeIndexSeekByRange](#) operator finds nodes using an index seek where the value of the property matches a given prefix string. [NodeIndexSeekByRange](#) can be used for `STARTS WITH` and comparison operators such as `<`, `>`, `<=` and `>=`. If the index is a unique index, the operator is instead called [NodeUniqueIndexSeekByRange](#).

### Query

```
MATCH (l:Location)
WHERE l.name STARTS WITH 'Lon'
RETURN l
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details			Estimated Rows	Rows
DB Hits	Memory (Bytes)	Other			
+ProduceResults	l				
0		Fused in Pipeline 0		2	1
+NodeIndexSeekByRange	l:Location(name) WHERE name STARTS WITH \$autostring_0	72	Fused in Pipeline 0	2	1
2					

Total database accesses: 2, total allocated memory: 72

## 7.4.9. Node Unique Index Seek By Range

The `NodeUniqueIndexSeekByRange` operator finds nodes using an index seek within a unique index, where the value of the property matches a given prefix string. `NodeUniqueIndexSeekByRange` is used by `STARTS WITH` and comparison operators such as `<`, `>`, `<=` and `>=`. If the index is not unique, the operator is instead called `NodeIndexSeekByRange`.

### Query

```
MATCH (t:Team)
WHERE t.name STARTS WITH 'Ma'
RETURN t
```

### Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details			Estimated Rows
Rows	DB Hits	Memory (Bytes)	Other	
+ProduceResults	t			2
0   0	Fused in Pipeline 0			
+NodeUniqueIndexSeekByRange	UNIQUE t:Team(name) WHERE name STARTS WITH \$autostring_0			2
0   1	72   Fused in Pipeline 0			

Total database accesses: 1, total allocated memory: 72

## 7.4.10. Node Index Contains Scan

The `NodeIndexContainsScan` operator examines all values stored in an index, searching for entries containing a specific string; for example, in queries including `CONTAINS`. Although this is slower than an index seek (since all entries need to be examined), it is still faster than the indirection resulting from a label scan using `NodeByLabelScan`, and a property store filter.

### Query

```
MATCH (l:Location)
WHERE l.name CONTAINS 'al'
RETURN l
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB
Hits	Memory (Bytes)	Other		
+ProduceResults	l		0	2
0	Fused in Pipeline 0			
+NodeIndexContainsScan	l:Location(name) WHERE name CONTAINS \$autostring_0	0	2	
3	72   Fused in Pipeline 0			

Total database accesses: 3, total allocated memory: 72

## 7.4.11. Node Index Ends With Scan

The `NodeIndexEndsWithScan` operator examines all values stored in an index, searching for entries ending in a specific string; for example, in queries containing `ENDS WITH`. Although this is slower than an index seek (since all entries need to be examined), it is still faster than the indirection resulting from a label scan using `NodeByLabelScan`, and a property store filter.

### Query

```
MATCH (l:Location)
WHERE l.name ENDS WITH 'al'
RETURN 1
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB
DB Hits	Memory (Bytes)	Other		
+ProduceResults	l		0	0
0	Fused in Pipeline 0			
+NodeIndexEndsWithScan	l:Location(name) WHERE name ENDS WITH \$autostring_0	0	0	
1	72   Fused in Pipeline 0			

Total database accesses: 1, total allocated memory: 72

## 7.4.12. Node Index Scan

The [NodeIndexScan](#) operator examines all values stored in an index, returning all nodes with a particular label having a specified property.

### Query

```
MATCH (l:Location)
WHERE EXISTS (l.name)
RETURN l
```

### Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Memory (Bytes)
Other					
+ProduceResults	1	10	10	0	
Fused in Pipeline	0				
+NodeIndexScan	l:Location(name) WHERE exists(name)	10	10	11	72
Fused in Pipeline	0				

Total database accesses: 11, total allocated memory: 72

## 7.4.13. Undirected Relationship By Id Seek

The [UndirectedRelationshipByIdSeek](#) operator reads one or more relationships by id from the relationship store. As the direction is unspecified, two rows are produced for each relationship as a result of alternating the combination of the start and end node.

### Query

```
MATCH (n1)-[r]-()
WHERE id(r)= 1
RETURN r, n1
```

## Query Plan

```
Compiler CYPHER 4.2
```

```
Planner COST
```

```
Runtime PIPELINED
```

```
Runtime version 4.2
```

Operator	Details	Estimated Rows	Rows
DB Hits	Memory (Bytes)	Other	
0   +ProduceResults	r, n1   Fused in Pipeline 0	1	2
1   +UndirectedRelationshipByIdSeek	(n1)-[r]-(anon_16) WHERE id(r) = \$autoint_0     72   Fused in Pipeline 0	1	2

```
Total database accesses: 1, total allocated memory: 72
```

### 7.4.14. Apply

All the different [Apply](#) operators (listed below) share the same basic functionality: they perform a nested loop by taking a single row from the left-hand side, and using the [Argument](#) operator on the right-hand side, execute the operator tree on the right-hand side. The versions of the [Apply](#) operators differ in how the results are managed. The [Apply](#) operator (i.e. the standard version) takes the row produced by the right-hand side — which at this point contains data from both the left-hand and right-hand sides — and yields it..

#### Query

```
MATCH (p:Person { name:'me' })
MATCH (q:Person { name: p.secondName })
RETURN p, q
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator (Bytes)	Details			Estimated Rows	Rows	DB Hits	Memory
	Page Cache Hits/Misses	Time (ms)	Other				
+ProduceResults   p, q			Fused in Pipeline 1		1	0	0
+Apply	0/0				1	0	0
\							
+NodeIndexSeek   q:Person(name) WHERE name = p.secondName			Fused in Pipeline 1		1	0	0
80							
+NodeIndexSeek   p:Person(name) WHERE name = \$autostring_0					1	1	2
72	0/1	0.294	In Pipeline 0				

Total database accesses: 2, total allocated memory: 80

### 7.4.15. Semi Apply

The [SemiApply](#) operator tests for the presence of a pattern predicate, and is a variation of the [Apply](#) operator. If the right-hand side operator yields at least one row, the row from the left-hand side operator is yielded by the [SemiApply](#) operator. This makes [SemiApply](#) a filtering operator, used mostly for pattern predicates in queries.

#### Query

```
CYPHER runtime=slotted
MATCH (p:Person)
WHERE (p)-[:FRIENDS_WITH]->(:Person)
RETURN p.name
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Page Cache
Hits/Misses					
+ProduceResults	`p.name`	11	2	0	
0/0					
+Projection	p.name AS `p.name`	11	2	2	
1/0					
+SemiApply		11	2	0	
0/0					
+Filter	anon_45:Person	2	0	2	
1/0					
+Expand(All)	(p)-[anon_27:FRIENDS_WITH]->(anon_45)	2	2	33	
15/0					
+Argument	p	14	14	0	
0/0					
+NodeByLabelScan	p:Person	14	14	15	
2/0					

Total database accesses: 52, total allocated memory: 0

### 7.4.16. Anti Semi Apply

The [AntiSemiApply](#) operator tests for the absence of a pattern, and is a variation of the [Apply](#) operator. If the right-hand side operator yields no rows, the row from the left-hand side operator is yielded by the [AntiSemiApply](#) operator. This makes [AntiSemiApply](#) a filtering operator, used for pattern predicates in queries.

#### Query

```
CYPHER runtime=slotted
MATCH (me:Person { name: "me" }),(other:Person)
WHERE NOT (me)-[:FRIENDS_WITH]->(other)
RETURN other.name
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits
Memory (Bytes)	Page Cache Hits/Misses			
+ProduceResults	`other.name`   0/0	4	13	0
+Projection	other.name AS `other.name`   2/0	4	13	13
+AntiSemiApply	   0/0	4	13	0
+Expand(Into)	(me)-[anon_62:FRIENDS_WITH]->(other)   15/0	0	0	55
+Argument	me, other   0/0	14	14	0
+CartesianProduct	   0/0	14	14	0
+NodeByLabelScan	other:Person   2/0	14	14	15
+NodeIndexSeek	me:Person(name) WHERE name = \$autostring_0     0/1	1	1	2

Total database accesses: 85, total allocated memory: 888

## 7.4.17. Anti

The **Anti** operator tests for the absence of a pattern. If there are incoming rows, the **Anti** operator will yield no rows. If there are no incoming rows, the **Anti** operator will yield a single row.

### Query

```
CYPHER runtime=pipelined
MATCH (me:Person { name: "me" }),(other:Person)
WHERE NOT (me)-[:FRIENDS_WITH]->(other)
RETURN other.name
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details				Estimated Rows	Rows	DB Hits
	Memory (Bytes)	Page Cache Hits/Misses	Time (ms)	Other			
+ProduceResults		`other.name`			4	13	0
	0/0	0.131	In Pipeline 4				
+Projection		other.name AS `other.name`			4	13	26
	2/0	0.089	In Pipeline 4				
+Apply					4	13	0
	0/0						
+Anti					14	13	0
	0/0	1.161	In Pipeline 4				
+Limit	1				14	1	0
			Fused in Pipeline 3				
+Expand(Into)	(me)-[anon_62:FRIENDS_WITH]->(:other)				0	1	55
2848			Fused in Pipeline 3				
+Argument	me, other				14	14	0
408			Fused in Pipeline 3				
+CartesianProduct					14	14	0
296	0/0	0.124	In Pipeline 2				
+NodeByLabelScan	other:Person				14	14	15
88	2/0	0.176	In Pipeline 1				
+NodeIndexSeek	me:Person(name) WHERE name = \$autostring_0				1	1	2
72	0/1	0.269	In Pipeline 0				

Total database accesses: 98, total allocated memory: 2848

## 7.4.18. Let Semi Apply

The [LetSemiApply](#) operator tests for the presence of a pattern predicate, and is a variation of the [Apply](#) operator. When a query contains multiple pattern predicates separated with [OR](#), [LetSemiApply](#) will be used to evaluate the first of these. It will record the result of evaluating the predicate but will leave any filtering to another operator. In the example, [LetSemiApply](#) will be used to check for the presence of the [FRIENDS\\_WITH](#) relationship from each person.

### Query

```
CYPHER runtime=slotted
MATCH (other:Person)
WHERE (other)-[:FRIENDS_WITH]->(:Person) OR (other)-[:WORKS_IN]->(:Location)
RETURN other.name
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Page
Cache Hits/Misses					
+ProduceResults	`other.name`	13	14	0	
0/0					
+Projection	other.name AS `other.name`	13	14	14	
1/0					
+SelectOrSemiApply	anon_27	14	14	0	
0/0					
+Filter	anon_87:Location	15	0	12	
0/0					
+Expand(All)	(other)-[anon_73:WORKS_IN]->(anon_87)	15	12	26	
12/0					
+Argument	other	14	12	0	
0/0					
+LetSemiApply		14	14	0	
0/0					
+Filter	anon_53:Person	2	0	2	
1/0					
+Expand(All)	(other)-[anon_35:FRIENDS_WITH]->(anon_53)	2	2	33	
15/0					
+Argument	other	14	14	0	
0/0					
+NodeByLabelScan	other:Person	14	14	15	
2/0					

Total database accesses: 102, total allocated memory: 0

## 7.4.19. Let Anti Semi Apply

The [LetAntiSemiApply](#) operator tests for the absence of a pattern, and is a variation of the [Apply](#) operator. When a query contains multiple negated pattern predicates — i.e. predicates separated with `OR`, where at least one predicate contains `NOT` — [LetAntiSemiApply](#) will be used to evaluate the first of these. It will record the result of evaluating the predicate but will leave any filtering to another operator. In the example, [LetAntiSemiApply](#) will be used to check for the absence of the `FRIENDS_WITH` relationship from each person.

## Query

```
CYPHER runtime=slotted
MATCH (other:Person)
WHERE NOT ((other)-[:FRIENDS_WITH]->(:Person)) OR (other)-[:WORKS_IN]->(:Location)
RETURN other.name
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Page
Cache Hits/Misses					
+ProduceResults	`other.name`	11   14   0	0/0		
+Projection	other.name AS `other.name`	11   14   14	1/0		
+SelectOrSemiApply	anon_32	14   14   0	0/0		
+Filter	anon_93:Location	15   0   2	0/0		
+Expand(All)	(other)-[anon_79:WORKS_IN]->(anon_93)	15   2   7	2/0		
+Argument	other	14   2   0	0/0		
+LetAntiSemiApply		14   14   0	0/0		
+Filter	anon_58:Person	2   0   2	1/0		
+Expand(All)	(other)-[anon_40:FRIENDS_WITH]->(anon_58)	2   2   33	15/0		
+Argument	other	14   14   0	0/0		
+NodeByLabelScan	other:Person	14   14   15	2/0		

Total database accesses: 73, total allocated memory: 0

## 7.4.20. Select Or Semi Apply

The [SelectOrSemiApply](#) operator tests for the presence of a pattern predicate and evaluates a predicate, and is a variation of the [Apply](#) operator. This operator allows for the mixing of normal

predicates and pattern predicates that check for the presence of a pattern. First, the normal expression predicate is evaluated, and, only if it returns `false`, is the costly pattern predicate evaluated.

## Query

```
MATCH (other:Person)
WHERE other.age > 25 OR (other)-[:FRIENDS_WITH]->(:Person)
RETURN other.name
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows			Rows	DB Hits
		Memory (Bytes)	Page Cache Hits/Misses	Time (ms)		
+ProduceResults	`other.name`   `other.name`     Fused in Pipeline 2				11	2
+Projection	other.name AS `other.name`   other.name AS `other.name`     Fused in Pipeline 2				11	2
+SelectOrSemiApply	other.age > \$autoInt_0 128     Fused in Pipeline 2				14	2
+Limit	1   1   Fused in Pipeline 1				14	2
+Filter	anon_71:Person   anon_71:Person     Fused in Pipeline 1				2	2
+Expand(All)	(other)-[anon_53:FRIENDS_WITH]->(anon_71)   (other)-[anon_53:FRIENDS_WITH]->(anon_71)     Fused in Pipeline 1				2	2
+Argument	other 296     Fused in Pipeline 1				14	14
+NodeByLabelScan	other:Person 72   2/0   0.227   In Pipeline 0				14	14
						15

Total database accesses: 53, total allocated memory: 296

## 7.4.21. Select Or Anti Semi Apply

The `SelectOrAntiSemiApply` operator is used to evaluate `OR` between a predicate and a negative pattern predicate (i.e. a pattern predicate preceded with `NOT`), and is a variation of the `Apply` operator. If the predicate returns `true`, the pattern predicate is not tested. If the predicate returns `false` or `null`, `SelectOrAntiSemiApply` will instead test the pattern predicate.

## Query

```
MATCH (other:Person)
WHERE other.age > 25 OR NOT (other)-[:FRIENDS_WITH]->(:Person)
RETURN other.name
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Memory (Bytes)	Page Cache Hits/Misses	Time (ms)	Other	Estimated Rows	Rows	DB Hits
+ProduceResults	`other.name`   Fused in Pipeline 3					4	12	0
+Projection	other.name AS `other.name`   Fused in Pipeline 3					4	12	24
+SelectOrAntiSemiApply	other.age > \$autoint_0 448     Fused in Pipeline 3					14	12	0
+Anti	0/0   0.384   In Pipeline 2	0				14	12	0
+Limit	1   Fused in Pipeline 1					14	2	0
+Filter	anon_75:Person   Fused in Pipeline 1					2	2	2
+Expand(All)	(other)-[:FRIENDS_WITH]->(anon_75)   Fused in Pipeline 1					2	2	32
+Argument	other   Fused in Pipeline 1	296				14	14	0
+NodeByLabelScan	other:Person 2/0   0.943   In Pipeline 0	72				14	14	15

Total database accesses: 73, total allocated memory: 448

## 7.4.22. Let Select Or Semi Apply

The `LetSelectOrSemiApply` operator is planned for pattern predicates that are combined with other predicates using `OR`. This is a variation of the `Apply` operator.

## Query

```
CYPHER runtime=slotted
MATCH (other:Person)
WHERE (other)-[:FRIENDS_WITH]->(:Person) OR (other)-[:WORKS_IN]->(:Location) OR other.age = 5
RETURN other.name
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits
Page Cache Hits/Misses				
+ProduceResults   `other.name`		13	14	0
0/0				
+Projection   other.name AS `other.name`		13	14	14
1/0				
+SelectOrSemiApply   anon_27		14	14	0
0/0				
+Filter   anon_87:Location		15	0	12
0/0				
+Expand(All)   (other)-[anon_73:WORKS_IN]->(anon_87)		15	12	26
12/0				
+Argument   other		14	12	0
0/0				
+LetSelectOrSemiApply   other.age = \$autoint_0		14	14	14
0/0				
+Filter   anon_53:Person		2	0	2
1/0				
+Expand(All)   (other)-[anon_35:FRIENDS_WITH]->(anon_53)		2	2	33
15/0				
+Argument   other		14	14	0
0/0				
+NodeByLabelScan   other:Person		14	14	15
2/0				

Total database accesses: 116, total allocated memory: 0

### 7.4.23. Let Select Or Anti Semi Apply

The `LetSelectOrAntiSemiApply` operator is planned for negated pattern predicates — i.e. pattern predicates preceded with `NOT` — that are combined with other predicates using `OR`. This operator is a variation of the [Apply](#) operator.

## Query

```
CYPHER runtime=slotted
MATCH (other:Person)
WHERE NOT (other)-[:FRIENDS_WITH]->(:Person) OR (other)-[:WORKS_IN]->(:Location) OR other.age = 5
RETURN other.name
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits
+-----+   Operator   Details   Estimated Rows   Rows   DB Hits     Page Cache Hits/Misses   +-----+-----+-----+-----+-----+				
+ProduceResults   `other.name`   11   14   0     0/0   +-----+-----+-----+-----+-----+				
+Projection   other.name AS `other.name`   11   14   14     1/0   +-----+-----+-----+-----+-----+				
+SelectOrSemiApply   anon_31   14   14   0     0/0       \   +-----+-----+-----+-----+-----+				
+Filter   anon_91:Location   15   0   2       0/0         +-----+-----+-----+-----+-----+				
+Expand(All)   (other)-[anon_77:WORKS_IN]->(anon_91)   15   2   7       2/0         +-----+-----+-----+-----+-----+				
+Argument   other   14   2   0       0/0         +-----+-----+-----+-----+-----+				
+LetSelectOrAntiSemiApply   other.age = \$autoint_0   14   14   14     0/0       \   +-----+-----+-----+-----+-----+				
+Filter   anon_57:Person   2   0   2       1/0         +-----+-----+-----+-----+-----+				
+Expand(All)   (other)-[anon_39:FRIENDS_WITH]->(anon_57)   2   2   33       15/0         +-----+-----+-----+-----+-----+				
+Argument   other   14   14   0       0/0         +-----+-----+-----+-----+-----+				
+NodeByLabelScan   other:Person   14   14   15     2/0   +-----+-----+-----+-----+-----+				

Total database accesses: 87, total allocated memory: 0

## 7.4.24. Conditional Apply

The [ConditionalApply](#) operator checks whether a variable is not `null`, and if so, the right child operator will be executed. This operator is a variation of the [Apply](#) operator.

## Query

```
MERGE (p:Person { name: 'Andy' })
ON MATCH SET p.exists = TRUE
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits
Page Cache Hits/Misses				
+ProduceResults		1	0	0
0/0				
+EmptyResult		1	0	0
0/0				
+AntiConditionalApply		1	1	0
0/0				
+MergeCreateNode	p	1	0	0
0/0				
+ConditionalApply		1	1	0
0/0				
+SetProperty	p.exists = true	1	1	3
2/0				
+Argument	p	1	1	0
0/0				
+Optional		1	1	0
0/0				
+NodeIndexSeek	p:Person(name) WHERE name = \$autostring_0	1	1	2
0/1				

Total database accesses: 5, total allocated memory: 0

## 7.4.25. Anti Conditional Apply

The **AntiConditionalApply** operator checks whether a variable is **null**, and if so, the right child operator will be executed. This operator is a variation of the **Apply** operator.

## Query

```
MERGE (p:Person { name: 'Andy' })
ON CREATE SET p.exists = TRUE
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits
Page Cache Hits/Misses				
+ProduceResults		1	0	0
0/0				
+EmptyResult		1	0	0
0/0				
+AntiConditionalApply		1	1	0
0/0				
+SetProperty   p.exists = true		1	0	0
0/0				
+MergeCreateNode   p		1	0	0
0/0				
+Optional		1	1	0
0/0				
+NodeIndexSeek   p:Person(name) WHERE name = \$autostring_0		1	1	2
0/1				

Total database accesses: 2, total allocated memory: 0

## 7.4.26. Roll Up Apply

The [RollUpApply](#) operator is used to execute an expression which takes as input a pattern, and returns a list with content from the matched pattern; for example, when using a pattern expression or pattern comprehension in a query. This operator is a variation of the [Apply](#) operator.

### Query

```
CYPHER runtime=slotted
MATCH (p:Person)
RETURN p.name,[((p)-[:WORKS_IN]->(location)| location.name] AS cities
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator Hits/Misses	Details	Estimated Rows	Rows	DB Hits	Page Cache
0/0	+ProduceResults   `p.name`, cities	14	14	0	
0/0	+Projection   p.name AS `p.name`	14	14	14	
0/0	+RollUpApply   cities, anon_32	14	14	0	
2/0	+Projection   location.name AS anon_32	0	15	15	
15/0	+Expand(All)   (p)-[anon_38:WORKS_IN]->(location)	0	15	33	
0/0	+Argument   p	1	14	0	
2/0	+NodeByLabelScan   p:Person	14	14	15	

Total database accesses: 77, total allocated memory: 0

## 7.4.27. Argument

The [Argument](#) operator indicates the variable to be used as an argument to the right-hand side of an [Apply](#) operator.

### Query

```
MATCH (s:Person { name: 'me' })
MERGE (s)-[:FRIENDS_WITH]->(s)
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator			Details	Estimated Rows	Rows	DB
Hits	Memory (Bytes)	Page Cache Hits/Misses				
+ProduceResults		0/0			1	0
+EmptyResult		0/0			1	0
+Apply		0/0			1	1
+AntiConditionalApply		0/0			1	1
+MergeCreateRelationship   (s)-[anon_40:FRIENDS_WITH]->(s)		2/0			1	1
+Argument	s	0/0			1	1
+AntiConditionalApply		0/0			1	1
+Optional	s	0/0			1	1
+Expand(Into)	(s)-[anon_40:FRIENDS_WITH]->(s)	1/0			0	0
+LockNodes	s	0/0			1	1
+Argument	s	0/0			1	1
+Optional	s	0/0			1	1
+Expand(Into)	(s)-[anon_40:FRIENDS_WITH]->(s)	2/0			0	0
+Argument	s	0/0			1	1
+NodeIndexSeek	s:Person(name) WHERE name = \$autostring_0	0/1			1	1

Total database accesses: 12, total allocated memory: 888

## 7.4.28. Expand All

Given a start node, and depending on the pattern relationship, the `Expand(All)` operator will traverse incoming or outgoing relationships.

### Query

```
MATCH (p:Person { name: 'me' })-[:FRIENDS_WITH]->(fof)
RETURN fof
```

### Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator (Bytes)	Details Other	Estimated Rows	Rows	DB Hits	Memory
+ProduceResults	fof	0	1	0	
Fused in Pipeline 0					
+Expand(All)	(p)-[anon_30:FRIENDS_WITH]->(fof)	0	1	3	
Fused in Pipeline 0					
+NodeIndexSeek	p:Person(name) WHERE name = \$autostring_0   72   Fused in Pipeline 0	1	1	2	

Total database accesses: 5, total allocated memory: 72

## 7.4.29. Expand Into

When both the start and end node have already been found, the `Expand(Into)` operator is used to find all relationships connecting the two nodes. As both the start and end node of the relationship are already in scope, the node with the smallest degree will be used. This can make a noticeable difference when dense nodes appear as end points.

### Query

```
MATCH (p:Person { name: 'me' })-[:FRIENDS_WITH]->(fof)-->(p)
RETURN fof
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator (Bytes)	Details	Estimated Rows	Rows	DB Hits	Memory
Other					
+ProduceResults   fof		0   0   0			
Fused in Pipeline 0					
	+-----+	+-----+	+-----+	+-----+	+-----+
+Filter   not anon_30 = anon_53		0   0   0			
Fused in Pipeline 0					
	+-----+	+-----+	+-----+	+-----+	+-----+
+Expand(Into)   (p)-[anon_30:FRIENDS_WITH]->(fof)		0   0   0			
0   Fused in Pipeline 0					
	+-----+	+-----+	+-----+	+-----+	+-----+
+Expand(All)   (p)<-[anon_53]-(fof)		0   0   3			
Fused in Pipeline 0					
	+-----+	+-----+	+-----+	+-----+	+-----+
+NodeIndexSeek   p:Person(name) WHERE name = \$autostring_0		1   1   2			
72   Fused in Pipeline 0					
+-----+	+-----+	+-----+	+-----+	+-----+	+-----+
+-----+	+-----+	+-----+	+-----+	+-----+	+-----+

Total database accesses: 5, total allocated memory: 72

### 7.4.30. Optional Expand All

The [OptionalExpand\(All\)](#) operator is analogous to [Expand\(All\)](#), apart from when no relationships match the direction, type and property predicates. In this situation, [OptionalExpand\(all\)](#) will return a single row with the relationship and end node set to [null](#).

#### Query

```
MATCH (p:Person)
OPTIONAL MATCH (p)-[works_in:WORKS_IN]->(l)
WHERE works_in.duration > 180
RETURN p, l
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator   Details   Estimated				
Rows	Rows	DB Hits	Memory (Bytes)	Other
+ProduceResults   p, l	14	15	1	Fused in Pipeline 0
			+	
+OptionalExpand(All)   (p)-[works_in:WORKS_IN]->(l) WHERE works_in.duration > \$autoint_0	14	15	47	Fused in Pipeline 0
			+	
+NodeByLabelScan   p:Person	14	14	15	Fused in Pipeline 0
+-----+				

Total database accesses: 63, total allocated memory: 72

### 7.4.31. Optional Expand Into

The `OptionalExpand(Into)` operator is analogous to `Expand(Into)`, apart from when no matching relationships are found. In this situation, `OptionalExpand(Into)` will return a single row with the relationship and end node set to `null`. As both the start and end node of the relationship are already in scope, the node with the smallest degree will be used. This can make a noticeable difference when dense nodes appear as end points.

#### Query

```
MATCH (p:Person)-[works_in:WORKS_IN]->(l)
OPTIONAL MATCH (l)-->(p)
RETURN p
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Memory (Bytes)
Other					
+ProduceResults	p	15	15	0	
Fused in Pipeline 0					
	+-----+-----+-----+				
+OptionalExpand(Into)	(1)-[anon_61]->(p)	15	15	105	3352
Fused in Pipeline 0					
	+-----+-----+-----+				
+Expand(All)	(p)-[works_in:WORKS_IN]->(l)	15	15	33	
Fused in Pipeline 0					
	+-----+-----+-----+				
+NodeByLabelScan	p:Person	14	14	15	72
Fused in Pipeline 0					
	+-----+-----+-----+				

Total database accesses: 153, total allocated memory: 3352

## 7.4.32. VarLength Expand All

Given a start node, the `VarLengthExpand(All)` operator will traverse variable-length relationships.

### Query

```
MATCH (p:Person)-[:FRIENDS_WITH *1..2]-(q:Person)
RETURN p, q
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator (Bytes)	Details	Estimated Rows	Rows	DB Hits	Memory
+ProduceResults	p, q	4	6	0	
+Fused in Pipeline 0					
+Filter	q:Person	4	6	6	
+Fused in Pipeline 0					
+VarLengthExpand(All) 128	(p)-[anon_17:FRIENDS_WITH*..2]-(q)   Fused in Pipeline 0	4	6	47	
+NodeByLabelScan 72	p:Person   Fused in Pipeline 0	14	14	15	

Total database accesses: 68, total allocated memory: 128

## 7.4.33. VarLength Expand Into

When both the start and end node have already been found, the `VarLengthExpand(Into)` operator is used to find all variable-length relationships connecting the two nodes.

### Query

```
MATCH (p:Person)-[:FRIENDS_WITH *1..2]-(p:Person)
RETURN p
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator (Bytes)	Details	Estimated Rows	Rows	DB Hits	Memory
Other					
+ProduceResults	p		0	0	0
+VarLengthExpand(Into)	(p)-[:FRIENDS_WITH*..2]-(p)   128		0	0	47
+NodeByLabelScan	p:Person   72		14	14	15

Total database accesses: 62, total allocated memory: 128

## 7.4.34. VarLength Expand Pruning

Given a start node, the `VarLengthExpand(Pruning)` operator will traverse variable-length relationships much like the `VarLengthExpand(All)` operator. However, as an optimization, some paths will not be explored if they are guaranteed to produce an end node that has already been found (by means of a previous path traversal). This will only be used in cases where the individual paths are not of interest. This operator guarantees that all the end nodes produced will be unique.

### Query

```
MATCH (p:Person)-[:FRIENDS_WITH *3..4]-(q:Person)
RETURN DISTINCT p, q
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator (Bytes)	Details			Estimated Rows	Rows	DB Hits	Memory
	Page Cache Hits/Misses	Time (ms)	Other				
+ProduceResults	p, q			0	0	0	
	0/0	0.013	In Pipeline 1				
+Distinct	p, q			0	0	0	
192	0/0	1.005	In Pipeline 1				
+Filter	q:Person			0	0	0	
	0/0	0.096	In Pipeline 1				
+VarLengthExpand(Pruning)	(p)-[:FRIENDS_WITH*3..4]-(q)			0	0	32	
896			In Pipeline 1				
+NodeByLabelScan	p:Person			14	14	15	
72	2/0	0.115	In Pipeline 0				

Total database accesses: 47, total allocated memory: 1088

### 7.4.35. Assert Same Node

The `AssertSameNode` operator is used to ensure that no unique constraints are violated. The example looks for the presence of a team with the supplied name and id, and if one does not exist, it will be created. Owing to the existence of two unique constraints on `:Team(name)` and `:Team(id)`, any node that would be found by the `UniqueIndexSeek` must be the very same node, or the constraints would be violated.

#### Query

```
MERGE (t:Team { name: 'Engineering', id: 42 })
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows
DB Hits	Page Cache Hits/Misses		
+ProduceResults		1	0
0   0/0			
+EmptyResult		1	0
0   0/0			
+AntiConditionalApply		1	1
0   0/0			
+MergeCreateNode	t	1	0
0   0/0			
+Optional		1	1
0   0/0			
+AssertSameNode	t	0	1
0   0/0			
+NodeUniqueIndexSeek(Locking)	UNIQUE t:Team(id) WHERE id = \$autoint_1	1	1
1   0/1			
+NodeUniqueIndexSeek(Locking)	UNIQUE t:Team(name) WHERE name = \$autostring_0	0	1
1   0/1			

Total database accesses: 2, total allocated memory: 0

## 7.4.36. Drop Result

The `DropResult` operator produces zero rows. It is applied when it can be deduced through static analysis that the result of an expression will be empty, such as when a predicate guaranteed to return `false` (e.g. `1 > 5`) is used in a query.

### Query

```
CYPHER runtime=slotted
MATCH (p)
WHERE FALSE RETURN p
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Page Cache Hits/Misses
+ProduceResults	p	0	0	0	0/0
+DropResult		0	0	0	0/0
+AllNodesScan	p	35	0	0	0/0

Total database accesses: 0, total allocated memory: 0

## 7.4.37. Empty Result

The `EmptyResult` operator eagerly loads all incoming data and discards it.

### Query

```
CREATE (:Person)
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Page Cache Hits/Misses
+ProduceResults		1	0	0	0/0
+EmptyResult		1	0	0	0/0
+Create	(anon_8:Person)	1	1	1	0/0

Total database accesses: 1, total allocated memory: 0

## 7.4.38. Produce Results

The `ProduceResults` operator prepares the result so that it is consumable by the user, such as transforming internal values to user values. It is present in every single query that returns data to the user, and has little bearing on performance optimisation.

### Query

```
MATCH (n)
RETURN n
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Memory (Bytes)	Other
+ProduceResults	n	35	35	0		Fused in Pipeline 0
+AllNodesScan	n	35	35	36	72	Fused in Pipeline 0

Total database accesses: 36, total allocated memory: 72

## 7.4.39. Load CSV

The [LoadCSV](#) operator loads data from a CSV source into the query. It is used whenever the [LOAD CSV](#) clause is used in a query.

### Query

```
LOAD CSV FROM 'https://neo4j.com/docs/cypher-refcard/3.3/csv/artists.csv' AS line
RETURN line
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Page Cache Hits/Misses
+ProduceResults	line	10	4	0	0/0
+LoadCSV	line	10	4	0	0/0

Total database accesses: 0, total allocated memory: 0

## 7.4.40. Hash joins in general

Hash joins have two inputs: the build input and probe input. The query planner assigns these roles so that the smaller of the two inputs is the build input. The build input is pulled in eagerly, and is used to build a probe table. Once this is complete, the probe table is checked for each row coming from the probe input side.

In query plans, the build input is always the left operator, and the probe input the right operator.

There are four hash join operators:

- [NodeHashJoin](#)
- [ValueHashJoin](#)
- [NodeLeftOuterHashJoin](#)

- [NodeRightOuterHashJoin](#)

## 7.4.41. Node Hash Join

The [NodeHashJoin](#) operator is a variation of the [hash join](#). [NodeHashJoin](#) executes the hash join on node ids. As primitive types and arrays can be used, it can be done very efficiently.

### Query

```
MATCH (bob:Person { name:'Bob' })-[:WORKS_IN]->(loc)<-[ :WORKS_IN ]-(matt:Person { name:'Mattis' })
RETURN loc.name
```

### Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details		Estimated Rows	Rows	DB Hits
Memory (Bytes)	Page Cache Hits/Misses	Time (ms)			
+ProduceResults	`loc.name`		10	0	0
	0/0   0.000   In Pipeline 2				
+Projection	loc.name AS `loc.name`		10	0	0
	0/0   0.000   In Pipeline 2				
+Filter	not anon_32 = anon_51		10	0	0
	0/0   0.000   In Pipeline 2				
+NodeHashJoin	loc		10	0	0
496		0.051   In Pipeline 2			
+Expand(All)	(matt)-[anon_51:WORKS_IN]->(loc)		19	0	0
		Fused in Pipeline 1			
+NodeIndexSeek	matt:Person(name) WHERE name = \$autostring_1		1	0	1
72		Fused in Pipeline 1			
+Expand(All)	(bob)-[anon_32:WORKS_IN]->(loc)		19	1	3
		Fused in Pipeline 0			
+NodeIndexSeek	bob:Person(name) WHERE name = \$autostring_0		1	1	2
72		Fused in Pipeline 0			

Total database accesses: 6, total allocated memory: 568

## 7.4.42. Value Hash Join

The [ValueHashJoin](#) operator is a variation of the [hash join](#). This operator allows for arbitrary values to be used as the join key. It is most frequently used to solve predicates of the form: `n.prop1 = m.prop2` (i.e. equality predicates between two property columns).

## Query

```
MATCH (p:Person),(q:Person)
WHERE p.age = q.age
RETURN p,q
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator		Details	Estimated Rows	Rows	DB Hits	Memory (Bytes)	Page Cache
Hits/Misses	Time (ms)	Other					
+ProduceResults	p, q		0	0	0		
0/0	0.019	In Pipeline 2					
	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+
+ValueHashJoin	p.age = q.age		0	0	0	432	
0/0	2.060	In Pipeline 2					
\	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+
+NodeByLabelScan	q:Person		14	14	15	72	
2/0	0.674	In Pipeline 1					
+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+
+NodeByLabelScan	p:Person		14	14	15	72	
2/0	2.252	In Pipeline 0					

Total database accesses: 30, total allocated memory: 432

## 7.4.43. Node Left/Right Outer Hash Join

The [NodeLeftOuterHashJoin](#) and [NodeRightOuterHashJoin](#) operators are variations of the [hash join](#). The query below can be planned with either a left or a right outer join. The decision depends on the cardinalities of the left-hand and right-hand sides; i.e. how many rows would be returned, respectively, for `(a:Person)` and `(a)->(b:Person)`. If `(a:Person)` returns fewer results than `(a)->(b:Person)`, a left outer join — indicated by [NodeLeftOuterHashJoin](#) — is planned. On the other hand, if `(a:Person)` returns more results than `(a)->(b:Person)`, a right outer join — indicated by [NodeRightOuterHashJoin](#) — is planned instead.

## Query

```
MATCH (a:Person)
OPTIONAL MATCH (a)-->(b:Person)
USING JOIN ON a
RETURN a.name, b.name
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator   Details   Estimated Rows   Rows				
DB Hits	Memory (Bytes)	Page Cache Hits/Misses	Time (ms)	Other
0		`a.name`, `b.name` 0/0	0.241   In Pipeline 2	14   14
24		cache[a.name] AS `a.name`, cache[b.name] AS `b.name` 0/0	0.135   In Pipeline 2	14   14
0	1072	a 0/0	3.920   In Pipeline 2	14   14
15	72	a:Person 2/0	0.336   In Pipeline 1	14   14
6		cache[a.name], cache[b.name]   Fused in Pipeline 0		2   2
33		(b)->[anon_36]-(a)   Fused in Pipeline 0		2   2
15	72	b:Person   Fused in Pipeline 0		14   14

Total database accesses: 93, total allocated memory: 1072

### 7.4.44. Triadic Selection

The [TriadicSelection](#) operator is used to solve triangular queries, such as the very common 'find my friend-of-friends that are not already my friend'. It does so by putting all the friends into a set, and uses the set to check if the friend-of-friends are already connected to me. The example finds the names of all friends of my friends that are not already my friends.

#### Query

```
CYPHER runtime=slotted
MATCH (me:Person)-[:FRIENDS_WITH]-()-[:FRIENDS_WITH]-(other)
WHERE NOT (me)-[:FRIENDS_WITH]-(other)
RETURN other.name
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Page
Cache Hits/Misses					
+ProduceResults	`other.name`	0	2	0	
0/0					
+Projection	other.name AS `other.name`	0	2	2	
2/0					
+TriadicSelection	WHERE NOT (me)--(other)	0	2	0	
0/0					
+Filter	not anon_18 = anon_37	0	2	0	
0/0					
+Expand(All)	(anon_35)-[anon_37:FRIENDS_WITH]-(other)	0	6	14	
4/0					
+Argument	me, anon_18, anon_35	4	4	0	
0/0					
+Expand(All)	(me)-[anon_18:FRIENDS_WITH]-(anon_35)	4	4	33	
15/0					
+NodeByLabelScan	me:Person	14	14	15	
2/0					

Total database accesses: 64, total allocated memory: 0

## 7.4.45. Triadic Build

The [TriadicBuild](#) operator is used in conjunction with [TriadicFilter](#) to solve triangular queries, such as the very common 'find my friend-of-friends that are not already my friend'. These two operators are specific to Pipelined runtime and together perform the same logic as [TriadicSelection](#) does for other runtimes. [TriadicBuild](#) builds a set of all friends, which is later used by [TriadicFilter](#). The example finds the names of all friends of my friends that are not already my friends.

### Query

```
CYPHER runtime=pipelined
MATCH (me:Person)-[:FRIENDS_WITH]-(n)-[:FRIENDS_WITH]-(other)
WHERE NOT (me)-[:FRIENDS_WITH]-(other)
RETURN other.name
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator (Bytes)	Details	Estimated Rows   Rows   DB Hits   Memory			
		Page Cache Hits/Misses	Time (ms)	Other	
+ProduceResults	`other.name`   0/0   0.073   In Pipeline 3		0	2	0
	+-----+   +Projection	other.name AS `other.name`   2/0   0.087   In Pipeline 3		0	2
	+-----+		4		
+TriadicFilter	WHERE NOT (me)--(other) 808   0/0   0.085   In Pipeline 3		0	2	0
	+-----+				
+Apply	0/0		0	2	0
\	+-----+				
+Filter	not anon_18 = anon_37     Fused in Pipeline 2		0	2	0
	+-----+				
+Expand(All)	(anon_35)-[anon_37:FRIENDS_WITH]-(other)       Fused in Pipeline 2		0	6	14
	+-----+				
+Argument	me, anon_18, anon_35 192       Fused in Pipeline 2		4	4	0
	+-----+				
+TriadicBuild	(me)--(anon_35) 328   0/0   0.275   In Pipeline 1		4	4	0
	+-----+				
+Expand(All)	(me)-[anon_18:FRIENDS_WITH]-(anon_35)       Fused in Pipeline 0		4	4	33
	+-----+				
+NodeByLabelScan	me:Person 72       Fused in Pipeline 0		14	14	15
	+-----+				

Total database accesses: 66, total allocated memory: 976

### 7.4.46. Triadic Filter

The **TriadicFilter** operator is used in conjunction with **TriadicBuild** to solve triangular queries, such as the very common 'find my friend-of-friends that are not already my friend'. These two operators are specific to Pipelined runtime and together perform the same logic as **TriadicSelection** does for other runtimes. **TriadicFilter** uses a set of friends previously built by **TriadicBuild** to check if the friend-of-friends are already connected to me. The example finds the names of all friends of my friends that are not already my friends.

## Query

```
CYPHER runtime=pipelined
MATCH (me:Person)-[:FRIENDS_WITH]-(other)-[:FRIENDS_WITH]-(other)
WHERE NOT (me)-[:FRIENDS_WITH]-(other)
RETURN other.name
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator (Bytes)	Details			Estimated Rows	Rows	DB Hits	Memory
	Page Cache Hits/Misses	Time (ms)	Other				
+ProduceResults	`other.name`			0	2	0	
	0/0	0.148	In Pipeline 3				
+Projection	other.name AS `other.name`			0	2	4	
	2/0	0.196	In Pipeline 3				
+TriadicFilter	WHERE NOT (me)--(other)			0	2	0	
808	0/0	0.858	In Pipeline 3				
+Apply				0	2	0	
	0/0						
+Filter	not anon_18 = anon_37		Fused in Pipeline 2	0	2	0	
+Expand(All)	(anon_35)-[anon_37:FRIENDS_WITH]-(other)		Fused in Pipeline 2	0	6	14	
+Argument	me, anon_18, anon_35		Fused in Pipeline 2	4	4	0	
192							
+TriadicBuild	(me)--(anon_35)			4	4	0	
328	0/0	2.366	In Pipeline 1				
+Expand(All)	(me)-[anon_18:FRIENDS_WITH]-(anon_35)		Fused in Pipeline 0	4	4	33	
+NodeByLabelScan	me:Person		Fused in Pipeline 0	14	14	15	
72							

Total database accesses: 66, total allocated memory: 976

## 7.4.47. Cartesian Product

The [CartesianProduct](#) operator produces a cartesian product of the two inputs — each row coming from the left child operator will be combined with all the rows from the right child operator. [CartesianProduct](#) generally exhibits bad performance and ought to be avoided if possible.

## Query

```
MATCH (p:Person),(t:Team)
RETURN p, t
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Memory (Bytes)	Page Cache
Hits/Misses	Time (ms)	Other				
+ProduceResults	p, t	140	140	0		
2/0	12.193   In Pipeline 2					
+CartesianProduct		140	140	0	288	
0/0	1.193   In Pipeline 2					
+NodeByLabelScan	p:Person	14	14	15	88	
2/0	0.050   In Pipeline 1					
+NodeByLabelScan	t:Team	10	10	11	72	
2/0	0.128   In Pipeline 0					

Total database accesses: 26, total allocated memory: 288

## 7.4.48. Foreach

The **Foreach** operator executes a nested loop between the left child operator and the right child operator. In an analogous manner to the **Apply** operator, it takes a row from the left-hand side and, using the **Argument** operator, provides it to the operator tree on the right-hand side. **Foreach** will yield all the rows coming in from the left-hand side; all results from the right-hand side are pulled in and discarded.

## Query

```
FOREACH (value IN [1,2,3]| CREATE (:Person { age: value }))
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Page Cache Hits/Misses
+ProduceResults		1	0	0	0/0
+EmptyResult		1	0	0	0/0
+Foreach	value IN [1, 2, 3]	1	1	0	0/0
\	+Create (anon_36:Person)	1	3	9	0/0
+Argument	value	1	3	0	0/0
+EmptyRow		1	1	0	0/0

Total database accesses: 9, total allocated memory: 0

## 7.4.49. Eager

For isolation purposes, the **Eager** operator ensures that operations affecting subsequent operations are executed fully for the whole dataset before continuing execution. Information from the stores is fetched in a lazy manner; i.e. the pattern matching might not be fully exhausted before updates are applied. To guarantee reasonable semantics, the query planner will insert **Eager** operators into the query plan to prevent updates from influencing pattern matching; this scenario is exemplified by the query below, where the **DELETE** clause influences the **MATCH** clause. The **Eager** operator can cause high memory usage when importing data or migrating graph structures. In such cases, the operations should be split into simpler steps; e.g. importing nodes and relationships separately. Alternatively, the records to be updated can be returned, followed by an update statement.

## Query

```
MATCH (a)-[r]-(b)
DELETE r,a,b
MERGE ()
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator Hits/Misses	Details	Estimated Rows	Rows	DB Hits	Memory (Bytes)	Page Cache
0/0		1	0	0		
0/0		1	0	0		
0/0		1	504	0		
0/0		1	504	0		
0/0	+MergeCreateNode   anon_38	1	0	0		
0/0		35	504	0		
0/0	+AllNodesScan   anon_38	35	504	540		
0/0		36	36	0	7456	
0/0	+Delete   b	36	36	9		
1/0		36	36	12		
1/0	+Delete   a	36	36	18		
19/0		36	36	0	7456	
22/0	+Expand(All)   (a)-[r]-(b)	36	36	71		
1/0	+AllNodesScan   a	35	35	36		

Total database accesses: 686, total allocated memory: 14824

## 7.4.50. Eager Aggregation

The [EagerAggregation](#) operator evaluates a grouping expression and uses the result to group rows into different groupings. For each of these groupings, [EagerAggregation](#) will then evaluate all aggregation functions and return the result. To do this, [EagerAggregation](#), as the name implies, needs to pull in all data eagerly from its source and build up state, which leads to increased memory pressure in the system.

### Query

```
MATCH (l:Location)<-[>:WORKS_IN]-(p:Person)
RETURN l.name AS location, collect(p.name) AS people
```

### Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator		Details			Estimated Rows	Rows	DB
Hits	Memory (Bytes)	Page Cache Hits/Misses	Time (ms)	Other			
0		+ProduceResults	location, people	0/0   0.265   In Pipeline 1		4   6	
30	2404	+EagerAggregation	cache[l.name] AS location, collect(p.name) AS people	0.483   Fused in Pipeline 0		4   6	
15		+Filter	p:Person	Fused in Pipeline 0		15   15	
26		+Expand(All)	(1)<-[>:WORKS_IN]-(p)	Fused in Pipeline 0		15   15	
20		+CacheProperties	cache[l.name]	Fused in Pipeline 0		10   10	
11	72	+NodeByLabelScan	l:Location	Fused in Pipeline 0		10   10	

Total database accesses: 102, total allocated memory: 2404

## 7.4.51. Ordered Aggregation

The [OrderedAggregation](#) operator is an optimization of the [EagerAggregation](#) operator that takes advantage of the ordering of the incoming rows. This operator uses lazy evaluation and has a lower memory pressure in the system than the [EagerAggregation](#) operator.

### Query

```
MATCH (p:Person)
WHERE p.name STARTS WITH 'P'
RETURN p.name, count(*) AS count
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator		Details					Estimated	
Rows	Rows	DB Hits	Memory (Bytes)	Page Cache Hits/Misses	Time (ms)	Ordered by	Other	
0	2	0			0/0	0.085	p.name ASC	In Pipeline 1
		+						
+ProduceResults		`p.name` , count						
0	2	0	208	0/0	0.494	p.name ASC	In Pipeline 1	
		+						
+OrderedAggregation		cache[p.name] AS `p.name` , count(*) AS count						
0	2	3	72	0/1	0.354	p.name ASC	In Pipeline 0	
		+						
+NodeIndexSeekByRange		p:Person(name) WHERE name STARTS WITH \$autostring_0 , cache[p.name]						
0	2	3	72	0/1	0.354	p.name ASC	In Pipeline 0	
		+						

Total database accesses: 3, total allocated memory: 208

## 7.4.52. Node Count From Count Store

The [NodeCountFromCountStore](#) operator uses the count store to answer questions about node counts. This is much faster than the [EagerAggregation](#) operator which achieves the same result by actually counting. However, as the count store only stores a limited range of combinations, [EagerAggregation](#) will still be used for more complex queries. For example, we can get counts for all nodes, and nodes with a label, but not nodes with more than one label.

### Query

```
MATCH (p:Person)
RETURN count(p) AS people
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator (Bytes)	Details	Estimated Rows	Rows	DB Hits	Memory
Other					
+ProduceResults	people	1	1	0	
Fused in Pipeline 0					
+NodeCountFromCountStore	count( (:Person) ) AS people	1	1	1	
72   Fused in Pipeline 0					
+					

Total database accesses: 1, total allocated memory: 72

## 7.4.53. Relationship Count From Count Store

The [RelationshipCountFromCountStore](#) operator uses the count store to answer questions about relationship counts. This is much faster than the [EagerAggregation](#) operator which achieves the same result by actually counting. However, as the count store only stores a limited range of combinations, [EagerAggregation](#) will still be used for more complex queries. For example, we can get counts for all relationships, relationships with a type, relationships with a label on one end, but not relationships with labels on both end nodes.

### Query

```
MATCH (p:Person)-[r:WORKS_IN]->()
RETURN count(r) AS jobs
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator DB Hits	Details	Estimated Rows	Rows	Memory
Memory (Bytes)	Other			
+ProduceResults	jobs	1	1	
0   Fused in Pipeline 0				
+RelationshipCountFromCountStore	count( (:Person)-[:WORKS_IN]->() ) AS jobs	1	1	
1   72   Fused in Pipeline 0				
+				

Total database accesses: 1, total allocated memory: 72

## 7.4.54. Distinct

The `Distinct` operator removes duplicate rows from the incoming stream of rows. To ensure only distinct elements are returned, `Distinct` will pull in data lazily from its source and build up state. This may lead to increased memory pressure in the system.

### Query

```
MATCH (l:Location)-[:WORKS_IN]-(p:Person)
RETURN DISTINCT l
```

### Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Memory (Bytes)
Other					
+ProduceResults	l Fused in Pipeline 0	14	6	0	
+Distinct	l Fused in Pipeline 0	14	6	0	192
+Filter	p:Person Fused in Pipeline 0	15	15	15	
+Expand(All)	(l)-[:WORKS_IN]->(p)   Fused in Pipeline 0	15	15	26	
+NodeByLabelScan	l:Location Fused in Pipeline 0	10	10	11	72

Total database accesses: 52, total allocated memory: 192

## 7.4.55. Ordered Distinct

The `OrderedDistinct` operator is an optimization of the `Distinct` operator that takes advantage of the ordering of the incoming rows. This operator has a lower memory pressure in the system than the `Distinct` operator.

### Query

```
MATCH (p:Person)
WHERE p.name STARTS WITH 'P'
RETURN DISTINCT p.name
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator		Details					Estimated	
Rows	Rows	DB Hits	Memory (Bytes)	Page Cache Hits/Misses	Time (ms)	Ordered by	Other	
0	2	0			0/0	0.077	p.name ASC	In Pipeline 0
		+						
+ProduceResults		`p.name`						
0	2	0			0/0	0.067	p.name ASC	In Pipeline 0
		+						
+OrderedDistinct		cache[p.name] AS `p.name`						
0	2	0			0/0	0.317	p.name ASC	In Pipeline 0
		+						
+NodeIndexSeekByRange		p:Person(name) WHERE name STARTS WITH \$autostring_0, cache[p.name]						
0	2	3	72		0/1	0.317	p.name ASC	In Pipeline 0
		+						
		+						

Total database accesses: 3, total allocated memory: 72

## 7.4.56. Filter

The **Filter** operator filters each row coming from the child operator, only passing through rows that evaluate the predicates to **true**.

### Query

```
MATCH (p:Person)
WHERE p.name =~ '^a.*'
RETURN p
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits
Memory (Bytes)	Other			
+ProduceResults	p	14	0	0
Fused in Pipeline 0				
+Filter	cache[p.name] =~ \$autostring_0	14	0	0
Fused in Pipeline 0				
+NodeIndexScan	p:Person(name) WHERE exists(name), cache[p.name]	14	14	15
72   Fused in Pipeline 0				

Total database accesses: 15, total allocated memory: 72

## 7.4.57. Limit

The **Limit** operator returns the first 'n' rows from the incoming input.

### Query

```
MATCH (p:Person)
RETURN p
LIMIT 3
```

### Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Memory (Bytes)	Other
+ProduceResults	p	3	3	0		Fused in Pipeline 0
+Limit	3	3	3	0		Fused in Pipeline 0
+NodeByLabelScan	p:Person	14	4	5	72	Fused in Pipeline 0

Total database accesses: 5, total allocated memory: 72

## 7.4.58. Skip

The **Skip** operator skips 'n' rows from the incoming rows.

## Query

```
MATCH (p:Person)
RETURN p
ORDER BY p.id
SKIP 1
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator		Details	Estimated Rows	Rows	DB Hits	Memory (Bytes)	Page Cache Hits/Misses	Time (ms)	Ordered by	Other
+ProduceResults		p	13	13	0					
2/0		0.826   p.id ASC   In Pipeline 1								
+Skip		\$autoint_0	13	13	0					
0/0		0.024   p.id ASC   In Pipeline 1								
+Sort		`p.id` ASC	14	14	0	360				
0/0		0.597   p.id ASC   In Pipeline 1								
+Projection		p.id AS `p.id`	14	14	28					
		Fused in Pipeline 0								
+NodeByLabelScan		p:Person	14	14	15	72				
		Fused in Pipeline 0								

Total database accesses: 43, total allocated memory: 360

## 7.4.59. Sort

The **Sort** operator sorts rows by a provided key. In order to sort the data, all data from the source operator needs to be pulled in eagerly and kept in the query state, which will lead to increased memory pressure in the system.

## Query

```
MATCH (p:Person)
RETURN p
ORDER BY p.name
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Memory (Bytes)	Page Cache
						Hits/Misses
+ProduceResults	p	14	14	0		
2/0	0.403   p.name ASC   In Pipeline 1					
	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+
+Sort	`p.name` ASC	14	14	0	1152	
0/0	0.210   p.name ASC   In Pipeline 1					
	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+
+Projection	p.name AS `p.name`	14	14	28		
	Fused in Pipeline 0					
+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+
+NodeByLabelScan	p:Person	14	14	15	72	
	Fused in Pipeline 0					
+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+

Total database accesses: 43, total allocated memory: 1152

## 7.4.60. Partial Sort

The **PartialSort** operator is an optimization of the **Sort** operator that takes advantage of the ordering of the incoming rows. This operator uses lazy evaluation and has a lower memory pressure in the system than the **Sort** operator. Partial sort is only applicable when sorting on multiple columns.

### Query

```
MATCH (p:Person)
WHERE p.name STARTS WITH 'P'
RETURN p
ORDER BY p.name, p.age
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator   Details   Estimated					
Rows	Rows	DB Hits	Memory (Bytes)	Page Cache Hits/Misses	Time (ms)
Other					Ordered by
+-----	+-----	+-----	+-----	+-----	+-----
+ProduceResults	p				In
0	2	0		2/0	0.196   p.name ASC, p.age ASC
Pipeline 1					
+-----	+-----	+-----	+-----	+-----	+-----
+PartialSort	`p.name` ASC, `p.age` ASC				In
0	2	0	488	0/0	0.111   p.name ASC, p.age ASC
Pipeline 1					
+-----	+-----	+-----	+-----	+-----	+-----
+Projection	cache[p.name] AS `p.name`, p.age AS `p.age`				Fused
0	2	0			p.name ASC
in Pipeline 0					
+-----	+-----	+-----	+-----	+-----	+-----
+NodeIndexSeekByRange	p:Person(name) WHERE name STARTS WITH \$autostring_0, cache[p.name]				Fused
0	2	3	72		p.name ASC
in Pipeline 0					
+-----	+-----	+-----	+-----	+-----	+-----
+-----	+-----	+-----	+-----	+-----	+-----

Total database accesses: 3, total allocated memory: 488

## 7.4.61. Top

The **Top** operator returns the first 'n' rows sorted by a provided key. Instead of sorting the entire input, only the top 'n' rows are retained.

### Query

```
MATCH (p:Person)
RETURN p
ORDER BY p.name
LIMIT 2
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Memory (Bytes)	Page Cache Hits/Misses	Time (ms)	Ordered by	Other
+ProduceResults	p	2	2	0					
2/0	0.727   p.name ASC   In Pipeline 1								
	+-----+								
+Top	`p.name` ASC LIMIT 2	2	2	0	1104		0/0	p.name ASC	In Pipeline 1
0/0	0.103   p.name ASC   In Pipeline 1								
+Projection	p.name AS `p.name`	14	14	28					
	Fused in Pipeline 0								
+NodeByLabelScan	p:Person	14	14	15	72				
	Fused in Pipeline 0								

Total database accesses: 43, total allocated memory: 1104

## 7.4.62. Partial Top

The **PartialTop** operator is an optimization of the **Top** operator that takes advantage of the ordering of the incoming rows. This operator uses lazy evaluation and has a lower memory pressure in the system than the **Top** operator. Partial top is only applicable when sorting on multiple columns.

### Query

```
MATCH (p:Person)
WHERE p.name STARTS WITH 'P'
RETURN p
ORDER BY p.name, p.age
LIMIT 2
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator   Details   Estimated					
Rows	Rows	DB Hits	Memory (Bytes)	Page Cache Hits/Misses	Time (ms)
Other					Ordered by
+-----	+-----	+-----	+-----	+-----	+-----
+ProduceResults	p				In
0	2	0		2/0	0.128   p.name ASC, p.age ASC
Pipeline 1					
+-----	+-----	+-----	+-----	+-----	+-----
+PartialTop		`p.name` ASC, `p.age` ASC LIMIT 2			In
0	2	0	352	0/0	0.857   p.name ASC, p.age ASC
Pipeline 1					
+-----	+-----	+-----	+-----	+-----	+-----
+Projection		cache[p.name] AS `p.name`, p.age AS `p.age`			Fused
0	2	0			p.name ASC
in Pipeline 0					
+-----	+-----	+-----	+-----	+-----	+-----
+NodeIndexSeekByRange	p:Person(name) WHERE name STARTS WITH \$autostring_0, cache[p.name]				Fused
0	2	3	72		p.name ASC
in Pipeline 0					
+-----	+-----	+-----	+-----	+-----	+-----
+-----	+-----	+-----	+-----	+-----	+-----

Total database accesses: 3, total allocated memory: 352

## 7.4.63. Union

The **Union** operator concatenates the results from the right child operator with the results from the left child operator.

### Query

```
MATCH (p:Location)
RETURN p.name
UNION ALL MATCH (p:Country)
RETURN p.name
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Memory (Bytes)	Other
+ProduceResults	`p.name`	20	11	0		Fused in Pipeline 2
+Union		20	11	0	768	Fused in Pipeline 2
+Projection	`p.name`	10	1	0		Fused in Pipeline 1
+Projection	p.name AS `p.name`	10	1	2		Fused in Pipeline 1
+NodeByLabelScan	p:Country	10	1	2	72	Fused in Pipeline 1
+Projection	`p.name`	10	10	0		Fused in Pipeline 0
+Projection	p.name AS `p.name`	10	10	20		Fused in Pipeline 0
+NodeByLabelScan	p:Location	10	10	11	72	Fused in Pipeline 0

Total database accesses: 35, total allocated memory: 840

## 7.4.64. Unwind

The **Unwind** operator returns one row per item in a list.

### Query

```
UNWIND range(1, 5) AS value
RETURN value
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Other
+ProduceResults Pipeline 0	value	10	5	0	Fused in
+Unwind Pipeline 0	range(\$autoint_0, \$autoint_1) AS value	10	5	0	Fused in

Total database accesses: 0, total allocated memory: 72

## 7.4.65. Lock Nodes

The [LockNodes](#) operator locks the start and end node when creating a relationship.

### Query

```
MATCH (s:Person { name: 'me' })
MERGE (s)-[:FRIENDS_WITH]->(s)
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details			Estimated Rows	Rows	DB
	Hits	Memory (Bytes)	Page Cache Hits/Misses			
+ProduceResults			0/0		1	0
+EmptyResult			0/0		1	0
+Apply			0/0		1	1
+AntiConditionalApply			0/0		1	1
+MergeCreateRelationship   (s)-[anon_40:FRIENDS_WITH]->(s)	2		2/0		1	1
+Argument	0		0/0		1	1
+AntiConditionalApply	0		0/0		1	1
+Optional	0		0/0		1	1
+Expand(Into)   (s)-[anon_40:FRIENDS_WITH]->(s)	4 888		1/0		0	0
+LockNodes	0		0/0		1	1
+Argument	0		0/0		1	1
+Optional	0		0/0		1	1
+Expand(Into)   (s)-[anon_40:FRIENDS_WITH]->(s)	4 888		2/0		0	0
+Argument	0		0/0		1	1
+NodeIndexSeek   s:Person(name) WHERE name = \$autostring_0	2		0/1		1	1

Total database accesses: 12, total allocated memory: 888

## 7.4.66. Optional

The `Optional` operator is used to solve some **OPTIONAL MATCH** queries. It will pull data from its source, simply passing it through if any data exists. However, if no data is returned by its source, `Optional` will yield a single row with all columns set to `null`.

### Query

```
MATCH (p:Person { name:'me' })
OPTIONAL MATCH (q:Person { name: 'Lulu' })
RETURN p, q
```

### Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator (Bytes)	Details			Estimated Rows	Rows	DB Hits	Memory
	Page Cache Hits/Misses	Time (ms)	Other				
+ProduceResults	p, q 2/0	0.135	In Pipeline 2	1	1	0	
+Apply		0.010		1	1	0	
+Optional	p 0/0	0.052	In Pipeline 2	1	1	0	
+NodeIndexSeek	q:Person(name) WHERE name = \$autostring_1 80/1	0.176	In Pipeline 1	1	0	1	
+NodeIndexSeek	p:Person(name) WHERE name = \$autostring_0 72/0/1	0.374	In Pipeline 0	1	1	2	

Total database accesses: 3, total allocated memory: 80

## 7.4.67. Project Endpoints

The `ProjectEndpoints` operator projects the start and end node of a relationship.

### Query

```
CREATE (n)-[p:KNOWS]->(m)
WITH p AS r
MATCH (u)-[r]->(v)
RETURN u, v
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator Hits/Misses	Details	Estimated Rows	Rows	DB Hits	Page Cache
+ProduceResults 0/0	u, v		18	1	0
+Apply 0/0			18	1	0
+ProjectEndpoints 0/0	(u)-[r*]->(v)		18	1	0
+Argument 0/0	r		1	1	0
+Projection 0/0	p AS r		1	1	0
+Create 0/0	(n), (m), (n)-[p:KNOWS]->(m)		1	1	4

Total database accesses: 4, total allocated memory: 0

## 7.4.68. Projection

For each incoming row, the **Projection** operator evaluates a set of expressions and produces a row with the results of the expressions.

### Query

```
RETURN 'hello' AS greeting
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Other
+ProduceResults	greeting		1	1	0   Fused in Pipeline 0
+Projection	\$autostring_0 AS greeting		1	1	0   Fused in Pipeline 0

Total database accesses: 0, total allocated memory: 72

## 7.4.69. Empty Row

The `EmptyRow` operator returns a single row with no columns.

### Query

```
FOREACH (value IN [1,2,3]| CREATE (:Person { age: value }))
```

### Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Page Cache Hits/Misses
+ProduceResults		1	0	0	0/0
+EmptyResult		1	0	0	0/0
+Foreach	value IN [1, 2, 3]	1	1	0	0/0
\					
+Create	(anon_36:Person)	1	3	9	0/0
+Argument	value	1	3	0	0/0
+EmptyRow		1	1	0	0/0

Total database accesses: 9, total allocated memory: 0

## 7.4.70. Procedure Call

The `ProcedureCall` operator indicates an invocation to a procedure.

### Query

```
CALL db.labels() YIELD label
RETURN *
ORDER BY label
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Memory (Bytes)
Page Cache Hits/Misses	Time (ms)	Ordered by	Other		
+ProduceResults	label	10	4	0	
0/0	1.162   label ASC   In Pipeline 1				
+Sort	label ASC	10	4	0	496
0/0	0.178   label ASC   In Pipeline 1				
+ProcedureCall	db.labels() :: (label :: STRING?)	10	4		
	Fused in Pipeline 0				

Total database accesses: ?, total allocated memory: 496

## 7.4.71. Cache Properties

The [CacheProperties](#) operator reads nodes and relationship properties and caches them in the current row. Future accesses to these properties can avoid reading from the store which will speed up the query. In the plan below we will cache `l.name` before [Expand\(All\)](#) where there are fewer rows.

### Query

```
MATCH (l:Location)<-[>:WORKS_IN]-(p:Person)
RETURN l.name AS location, p.name AS name
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime PIPELINED

Runtime version 4.2

Operator (Bytes)	Details	Estimated Rows	Rows	DB Hits	Memory
+ProduceResults   location, name		15	15	0	
Fused in Pipeline 0					
+Projection   cache[l.name] AS location, p.name AS name		15	15	30	
Fused in Pipeline 0					
+Filter   p:Person		15	15	15	
Fused in Pipeline 0					
+Expand(All)   (l)<-[anon_19:WORKS_IN]-(p)		15	15	26	
Fused in Pipeline 0					
+CacheProperties   cache[l.name]		10	10	20	
Fused in Pipeline 0					
+NodeByLabelScan   l:Location		10	10	11	
72   Fused in Pipeline 0					

Total database accesses: 102, total allocated memory: 72

## 7.4.72. Create Nodes / Relationships

The `Create` operator is used to create nodes and relationships.

### Query

```
CREATE (max:Person { name: 'Max' }),(chris:Person { name: 'Chris' })
CREATE (max)-[:FRIENDS_WITH]->(chris)
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator Details			Estimated Rows
Rows	DB Hits	Page Cache Hits/Misses	
+ProduceResults	0	0/0	1
+EmptyResult	0	0/0	1
+Create   (max:Person), (chris:Person), (max)-[anon_79:FRIENDS_WITH]->(chris)	1	0/0	1

Total database accesses: 8, total allocated memory: 0

## 7.4.73. Delete

The **Delete** operator is used to delete a node or a relationship.

### Query

```
MATCH (me:Person { name: 'me' })-[w:WORKS_IN { duration: 190 }]->(london:Location { name: 'London' })
DELETE w
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator Details				Estimated Rows
Rows	DB Hits	Memory (Bytes)	Page Cache Hits/Misses	
+ProduceResults			0/0	0
0   0     0/0				
+EmptyResult			0/0	0
0   0     0/0				
+Delete   w			2/0	0
1   1     2/0				
+Eager			0/0	0
1   0   4376   0/0				
+Filter   w.duration = \$autoint_1 AND me.name = \$autostring_0 AND me:Person   0				
1   9     3/0				
+Expand(All)   (london)<-[w:WORKS_IN]-(me)   0				
7   9     2/0				
+NodeIndexSeek   london:Location(name) WHERE name = \$autostring_2   0				
1   2     0/1				

Total database accesses: 21, total allocated memory: 4376

## 7.4.74. Detach Delete

The **DetachDelete** operator is used in all queries containing the **DETACH DELETE** clause, when deleting nodes and their relationships.

### Query

```
MATCH (p:Person)
DETACH DELETE p
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Page Cache Hits/Misses
+ProduceResults		14	0	0	0/0
+EmptyResult		14	0	0	0/0
+DetachDelete	p	14	14	0	48/0
+NodeByLabelScan	p:Person	14	14	15	2/0

Total database accesses: 15, total allocated memory: 0

## 7.4.75. Merge Create Node

The `MergeCreateNode` operator is used when creating a node as a result of a `MERGE` clause failing to find the node.

### Query

```
MERGE (:Person { name: 'Sally' })
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits
Page Cache Hits/Misses				
+ProduceResults	0/0	1	0	0
+EmptyResult	0/0	1	0	0
+AntiConditionalApply	0/0	1	1	0
+MergeCreateNode	anon_7 0/0	1	1	3
+Optional	0/0	1	1	0
+NodeIndexSeek	anon_7:Person(name) WHERE name = \$autostring_0 0/1	1	0	1

Total database accesses: 4, total allocated memory: 0

## 7.4.76. Merge Create Relationship

The `MergeCreateRelationship` operator is used when creating a relationship as a result of a `MERGE` clause failing to find the relationship.

### Query

```
MATCH (s:Person { name: 'Sally' })
MERGE (s)-[:FRIENDS_WITH]->(s)
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB
Hits	Page Cache Hits/Misses			
+ProduceResults			1	0
0   0/0				
+EmptyResult			1	0
0   0/0				
+Apply			1	0
0   0/0				
+AntiConditionalApply			1	0
0   0/0				
+MergeCreateRelationship	(s)-[anon_43:FRIENDS_WITH]->(s)		1	0
0   0/0				
+Argument	s		1	0
0   0/0				
+AntiConditionalApply			1	0
0   0/0				
+Optional	s		1	0
0   0/0				
+Expand(Into)	(s)-[anon_43:FRIENDS_WITH]->(s)		0	0
0   0/0				
+LockNodes	s		1	0
0   0/0				
+Argument	s		1	0
0   0/0				
+Optional	s		1	0
0   0/0				
+Expand(Into)	(s)-[anon_43:FRIENDS_WITH]->(s)		0	0
0   0/0				
+Argument	s		1	0
0   0/0				
+NodeIndexSeek	s:Person(name) WHERE name = \$autostring_0	1	0	
1   0/1				

Total database accesses: 1, total allocated memory: 0

## 7.4.77. Set Labels

The `SetLabels` operator is used when setting labels on a node.

### Query

```
MATCH (n)
SET n:Person
```

### Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Page Cache Hits/Misses
+ProduceResults		35	0	0	0/0
+EmptyResult		35	0	0	0/0
+SetLabels	n:Person	35	35	35	2/0
+AllNodesScan	n	35	35	36	1/0

Total database accesses: 71, total allocated memory: 0

## 7.4.78. Remove Labels

The `RemoveLabels` operator is used when deleting labels from a node.

### Query

```
MATCH (n)
REMOVE n:Person
```

### Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows	DB Hits	Page Cache Hits/Misses
+ProduceResults		35	0	0	0/0
+EmptyResult		35	0	0	0/0
+RemoveLabels	n:Person	35	35	35	2/0
+AllNodesScan	n	35	35	36	1/0

Total database accesses: 71, total allocated memory: 0

## 7.4.79. Set Node Properties From Map

The `SetNodePropertiesFromMap` operator is used when setting properties from a map on a node.

### Query

```
MATCH (n)
SET n = { weekday: 'Monday', meal: 'Lunch' }
```

### Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator	Details	Estimated Rows	Rows
DB Hits	Page Cache Hits/Misses		
+ProduceResults	0/0	35	0
+EmptyResult	0/0	35	0
+SetNodePropertiesFromMap	n = {weekday: \$autostring_0, meal: \$autostring_1}	35	35
AllNodesScan	1/0	35	35

Total database accesses: 177, total allocated memory: 0

## 7.4.80. Set Relationship Properties From Map

The `SetRelationshipPropertiesFromMap` operator is used when setting properties from a map on a relationship.

### Query

```
MATCH (n)-[r]->(m)
SET r = { weight: 5, unit: 'kg' }
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator		Details		Estimated Rows	
Rows	DB Hits	Page Cache Hits/Misses			
+ProduceResults					18
0	0	0/0			
+EmptyResult					18
0	0	0/0			
+SetRelationshipPropertiesFromMap	r = {weight: \$autoint_0, unit: \$autostring_1}				18
18	69	4/0			
+Expand(All)	(m)<-[r]-(n)				18
18	71	22/0			
+AllNodesScan	m				35
35	36	1/0			

Total database accesses: 176, total allocated memory: 0

## 7.4.81. Set Property

The  [SetProperty](#) operator is used when setting a property on a node or relationship.

### Query

```
MATCH (n)
SET n.checked = TRUE
```

## Query Plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator		Details		Estimated Rows	Rows	DB Hits	Page Cache Hits/Misses
+ProduceResults				35	0	0	0/0
+EmptyResult				35	0	0	0/0
+SetProperty	n.checked = true			35	35	38	2/0
+AllNodesScan	n			35	35	36	1/0

Total database accesses: 74, total allocated memory: 0

## 7.4.82. Create Unique Constraint

The `CreateUniqueConstraint` operator creates a unique constraint on a property for all nodes having a certain label. The following query will create a unique constraint with the name `uniqueness` on the `name` property of nodes with the `Country` label.

### Query

```
CREATE CONSTRAINT uniqueness
ON (c:Country) ASSERT c.name IS UNIQUE
```

### Query Plan

Compiler CYPHER 4.2

Planner ADMINISTRATION

Runtime SCHEMA

Runtime version 4.2

Operator	Details
+CreateConstraint	CONSTRAINT uniqueness ON (c:Country) ASSERT (c.name) IS UNIQUE

Total database accesses: ?

## 7.4.83. Drop Unique Constraint

The `DropUniqueConstraint` operator removes a unique constraint from a property for all nodes having a certain label. The following query will drop a unique constraint on the `name` property of nodes with the `Country` label.

### Query

```
DROP CONSTRAINT ON (c:Country) ASSERT c.name IS UNIQUE
```

### Query Plan

Compiler CYPHER 4.2

Planner ADMINISTRATION

Runtime SCHEMA

Runtime version 4.2

Operator	Details
+DropConstraint	CONSTRAINT ON (c:Country) ASSERT (c.name) IS UNIQUE

Total database accesses: ?

## 7.4.84. Create Constraint only if it does not already exist

To not get an error creating the same constraint twice, we use the `DoNothingIfExists` operator for constraints. This will make sure no other constraint with the given name or another constraint of the same type and schema already exists before the specific `CreateConstraint` operator creates the constraint. If it finds a constraint with the given name or with the same type and schema it will stop

the execution and no new constraint is created. The following query will create a unique constraint with the name `uniqueness` on the `name` property of nodes with the `Country` label only if no constraint named `uniqueness` or unique constraint on `(:Country {name})` already exists.

### Query

```
CREATE CONSTRAINT uniqueness IF NOT EXISTS ON (c:Country) ASSERT c.name IS UNIQUE
```

### Query Plan

Compiler CYPHER 4.2

Planner ADMINISTRATION

Runtime SCHEMA

Runtime version 4.2

Operator	Details
+CreateConstraint	CONSTRAINT uniqueness ON (c:Country) ASSERT (c.name) IS UNIQUE
+DoNothingIfExists(CONSTRAINT)	CONSTRAINT uniqueness ON (c:Country) ASSERT (c.name) IS UNIQUE

Total database accesses: ?

## 7.4.85. Create Node Property Existence Constraint

The `CreateNodePropertyExistenceConstraint` operator creates an existence constraint with the name `existence` on a property for all nodes having a certain label. This will only appear in Enterprise Edition.

### Query

```
CREATE CONSTRAINT existence  
ON (p:Person) ASSERT EXISTS (p.name)
```

### Query Plan

Compiler CYPHER 4.2

Planner ADMINISTRATION

Runtime SCHEMA

Runtime version 4.2

Operator	Details
+CreateConstraint	CONSTRAINT existence ON (p:Person) ASSERT exists(p.name)

Total database accesses: ?

## 7.4.86. Drop Node Property Existence Constraint

The `DropNodePropertyExistenceConstraint` operator removes an existence constraint from a property for all nodes having a certain label. This will only appear in Enterprise Edition.

### Query

```
DROP CONSTRAINT ON (p:Person) ASSERT EXISTS (p.name)
```

## Query Plan

```
Compiler CYPHER 4.2
```

```
Planner ADMINISTRATION
```

```
Runtime SCHEMA
```

```
Runtime version 4.2
```

Operator	Details
+DropConstraint	CONSTRAINT ON (p:Person) ASSERT exists(p.name)

```
Total database accesses: ?
```

## 7.4.87. Create Node Key Constraint

The `CreateNodeKeyConstraint` operator creates a node key constraint with the name `node_key` which ensures that all nodes with a particular label have a set of defined properties whose combined value is unique, and where all properties in the set are present. This will only appear in Enterprise Edition.

### Query

```
CREATE CONSTRAINT node_key  
ON (e:Employee) ASSERT (e.firstname, e.surname) IS NODE KEY
```

## Query Plan

```
Compiler CYPHER 4.2
```

```
Planner ADMINISTRATION
```

```
Runtime SCHEMA
```

```
Runtime version 4.2
```

Operator	Details
+CreateConstraint	CONSTRAINT node_key ON (e:Employee) ASSERT (e.firstname, e.surname) IS NODE KEY

```
Total database accesses: ?
```

## 7.4.88. Drop Node Key Constraint

The `DropNodeKeyConstraint` operator removes a node key constraint from a set of properties for all nodes having a certain label. This will only appear in Enterprise Edition.

### Query

```
DROP CONSTRAINT ON (e:Employee) ASSERT (e.firstname, e.surname) IS NODE KEY
```

## Query Plan

```
Compiler CYPHER 4.2
Planner ADMINISTRATION
Runtime SCHEMA
Runtime version 4.2
+-----+
| Operator      | Details
+-----+
| +DropConstraint | CONSTRAINT ON (e:Employee) ASSERT (e.firstname, e.surname) IS NODE KEY |
+-----+
Total database accesses: ?
```

## 7.4.89. Create Relationship Property Existence Constraint

The `CreateRelationshipPropertyExistenceConstraint` operator creates an existence constraint with the name `existence` on a property for all relationships of a certain type. This will only appear in Enterprise Edition.

### Query

```
CREATE CONSTRAINT existence
ON ()-[l:LIKED]-() ASSERT EXISTS (l.when)
```

## Query Plan

```
Compiler CYPHER 4.2
Planner ADMINISTRATION
Runtime SCHEMA
Runtime version 4.2
+-----+
| Operator      | Details
+-----+
| +CreateConstraint | CONSTRAINT existence ON ()-[l:LIKED]-() ASSERT exists(l.when) |
+-----+
Total database accesses: ?
```

## 7.4.90. Drop Relationship Property Existence Constraint

The `DropRelationshipPropertyExistenceConstraint` operator removes an existence constraint from a property for all relationships of a certain type. This will only appear in Enterprise Edition.

### Query

```
DROP CONSTRAINT ON ()-[l:LIKED]-() ASSERT EXISTS (l.when)
```

## Query Plan

```
Compiler CYPHER 4.2
Planner ADMINISTRATION
Runtime SCHEMA
Runtime version 4.2
+-----+
| Operator      | Details           |
+-----+
| +DropConstraint | CONSTRAINT ON ()-[l:LIKED]-() ASSERT exists(l.when) |
+-----+
Total database accesses: ?
```

## 7.4.91. Drop Constraint by name

The `DropConstraint` operator removes a constraint using the name of the constraint, no matter the type.

### Query

```
DROP CONSTRAINT name
```

## Query Plan

```
Compiler CYPHER 4.2
Planner ADMINISTRATION
Runtime SCHEMA
Runtime version 4.2
+-----+
| Operator      | Details           |
+-----+
| +DropConstraint | CONSTRAINT name |
+-----+
Total database accesses: ?
```

## 7.4.92. Create Index

The `CreateIndex` operator creates an index on a property for all nodes having a certain label. The following query will create an index with the name `my_index` on the `name` property of nodes with the `Country` label.

### Query

```
CREATE INDEX my_index FOR (c:Country)
ON (c.name)
```

## Query Plan

```
Compiler CYPHER 4.2
Planner ADMINISTRATION
Runtime SCHEMA
Runtime version 4.2
+-----+
| Operator      | Details           |
+-----+
| +CreateIndex  | INDEX my_index FOR (:Country) ON (name) |
+-----+
Total database accesses: ?
```

### 7.4.93. Create Index only if it does not already exist

To not get an error creating the same index twice, we use the `DoNothingIfExists` operator for indexes. This will make sure no other index with the given name or schema already exists before the `CreateIndex` operator creates an index on a property for all nodes having a certain label. If it finds an index with the given name or schema it will stop the execution and no new index is created. The following query will create an index with the name `my_index` on the `name` property of nodes with the `Country` label only if no such index already exists.

#### Query

```
CREATE INDEX my_index IF NOT EXISTS FOR (c:Country)
ON (c.name)
```

## Query Plan

```
Compiler CYPHER 4.2
Planner ADMINISTRATION
Runtime SCHEMA
Runtime version 4.2
+-----+
| Operator      | Details           |
+-----+
| +CreateIndex  | INDEX my_index FOR (:Country) ON (name) |
| |           +-----+
| +DoNothingIfExists(INDEX) | INDEX my_index FOR (:Country) ON (name) |
+-----+
Total database accesses: ?
```

### 7.4.94. Drop Index by schema

The `DropIndex` operator removes an index from a property for all nodes having a certain label. The following query will drop an index on the `name` property of nodes with the `Country` label.

#### Query

```
DROP INDEX ON :Country(name)
```

## Query Plan

```
Compiler CYPHER 4.2
Planner ADMINISTRATION
Runtime SCHEMA
Runtime version 4.2
+-----+
| Operator   | Details           |
+-----+
| +DropIndex | INDEX FOR (:Country) ON (name) |
+-----+
Total database accesses: ?
```

## 7.4.95. Drop Index by name

The  `DropIndex` operator removes an index using the name of the index.

### Query

```
DROP INDEX name
```

## Query Plan

```
Compiler CYPHER 4.2
Planner ADMINISTRATION
Runtime SCHEMA
Runtime version 4.2
+-----+
| Operator   | Details           |
+-----+
| +DropIndex | INDEX name |
+-----+
Total database accesses: ?
```

## 7.5. Shortest path planning

*Shortest path finding in Cypher and how it is planned.*

Planning shortest paths in Cypher can lead to different query plans depending on the predicates that need to be evaluated. Internally, Neo4j will use a fast bidirectional breadth-first search algorithm if the predicates can be evaluated whilst searching for the path. Therefore, this fast algorithm will always be certain to return the right answer when there are universal predicates on the path; for example, when searching for the shortest path where all nodes have the `Person` label, or where there are no nodes with a `name` property.

If the predicates need to inspect the whole path before deciding on whether it is valid or not, this fast algorithm cannot be relied on to find the shortest path, and Neo4j may have to resort to using a slower exhaustive depth-first search algorithm to find the path. This means that query plans for shortest path queries with non-universal predicates will include a fallback to running the exhaustive search to find the path should the fast algorithm not succeed. For example, depending on the data, an answer to a shortest path query with existential predicates — such as the requirement that at least one node contains the property `name='Kevin Bacon'` — may not be able to be found by the fast algorithm. In this case, Neo4j will fall back to using the exhaustive search to enumerate all paths and

potentially return an answer.

The running times of these two algorithms may differ by orders of magnitude, so it is important to ensure that the fast approach is used for time-critical queries.

When the exhaustive search is planned, it is still only executed when the fast algorithm fails to find any matching paths. The fast algorithm is always executed first, since it is possible that it can find a valid path even though that could not be guaranteed at planning time.

Please note that falling back to the exhaustive search may prove to be a very time consuming strategy in some cases; such as when there is no shortest path between two nodes. Therefore, in these cases, it is recommended to set `cypher.forbid_exhaustive_shortestpath` to `true`, as explained in [Operations Manual Configuration settings](#)

## 7.5.1. Shortest path with fast algorithm

### Query

```
MATCH (KevinB:Person { name: 'Kevin Bacon' }),(Al:Person { name: 'Al Pacino' }), p =
shortestPath((KevinB)-[:ACTED_IN*]-(Al))
WHERE ALL (r IN relationships(p) WHERE EXISTS (r.role))
RETURN p
```

This query can be evaluated with the fast algorithm — there are no predicates that need to see the whole path before being evaluated.

### Query plan

```
Compiler CYPHER 4.2
Planner COST
Runtime PIPELINED
Runtime version 4.2

+-----+
+-----+
+-----+-----+-----+-----+-----+-----+
| Operator      | Details
| Estimated Rows | Rows | DB Hits | Memory (Bytes) | Page Cache Hits/Misses | Time (ms) | Other
+-----+
+-----+
+-----+-----+-----+-----+-----+-----+
| +ProduceResults | p
|          0 |   1 |     0 |           |           0/0 |    0.160 | In Pipeline 1 |
| |
+-----+
+-----+
+-----+-----+-----+-----+-----+-----+
| +ShortestPath | p = (KevinB)-[anon_107:ACTED_IN*]-(Al) WHERE all(r IN relationships(p) WHERE
EXISTS(r.role)) |
|          0 |   1 |    13 |        1704 |           |           |
In Pipeline 1 |
| |
+-----+
+-----+
+-----+-----+-----+-----+-----+-----+
| +MultiNodeIndexSeek | KevinB:Person(name) WHERE name = $autostring_0, Al:Person(name) WHERE name =
$autostring_1 |
|          0 |   1 |     4 |        72 |           1/1 |    3.172 |
In Pipeline 0 |
+-----+
+-----+
+-----+-----+-----+-----+-----+-----+
Total database accesses: 17, total allocated memory: 1704
```

## 7.5.2. Shortest path with additional predicate checks on the paths

Consider using the exhaustive search as a fallback

Predicates used in the **WHERE** clause that apply to the shortest path pattern are evaluated before deciding what the shortest matching path is.

#### Query

```
MATCH (KevinB:Person { name: 'Kevin Bacon' }),(Al:Person { name: 'Al Pacino' })
shortestPath((KevinB)-[*]-(Al))
WHERE length(p)> 1
RETURN p
```

This query, in contrast with the one above, needs to check that the whole path follows the predicate before we know if it is valid or not, and so the query plan will also include the fallback to the slower exhaustive search algorithm.

## Query plan

Compiler CYPHER 4.2

Planner COST

Runtime SLOTTED

Runtime version 4.2

Operator Details				Estimated Rows
Rows	DB Hits	Memory (Bytes)	Page Cache Hits/Misses	
+ProduceResults	p			0
1   0			0/0	
	+-----			
+AntiConditionalApply				0
1   0			0/0	
\	+-----			
+Top	anon_85 ASC LIMIT 1			0
0   0			0/0	
	+-----			
+Projection	length(p) AS anon_85			0
0   0			0/0	
	+-----			
+Filter	length(p) > \$autoint_2			0
0   0			0/0	
	+-----			
+Projection	(KevinB)-[anon_107*]-(A1) AS p			0
0   0			0/0	
	+-----			
+VarLengthExpand(Into)	(KevinB)-[anon_107*]-(A1)			0
0   0			0/0	
	+-----			
+Argument	KevinB, A1, p, anon_107			0
0   0			0/0	
	+-----			
+Apply				0
1   0			0/0	
\	+-----			
+Optional	KevinB, A1			1
1   0			0/0	
	+-----			
+ShortestPath	p = (KevinB)-[anon_107*]-(A1) WHERE length(p) > \$autoint_2	1776	21/0	0
1   1				
	+-----			
+Argument	KevinB, A1			0
1   0			0/0	
	+-----			
+CartesianProduct				0
1   0			0/0	
\	+-----			
+NodeIndexSeek	A1:Person(name) WHERE name = \$autostring_1			0
1   2			1/0	
	+-----			
+NodeIndexSeek	KevinB:Person(name) WHERE name = \$autostring_0			0
1   2			1/0	
	+-----			

Total database accesses: 5, total allocated memory: 1776

The way the bigger exhaustive query plan works is by using `Apply/Optional` to ensure that when the fast algorithm does not find any results, a `null` result is generated instead of simply stopping the result stream. On top of this, the planner will issue an `AntiConditionalApply`, which will run the exhaustive search if the path variable is pointing to `null` instead of a path.

An `ErrorPlan` operator will appear in the execution plan in cases where (i) `cypher.forbid_exhaustive_shortestpath` is set to `true`, and (ii) the fast algorithm is not able to find the shortest path.

Prevent the exhaustive search from being used as a fallback

#### Query

```
MATCH (KevinB:Person { name: 'Kevin Bacon' }),(Al:Person { name: 'Al Pacino' }), p =  
shortestPath((KevinB)-[*]-(Al))  
WITH p  
WHERE length(p)> 1  
RETURN p
```

This query, just like the one above, needs to check that the whole path follows the predicate before we know if it is valid or not. However, the inclusion of the `WITH` clause means that the query plan will not include the fallback to the slower exhaustive search algorithm. Instead, any paths found by the fast algorithm will subsequently be filtered, which may result in no answers being returned.

#### Query plan

```
Compiler CYPHER 4.2  
Planner COST  
Runtime PIPELINED  
Runtime version 4.2  
  
+-----  
+-----  
+-----+-----+-----+-----+-----+-----+  
| Operator | Details  
| Estimated Rows | Rows | DB Hits | Memory (Bytes) | Page Cache Hits/Misses | Time (ms) | Other |  
+-----  
+-----+-----+-----+-----+-----+-----+  
| +ProduceResults | p  
| 1 | 1 | 0 | | 0/0 | 0.243 | In Pipeline 1 |  
| |  
+-----  
+-----+-----+-----+-----+-----+  
| +Filter | length(p) > $autoint_2  
| 0 | 1 | 0 | | 0/0 | 0.120 | In Pipeline 1 |  
| |  
+-----  
+-----+-----+-----+-----+-----+  
| +ShortestPath | p = (KevinB)-[anon_107*]-(Al)  
| 0 | 1 | 1 | 1776 | | In Pipeline 1 |  
| |  
+-----  
+-----+-----+-----+-----+-----+  
| +MultiNodeIndexSeek | KevinB:Person(name) WHERE name = $autostring_0, Al:Person(name) WHERE name =  
$autostring_1 | 0 | 1 | 4 | 72 | 2/0 | 0.335 | In  
Pipeline 0 |  
+-----  
+-----+-----+-----+-----+-----+  
Total database accesses: 5, total allocated memory: 1776
```

# Chapter 8. Deprecations, additions and compatibility

*Cypher is a language that is constantly evolving. New features get added to the language continuously, and occasionally, some features become deprecated and are subsequently removed.*

- [Removals, deprecations, additions, and extensions](#)
  - [Version 4.2](#)
  - [Version 4.1.3](#)
  - [Version 4.1](#)
  - [Version 4.0](#)
  - [Version 3.5](#)
  - [Version 3.4](#)
  - [Version 3.3](#)
  - [Version 3.2](#)
  - [Version 3.1](#)
  - [Version 3.0](#)
- [Compatibility](#)
- [Supported language versions](#)

## 8.1. Removals, deprecations, additions, and extensions

The following tables list all of the features which have been removed, deprecated, added, or extended in Cypher. Replacement syntax for deprecated and removed features are also indicated.

### 8.1.1. Version 4.2

Feature	Type	Change	Details
<code>SHOW PRIVILEGES [AS [REVOKE] COMMAND[S]]</code>	Functionality	Added	Privileges can now be shown as Cypher commands
<code>SHOW ROLE name PRIVILEGES</code>	Functionality	Updated	Can now handle multiple roles, <code>SHOW ROLES n1, n2, ... PRIVILEGES</code>
<code>SHOW USER name PRIVILEGES</code>	Functionality	Updated	Can now handle multiple users, <code>SHOW USERS n1, n2, ... PRIVILEGES</code>
<code>round(expression, precision)</code>	Functionality	Updated	round()-function can now take an additional argument to specify rounding precision.
<code>round(expression, precision, mode)</code>	Functionality	Updated	round()-function can now take two additional arguments to specify rounding precision, and rounding mode.
<code>DEFAULT GRAPH</code>	Syntax	Added	New optional part of the Cypher commands for <a href="#">database privileges</a>

Feature	Type	Change	Details
<code>0o...</code>	Syntax	Added	Cypher will now interpret literals with prefix <code>0o</code> as an octal integer literal.
<code>0...</code>	Syntax	Deprecated	Replaced by <code>0o...</code> (see above).
<code>0x...</code>	Syntax	Deprecated	Only <code>0x...</code> (lowercase x) will be supported.
<code>SET [PLAINTEXT   ENCRYPTED] PASSWORD</code>	Syntax	Added	For <code>CREATE USER</code> and <code>ALTER USER</code> it is now possible to set (or update) a password when the plaintext password is unknown, but the encrypted password is available.
<code>EXECUTE</code> privileges	Functionality	Added	New Cypher commands for administering privileges for executing procedures and user defined functions.
<code>CREATE [BTREE] INDEX ... [OPTIONS {...}]</code>	Syntax	Added	Allows setting index provider and index configuration when creating an index.
<code>CREATE CONSTRAINT ... IS NODE KEY [OPTIONS {...}]</code>	Syntax	Added	Allows setting index provider and index configuration for the backing index when creating a node key constraint.
<code>CREATE CONSTRAINT ... IS UNIQUE [OPTIONS {...}]</code>	Syntax	Added	Allows setting index provider and index configuration for the backing index when creating a uniqueness constraint.
<code>db.createIndex</code>	Procedure	Deprecated	Replaced by <code>CREATE INDEX</code> command.
<code>db.createNodeKey</code>	Procedure	Deprecated	Replaced by <code>CREATE CONSTRAINT ... IS NODE KEY</code> command.
<code>db.createUniquePropertyConstraint</code>	Procedure	Deprecated	Replaced by <code>CREATE CONSTRAINT ... IS UNIQUE</code> command.
<code>SHOW CURRENT USER</code>	Syntax	Added	New Cypher command for showing current logged-in user and roles.
<code>SHOW [ALL   BTREE] INDEX[ES] [BRIEF   VERBOSE [OUTPUT]]</code>	Functionality	Added	New Cypher commands for listing indexes.
<code>SHOW [ALL   UNIQUE   NODE EXIST[S]   RELATIONSHIP EXIST[S]   EXISTS[S]   NODE KEY] CONSTRAINT[S] [BRIEF   VERBOSE [OUTPUT]]</code>	Functionality	Added	New Cypher commands for listing constraints.
<code>db.indexes</code>	Procedure	Deprecated	Replaced by <code>SHOW INDEXES</code>
<code>db.indexDetails</code>	Procedure	Deprecated	Replaced by <code>SHOW INDEXES VERBOSE</code>
<code>db.constraints</code>	Procedure	Deprecated	Replaced by <code>SHOW CONSTRAINTS</code>
<code>db.schemaStatements</code>	Procedure	Deprecated	Replaced by <code>SHOW INDEXES VERBOSE</code> and <code>SHOW CONSTRAINTS VERBOSE</code>

Feature	Type	Change	Details
<code>SHOW INDEX</code> privilege	Functionality	Added	New Cypher command for administering privilege for listing indexes.
<code>SHOW CONSTRAINT</code> privilege	Functionality	Added	New Cypher command for administering privilege for listing constraints.

## 8.1.2. Version 4.1.3

Feature	Type	Change	Details
<code>CREATE INDEX [name] IF NOT EXISTS FOR ...</code>	Syntax	Added	Makes index creation idempotent. If an index with the name or schema already exists no error will be thrown
<code>DROP INDEX name IF EXISTS</code>	Syntax	Added	Makes index deletion idempotent. If no index with the name exists no error will be thrown
<code>CREATE CONSTRAINT [name] IF NOT EXISTS ON ...</code>	Syntax	Added	Makes constraint creation idempotent. If a constraint with the name or type and schema already exists no error will be thrown
<code>DROP CONSTRAINT name IF EXISTS</code>	Syntax	Added	Makes constraint deletion idempotent. If no constraint with the name exists no error will be thrown

## 8.1.3. Version 4.1

Feature	Type	Change	Details
<code>queryId</code>	Procedure	Updated	The <code>queryId</code> procedure format has changed, and no longer includes the database name. For example, <code>mydb-query-123</code> is now <code>query-123</code> . This change affects built-in procedures <code>dbms.listQueries()</code> , <code>dbms.listActiveLocks(queryId)</code> , <code>dbms.killQueries(queryIds)</code> and <code>dbms.killQuery(queryId)</code>
<code>PUBLIC</code> role	Functionality	Added	The <code>PUBLIC</code> role is automatically assigned to all users, giving them a set of base privileges
<code>REVOKE MATCH</code>	Syntax	Added	The <code>MATCH</code> privilege can now be revoked
<code>REVOKE ...</code>	Functionality	Restricted	No longer revokes sub-privileges when revoking a compound privilege, e.g. when revoking <code>INDEX MANAGEMENT</code> , any <code>CREATE INDEX</code> and <code>DROP INDEX</code> privileges will no longer be revoked

Feature	Type	Change	Details
SHOW PRIVILEGES	Functionality	Updated	The returned privileges are a closer match to the original grants and denies, e.g. if granted <code>MATCH</code> the command will show that specific privilege and not the <code>TRAVERSE</code> and <code>READ</code> privileges. Added support for <code>YIELD</code> and <code>WHERE</code> clauses to allow filtering results.
SHOW USERS	Functionality	Added	New support for <code>YIELD</code> and <code>WHERE</code> clauses to allow filtering results.
SHOW ROLES	Functionality	Added	New support for <code>YIELD</code> and <code>WHERE</code> clauses to allow filtering results.
SHOW DATABASES	Functionality	Added	New support for <code>YIELD</code> and <code>WHERE</code> clauses to allow filtering results.
ALL DATABASE PRIVILEGES	Functionality	Restricted	No longer includes the privileges <code>START DATABASE</code> and <code>STOP DATABASE</code>
TRANSACTION MANAGEMENT privileges	Functionality	Added	New Cypher commands for administering transaction management
DBMS USER MANAGEMENT privileges	Functionality	Added	New Cypher commands for administering user management
DBMS DATABASE MANAGEMENT privileges	Functionality	Added	New Cypher commands for administering database management
DBMS PRIVILEGE MANAGEMENT privileges	Functionality	Added	New Cypher commands for administering privilege management
ALL DBMS PRIVILEGES	Functionality	Added	New Cypher command for administering role, user, database and privilege management
ALL GRAPH PRIVILEGES	Functionality	Added	New Cypher command for administering read and write privileges
Write privileges	Functionality	Added	New Cypher commands for administering write privileges
ON DEFAULT DATABASE	Syntax	Added	New optional part of the Cypher commands for database privileges

## 8.1.4. Version 4.0

Feature	Type	Change	Details
<code>rels()</code>	Function	Removed	Replaced by <code>relationships()</code>
<code>toInt()</code>	Function	Removed	Replaced by <code>toInteger()</code>
<code>lower()</code>	Function	Removed	Replaced by <code>toLowerCase()</code>
<code>upper()</code>	Function	Removed	Replaced by <code>toUpperCase()</code>
<code>extract()</code>	Function	Removed	Replaced by <code>list comprehension</code>

Feature	Type	Change	Details
<code>filter()</code>	Function	Removed	Replaced by <a href="#">list comprehension</a>
<code>length()</code>	Function	Restricted	Restricted to only work on paths. See <a href="#">length()</a> for more details.
<code>size()</code>	Function	Restricted	No longer works for paths. Only works for strings, lists and pattern expressions. See <a href="#">size()</a> for more details.
<code>CYPHER planner=rule</code> (Rule planner)	Functionality	Removed	The <code>RULE</code> planner was removed in 3.2, but still possible to trigger using <code>START</code> or <code>CREATE UNIQUE</code> clauses. Now it is completely removed.
<code>CREATE UNIQUE</code>	Clause	Removed	Running queries with this clause will cause a syntax error. Running with <a href="#">CYPHER 3.5</a> will cause a runtime error due to the removal of the rule planner.
<code>START</code>	Clause	Removed	Running queries with this clause will cause a syntax error. Running with <a href="#">CYPHER 3.5</a> will cause a runtime error due to the removal of the rule planner.
Explicit indexes	Functionality	Removed	The removal of the <code>RULE</code> planner in 3.2 was the beginning of the end for explicit indexes. Now they are completely removed, including the removal of the <a href="#">built-in procedures for Neo4j 3.3 to 3.5</a> .
<code>MATCH (n)-[rs*]-() RETURN rs</code>	Syntax	Deprecated	As in Cypher 3.2, this is replaced by <code>MATCH p=(n)-[*]-() RETURN relationships(p) AS rs</code>
<code>MATCH (n)-[:A B C] {foo: 'bar'}]-() RETURN n</code>	Syntax	Removed	Replaced by <code>MATCH (n)-[:A B C {foo: 'bar'}]-() RETURN n</code>
<code>MATCH (n)-[x:A B C]-() RETURN n</code>	Syntax	Removed	Replaced by <code>MATCH (n)-[x:A B C]-() RETURN n</code>
<code>MATCH (n)-[x:A B C*]-() RETURN n</code>	Syntax	Removed	Replaced by <code>MATCH (n)-[x:A B C*]-() RETURN n</code>
<code>{parameter}</code>	Syntax	Removed	Replaced by <code>\$parameter</code>
<code>CYPHER runtime=pipelined</code> (Pipelined runtime)	Functionality	Added	This Neo4j Enterprise Edition only feature involves a new runtime that has many performance enhancements.
<code>CYPHER runtime=compiled</code> (Compiled runtime)	Functionality	Removed	Replaced by the new <code>pipelined</code> runtime which covers a much wider range of queries.
<code>CREATE INDEX [name] FOR (n:Label) ON (n.prop)</code>	Syntax	Added	New syntax for creating indexes, which can include a name.
<code>CREATE CONSTRAINT [name] ON ...</code>	Syntax	Extended	The create constraint syntax can now include a name.

Feature	Type	Change	Details
DROP INDEX name	Syntax	Added	New command for dropping an index by name.
DROP CONSTRAINT name	Syntax	Added	New command for dropping a constraint by name, no matter the type.
CREATE INDEX ON :Label(prop)	Syntax	Deprecated	Replaced by <a href="#">CREATE INDEX FOR (n:Label) ON (n.prop)</a>
DROP INDEX ON :Label(prop)	Syntax	Deprecated	Replaced by <a href="#">DROP INDEX name</a>
DROP CONSTRAINT ON (n:Label) ASSERT (n.prop) IS NODE KEY	Syntax	Deprecated	Replaced by <a href="#">DROP CONSTRAINT name</a>
DROP CONSTRAINT ON (n:Label) ASSERT (n.prop) IS UNIQUE	Syntax	Deprecated	Replaced by <a href="#">DROP CONSTRAINT name</a>
DROP CONSTRAINT ON (n:Label) ASSERT exists(n.prop)	Syntax	Deprecated	Replaced by <a href="#">DROP CONSTRAINT name</a>
DROP CONSTRAINT ON ()-[r:Type]-() ASSERT exists(r.prop)	Syntax	Deprecated	Replaced by <a href="#">DROP CONSTRAINT name</a>
WHERE EXISTS {...}	Clause	Added	Existential sub-queries are sub-clauses used to filter the results of a <a href="#">MATCH</a> , <a href="#">OPTIONAL MATCH</a> , or <a href="#">WITH</a> clause.
Multi-database administration	Functionality	Added	New Cypher commands for administering multiple databases
Security administration	Functionality	Added	New Cypher commands for administering role-based access-control
Fine-grained security	Functionality	Added	New Cypher commands for administering dbms, database, graph and sub-graph access control
USE neo4j	Clause	Added	New clause to specify which graph a query, or query part, is executed against.

## 8.1.5. Version 3.5

Feature	Type	Change	Details
CYPHER runtime=compiled (Compiled runtime)	Functionality	Deprecated	The compiled runtime will be discontinued in the next major release. It might still be used for default queries in order to not cause regressions, but explicitly requesting it will not be possible.
extract()	Function	Deprecated	Replaced by <a href="#">list comprehension</a>
filter()	Function	Deprecated	Replaced by <a href="#">list comprehension</a>

## 8.1.6. Version 3.4

Feature	Type	Change	Details
Spatial point types	Functionality	Amendment	A point — irrespective of which Coordinate Reference System is used — can be stored as a property and is able to be backed by an index. Prior to this, a point was a virtual property only.
point() - Cartesian 3D	Function	Added	
point() - WGS 84 3D	Function	Added	
randomUUID()	Function	Added	
Temporal types	Functionality	Added	Supports storing, indexing and working with the following temporal types: Date, Time, LocalTime, DateTime, LocalDateTime and Duration.
Temporal functions	Functionality	Added	Functions allowing for the creation and manipulation of values for each temporal type — Date, Time, LocalTime, DateTime, LocalDateTime and Duration.
Temporal operators	Functionality	Added	Operators allowing for the manipulation of values for each temporal type — Date, Time, LocalTime, DateTime, LocalDateTime and Duration.
toString()	Function	Extended	Now also allows temporal values as input (i.e. values of type Date, Time, LocalTime, DateTime, LocalDateTime or Duration).

## 8.1.7. Version 3.3

Feature	Type	Change	Details
START	Clause	Removed	As in Cypher 3.2, any queries using the START clause will revert back to Cypher 3.1 planner=rule. However, there are built-in procedures for Neo4j versions 3.3 to 3.5 for accessing explicit indexes. The procedures will enable users to use the current version of Cypher and the cost planner together with these indexes. An example of this is CALL db.index.explicit.searchNodes('my_index', 'email:me*').
CYPHER runtime=slotted (Faster interpreted runtime)	Functionality	Added	Neo4j Enterprise Edition only
max(), min()	Function	Extended	Now also supports aggregation over sets containing lists of strings and/or numbers, as well as over sets containing strings, numbers, and lists of strings and/or numbers

## 8.1.8. Version 3.2

Feature	Type	Change	Details
<code>CYPHER planner=rule</code> (Rule planner)	Functionality	Removed	All queries now use the cost planner. Any query prepended thus will fall back to using Cypher 3.1.
<code>CREATE UNIQUE</code>	Clause	Removed	Running such queries will fall back to using Cypher 3.1 (and use the rule planner)
<code>START</code>	Clause	Removed	Running such queries will fall back to using Cypher 3.1 (and use the rule planner)
<code>MATCH (n)-[rs*]-() RETURN rs</code>	Syntax	Deprecated	Replaced by <code>MATCH p=(n)-[*]-() RETURN relationships(p) AS rs</code>
<code>MATCH (n)-[:A :B :C {foo: 'bar'}]-() RETURN n</code>	Syntax	Deprecated	Replaced by <code>MATCH (n)-[:A B C {foo: 'bar'}]-() RETURN n</code>
<code>MATCH (n)-[x:A :B :C]-() RETURN n</code>	Syntax	Deprecated	Replaced by <code>MATCH (n)-[x:A B C]-() RETURN n</code>
<code>MATCH (n)-[x:A :B :C*]-() RETURN n</code>	Syntax	Deprecated	Replaced by <code>MATCH (n)-[x:A B C*]-() RETURN n</code>
User-defined aggregation functions	Functionality	Added	
Composite indexes	Index	Added	
Node Key	Index	Added	Neo4j Enterprise Edition only
<code>CYPHER runtime=compiled</code> (Compiled runtime)	Functionality	Added	Neo4j Enterprise Edition only
<code>reverse()</code>	Function	Extended	Now also allows a list as input
<code>max(), min()</code>	Function	Extended	Now also supports aggregation over a set containing both strings and numbers

## 8.1.9. Version 3.1

Feature	Type	Change	Details
<code>rels()</code>	Function	Deprecated	Replaced by <code>relationships()</code>
<code>toInt()</code>	Function	Deprecated	Replaced by <code>toInteger()</code>
<code>lower()</code>	Function	Deprecated	Replaced by <code>toLower()</code>
<code>upper()</code>	Function	Deprecated	Replaced by <code>toUpper()</code>
<code>toBoolean()</code>	Function	Added	
Map projection	Syntax	Added	
Pattern comprehension	Syntax	Added	
User-defined functions	Functionality	Added	
<code>CALL...YIELD...WHERE</code>	Clause	Extended	Records returned by <code>YIELD</code> may be filtered further using <code>WHERE</code>

## 8.1.10. Version 3.0

Feature	Type	Change	Details
has()	Function	Removed	Replaced by <code>exists()</code>
str()	Function	Removed	Replaced by <code>toString()</code>
{parameter}	Syntax	Deprecated	Replaced by <code>\$parameter</code>
properties()	Function	Added	
CALL [...YIELD]	Clause	Added	
point() - Cartesian 2D	Function	Added	
point() - WGS 84 2D	Function	Added	
distance()	Function	Added	
User-defined procedures	Functionality	Added	
toString()	Function	Extended	Now also allows Boolean values as input

## 8.2. Compatibility



The ability of Neo4j to support multiple older versions of the Cypher language has been changing. In versions of Neo4j before 3.5 the backwards compatibility layer included the Cypher language parser, planner and runtime. All supported versions of Cypher would run on the same Neo4j kernel. In Neo4j 3.4, however, this was changed such that the compatibility layer no longer included the runtime. This meant that running, for example, a `CYPHER 3.1` query inside Neo4j 3.5 would plan the query using the 3.1 planner, and run it using the 3.5 runtime and kernel. In Neo4j 4.0 this was changed again, such that the compatibility layer includes only the parser. For example, running a `CYPHER 3.5` query inside Neo4j will parse older language features, but plan using the 4.2 planner, and run using the 4.2 runtime and kernel. The primary reason for this change has been optimizations in the Cypher runtime to allow Cypher query to perform better.

Older versions of the language can still be accessed if required. There are two ways to select which version to use in queries.

1. Setting a version for all queries: You can configure your database with the configuration parameter `cypher.default_language_version`, and enter which version you'd like to use (see [Supported language versions](#)). Every Cypher query will use this version, provided the query hasn't explicitly been configured as described in the next item below.
2. Setting a version on a query by query basis: The other method is to set the version for a particular query. Prepending a query with `CYPHER 3.5` will execute the query with the version of Cypher included in Neo4j 3.5.

Below is an example using the older parameter syntax `{param}`:

```
CYPHER 3.5
MATCH (n:Person)
WHERE n.age > {agelimit}
RETURN n.name, n.age
```

Without the `CYPHER 3.5` prefix this query would fail with a syntax error. With `CYPHER 3.5` however, it will only generate a warning and still work.



In Neo4j 4.2 some older language features are understood by the Cypher parser even if they are no longer supported by the Neo4j kernel. These features will result in runtime errors. See the table at [Cypher Version 4.0](#) for the list of affected features.

## 8.3. Supported language versions

Neo4j 4.2 supports the following versions of the Cypher language:

- Neo4j Cypher 3.5
- Neo4j Cypher 4.1
- Neo4j Cypher 4.2



Each release of Neo4j supports a limited number of old Cypher Language Versions. When you upgrade to a new release of Neo4j, please make sure that it supports the Cypher language version you need. If not, you may need to modify your queries to work with a newer Cypher language version.

# Chapter 9. Glossary of keywords

*This section comprises a glossary of all the keywords—grouped by category and thence ordered lexicographically—in the Cypher query language.*

- [Clauses](#)
- [Operators](#)
- [Functions](#)
- [Expressions](#)
- [Cypher query options](#)
- [Administrative commands](#)
- [Privilege Actions](#)

## 9.1. Clauses

Clause	Category	Description
<code>CALL [...YIELD]</code>	Reading/Writing	Invoke a procedure deployed in the database.
<code>CALL {...}</code>	Reading/Writing	Evaluates a subquery, typically used for post-union processing or aggregations.
<code>CREATE</code>	Writing	Create nodes and relationships.
<code>CREATE CONSTRAINT [existence] [IF NOT EXISTS] ON (n:Label) ASSERT exists(n.property)</code>	Schema	Create a constraint ensuring that all nodes with a particular label have a certain property.
<code>CREATE CONSTRAINT [node_key] [IF NOT EXISTS] ON (n:Label) ASSERT (n.prop1, ..., n.propN) IS NODE KEY</code>	Schema	Create a constraint ensuring all nodes with a particular label have all the specified properties and that the combination of property values is unique; i.e. ensures existence and uniqueness.
<code>CREATE CONSTRAINT [existence] [IF NOT EXISTS] ON ()-[r:REL_TYPE]-() ASSERT exists(r.property)</code>	Schema	Create a constraint ensuring that all relationships with a particular type have a certain property.
<code>CREATE CONSTRAINT [uniqueness] [IF NOT EXISTS] ON (n:Label) ASSERT n.property IS UNIQUE</code>	Schema	Create a constraint ensuring the uniqueness of the combination of node label and property value for a particular property key across all nodes.
<code>CREATE INDEX [single] [IF NOT EXISTS] FOR (n:Label) ON (n.property)</code>	Schema	Create an index on all nodes with a particular label and a single property; i.e. create a single-property index.
<code>CREATE INDEX [composite] [IF NOT EXISTS] FOR (n:Label) ON (n.prop1, ..., n.propN)</code>	Schema	Create an index on all nodes with a particular label and multiple properties; i.e. create a composite index.
<code>DELETE</code>	Writing	Delete nodes, relationships or paths. Any node to be deleted must also have all associated relationships explicitly deleted.
<code>DETACH DELETE</code>	Writing	Delete a node or set of nodes. All associated relationships will automatically be deleted.
<code>DROP CONSTRAINT name [IF EXISTS]</code>	Schema	Drop a constraint using the name.

Clause	Category	Description
DROP INDEX name [IF EXISTS]	Schema	Drop an index using the name.
FOREACH	Writing	Update data within a list, whether components of a path, or the result of aggregation.
LIMIT	Reading sub-clause	A sub-clause used to constrain the number of rows in the output.
LOAD CSV	Importing data	Use when importing data from CSV files.
MATCH	Reading	Specify the patterns to search for in the database.
MERGE	Reading/Writing	Ensures that a pattern exists in the graph. Either the pattern already exists, or it needs to be created.
ON CREATE	Reading/Writing	Used in conjunction with <a href="#">MERGE</a> , specifying the actions to take if the pattern needs to be created.
ON MATCH	Reading/Writing	Used in conjunction with <a href="#">MERGE</a> , specifying the actions to take if the pattern already exists.
OPTIONAL MATCH	Reading	Specify the patterns to search for in the database while using <a href="#">nulls</a> for missing parts of the pattern.
ORDER BY [ASC[ENDING]   DESC[ENDING]]	Reading sub-clause	A sub-clause following <a href="#">RETURN</a> or <a href="#">WITH</a> , specifying that the output should be sorted in either ascending (the default) or descending order.
REMOVE	Writing	Remove properties and labels from nodes and relationships.
RETURN ... [AS]	Projecting	Defines what to include in the query result set.
SET	Writing	Update labels on nodes and properties on nodes and relationships.
SHOW [ALL   UNIQUE   NODE EXIST[S]   RELATIONSHIP EXIST[S]   EXIST[S]   NODE KEY] CONSTRAINT[S] [BRIEF   VERBOSE [OUTPUT]]	Schema	List constraints in the database, either all or filtered on type.
SHOW [ALL   BTREE] INDEX[ES] [BRIEF   VERBOSE [OUTPUT]]	Schema	List indexes in the database, either all or B-tree only.
SKIP	Reading/Writing	A sub-clause defining from which row to start including the rows in the output.
UNION	Set operations	Combines the result of multiple queries. Duplicates are removed.
UNION ALL	Set operations	Combines the result of multiple queries. Duplicates are retained.
UNWIND ... [AS]	Projecting	Expands a list into a sequence of rows.
USE	Multiple graphs	Determines which graph a query, or query part, is executed against.
USING INDEX variable:Label(property)	Hint	Index hints are used to specify which index, if any, the planner should use as a starting point.
USING INDEX SEEK variable:Label(property)	Hint	Index seek hint instructs the planner to use an index seek for this clause.

Clause	Category	Description
USING JOIN ON variable	Hint	Join hints are used to enforce a join operation at specified points.
USING PERIODIC COMMIT	Hint	This query hint may be used to prevent an out-of-memory error from occurring when importing large amounts of data using <code>LOAD CSV</code> .
USING SCAN variable:Label	Hint	Scan hints are used to force the planner to do a label scan (followed by a filtering operation) instead of using an index.
WITH ... [AS]	Projecting	Allows query parts to be chained together, piping the results from one to be used as starting points or criteria in the next.
WHERE	Reading sub-clause	A sub-clause used to add constraints to the patterns in a <code>MATCH</code> or <code>OPTIONAL MATCH</code> clause, or to filter the results of a <code>WITH</code> clause.
WHERE EXISTS {...}	Reading sub-clause	An existential sub-query used to filter the results of a <code>MATCH</code> , <code>OPTIONAL MATCH</code> or <code>WITH</code> clause.

## 9.2. Operators

Operator	Category	Description
%	Mathematical	Modulo division
*	Mathematical	Multiplication
*	Temporal	Multiplying a duration with a number
+	Mathematical	Addition
+	String	Concatenation
+=	Property	Property mutation
+	List	Concatenation
+	Temporal	Adding two durations, or a duration and a temporal instant
-	Mathematical	Subtraction or unary minus
-	Temporal	Subtracting a duration from a temporal instant or from another duration
.	Map	Static value access by key
.	Property	Static property access
/	Mathematical	Division
/	Temporal	Dividing a duration by a number
<	Comparison	Less than
<=	Comparison	Less than or equal to
<>	Comparison	Inequality
=	Comparison	Equality
=	Property	Property replacement
=~	String	Regular expression match
>	Comparison	Greater than

Operator	Category	Description
<code>&gt;=</code>	Comparison	Greater than or equal to
<code>AND</code>	Boolean	Conjunction
<code>CONTAINS</code>	String comparison	Case-sensitive inclusion search
<code>DISTINCT</code>	Aggregation	Duplicate removal
<code>ENDS WITH</code>	String comparison	Case-sensitive suffix search
<code>IN</code>	List	List element existence check
<code>IS NOT NULL</code>	Comparison	<code>Non-null</code> check
<code>IS NULL</code>	Comparison	<code>null</code> check
<code>NOT</code>	Boolean	Negation
<code>OR</code>	Boolean	Disjunction
<code>STARTS WITH</code>	String comparison	Case-sensitive prefix search
<code>XOR</code>	Boolean	Exclusive disjunction
<code>[ ]</code>	Map	Subscript (dynamic value access by key)
<code>[ ]</code>	Property	Subscript (dynamic property access)
<code>[ ]</code>	List	Subscript (accessing element(s) in a list)
<code>^</code>	Mathematical	Exponentiation

## 9.3. Functions

Function	Category	Description
<code>abs()</code>	Numeric	Returns the absolute value of a number.
<code>acos()</code>	Trigonometric	Returns the arccosine of a number in radians.
<code>all()</code>	Predicate	Tests whether the predicate holds for all elements in a list.
<code>any()</code>	Predicate	Tests whether the predicate holds for at least one element in a list.
<code>asin()</code>	Trigonometric	Returns the arcsine of a number in radians.
<code>atan()</code>	Trigonometric	Returns the arctangent of a number in radians.
<code>atan2()</code>	Trigonometric	Returns the arctangent2 of a set of coordinates in radians.
<code>avg()</code>	Aggregating	Returns the average of a set of values.
<code>ceil()</code>	Numeric	Returns the smallest floating point number that is greater than or equal to a number and equal to a mathematical integer.
<code>coalesce()</code>	Scalar	Returns the first <code>non-null</code> value in a list of expressions.
<code>collect()</code>	Aggregating	Returns a list containing the values returned by an expression.
<code>cos()</code>	Trigonometric	Returns the cosine of a number.
<code>cot()</code>	Trigonometric	Returns the cotangent of a number.

Function	Category	Description
count()	Aggregating	Returns the number of values or rows.
date()	Temporal	Returns the current <i>Date</i> .
date({year [, month, day]})	Temporal	Returns a calendar (Year-Month-Day) <i>Date</i> .
date({year [, week, dayOfWeek]})	Temporal	Returns a week (Year-Week-Day) <i>Date</i> .
date({year [, quarter, dayOfQuarter]})	Temporal	Returns a quarter (Year-Quarter-Day) <i>Date</i> .
date({year [, ordinalDay]})	Temporal	Returns an ordinal (Year-Day) <i>Date</i> .
date(string)	Temporal	Returns a <i>Date</i> by parsing a string.
date({map})	Temporal	Returns a <i>Date</i> from a map of another temporal value's components.
date.realtime()	Temporal	Returns the current <i>Date</i> using the <code>realtime</code> clock.
date.statement()	Temporal	Returns the current <i>Date</i> using the <code>statement</code> clock.
date.transaction()	Temporal	Returns the current <i>Date</i> using the <code>transaction</code> clock.
date.truncate()	Temporal	Returns a <i>Date</i> obtained by truncating a value at a specific component boundary. <a href="#">Truncation summary</a> .
datetime()	Temporal	Returns the current <i>DateTime</i> .
datetime({year [, month, day, ...]})	Temporal	Returns a calendar (Year-Month-Day) <i>DateTime</i> .
datetime({year [, week, dayOfWeek, ...]})	Temporal	Returns a week (Year-Week-Day) <i>DateTime</i> .
datetime({year [, quarter, dayOfQuarter, ...]})	Temporal	Returns a quarter (Year-Quarter-Day) <i>DateTime</i> .
datetime({year [, ordinalDay, ...]})	Temporal	Returns an ordinal (Year-Day) <i>DateTime</i> .
datetime(string)	Temporal	Returns a <i>DateTime</i> by parsing a string.
datetime({map})	Temporal	Returns a <i>DateTime</i> from a map of another temporal value's components.
datetime({epochSeconds})	Temporal	Returns a <i>DateTime</i> from a timestamp.
datetime.realtime()	Temporal	Returns the current <i>DateTime</i> using the <code>realtime</code> clock.
datetime.statement()	Temporal	Returns the current <i>DateTime</i> using the <code>statement</code> clock.
datetime.transaction()	Temporal	Returns the current <i>DateTime</i> using the <code>transaction</code> clock.
datetime.truncate()	Temporal	Returns a <i>DateTime</i> obtained by truncating a value at a specific component boundary. <a href="#">Truncation summary</a> .
degrees()	Trigonometric	Converts radians to degrees.
distance()	Spatial	Returns a floating point number representing the geodesic distance between any two points in the same CRS.
duration({map})	Temporal	Returns a <i>Duration</i> from a map of its components.
duration(string)	Temporal	Returns a <i>Duration</i> by parsing a string.

Function	Category	Description
<code>duration.between()</code>	Temporal	Returns a <i>Duration</i> equal to the difference between two given instants.
<code>duration.inDays()</code>	Temporal	Returns a <i>Duration</i> equal to the difference in whole days or weeks between two given instants.
<code>duration.inMonths()</code>	Temporal	Returns a <i>Duration</i> equal to the difference in whole months, quarters or years between two given instants.
<code>duration.inSeconds()</code>	Temporal	Returns a <i>Duration</i> equal to the difference in seconds and fractions of seconds, or minutes or hours, between two given instants.
<code>e()</code>	Logarithmic	Returns the base of the natural logarithm, <i>e</i> .
<code>endNode()</code>	Scalar	Returns the end node of a relationship.
<code>exists()</code>	Predicate	Returns true if a match for the pattern exists in the graph, or if the specified property exists in the node, relationship or map.
<code>exp()</code>	Logarithmic	Returns <i>e<sup>n</sup></i> , where <i>e</i> is the base of the natural logarithm, and <i>n</i> is the value of the argument expression.
<code>floor()</code>	Numeric	Returns the largest floating point number that is less than or equal to a number and equal to a mathematical integer.
<code>haversin()</code>	Trigonometric	Returns half the versine of a number.
<code>head()</code>	Scalar	Returns the first element in a list.
<code>id()</code>	Scalar	Returns the id of a relationship or node.
<code>keys()</code>	List	Returns a list containing the string representations for all the property names of a node, relationship, or map.
<code>labels()</code>	List	Returns a list containing the string representations for all the labels of a node.
<code>last()</code>	Scalar	Returns the last element in a list.
<code>left()</code>	String	Returns a string containing the specified number of leftmost characters of the original string.
<code>length()</code>	Scalar	Returns the length of a path.
<code>localdatetime()</code>	Temporal	Returns the current <i>LocalDateTime</i> .
<code>localdatetime({year [, month, day, ...]})</code>	Temporal	Returns a calendar (Year-Month-Day) <i>LocalDateTime</i> .
<code>localdatetime({year [, week, dayOfWeek, ...]})</code>	Temporal	Returns a week (Year-Week-Day) <i>LocalDateTime</i> .
<code>localdatetime({year [, quarter, dayOfQuarter, ...]})</code>	Temporal	Returns a quarter (Year-Quarter-Day) <i>DateTime</i> .
<code>localdatetime({year [, ordinalDay, ...]})</code>	Temporal	Returns an ordinal (Year-Day) <i>LocalDateTime</i> .
<code>localdatetime(string)</code>	Temporal	Returns a <i>LocalDateTime</i> by parsing a string.

Function	Category	Description
<code>localdatetime({map})</code>	Temporal	Returns a <i>LocalDateTime</i> from a map of another temporal value's components.
<code>localdatetime.realtime()</code>	Temporal	Returns the current <i>LocalDateTime</i> using the <code>realtime</code> clock.
<code>localdatetime.statement()</code>	Temporal	Returns the current <i>LocalDateTime</i> using the <code>statement</code> clock.
<code>localdatetime.transaction()</code>	Temporal	Returns the current <i>LocalDateTime</i> using the <code>transaction</code> clock.
<code>localdatetime.truncate()</code>	Temporal	Returns a <i>LocalDateTime</i> obtained by truncating a value at a specific component boundary. <a href="#">Truncation summary</a> .
<code>localtime()</code>	Temporal	Returns the current <i>LocalTime</i> .
<code>localtime({hour [, minute, second, ...]})</code>	Temporal	Returns a <i>LocalTime</i> with the specified component values.
<code>localtime(string)</code>	Temporal	Returns a <i>LocalTime</i> by parsing a string.
<code>localtime({time [, hour, ...]})</code>	Temporal	Returns a <i>LocalTime</i> from a map of another temporal value's components.
<code>localtime.realtime()</code>	Temporal	Returns the current <i>LocalTime</i> using the <code>realtime</code> clock.
<code>localtime.statement()</code>	Temporal	Returns the current <i>LocalTime</i> using the <code>statement</code> clock.
<code>localtime.transaction()</code>	Temporal	Returns the current <i>LocalTime</i> using the <code>transaction</code> clock.
<code>localtime.truncate()</code>	Temporal	Returns a <i>LocalTime</i> obtained by truncating a value at a specific component boundary. <a href="#">Truncation summary</a> .
<code>log()</code>	Logarithmic	Returns the natural logarithm of a number.
<code>log10()</code>	Logarithmic	Returns the common logarithm (base 10) of a number.
<code>lTrim()</code>	String	Returns the original string with leading whitespace removed.
<code>max()</code>	Aggregating	Returns the maximum value in a set of values.
<code>min()</code>	Aggregating	Returns the minimum value in a set of values.
<code>nodes()</code>	List	Returns a list containing all the nodes in a path.
<code>none()</code>	Predicate	Returns true if the predicate holds for no element in a list.
<code>percentileCont()</code>	Aggregating	Returns the percentile of the given value over a group using linear interpolation.
<code>percentileDisc()</code>	Aggregating	Returns the nearest value to the given percentile over a group using a rounding method.
<code>pi()</code>	Trigonometric	Returns the mathematical constant <i>pi</i> .
<code>point() - Cartesian 2D</code>	Spatial	Returns a 2D point object, given two coordinate values in the Cartesian coordinate system.

Function	Category	Description
<a href="#">point() - Cartesian 3D</a>	Spatial	Returns a 3D point object, given three coordinate values in the Cartesian coordinate system.
<a href="#">point() - WGS 84 2D</a>	Spatial	Returns a 2D point object, given two coordinate values in the WGS 84 coordinate system.
<a href="#">point() - WGS 84 3D</a>	Spatial	Returns a 3D point object, given three coordinate values in the WGS 84 coordinate system.
<a href="#">properties()</a>	Scalar	Returns a map containing all the properties of a node or relationship.
<a href="#">radians()</a>	Trigonometric	Converts degrees to radians.
<a href="#">rand()</a>	Numeric	Returns a random floating point number in the range from 0 (inclusive) to 1 (exclusive); i.e. [0, 1).
<a href="#">randomUUID()</a>	Scalar	Returns a string value corresponding to a randomly-generated UUID.
<a href="#">range()</a>	List	Returns a list comprising all integer values within a specified range.
<a href="#">reduce()</a>	List	Runs an expression against individual elements of a list, storing the result of the expression in an accumulator.
<a href="#">relationships()</a>	List	Returns a list containing all the relationships in a path.
<a href="#">replace()</a>	String	Returns a string in which all occurrences of a specified string in the original string have been replaced by another (specified) string.
<a href="#">reverse()</a>	List	Returns a list in which the order of all elements in the original list have been reversed.
<a href="#">reverse()</a>	String	Returns a string in which the order of all characters in the original string have been reversed.
<a href="#">right()</a>	String	Returns a string containing the specified number of rightmost characters of the original string.
<a href="#">round()</a>	Numeric	Returns the value of the given number rounded to the nearest integer, with half-way values always rounded up.
<a href="#">round(), with precision</a>	Numeric	Returns the value of the given number rounded with the specified precision, with half-values always being rounded up.
<a href="#">round(), with precision and rounding mode</a>	Numeric	Returns the value of the given number rounded with the specified precision and the specified rounding mode.
<a href="#">rTrim()</a>	String	Returns the original string with trailing whitespace removed.
<a href="#">sign()</a>	Numeric	Returns the signum of a number: 0 if the number is 0, -1 for any negative number, and 1 for any positive number.
<a href="#">sin()</a>	Trigonometric	Returns the sine of a number.
<a href="#">single()</a>	Predicate	Returns true if the predicate holds for exactly one of the elements in a list.

Function	Category	Description
<code>size()</code>	Scalar	Returns the number of items in a list.
<code>size() applied to pattern expression</code>	Scalar	Returns the number of paths matching the pattern expression.
<code>size() applied to string</code>	Scalar	Returns the number of Unicode characters in a string.
<code>split()</code>	String	Returns a list of strings resulting from the splitting of the original string around matches of the given delimiter.
<code>sqrt()</code>	Logarithmic	Returns the square root of a number.
<code>startNode()</code>	Scalar	Returns the start node of a relationship.
<code>stDev()</code>	Aggregating	Returns the standard deviation for the given value over a group for a sample of a population.
<code>stDevP()</code>	Aggregating	Returns the standard deviation for the given value over a group for an entire population.
<code>substring()</code>	String	Returns a substring of the original string, beginning with a 0-based index start and length.
<code>sum()</code>	Aggregating	Returns the sum of a set of numeric values.
<code>tail()</code>	List	Returns all but the first element in a list.
<code>tan()</code>	Trigonometric	Returns the tangent of a number.
<code>time()</code>	Temporal	Returns the current <i>Time</i> .
<code>time({hour [, minute, ...]})</code>	Temporal	Returns a <i>Time</i> with the specified component values.
<code>time(string)</code>	Temporal	Returns a <i>Time</i> by parsing a string.
<code>time({time [, hour, ..., timezone]})</code>	Temporal	Returns a <i>Time</i> from a map of another temporal value's components.
<code>time.realtime()</code>	Temporal	Returns the current <i>Time</i> using the <i>realtime</i> clock.
<code>time.statement()</code>	Temporal	Returns the current <i>Time</i> using the <i>statement</i> clock.
<code>time.transaction()</code>	Temporal	Returns the current <i>Time</i> using the <i>transaction</i> clock.
<code>time.truncate()</code>	Temporal	Returns a <i>Time</i> obtained by truncating a value at a specific component boundary. <a href="#">Truncation summary</a> .
<code>timestamp()</code>	Scalar	Returns the difference, measured in milliseconds, between the current time and midnight, January 1, 1970 UTC.
<code>toBoolean()</code>	Scalar	Converts a string value to a boolean value.
<code>toFloat()</code>	Scalar	Converts an integer or string value to a floating point number.
<code>toInteger()</code>	Scalar	Converts a floating point or string value to an integer value.
<code>toLower()</code>	String	Returns the original string in lowercase.

Function	Category	Description
<code>toString()</code>	String	Converts an integer, float, boolean or temporal (i.e. Date, Time, LocalTime, DateTime, LocalDateTime or Duration) value to a string.
<code>toUpper()</code>	String	Returns the original string in uppercase.
<code>trim()</code>	String	Returns the original string with leading and trailing whitespace removed.
<code>type()</code>	Scalar	Returns the string representation of the relationship type.

## 9.4. Expressions

Name	Description
<code>CASE Expression</code>	A generic conditional expression, similar to if/else statements available in other languages.

## 9.5. Cypher query options

Name	Type	Description
<code>CYPHER \$version query</code>	Version	This will force ' <code>query</code> ' to use Neo4j Cypher <code>\$version</code> . The default is <code>4.0</code> .
<code>CYPHER runtime=interpreted query</code>	Runtime	This will force the query planner to use the interpreted runtime. This is the only option in Neo4j Community Edition.
<code>CYPHER runtime=slotted query</code>	Runtime	This will cause the query planner to use the slotted runtime. This is only available in Neo4j Enterprise Edition.
<code>CYPHER runtime=pipelined query</code>	Runtime	This will cause the query planner to use the pipelined runtime if it supports ' <code>query</code> '. This is only available in Neo4j Enterprise Edition.

## 9.6. Administrative commands

The following commands are only executable against the `system` database:

Command	Admin category	Description
<code>ALTER CURRENT USER SET PASSWORD FROM ... TO</code>	User and role	Change the password of the user that is currently logged in.
<code>ALTER USER ... [SET [PLAINTEXT   ENCRYPTED] PASSWORD {password [CHANGE [NOT] REQUIRED]   CHANGE [NOT] REQUIRED}] [SET STATUS {ACTIVE   SUSPENDED}]</code>	User and role	Changes a user account. Changes can include setting a new password, setting the account status and enabling that the user should change the password upon next login.
<code>CREATE [OR REPLACE] DATABASE ... [IF NOT EXISTS]</code>	Database	Creates a new database.
<code>CREATE [OR REPLACE] ROLE ... [IF NOT EXISTS] [AS COPY OF]</code>	User and role	Creates new roles.
<code>CREATE [OR REPLACE] USER ... [IF NOT EXISTS] SET [PLAINTEXT   ENCRYPTED] PASSWORD ... [[SET PASSWORD] CHANGE [NOT] REQUIRED] [SET STATUS {ACTIVE   SUSPENDED}]</code>	User and role	Creates a new user and sets the password for the new account. Optionally the account status can also be set and if the user should change the password upon first login.

Command	Admin category	Description
DENY ... ON DATABASE ... TO	Privilege	Denies a database or schema privilege to one or multiple roles.
DENY ... ON DBMS TO	Privilege	Denies a DBMS privilege to one or multiple roles.
DENY ... ON GRAPH ... [NODES   RELATIONSHIPS   ELEMENTS] ... TO	Privilege	Denies a graph privilege for one or multiple specified elements to one or multiple roles.
DROP DATABASE ... [IF EXISTS] [DUMP DATA   DESTROY DATA]	Database	Deletes a specified database.
DROP ROLE ... [IF EXISTS]	User and role	Deletes a specified role.
DROP USER ... [IF EXISTS]	User and role	Deletes a specified user.
GRANT ... ON DATABASE ... TO	Privilege	Assigns a database or schema privilege to one or multiple roles.
GRANT ... ON DBMS TO	Privilege	Assigns a DBMS privilege to one or multiple roles.
GRANT ... ON GRAPH ... [NODES   RELATIONSHIPS   ELEMENTS] ... TO	Privilege	Assigns a graph privilege for one or multiple specified elements to one or multiple roles.
GRANT ROLE[S] ... TO	User and role	Assigns one or multiple roles to one or multiple users.
REVOKE [GRANT   DENY] ... ON DATABASE ... FROM	Privilege	Removes a database or schema privilege from one or multiple roles.
REVOKE [GRANT   DENY] ... ON DBMS FROM	Privilege	Removes a DBMS privilege from one or multiple roles.
REVOKE [GRANT   DENY] ... ON GRAPH ... [NODES   RELATIONSHIPS   ELEMENTS] ... FROM	Privilege	Removes a graph privilege for one or multiple specified elements from one or multiple roles
REVOKE ROLE[S] ... FROM	User and role	Removes one or multiple roles from one or multiple users.
SHOW [ALL   POPULATED] ROLES [WITH USERS]	User and role	Returns information about all or populated roles, optionally including the assigned users.
SHOW DATABASE	Database	Returns information about a specified database.
SHOW DATABASES	Database	Returns information about all databases.
SHOW DEFAULT DATABASE	Database	Returns information about the default database.
SHOW [ROLE ...   USER ...   ALL] PRIVILEGES	Privilege	Returns information about role, user or all privileges.
SHOW USERS	User and role	Returns information about all users.
START DATABASE	Database	Starts up a specified database.
STOP DATABASE	Database	Stops a specified database.

## 9.7. Privilege Actions

Name	Category	Description
ACCESS	Database	Determines whether a user can access a specific database.

Name	Category	Description
ALL DATABASE PRIVILEGES	Database and schema	Determines whether a user is allowed to access, create, drop, and list indexes and constraints, create new labels, types and property names on a specific database.
ALL DBMS PRIVILEGES	DBMS	Determines whether a user is allowed to perform role, user, database and privilege management.
ALL GRAPH PRIVILEGES	GRAPH	Determines whether a user is allowed to perform reads and writes.
ALTER USER	DBMS	Determines whether the user can modify users.
ASSIGN PRIVILEGE	DBMS	Determines whether the user can assign privileges using the GRANT and DENY commands.
ASSIGN ROLE	DBMS	Determines whether the user can grant roles.
CONSTRAINT MANAGEMENT	Schema	Determines whether a user is allowed to create, drop, and list constraints on a specific database.
CREATE	GRAPH	Determines whether the user can create a new element (node, relationship or both).
CREATE CONSTRAINT	Schema	Determines whether a user is allowed to create constraints on a specific database.
CREATE DATABASE	DBMS	Determines whether the user can create new databases.
CREATE INDEX	Schema	Determines whether a user is allowed to create indexes on a specific database.
CREATE NEW NODE LABEL	Schema	Determines whether a user is allowed to create new node labels on a specific database.
CREATE NEW PROPERTY NAME	Schema	Determines whether a user is allowed to create new property names on a specific database.
CREATE NEW RELATIONSHIP TYPE	Schema	Determines whether a user is allowed to create new relationship types on a specific database.
CREATE ROLE	DBMS	Determines whether the user can create new roles.
CREATE USER	DBMS	Determines whether the user can create new users.
DATABASE MANAGEMENT	DBMS	Determines whether the user can create and delete databases.
DELETE	GRAPH	Determines whether the user can delete an element (node, relationship or both).
DROP CONSTRAINT	Schema	Determines whether a user is allowed to drop constraints on a specific database.
DROP DATABASE	DBMS	Determines whether the user can delete databases.
DROP INDEX	Schema	Determines whether a user is allowed to drop indexes on a specific database.

Name	Category	Description
DROP ROLE	DBMS	Determines whether the user can delete roles.
DROP USER	DBMS	Determines whether the user can delete users.
EXECUTE ADMIN PROCEDURE	DBMS	Determines whether the user can execute admin procedures.
EXECUTE BOOSTED FUNCTION	DBMS	Determines whether the user can execute functions with elevated privileges.
EXECUTE BOOSTED PROCEDURE	DBMS	Determines whether the user can execute procedures with elevated privileges.
EXECUTE FUNCTION	DBMS	Determines whether the user can execute functions.
EXECUTE PROCEDURE	DBMS	Determines whether the user can execute procedures.
INDEX MANAGEMENT	Schema	Determines whether a user is allowed to create, drop, and list indexes on a specific database.
MATCH	GRAPH	Determines whether the properties of an element (node, relationship or both) can be read and the element can be found and traversed while executing queries on the specified graph.
MERGE	GRAPH	Determines whether the user can find, read, create and set properties on an element (node, relationship or both).
NAME MANAGEMENT	Schema	Determines whether a user is allowed to create new labels, types and property names on a specific database.
PRIVILEGE MANAGEMENT	DBMS	Determines whether the user can show, assign and remove privileges.
READ	GRAPH	Determines whether the properties of an element (node, relationship or both) can be read while executing queries on the specified graph.
REMOVE LABEL	GRAPH	Determines whether the user can remove a label from a node using the REMOVE clause.
REMOVE PRIVILEGE	DBMS	Determines whether the user can remove privileges using the REVOKE command.
REMOVE ROLE	DBMS	Determines whether the user can revoke roles.
ROLE MANAGEMENT	DBMS	Determines whether the user can create, drop, grant, revoke and show roles.
SET LABEL	GRAPH	Determines whether the user can set a label to a node using the SET clause.
SET PASSWORDS	DBMS	Determines whether the user can modify users' passwords and whether those passwords must be changed upon first login.

Name	Category	Description
SET PROPERTY	GRAPH	Determines whether the user can set a property to an element (node, relationship or both) using the SET clause.
SET USER STATUS	DBMS	Determines whether the user can modify the account status of users.
SHOW CONSTRAINT	Schema	Determines whether the user is allowed to list constraints.
SHOW INDEX	Schema	Determines whether the user is allowed to list indexes.
SHOW PRIVILEGE	DBMS	Determines whether the user can get information about privileges assigned to users and roles.
SHOW ROLE	DBMS	Determines whether the user can get information about existing and assigned roles.
SHOW TRANSACTION	Database	Determines whether a user is allowed to list transactions and queries.
SHOW USER	DBMS	Determines whether the user can get information about existing users.
START	Database	Determines whether a user can start up a specific database.
STOP	Database	Determines whether a user can stop a specific running database.
TERMINATE TRANSACTION	Database	Determines whether a user is allowed to end running transactions and queries.
TRANSACTION MANAGEMENT	Database	Determines whether a user is allowed to list and end running transactions and queries.
TRAVERSE	GRAPH	Determines whether an element (node, relationship or both) can be found and traversed while executing queries on the specified graph.
USER MANAGEMENT	DBMS	Determines whether the user can create, drop, modify and show users.
WRITE	GRAPH	Determines whether the user can execute write operations on the specified graph.

# Appendix A: Cypher styleguide

*This appendix contains the recommended style when writing Cypher queries.*

This appendix contains the following:

- [General recommendations](#)
- [Indentations and line breaks](#)
- [Casing](#)
- [Spacing](#)
- [Patterns](#)
- [Meta characters](#)

The purpose of the styleguide is to make the code as easy to read as possible, and thereby contributing to lower cost of maintenance.

For rules and recommendations for naming of labels, relationship types and properties, please see the [Naming rules and recommendations](#).

## A.1. General recommendations

- When using Cypher language constructs in prose, use a **monospaced** font and follow the styling rules.
- When referring to labels and relationship types, the colon should be included as follows: `:Label1`, `:REL_TYPE`.
- When referring to functions, use lower camel case and parentheses should be used as follows: `shortestPath()`. Arguments should normally not be included.
- If you are storing Cypher statements in a separate file, use the file extension `.cypher`.

## A.2. Indentation and line breaks

- Start a new clause on a new line.

*Bad*

```
MATCH (n) WHERE n.name CONTAINS 's' RETURN n.name
```

*Good*

```
MATCH (n)
WHERE n.name CONTAINS 's'
RETURN n.name
```

- Indent `ON CREATE` and `ON MATCH` with two spaces. Put `ON CREATE` before `ON MATCH` if both are present.

*Bad*

```
MERGE (n) ON CREATE SET n.prop = 0
MERGE (a:A)-[:T]-(b:B)
ON MATCH SET b.name = 'you'
ON CREATE SET a.name = 'me'
RETURN a.prop
```

### *Good*

```

MERGE (n)
  ON CREATE SET n.prop = 0
MERGE (a:A)-[:T]-(b:B)
  ON CREATE SET a.name = 'me'
  ON MATCH SET b.name = 'you'
RETURN a.prop

```

- Start a subquery on a new line after the opening brace, indented with two (additional) spaces. Leave the closing brace on its own line.

### *Bad*

```

MATCH (a:A)
WHERE
  EXISTS { MATCH (a)-->(b:B) WHERE b.prop = $param }
RETURN a.foo

```

### *Also bad*

```

MATCH (a:A)
WHERE EXISTS
{MATCH (a)-->(b:B)
 WHERE b.prop = $param}
RETURN a.foo

```

### *Good*

```

MATCH (a:A)
WHERE EXISTS {
  MATCH (a)-->(b:B)
  WHERE b.prop = $param
}
RETURN a.foo

```

- Do not break the line if the simplified subquery form is used.

### *Bad*

```

MATCH (a:A)
WHERE EXISTS {
  (a)-->(b:B)
}
RETURN a.prop

```

### *Good*

```

MATCH (a:A)
WHERE EXISTS { (a)-->(b:B) }
RETURN a.prop

```

## A.3. Casing

- Write keywords in upper case.

### *Bad*

```

match (p:Person)
where p.name starts with 'Ma'
return p.name

```

*Good*

```
MATCH (p:Person)
WHERE p.name STARTS WITH 'Ma'
RETURN p.name
```

- Write the value `null` in lower case.

*Bad*

```
WITH NULL AS n1, Null AS n2
RETURN n1 IS NULL AND n2 IS NOT NULL
```

*Good*

```
WITH null AS n1, null as n2
RETURN n1 IS NULL AND n2 IS NOT NULL
```

- Write boolean literals (`true` and `false`) in lower case.

*Bad*

```
WITH TRUE AS b1, False AS b2
RETURN b1 AND b2
```

*Good*

```
WITH true AS b1, false AS b2
RETURN b1 AND b2
```

- Use camel case, starting with a lower-case character, for:

- functions
- properties
- variables
- parameters

*Bad*

```
CREATE (N {Prop: 0})
WITH RAND() AS Rand, $pArAm AS MAP
RETURN Rand, MAP.property_key, Count(N)
```

*Good*

```
CREATE (n {prop: 0})
WITH rand() AS rand, $param AS map
RETURN rand, map.propertyKey, count(n)
```

## A.4. Spacing

- For literal maps:
  - No space between the opening brace and the first key
  - No space between key and colon
  - One space between colon and value

- No space between value and comma
- One space between comma and next key
- No space between the last value and the closing brace

*Bad*

```
WITH { key1 :'value' ,key2 : 42 } AS map
RETURN map
```

*Good*

```
WITH {key1: 'value', key2: 42} AS map
RETURN map
```

- One space between label/type predicates and property predicates in patterns.

*Bad*

```
MATCH (p:Person{property: -1})-[:KNOWS {since: 2016}]->()
RETURN p.name
```

*Good*

```
MATCH (p:Person {property: -1})-[:KNOWS {since: 2016}]->()
RETURN p.name
```

- No space in patterns.

*Bad*

```
MATCH (:Person) --> (:Vehicle)
RETURN count(*)
```

*Good*

```
MATCH (:Person)-->(:Vehicle)
RETURN count(*)
```

- Use a wrapping space around operators.

*Bad*

```
MATCH p=(s)-->(e)
WHERE s.name<>e.name
RETURN length(p)
```

*Good*

```
MATCH p = (s)-->(e)
WHERE s.name <> e.name
RETURN length(p)
```

- No space in label predicates.

*Bad*

```
MATCH (person      : Person   : Owner   )
      RETURN person.name
```

*Good*

```
MATCH (person:Person:Owner)
      RETURN person.name
```

- Use a space after each comma in lists and enumerations.

*Bad*

```
MATCH (),()
WITH ['a','b',3.14] AS list
RETURN list,2,3,4
```

*Good*

```
MATCH (), ()
WITH ['a', 'b', 3.14] AS list
RETURN list, 2, 3, 4
```

- No padding space within function call parentheses.

*Bad*

```
RETURN split( 'original', 'i' )
```

*Good*

```
RETURN split('original', 'i')
```

- Use padding space within simple subquery expressions.

*Bad*

```
MATCH (a:A)
WHERE EXISTS {(a)-->(b:B)}
RETURN a.prop
```

*Good*

```
MATCH (a:A)
WHERE EXISTS { (a)-->(b:B) }
RETURN a.prop
```

## A.5. Patterns

- When patterns wrap lines, break after arrows, not before.

*Bad*

```
MATCH (:Person)-->(vehicle:Car)-->(:Company)
      <--(:Country)
      RETURN count(vehicle)
```

*Good*

```
MATCH (:Person)-->(vehicle:Car)-->(:Company)<--  
      (:Country)  
RETURN count(vehicle)
```

- Use anonymous nodes and relationships when the variable would not be used.

*Bad*

```
CREATE (a:End {prop: 42}),  
       (b:End {prop: 3}),  
       (c:Begin {prop: id(a)})
```

*Good*

```
CREATE (a:End {prop: 42}),  
       (:End {prop: 3}),  
       (:Begin {prop: id(a)})
```

- Chain patterns together to avoid repeating variables.

*Bad*

```
MATCH (:Person)-->(vehicle:Car), (vehicle:Car)-->(:Company)  
RETURN count(vehicle)
```

*Good*

```
MATCH (:Person)-->(vehicle:Car)-->(:Company)  
RETURN count(vehicle)
```

- Put named nodes before anonymous nodes.

*Bad*

```
MATCH ()-->(vehicle:Car)-->(:manufacturer:Company)  
WHERE manufacturer.foundedYear < 2000  
RETURN vehicle.mileage
```

*Good*

```
MATCH (:manufacturer:Company)<--(vehicle:Car)<--()  
WHERE manufacturer.foundedYear < 2000  
RETURN vehicle.mileage
```

- Keep anchor nodes at the beginning of the **MATCH** clause.

*Bad*

```
MATCH (:Person)-->(vehicle:Car)-->(:manufacturer:Company)  
WHERE manufacturer.foundedYear < 2000  
RETURN vehicle.mileage
```

*Good*

```
MATCH (:manufacturer:Company)<--(vehicle:Car)<--(:Person)  
WHERE manufacturer.foundedYear < 2000  
RETURN vehicle.mileage
```

- Prefer outgoing (left to right) pattern relationships to incoming pattern relationships.

*Bad*

```
MATCH (:Country)-->(:Company)<--(vehicle:Car)<--(:Person)
RETURN vehicle.mileage
```

*Good*

```
MATCH (:Person)-->(vehicle:Car)-->(:Company)<--(:Country)
RETURN vehicle.mileage
```

## A.6. Meta-characters

- Use single quotes, ' , for literal string values.

*Bad*

```
RETURN "Cypher"
```

*Good*

```
RETURN 'Cypher'
```

□ Disregard this rule for literal strings that contain a single quote character. If the string has both, use the form that creates the fewest escapes. In the case of a tie, prefer single quotes.

*Bad*

```
RETURN 'Cypher\'s a nice language', "Mats' quote: \"statement\""
```

*Good*

```
RETURN "Cypher's a nice language", 'Mats' quote: "statement"
```

- Avoid having to use back-ticks to escape characters and keywords.

*Bad*

```
MATCH (`odd-ch@racter$`:`Spaced Label` {`&property` : 42})
RETURN labels(`odd-ch@racter$`)
```

*Good*

```
MATCH (node:NonSpacedLabel {property: 42})
RETURN labels(node)
```

- Do not use a semicolon at the end of the statement.

*Bad*

```
RETURN 1;
```

*Good*

RETURN 1

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