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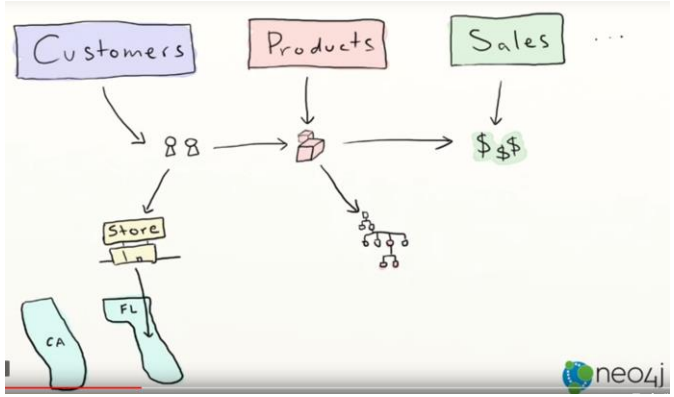
Neo4j

Agenda

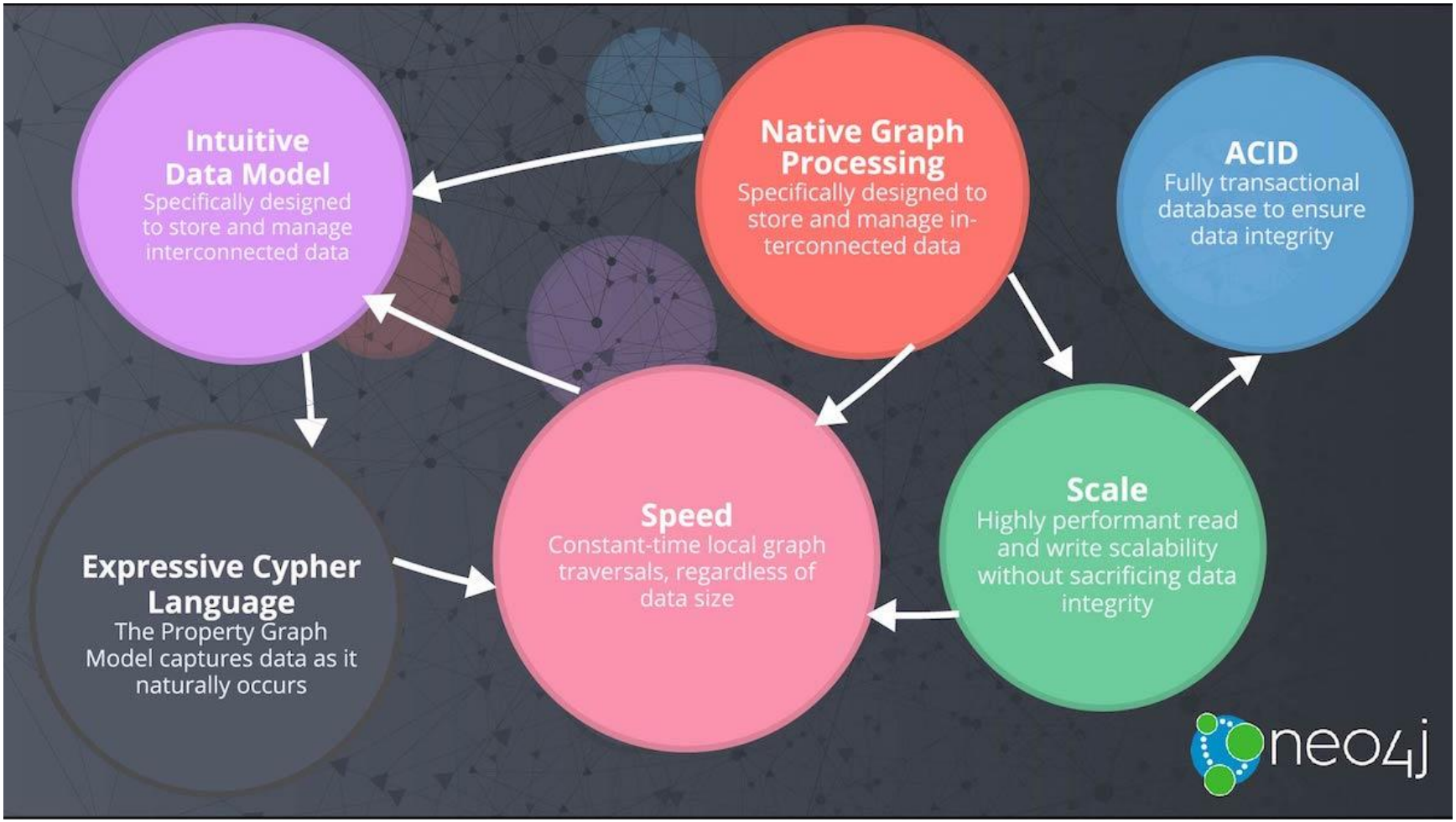
- Introduction
- Graph model
- Properties of graph database
- Cypher and example database

Introduction



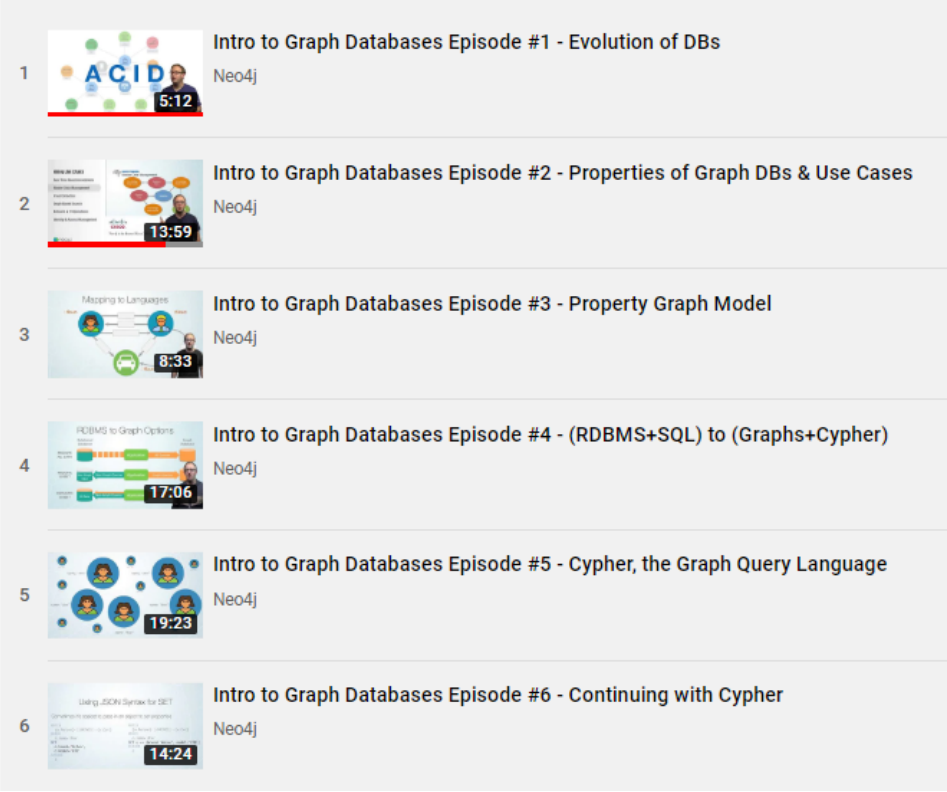
- Website: https://neo4j.com/
- A graph database
  - Focusing primarily on relations
- Cypher as a query language
  - With roots in SQL
- Drivers for Popular Programming Languages
  - .Net, Java (also Spring), JavaScript, and Python
  - Communication based on binary "Bolt" protocol

Introduction



Introduction

- A series of introduction videos available
  https://www.youtube.com/playlist?list=PL9Hl4pk2FsvWM9GWaguRhlCQ-pa-ERd4U



Introduction

NEO4j USE CASES

- Real Time Recommendations
- Master Data Management
- Fraud Detection
- Graph Based Search
- Network & IT-Operations
- Identity & Access Management

Filter by Industry: All Industries

Filter by Use Case: All Use Cases

Search by Name: Company name

Walmart	Comcast	Adobe	eBay
The ICIJ – Panama Papers	Digitate	Lyft	Lockheed Martin Space
U.S. Army	Dun & Bradstreet	Global 50 Bank	German Centre for Diabetes Research
UBS	Perform Media	Airbnb	Microsoft

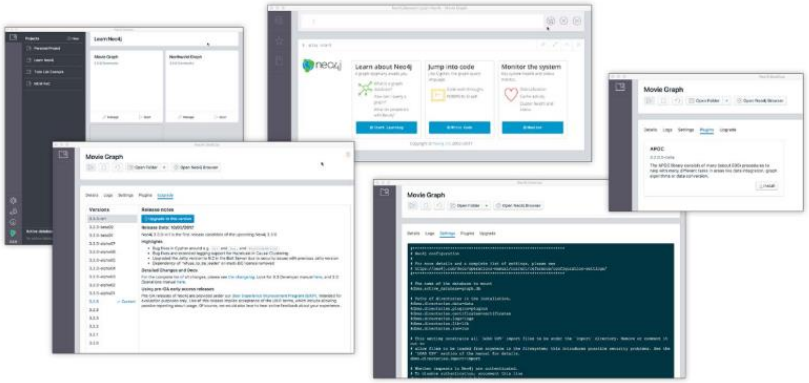
Introduction

- Releases

Server Architecture	Community	Enterprise	Neo4j Aura
Native graph processing & storage	✔	✔	✔
Graph size limitations	34B nodes	None	34B nodes
ACID Transactions	✔	✔	✔
Node Key schema constraints	–	✔	✔
Property existence constraints	–	✔	✔
Auto Reuse of Deleted Space*	✔	✔	–
Transactional ID Management*	✔	✔	–
Transaction Memory Constraint*	–	✔	–
Labeled property graph model	✔	✔	✔
System database*	✔	✔	–
High Performance Caching	✔	✔	✔
Cypher Graph Query Language	✔	✔	✔
Parallel Cypher Runtime*	–	✔	–
Cost-based Query Optimizer	✔	✔	✔
Cypher Sub-queries*	✔	✔	–
Cypher Query Tracing	–	✔	✔

New in Version 4.0

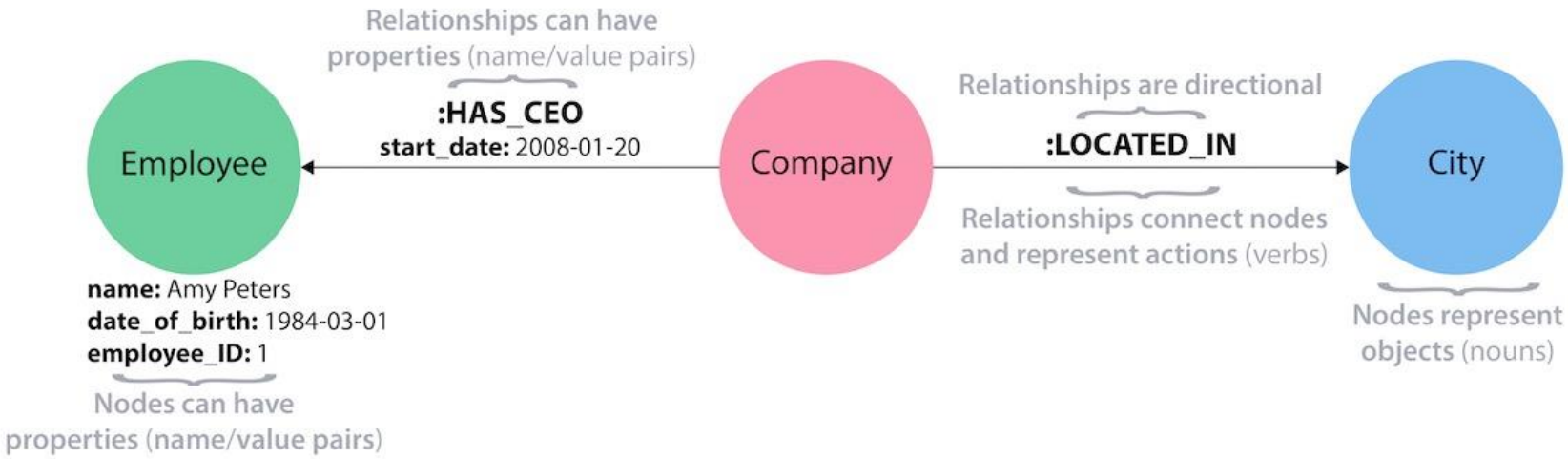
Neo4j Desktop: Developer-Friendly Packaging



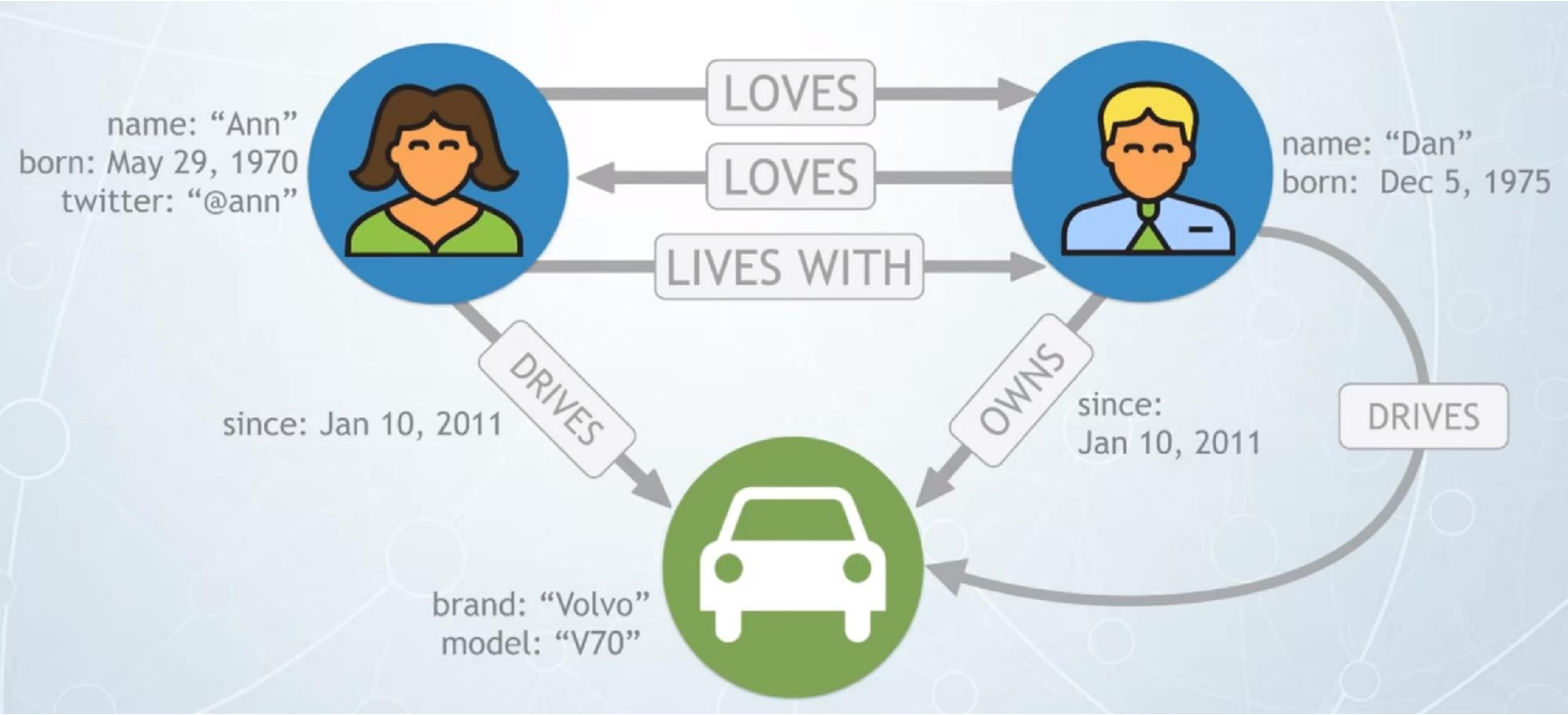
Graph model

- Treat the relationships between data as equally important to the data itself
- Rel. databases compute relationships at query time through JOIN operations
  - A graph database stores connections alongside the data in the model
- Key constituents of the graph model
  - Nodes – entities in the graph
  - Relationships – directed, named connections between two nodes (e.g. Employee *WORKS_FOR* Company)
    - Even if directed, they can be navigated in both directions
  - Properties – key/value pairs that can be attached both to nodes and relationships
  - Labels on nodes – representing types of nodes

Graph model


Relationships can have properties (name/value pairs)
:HAS_CEO
start_date: 2008-01-20
Employee
Company
Relationships are directional
:LOCATED_IN
City
Relationships connect nodes and represent actions (verbs)
name: Amy Peters
date_of_birth: 1984-03-01
employee_ID: 1
Nodes can have properties (name/value pairs)
Nodes represent objects (nouns)

Graph model


name: "Ann"
born: May 29, 1970
twitter: "@ann"
LOVES
LOVES
LIVES WITH
name: "Dan"
born: Dec 5, 1975
DRIVES
since: Jan 10, 2011
OWNS
since:
Jan 10, 2011
DRIVES
brand: "Volvo"
model: "V70"

Properties of graph databases

- Criterias to evaluate
  - Intuitiveness
    - Easier to take a journey from requirements and whiteboard to the actual data model
      - graph is natural way of expressing thoughts and though less translations are needed
  - Speed
    - Simpler model, so much quicker from the idea to the deployment
      - Ebay: Neo4j 1000x faster than MySQL based solution with 10-100 less code
  - Agility
    - No schemas, a naturally adaptive model (if sth needed, just add it)
    - Cypher language as a more concise way to express queries
      - What enables quicker understanding and easier way to change

Properties of graph databases

- Graph & Cypher power*

Typical Complex SQL Join

```
(SELECT T.directReportees AS directReportees, sum(T.count) AS count
FROM (
SELECT manager.pid AS directReportees, 0 AS count
  FROM person_reportee manager
  WHERE manager.pid = (SELECT id FROM person WHERE name = "fName lName")
UNION
  SELECT manager.pid AS directReportees, count(manager.directly_manages) AS count
FROM person_reportee manager
WHERE manager.pid = (SELECT id FROM person WHERE name = "fName lName")
GROUP BY directReportees
UNION
SELECT manager.pid AS directReportees, count(reportee.directly_manages) AS count
FROM person_reportee manager
JOIN person_reportee reportee
ON manager.directly_manages = reportee.pid
WHERE manager.pid = (SELECT id FROM person WHERE name = "fName lName")
GROUP BY directReportees
UNION
SELECT manager.pid AS directReportees, count(L2Reportees.directly_manages) AS count
FROM person_reportee manager
JOIN person_reportee L1Reportees
ON manager.directly_manages = L1Reportees.pid
JOIN person_reportee L2Reportees
ON L1Reportees.directly_manages = L2Reportees.pid
WHERE manager.pid = (SELECT id FROM person WHERE name = "fName lName")
GROUP BY directReportees
) AS T
GROUP BY directReportees)
UNION
(SELECT T.directReportees AS directReportees, sum(T.count) AS count
FROM (
SELECT manager.directly_manages AS directReportees, 0 AS count
FROM person_reportee manager
WHERE manager.pid = (SELECT id FROM person WHERE name = "fName lName")
UNION
SELECT reportee.pid AS directReportees, count(reportee.directly_manages) AS count
FROM person_reportee manager
JOIN person_reportee reportee
ON manager.directly_manages = reportee.pid
WHERE manager.pid = (SELECT id FROM person WHERE name = "fName lName")
GROUP BY directReportees
UNION
SELECT depth1Reportees.pid AS directReportees,
count(depth2Reportees.directly_manages) AS count
FROM person_reportee manager
JOIN person_reportee L1Reportees
ON manager.directly_manages = L1Reportees.pid
JOIN person_reportee L2Reportees
ON L1Reportees.directly_manages = L2Reportees.pid
WHERE manager.pid = (SELECT id FROM person WHERE name = "fName lName")
GROUP BY directReportees
) AS T
GROUP BY directReportees)
UNION
(SELECT T.directReportees AS directReportees, sum(T.count) AS count
  FROM(
  SELECT reportee.directly_manages AS directReportees, 0 AS count
FROM person_reportee manager
JOIN person_reportee reportee
ON manager.directly_manages = reportee.pid
WHERE manager.pid = (SELECT id FROM person WHERE name = "fName lName")
GROUP BY directReportees
UNION
SELECT L2Reportees.pid AS directReportees, count(L2Reportees.directly_manages)
AS count
FROM person_reportee manager
JOIN person_reportee L1Reportees
ON manager.directly_manages = L1Reportees.pid
JOIN person_reportee L2Reportees
ON L1Reportees.directly_manages = L2Reportees.pid
WHERE manager.pid = (SELECT id FROM person WHERE name = "fName lName")
GROUP BY directReportees
) AS T
GROUP BY directReportees)
UNION
(SELECT L2Reportees.directly_manages AS directReportees, 0 AS count
FROM person_reportee manager
JOIN person_reportee L1Reportees
ON manager.directly_manages = L1Reportees.pid
JOIN person_reportee L2Reportees
ON L1Reportees.directly_manages = L2Reportees.pid
WHERE manager.pid = (SELECT id FROM person WHERE name = "fName lName")
)
```

The Same Query using Cypher

```
MATCH (boss)-[:MANAGES*0..3]->(sub),
      (sub)-[:MANAGES*1..3]->(report)
WHERE boss.name = "John Doe"
RETURN sub.name AS Subordinate,
  count(report) AS Total
```

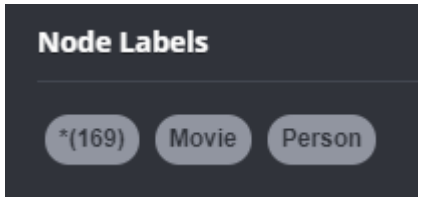
*Assuming the SQL query is written in the optimal way what probably is not the case

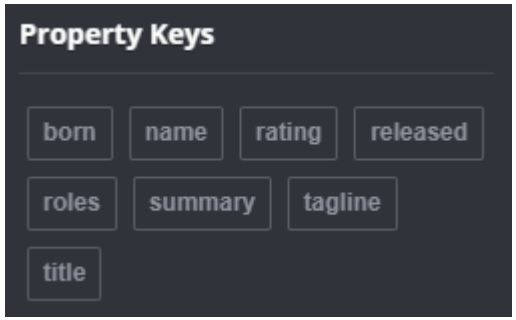
Example database

- Movies database
  - https://neo4j.com/developer/example-project/
- Domain model

```
(:Person {name})-[:ACTED_IN {roles}]->(:Movie {title,released})
```

- What's inside?





Cypher

- Open language
  - http://www.opencypher.org/
- Useful command
  - :help CREATE, :help MATCH, :help STH
- Based on ASCII Art and patterns
- Basic pattern
  - ()-[:RELATIONSHIP]->()
    - Node – REL –> Node
- Query
  - MATCH pattern
    WHERE conditions
    RETURN result

Cypher

- AsciiArt for nodes
  - Nodes
    - () or (p)
  - Labels, tags
    - (p:Person:Mammal)
  - Properties
    - (p:Person { name: 'John'})
- AsciiArt for relationship
  - Relationship
    - --> -[a:ACTED_IN]->
  - Direction
    - (p1) -[:ACTED_IN]-> (p2) (p1) <-[:ACTED_IN]- (p2)
  - Properties
    - (p1) -[a:ACTED_IN { type: 'series' }]-> (p2)
- Aliases
  - p1, p2, a

Cypher

- Actors
  - Marek Kondrat (MK)
    - Ur. 18.10.1950
  - Piotr Fronczewski (PF)
    - Ur. 8.6.1946
  - Krzysztof Kowalewski (KK)
    - Ur. 20.03.1937
  - Janusz Gajos (JG)
    - Ur. 23.09.1939
  - Zbigniew Zapasiewicz (ZZ)
    - Ur. 13.09.1934, Zm. 14.07.2009
- Movies
  - Psy (Psy)
  - C.K. Dezerterzy (CKD)
  - Dzień świra (DS)
  - Miś (Miś)
  - Akademia Pana Kleksa (APK)
- Acted in
  - Psy
    - MK (Olo)
    - ZZ (Wencel)
    - JG (Siwy)
  - CKD
    - MK (Kania)
    - KK (boss)
    - ZZ (Wagner)
  - DS
    - MK (Adaś Miauczyński)
    - PF (doctor)
  - Miś
    - KK (Jan Hochwander)
  - APK
    - PF (Ambroży Kleks)

Cypher

- **CRUD Examples**

```
CREATE (:Person { name: "Marek Kondrat" }) -[:ACTED_IN]-> (:Movie { name: "Psy" })
CREATE (:Person { name: "Janusz Gajos", born: "23.09.1939" })
MATCH (:Movie { name: "Psy" })<-[a:ACTED_IN]-(:Person { name: "Marek Kondrat"}) SET
a.character="Olo" RETURN a

MATCH (p:Person),(m:Movie)
WHERE p.name = 'Janusz Gajos' AND m.name = 'Psy'
CREATE (p)-[r:ACTED_IN { character: "Siwy" }]->(m)
RETURN type(r), r.character

MATCH (:Movie { name: "Psy" })<-[:ACTED_IN]-(p:Person) RETURN p
MATCH (m:Movie)<-[:ACTED_IN]-(p:Person) WHERE m.name="Psy" RETURN p

MATCH (n:Person { name: 'UNKNOWN' })
DELETE n

MATCH (n)
DETACH DELETE n
```

Więcej: https://neo4j.com/docs/cypher-manual/current/clauses/

Others

- Potentially useful
  - https://neo4j.com/docs/operations-manual/current/configuration/password-and-user-recovery/