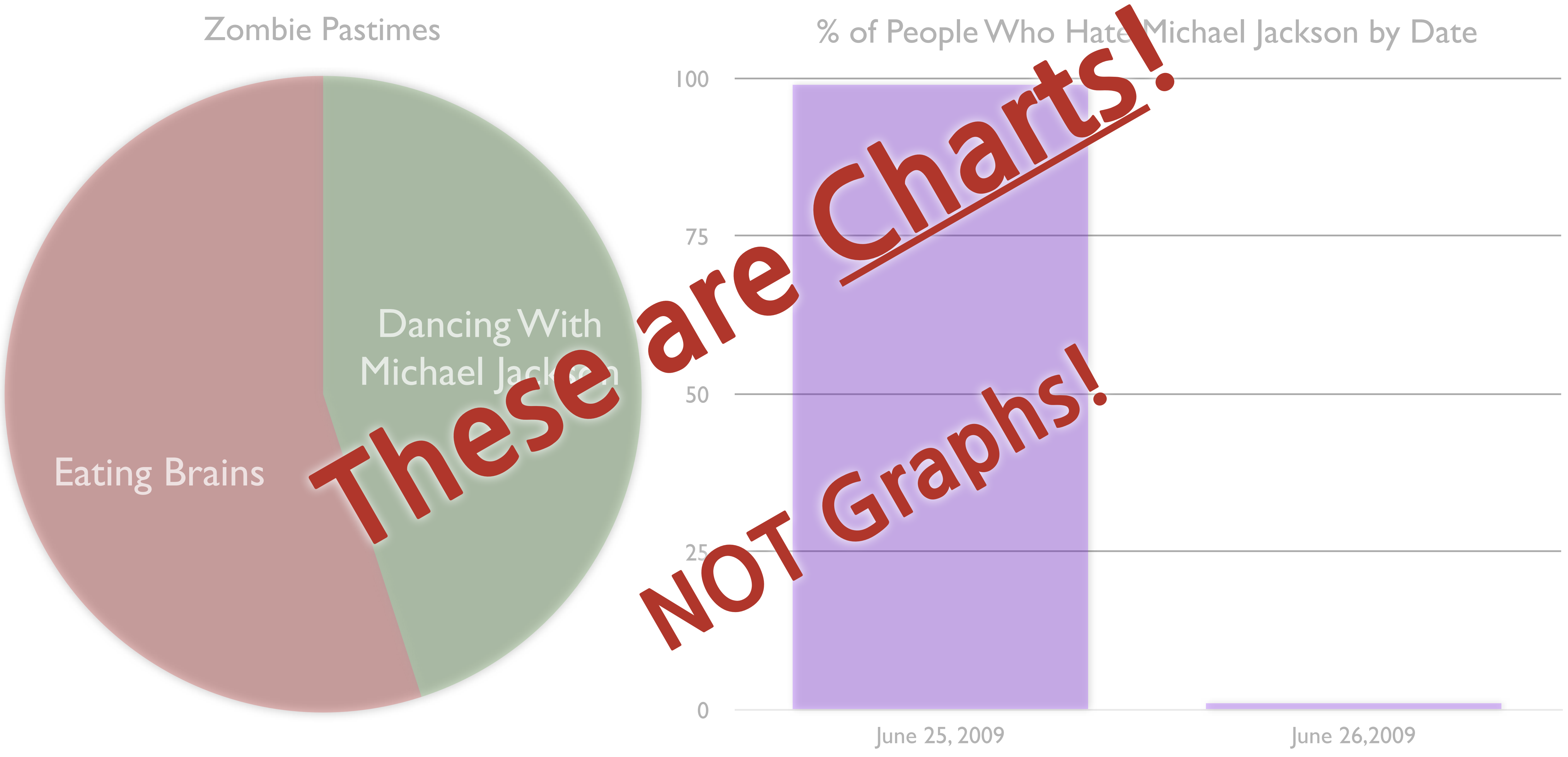
Neo4j Tutorial

```
(you)-[:know]->(Neo4j)
```


neotechnology

(Introduction to Graphs)

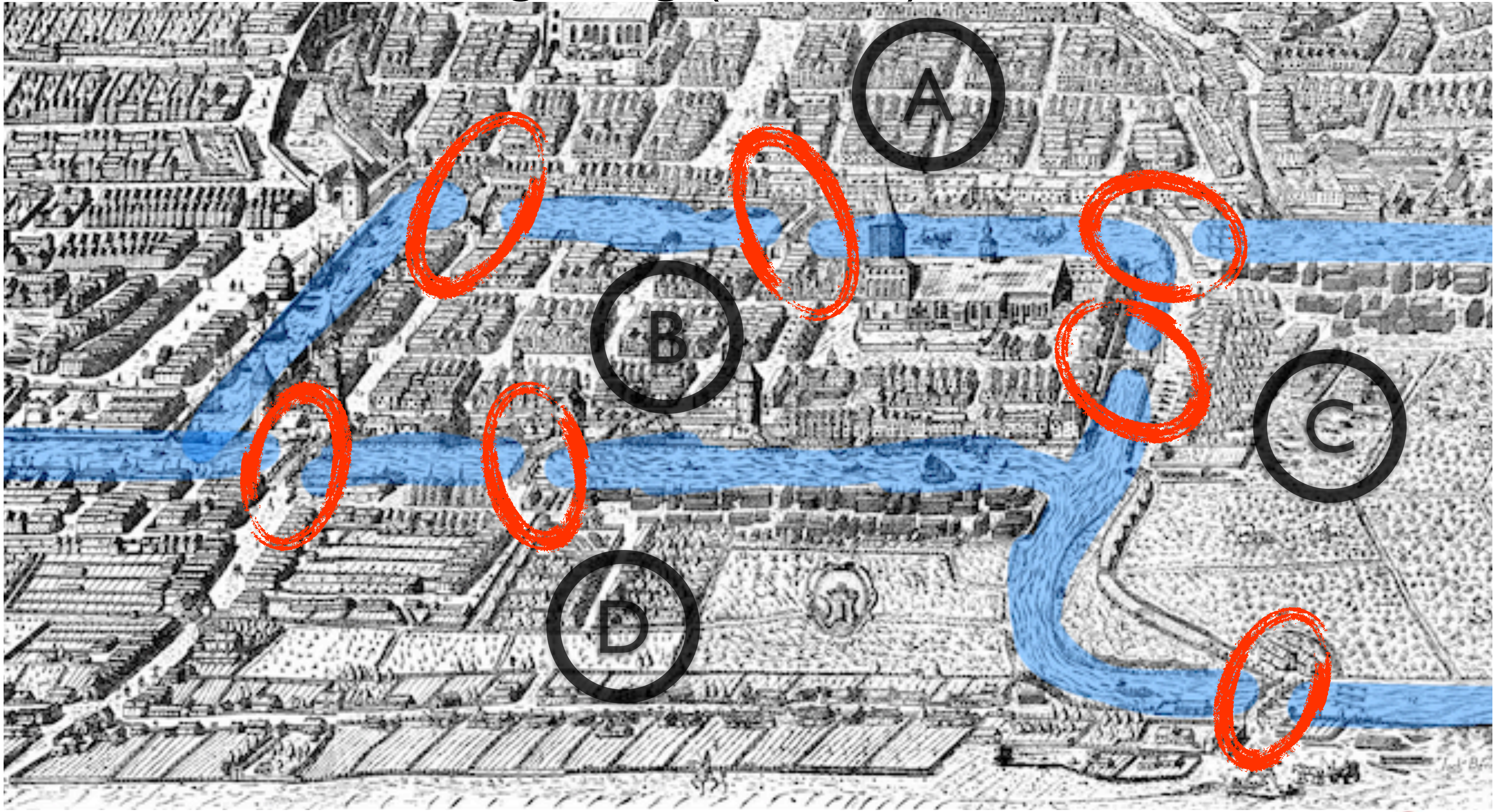
But first...
an important message...

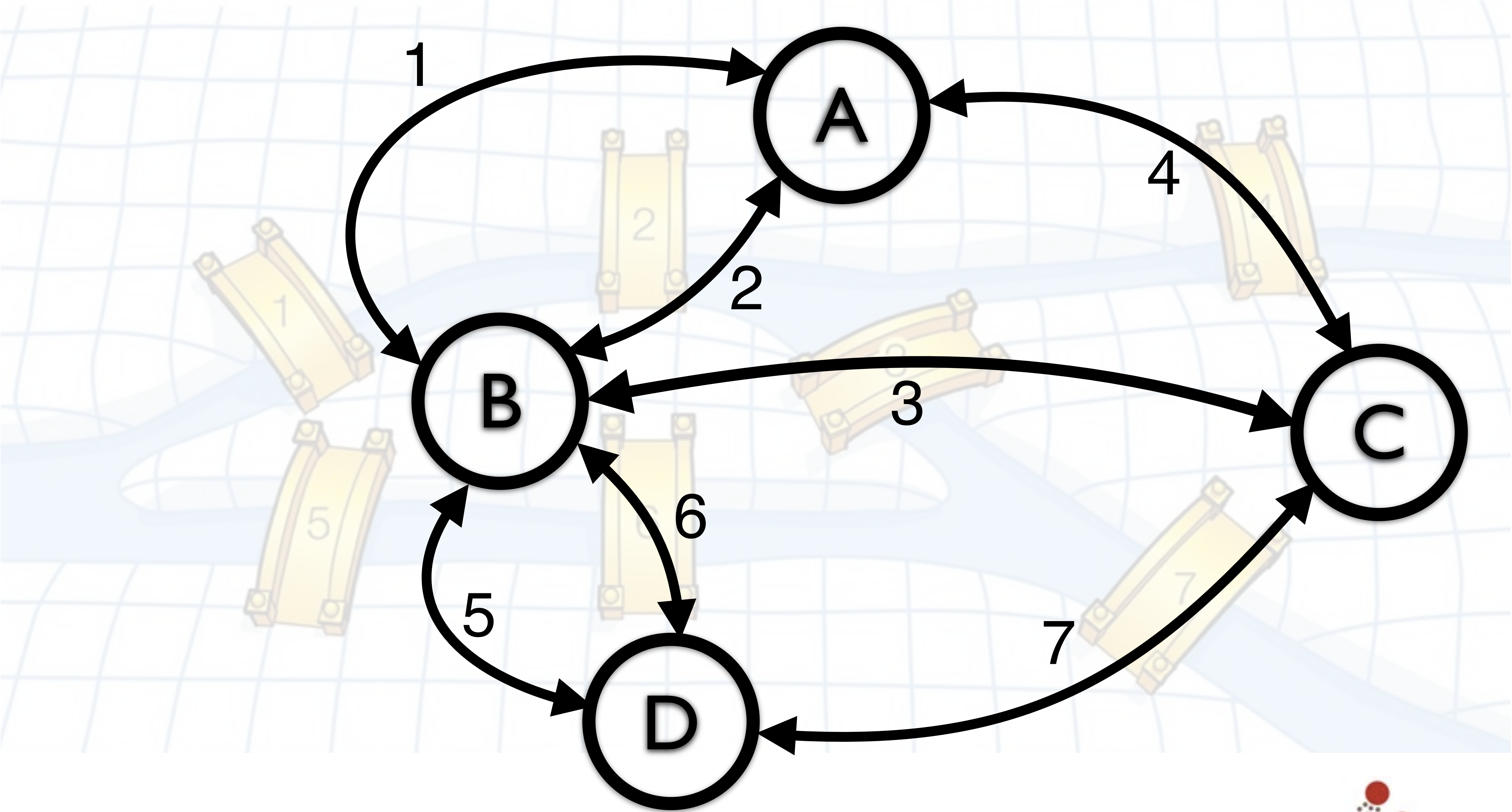


Zombie Pastimes
Dancing With Michael Jackson
Eating Brains
% of People Who Hate Michael Jackson by Date
100
75
50
25
0
June 25, 2009
June 26,2009
These are Charts!
NOT Graphs!

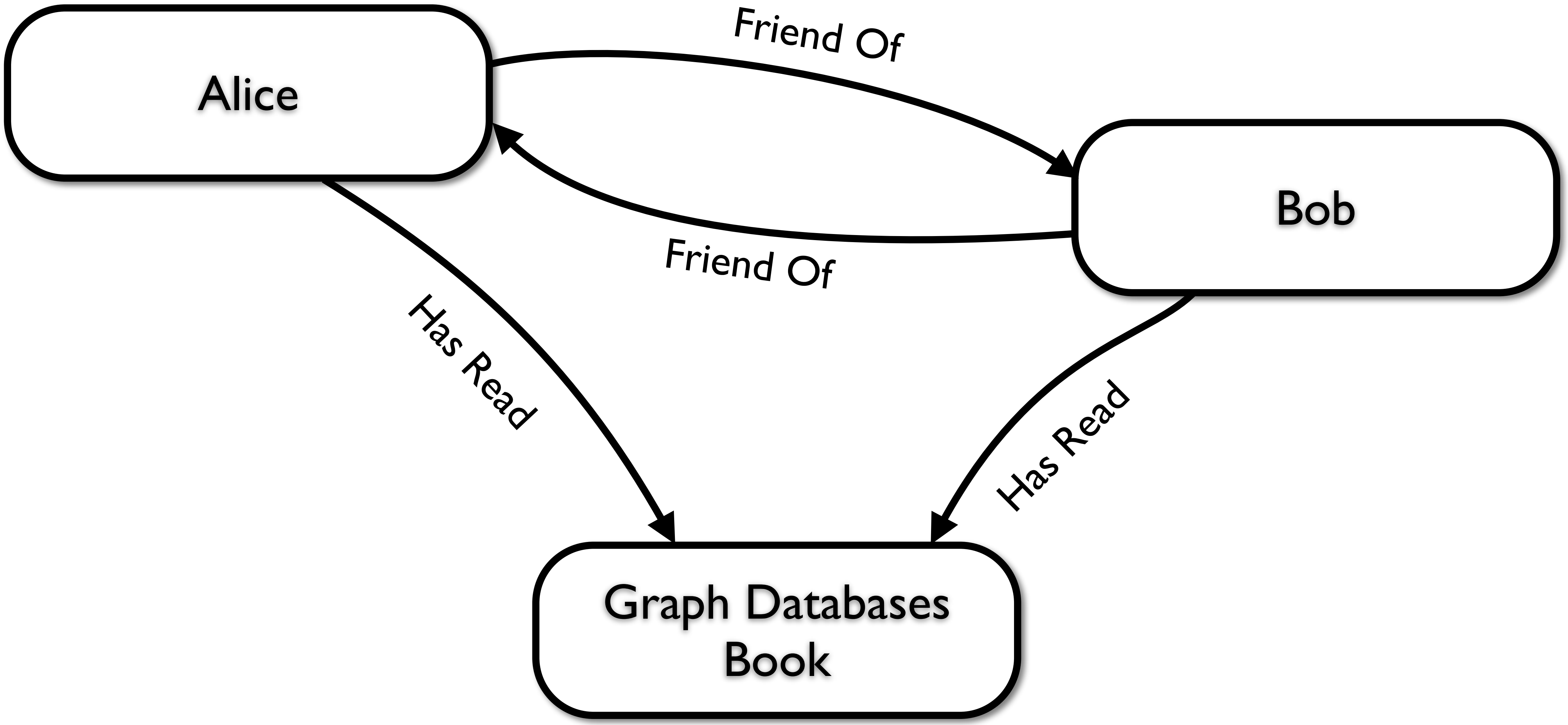
Leonhard Euler 1707-1783

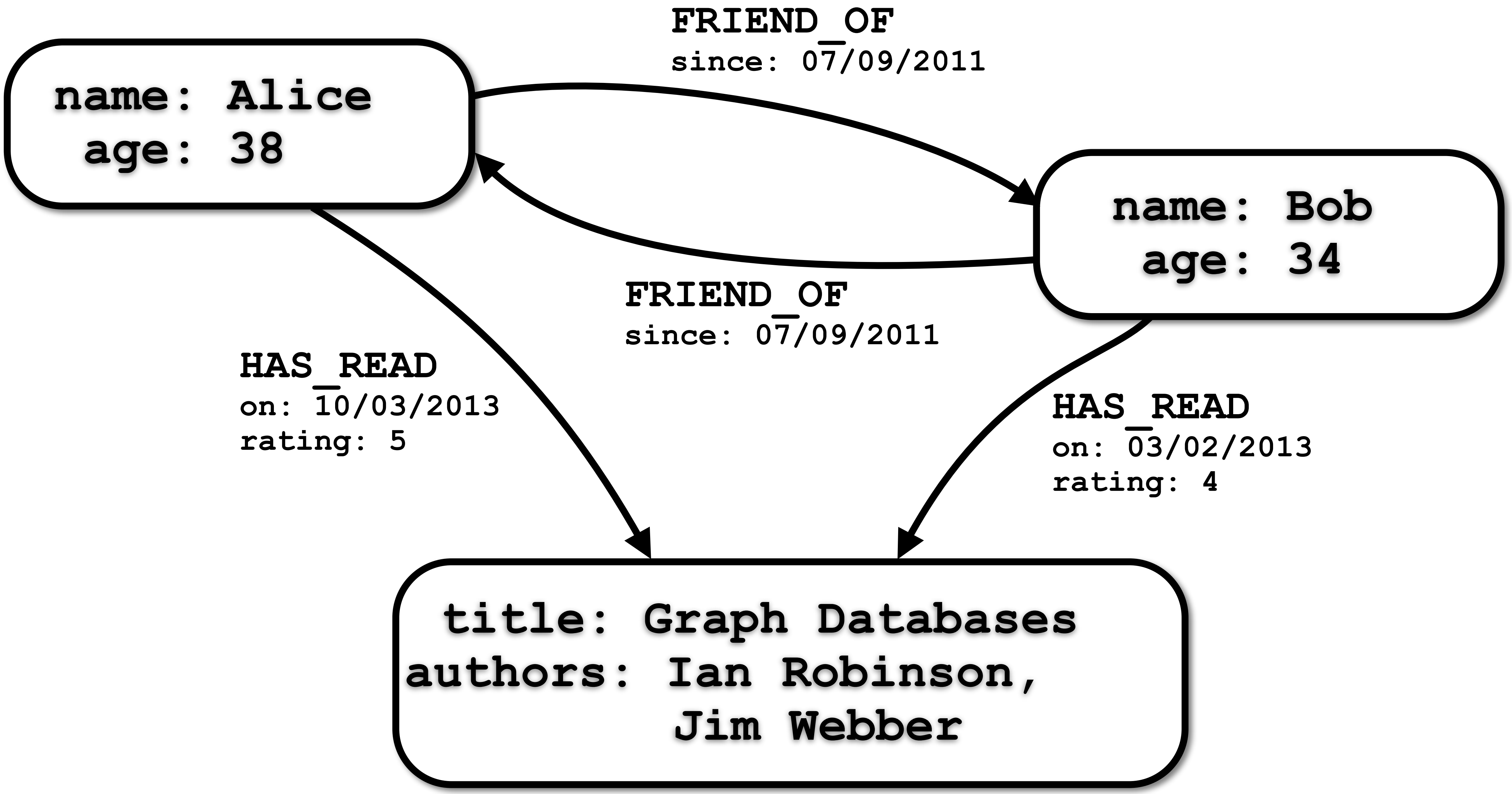
Königsberg (Prussia) - 1736



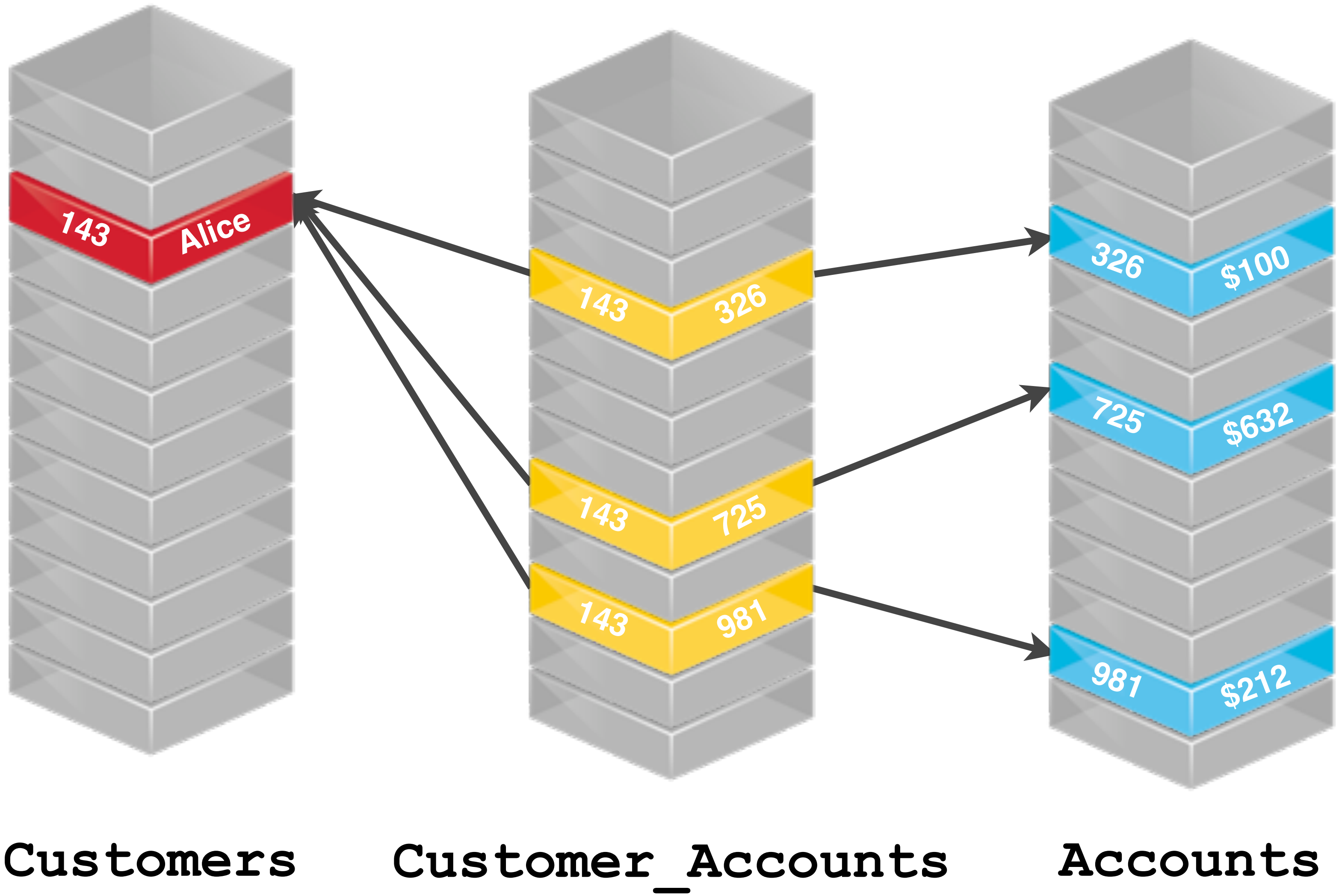

1
A
4
2
B
3
C
6
5
7
D

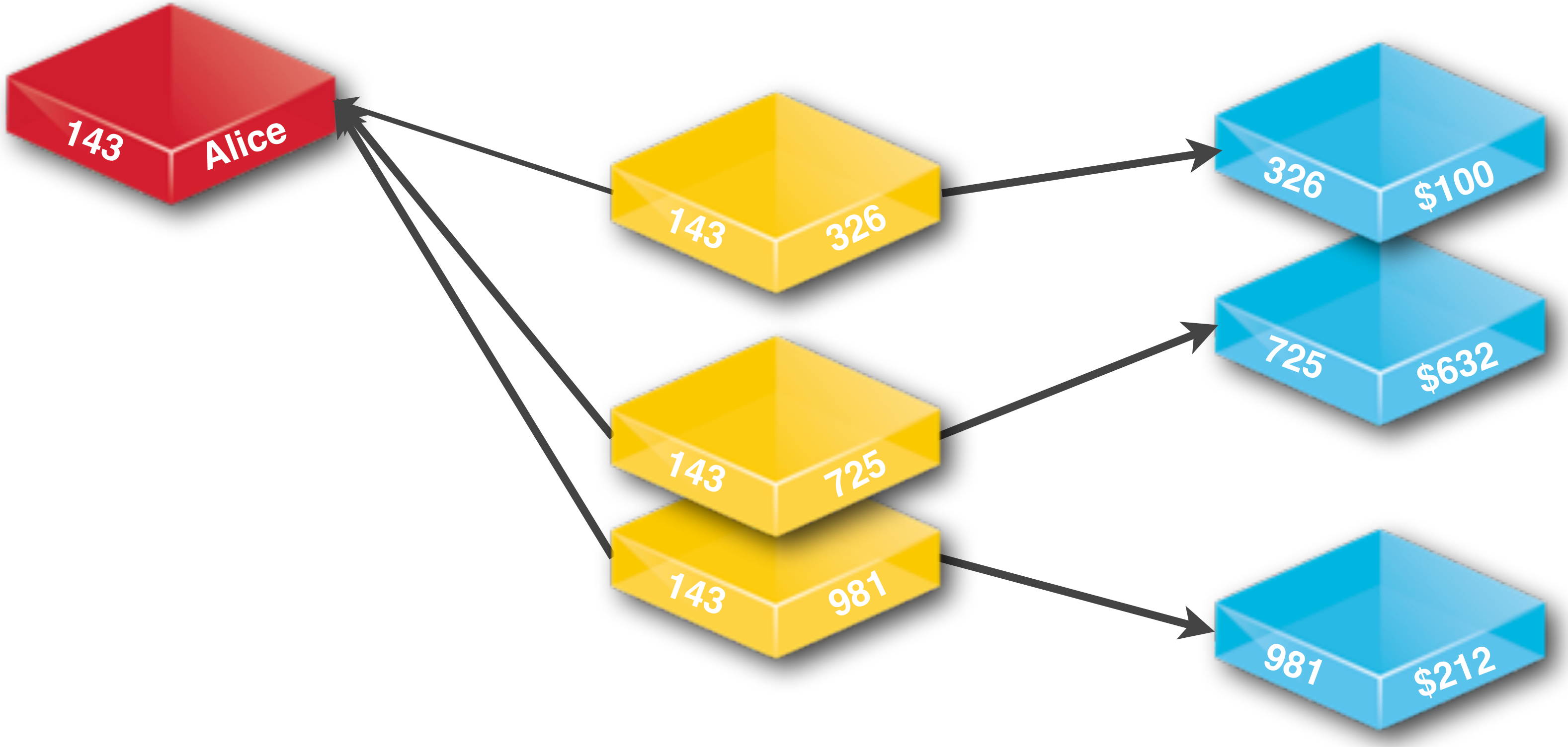
So what about data?

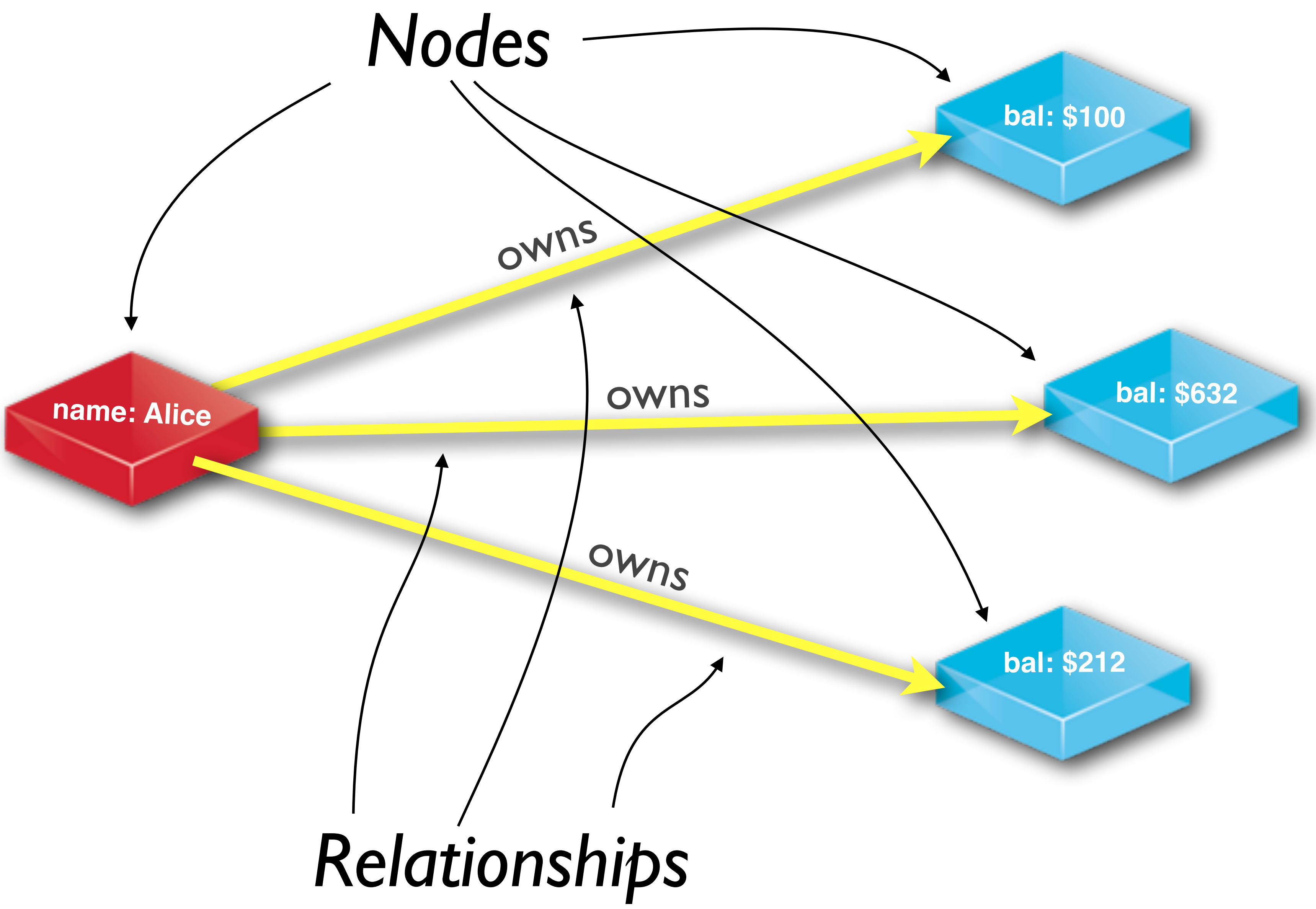

Alice
Friend Of
Bob
Friend Of
Has Read
Has Read
Graph Databases
Book


FRIEND_OF
since: 07/09/2011
name: Alice
age: 38
name: Bob
age: 34
FRIEND_OF
since: 07/09/2011
HAS_READ
on: 10/03/2013
rating: 5
HAS_READ
on: 03/02/2013
rating: 4
title: Graph Databases
authors: Ian Robinson,
Jim Webber

Segue: Graphs in a Relational World

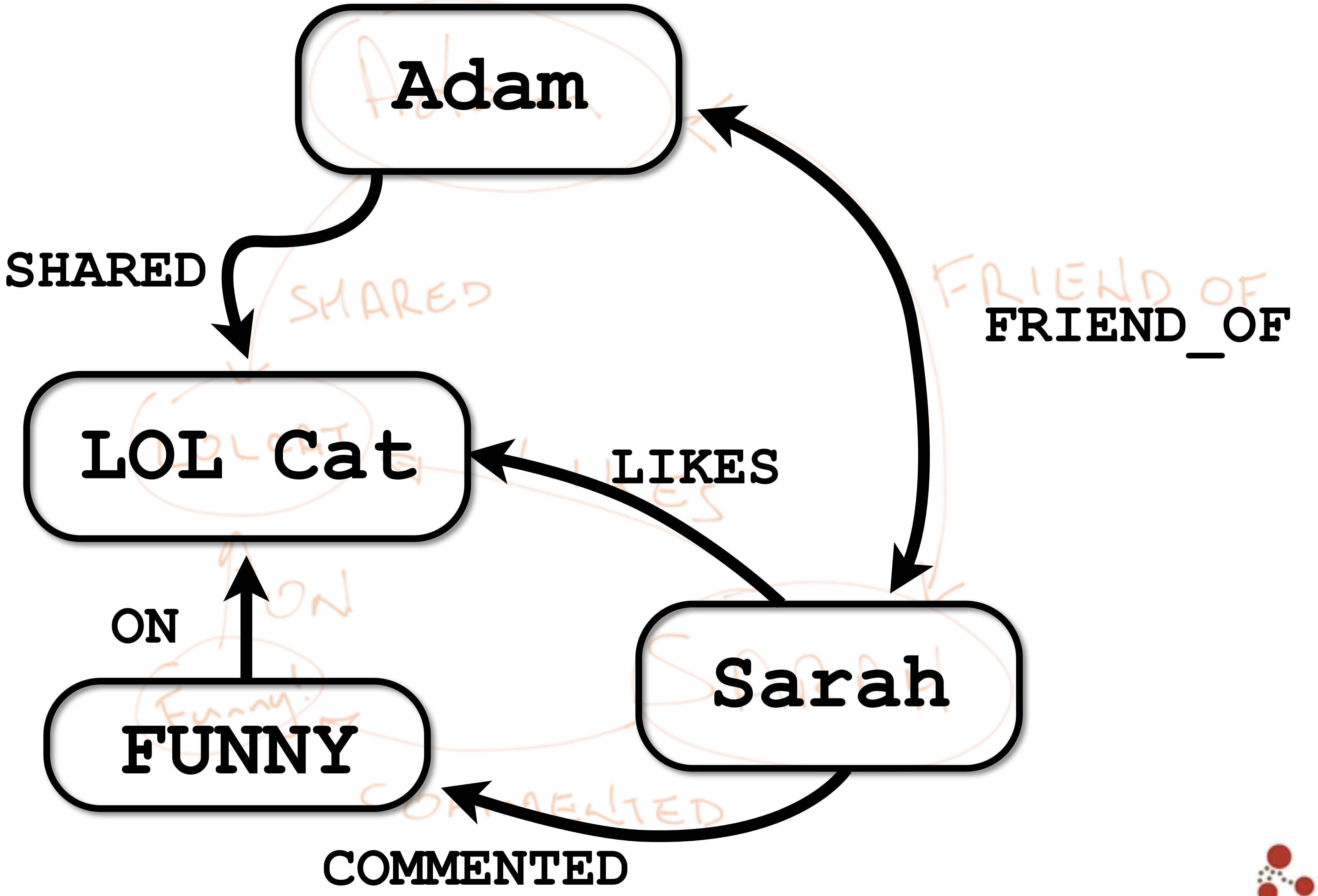

143
Alice
143
326
143
725
143
981
326
$100
725
$632
981
$212
Customers
Customer_Accounts
Accounts

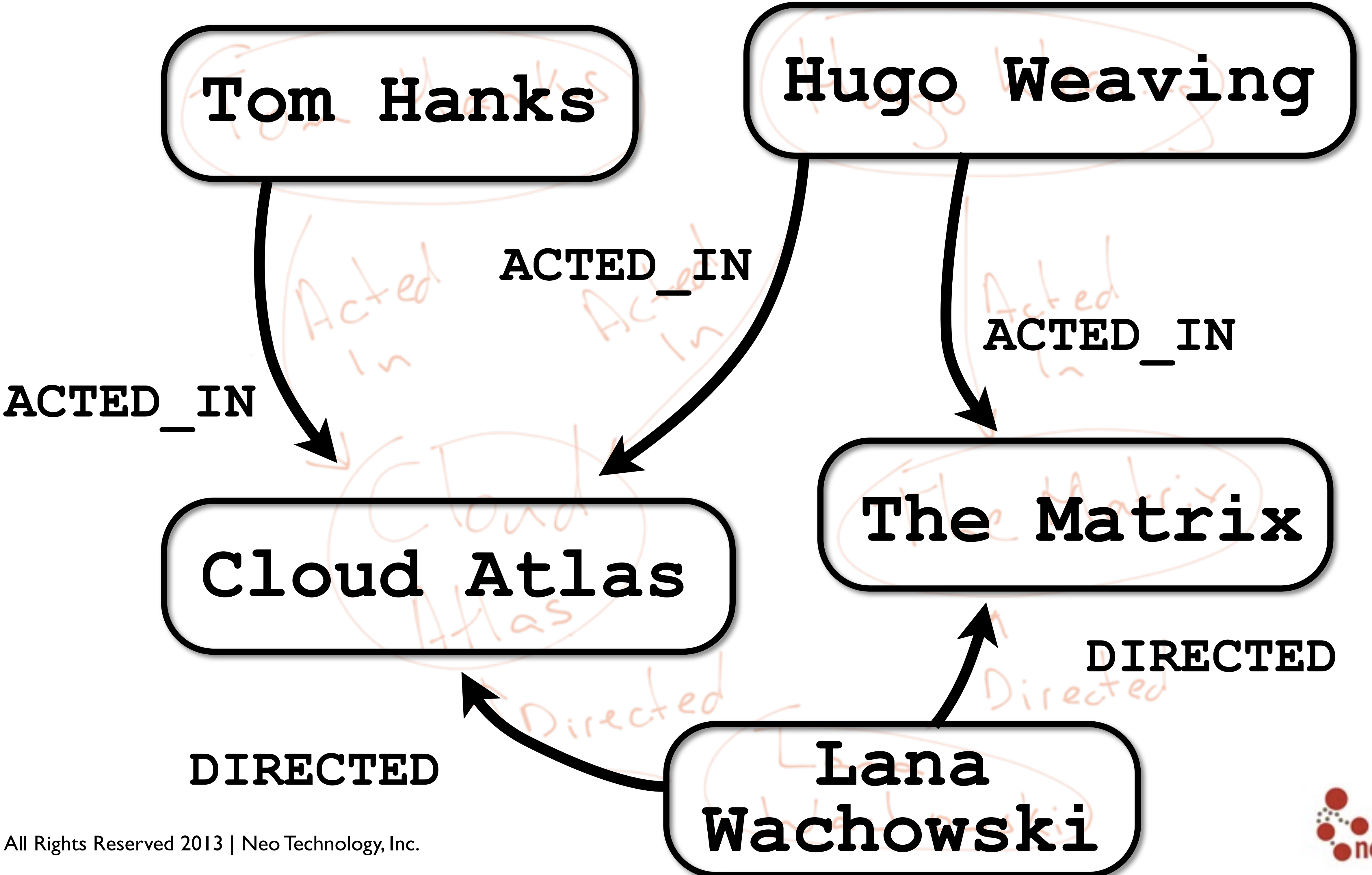

143
Alice
143
326
143
725
143
981
326
$100
725
$632
981
$212


Nodes
bal: $100
owns
name: Alice
owns
bal: $632
owns
bal: $212
Relationships

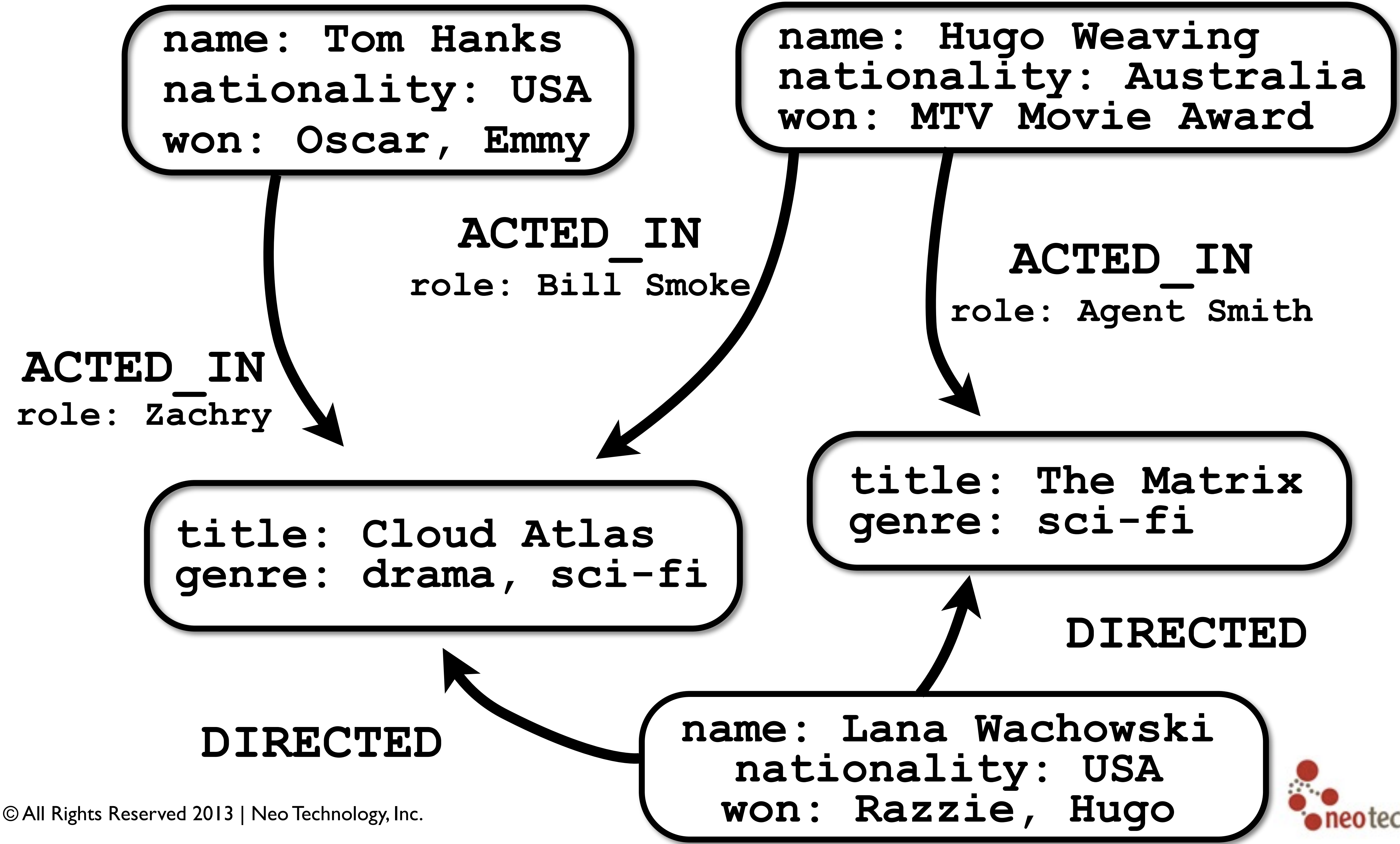
(Modeling with Graphs)

Start with a whiteboard


Adam
SHARED
FRIEND_OF
LOL Cat
LIKES
ON
Sarah
FUNNY
COMMENTED


Tom Hanks
Hugo Weaving
ACTED_IN
ACTED_IN
ACTED_IN
Cloud Atlas
The Matrix
DIRECTED
DIRECTED
Lana Wachowski

Model Incrementally


name: Tom Hanks
nationality: USA
won: Oscar, Emmy
name: Hugo Weaving
nationality: Australia
won: MTV Movie Award
ACTED_IN
role: Zachry
ACTED_IN
role: Bill Smoke
ACTED_IN
role: Agent Smith
title: Cloud Atlas
genre: drama, sci-fi
title: The Matrix
genre: sci-fi
DIRECTED
DIRECTED
name: Lana Wachowski
nationality: USA
won: Razzie, Hugo

(Brief tour of Neo4j)

`bin/neo4j`	neo4j itself
`bin/neo4j-shell`	a command-line shell
`conf/`	configuration files
`data/`	graph data, logs

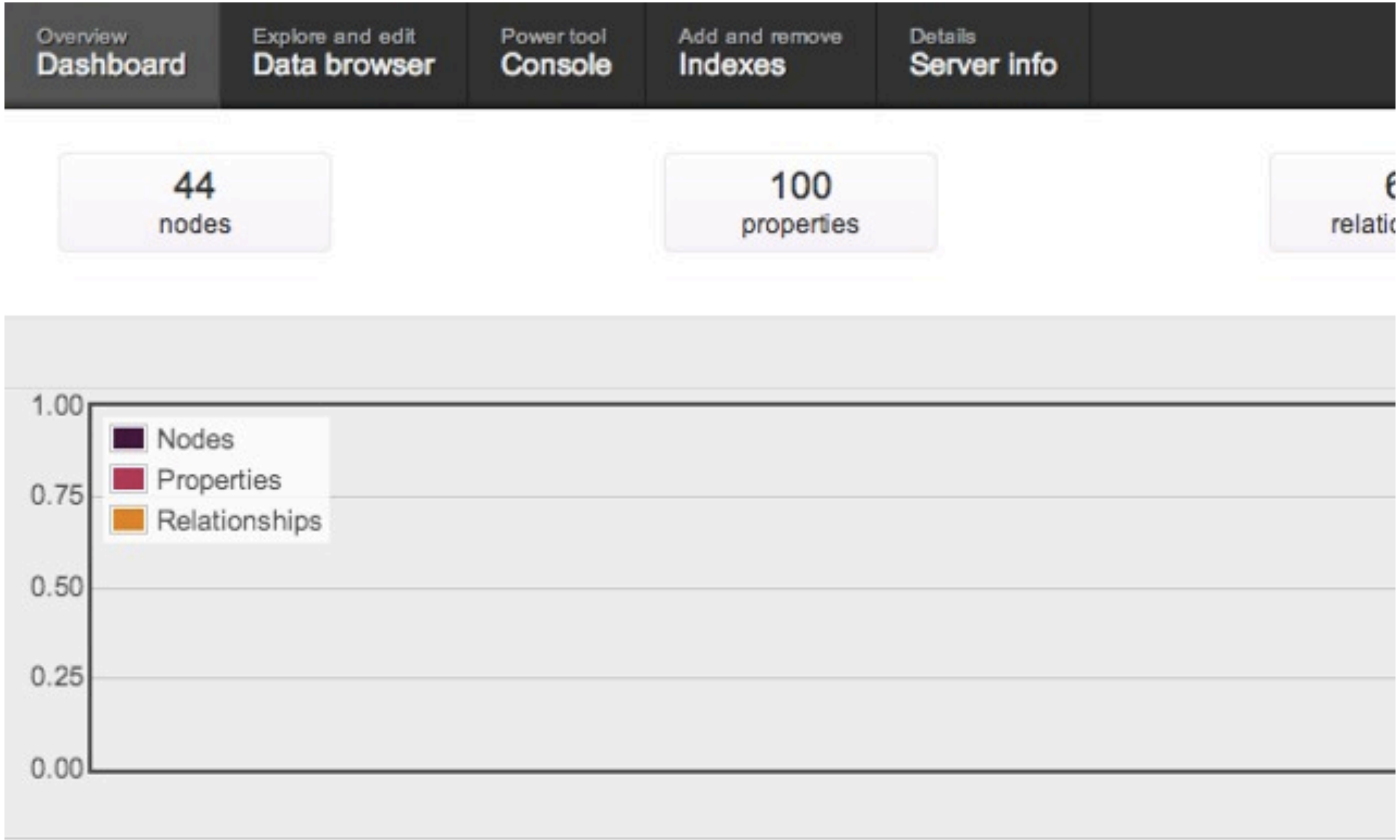
Mac OS X

1. `./bin/neo4j start`
2. `./bin/neo4j-shell < sample/movies.cyp`
3. `open http://localhost:7474/`

Windows

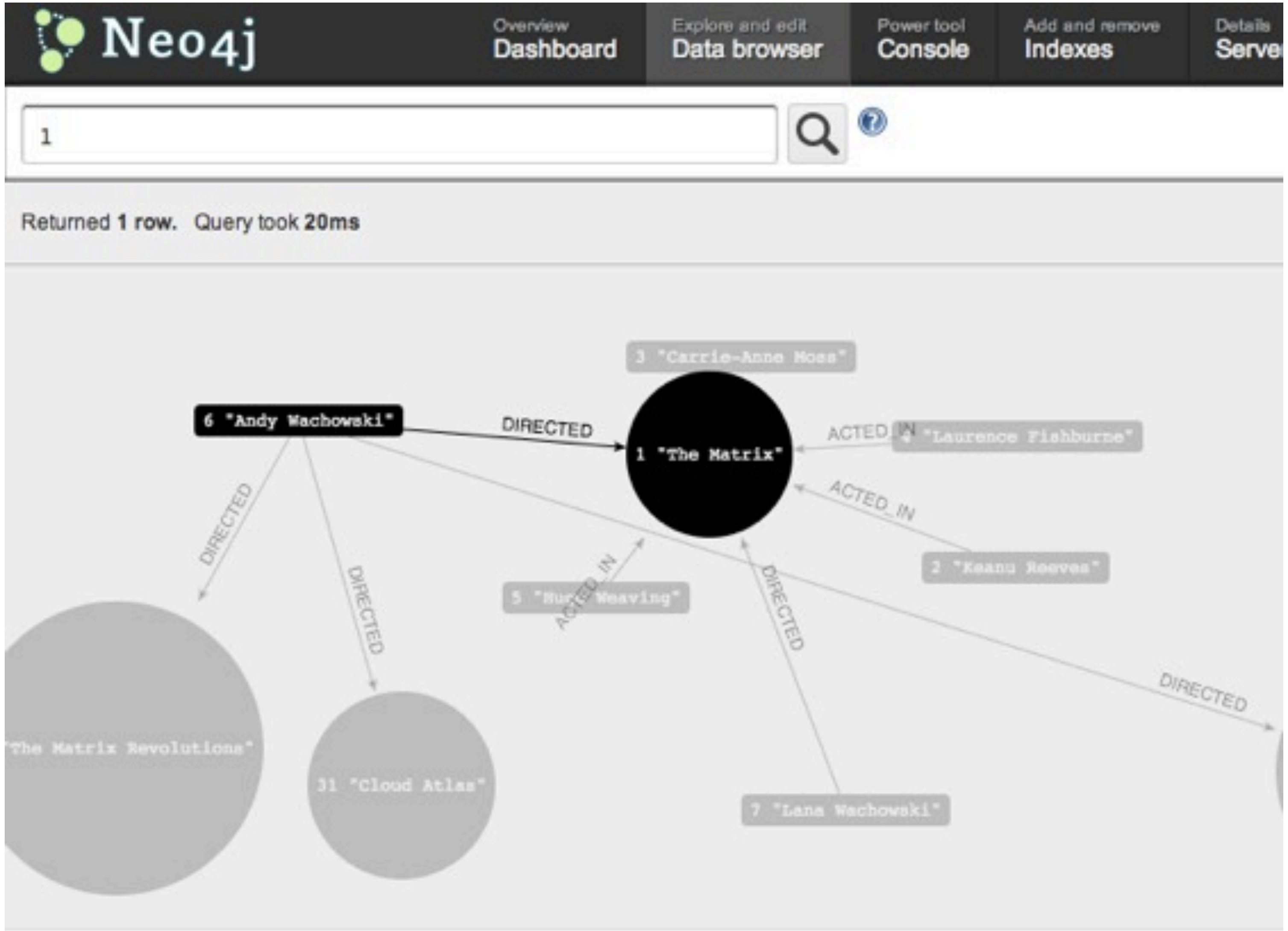
1. `bin\neo4j start`
2. `java -jar gumdrop.jar --file sample\movies.cyp`
3. `start http://localhost:7474/`

Neo4j Dashboard - for monitoring of key stats



http://localhost:7474/

Neo4j Data browser - to inspect or visualize data



http://localhost:7474/

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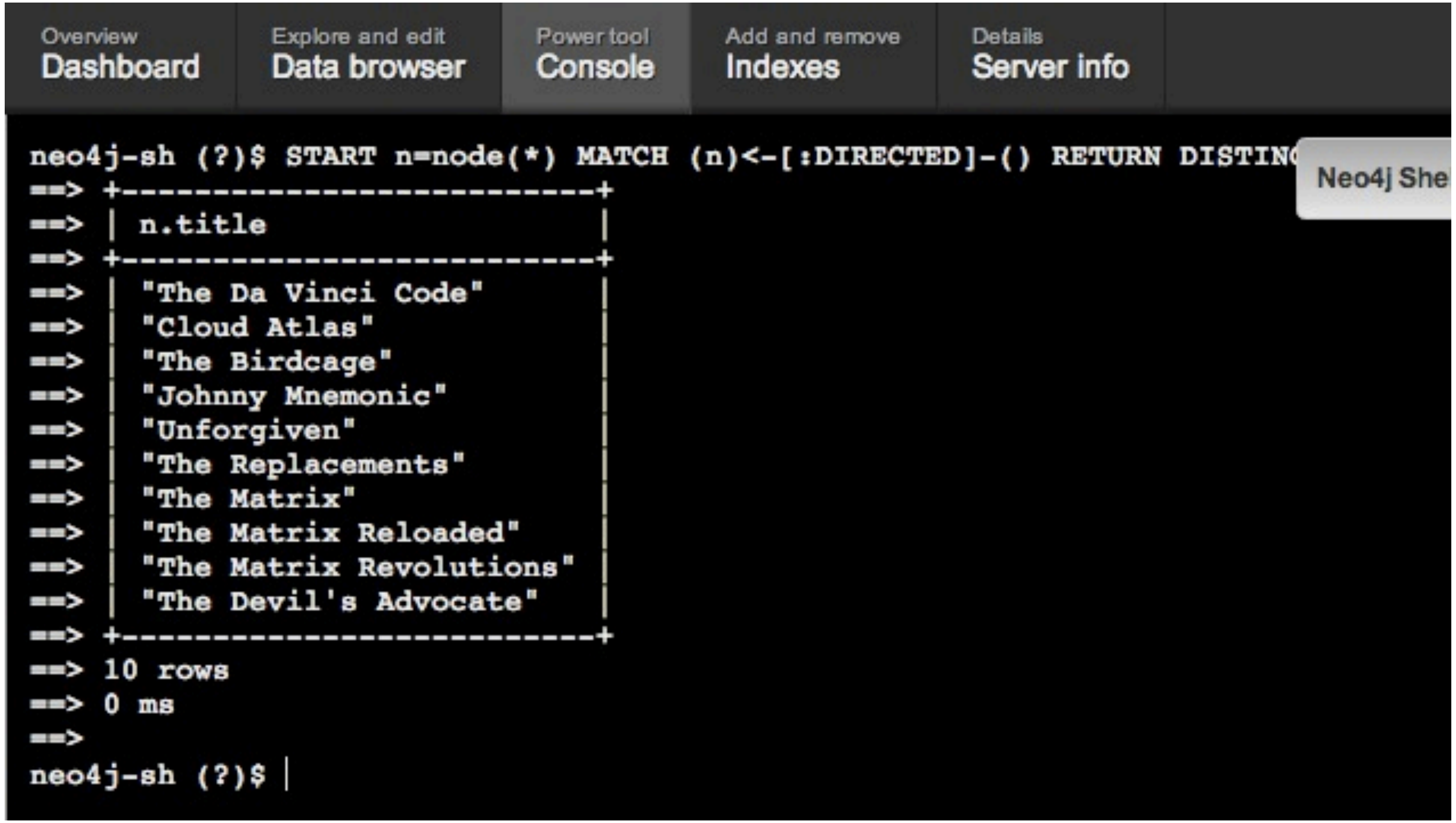
Neo4j Console - for running commands and queries



http://localhost:7474/

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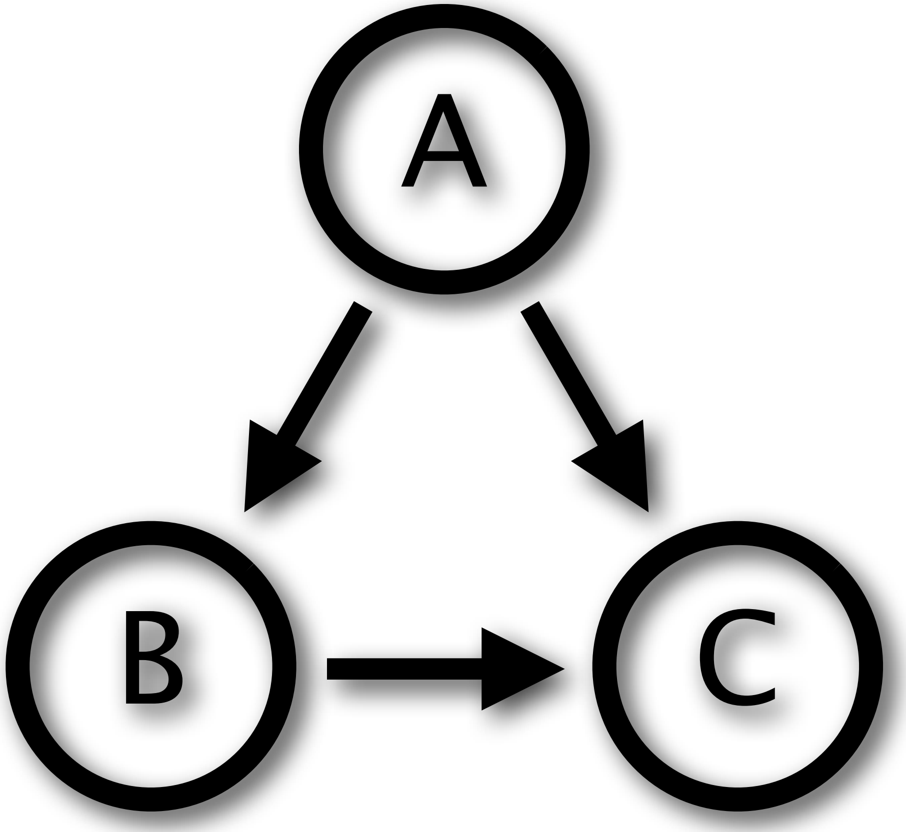
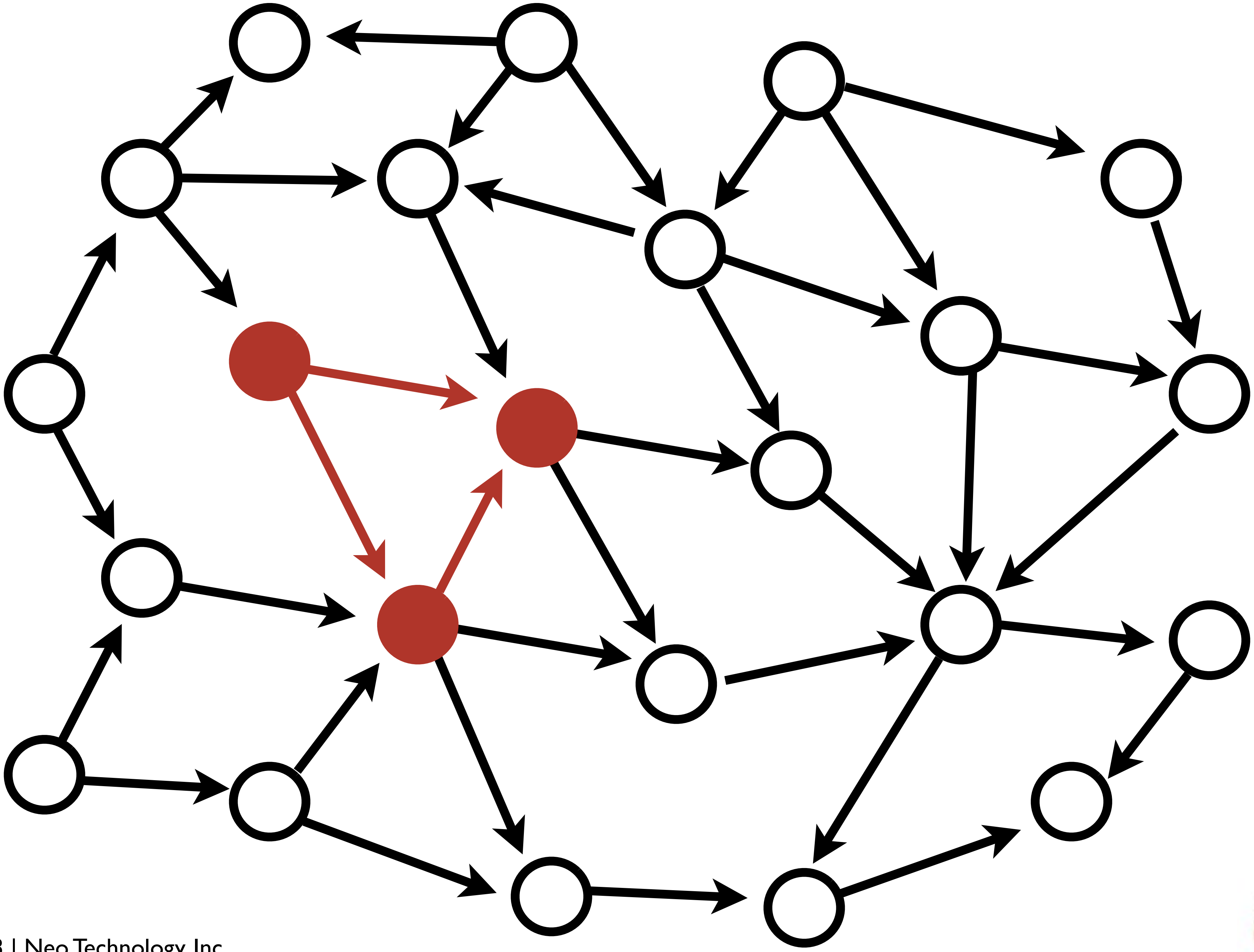
(Introduction to Cypher)

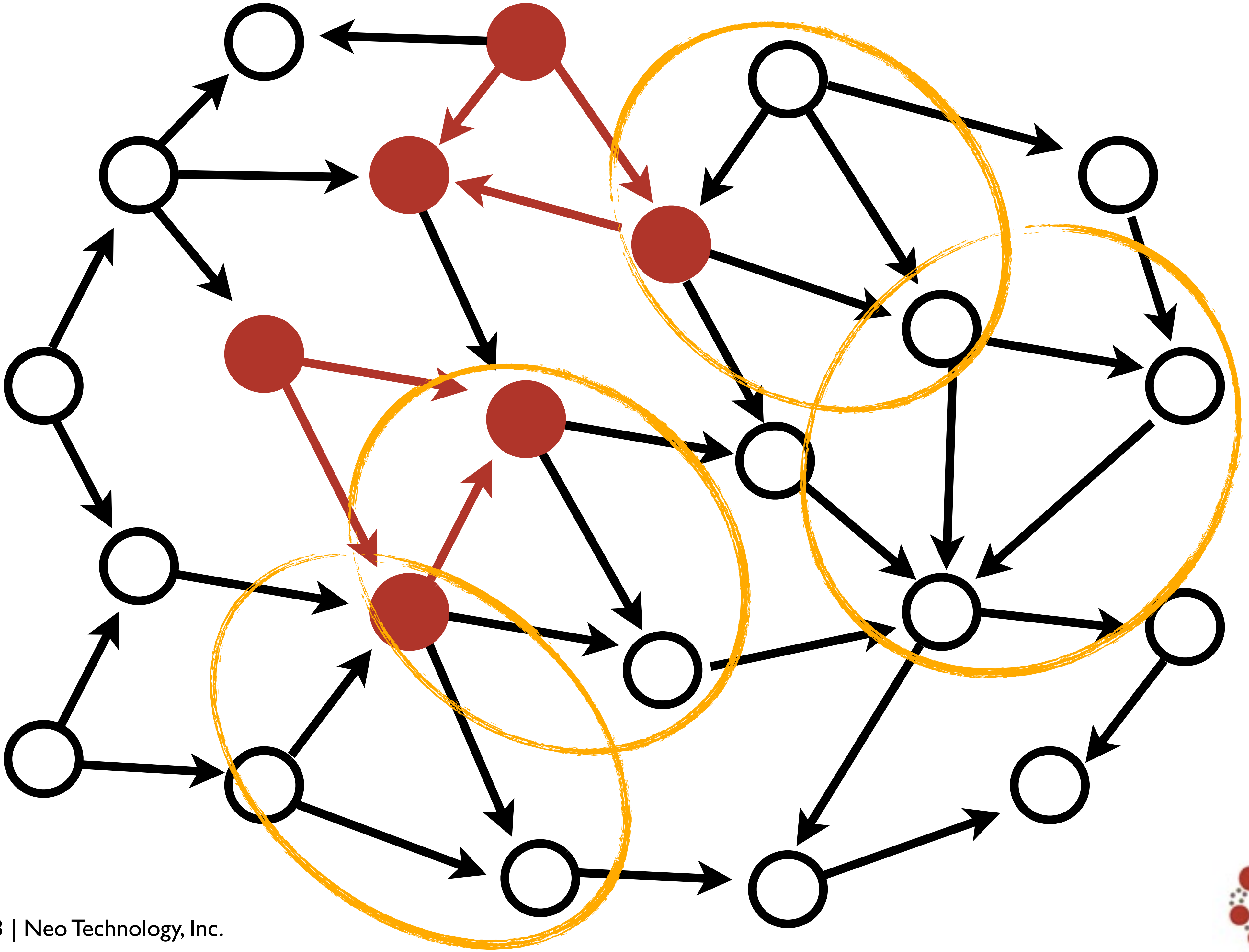
Cypher is Neo4j's graph query language

- Declarative Pattern-Matching language
- SQL-like syntax
- Designed for graphs

It's all about Patterns







How?

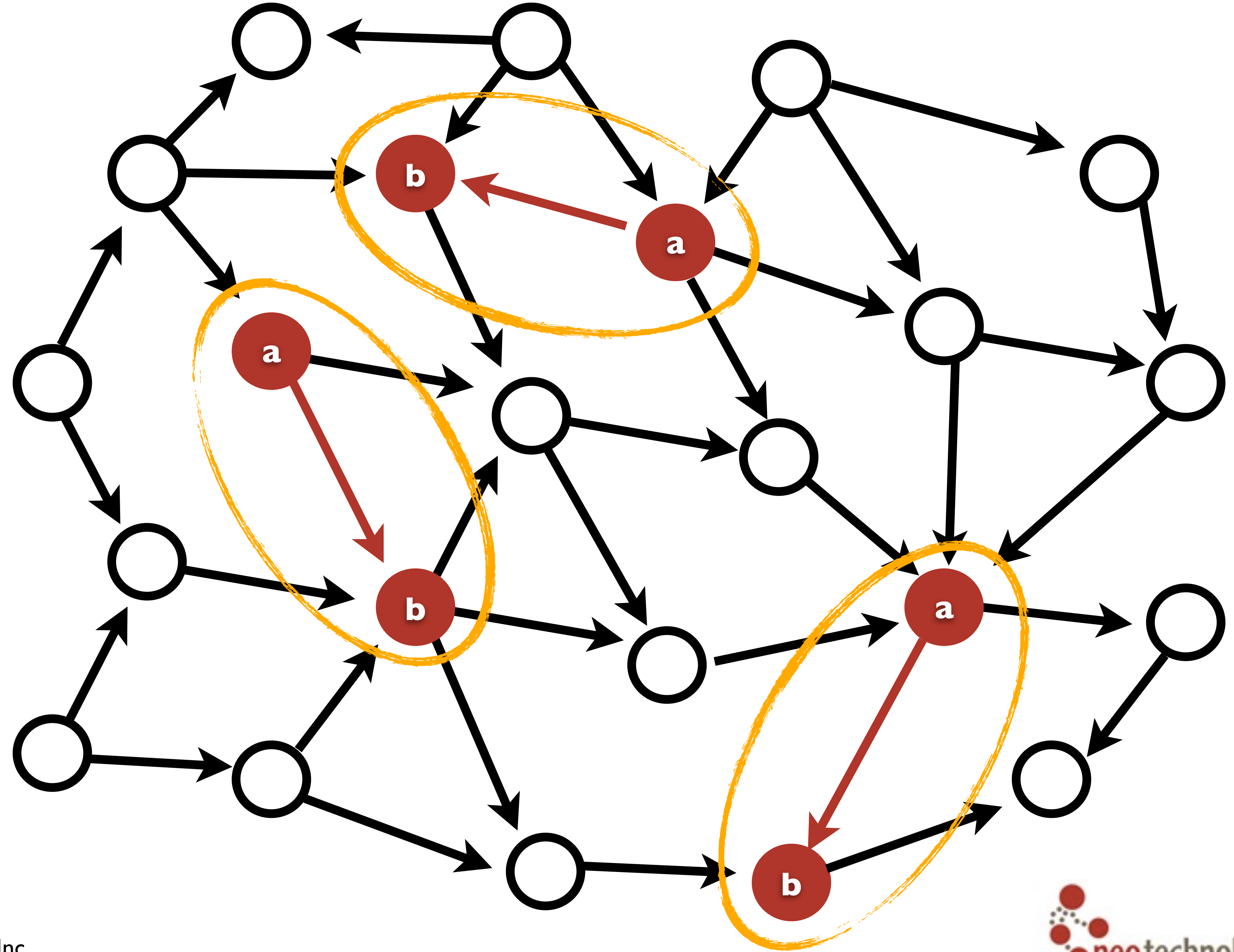
Two nodes, one relationship

(a) --> (b)

Two nodes, one relationship

```
START a=node(*)
MATCH (a)-->(b)
RETURN a, b;
```

```
START a=node(*)
MATCH (a)-->(b)
RETURN a, b;
```



Two nodes, one relationship


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

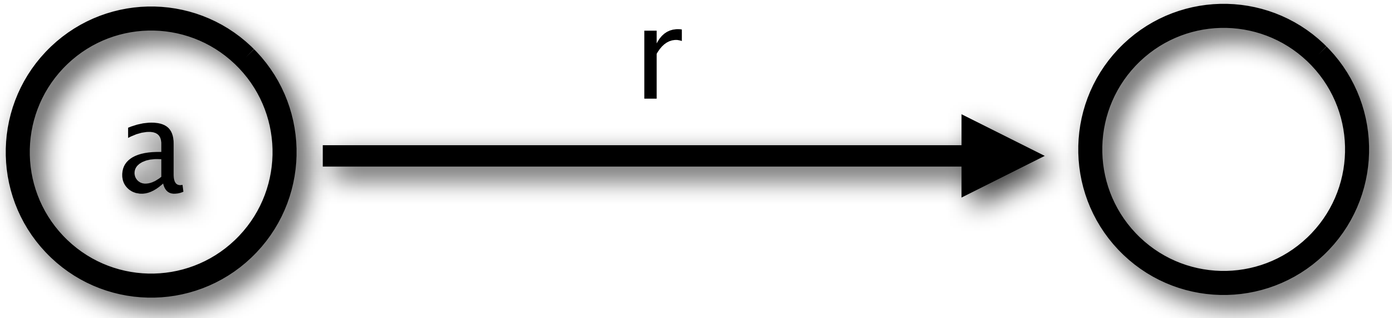
Two nodes, one relationship

```
START a=node(*)
MATCH (a)-->()
RETURN a;
```

Two nodes, one relationship

```
START a=node(*)
MATCH (a)-->()
RETURN a.name;
```

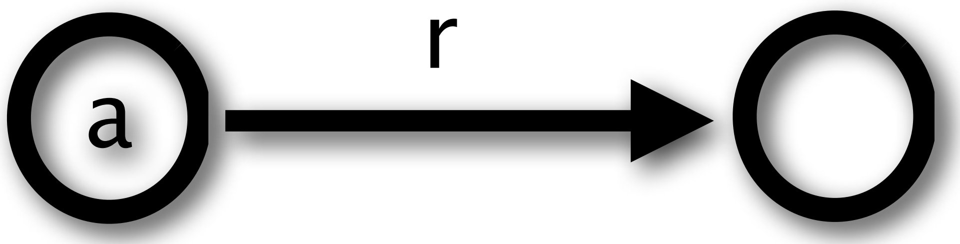
Two nodes, one relationship




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

Two nodes, one relationship

```
START a=node(*)
MATCH (a)-[r]->()
RETURN a.name, type(r);
```



Two nodes, one relationship


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

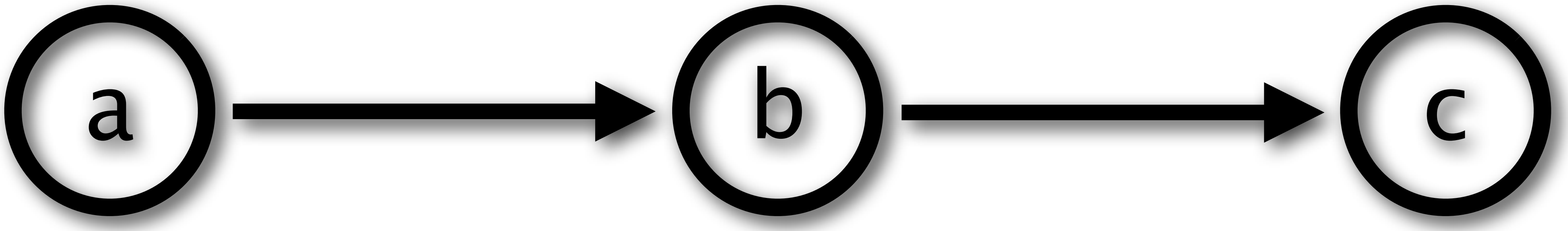
Two nodes, one relationship

```
START a=node(*)
MATCH (a)-[:ACTED_IN]->(b)
RETURN a.name, b.title;
```

Two nodes, one relationship

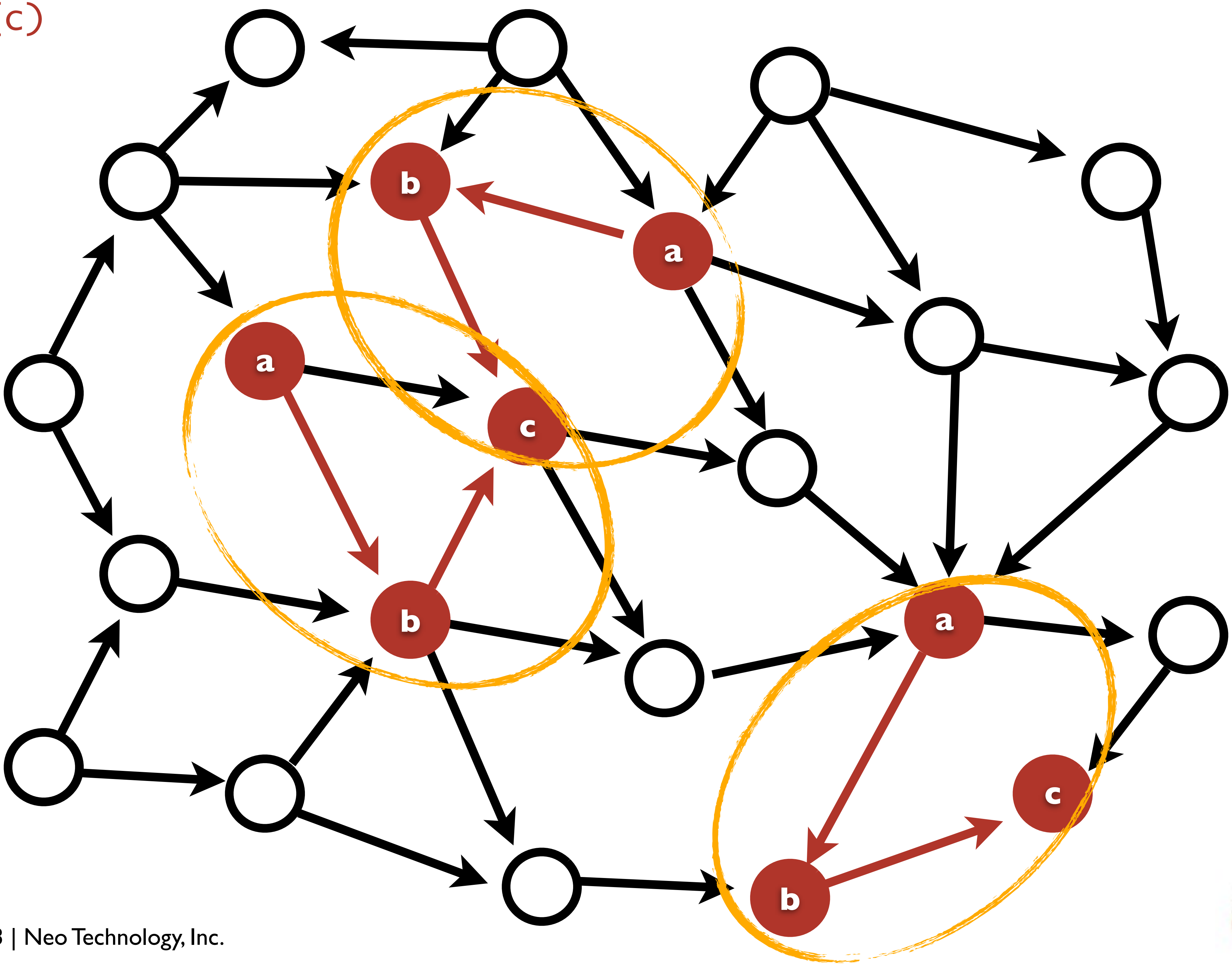
```
START a=node(*)
MATCH (a)-[r:ACTED_IN]->(b)
RETURN a.name, r.roles, b.title;
```

Paths

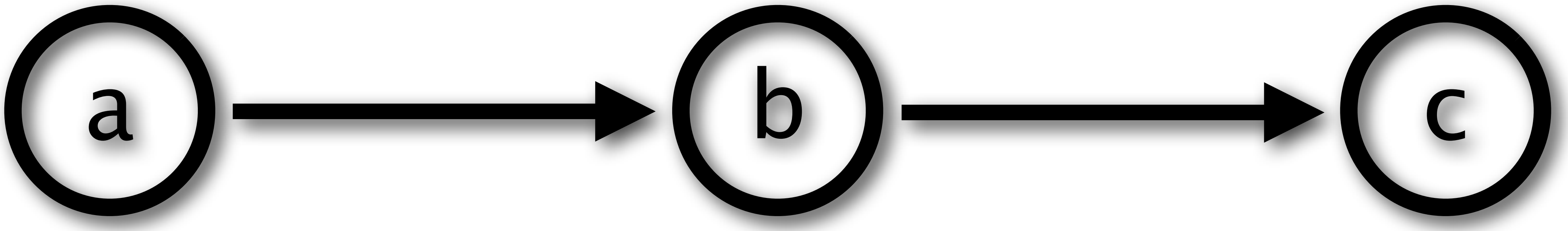


(a)-->(b)-->(c)

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

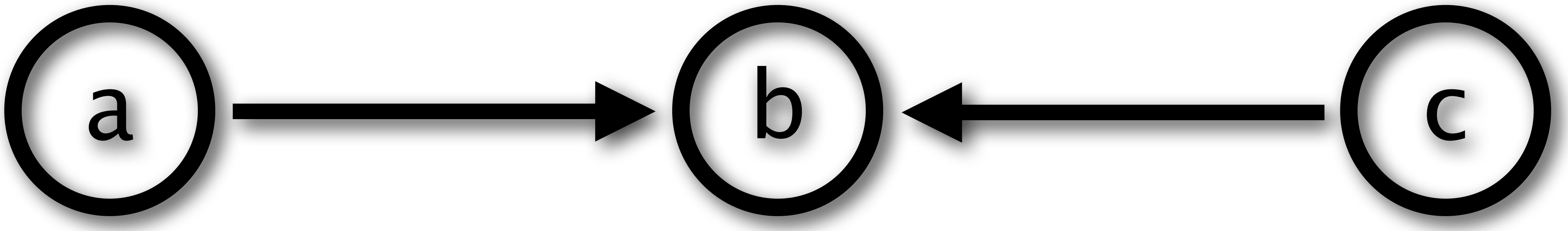


Paths



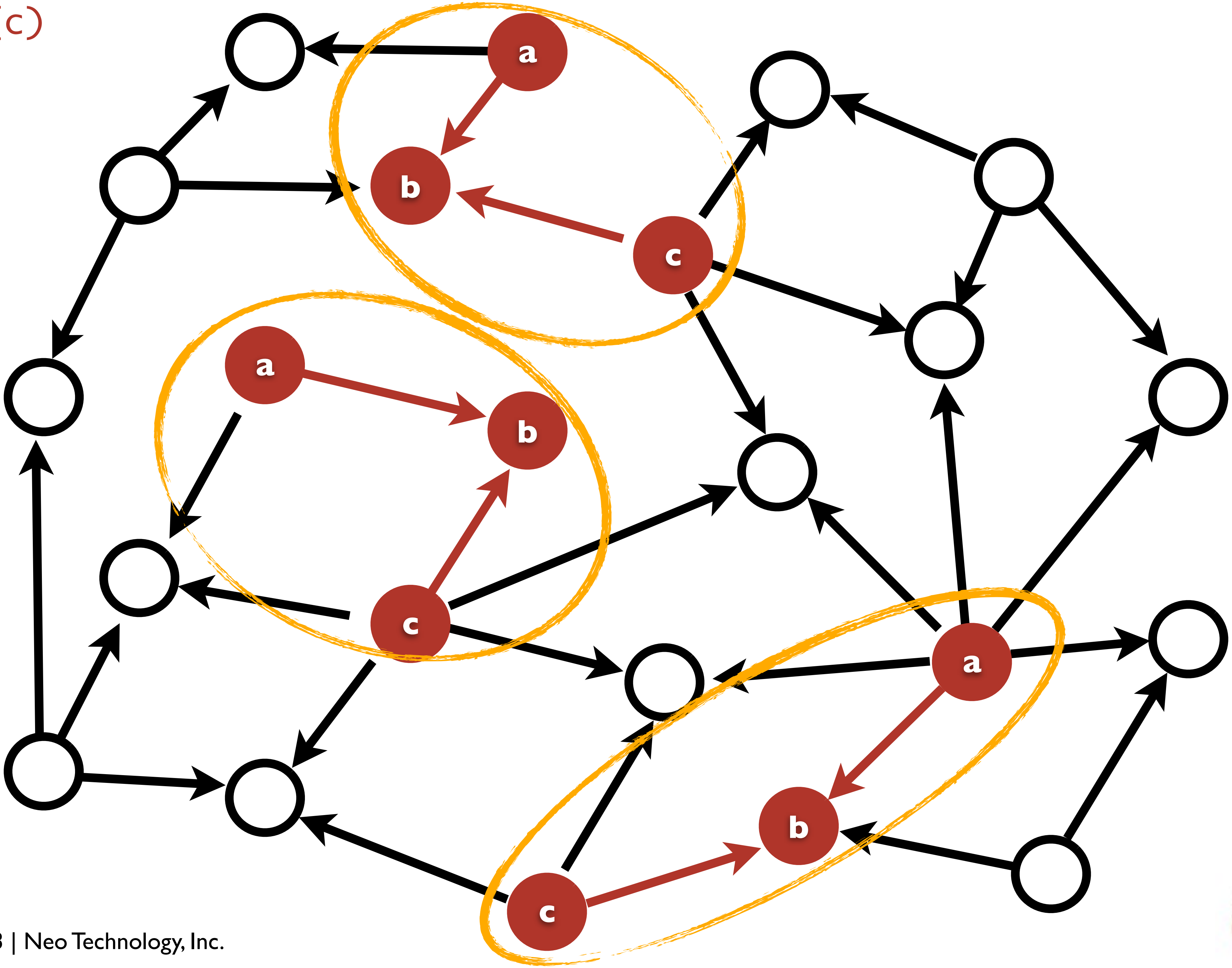
(a)-->(b)-->(c)

Paths



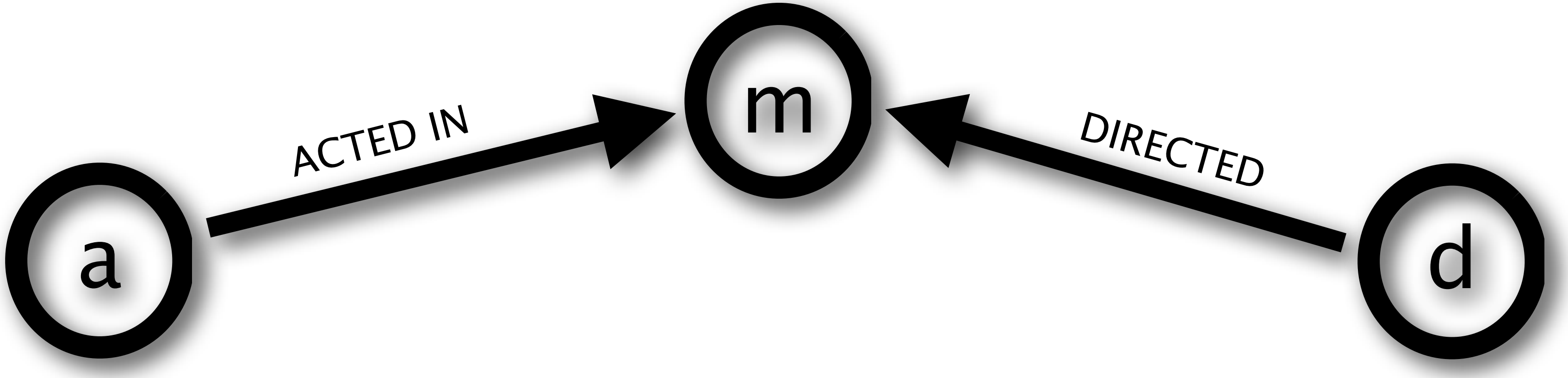
(a)-->(b)<--(c)

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

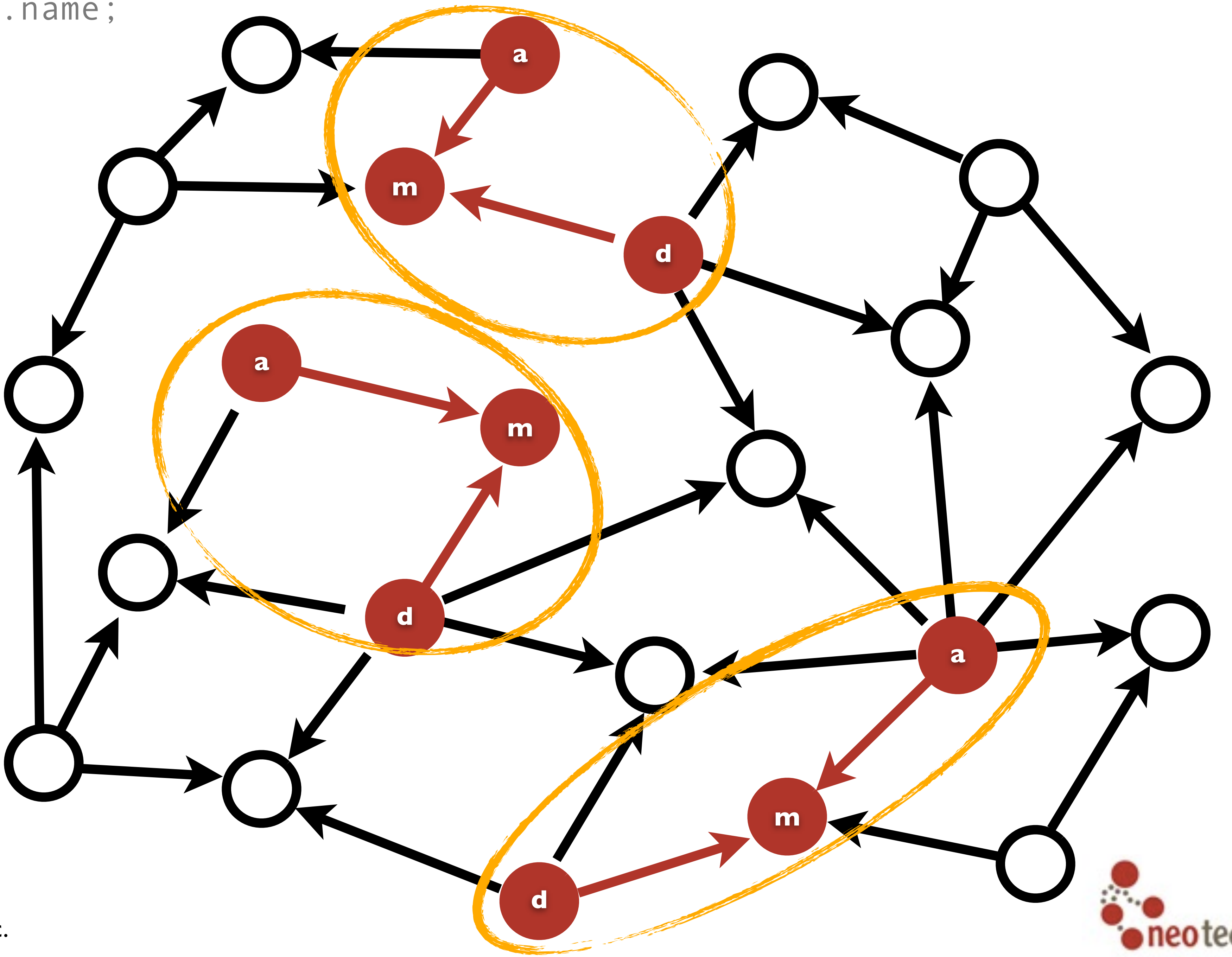


Paths

```
START a=node(*)
MATCH (a)-[:ACTED_IN]->(m)<-[:DIRECTED]-(d)
RETURN a.name, m.title, d.name;
```



```
START a=node(*)
MATCH (a)-[:ACTED_IN]->(m)<-[:DIRECTED]-(d)
RETURN a.name, m.title, d.name;
```



Paths

```
START a=node(*)
MATCH (a)-[:ACTED_IN]->(m)<-[:DIRECTED]-(d)
RETURN a.name, m.title, d.name;
```

a.name	m.title	d.name
“Keanu Reeves”	“The Matrix”	“Andy Wachowski”
“Keanu Reeves”	“The Matrix Reloaded”	“Andy Wachowski”
“Noah Wyle”	“A Few Good Men”	“Rob Reiner”
“Tom Hanks”	“Cloud Atlas”	“Andy Wachowski”
…	…	…

Paths

```
START a=node(*)
MATCH (a)-[:ACTED_IN]->(m)<-[:DIRECTED]-(d)
RETURN a.name AS actor, m.title AS movie,
       d.name AS director;
```

actor	movie	director
“Keanu Reeves”	“The Matrix”	“Andy Wachowski”
“Keanu Reeves”	“The Matrix Reloaded”	“Andy Wachowski”
“Noah Wyle”	“A Few Good Men”	“Rob Reiner”
“Tom Hanks”	“Cloud Atlas”	“Andy Wachowski”
…	…	…

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Paths

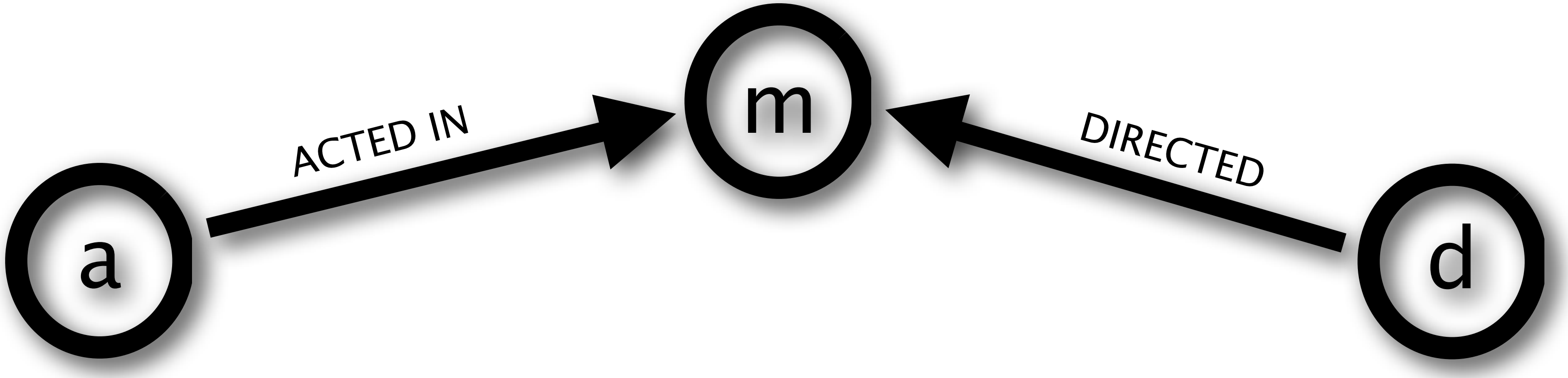
```
START a=node(*)
MATCH (a)-[:ACTED_IN]->(m), (m)<-[:DIRECTED]-(d)
RETURN a.name, m.title, d.name;
```

Paths

```
START a=node(*)
MATCH (a)-[:ACTED_IN]->(m), (d)-[:DIRECTED]->(m)
RETURN a.name, m.title, d.name;
```

Paths

```
START a=node(*)
MATCH p=(a)-[:ACTED_IN]->(m)<-[:DIRECTED]-(d)
RETURN p;
```



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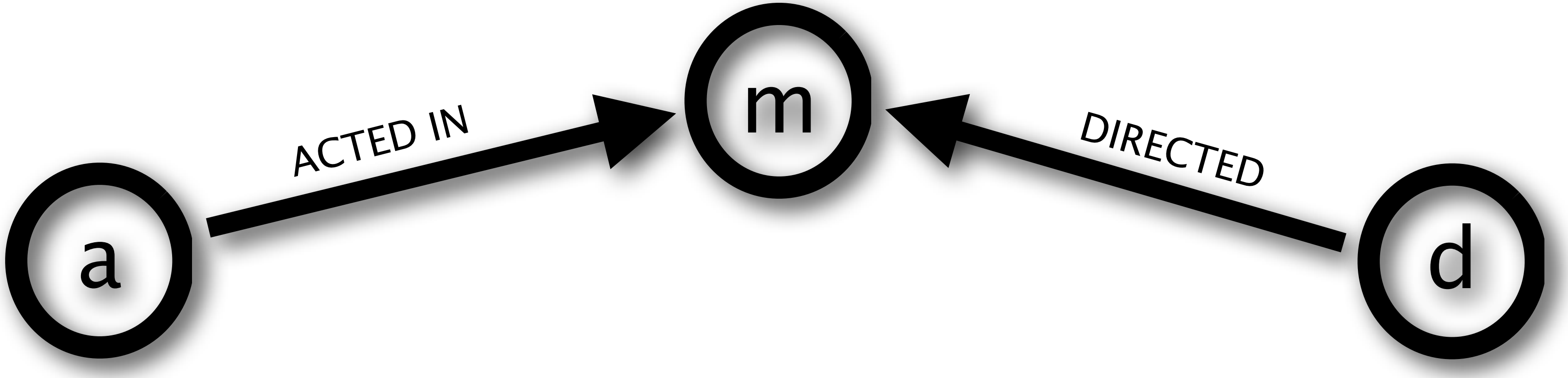
Paths

```
START a=node(*)
MATCH p=(a)-[:ACTED_IN]->(m)<-[:DIRECTED]-(d)
RETURN nodes(p);
```



Paths

```
START a=node(*)
MATCH p1=(a)-[:ACTED_IN]->(m), p2=(d)-[:DIRECTED]->(m)
RETURN p1, p2;
```

Aggregation

```
START a=node(*)
MATCH (a)-[:ACTED_IN]->(m)<-[:DIRECTED]-(d)
RETURN a.name, m.title, d.name;
```

a.name	m.title	d.name
“Keanu Reeves”	“The Matrix”	“Andy Wachowski”
“Keanu Reeves”	“The Matrix Reloaded”	“Andy Wachowski”
“Noah Wyle”	“A Few Good Men”	“Rob Reiner”
“Tom Hanks”	“Cloud Atlas”	“Andy Wachowski”
…	…	…

Aggregation

```
START a=node(*)
MATCH (a)-[:ACTED_IN]->(m)<-[:DIRECTED]-(d)
RETURN a.name, d.name, count(*);
```

a.name	d.name	count(*)
"Aaron Sorkin"	"Rob Reiner"	2
"Keanu Reeves"	"Andy Wachowski"	3
"Hugo Weaving"	"Tom Tykwer"	1
...	...	...

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Aggregation

```
START a=node(*)
MATCH (a)-[:ACTED_IN]->(m)<-[:DIRECTED]-(d)
RETURN a.name, d.name, count(m);
```

a.name	d.name	count(m)
“Aaron Sorkin"	“Rob Reiner”	2
“Keanu Reeves”	“Andy Wachowski”	3
“Hugo Weaving”	“Tom Tykwer”	1
…	…	…

LAB

Which directors also acted in their movie?

```
START d=node(*)
MATCH (d)-[:DIRECTED]->(m)<-[:ACTED_IN]-(d)
RETURN d.name, m.title;
```

Unique relationships in paths

```
START a=node(*)
MATCH (a)-[:ACTED_IN]->(m)<-[:ACTED_IN]-(a)
RETURN a.name, m.title;
```

Sort & Limit

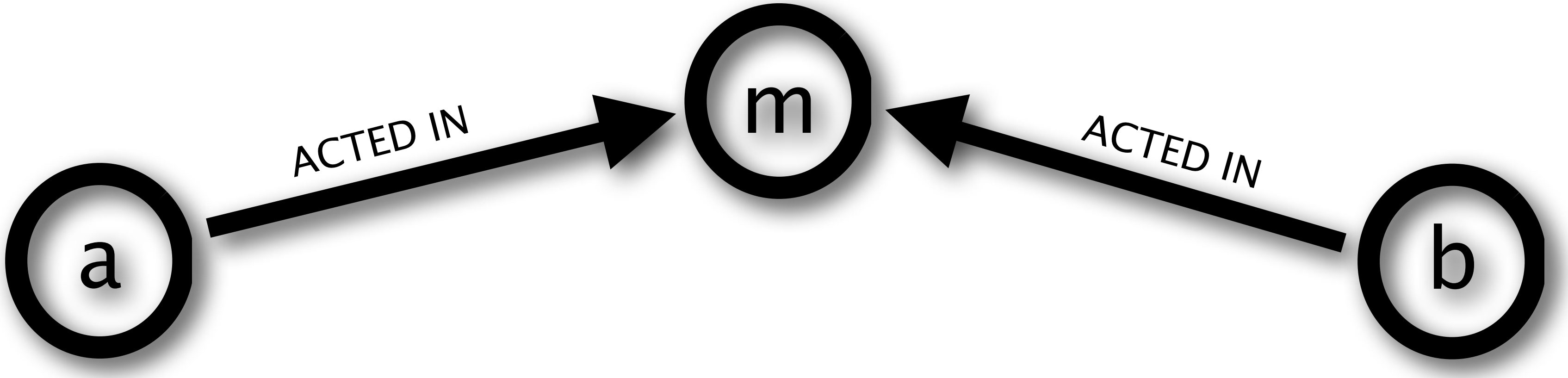
```
START a=node(*)
MATCH (a)-[:ACTED_IN]->(m)<-[:DIRECTED]-(d)
RETURN a.name, d.name, count(*) AS count
ORDER BY(count) DESC
LIMIT 5;
```

Aggregation

`count(x)`	*- add up the number of occurrences*
`min(x)`	*- get the lowest value*
`max(x)`	*- get the highest value*
`avg(x)`	*- get the average of a numeric value*
`collect(x)`	*- collected all the occurrences into an array*

Aggregation

```
START a=node(*)
MATCH (a)-[:ACTED_IN]->(m)<-[:DIRECTED]-(d)
RETURN a.name, d.name, collect(m.title);
```



Starting somewhere

All-nodes Query

```
START n=node(*) RETURN n;
```

```
START - clause for looking up starting points
node(*) - all nodes in the graph
RETURN n - clause to specify data to return
```

Find a specific node (all-node query)

```
START n=node(*)
WHERE has(n.name) AND n.name = "Keanu Reeves"
RETURN n;
```

```
WHERE - filter the results
has(n.name) - the name property must exist
n.name = "Keanu Reeves" - and have that value
```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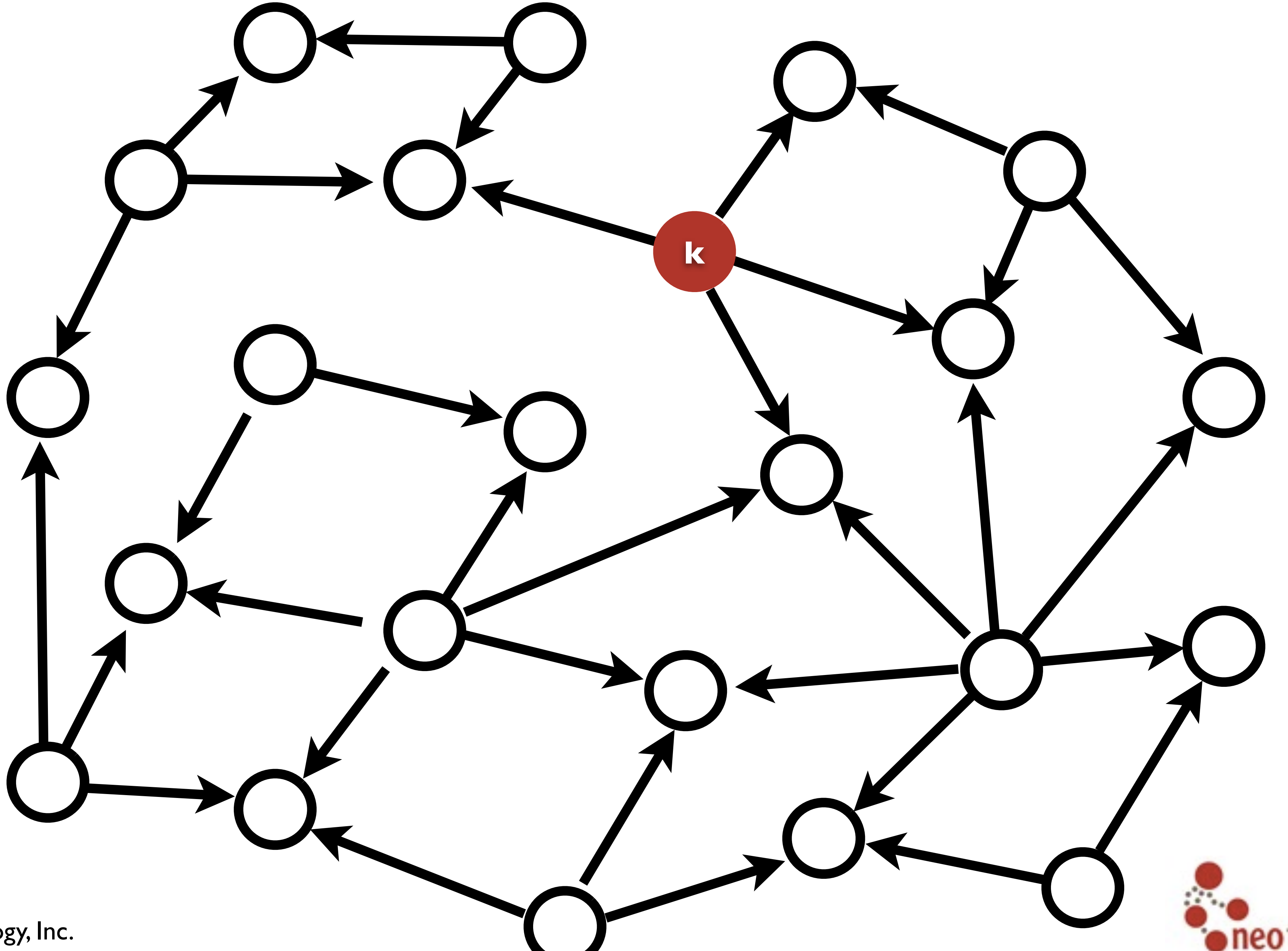
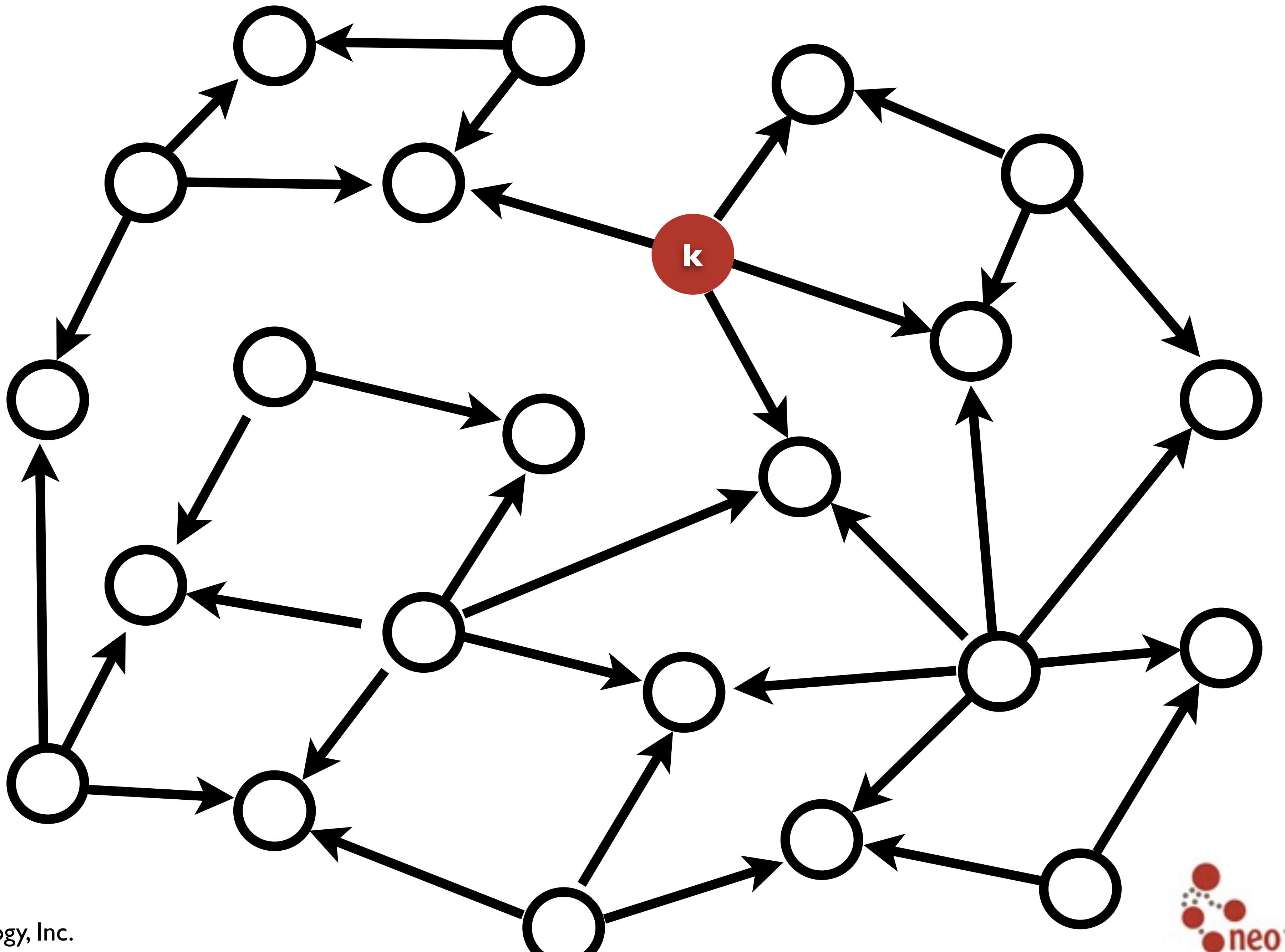
```
START n=node(*)
WHERE has(n.name) AND n.name = "Keanu Reeves"
RETURN n;
```



Find a specific node (auto-index query)

```
START keanu=node:node_auto_index(name="Keanu Reeves")
RETURN keanu;
```

```
START keanu=node:node_auto_index(name="Keanu Reeves")
RETURN keanu;
```

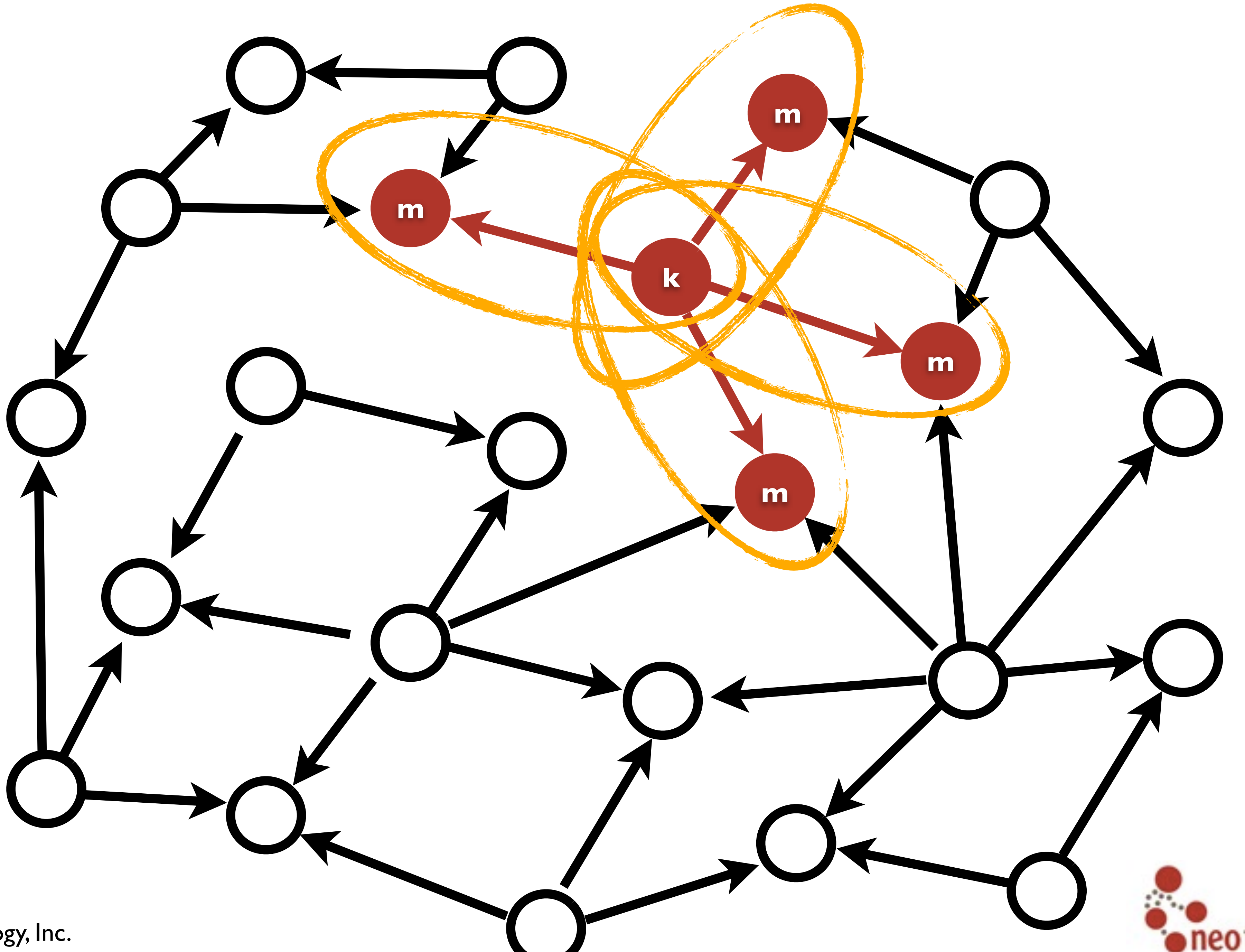


Start with specific node (auto-indexed)

```
START keanu=node:node_auto_index(name="Keanu Reeves")
MATCH (keanu)-[:ACTED_IN]->(movie)
RETURN movie.title;
```

(Movies featuring Keanu)

```
START keanu=node:node_auto_index(name="Keanu Reeves")
MATCH (keanu)-[:ACTED_IN]->(movie)
RETURN movie.title;
```

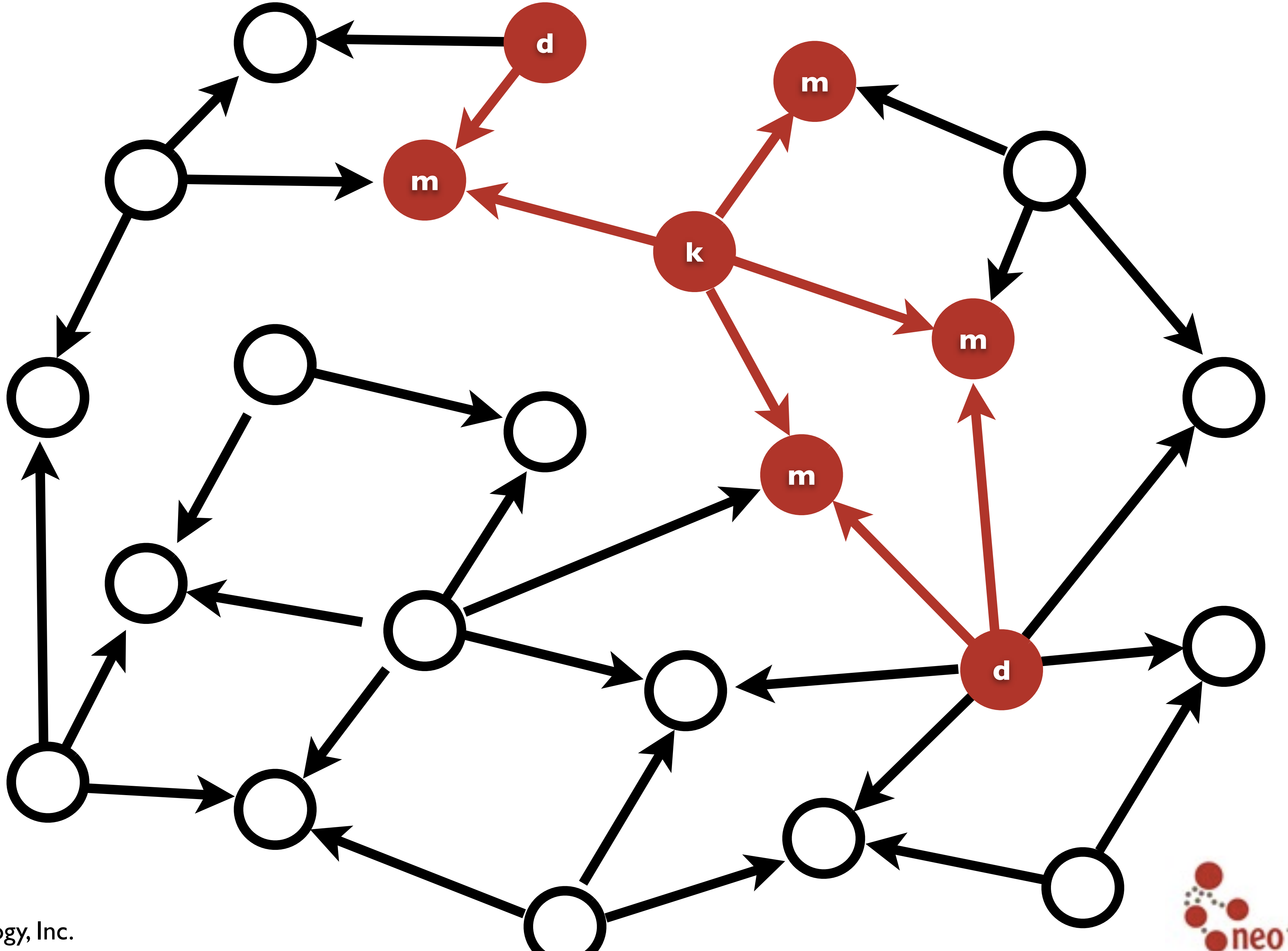


Start with specific node (auto-indexed)

```
START keanu=node:node_auto_index(name="Keanu Reeves")
MATCH (keanu)-[:ACTED_IN]->()<-[:DIRECTED]-(director)
RETURN director.name;
```

(Directors who worked with Keanu)

```
START keanu=node:node_auto_index(name="Keanu Reeves")
MATCH (keanu)-[:ACTED_IN]->()<-[:DIRECTED]-(director)
RETURN director.name;
```



Start with specific node (auto-indexed)

```
START keanu=node:node_auto_index(name="Keanu Reeves")
MATCH (keanu)-[:ACTED_IN]->()<-[:DIRECTED]-(director)
RETURN DISTINCT director.name;
```

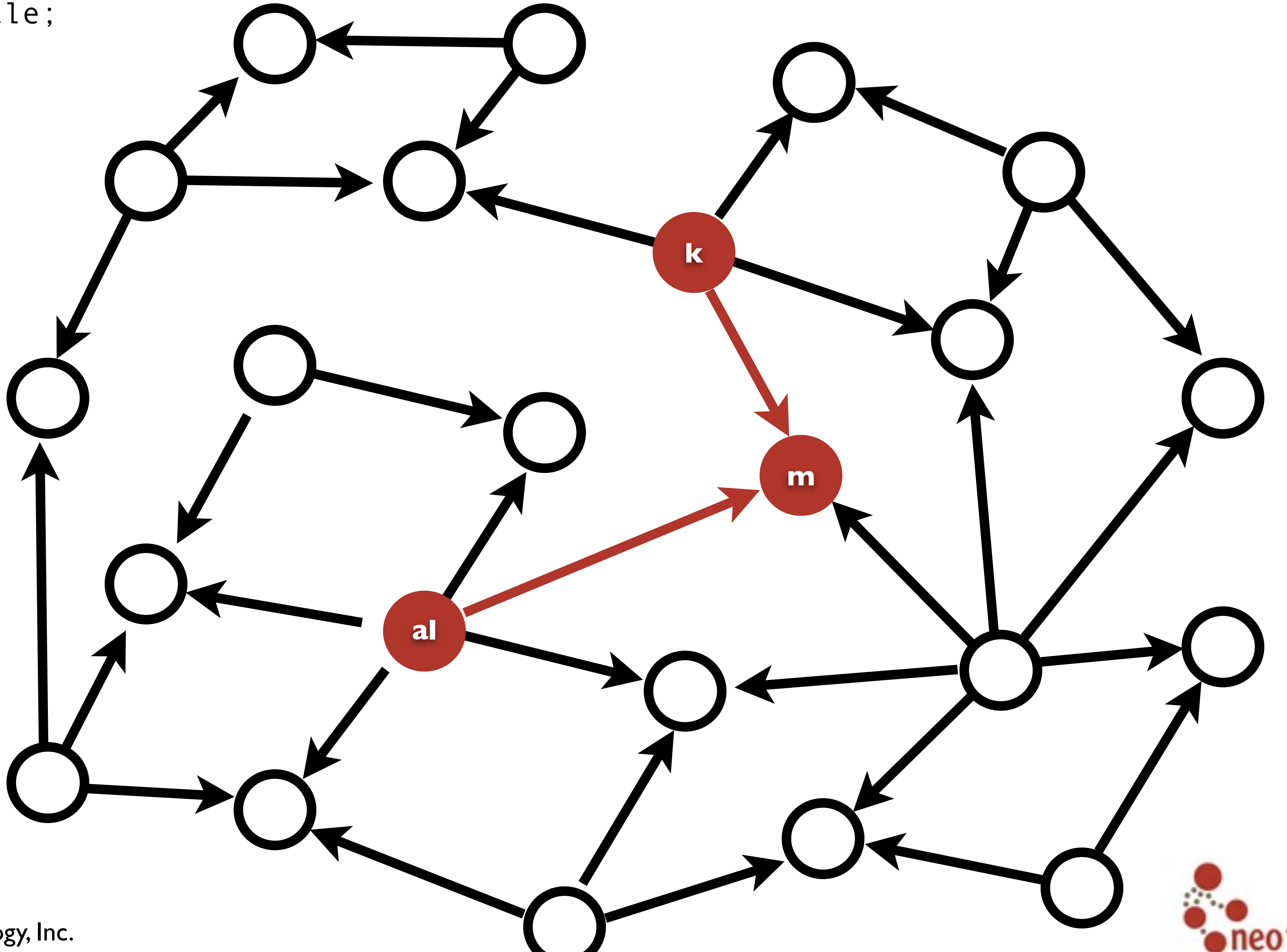
(Directors who worked with Keanu)

Start with multiple nodes (auto-indexed)

```
START keanu=node:node_auto_index(name="Keanu Reeves"),
      al=node:node_auto_index(name="Al Pacino")
MATCH (keanu)-[:ACTED_IN]->(movie)<-[:ACTED_IN]-(al)
RETURN DISTINCT movie.title;
```

(Movies featuring both Keanu and Al Pacino)

```
START keanu=node:node_auto_index(name="Keanu Reeves"),
      al=node:node_auto_index(name="Al Pacino")
MATCH (keanu)-[:ACTED_IN]->(movie)<-[:ACTED_IN]-(al)
RETURN DISTINCT movie.title;
```



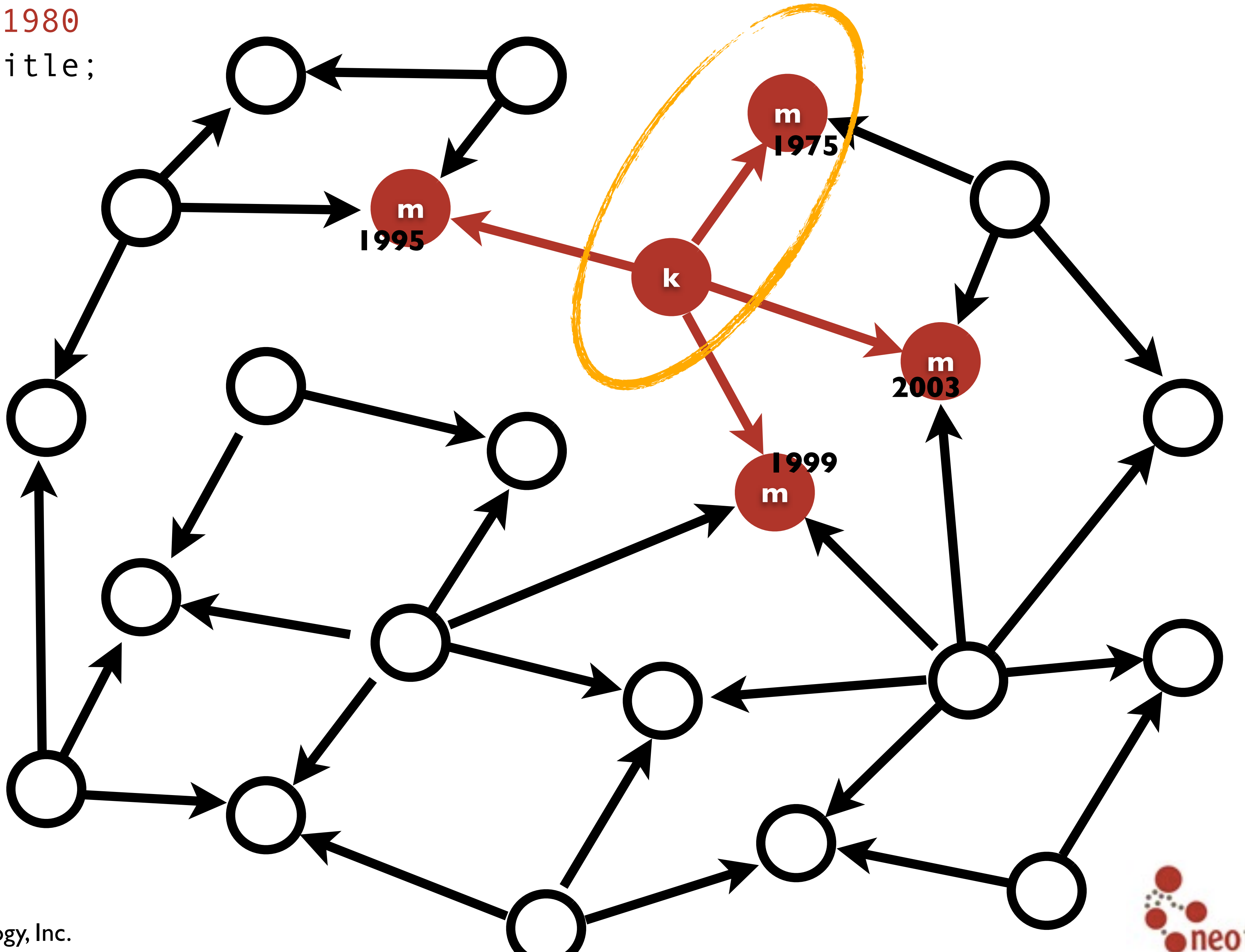
Conditions

Constraints on properties

```
START keanu=node:node_auto_index(name="Keanu Reeves")
MATCH (keanu)-[:ACTED_IN]->(movie)
WHERE movie.released < 1980
RETURN DISTINCT movie.title;
```

(Movies in which Keanu acted, that were released before 1980)

```
START keanu=node:node_auto_index(name="Keanu Reeves")
MATCH (keanu)-[:ACTED_IN]->(movie)
WHERE movie.released < 1980
RETURN DISTINCT movie.title;
```



Constraints on properties

```
START keanu=node:node_auto_index(name="Keanu Reeves")
MATCH (keanu)-[r:ACTED_IN]->(movie)
WHERE "Neo" IN r.roles
RETURN DISTINCT movie.title;
```

(Movies in which Keanu played Neo)

Constraints based on comparisons

```
START keanu=node:node_auto_index(name="Keanu Reeves")
MATCH (keanu)-[:ACTED_IN]->(movie)<-[:ACTED_IN]-(n)
WHERE n.born < keanu.born
RETURN DISTINCT n.name;
```

(Actors who worked with Keanu and are older than he was)

Constraints based on comparisons

```
START keanu=node:node_auto_index(name="Keanu Reeves")
MATCH (keanu)-[:ACTED_IN]->(movie)<-[:ACTED_IN]-(n)
WHERE n.born < keanu.born
RETURN DISTINCT n.name, (keanu.born - n.born) AS diff;
```

(Actors who worked with Keanu and are older than he was)

Constraints based on patterns

```
START gene=node:node_auto_index(name="Gene Hackman")
MATCH (gene)-[:ACTED_IN]->(movie)<-[:ACTED_IN]-(n)
RETURN DISTINCT n.name;
```

(Actors who worked with Gene Hackman)

Constraints based on patterns

```
START gene=node:node_auto_index(name="Gene Hackman")
MATCH (gene)-[:ACTED_IN]->(movie)<-[:ACTED_IN]-(n)
WHERE (n)-[:DIRECTED]->()
RETURN DISTINCT n.name;
```

(Actors who worked with Gene and were directors of their own films)

Constraints based on patterns

```
START keanu=node:node_auto_index(name="Keanu Reeves"),
      hugo=node:node_auto_index(name="Hugo Weaving")
MATCH (keanu)-[:ACTED_IN]->(movie)<-[:ACTED_IN]-(n)
WHERE NOT((hugo)-[:ACTED_IN]->(movie))
RETURN DISTINCT n.name;
```

(Actors who worked with Keanu, but never worked with Hugo)

LAB

Who are the five busiest actors?

```
START a=node(*)
MATCH (a)-[:ACTED_IN]->(m)
RETURN a.name, count(m)
ORDER BY count(m) DESC
LIMIT 5;
```

ADVANCED LAB

Recommend 3 actors that Keanu Reeves should work with (but hasn't).

```
START keanu=node:node_auto_index(name="Keanu Reeves")
MATCH (keanu)-[:ACTED_IN]->()<-[:ACTED_IN]-(c),
      (c)-[:ACTED_IN]->()<-[:ACTED_IN]-(coc)
WHERE NOT((keanu)-[:ACTED_IN]->()<-[:ACTED_IN]-(coc))
AND coc <> keanu
RETURN coc.name, count(coc)
ORDER BY count(coc) DESC
LIMIT 3;
```

```
START kevin=node:node_auto_index(name="Kevin Bacon")
MATCH (kevin)-[:ACTED_IN]->(movie)
RETURN DISTINCT movie.title;
```

(Movies featuring Kevin Bacon)

(Updating Graphs with Cypher)

Creating nodes

```
CREATE ({title:"Mystic River", released:1993});
```

```
START movie=node:node_auto_index(title="Mystic River")
RETURN movie;
```

Adding properties

```
START movie=node:node_auto_index(title="Mystic River")
SET movie.tagline = "We bury our sins here, Dave. We wash them clean."
RETURN movie;
```

Changing properties

```
START movie=node:node_auto_index(title="Mystic River")
SET movie.released = 2003
RETURN movie;
```

Creating Relationships

```
START movie=node:node_auto_index(title="Mystic River"),
      kevin=node:node_auto_index(name="Kevin Bacon")
CREATE UNIQUE (kevin)-[:ACTED_IN {roles:["Sean"]}]->(movie);
```

```
START kevin=node:node_auto_index(name="Kevin Bacon")
MATCH (kevin)-[:ACTED_IN]->(movie)
RETURN DISTINCT movie.title;
```

LAB

Change Kevin Bacon's role in Mystic River from "Sean" to "Sean Devine"

```
START movie=node:node_auto_index(title="Mystic River"),
      kevin=node:node_auto_index(name="Kevin Bacon")
MATCH (kevin)-[r:ACTED_IN]->(movie)
SET r.roles = ["Sean Devine"]
RETURN r.roles;
```


neotechnology

LAB

Change Kevin Bacon’s role in Mystic River from “Sean” to “Sean Devine”

```
START movie=node:node_auto_index(title="Mystic River"),
      kevin=node:node_auto_index(name="Kevin Bacon")
MATCH (kevin)-[r:ACTED_IN]->(movie)
SET r.roles = filter(n in r.roles : n <> "Sean") + "Sean Devine"
RETURN r.roles;
```

LAB

Add Clint Eastwood as the director of Mystic River

```
START movie=node:node_auto_index(title="Mystic River"),
      clint=node:node_auto_index(name="Clint Eastwood")
CREATE UNIQUE (clint)-[:DIRECTED]->(movie);
```

LAB

List all the characters in the movie "The Matrix"

```
START matrix=node:node_auto_index(title="The Matrix")
MATCH (matrix)<-[r:ACTED_IN]-()
RETURN r.roles;
```

```
START matrix=node:node_auto_index(title="The Matrix")
MATCH (matrix)<-[r:ACTED_IN]-(a)
WHERE "Emil" IN r.roles
RETURN a;
```

Deleting nodes

```
START emil=node:node_auto_index(name="Emil Eifrem")
DELETE emil;
```

Deleting relationships

```
START emil=node:node_auto_index(name="Emil Eifrem")
MATCH (emil)-[r]->()
DELETE r;
```

Deleting nodes and relationships

```
START emil=node:node_auto_index(name="Emil Eifrem")
MATCH (emil)-[r]->()
DELETE r, emil;
```

Deleting nodes and relationships

```
START emil=node:node_auto_index(name="Emil Eifrem")
MATCH (emil)-[r?]->()
DELETE r, emil;
```

LAB

Add KNOWS relationships between all actors who were in the same movie

```
START a=node(*)
MATCH (a)-[:ACTED_IN]->()<-[:ACTED_IN]-(b)
CREATE UNIQUE (a)-[:KNOWS]->(b);
```

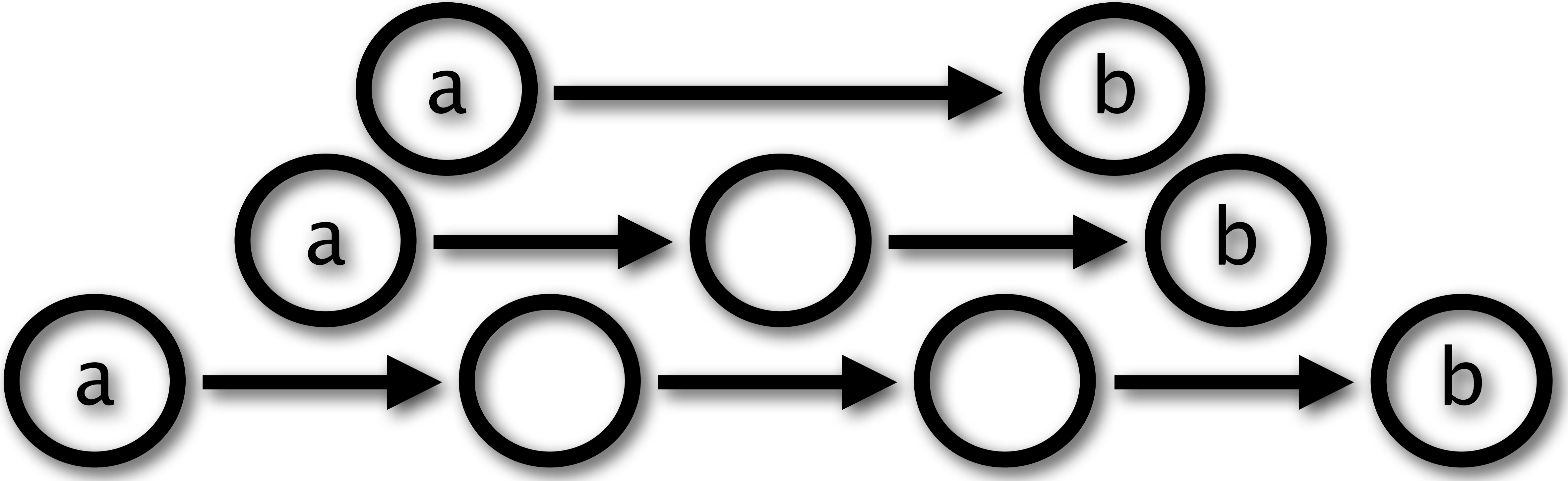
(More Cypher)

Matching multiple relationships

```
START a=node(*)
MATCH (a)-[:ACTED_IN|DIRECTED]->()<-[:ACTED_IN|DIRECTED]-(b)
CREATE UNIQUE (a)-[:KNOWS]->(b);
```

(Create KNOWS relationships between anyone, Actors or Directors, who worked together)

Variable length paths



(a)-[*1..3]->(b)

Friends-of-Friends

```
START keanu=node:node_auto_index(name="Keanu Reeves")
MATCH (keanu)-[:KNOWS*2]->(fof)
RETURN DISTINCT fof.name;
```

LAB

Return Friends-of-Friends who are not immediate friends

```
START keanu=node:node_auto_index(name="Keanu Reeves")
MATCH (keanu)-[:KNOWS*2]->(fof)
WHERE NOT((keanu)-[:KNOWS]-(fof))
RETURN DISTINCT fof.name;
```

Bacon Number!

```
START charlize=node:node_auto_index(name="Charlize Theron"),
      bacon=node:node_auto_index(name="Kevin Bacon")
MATCH p=shortestPath((charlize)-[:KNOWS*]->(bacon))
RETURN length(rels(p));
```

LAB

Return the names of the people joining Charlize to Kevin.

```
START charlize=node:node_auto_index(name="Charlize Theron"),
      bacon=node:node_auto_index(name="Kevin Bacon")
MATCH p=shortestPath((charlize)-[:KNOWS*]->(bacon))
RETURN extract(n in nodes(p) : n.name);
```

(Graphs are Everywhere)

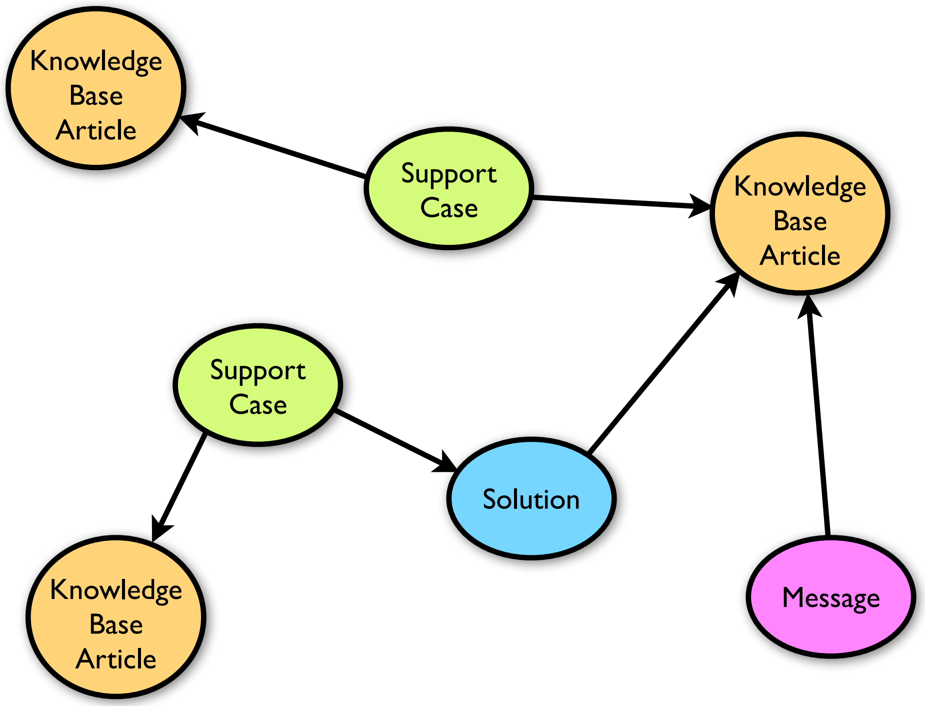
Neo4j Case Studies

neotechnology

Industry: Communications
Use case: Recommendations
San Jose, CA
Cisco.com

Background

- Cisco.com serves customer and business customers with Support Services
- Needed real-time recommendations, to encourage use of online knowledge base
- Cisco had been successfully using Neo4j for its internal master data management solution.
  - Identified a strong fit for online recommendations



Business problem

- Call center volumes needed to be lowered by improving the efficacy of online self service
- Leverage large amounts of knowledge stored in service cases, solutions, articles, forums, etc.
- Problem resolution times, as well as support costs, needed to be lowered

Solution & Benefits

- Cases, solutions, articles, etc. continuously scraped for cross-reference links, and represented in Neo4j
- Real-time reading recommendations via Neo4j
- Neo4j Enterprise with HA cluster
- The result: customers obtain help faster, with decreased reliance on customer support

Industry: Communications
Use case: Master Data Management
San Jose, CA

Cisco HMP

Background

- One of the world's largest communications equipment manufacturers
- #91 Global 2000. $44B in annual sales.
- Needed a system that could accommodate its master data hierarchies in a performant way
- HMP is a Master Data Management system at whose heart is Neo4j. Data access services available 24x7 to applications companywide

Business problem

- Sales compensation system had become unable to meet Cisco's needs
- Existing Oracle RAC system had reached its limits:
  - Insufficient flexibility for handling complex organizational hierarchies and mappings
  - "Real-time" queries were taking > 1 minute!
- Business-critical "P1" system needs to be continually available, with zero downtime

Solution & Benefits

- Cisco created a new system: the Hierarchy Management Platform (HMP)
- Allows Cisco to manage master data centrally, and centralize data access and business rules
- Neo4j provided "Minutes to Milliseconds" performance over Oracle RAC, serving master data in real time
- The graph database model provided exactly the flexibility needed to support Cisco's business rules
- HMP so successful that it has expanded to include product hierarchy

Industry: Logistics
Use case: Parcel Routing

Background

- One of the world's largest logistics carriers
- Projected to outgrow capacity of old system
- New parcel routing system
  - Single source of truth for entire network
  - B2C & B2B parcel tracking
  - Real-time routing: up to 5M parcels per day

Business problem

- 24x7 availability, year round
- Peak loads of 2500+ parcels per second
- Complex and diverse software stack
- Need predictable performance & linear scalability
- Daily changes to logistics network: route from any point, to any point

Solution & Benefits

- Neo4j provides the ideal domain fit:
  - a logistics network is a graph
- Extreme availability & performance with Neo4j clustering
- Hugely simplified queries, vs. relational for complex routing
- Flexible data model can reflect real-world data variance much better than relational
- "Whiteboard friendly" model easy to understand

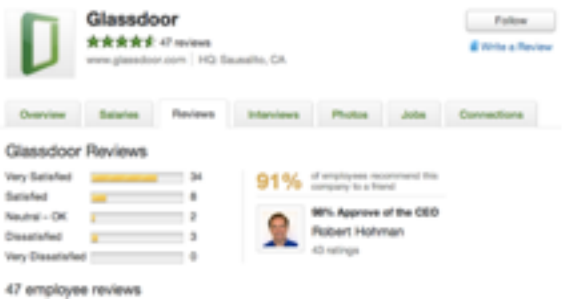
Industry: Online Job Search
Use case: Social / Recommendations

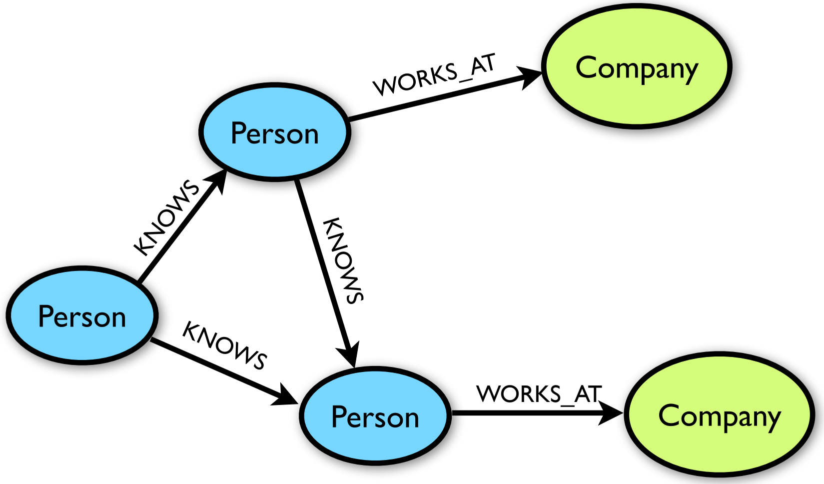
Sausalito, CA

GlassDoor

Background

- Online jobs and career community, providing anonymized inside information to job seekers





Business problem

- Wanted to leverage known fact that most jobs are found through personal & professional connections
- Needed to rely on an existing source of social network data. Facebook was the ideal choice.
- End users needed to get instant gratification
- Aiming to have the best job search service, in a very competitive market

Solution & Benefits

- First-to-market with a product that let users find jobs through their network of Facebook friends
- Job recommendations served real-time from Neo4j
- Individual Facebook graphs imported real-time into Neo4j
- Glassdoor now stores > 50% of the entire Facebook social graph
- Neo4j cluster has grown seamlessly, with new instances being brought online as graph size and load have increased

Industry: Web/ISV
Use case: Content Management, Social, Access Control
San Jose, CA
Adobe

Background

- One of the ten largest software companies globally
- $4B+ in revenue. Over 11,000 employees.
- Launched Creative Cloud in 2012, allowing its Creative Suite users to collaborate via the Cloud

User-Content-Access Graph

Business problem

- Adobe needed a highly robust and available, 24x7 distributed global system, supporting collaboration for users of its highest revenue product line
- Storing creative artifacts in the cloud meant managing access rights for (eventually) millions of users, groups, collections, and pieces of content
- Complex access control rules controlling who was connected to whom, and who could see or edit what, proved a significant technical challenge

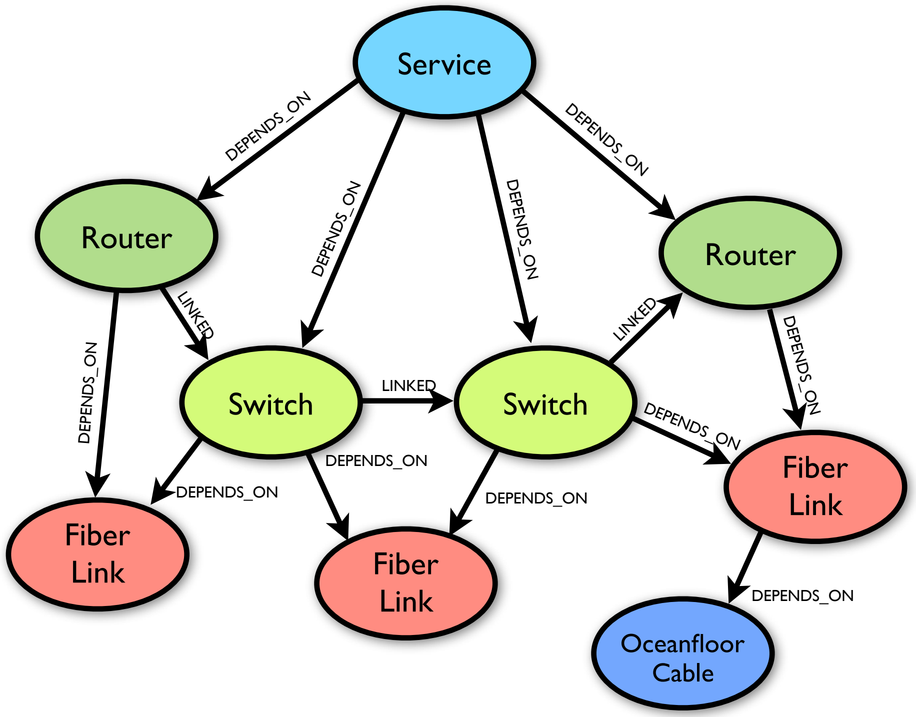
Solution & Benefits

- Selected Neo4j to meet very aggressive project deadlines. The flexibility of the graph model, and performance, were the two major selection factors.
- Easily evolve the system to meet tomorrow's needs
- Extremely high availability and transactional performance requirements. 24x7 with no downtime.
- Neo4j allows consistently fast response times with complex queries, even as the system grows
- First (and possibly still only) database cluster to run across three Amazon EC2 regions: U.S., Europe, Asia

Industry: Communications
Use case: Network Management
Paris, France
SFR

Background

- Second largest communications company in France
- Part of Vivendi Group, partnering with Vodafone



Business problem

- Infrastructure maintenance took one full week to plan, because of the need to model network impacts
- Needed rapid, automated "what if" analysis to ensure resilience during unplanned network outages
- Identify weaknesses in the network to uncover the need for additional redundancy
- Network information spread across > 30 systems, with daily changes to network infrastructure
- Business needs sometimes changed very rapidly

Solution & Benefits

- Flexible network inventory management system, to support modeling, aggregation & troubleshooting
- Single source of truth (Neo4j) representing the entire network
- Dynamic system loads data from 30+ systems, and allows new applications to access network data
- Modeling efforts greatly reduced because of the near 1:1 mapping between the real world and the graph
- Flexible schema highly adaptable to changing business requirements

Industry: Communications
Use case: Social gaming

Frankfurt, Germany

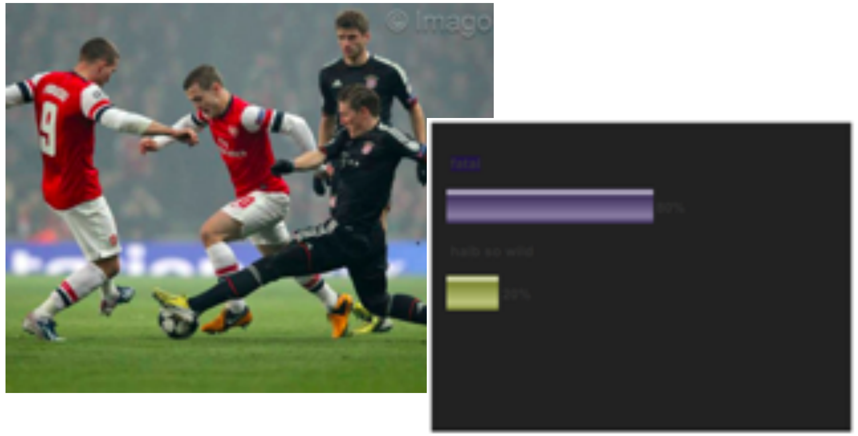
Deutsche Telecom

Background

- Europe's largest communications company
- Provider of mobile & land telephone lines to consumers and businesses, as well as internet services, television, and other services

> 236,000 Employees worldwide in 2011	50 Countries	> 58 bn. € Revenue in 2011

Interactive Television Programming



Business problem

- The Fanorakel application allows fans to have an interactive experience while watching sports
- Fans can vote for referee decisions and interact with other fans watching the game
- Highly connected dataset with real-time updates
- Queries need to be served real-time on rapidly changing data
- One technical challenge is to handle the very high spikes of activity during popular games

Solution & Benefits

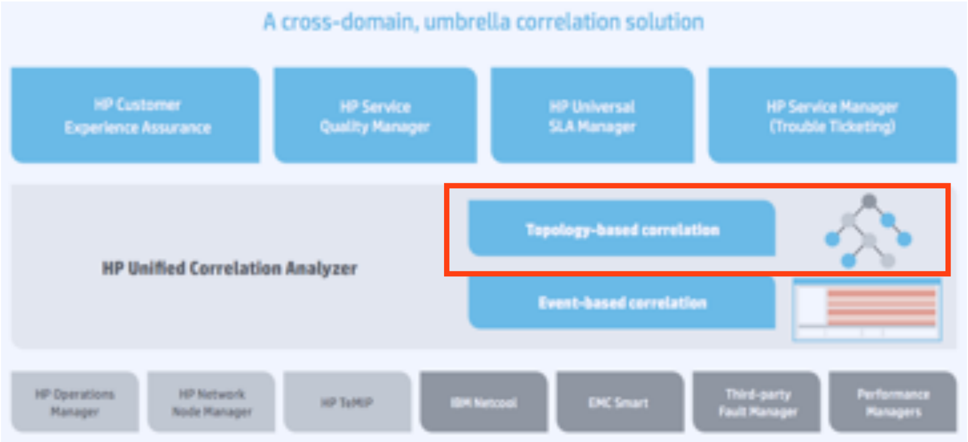
- Interactive, social offering gives fans a way to experience the game more closely
- Increased customer stickiness for Deutsche Telekom
- A completely new channel for reaching customers with information, promotions, and ads
- Clear competitive advantage

Industry: Web/ISV, Communications
Use case: Network Management
Global (U.S., France)

Hewlett Packard

Background

- World's largest provider of IT infrastructure, software & services
- HP's Unified Correlation Analyzer (UCA) application is a key application inside HP's OSS Assurance portfolio
- Carrier-class resource & service management, problem determination, root cause & service impact analysis
- Helps communications operators manage large, complex and fast changing networks



Business problem

- Use network topology information to identify root problems causes on the network
- Simplify alarm handling by human operators
- Automate handling of certain types of alarms Help operators respond rapidly to network issues
- Filter/group/eliminate redundant Network Management System alarms by event correlation

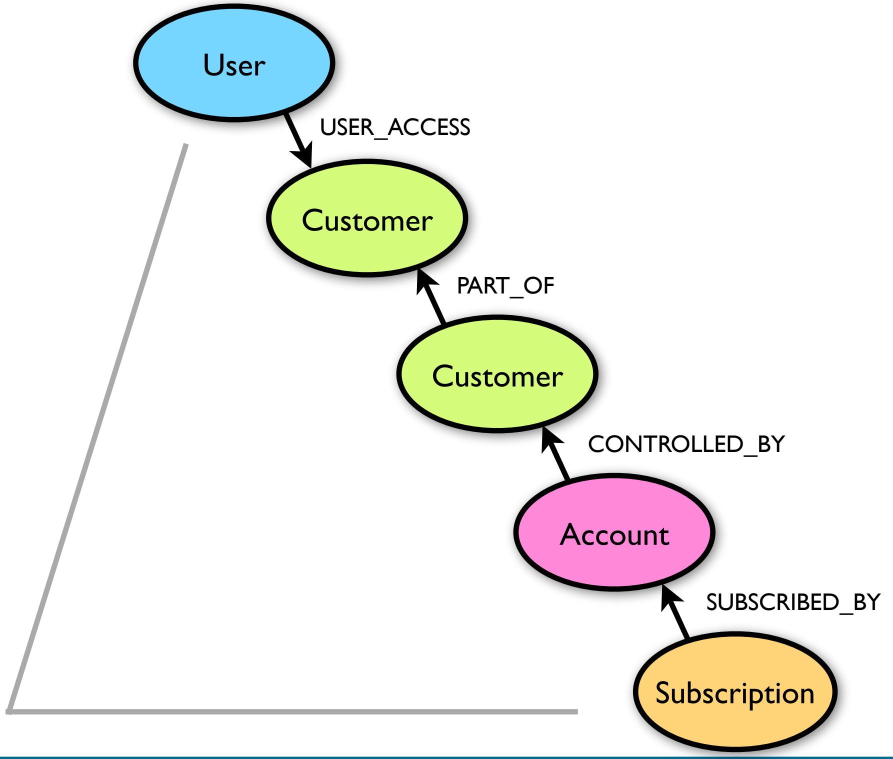
Solution & Benefits

- Accelerated product development time
- Extremely fast querying of network topology
- Graph representation a perfect domain fit
- 24x7 carrier-grade reliability with Neo4j HA clustering
- Met objective in under 6 months

Industry: Communications
Use case: Resource Authorization & Access Control

Oslo, Norway

Telenor



Background

- 10th largest Telco provider in the world, leading in the Nordics
- Online self-serve system where large business admins manage employee subscriptions and plans
- Mission-critical system whose availability and responsiveness is critical to customer satisfaction

Business problem

- Degrading relational performance. User login taking minutes while system retrieved access rights
- Millions of plans, customers, admins, groups. Highly interconnected data set w/massive joins
- Nightly batch workaround solved the performance problem, but meant data was no longer current
- Primary system was Sybase. Batch pre-compute workaround projected to reach 9 hours by 2014: longer than the nightly batch window

Solution & Benefits

- Moved authorization functionality from Sybase to Neo4j
- Modeling the resource graph in Neo4j was straightforward, as the domain is inherently a graph
- Able to retire the batch process, and move to real-time responses: measured in milliseconds
- Users able to see fresh data, not yesterday's snapshot
- Customer retention risks fully mitigated

Industry: Professional Social Network
Use case: Social, Recommendations

Silicon Valley & France

Viadeo

Background

- World's second-largest professional network (after LinkedIn)
- 50M members. 30K+ new members daily.
- Over 400 staff with offices in 12 countries

Business problem

- Business imperative for real-time recommendations: to attract new users and retain existing ones
- Key differentiator: show members how they are connected to any other member
- Real-time traversals of social graph not feasible with MySQL cluster. Batch precompute meant stale data.
- Process taking longer & longer: > 1 week!

Solution & Benefits

- Neo4j solution implemented in 8 weeks with 3 part-time programmers
- Able to move from batch to real-time: improved responsiveness with up-to-date data.
- Viadeo (at the time) had 8M members and 35M relationships.
- Neo4j cluster now sits at the heart of Viadeo's professional network, connecting 50M + professionals

Industry: Communications
Use case: Social, Mobile

Hong Kong

Maaii

Background

- Hong Kong based telephony infrastructure provider (aka M800 aka Pop Media)
- Exclusive China Mobile partner for international toll-free services. SMS Hub & other offerings
- 2012 Red Herring Top 100 Global Winner

Business problem

- Launched a new mobile communication app "Maaii" allowing consumers to communicate by voice & text
  (Similar to Line, Viber, Rebtel, VoxOx...)
- Needed to store & relate devices, users, and contacts
- Import phone numbers from users' address books. Rapidly serve up contacts from central database
  to the mobile app
- Currently around 3M users w/200M nodes in the graph

Solution & Benefits

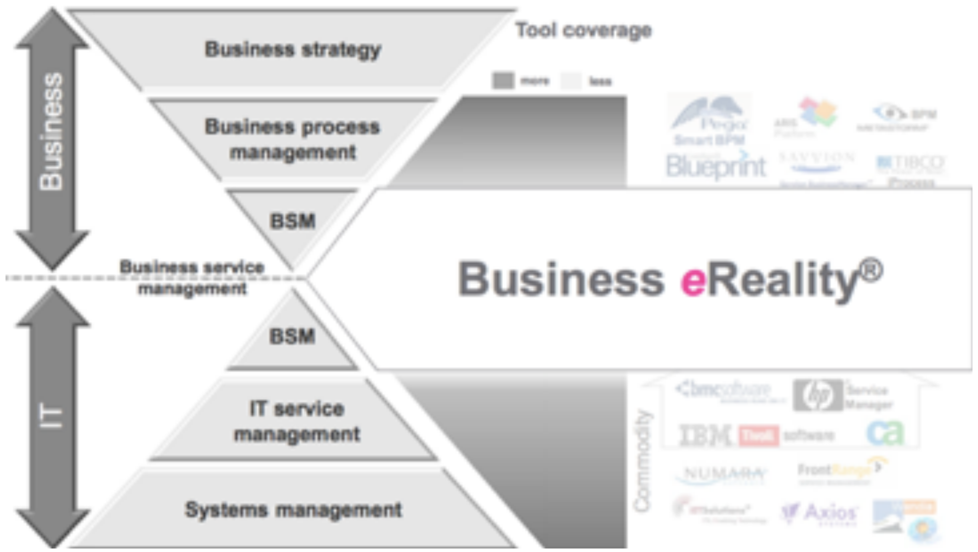
- Quick transactional performance for key operations:
  - friend suggestions ("friend of friend")
  - updating contacts, blocking calls, etc.
  - etc.
- High availability telephony app uses Neo4j clustering
- Strong architecture fit: Scala w/Neo4j embedded

Industry: Web/ISV, Communications
Use case: Data Center Management
Zürich, Switzerland

Junisphere

Background

- Junisphere AG is a Zurich-based IT solutions provider
- Founded in 2001. Profitable. Self funded.
- Software & services.
- Novel approach to infrastructure monitoring:
  Starts with the end user, mapped to business processes and services, and dependent infrastructure



Business problem

- "Business Service Management" requires mapping of complex graph, covering: business processes--> business services--> IT infrastructure
- Embed capability of storing and retrieving this information into OEM application
- Re-architecting outdated C++ application based on relational database, with Java

Solution & Benefits

- Actively sought out a Java-based solution that could store data as a graph
- Domain model is reflected directly in the database:
  - "No time lost in translation"
  - "Our business and enterprise consultants now speak the same language, and can model the domain with the database on a 1:1 ratio."
- Spring Data Neo4j strong fit for Java architecture

Industry: *Education*
Use case: *Resource Authorization & Access Control*

San Francisco, CA

Teachscape

Background

- Teachscape, Inc. develops online learning tools for K-12 teachers, school principals, and other instructional leaders.
- Teachscape evaluated relational as an option, considering MySQL and Oracle.
- Neo4j was selected because the graph data model provides a more natural fit for managing organizational hierarchy and access to assets.

Business problem

- Neo4j was selected to be at the heart of a new architecture.
- The user management system, centered around Neo4j, will be used to support single sign-on, user management, contract management, and end-user access to their subscription entitlements.

Solution & Benefits

- ***Domain and technology fit***
  - simple domain model where the relationships are relatively complex. Secondary factors included support for transactions, strong Java support, and well-implemented Lucene indexing integration
- ***Speed and Flexibility***
  - The business depends on being able to do complex walks quickly and efficiently. This was a major factor in the decision to use Neo4j.
- ***Ease of Use***
  - accommodate efficient access for home-grown and commercial off-the-shelf applications, as well as ad-hoc use.
  - Extreme availability & performance with Neo4j clustering
  - Hugely simplified queries, vs. relational for complex routing
  - Flexible data model can reflect real-world data variance much better than relational
  - "Whiteboard friendly" model easy to understand

Industry: Life Sciences
Use case: Content Management

Cambridge, Massachusetts

SevenBridges Genomics

Background

- Bioinformatics company offering gene sequencing "as a service" (over the web)
- Provider of genomic information services
- Needed a new platform to support storage & retrieval of sequenced genomes in the cloud

Business problem

- Neo4j is used to store metadata about each sequenced genome (including a pointer to the sequenced genome itself, which is a binary file stored on Amazon S3), and to support search and other forms of information processing against the genomic data.
- graph database was chosen because "Our specific domain maps naturally onto graph paradigm".

Solution & Benefits

- ***Domain fit***
  - Domain naturally lends itself to a graph representation.
  - Graph model determined to be a perfect fit.
- ***Agility & Performance***
  - Saved time with Neo4j as compared to the alternatives.
  - Queries "practically write themselves."
- ***Solution Completeness***
  - "Neo4j is incomparably better than other graph databases."

(More about Neo4j)

Neo4j APIs

Neo4j offers three APIs:

1. Cypher for most work
2. REST for management
3. Plugin API for special cases

Language Drivers

Friends of Neo4j speak many languages, and work in many frameworks.

Neo4j REST API

Neo4j Team

Discoverable, language-neutral data access from anything that can send HTTP requests. You could write a whole application with just bash scripts and curl.

Spring Data Neo4j

Neo4j Team

Familiar POJO-based development, enabling object-to-graph mapping using annotations. Amazingly simple, with full graph power just a traversal query away.

Java API

Neo4j Team

For intimate access, talk directly to Neo4j's graph engine directly in your JVM based application. Full feature parity with Neo4j Server, including HA clustering.

neo4j.rb

Andreas Ronge

Ruby on Rails? Try coasting along graph paths with Neo4j. Everything you know and love, wrapped with graph glory.

Neography

Max de Marzi

For native Ruby access to Neo4j, Neography provides a thin, elegant wrapper around the REST API.

Neo4jPHP

Josh Adell

Neo4jPHP provides an API that is both intuitive and flexible, and it takes advantage of 'under-the -hood' performance enhancements, such as caching and lazy-loading.

http://www.neo4j.org/develop/drivers

neotechnology

Traverses 1,000,000+ relationships / second on commodity hardware

Scale: 34 Bn nodes/relationships

Licensing options

(Next steps)

The rise of the graph

It's not just social

Find the graphs in your domain, and model them

Get involved in the community

Stack Overflow

Find answers or reach to fellow developers with questions.

Ask Neo4j questions »

http://stackoverflow.com/questions/tagged/neo4j

neotechnology

Neo4j Google Group

Share your experiences and expertise with fellow graphistas.

Join now »

http://groups.google.com/group/neo4j

GitHub Issues

Encountered an issue with Neo4j?
Submit it here.

https://github.com/neo4j/neo4j/issues

Meetups / User Groups

Neo4j meetups are worldwide. Make a connection or start a new group.

Join a Meetup »

http://neo4j.meetup.com/

Graphistas World Map

Add yourself to the graphistas world map and let it become a smaller place.

Add yourself »

http://www.neo4j.org/participate/contributors#map

(Thank You)

http://www.neo4j.org

http://groups.google.com/group/neo4j

http://www.neo4j.org/develop