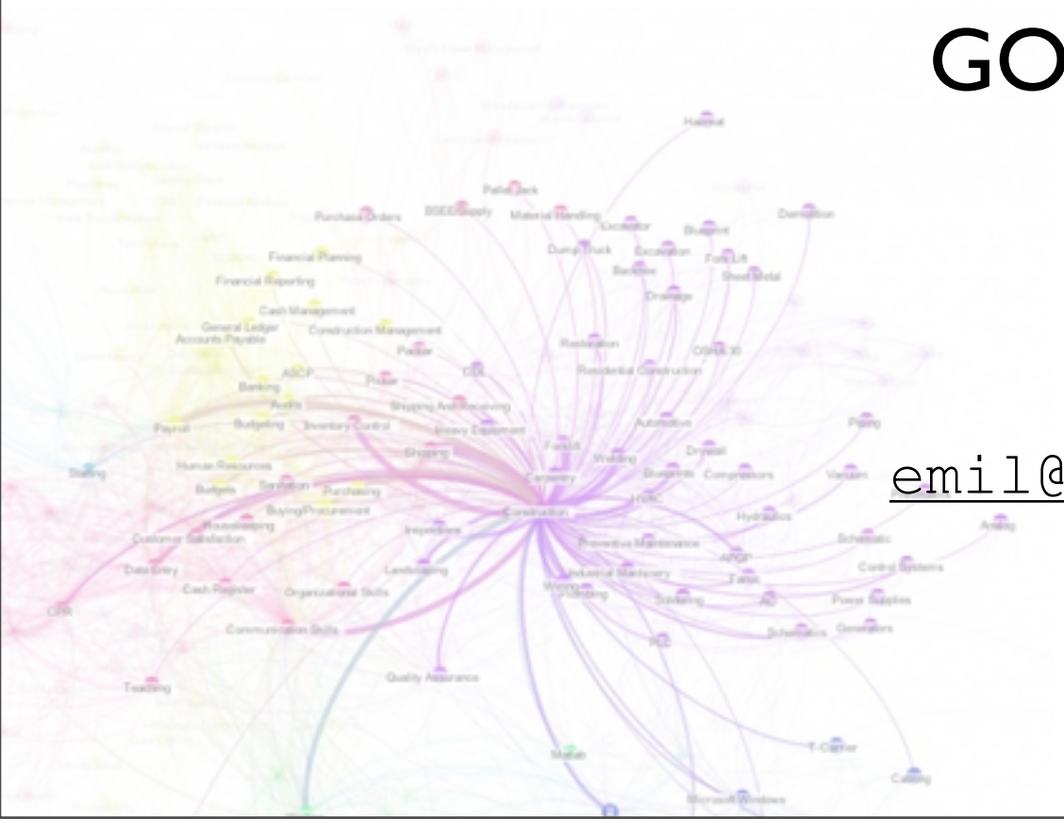
neotechnology
graphs are everywhere

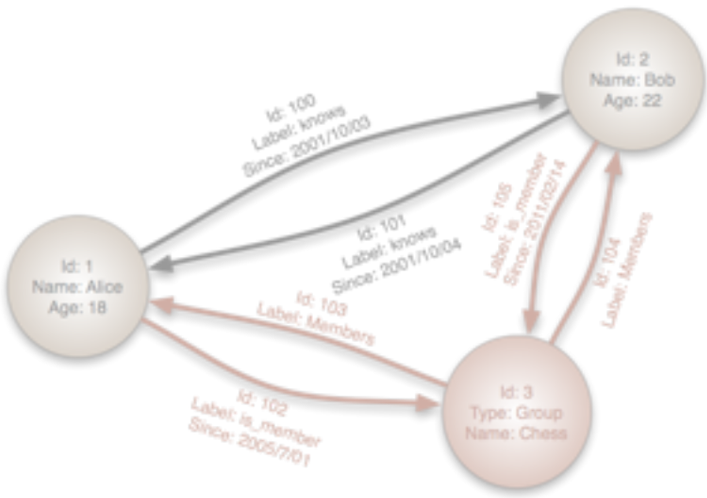
Graph All Teh Things!!!1 1 1

Graph Database Use Cases That Aren't Social

GOTO Berlin, 2014



Emil Eifrem
emil@neotechnology.com
@emileifrem
#neo4j



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Agenda

1. Context
2. Wait! What Is A Graph Anyway?
3. !Social Graph Use Cases

WARNING!

ALL I'M OFFERING IS THE TRUTH

Victims


Photo
shivprakash swami @shivswami · Dec 27
Just revisiting snaps from Diwali fireworks this year.. Seeing graphs everywhere .. @neo4j #graphdb pic.twitter.com/6WSjVcEeOK
Reply
Retweeted
Favorited
Flag media

Victims


Stefan Armbruster
@darthvader42
Following
graphs-[:ARE]->everywhere RT @djwork77: Even seeing graphs in the curtains now, thanks #neo4j pic.twitter.com/yUcWo9hJGW
Reply
Retweeted
Favorited
Pocket
More

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Context


Google


ebay


LinkedIn


PayPal

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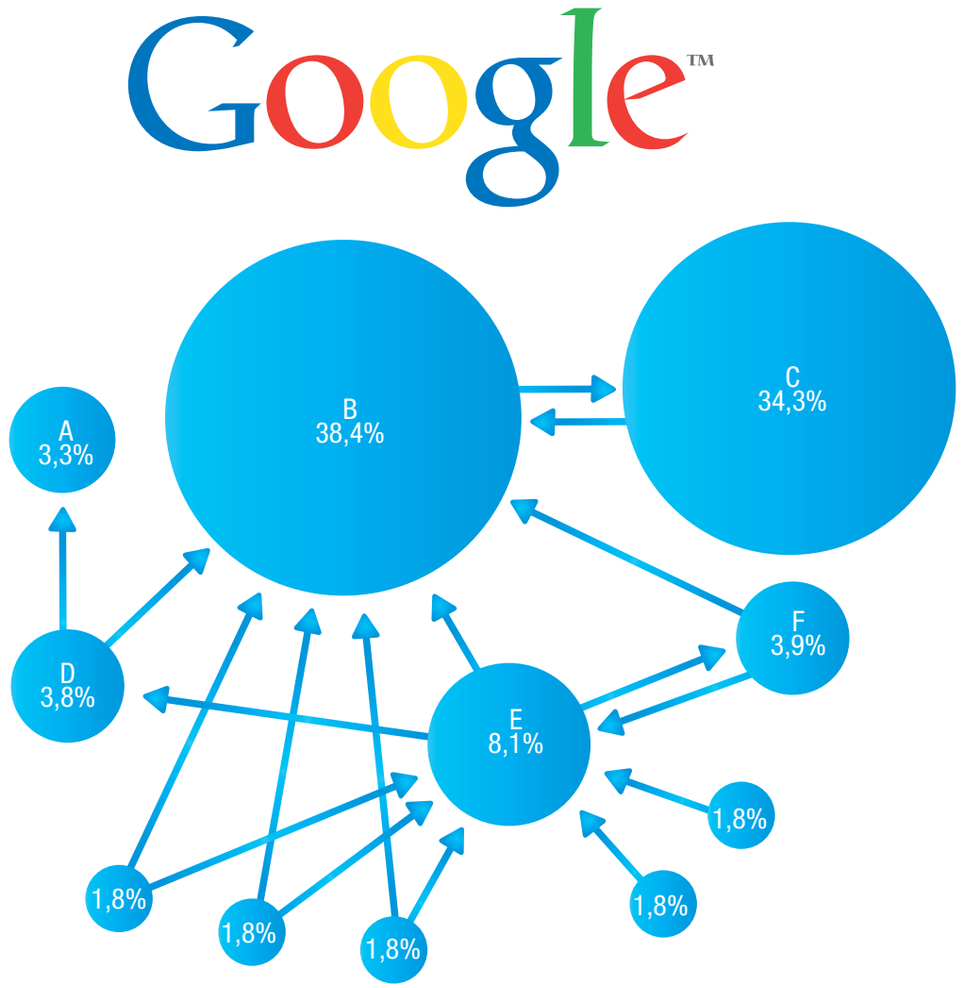
Graphs Are Eating The World


excite
altavista
LYCOS
THE CATALOG OF THE INTERNET


Google™
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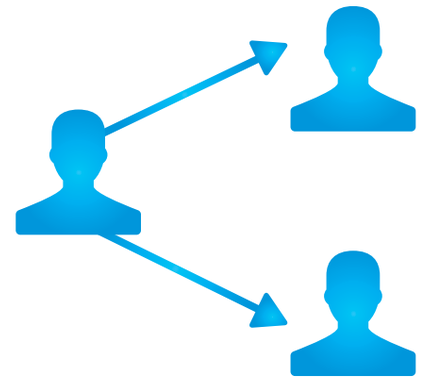
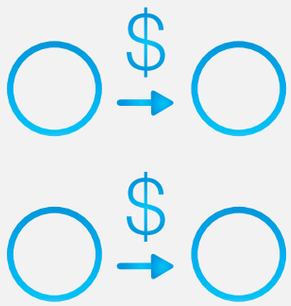
monster
Find better.™

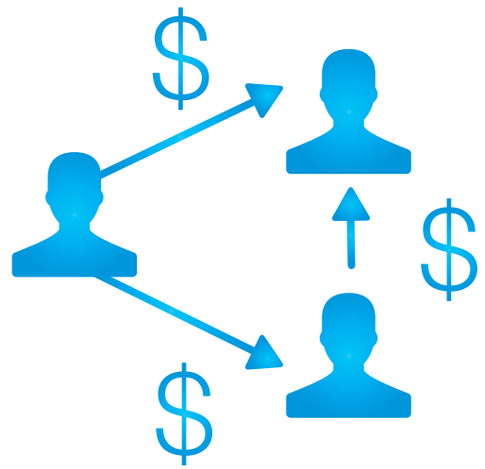
LinkedIn™



citibank



PayPal tm



Core industries & Use Cases	WEB / ISV	Financial Services	Tele-communications
Network & Data Center Management			
Master Data Management			
Social			
Geo			

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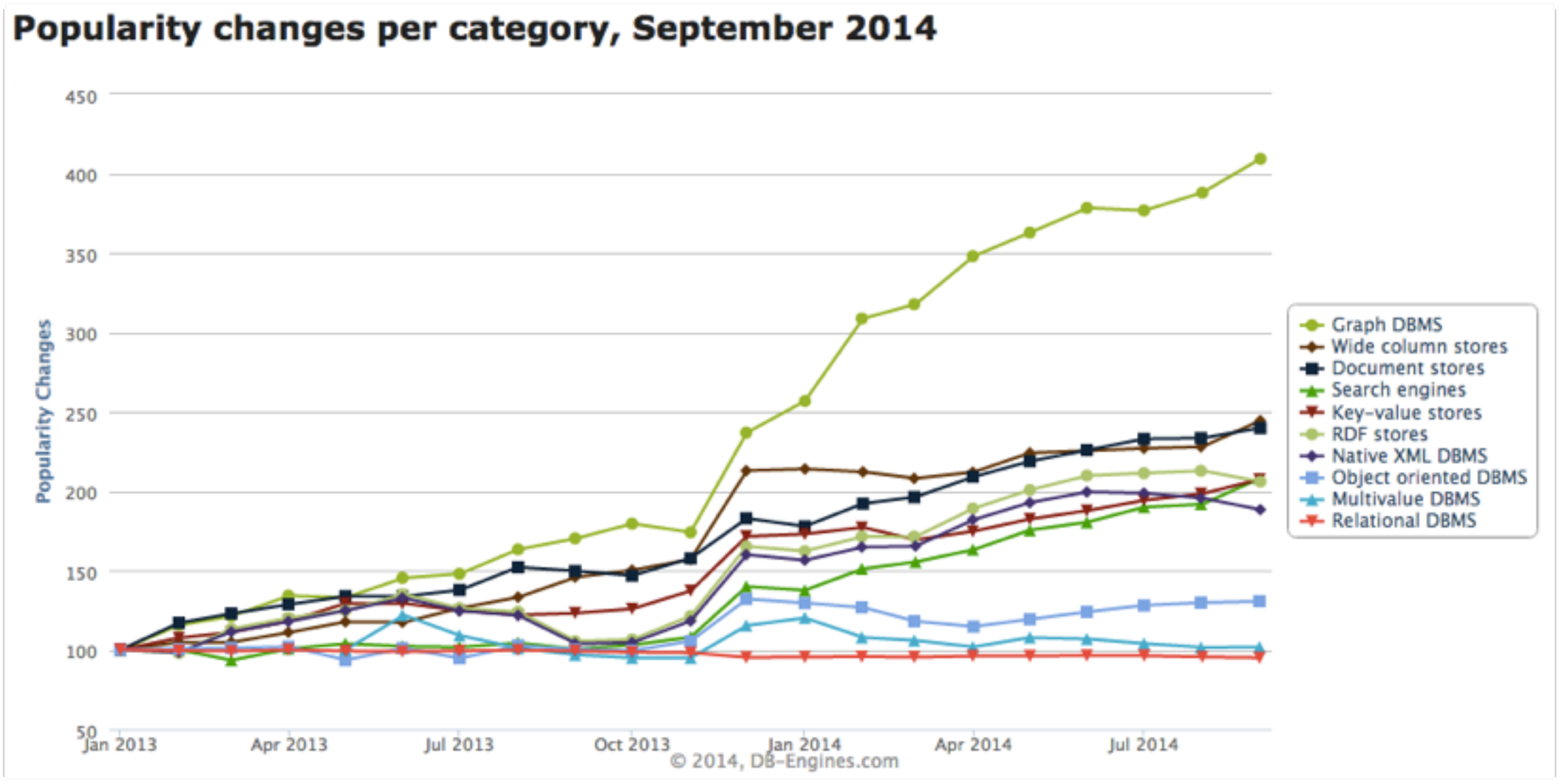
Core industries & Use Cases	WEB / ISV	Financial Services	Tele-communications
Network & Data Center Management	Zenoss, NetApp, Junisphere, SERENA, gen, VIRTUAL INSTRUMENTS	FORTUNE 100 Finance	hp, SFR, Alcatel·Lucent
Master Data Management	Pitney Bowes	die Bayerische, veda applied intelligence	CISCO, 3
Social	viadeo, careerbuilder, 53, glassdoor, Glowbl, eHarmony, Hinge, SNAP INTERACTIVE, ice, classmates, meetic, DOWN, mallow street		maaii Let's connect
GEO	TOMTOM		DingLicom Your Net Our Work

Graphs Are Growin'

Graph DBMSs are gaining in popularity faster than any other database category

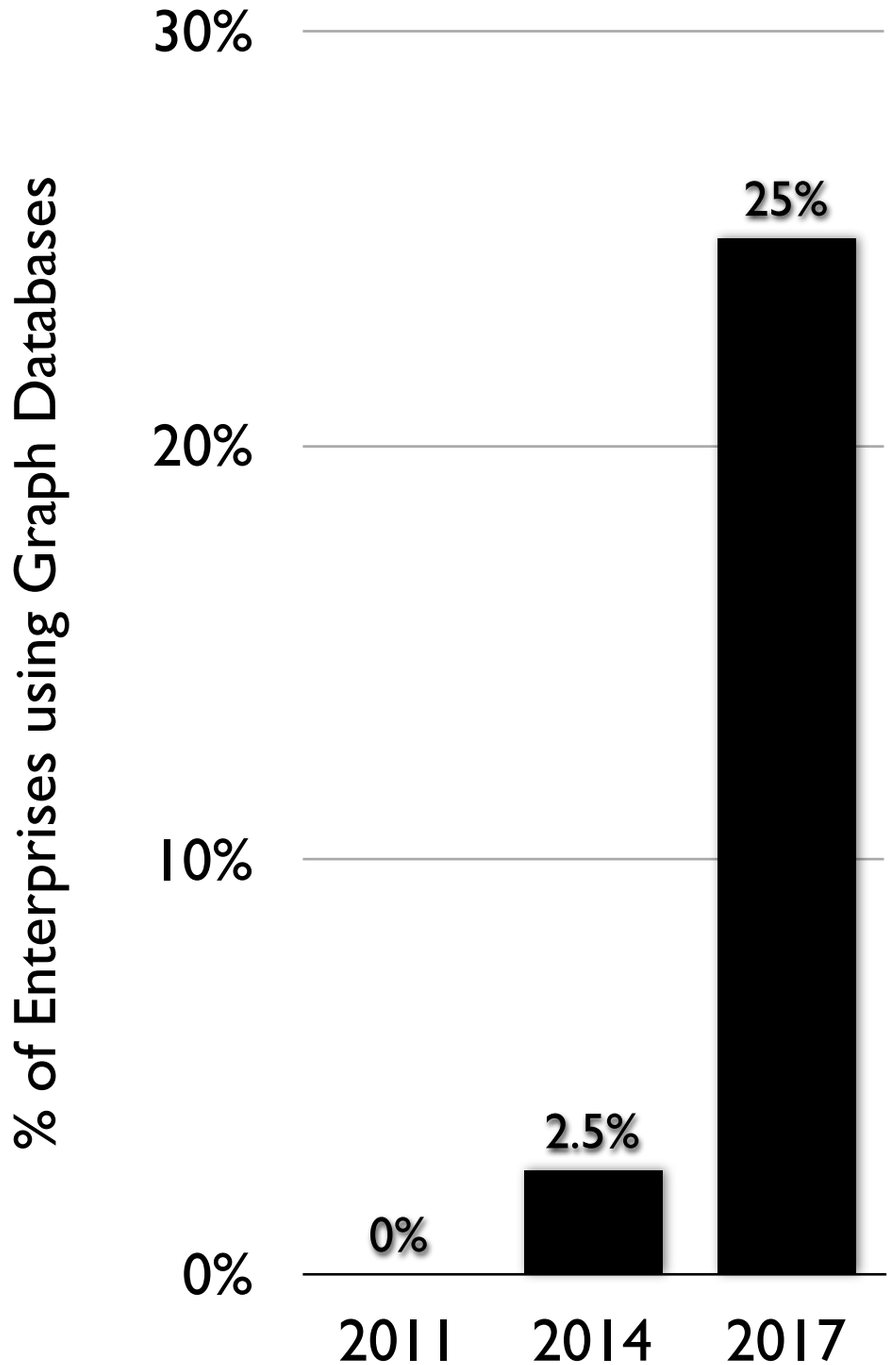
by Matthias Gelbmann, 21 January 2014

> *When we look at how much various categories of database management systems increased their popularity last year, Graph DBMSs are the clear winner with more than 250% increase.*



Source: http://db-engines.com/en/ranking/graph+dbms

Graph Databases In The Enterprise



*"Forrester estimates that **over 25% of enterprises** will be using graph databases by 2017"*

***"25% of survey respondents** said they plan to use Graph databases in the future."*

Sources

- Forrester *TechRadar*™: Enterprise DBMS, Feb 13 2014 (http://www.forrester.com/TechRadar+Enterprise+DBMS+Q1+2014/fulltext/-/E-RES106801)
- Dataversity Mar 31 2014: *"Deconstructing NoSQL: Analysis of a 2013 Survey on the Use, Production and Assessment of NoSQL Technologies in the Enterprise"* (http://www.dataversity.net)
- Neo Technology customer base in 2011 and 2014
- Estimation of other graph vendors' customer base in 2011 and 2014 based on best available intelligence

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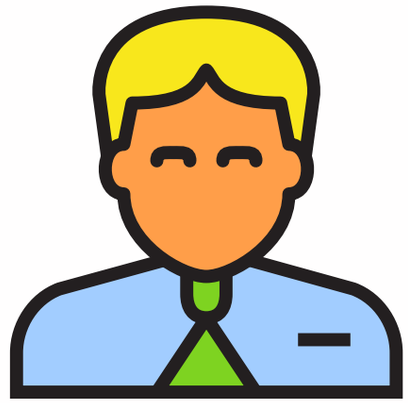
What Is A Graph, Anyway?

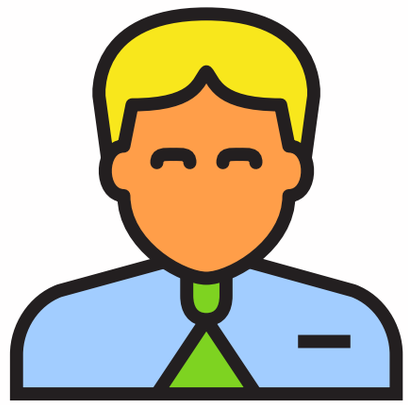
The Property Graph Model



The Property Graph Model

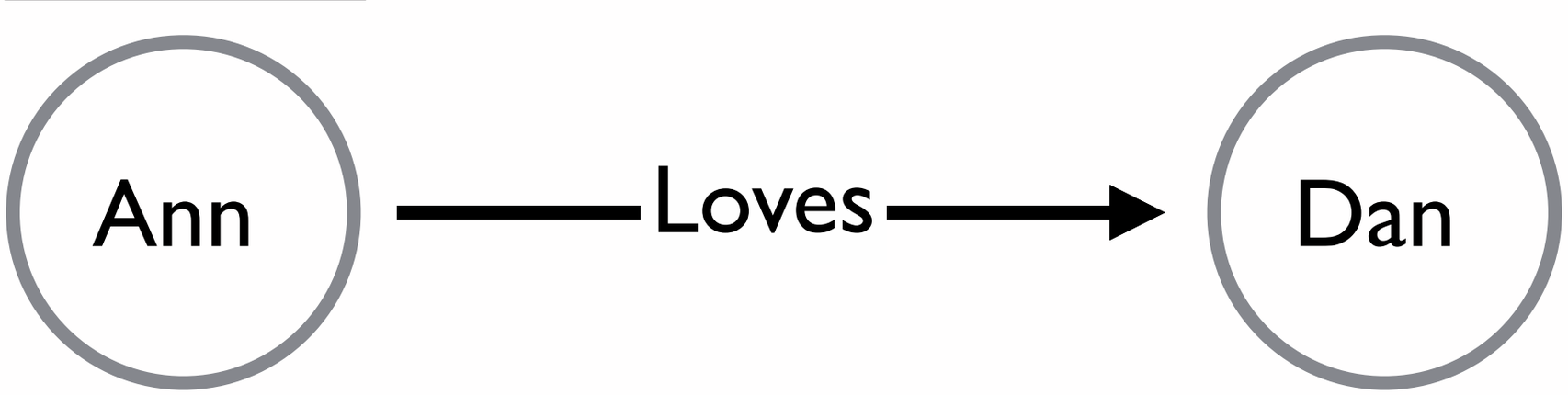
Ann

Loves

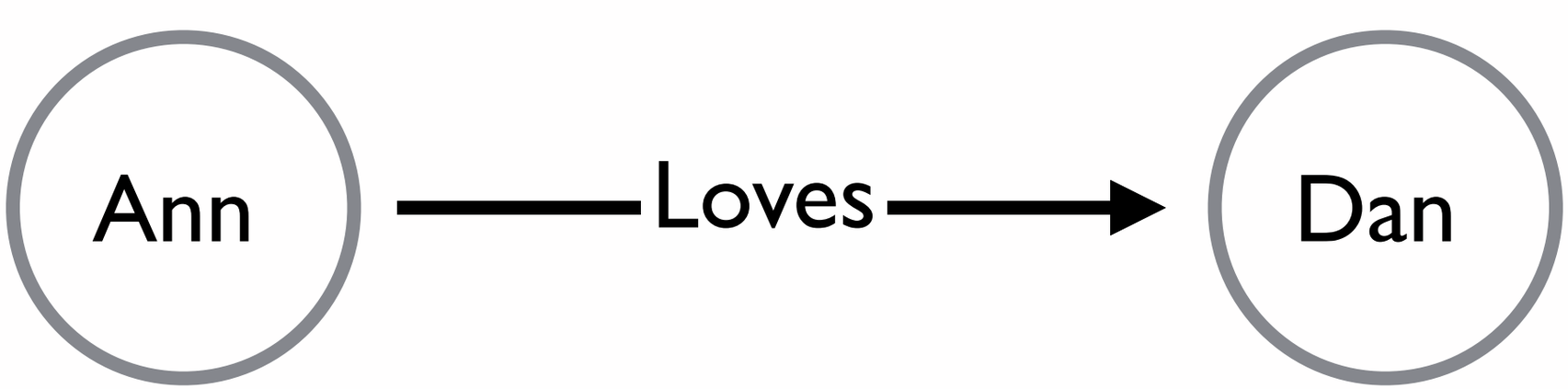


Dan

The Property Graph Model

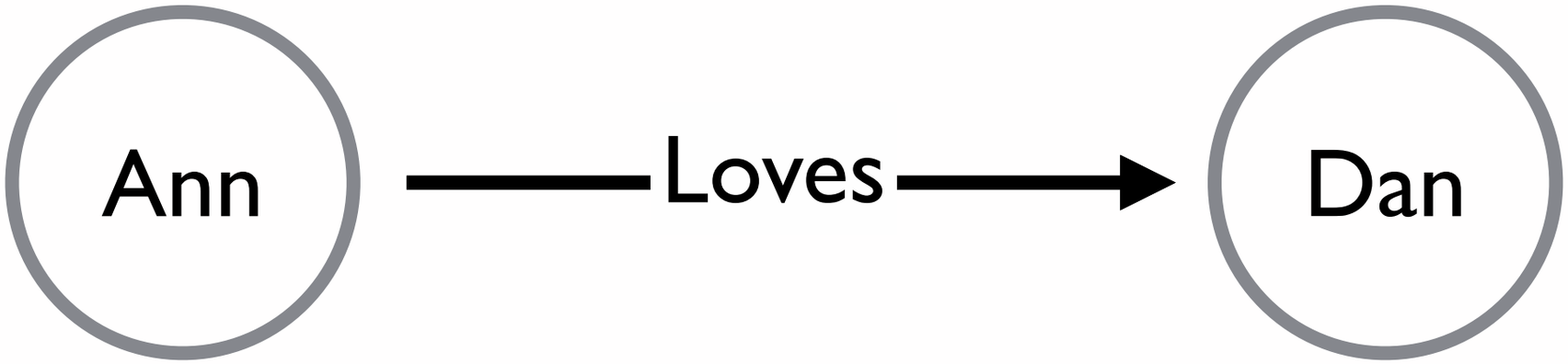


The Property Graph Model



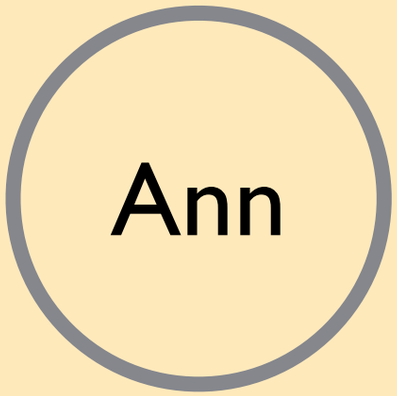

```
(Ann)    -[:LOVES]->    (Dan)
```

The Property Graph Model




```
(:Person {name:"Ann"})   -[:LOVES]->   (:Person {name:"Dan"})
```

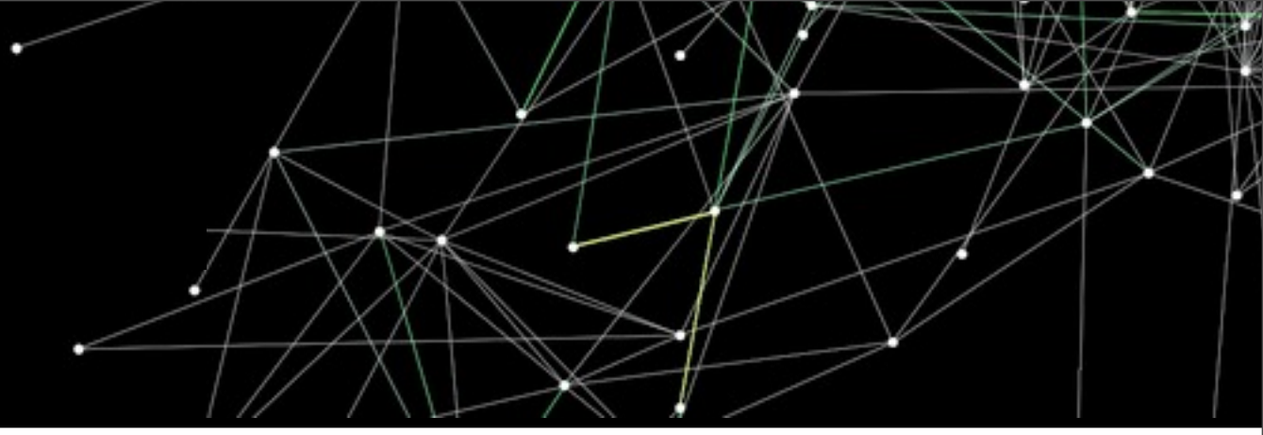
The Property Graph Model




```
(:Person {name:"Ann"})   -[:LOVES]->   (:Person {name:"Dan"})
```

Node | Relationship | Node

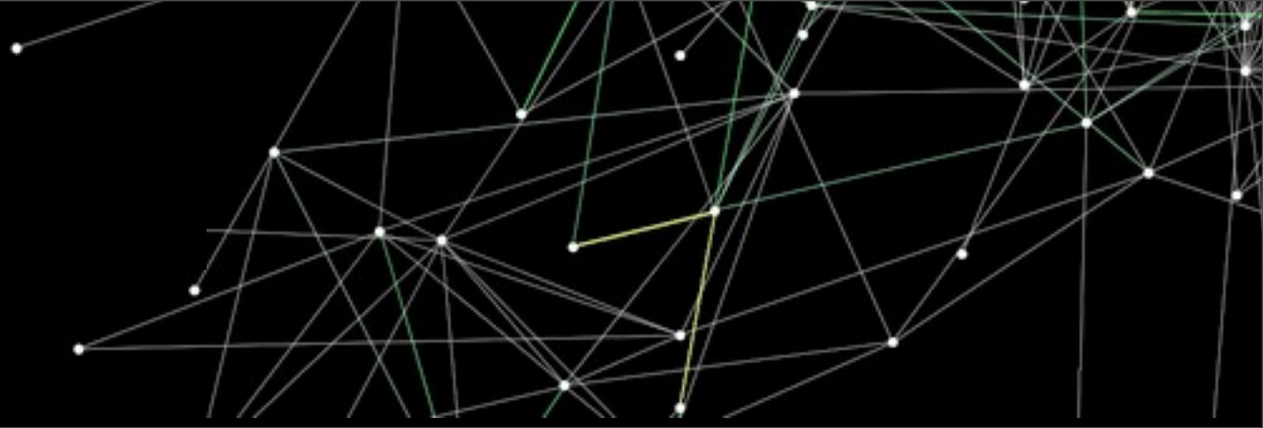
Cypher



Query: Whom does Ann love?

```
(:Person {name:"Ann"})-[:LOVES]->(whom)
```

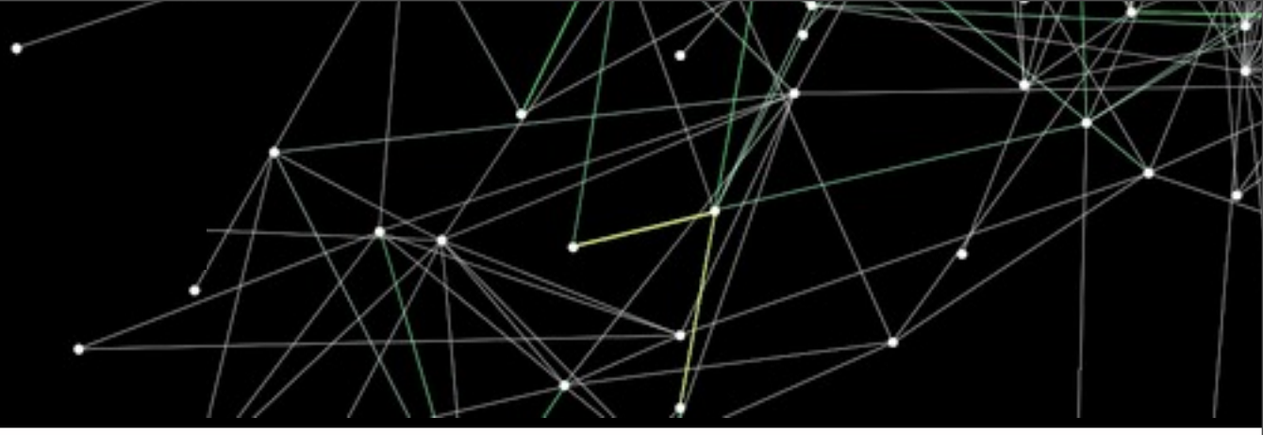
Cypher



Query: Whom does Ann love?

```
MATCH (:Person {name:"Ann"})-[:LOVES]->(whom)
```

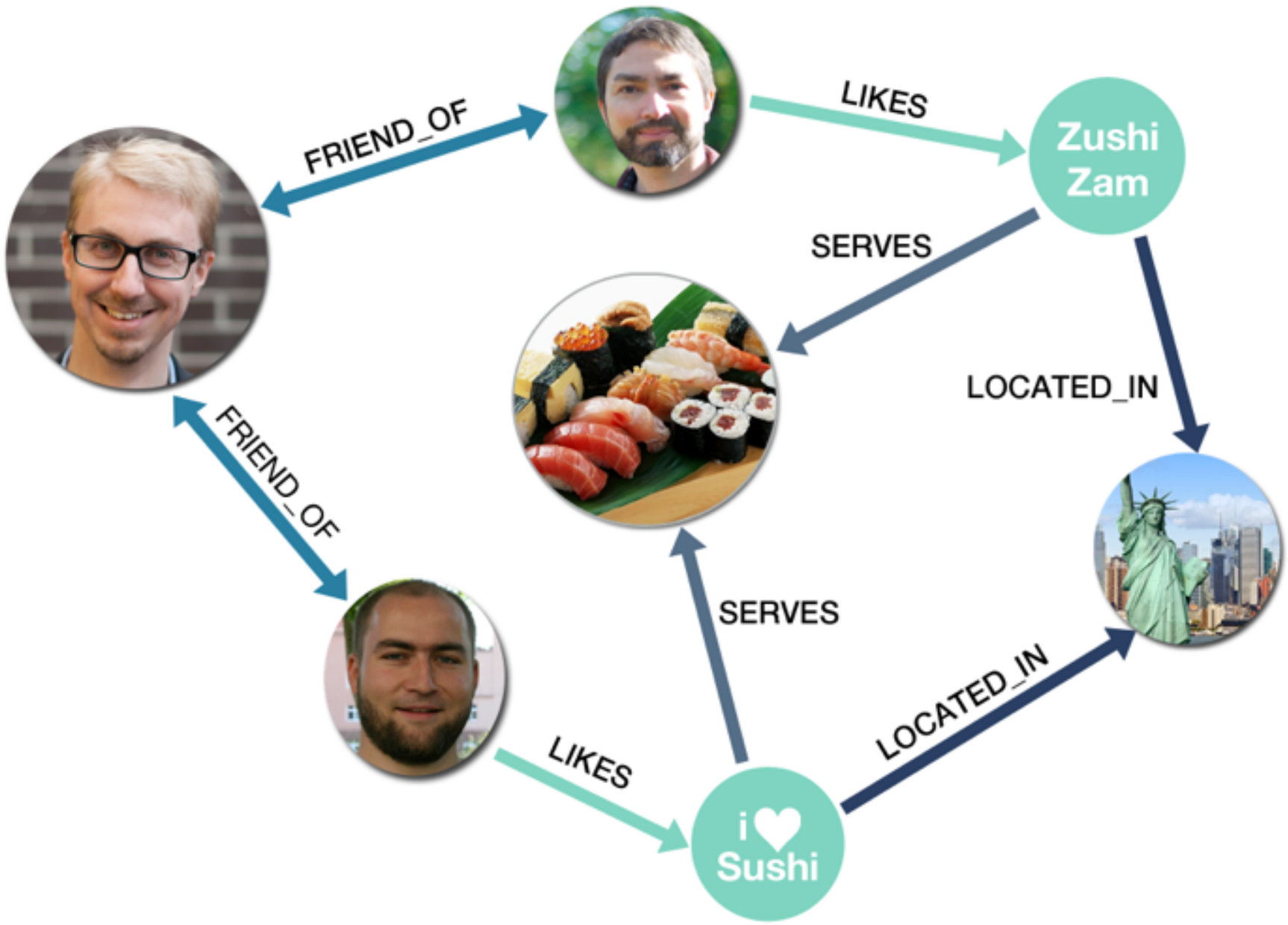
Cypher



Query: Whom does Ann love?

```
MATCH (:Person {name:"Ann"})-[:LOVES]->(whom)
RETURN whom
```


Sushi restaurants in **New York, New York** that my friends like
Sushi restaurants in **New York, New York** that my friends like


FRIEND_OF
LIKES
Zushi Zam
SERVES
LOCATED_IN
FRIEND_OF
SERVES
LIKES
LOCATED_IN
i ♥ Sushi


```
MATCH (me:Person)-[:IS_FRIEND_OF]->(friend:Person),
      (friend)-[:LIKES]->(restaurant),
      (restaurant)-[:LOCATED_IN]->(newyork:City),
      (restaurant)-[:SERVES]->(sushi:Cuisine)

WHERE me.name = 'Emil' AND newyork.location='New York' AND
      sushi.cuisine='Sushi'

RETURN restaurant.name
```

http://maxdemarzi.com/?s=facebook

Example HR Query (using SQL)

*"*Find all direct reports and how many they manage, up to 3 levels down"*

Example HR Query (using SQL)

```
 (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
```

(continued from previous page...)

```
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")
)
```

**"Find all direct reports and how many they manage, up to 3 levels down"*

Same Query in 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
```

*“Find all direct reports and how many they manage, up to 3 levels down”

DATABASE	# PEOPLE	QUERY TIME (MS)
MySQL	1,000	2,000
Neo4j	1,000	2
Neo4j	**1,000,000**	**2**

M'kay. But what about the Real World(tm)?

"Our Neo4j solution is literally **thousands of times**

faster than the prior MySQL solution,

with queries that require **10-100 times less code**."

- Volker Pacher, Senior Developer eBay

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!Social Graph Use Cases

Network Impact Analysis

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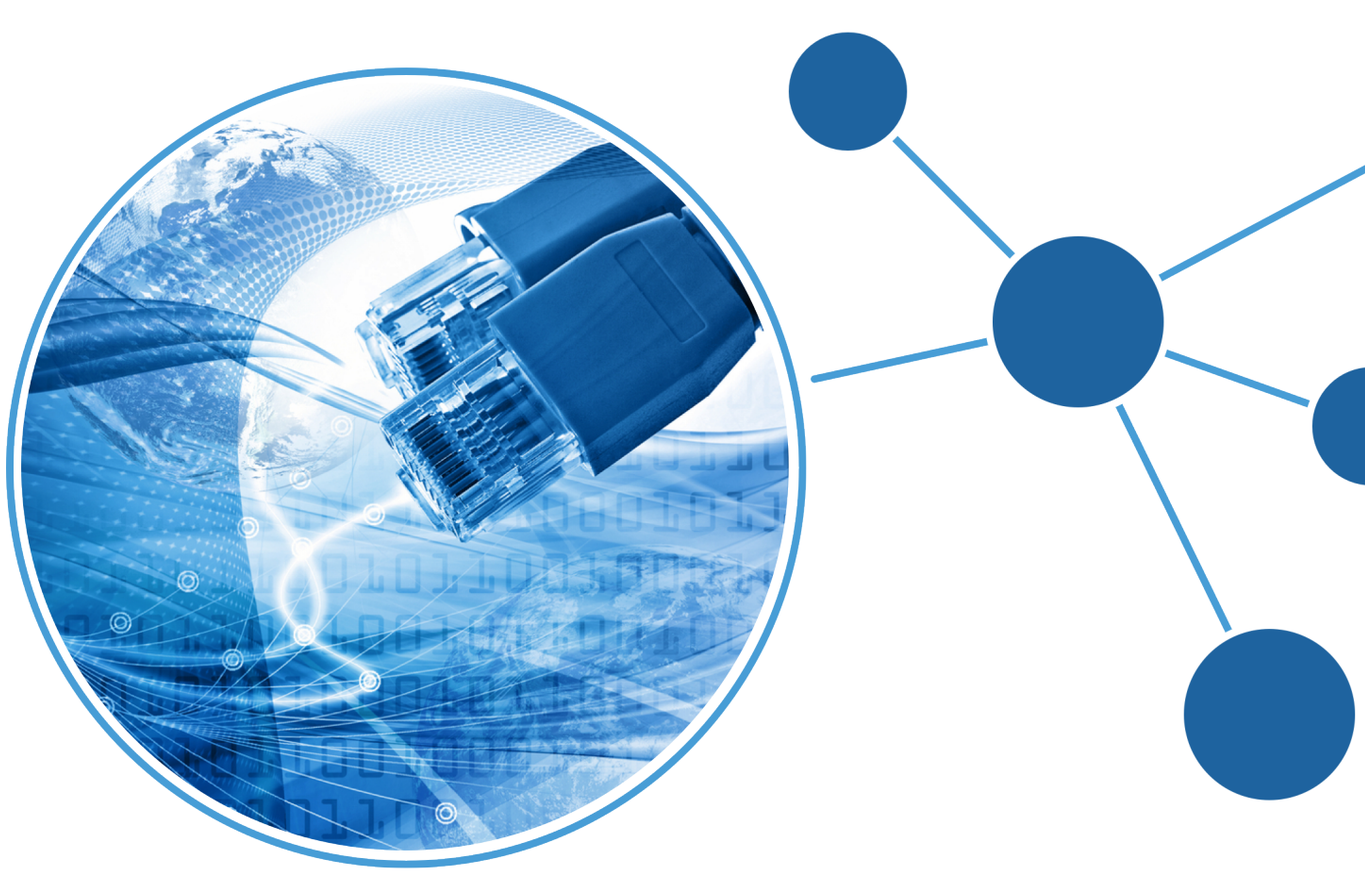
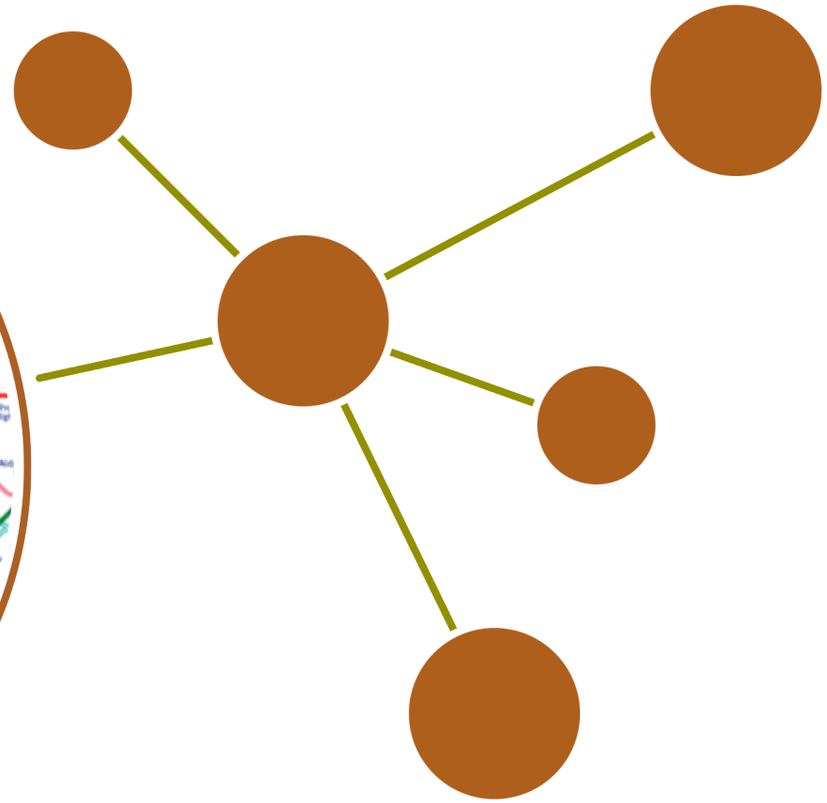
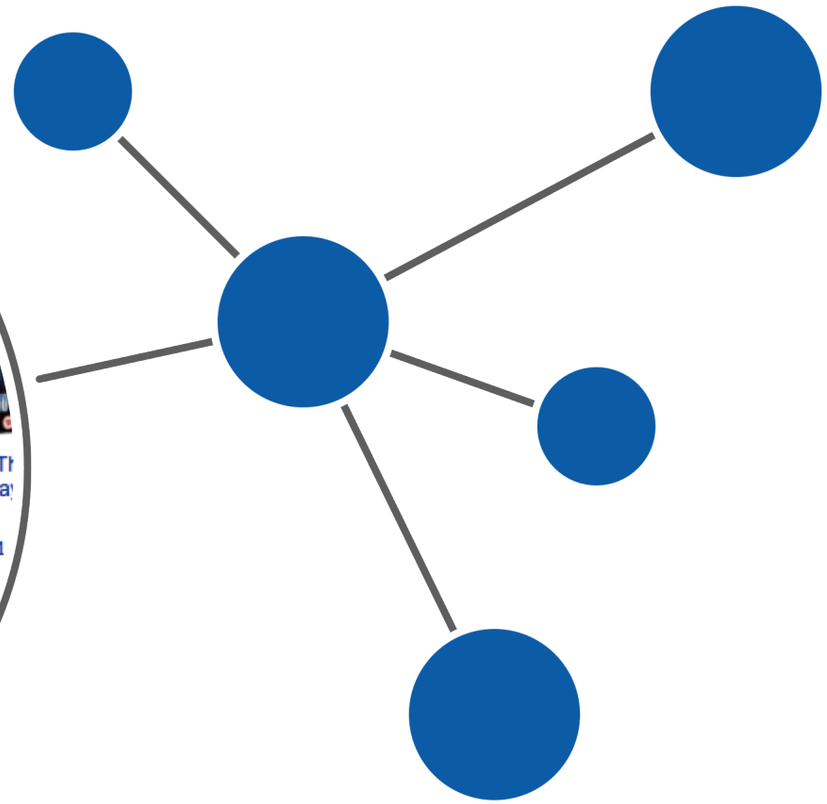


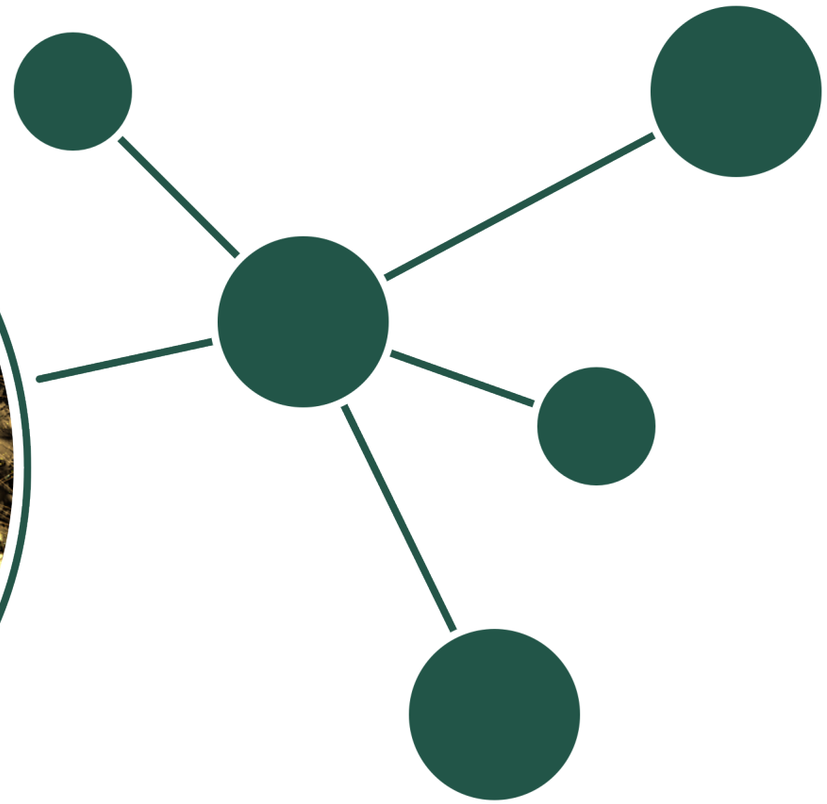
Route Finding



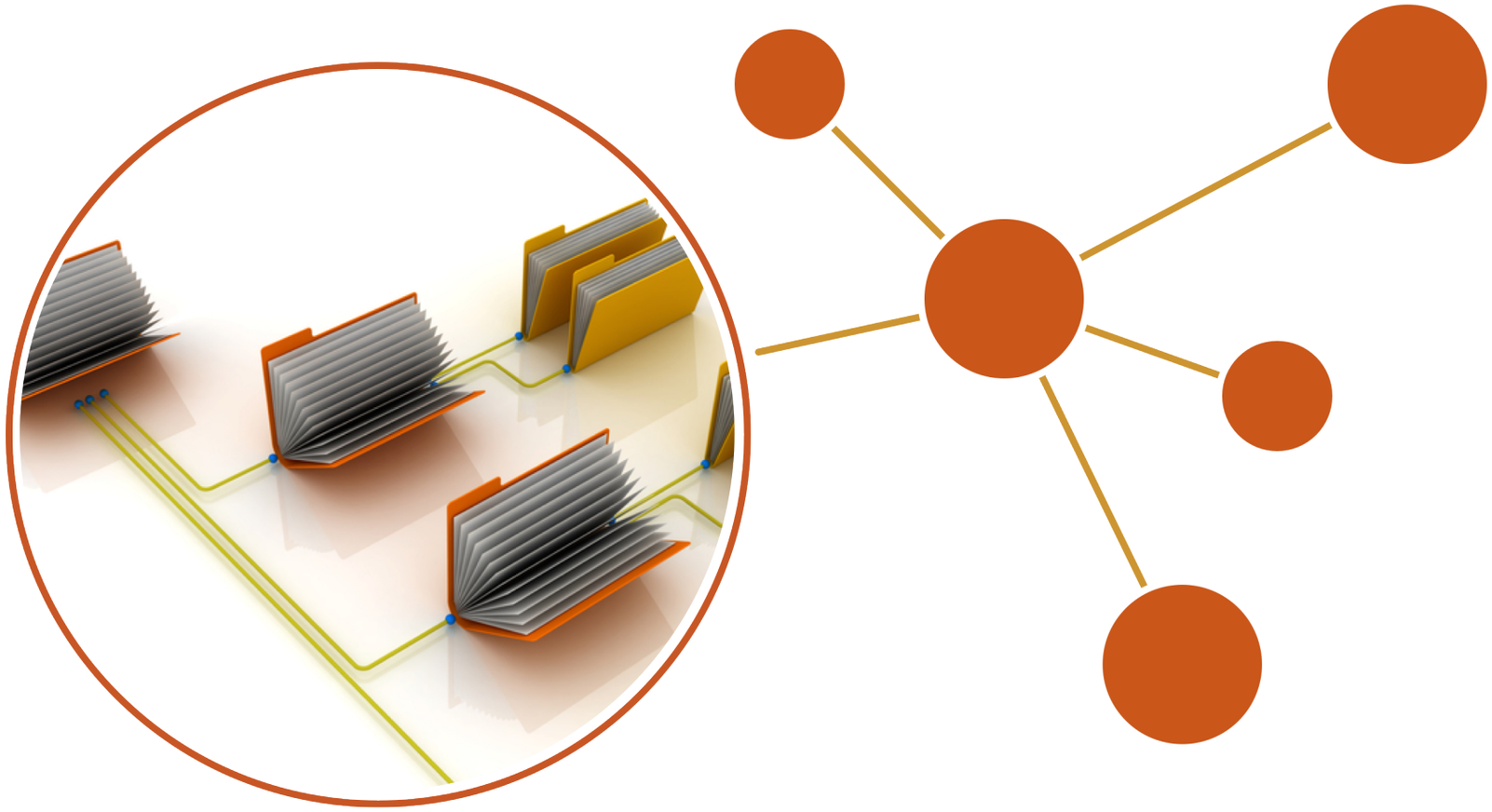
Recommendations



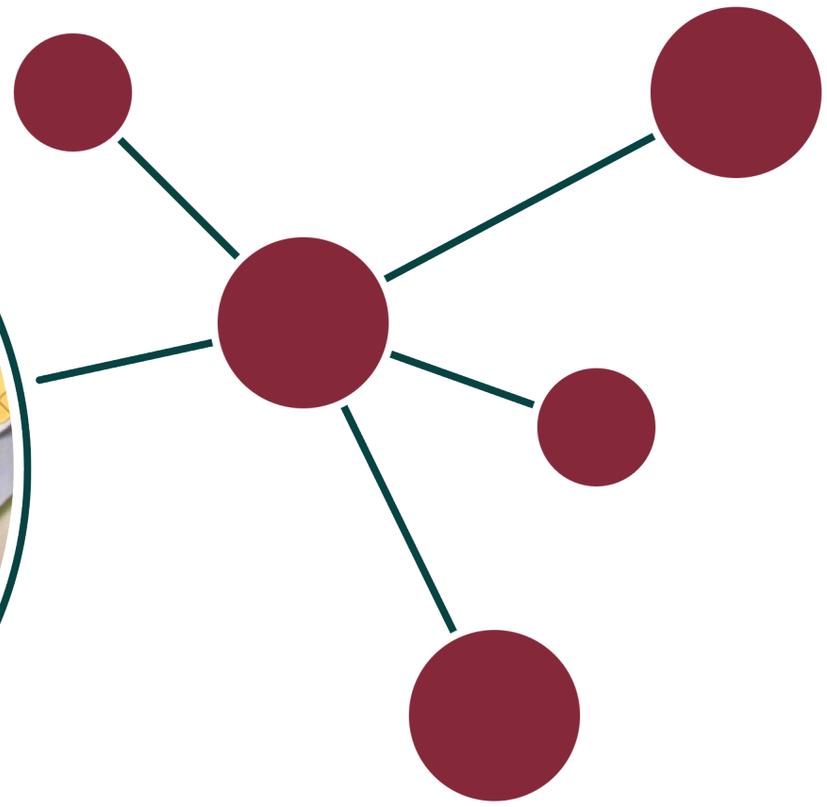
Logistics



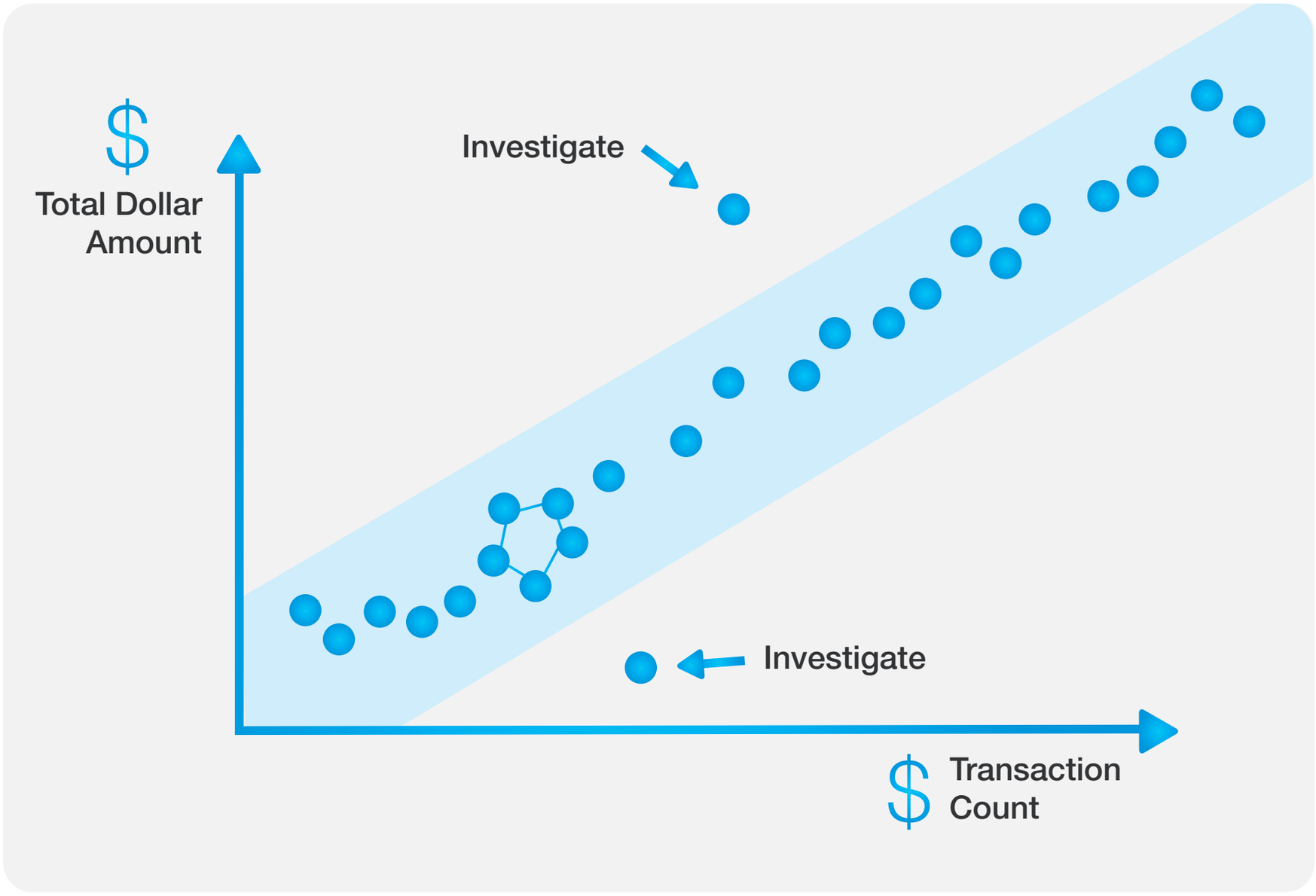
Access Control



Fraud Detection

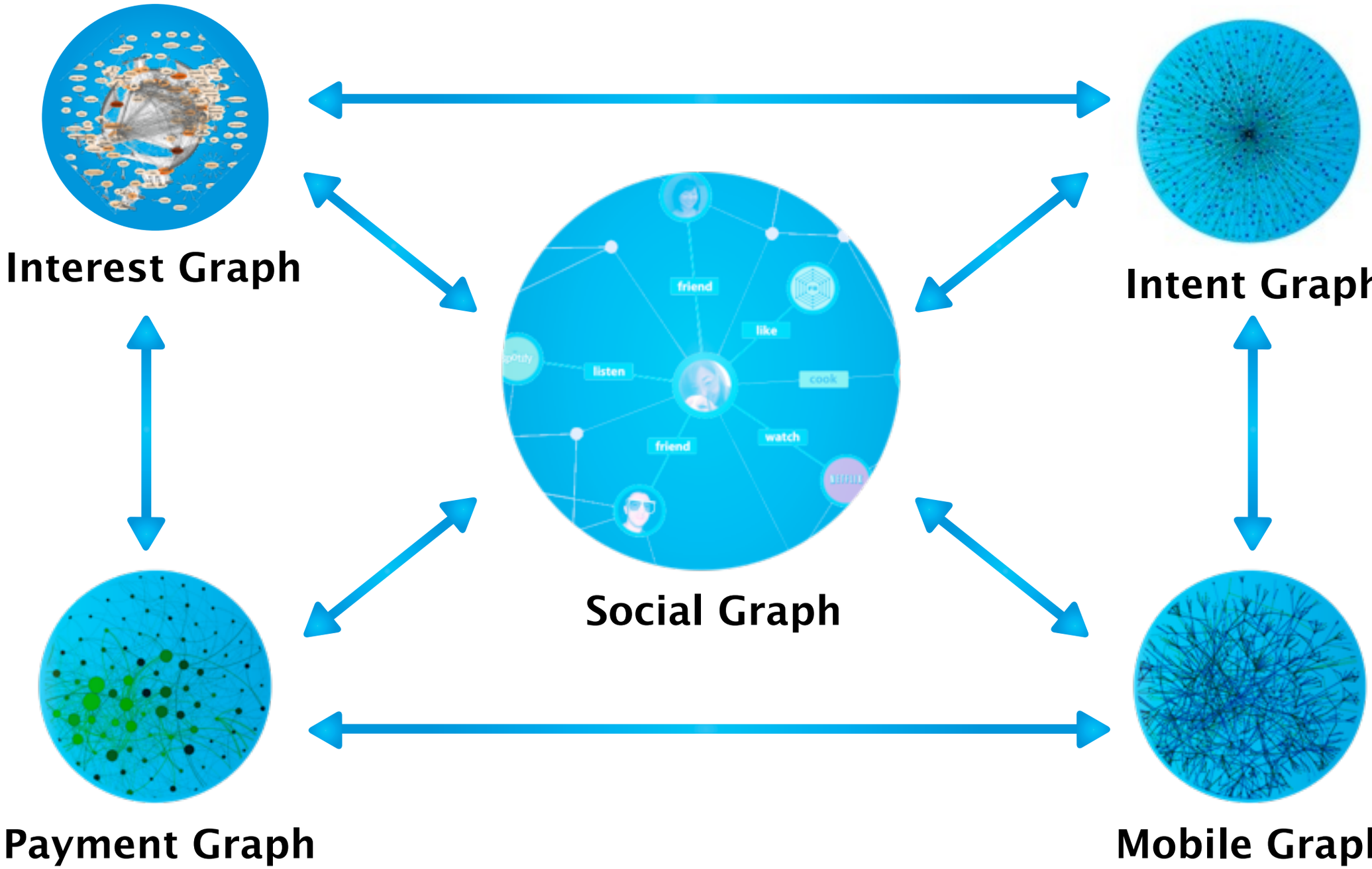


Fraud Detection: Uncovering Fraud Rings



Basically: Graph All The Things!!! I

Gartner's "5 Graphs"



Ref: http://www.gartner.com/id=2081316

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5 Graphs of Telco

- **Network Graph**
  (e.g. Network Dependency Analysis, Network Inventory, etc.)
- **Social Graph**
  (mobile apps, social recommendations, collaboration)
- **Call Graph**
  (creating inferred social graph, churn reduction, etc.)
- **Master Data Graph**
  (org & product hierarchy, data governance, IAM)
- **Help Desk Graph**
  (enterprise collaboration)

5 Graphs of Finance

- **Payment Graph** First Data. intuit
  (e.g. Fraud Detection, Credit Risk Analysis, Chargebacks...)
- **Customer Graph** opencorporates
  (org drillthru, product recommendations, mobile payments, etc.)
- **Entitlement Graph** Global 500 Finance
  (identity & access management, authorization)
- **Asset Graph** DRW TRADING GROUP Global 500 Finance
  (portfolio analytics, risk management, market & sentiment analysis, compliance)
- **Master Data Graph** ICE die Bayerische
  (enterprise collaboration, corporate hierarchy, data governance)

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5 Graphs of Health Care

- **Provider Graph**
  (e.g. referrals, patient management, research)

- **Patient Graph**
  (support communities, doctor recommendations, clinical trials)

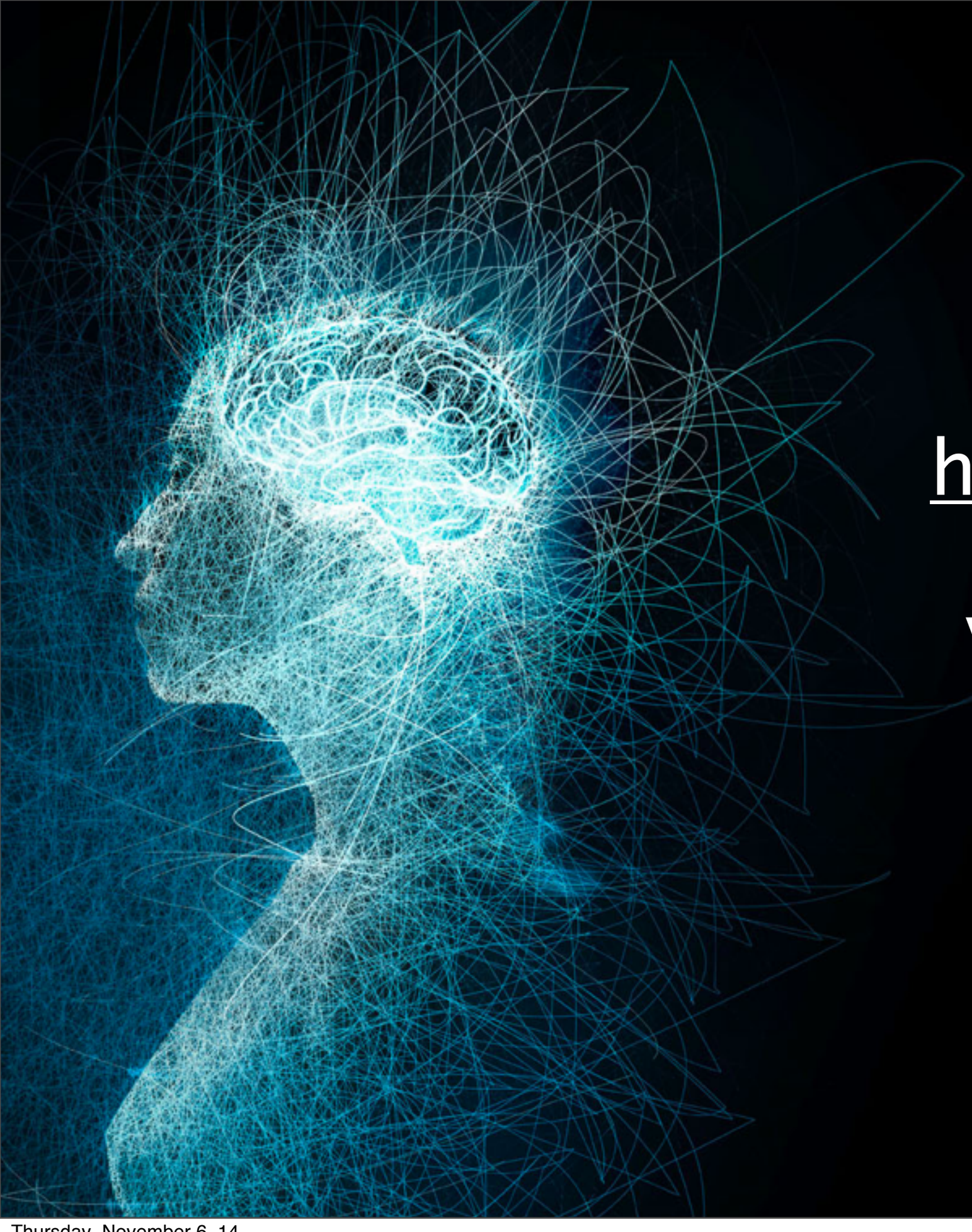
- **Bioinformatic Graph**
  (drug research, genetic screening, bioengineering, etc.)

- **Master Data Graph**
  (biological master data, evolutionary taxonomy, the access control graph, etc.)

- **Treatment Graph**
  (collaborative medicine, clinical trials, etc.)

5 Graphs of <YourIndustry>

Please help us map out the **five graphs** of your industry!



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http://neo4j.com

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Thanks for
Listening!