# Using AsciiArt to Analyse your SourceCode with Neo4j and OSS Tools

## Who the hell is this guy?

- Michael Hunger
- Developer Advocate Neo Technology
- Love People and Graphs
- @mesirii | michael@neotechnology.com

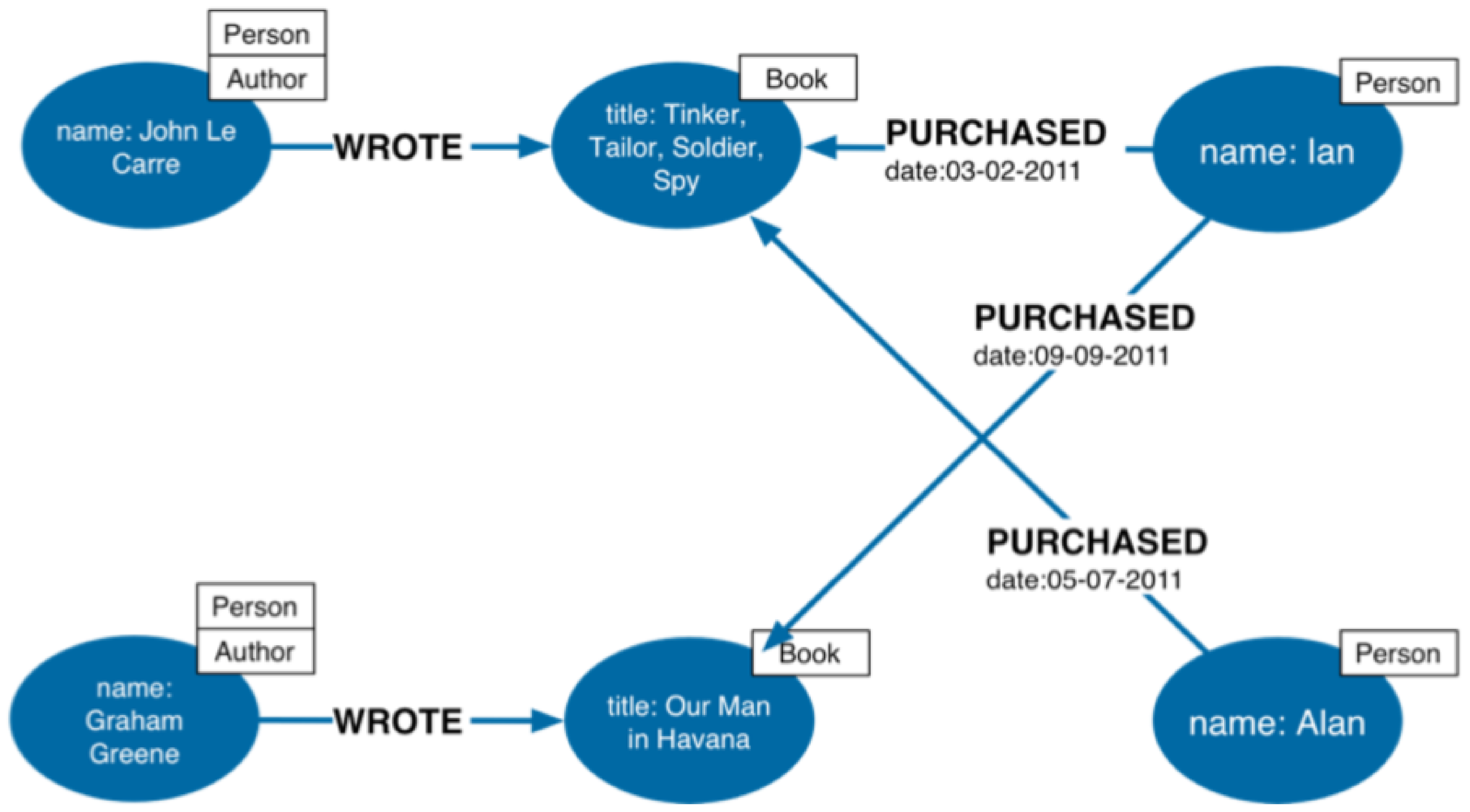
## What will he talk about?

- What is this Neo4j Graphdatabase thing?
- Ascii-Art Rocks
- Graphs in Your Code - The Idea
- Having Fun with your Code and jQAssistant
- Gimme More

## What is a Graph Database ?

- labeled Nodes
- directed, typed Relationships
- arbitrary Properties on each

# Property Graph Model

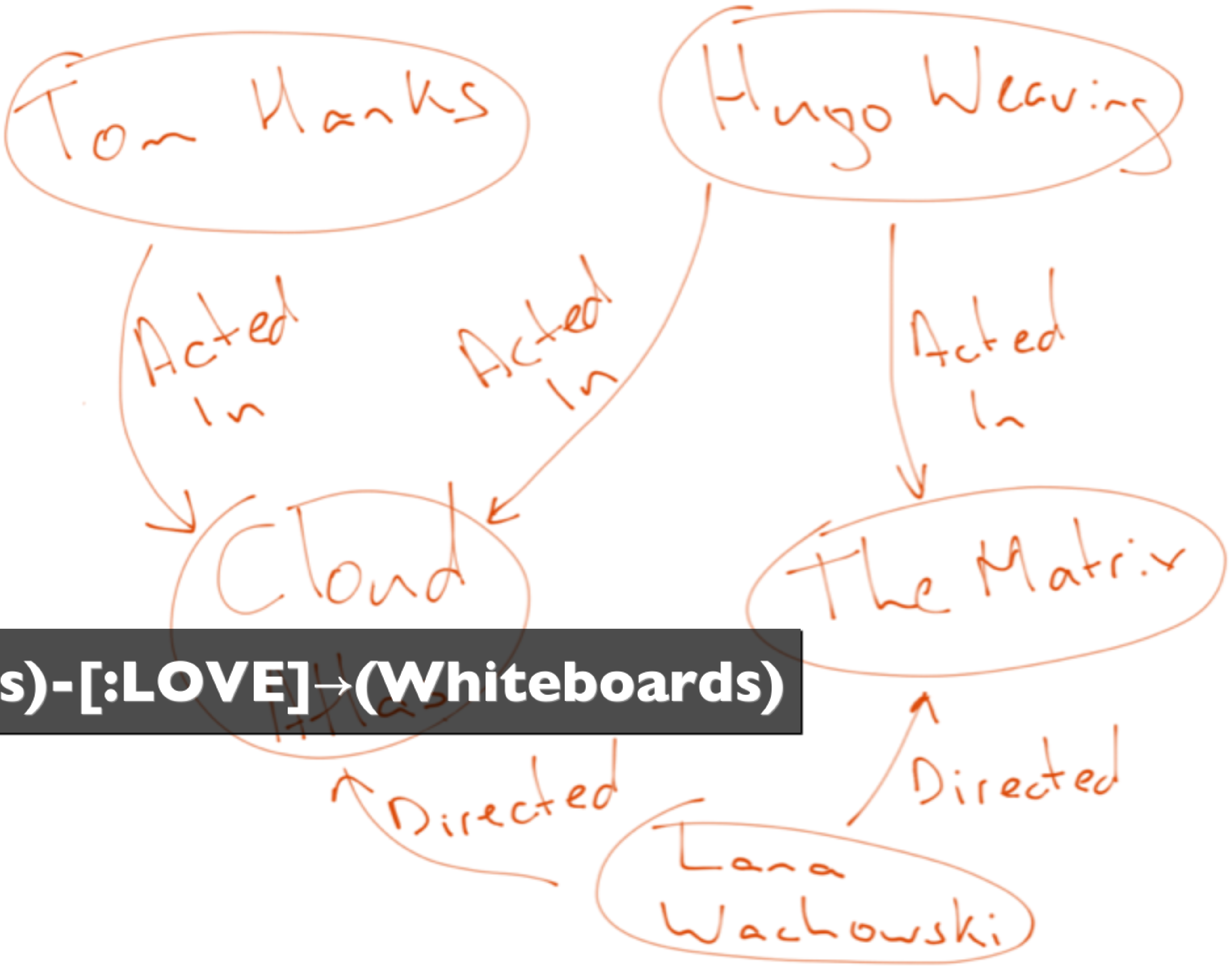


## What makes it special ?

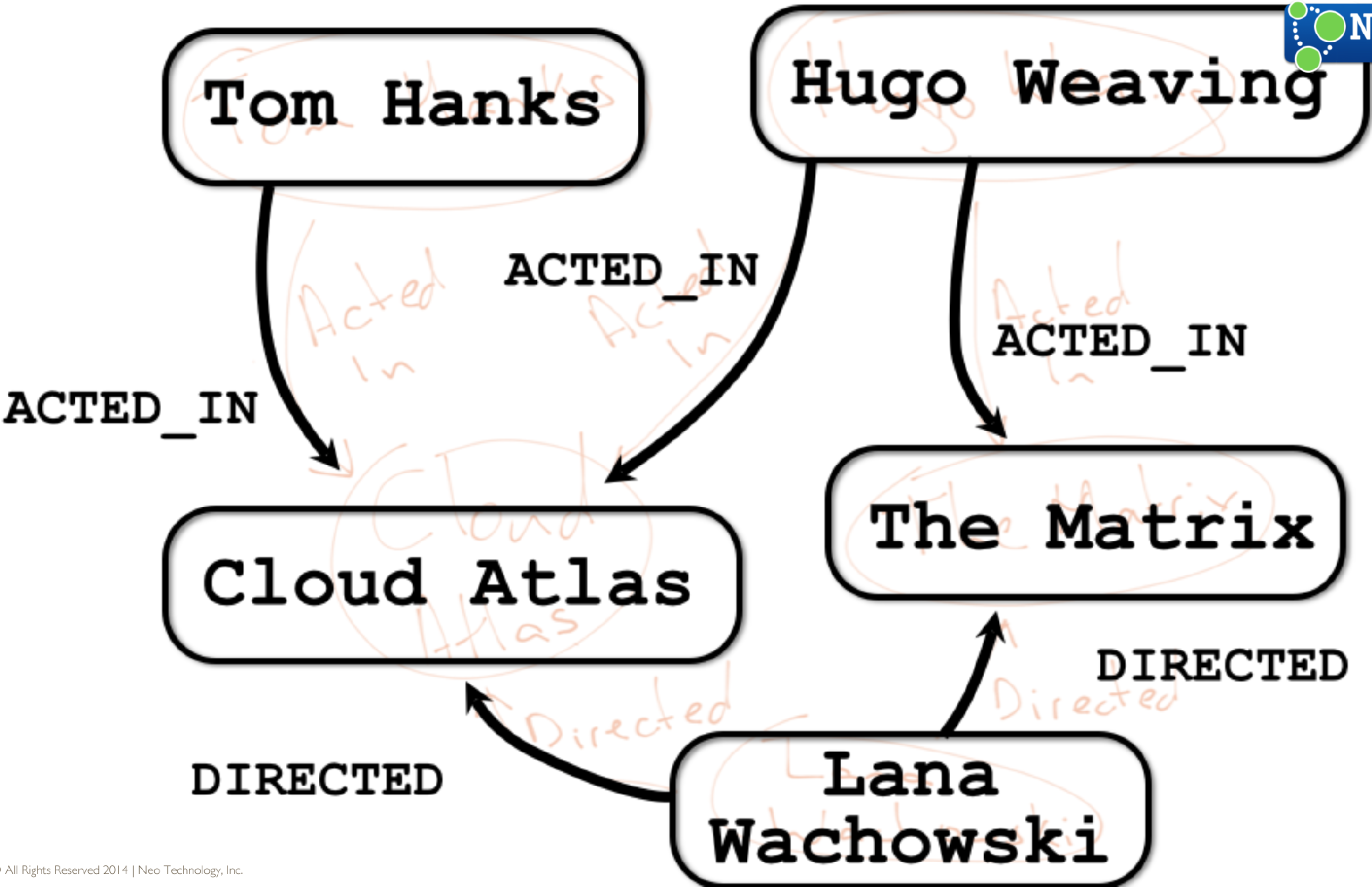
- close to the object model
- prematerialize relationships
- traversals in linear time
- sparse, heterogenous data + schema free
- local queries - explore the neighbourhood
- whiteboard-friendly

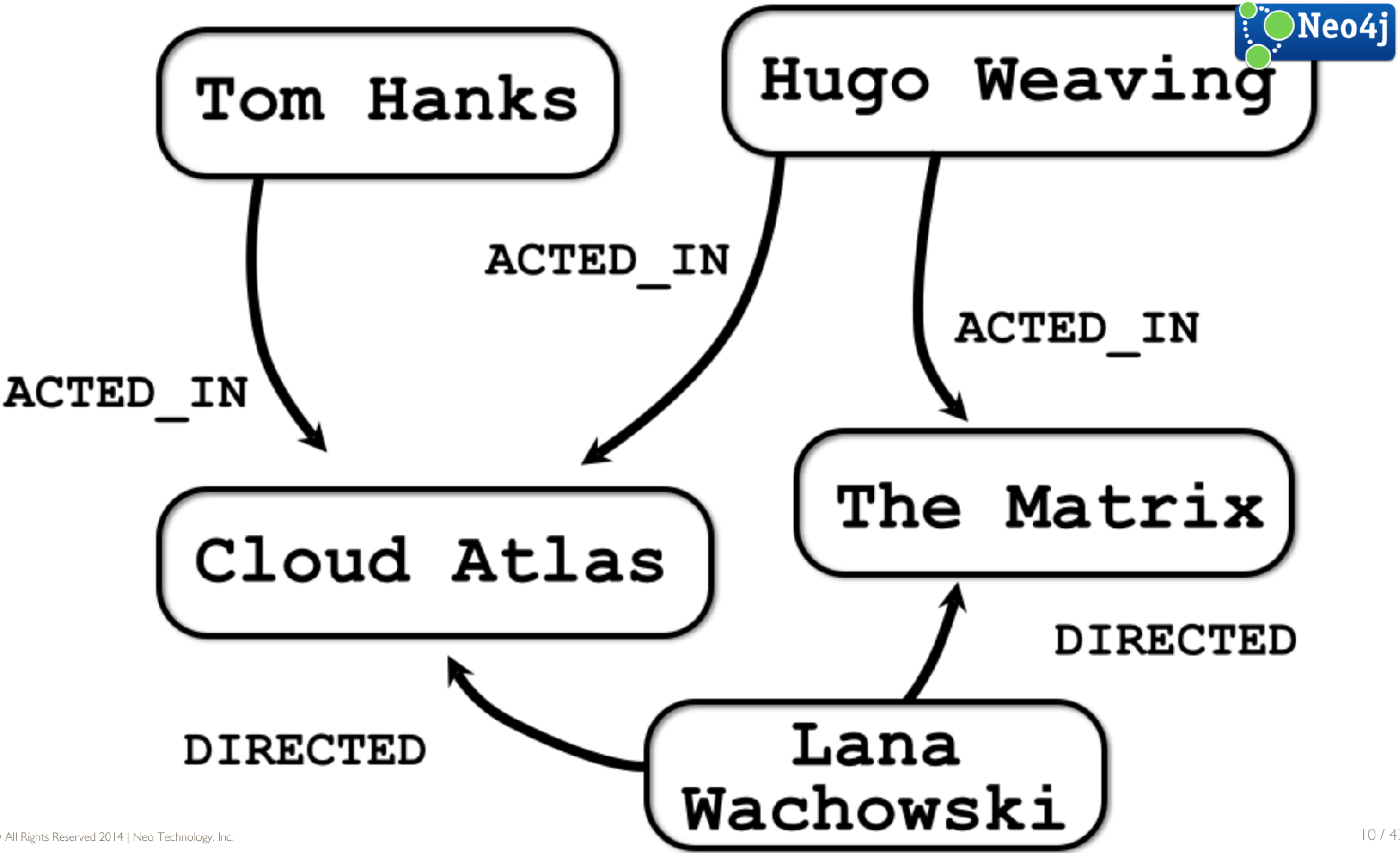
## Where can/should I use it ?

- Impact Analysis (Network, Software)
- Routing / Logistics
- Recommendation, Dating, Job-Search
- Sciene (Metadata, Drug Research)
- Masterdata, Hierarchy-Mgmt
- Fraud-Detection, Market-Analysis
- Social, …. and many more



# (Graphs)-[:LOVE]→(Whiteboards)


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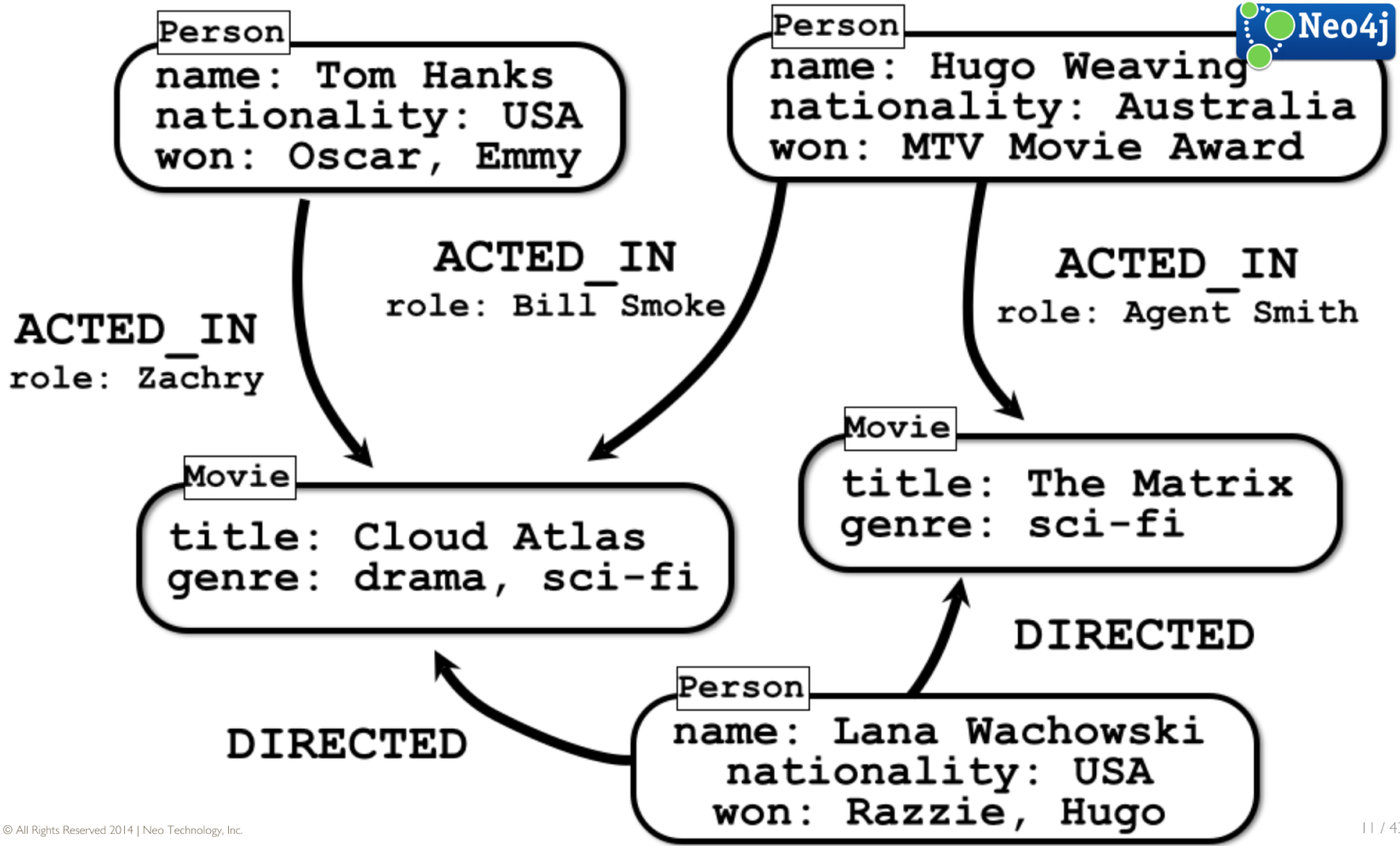

Person
name: Tom Hanks
nationality: USA
won: Oscar, Emmy
Person
name: Hugo Weaving
nationality: Australia
won: MTV Movie Award
ACTED_IN
role: Zachry
ACTED_IN
role: Bill Smoke
ACTED_IN
role: Agent Smith
Movie
title: Cloud Atlas
genre: drama, sci-fi
Movie
title: The Matrix
genre: sci-fi
DIRECTED
DIRECTED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

## Ascii-Art Rocks

- Turn text into pictures
- Turn picture into text
- The Power of Symbols
- Graph Patterns Made easy
- Hacker and Mudder Friendly
- Diffs, VCS

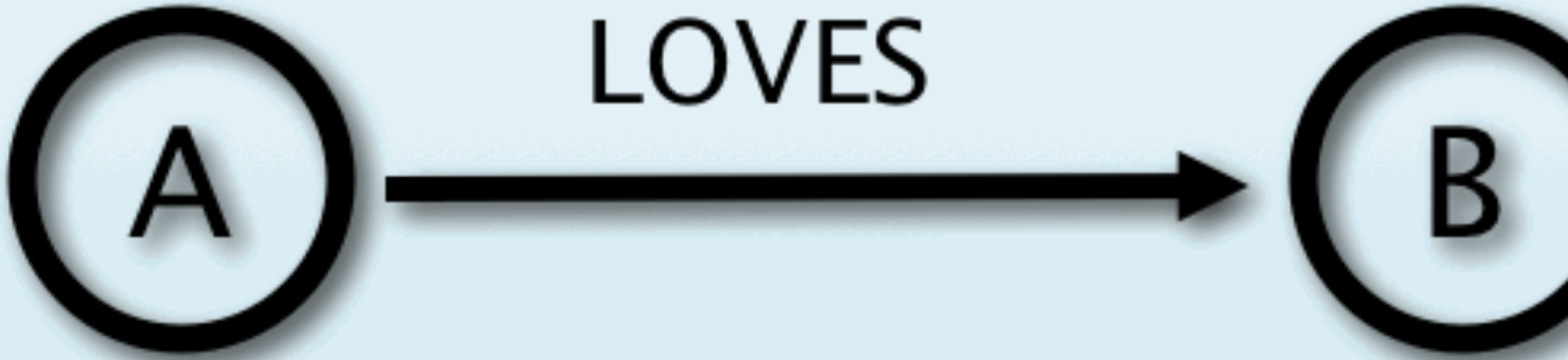
# Ascii-Art Rocks

```
_                         )      ((   ))     (
(@)                      /|\      ))_((     /|\                        _
|-|`\                   / | \    (/\|/\)   / | \                      (@)
| | -------------------/--|-voV---\`|'/--Vov-|--\---------------------|-|
|-|                         '^`   (o o)  '^`                          | |
| |                               `\Y/'                               |-|
|-|          Welcome to the Mages Lair Multiple User Dungeon          | |
| |                    Welcome to the Addiction.                      |-|
|-|                                                                   | |
| |                                                                   |-|
|_|___________________________________________________________________| |
(@)               l   /\ /        ( (       \ /\   l                `\|-|
                  l /   V          \ \       V   \ l                  (@)
                  l/               _) )_          \I
                                   `\ /'
                                     `
```

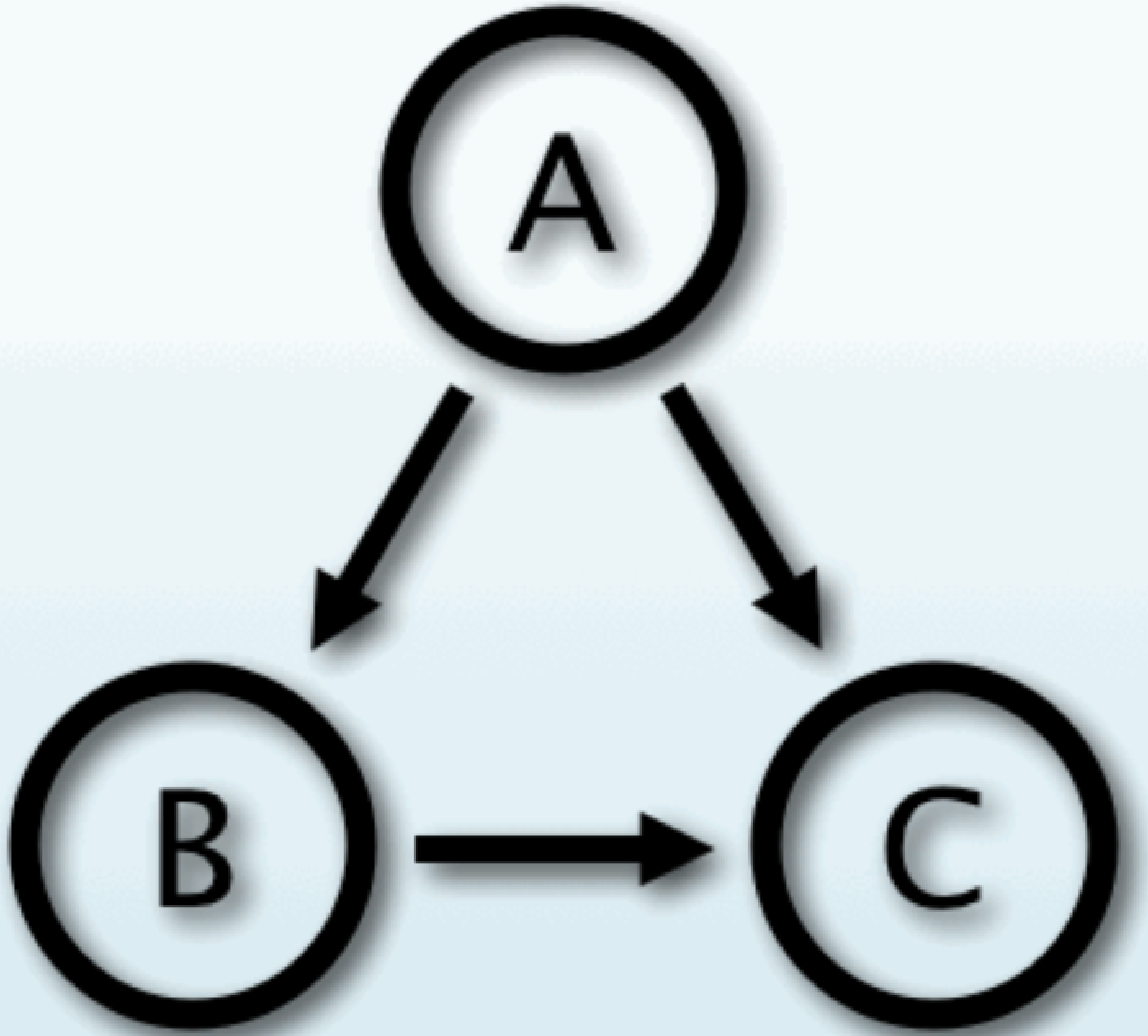
## Cypher

## (Cypher)-[:USES]→(Ascii-Art)

- Declarative Graph Query Language
- Graph Pattern Matching
- Humane, Readable
- Expressive
- Read and Write Graphs
- Tabular Results



```
A -[:LOVES]->
```



A --> B --> C, A --> C

A --> B --> C <-- A

## Cypher Query - Example Geekout

# Cypher Query - Example Geekout

## Setup

```
CREATE (:Year {year:2014})<-[:IN_YEAR]-(geekout:Conference {name:"Geekout"})
        -[:LOCATION]->(:City {name:"Tallinn"})
CREATE (track:Track {name:"Room 1"})-[:TRACK_OF]->(geekout)

MERGE (speaker:Attendee:Speaker {name:"Hadi Hariri"}) MERGE (geekout)<-[:ATTENDS]-(speaker)

CREATE (speaker)-[:PRESENTS]->(session:Session {title:"Mouseless IDE"})<-[:IN_TRACK]-(track)

FOREACH (name in ["Java","IDE","Development"] |
   MERGE (topic:Topic {name:name})
   CREATE (session)-[:HAS_TOPIC]->(topic))
```

# Cypher Query - Example Geekout

## Setup

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CREATE (:Year {year:2014})<-[:IN_YEAR]-(geekout:Conference {name:"Geekout"})
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FOREACH (name in ["Java","IDE","Development"] |
   MERGE (topic:Topic {name:name})
   CREATE (session)-[:HAS_TOPIC]->(topic))
```

## Query

```
// Which Speakers entertain you with Java ?
MATCH (t:Topic {name:"Java"})<-[:HAS_TOPIC]-(session)<-[:PRESENTS]-(speaker),
      (session)<-[:IN_TRACK]-(track)

RETURN speaker.name as speaker, {time:session.time, session:session.title} as session,
       track.name as track
ORDER BY session.time
```

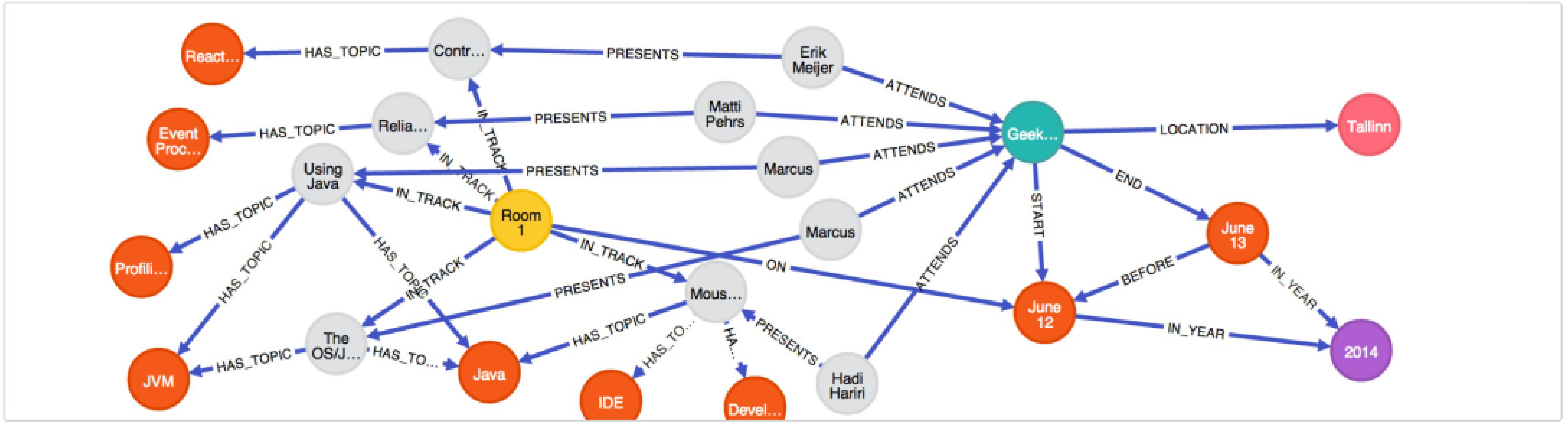
# Geekout 2014 GraphGist

### Let me graph that for you: GeekOut 2014

**What better way to show what a graph database is good at, is to show how it helps you to connect people, sessions, topics, time and more.**

Query 1 — this query has been used to initialize the console

Test run OK



### Which Speakers entertain you with *Java* ?

Query 2

```
MATCH (t:Topic {name:"Java"})<-[:HAS_TOPIC]-(session)<-[:PRESENTS]-(speaker), (session)<-[:IN_TRACK]-(track)
RETURN speaker.name as speaker, {time:session.time, session:session.title} as session
ORDER BY session.time
```

Test run OK

| speaker | session |
|---|---|
| Hadi Hariri | {time:"11.15", session:"Mouseless Driven Development"} |
| Marcus Hirt | {time:"14:30", session:"Using Java Flight Recorder"} |
| Marcus Lagergren | {time:"15:50", session:"The OS/JVM dialectic – ending the struggle through unity"} |

Interactive GraphGist Document WorldCup

# Software Analytics - Approach

1. look at one interesting aspect
2. which insights would be cool?
3. model it as a graph
4. get data
5. import into graph model
6. enrich graph model with concepts / structure
7. query for insights

# (Code)-[:IS_A]→(Graph)

- AST, ByteCode, Source-Code
- Inheritance, Composition, Dependencies
- Transitive Module and Library dependencies
- Dependency injection config
- Data model (db) <→ object model
- Runtime characteristics: call graph, heap
- Version control, repositories, issues

## jQAssistant

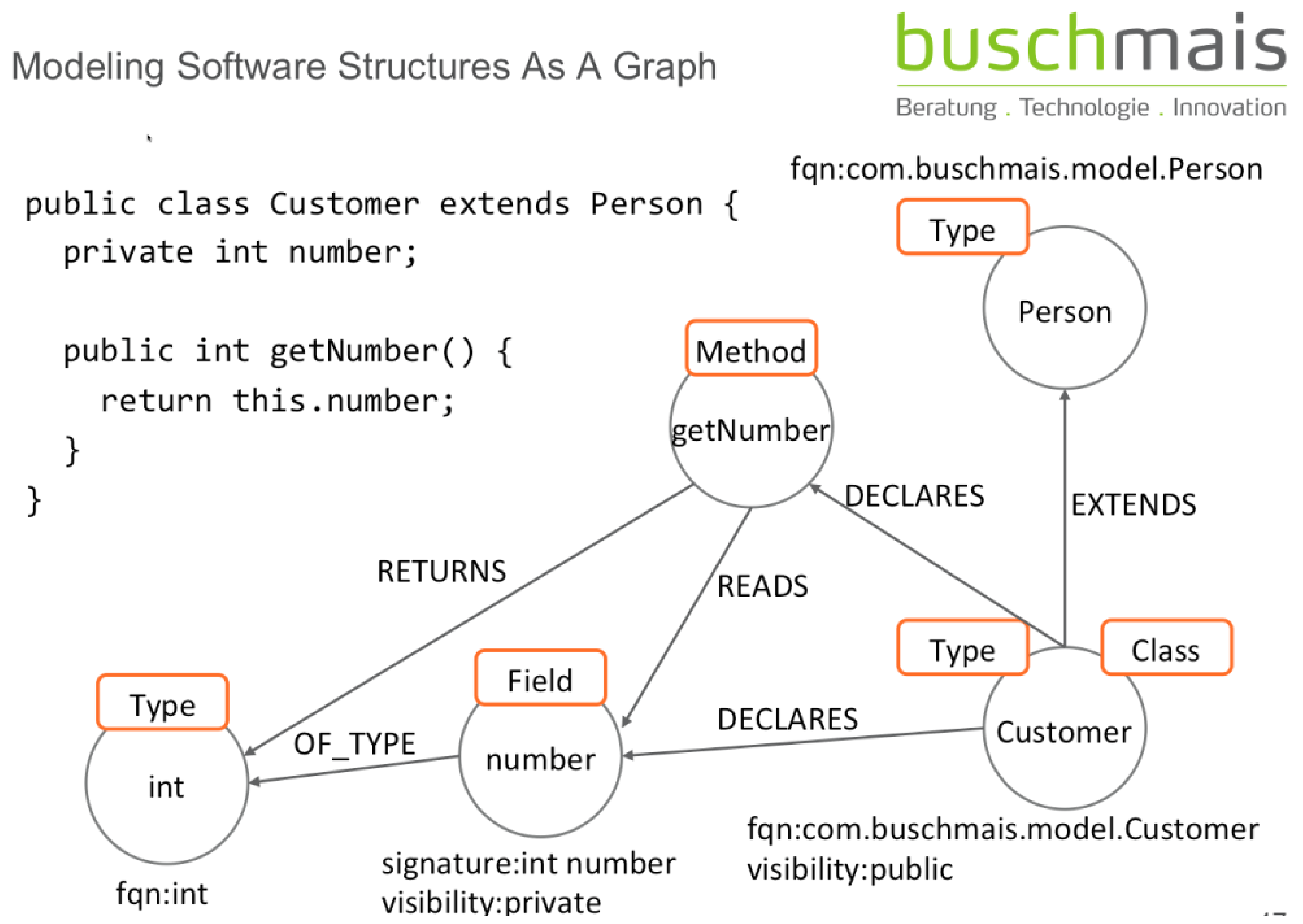
- Open Source Software Analytics Tool
- Plugins for Java, JEE, JPA, Maven, Gradle, SonarJ …
- All Cypher based
- Technical and Domain Concept Definitions
- Compute Software Metrics
- Declare and Validate Architectural Rules
- Integrated in Build Process

## jQAssistant

Actively Looking for Contributions

http://github.com/buschmais/jqassistant

# Modeling Source Code as a Graph



Modeling Software Structures As A Graph

```
public class Customer extends Person {
  private int number;

  public int getNumber() {
    return this.number;
  }
}
```

## Java software graph model : Nodes

- Artifact
- Package
- Type, Class, Interface, Annotation, Enum
- Method, Constructor, Parameter
- Field
- Value, Class, Annotation, Enum, Primitive, Array

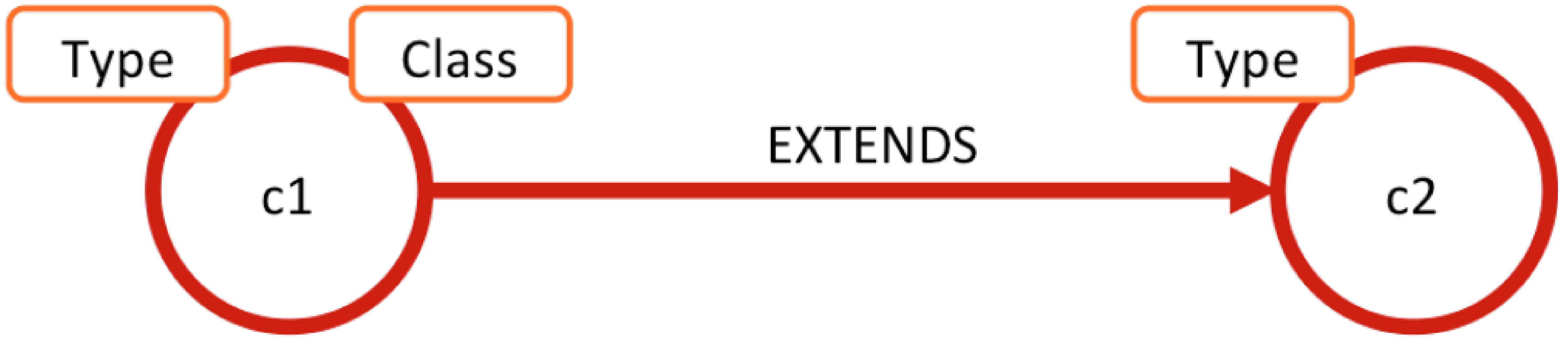
## Java software graph model: Relationships

- CONTAINS, DECLARES
- EXTENDS, IMPLEMENTS
- RETURNS, THROWS, INVOKES, HAS, IS
- ANNOTATED_BY, OF_TYPE

## Approach

1. Scan your project with
   Plugins for Code (Java-ASM), Config, Metadata
2. Import into Neo4j
3. Enrich with declared technical and domain concepts
4. On top of those concepts
5. Software-Metrics queries
6. Architectural-Rules queries

# Query the Data



Pattern matching is the core principle of Cypher!

```
MATCH
  (c1:Class)-[:EXTENDS]->(c2:Type)
RETURN
  c1.fqn, c2.fqn
```

## Demo

## Analyzing A Maven Repository

Rickard Öberg

This little nifty tool will allow you to import your local Maven repository information into a Neo4j graph, in particular dependencies between artifacts.

You can then take this graph and put it into a Neo4j server, and perform Cypher queries on it.

Or whatever else awesome you want to do.

```
mvn compile exec:java -Dexec.mainClass=com.github.rickardoberg.neomvn.Main \
  -Dexec.arguments="$HOME/.m2/repository"
```

https://github.com/rickardoberg/neomvn#example-queries

## NeoMVN: Example Queries

# NeoMVN: Example Queries

## Find all transitive dependencies of all artifacts with "org.neo4j" groups

```
MATCH (group:Group {groupId:'org.neo4j'}),
      (group)-[:HAS_ARTIFACT]->(artifact)-[:HAS_VERSION]->(version)<-[:HAS_DEPENDENCY]-(dependent)

WHERE left(dependent.groupId,9)<>group.groupId
RETURN DISTINCT dependent.artifactId, dependent.groupId
```

## NeoMVN: Example Queries

### Find all transitive dependencies of all artifacts with "org.neo4j" groups

```
MATCH (group:Group {groupId:'org.neo4j'}),
      (group)-[:HAS_ARTIFACT]->(artifact)-[:HAS_VERSION]->(version)<-[:HAS_DEPENDENCY]-(dependent)

WHERE left(dependent.groupId,9)<>group.groupId
RETURN DISTINCT dependent.artifactId, dependent.groupId
```

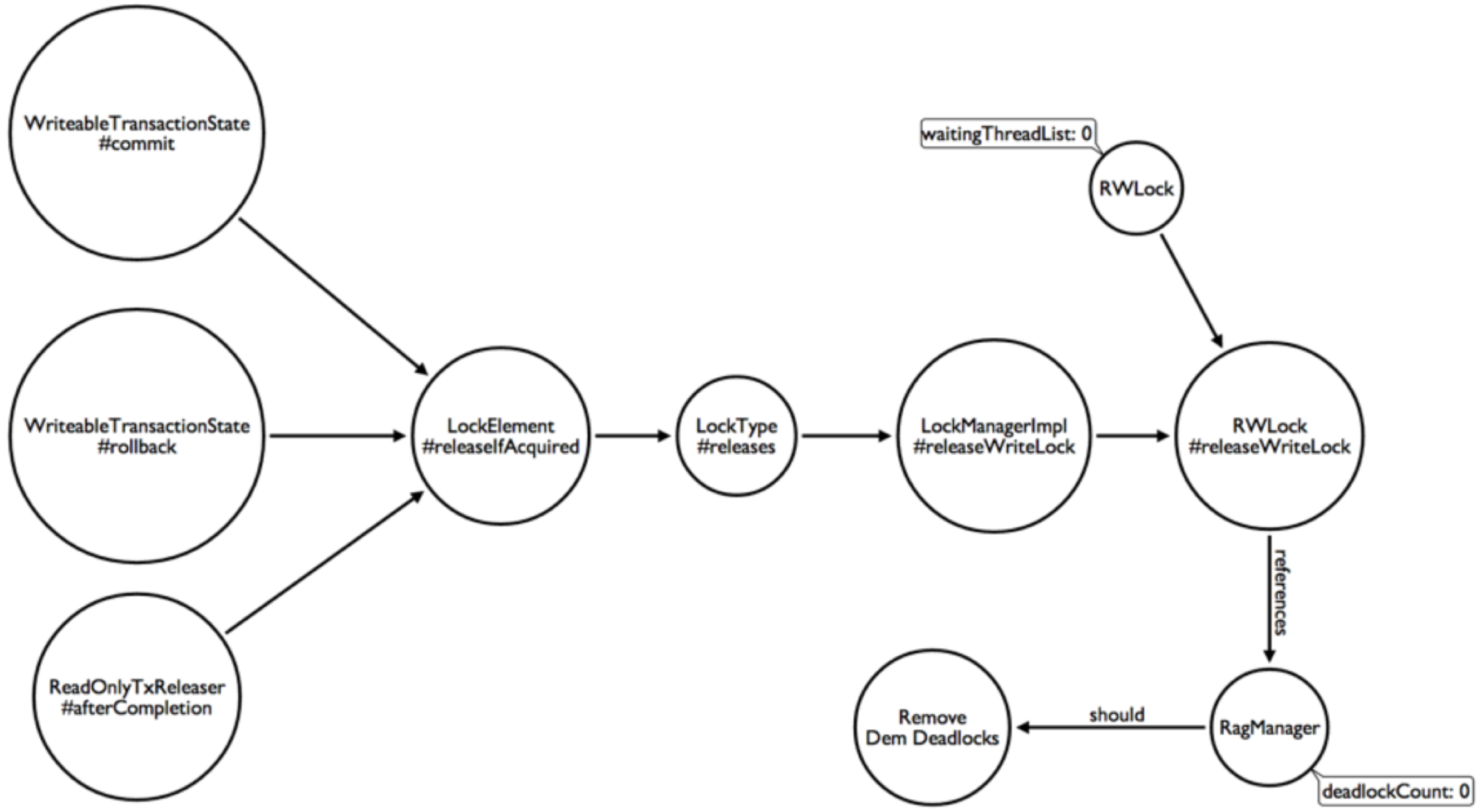
### Which version of JUnit is the most popular

```
MATCH (group:Group {groupId:'junit'})
MATCH (group)-[:HAS_ARTIFACT]->(artifact)-[:HAS_VERSION]->(version)<-[:HAS_DEPENDENCY]-(dependent)
RETURN version.version, count(dependent) as depCount
ORDER BY depCount DESC
```

# Query a JVM Heapdump

1. Get a heap-dump with `jmap`
   ```
   jmap -dump:format=b,file=dump.hprof <pid>
   ```
2. Use `jhat dump.hprof` find the /oql endpoint
3. run the *OQL* script to generate *Cypher* code
4. Import into Neo4j
5. Run arbitrary queries
6. Visualize

# Graph Domain Model


WriteableTransactionState #commit
WriteableTransactionState #rollback
ReadOnlyTxReleaser #afterCompletion
LockElement #releaseIfAcquired
LockType #releases
LockManagerImpl #releaseWriteLock
waitingThreadList: 0
RWLock
RWLock #releaseWriteLock
references
RagManager
deadlockCount: 0
should
Remove Dem Deadlocks

# OQL to Generate Cypher

```
select (function () {
  var entries = filter(p.waitingTxMap.data.table, function(it) { return it; });
  var resources = "";

  var idSeq = 0;

  for ( var i = 0; i < entries.length; i++ ) {
    var resource = entries[i].value.resource;
    var index = resource.index.toString();
    var key = resource.key.toString();
    var indexNameIndexKey = index + "_" + key;
    var indexName = "n" + idSeq++;

    var resourceName = "";

    var tx = entries[i].key;
    var txName = "n" + idSeq++;

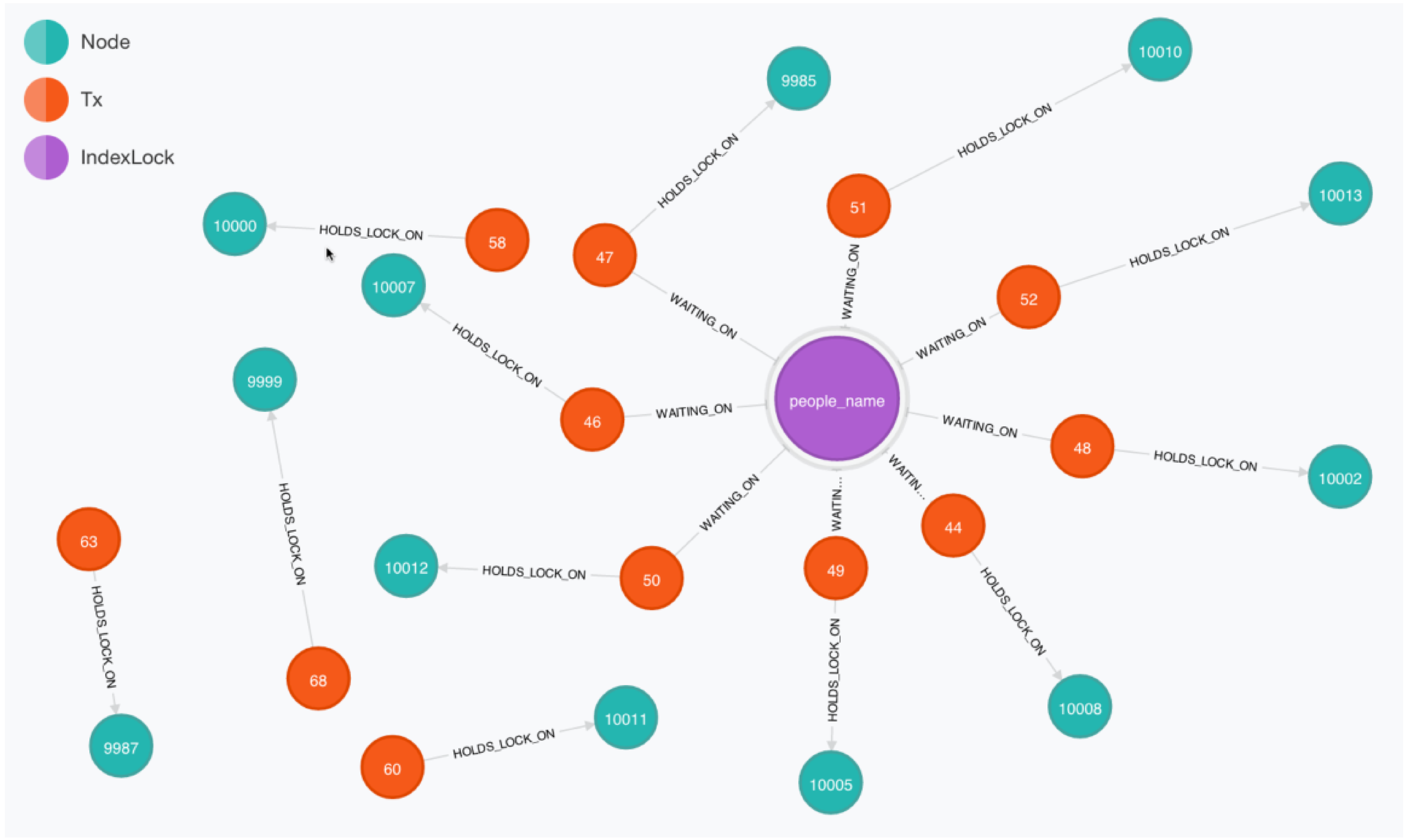
    var cypher =  "MERGE (" + txName + ":Tx {txId:" + tx.eventIdentifier + "})<br />";
    cypher     += "MERGE (" + indexName + ":IndexLock {indexLockId:'" + indexNameIndexKey + "'})<br />";
    cypher     += "CREATE (" + txName + ")-[:WAITING_ON]->(" + indexName + ")<br />";

    resources += cypher + "<br />";
  }

...

  return resources;
})()
from org.neo4j.kernel.impl.transaction.RagManager p
```

# Visualization of a Deadlock Scenario

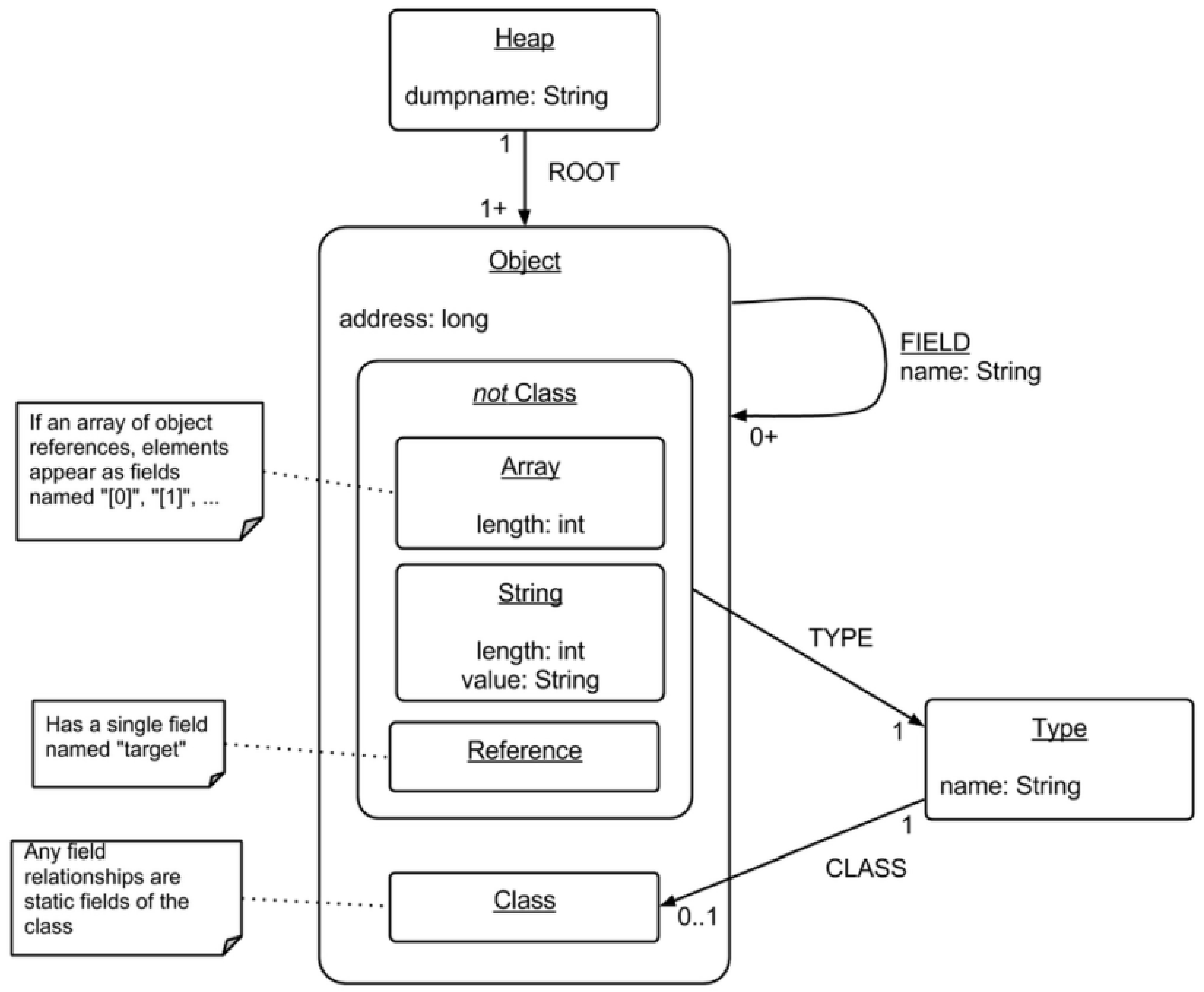


# JVM heap analysis using Neo4j

Nat Pryce, James Richardson (Software Engineers, Sky)

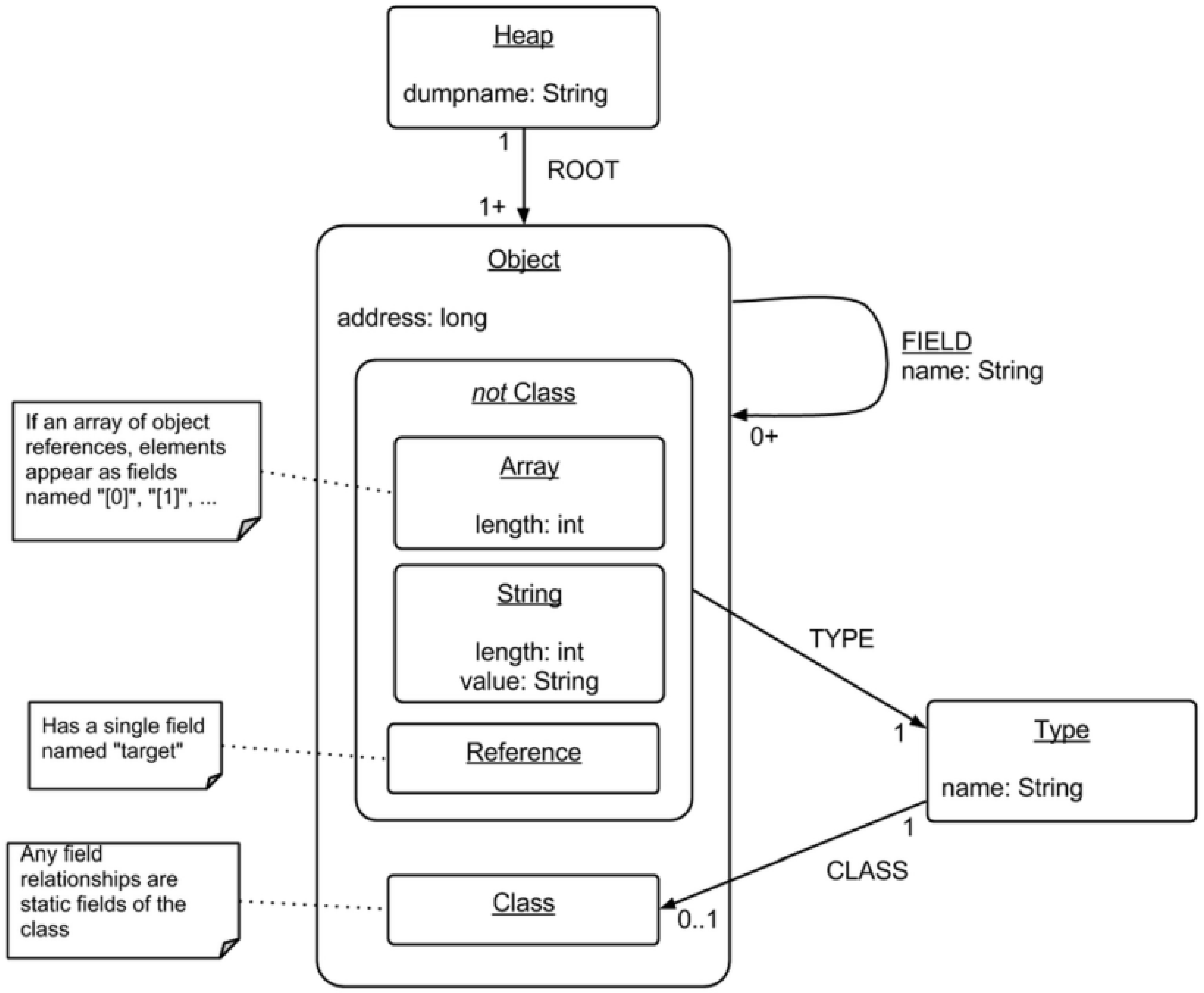
- Use Neo4J for ad-hoc analysis of heap use in a proprietary embedded JVM that's deployed in one of the most widely used consumer products in the UK (Sky Box).
- Used Cypher queries that uncovered surprising aspects of their code, platform and the Java compiler.
- **And finding a memory leaking JSON parser with a Cypher query.**

# Heap Model


Heap
dumpname: String
1
ROOT
1+
Object
address: long
FIELD
name: String
0+
not Class
Array
length: int
String
length: int
value: String
Reference
Class
TYPE
1
Type
name: String
1
CLASS
0..1
If an array of object references, elements appear as fields named "[0]", "[1]", ...
Has a single field named "target"
Any field relationships are static fields of the class

From Nat's Graph Schema Modeling Approach

# Heap Model


Heap
dumpname: String
1
ROOT
1+
Object
address: long
FIELD
name: String
0+
not Class
Array
length: int
If an array of object references, elements appear as fields named "[0]", "[1]", ...
String
length: int
value: String
TYPE
1
Type
name: String
Has a single field named "target"
Reference
1
CLASS
Any field relationships are static fields of the class
Class
0..1

From Nat's Graph Schema Modeling Approach

## Source Control, Issues, Social Coding

- What can you learn from commits
- about the code
- Class Toxicity, Frequency of Change (Feathers)
- about the people
- checkin times, collaboration, commit-size, commit-frequency
- Issues
- bug-rich classes (separation of concerns?)

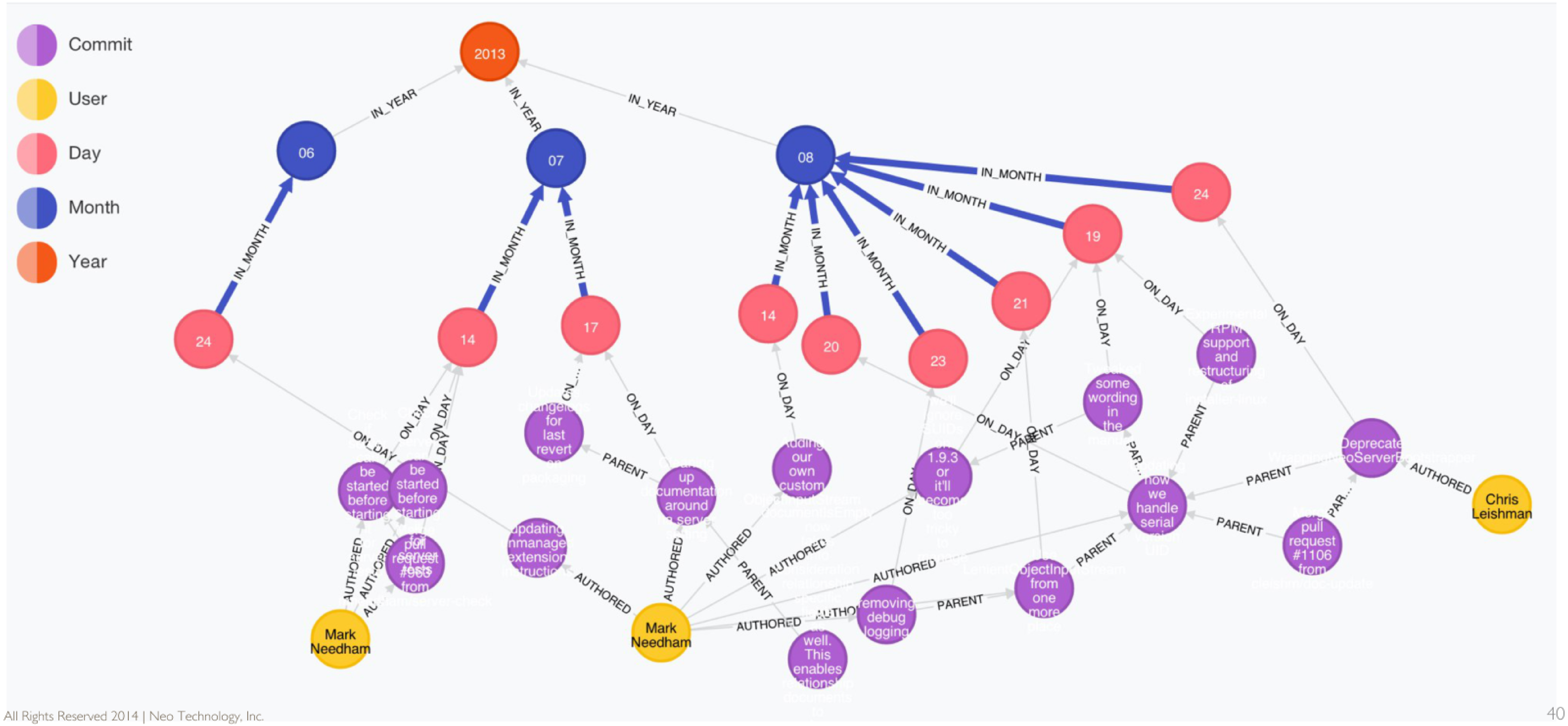
# Example: Import Git Commit Logs into Neo4j

- `git log --format` emits CSV
- Graph Model
- LOAD CSV with Cypher
- Create / Update complex Graph Structure

Blog Post

# Visualization

CYPHER MATCH path=(u:User {name:"Mark Needham"})-[:AUTHORED]->(:Commit)-[*..3]->(:Year) RETURN path



## Finally: Some Eye Candy

Isaac & Nash (Software Engineers at Leap Motion)

- Leap Motion Software
- Inheritance Hierarchy, Call Graph
- Render to .dot file
- Use dotparse.js to read it in
- WebGL enabled Three.js rendering
- LeapMotion SDK 2.x beta

Let's have a look: Demo Source

## Questions ? Thank You!