Neo4j.rb

Graph Database

The Natural Way to Persist Data ?

Andreas Kollegge

neo technology
value in relationships

Andreas Ronge

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NOSQL

The problem with SQL: not designed for

- Accelerating growth of data
- Huge clustered environments
- Complex and evolving data models

Choose the right tools - **N**ot **O**nly **SQL**

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The CAP Theorem

Can't achieve all three, pick two

- **Consistency** – all readers will see the same write
- **Availability** – tolerant of node failures
- **Partition tolerant** – if lost interconnect between nodes

Many NOSQL databases choose

- Sacrifice consistency over availability
- Eventual consistency instead of ACID (but not Neo4j)

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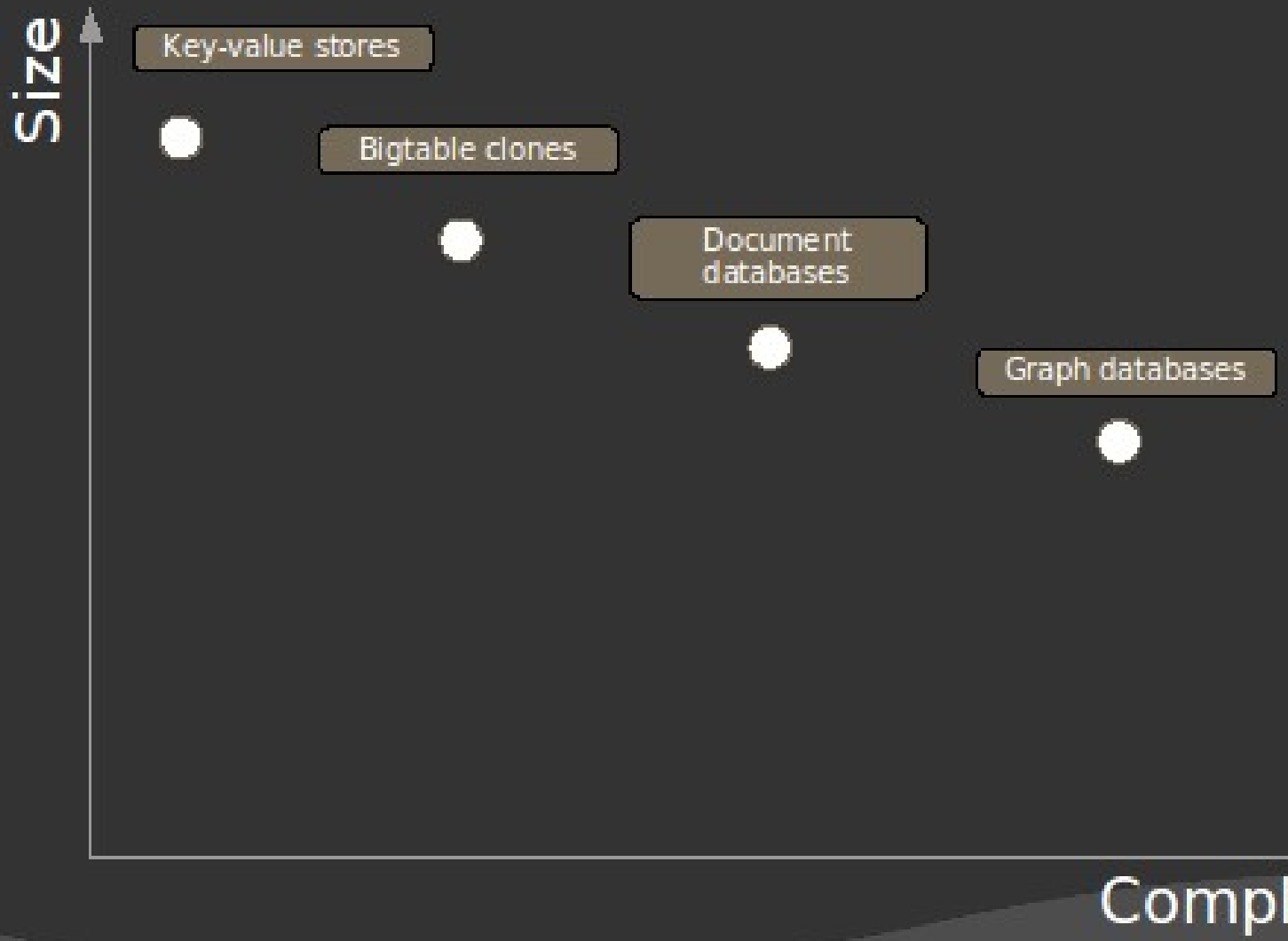
NOSQL data models



How can I talk to Neo4j ?

- Embedded with JRuby
  - Ruby Gems: **neo4j.rb**, **neo4jr-simple**
  - Ruby Gems: **pacer**
    - friends.out_e(:friend).in_v(:type => 'person').except(friends).except(person).most_frequent(0...10)
- Neo4j Server - HTTP/REST
  - Ruby Gems: **neography**

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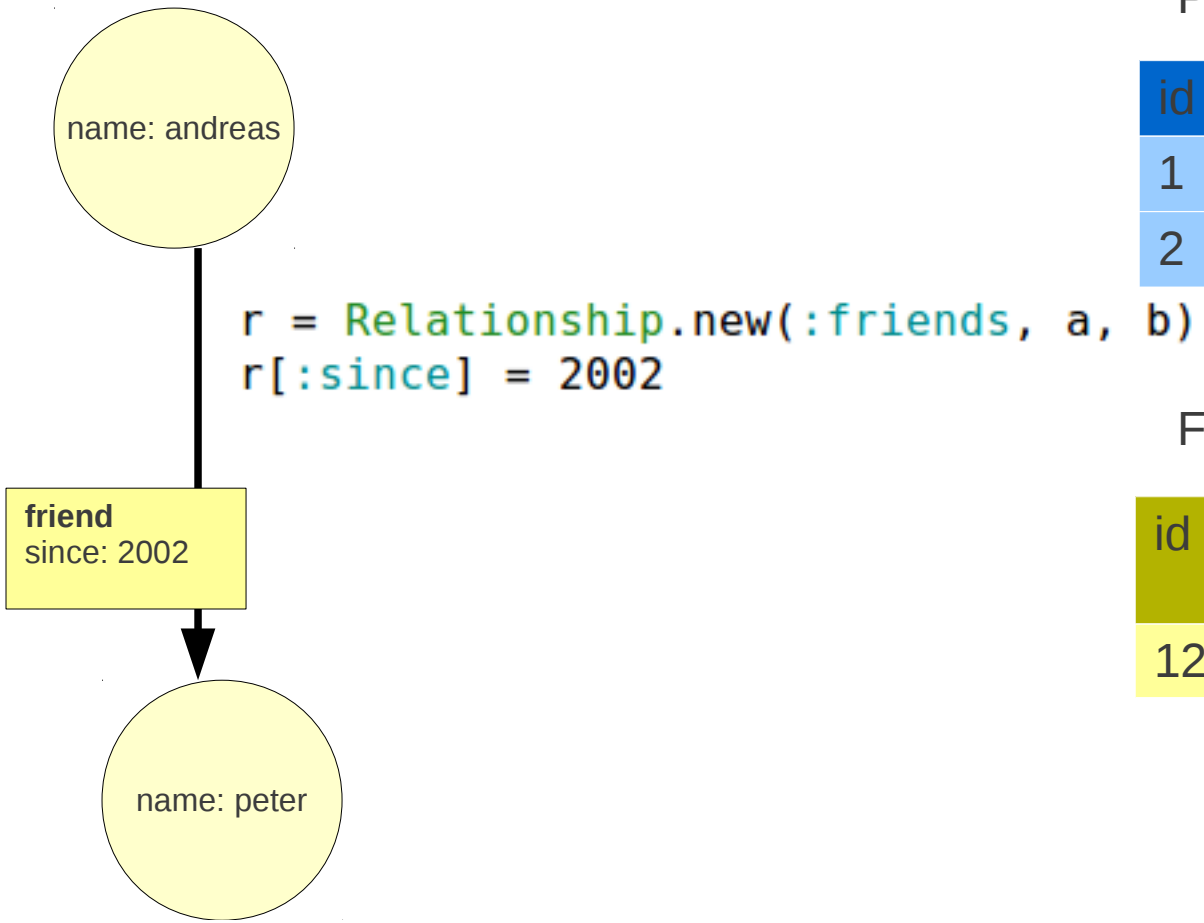
What is a Graph Database ?

Graph DB vs. SQL

```
Node.new :name => 'andreas'
```




```
r = Relationship.new(:friends, a, b)
r[:since] = 2002
```

```
Node.new :name => 'peter'
```

People

id	name
1	andreas
2	peter

Friends

id	p1_id	p2_id	since
1234	1	2	2002

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Graph DB vs SQL

```
node.outgoing(:friends)
```

```
SELECT p2.name FROM People p1, People p2
JOIN Friends f ON p2.id = f.p2_id OR p2.id = f.p1_id
WHERE p1.name = "peter" AND p1.id != p2.id
```

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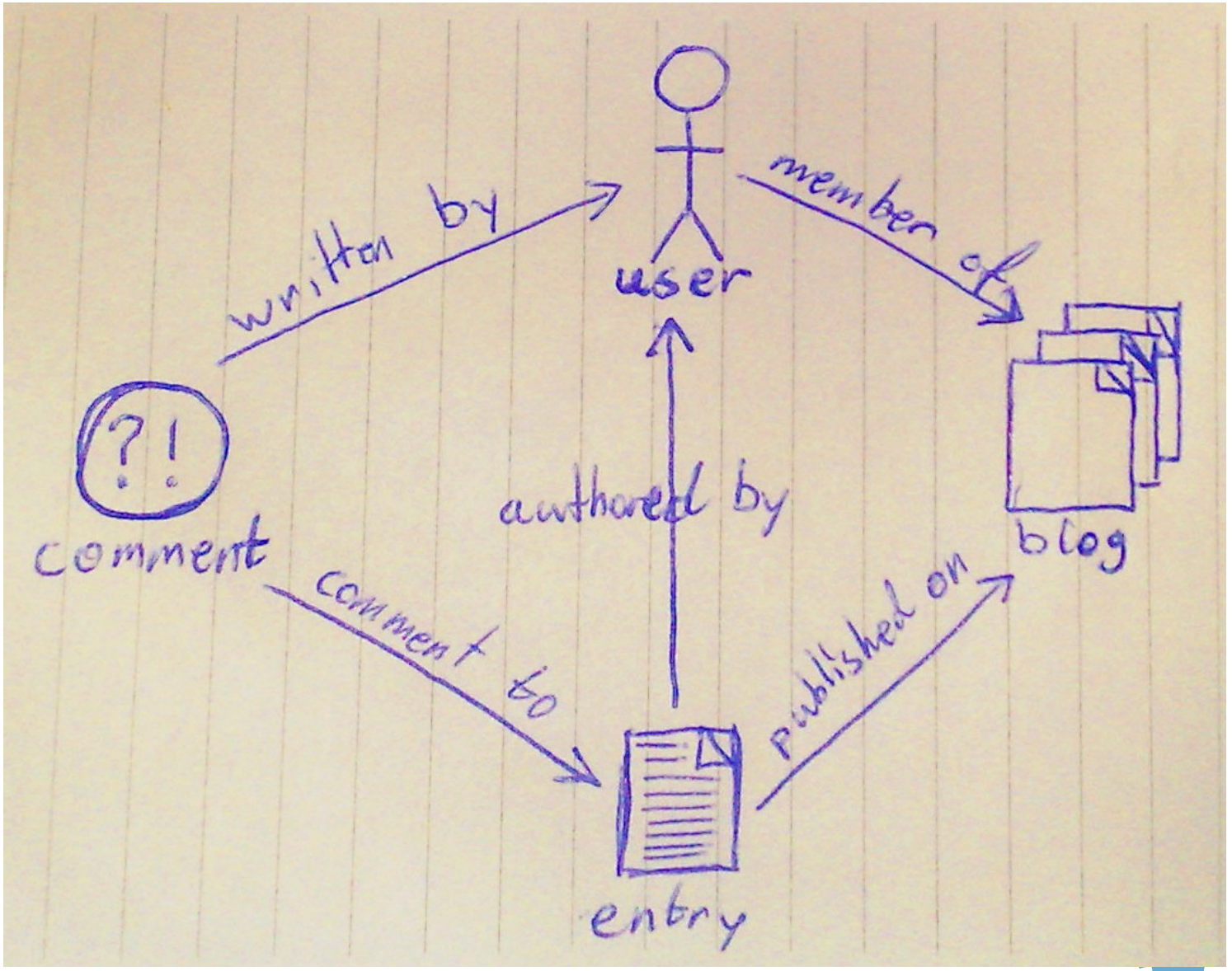
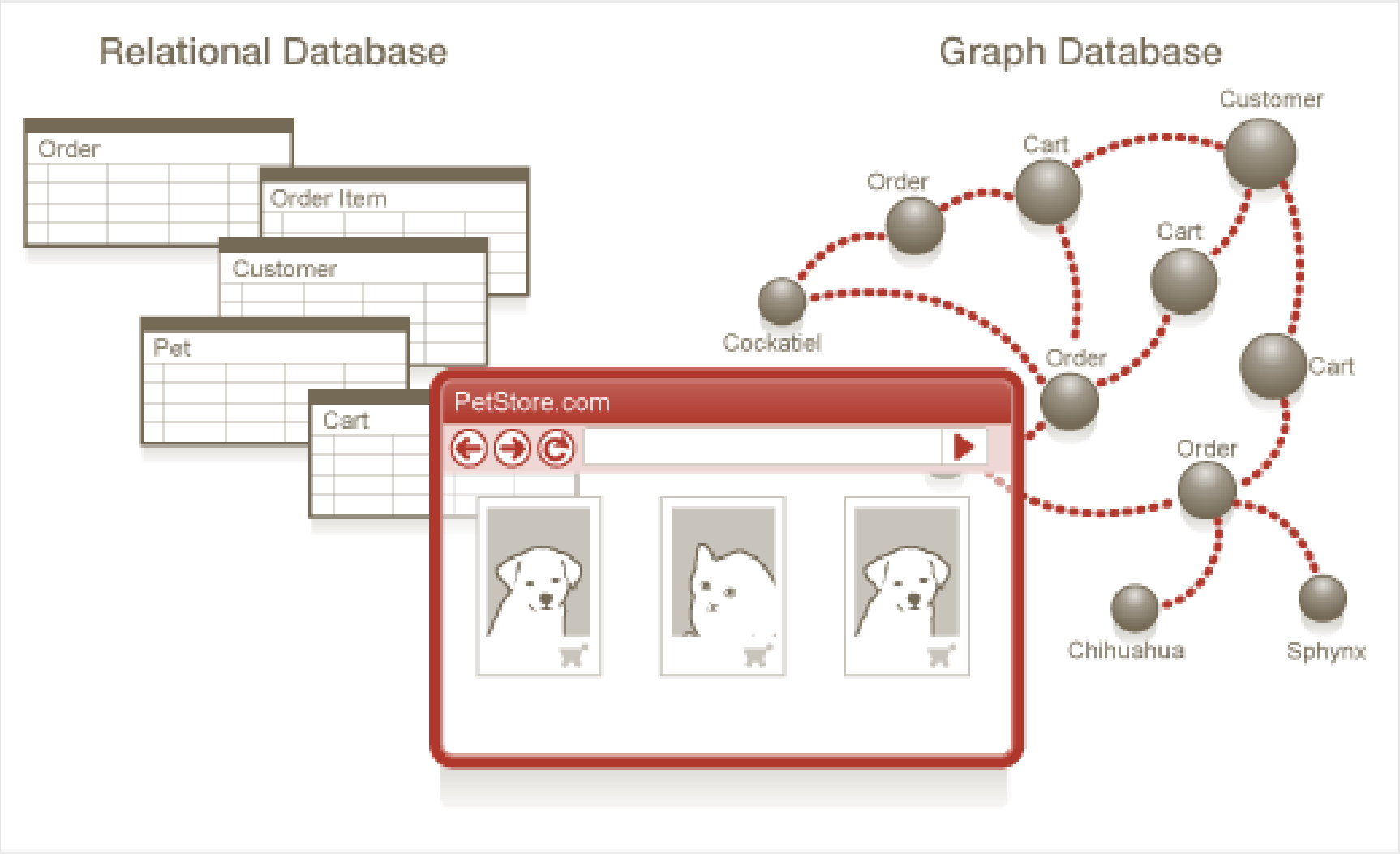
Benefit 1
Domain Modeling



Benefit 2
No O/R mismatch



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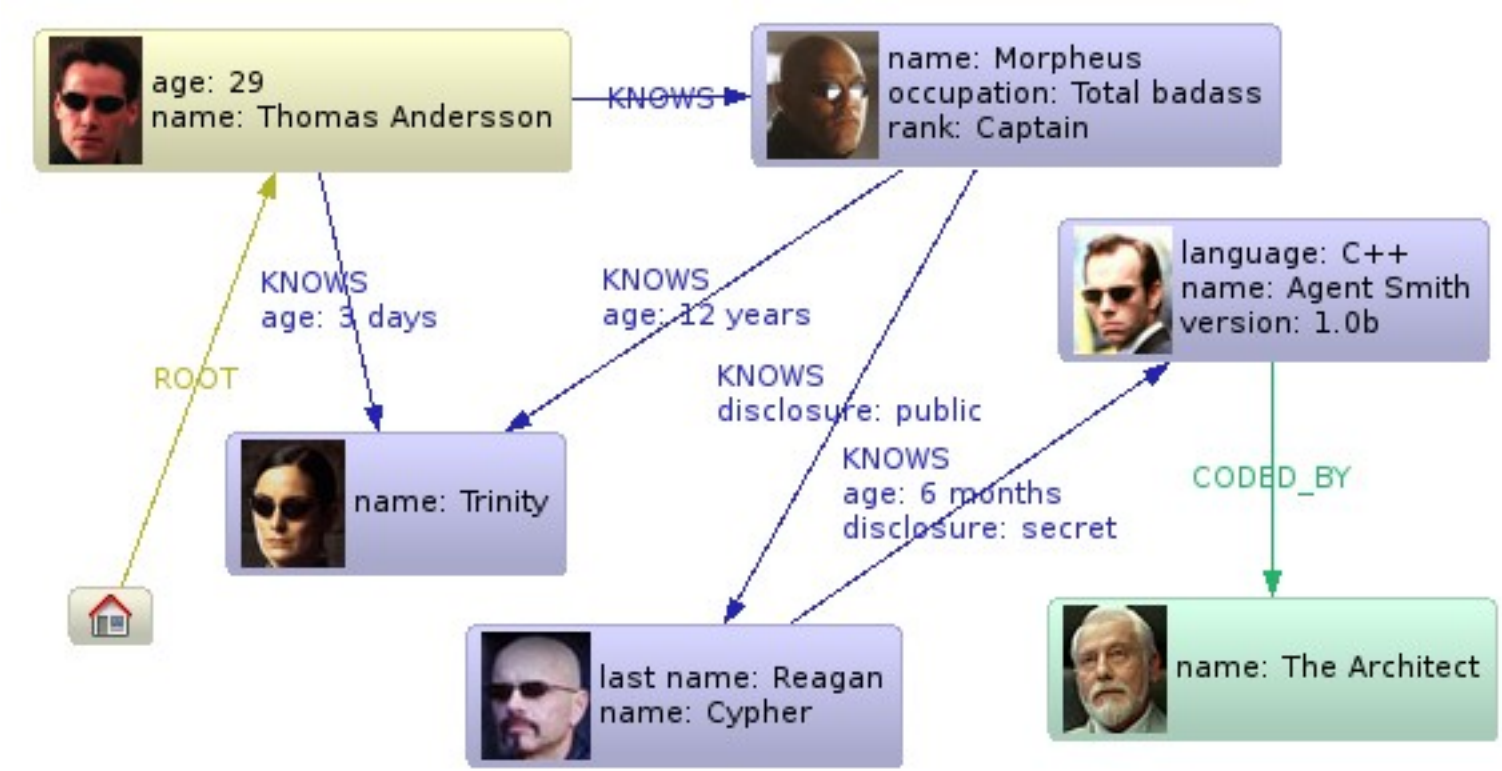
Benefit 3
Semi-structured information



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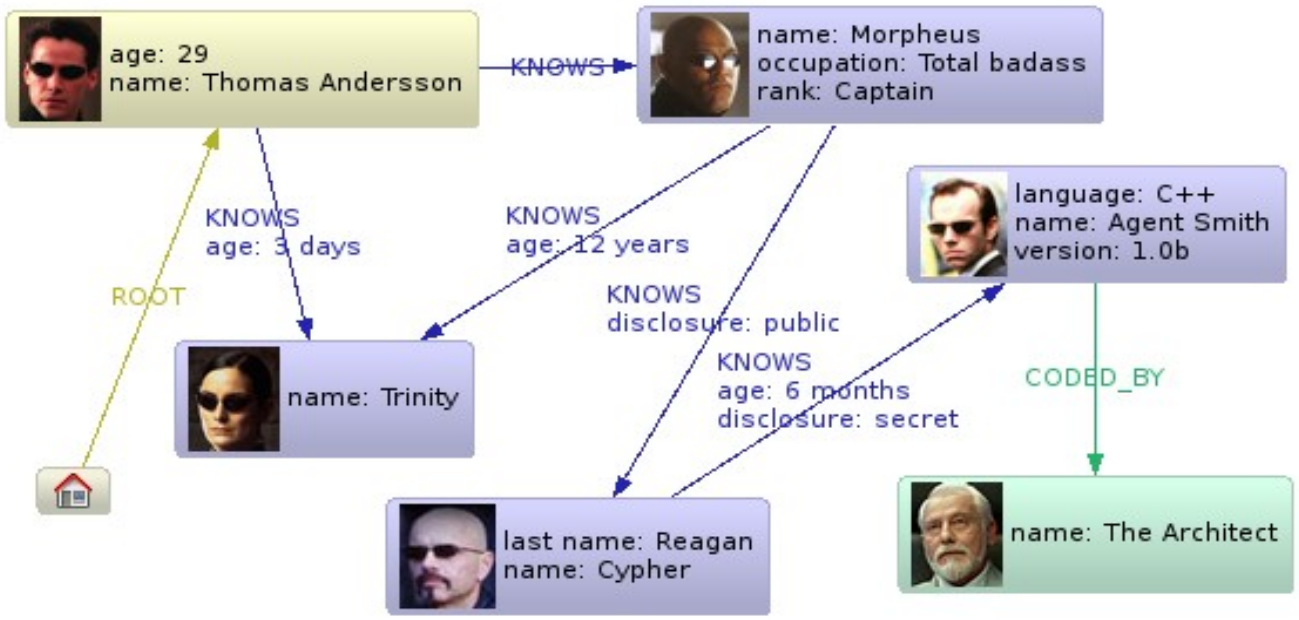


```
thomas   = Node.new :age => 29
morpheus = Node.new :rank => 'Captain', :occupation => 'Total badass'
trinity  = Node.new :name => 'Trinity'
cypher   = Node.new :last_name => 'Cypher'
smith    = Node.new :language => 'C++', :name => 'Agent Smith', :version => '1.0b'
architect = Node.new :name => 'The Architect'

Relationship.new(:root, Neo4j.ref_node, thomas)
Relationship.new(:knows, thomas, trinity)[:age] = '3 days'
Relationship.new(:knows, thomas, morpheus)
Relationship.new(:knows, morpheus, trinity)[:age] = '12 years'
Relationship.new(:knows, morpheus, cypher)[:disclojure] = 'public'
r = Relationship.new(:knows, cypher, smith)
r[:age] = '6 month'
r[:disclojure] = 'secret'
Relationship.new(:coded_by, smith, architect)
```

Benefit 4
No Schema

Benefit 5
Deep traversals

Does Thomas Andersson know someone [who knows]* called Agent Smith ?

```
thomas.outgoing(:knows).depth(:all).find{|node| node[:name] == 'Agent Smith'}
```

What does Neo4j.rb provide ?

The Embedded Java Neo4j

- Nodes, Properties, Relationship, Traversals
- ACID Transactions
- Lucene Integration
- Graph Algorithms
- High Availability Clustering

Neo4j.rb

- Object Oriented Mapping
- “Drop in” replacement for Rails Active Model
- Improved/extended API (lucene, rules, migrations,...)

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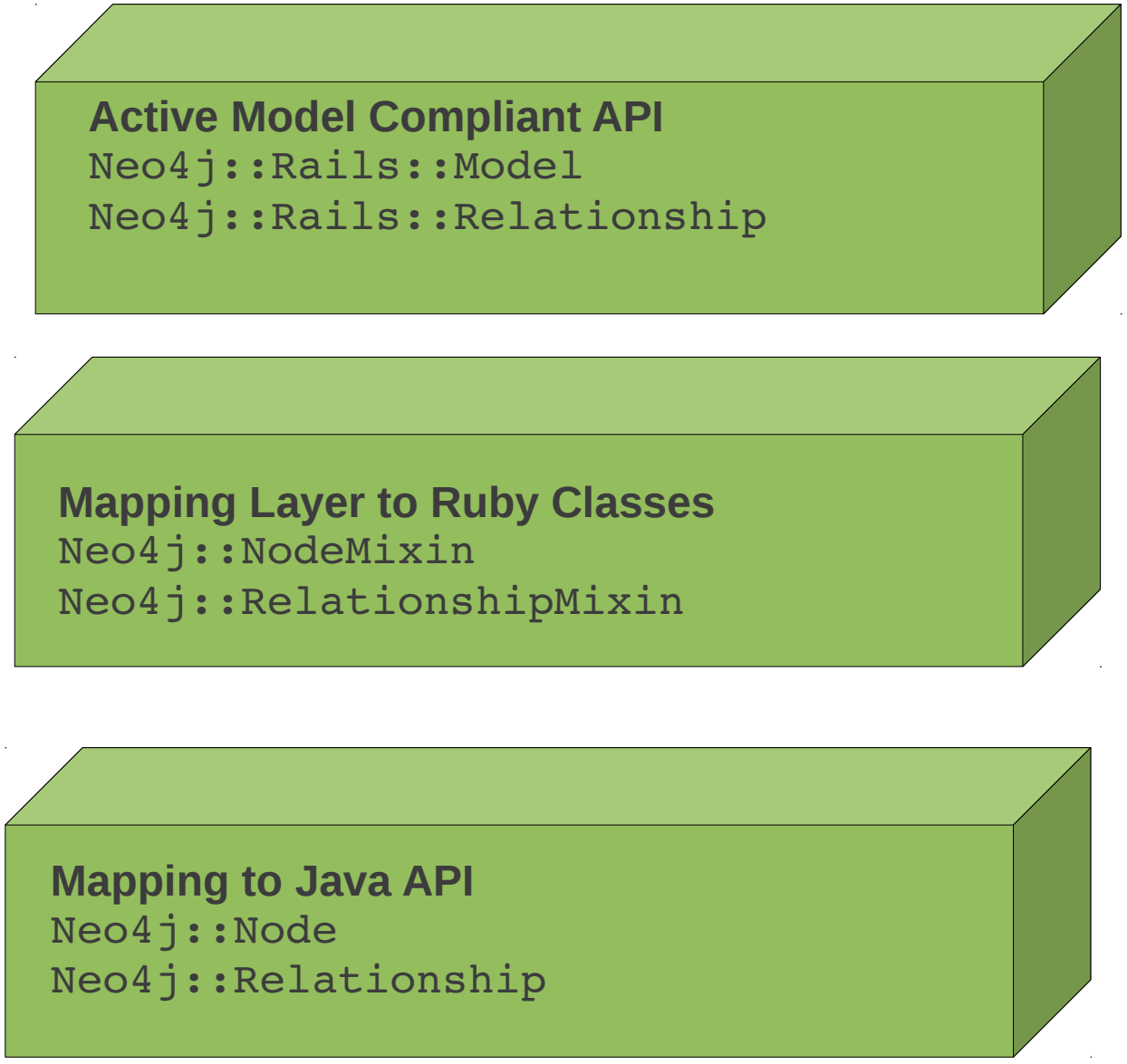
Neo4j.rb Architecture



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Embedded

Easier to install, deploy & test

Is running in same thread as your application

No network connection to DB needed

No Database Tier

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Embedded DB = Direct Access to Data

With Neo4j::NodeMixin

```
Neo4j::Transaction.run do
 Person.new(:name => 'foo')
end
```

With Neo4j::Rails::Model

```
person = Person.new(:name => 'foo')
person.save # callbacks/validation
```

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Transactions

ACID

- **a**tomicity, **c**onsistency, **i**solation, **d**urability
- only write locks, no read locks

```
Neo4j::Transaction.run do
  # do stuff
end
```

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Object Oriented Mapping

A Neo4j Node

Ruby Class

```ruby
class Person
  include NodeMixin
  property :name
end

node = Person.new
node.name = 'andreas'
```

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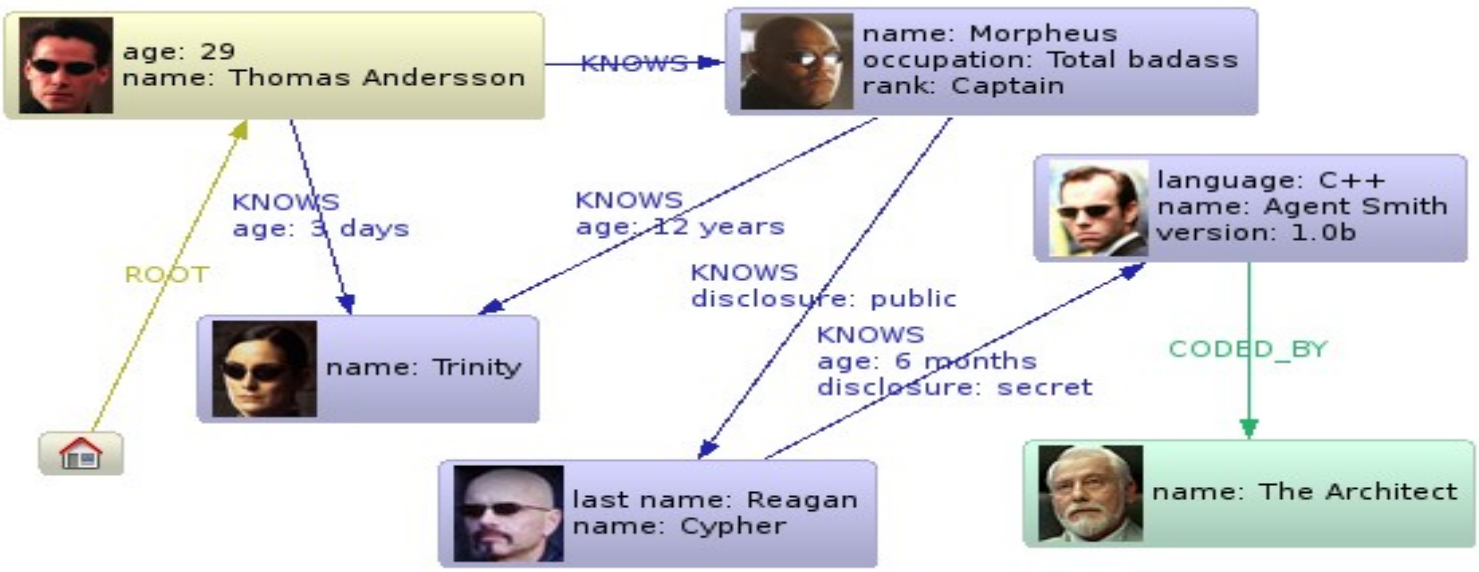
How do I find things ?

1. Start from Reference Node
2. Graph as an Index
3. Use Lucene



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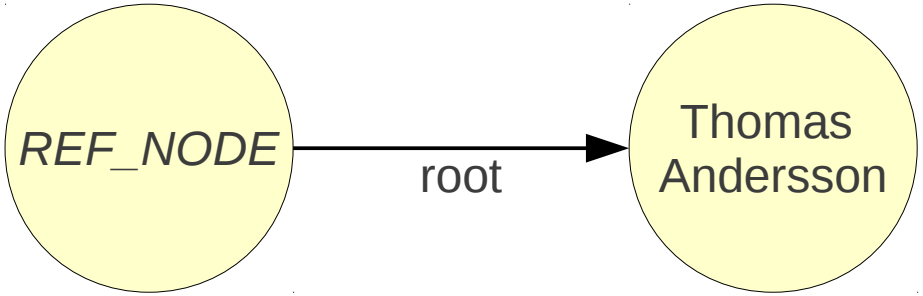
Reference Node

Find Thomas Andersson

```
Neo4j.ref_node.outgoing(:root).first
```



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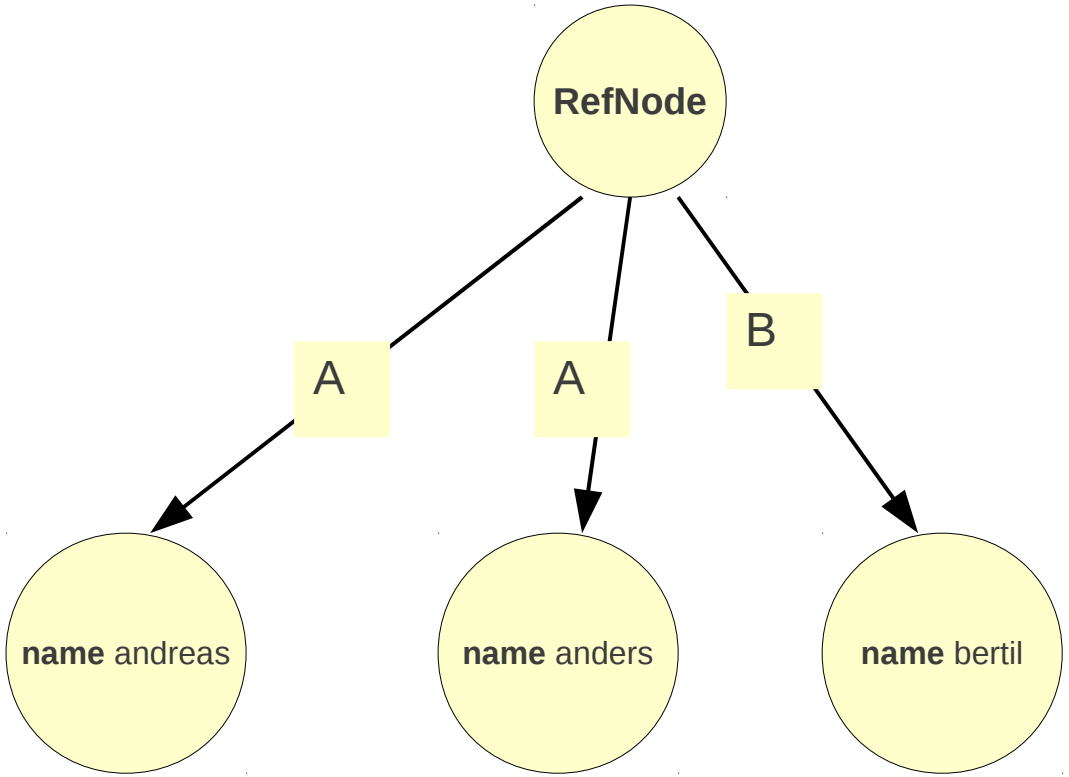
Use the Graph as an Index




```
Neo4j.ref_node.outgoing('A').each {...}
```

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Lucene

Full-featured text search engine

Features

- Phrase queries, wildcard queries, proximity queries, range queries and more
- Ranked searching
- Sorting
- Date-range
- Sorting by any field

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Lucene in Neo4j.rb

```ruby
class Person
  include NodeMixin
  index :name
end

Transaction.run do
  Person.new :name => 'andreas'
end

Person.find('name: andreas')
```

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NodeMixin

Lucene Integration

Accessors for properties

Accessors for relationships

Migrations

Works with inheritance

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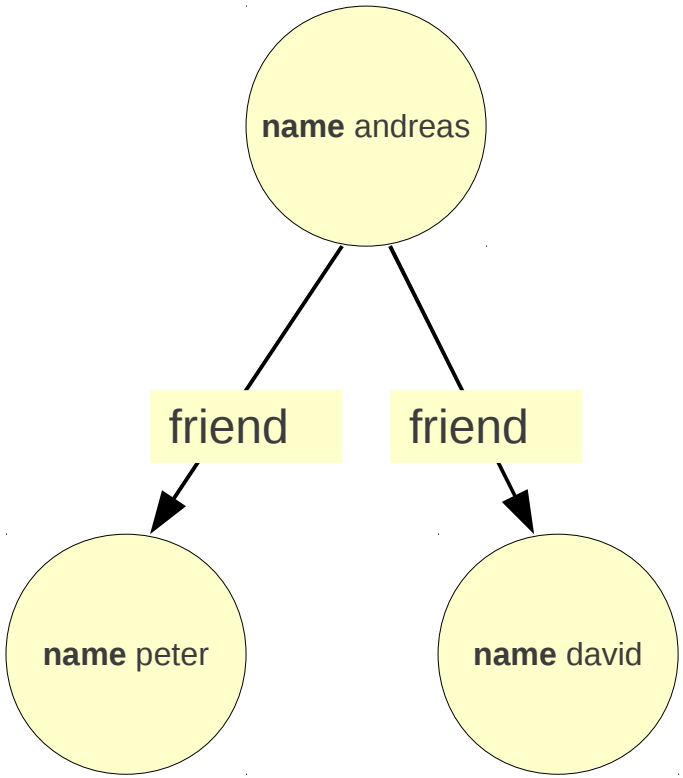
Ruby Class Mapping: Relationships




```ruby
class Person
  include NodeMixin
  has_n :friends
end

andreas = Person.new(:name => 'andreas')
peter = Person.new(:name => 'peter')
david = Person.new(:name => 'david')

andreas.friends << peter << david

andreas.friends.each {|n| puts n[:name]}
```

```ruby
andreas = Node.new :name => 'andreas'
peter = Node.new :name => 'peter'
david = Node.new :name => 'david'
andreas.outgoing(:friend) << peter << david
```

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Incoming Relationship

```ruby
class Actor
  include Neo4j::NodeMixin
  has_n(acted_in).to(Movie)
end
```

```ruby
class Movie
  include Neo4j::NodeMixin
  has_n(:actors).from(Actor, :acted_in)
end
```

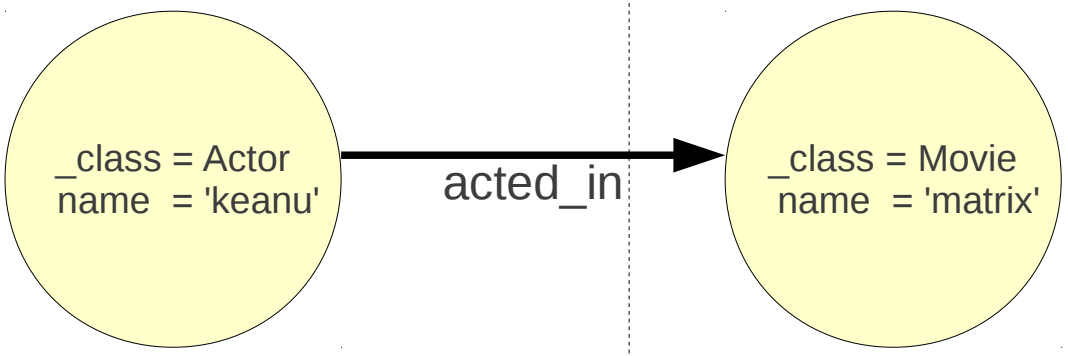
```ruby
keanu = Actor.new :name=>'keanu'
```

```ruby
matrix = Movie.new :name => 'matrix'
```

Same relationship different direction

```ruby
keanu.acted_in << matrix
```

```ruby
matrix.actors << keanu
```



Same

```ruby
matrix.actors.each
```

```ruby
matrix.incoming(:acted_in).each
```

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Ruby on Rails/Active Record
“drop in” replacement

```ruby
class User < ActiveRecord::Base
  attr_accessor :password
  attr_accessible :name, :email, :password, :password_confirmation

  after_save   :encrypt_password

  email_regex = /\A[\w+\-.]+@[a-z\d\-.]+\.[a-z]+\z/i

  validates :name,  :presence => true,
                    :length   => { :maximum => 50 }
  validates :email, :presence => true,
                    :format   => { :with => email_regex }
  validates :password, :presence     => true,
                       :confirmation => true,
                       :length       => { :within => 6..40 }




  has_one :profile

  private

  def encrypt_password
    self.salt = make_salt if new_record?
    self.encrypted_password = encrypt(password)
  end
```

```ruby
class User < Neo4j::Model
  attr_accessor :password
  attr_accessible :name, :email, :password, :password_confirmation

  after_save   :encrypt_password

  email_regex = /\A[\w+\-.]+@[a-z\d\-.]+\.[a-z]+\z/i

  validates :name,  :presence => true,
                    :length   => { :maximum => 50 }
  validates :email, :presence => true,
                    :format   => { :with => email_regex }
  validates :password, :presence     => true,
                       :confirmation => true,
                       :length       => { :within => 6..40 }
  property :name
  property :email
  property :salt
  property :encrypted_password
  index :email

  has_one :profile

  private

  def encrypt_password
    self.salt = make_salt if new_record?
    self.encrypted_password = encrypt(password)
  end
```

Active Record like API Examples:

Create Relationship

```
actor = Actor.new
matrix = actor.acted_in.build(:title => 'matrix')
actor.save
```

Find Relationships

```
rel = actor.acted_in.find(matix) # ret Neo4j::Rails::Relationship
rel[:role] = 'trinity'
actor.save
```

Delete Relationship

```
actor.acted_in.delete(matrix)
actor.acted_in.destroy_all
```

Updated relationships in nested forms using accepts_nested_attributes_for :acted_in

```
actor.update_attributes(:acted_in_attributes => {...})
```

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Mapping Relationships

```
class Role < Neo4j::Rails::Relationship
  property :role_name
  index :role_name
end

class Actor < Neo4j::Rails::Model
  has_n(:acted_in).relationship(Role)
end

actor = Actor.new

# create a node but return the relationship -
#   use the "_rels" accessor
role = actor.acted_in_rels.build(:title => 'matrix')
role.role_name = 'trinity'
role.save!

role = Role.find_by_role_name('trinity')
role.start_node #=> actor
role.end_node #=> the created matrix node
```

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A Common Problem

I have a

- System already in production
- Huge database

I need to

- Change the structure of the database

Solution:

- Migrations

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Migrations: Direct

```
Neo4j.migration 1, "My First Migration" do
  up do
    Neo4j::Transaction.run { DO_STUFF }
  end

  down do
    Neo4j::Transaction.run { DO_STUFF }
  end
end
```

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Migrations: Lazy

(Neo4j::LazyMigrationMixin)

```ruby
Actor.migration 1, :split_name do
  up do
    self[:given_name] = self[:name].split[0]
    self[:surname] = self[:name].split[1]
    self[:name] = nil
  end

  down do
    self[:name] = "#{self[:given_name]} #{self[:surname]}"
    self[:surename] = nil
    self[:given_name] = nil
  end
end
```

Migrations is **NOT** needed
when developing
unlike Active Record migrations

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Inheritance

```ruby
class Vehicle
  include Neo4j::NodeMixin
  property :name, :year
  index :name, :year
end

class Car < Vehicle
end

Neo4j::Transaction.run do
  Car.new :name => 'volvo', :year => 2000
end

Car.find(:name => 'volvo', :year => 1999..2001).first
Vehicle.find(:name => 'volvo', :year => 1999..2001).first
```

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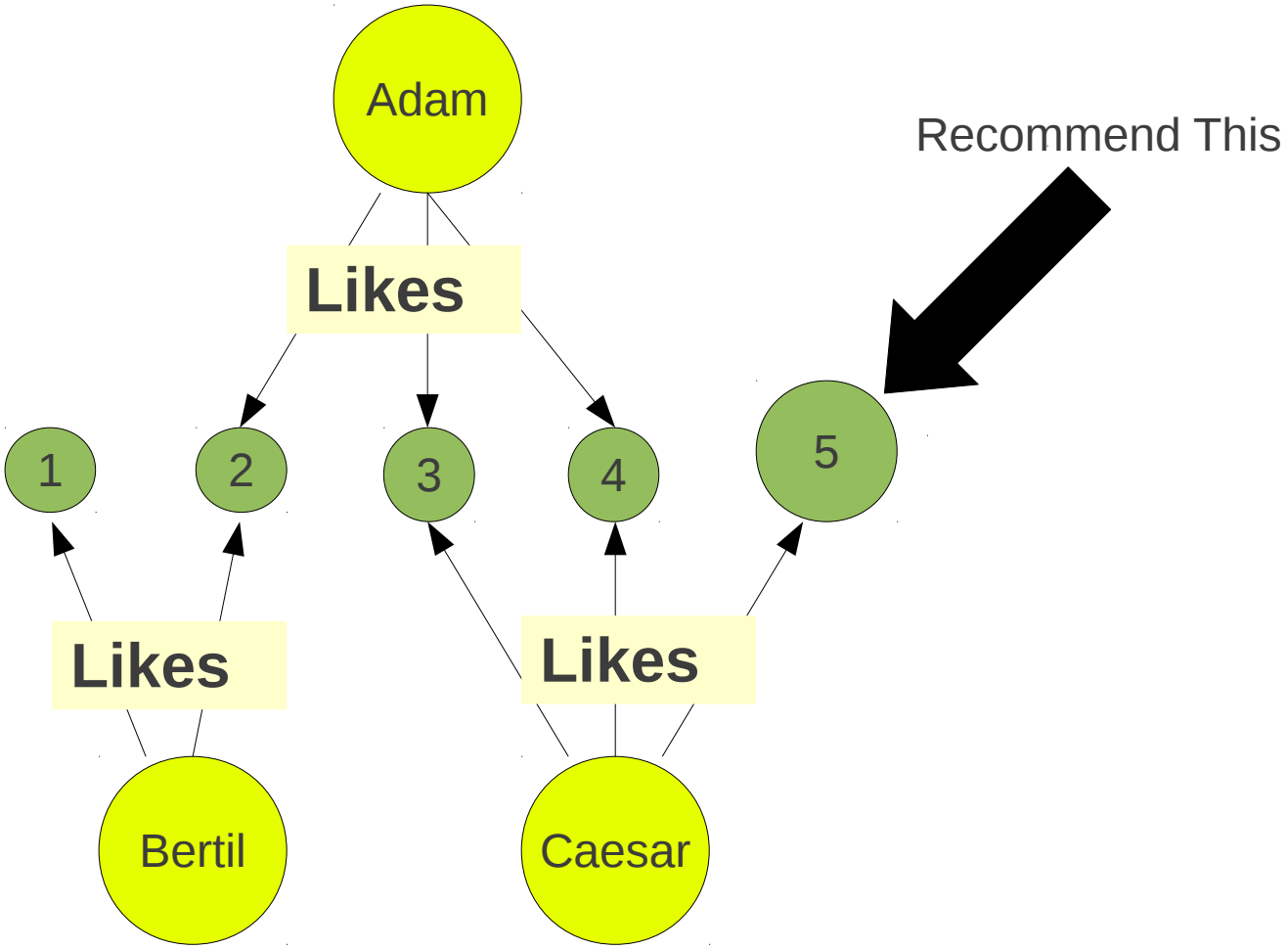
Recommendation Engine



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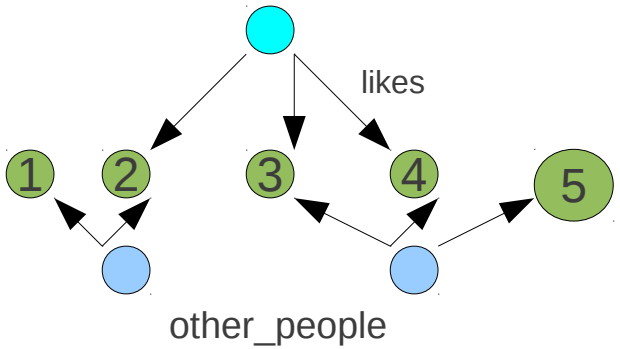
Example, Recommendation

```ruby
def composers_for(person)
  [*person.outgoing(:likes)]
end

# prints out recommendations for the given person
def recommend(person)
  # which composers does this person like ?
  my_composers = composers_for(person)

  # find all other people liking those composers
  other_people = person.outgoing(:likes).incoming(:likes).depth(2).filter{|f| f.depth == 2}

  # for each of those people, sort by the number of matching composers
  # so that the most relevant recommendations are printed first
  sorted = other_people.sort_by{|p| (composers_for(p) & my_composers).size}.reverse
  sorted.each do |other_person|
    # then print out those composers that he don't have
    puts "Recommendation from #{other_person[:name]}"
    (composers_for(other_person) - my_composers).each do |s|
      puts "  composer #{s[:name]}"
    end
  end
end
```



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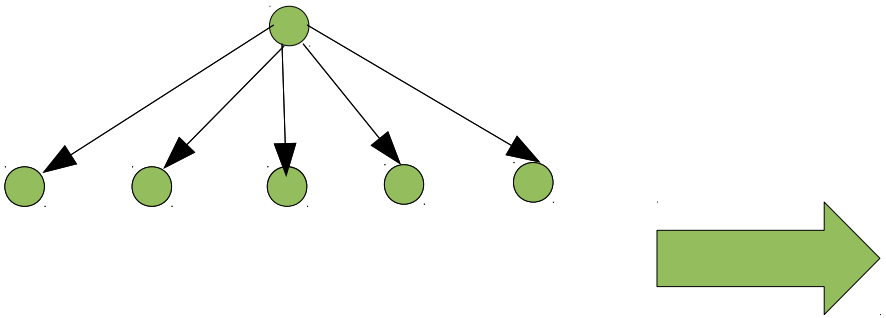
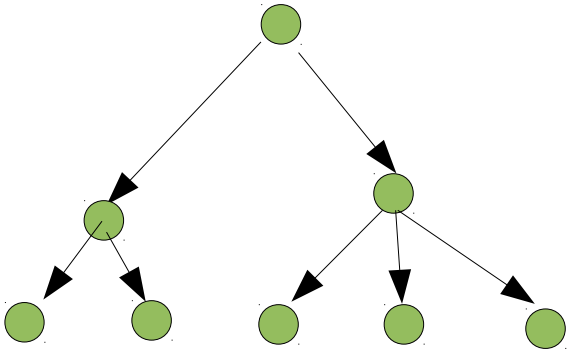
Aggregation/Rules

- How to make a flat structure into a graph ?
  - Use the Graph DB as an index



a.outgoing(:friends).find_all{|f| f.age > 20}



```
class Person < Neo4j::Rails::Model
  property :age
  rule(:old) {age > 20)}
end

Person.old
```

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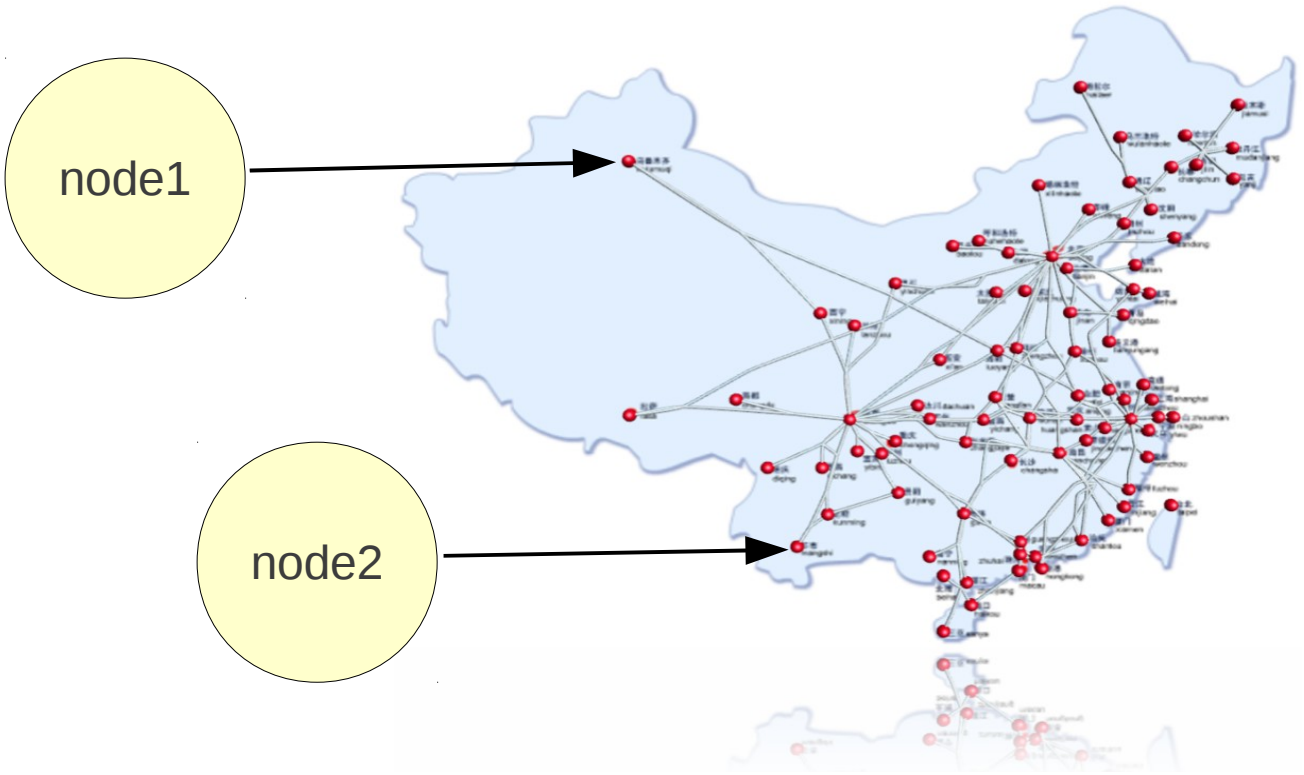
Included Graph Algorithms

Shortest paths, Simple paths, Graph measures ...




```
Neo4j::GraphAlgo.all_simple_paths.from(node1).outgoing(:knows).to(node2).depth(5)
```

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High Availability

Online Backup - hot spare

Read-slave replication

Write master election

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Neo4j – An Object DB ?

Neo4j has very fast traversals

- Avoids loading properties

No need to declare two way relationships

- A relationship has a start and end node

Does have two ways of finding objects

- Traversals
- Lucene

Optimized for Graph Algorithms

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Conclusions: Benefits

Express your domain as a Graph

- Domain Modeling
- No O/R mismatch
- Efficient storage of Semi Structured Information
- Schema Less

Express Queries as Traversals

- Fast deep traversal instead of slow SQL queries that span many table joins

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When **NOT** use Graph DB

Don't have a graph related problem ?

Not too much changing requirements ?

Easy to organized data into:

- Tables, Documents or Key-Value models ?

Few & well defined relationships in the domain ?

Don't have SQL queries that span many table joins ?

Many YES => *maybe* Graph DB **not** a good choice

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When should I use a Graph DB ?

Need to solve a graph related problem ?

- Recommendations, Shortest path, Social Networks

Have a complex and evolving data model ?

Few mandatory and many optional attributes ?

Big part of domain is expressed as relationships ?

Have SQL queries that span many table joins ?

Many YES => *maybe* a Graph DB is a good choice

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Neo4j Spatial**.rb**

A wrapper around Java Neo4j Spatial using Neo4j.rb

```
git clone git@github.com:craigtaverner/neo4j-spatial.rb.git
cd neo4j-spatial.rb/examples
jruby osm_import.rb map2.osm
jruby osm_layer.rb map2.osm highway highway-residential waterway
natural natural-water
  jruby osm_layer.rb -l
  jruby export_layer.rb highway-residential
  jruby export_layer.rb -F shp highway-residential natural
```

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Neo4j Spatial Queries

AbstractSearchIntersection
SearchAll
SearchClosest
SearchContain
SearchCover
SearchCoveredBy
SearchCross
SearchDisjoint
SearchEmpty
SearchEqual
SearchInRelation
SearchIntersect
SearchIntersectWindow
SearchInvalid
SearchOverlap
SearchPointsWithinOrthodromicDistance
SearchTouch
SearchWithin
SearchWithinDistance

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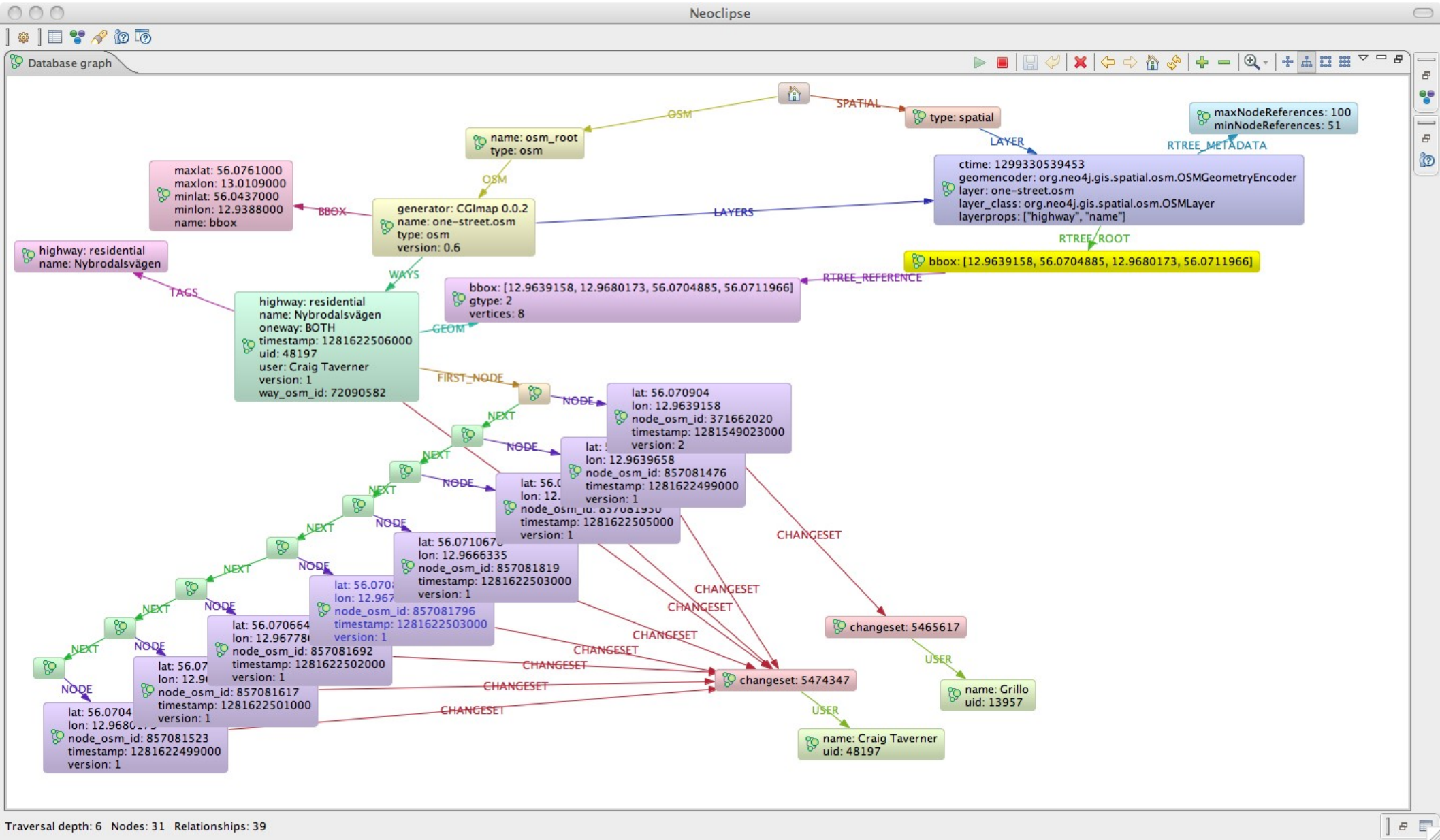
Spatial Graph



GeoServer

Neo4j Spatial includes built-in support for a GeoTools data store

GeoServer is an open source software server written in Java that allows users to share and edit geospatial data. Designed for interoperability, it publishes data from any major spatial data source using open standards.

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```
GraphDatabaseService database = new EmbeddedGraphDatabase(storeDir);
try {
    SpatialDatabaseService s = new SpatialDatabaseService(database);
    Layer layer = s.getLayer("layer_roads");
    SpatialIndexReader index = layer.getIndex();

    Search q = new SearchIntersectWindow(new Envelope(xmin, xmax, ymin, ymax));
    index.executeSearch(searchQuery);
    List<SpatialDatabaseRecord> results = q.getResults();
} finally {
    database.shutdown();
}
```

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