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Graph database using Neo4j

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Agenda

- What is a Graph Database?
- Graph Database motivations
- Graph vs Relational databases
- Why Neo4j?
- Real world use cases
- Cypher vs Gremlin
- Data Modeling techniques
- Neo4j Deployment
- Neo4j Configuration
- Profiling Queries
- Graph Algorithms
- Neo4j and Spark

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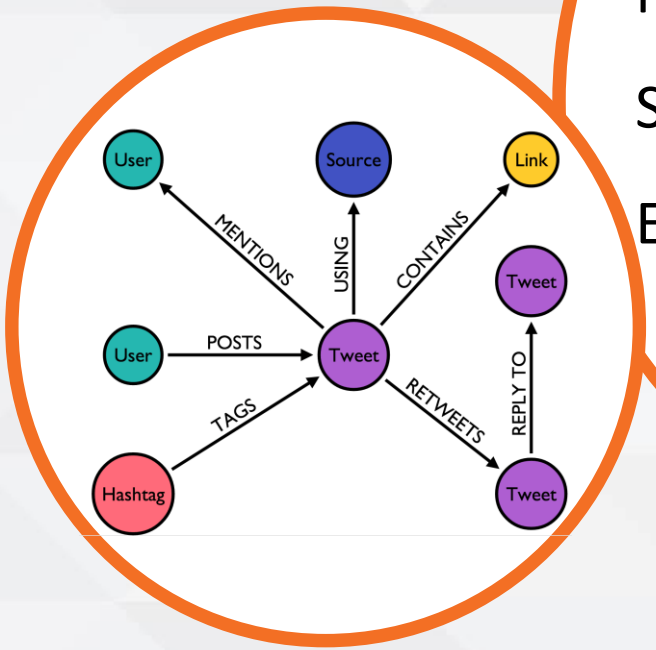
What is Graph Database?



NoSql database

Store data in a graph **structure**

Efficiently **traverses** the graph

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What is Graph Database?

- Nodes
  - Entities
- Relationships
  - Connect entities and structure domain
- Properties
  - Attributes and metadata
- Labels
  - Group nodes by role

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Graph Database motivation

- Solve problems that can't be solved with RDBMS
  - Think how to model Facebook data?
- Whiteboard friendly
- Productivity and Agility
  - Schema-less
  - Complex logic simple query
- Visualization of the data
- Performance

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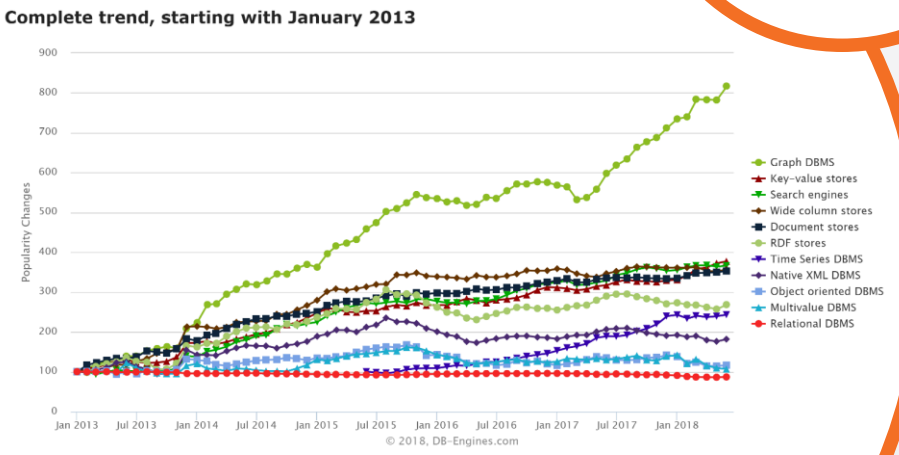
Graph Database motivation



https://db-engines.com/en/ranking_categories

Graph vs Relational databases

Graph

- Graph traversal
- Schemaless
- Related Data
  - How X related to Y?
- Clustering, Centrality, Influence
  - Who is the most influential persons?

RDBMS

- Table joins
- Strict schema
- Search data by properties
  - Get all rows with X?
- Aggregate
  - How many X in my system?

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Why Neo4j?

Great **Community**

Native graph storage

Cypher query language

Scalability using clustering

Great query **profiling** tool

Easy to **use**

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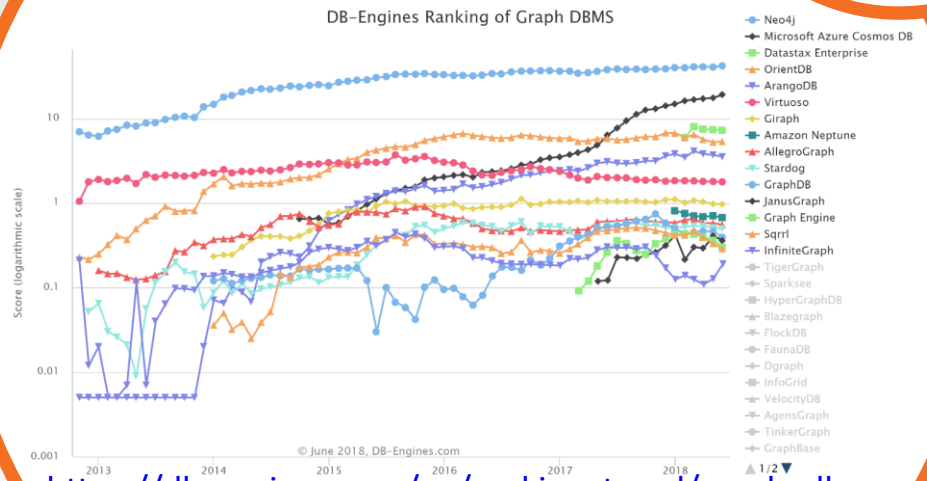
Why Neo4j?



https://db-engines.com/en/ranking_trend/graph+dbms

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Real world use cases

- Real-Time recommendation
- Social Network
  - Like Facebook and Instagram
- Resource management
  - Finding the correct permission to a file
- Fraud detection
- Route Finding

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Cypher query language

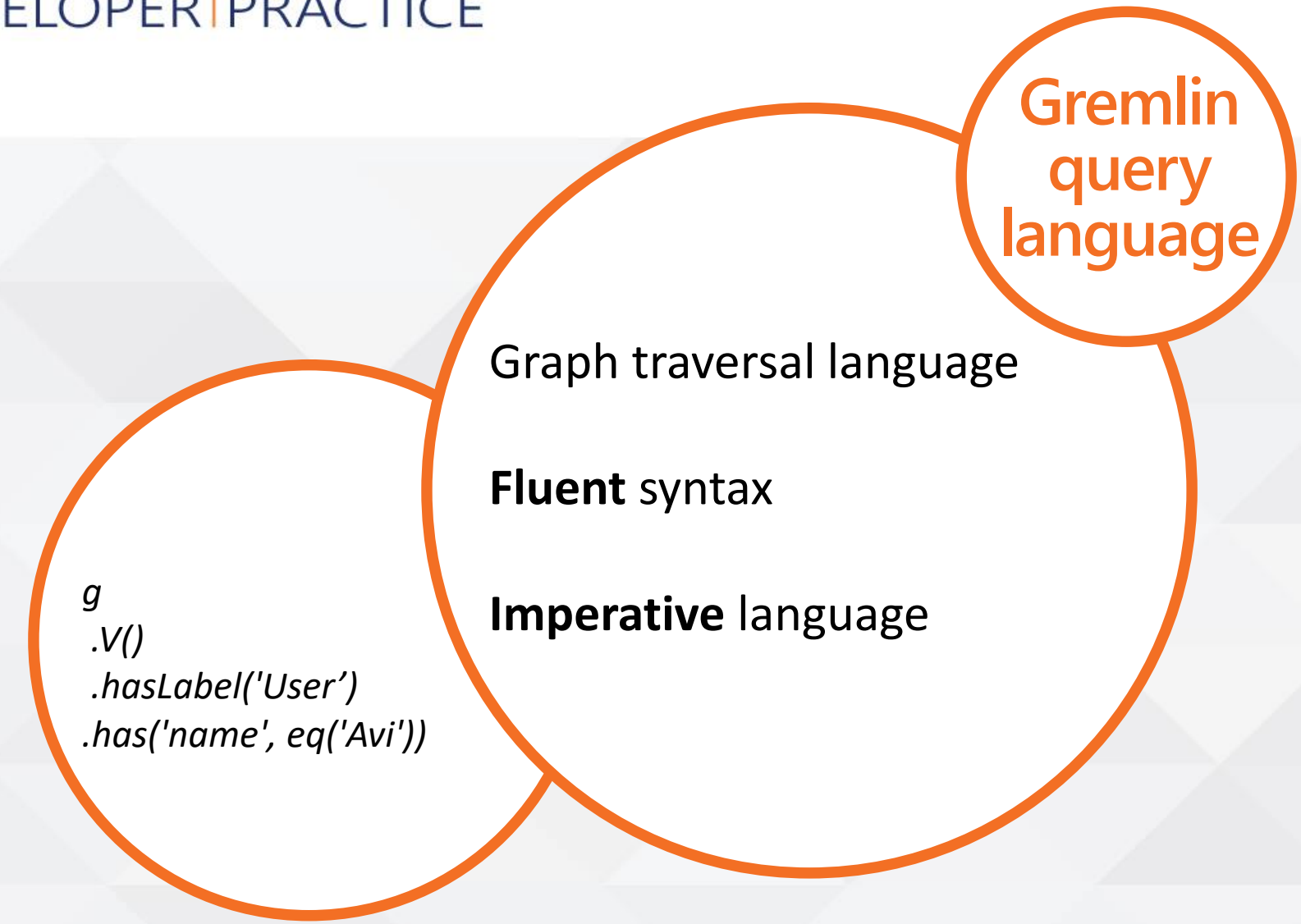
Declarative language

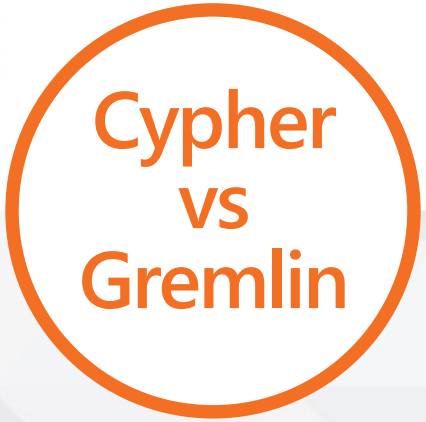
Inspired by SQL

Describes **patterns** in graphs

ASCII-art query language

```
MATCH (u:User)
WHERE u.name = "Avi"
RETURN u
```






```
CREATE (a:User { name: "Avi" })
CREATE (o:User { name: "Ofir" })
CREATE (s:User { name: "Sasha" })
CREATE (m:User { name: "Moshe" })
```

```
g.addV('User').as('a').property(single, 'name', 'Avi')
 .addV('User').as('o').property(single, 'name', 'Ofir')
 .addV('User').as('s').property(single, 'name', 'Sasha')
 .addV('User').as('m').property(single, 'name', 'Moshe')
```

Cypher vs Gremlin

```
CREATE (a)-[:Follow]->(o)
CREATE (a)-[:Follow]->(s)
CREATE (a)-[:Follow]->(m)
CREATE (o)-[:Follow]->(a)
```

```
.addE('Follow').from('a').to('o')
.addE('Follow').from('a').to('s')
.addE('Follow').from('a').to('m')
.addE('Follow').from('o').to('a')
```

Cypher vs Gremlin

```
MATCH (u:User)
WHERE u.name = "Avi"
RETURN u
```

```
g.V().hasLabel('User').has('name', eq('Avi'))
```

Cypher vs Gremlin

```
MATCH (u:User)-[:Follow]->(fu:User)
WHERE u.name = "Avi"
RETURN u, fu
```

```
g.V().as('u').hasLabel('User').has('name', eq('Avi'))
  .outE('Follow').inV().as('fu').hasLabel('User')
  .select('u', 'fu')
```

Cypher vs Gremlin

```
MATCH (u:User)-[:Follow]->(fu:User)-[:Follow]->(ffu:User)
WHERE u.name = "Avi"
RETURN u, fu, ffu
```

```
g.V().as('u').hasLabel('User').has('name', eq('Avi'))
  .outE('Follow').inV().as('fu').hasLabel('User')
  .outE('Follow').inV().as('ffu').hasLabel('User')
  .select('u', 'fu', 'ffu')
```

Cypher vs Gremlin

```
MATCH (u:User)-[:Follow]->(:User)<-[f:Follow]-(ru:User)
WHERE u.name = "Avi" AND NOT EXISTS((u)-[:Follow]->(ru))
RETURN ru, count(f) as mutual_followers
ORDER BY mutual_followers DESC
LIMIT 10
```

Cypher vs Gremlin


```
g.V().as('u').hasLabel('User').has('name', eq('A                    ').as('
UNNAMED15').inV().hasLabel('User').inE('Follow                    V().as('ru').hasLabel('User').where(__.and(__.sel
ect('  UNNAMED15').where(neq('f')), __.not(__.select('u').outE('Follow').inV().as('
GENERATED5').where(__.select('  GENERATED5').where(eq('ru'))).choose(__.is(neq('  cypher.null')),
__.constant(true), __.constant(false)).is(neq('  cypher.null')).is(eq(true))))).select('ru',
'f').group().by(__.select('ru')).by(__.fold().project('  FRESHID120', '
FRESHID124').by(__.unfold().select('ru')).by(__.unfold().select('f').is(neq('
cypher.null')).count()))).unfold().select(values).as('  GENERATED6').select('  FRESHID120').as('
FRESHID120').select('  GENERATED6').select('  FRESHID124').as('  FRESHID124').select('  FRESHID120', '
FRESHID124').project('  FRESHID120', '  FRESHID124').by(__.select('  FRESHID120')).by(__.select('
FRESHID124')).order().by(__.select('  FRESHID124'), decr).limit(10).as('  GENERATED7').select('
FRESHID120').as('  FRESHID120').select('  GENERATED7').select('  FRESHID124').as('  FRESHID124').select('
FRESHID120', '  FRESHID124').project('ru', 'mutual_followers').by(__.select('  FRESHID120').choose(neq('
cypher.null'), __.valueMap(true), __.constant('  cypher.null'))).by(__.select('  FRESHID124'))
```

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Exercise

- Use Movies dataset
- Search for movie you watched lately
- If it not exists add it to the dataset
- Search the most 10 prolific actors
- Recommend movies to the user “Joshua Elliott” based on movies he really liked and the actors acted in that movies

Use Cheat sheet
https://neo4j.com/docs/cypher-refcard/current/
Use Neo4J Sandbox
https://neo4j.com/sandbox-v2/

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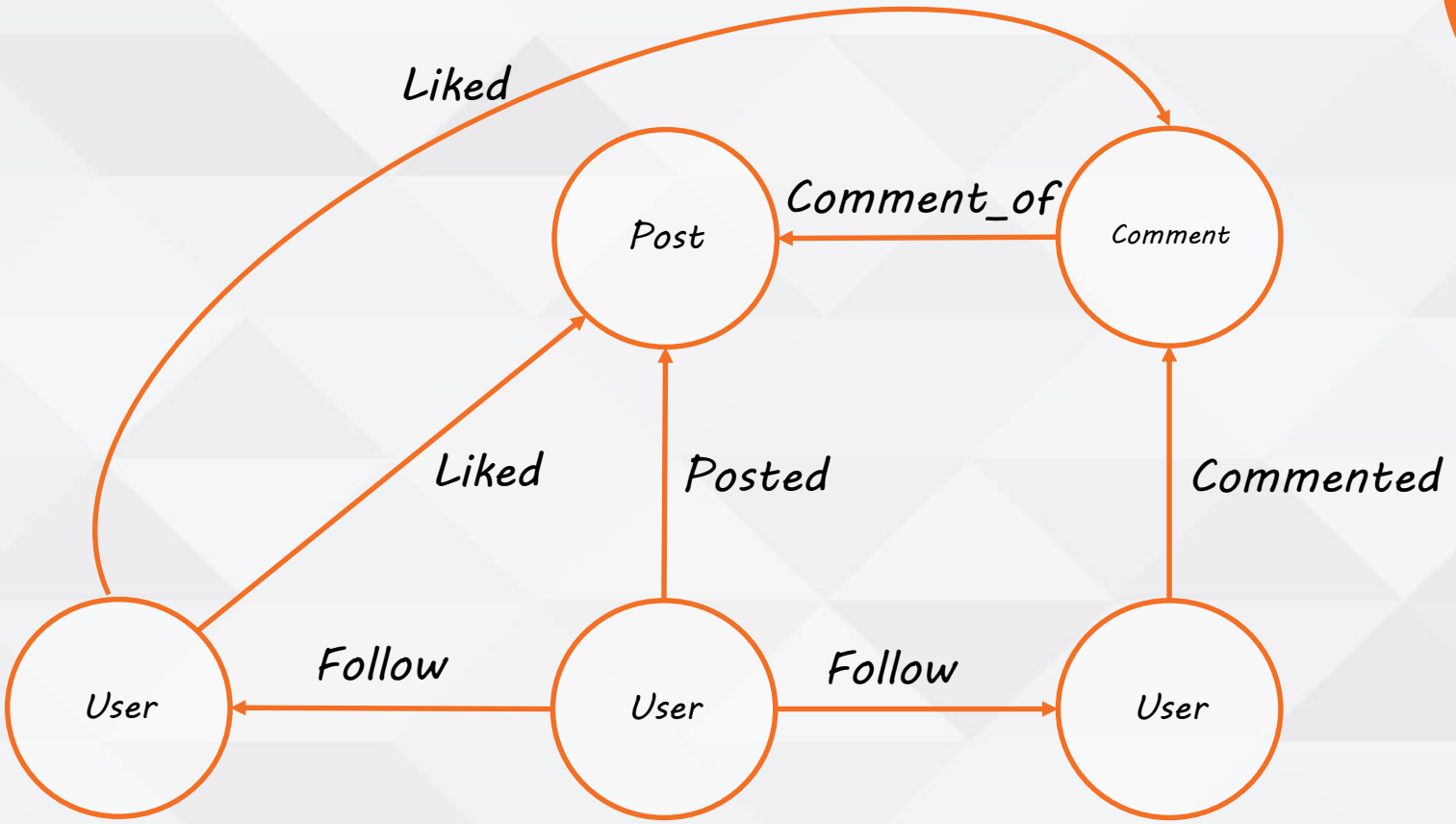
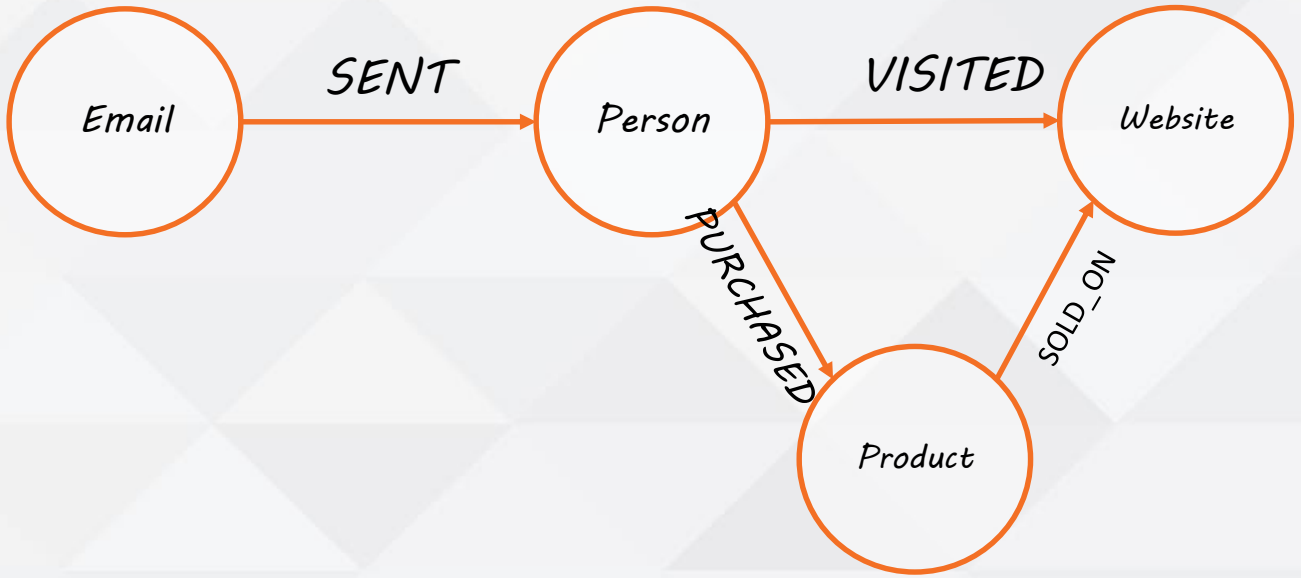
Data Modeling techniques



Data Modeling techniques

Language oriented example

We send email to people
so they will visit our website
and buy our product.



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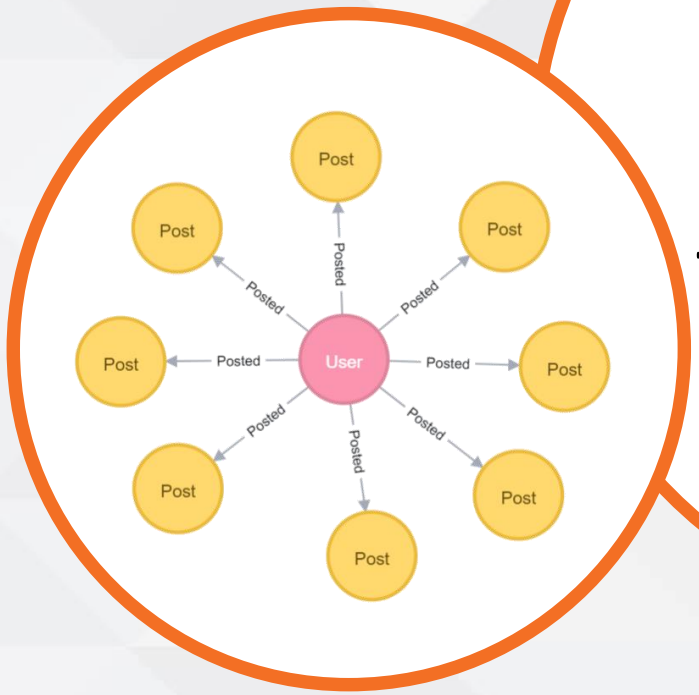
Data Modeling techniques



Star Model

- One to many relation
- User posted a post
- User followed other user

Trivial to understand

Data Modeling techniques

Social network feed requirement:

Return the X recent posts belong to my friends

What about Performance?

1000(friends)*
1000(posts)=
1,000,000(posts)

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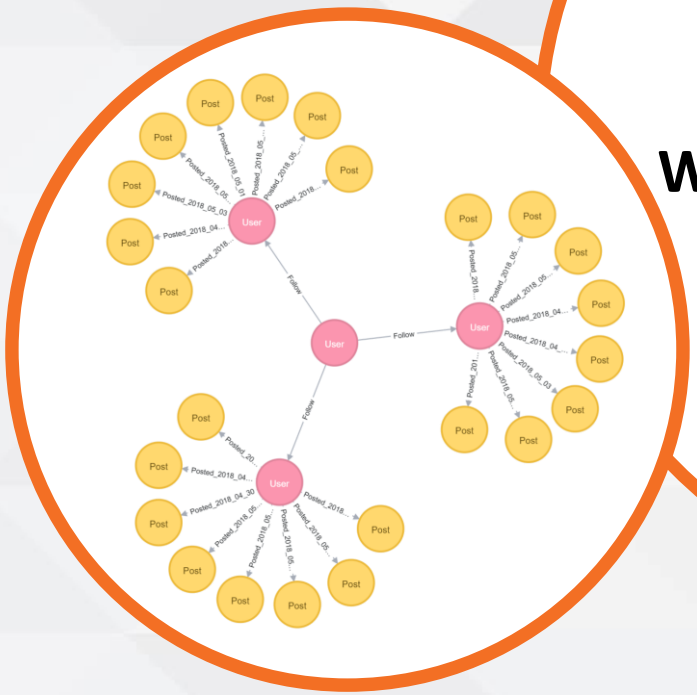
Data Modeling techniques



Dated Model

Embed the date
in the relationship type

What about Performance?

1000(friends)*
10(posts in last X days)=
10,000(posts)

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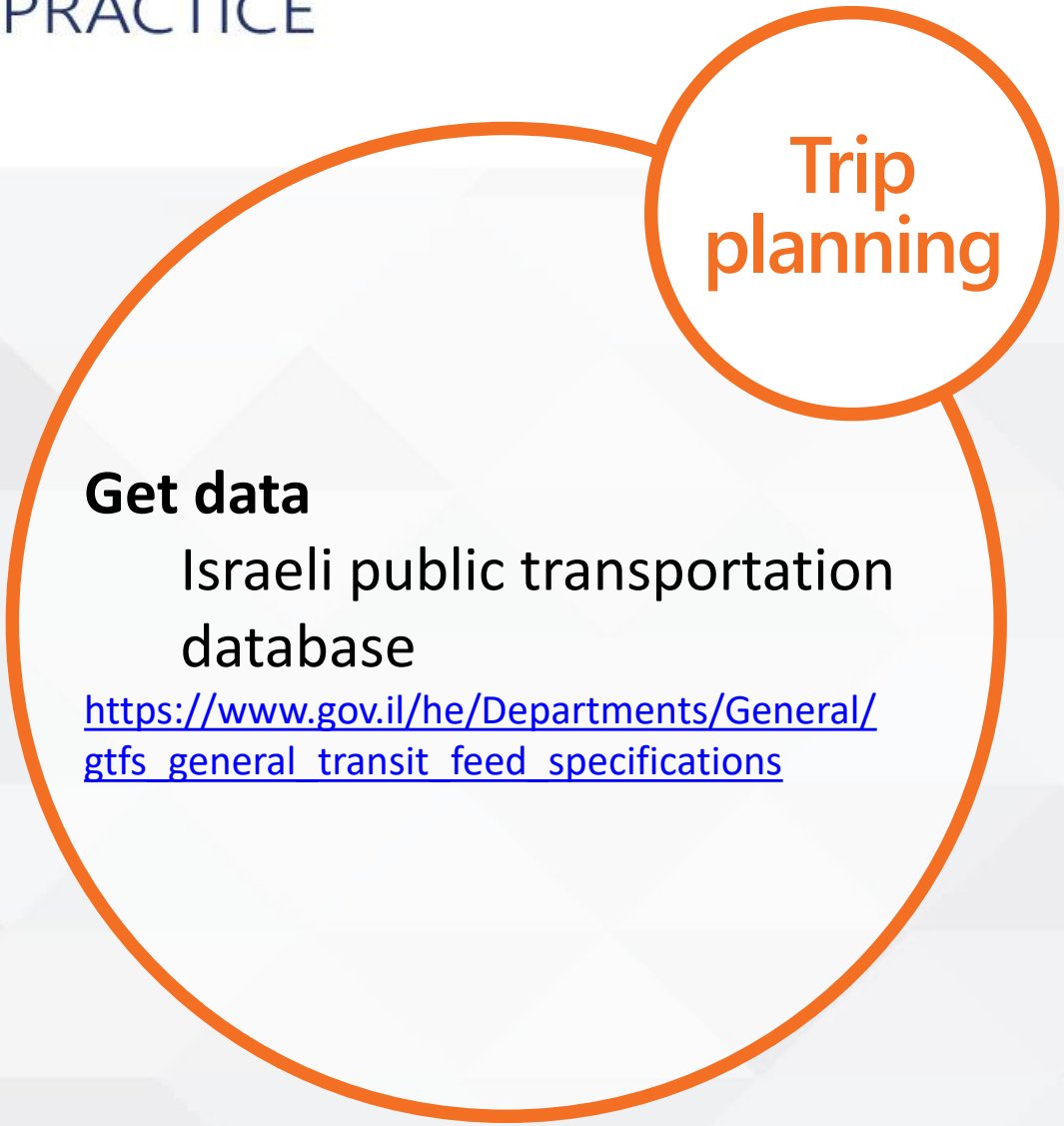
Trip planning

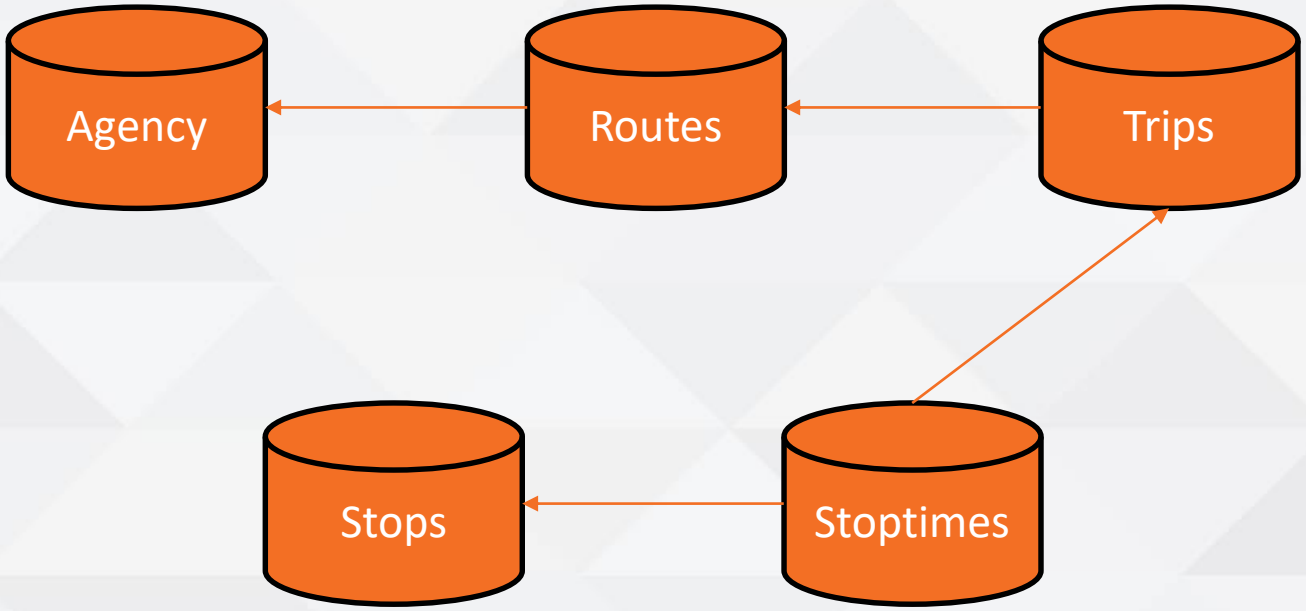
Build Moovit application

Requirement:

How to get from X to Y with public transportation?



Trip planning



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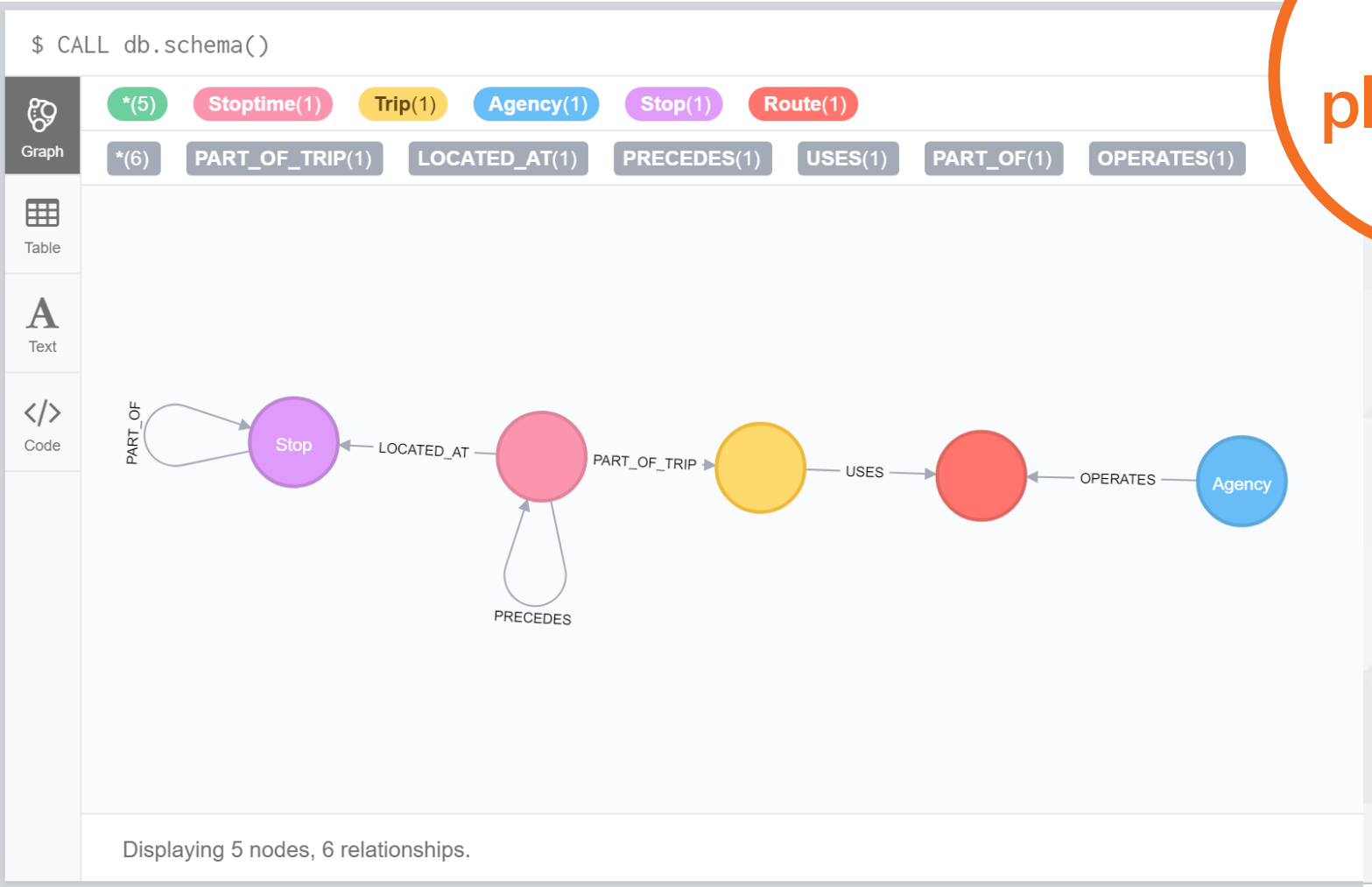
Trip planning



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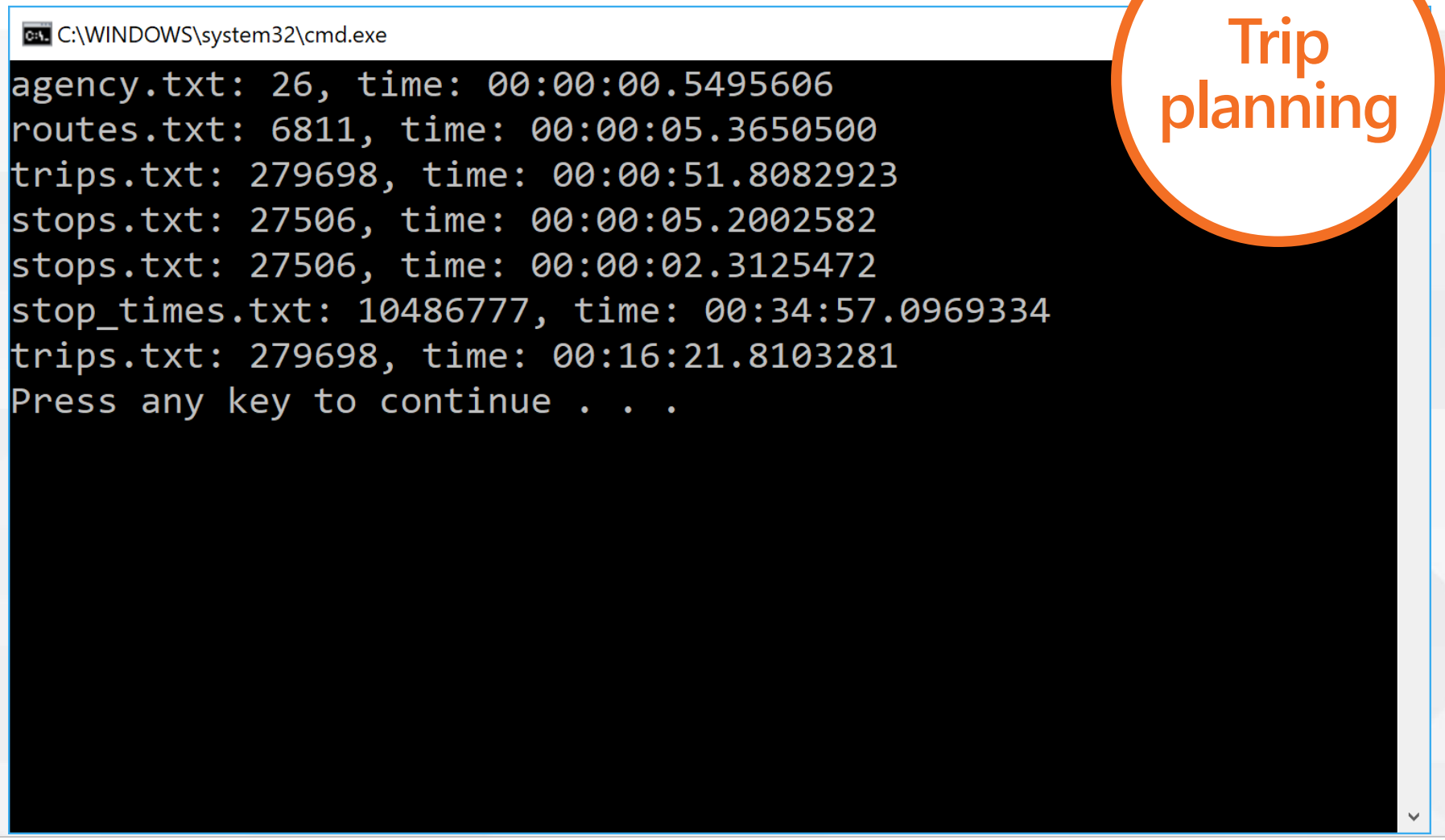

Trip planning

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Exercise

- Model a graph database that will helps your organization to build and maintain a better product
- The solution will help to answer questions like
  - If a developer change some code what will be affected?
  - Which part of the application needs architectural/design decisions? (usually parts with most of the bugs)

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Exercise

- The solution will help to
  - Developers
  - Architectures
  - Program managers
  - Product managers
  - Testers
- Consider uses data sources like
  - Source Code
  - Source Control
  - Tests results
  - Company Structure
  - Issue Tracker
  - Release Management

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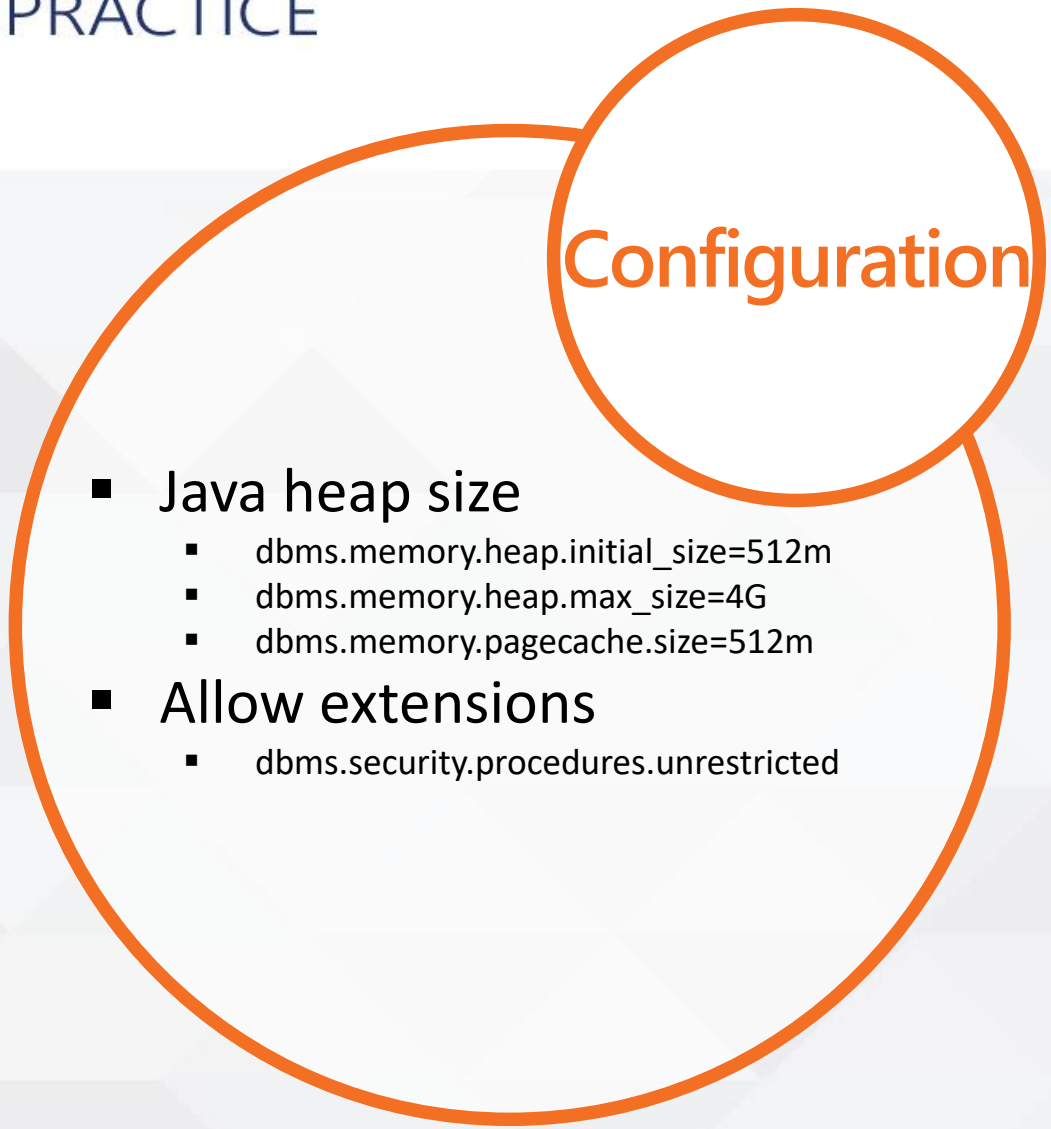
Exercise

- Draw the schema of the graph
- Write example query
- What else can be considered and how it affects the model?

Deployment

- Neo4j load the graph to memory ensure you have enough RAM
- All data is replicated on all nodes ensure you have enough disk size
- Backup the data with tool
- Monitor the database



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Profiling Queries

EXPLAIN

Shows the execution plan without actually executing it or returning any results.

PROFILE

Executes the statement and returns the results along with profiling information

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Profiling Queries

GOAL

Get the number of db hits down.

Db hit

An abstract unit of storage engine work

Create index for start node pattern

```
CREATE INDEX ON :User(name)

MATCH (u:User)
WHERE u.name = "AviAvni"
RETURN u
```

Profiling Queries

Reduce cardinality

```
MATCH (u:User)-[:Stared]->(r1)<-[:Stared]-
      (coUser)-[:Stared]->(r2)
WHERE u.name = "AviAvni"
RETURN DISTINCT r2.name
```

Profiling Queries

Reduce cardinality

```
MATCH (u:User)-[:Stared]->(r1)<-[:Stared]-
      (coUser)
WHERE u.name = "AviAvni"
WITH DISTINCT coUser
MATCH (coUser)-[:Stared]->(r2)
RETURN DISTINCT r2.name
```

Profiling Queries

Count relationships

```
MATCH (u:User)-[:Stared]->()
RETURN u, COUNT(*) as count
ORDER BY count DESC

MATCH (u:User)
RETURN u, SIZE((u)-[:Stared]->()) as count
ORDER BY count DESC
```

Profiling Queries

Avoid cartesian products

```
MATCH (u:User), (r:Repo)
RETURN count(u), count(r)

MATCH (u:User)
WITH count(u) as u_count
MATCH (r:Repo)
RETURN a_count, count(r)
```

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Graph Algorithms

- Graph algorithms plugin
- High performance
- User friendly using stored procedure
- Stream the result
- Write the result asynchronously

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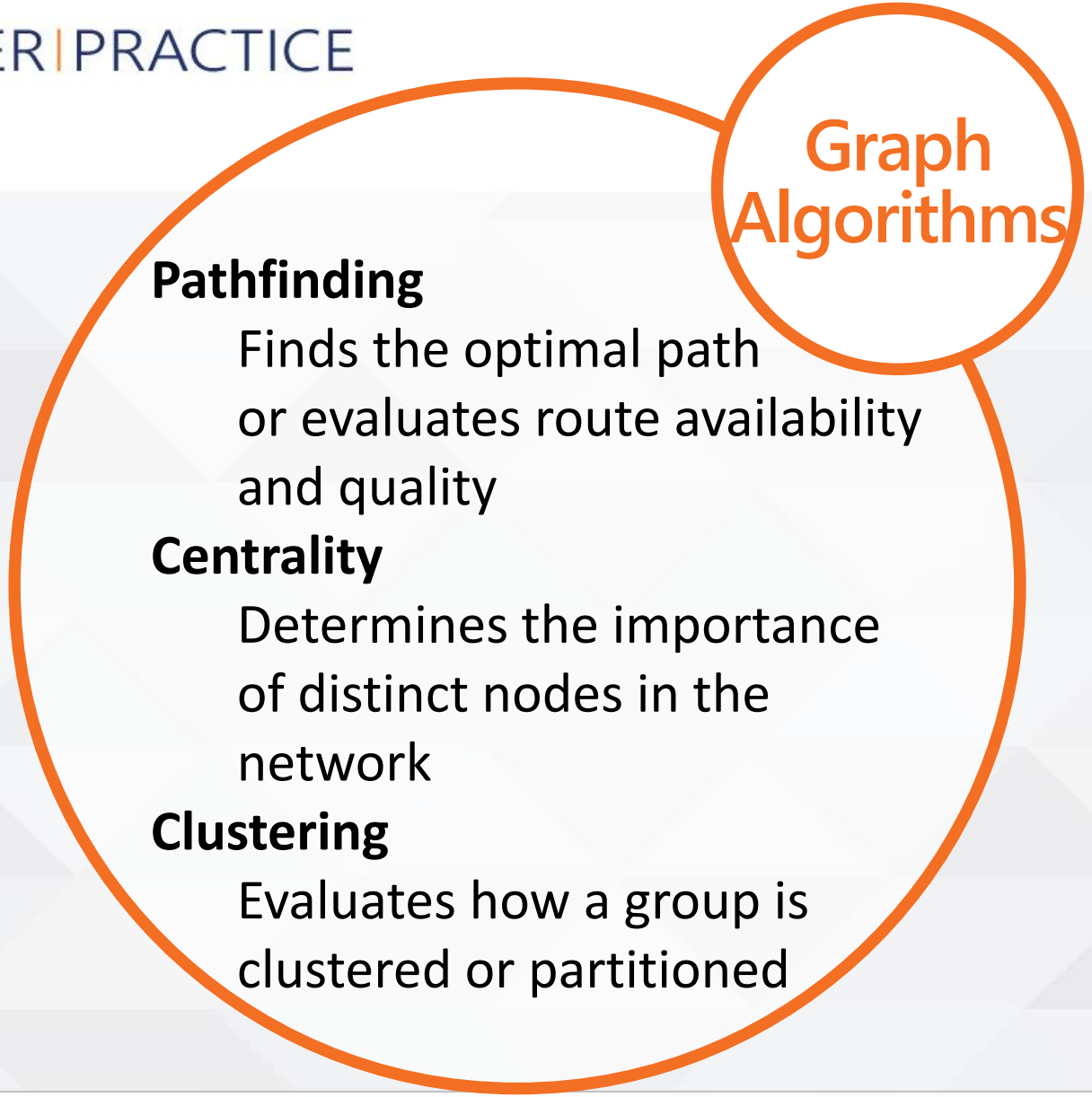
Graph Algorithms

https://neo4j.com/whitepapers/graph-algorithms-neo4j-ebook/?ref=social-camp-sales-intro

https://neo4j.com/docs/graph-algorithms/current/



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Neo4j and Spark

- Neo4j Spark connector
  - https://github.com/neo4j-contrib/neo4j-spark-connector
  - Manipulate neo4j graphs in spark
  - Use partition and batch carefully

Neo4j and Spark

- Spark GraphX
  - https://spark.apache.org/docs/1.2.1/graphx-programming-guide.html
  - Spark distributed graph algorithms
    - PageRank
    - Connected Components
    - Triangle Counting
  - Pregel API

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Summary

- Look for **connections** in you data
- Cross language between business and development
- Choose the right model
- Use productive query language
- Plan for deployment
- Profile query before usage
- Choose the right algorithm and run it in the right server

- **Demo**: https://github.com/AviAvni/GraphDatabaseDemo
- **Neo4j Sandbox:** https://neo4j.com/sandbox-v2/