Neo4j and Spring Data

Going from relational databases to databases with relations

Michael Simons, **@rotnroll666**

Agenda

- About Neo4j
- My „business“ domain
- Getting data into Neo4j
- Some options to access Neo4j on the JVM
- Spring Data Neo4j
- Some advanced queries

About Neo4j

neo4j

Neo4j

Mindset

"Graph Thinking" is all about considering connections in data as important as the data itself.

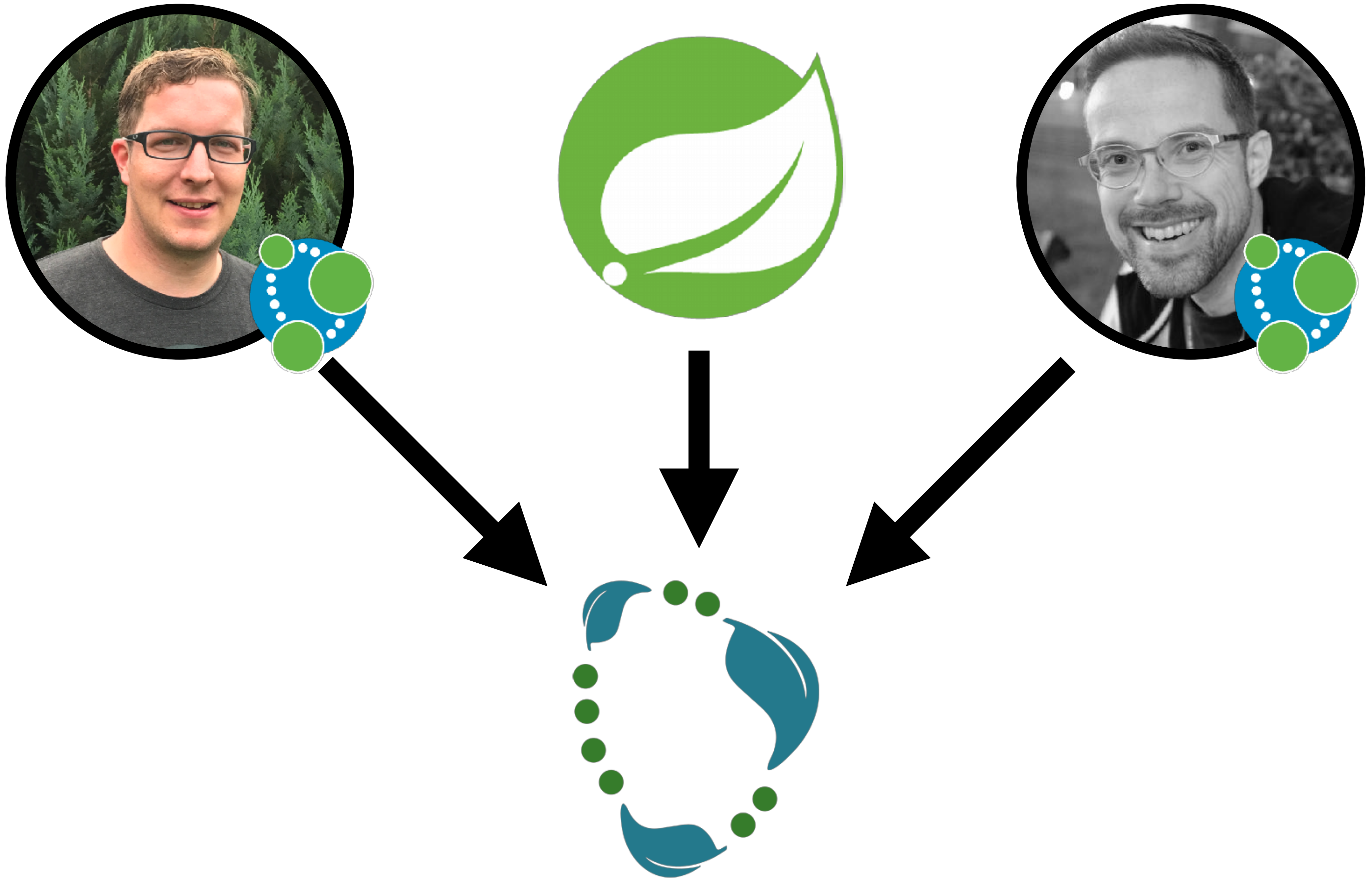
Native Graph Platform

Neo4j is an internet-scale, native graph database which executes connected workloads faster than any other database management system.

Ecosystem

Neo4j Professional Services
300+ partners
47,000 group members
61,000 trained engineers
3.5M downloads

Spring Data and Neo4j



About me

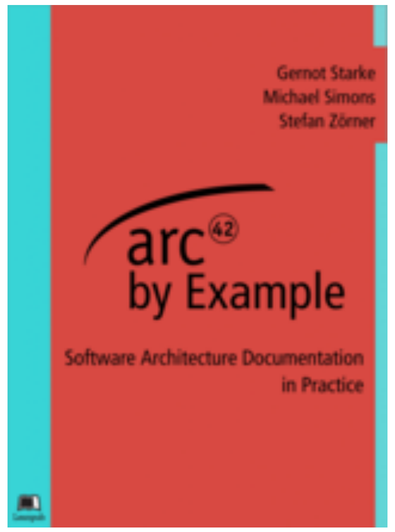
- Neo4j since July 2018
- Java Champion
- Co-Founder and current lead of Java User Group **EuregJUG**
- Author (**Spring Boot 2** und **Arc42 by example**)

Michael Simons

Spring Boot 2

Moderne Softwareentwicklung mit Spring 5

dpunkt.verlag



Gernot Starke
Michael Simons
Stefan Zörner

arc42 by Example

Software Architecture Documentation in Practice

First contact to Neo4j through jQAssistant

Java Champions

Known for

JAVA AND
DATABAS

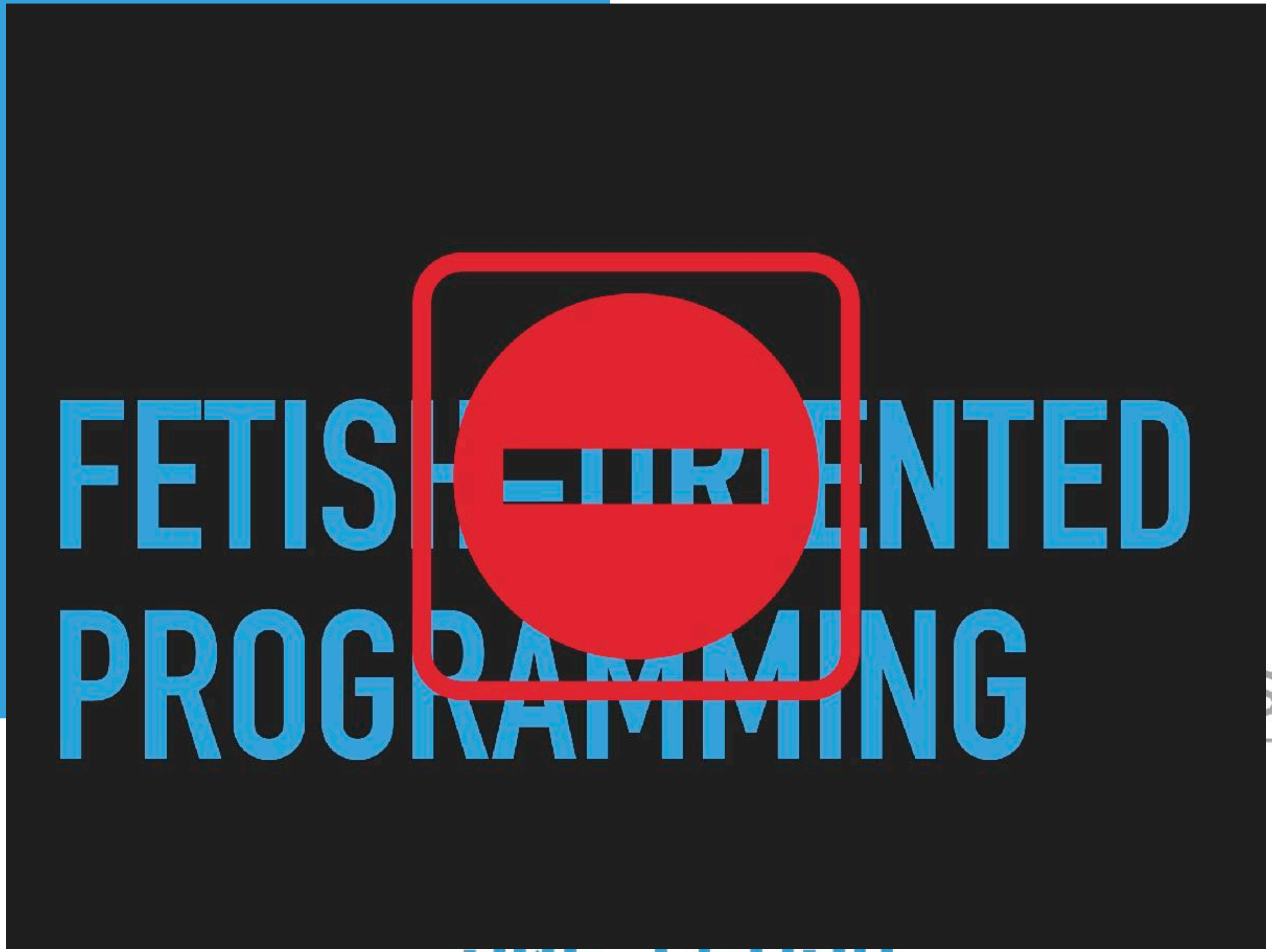
Plain SQL, ORM
something in
between?

JOIN 2017 AT ORDINA JWORKS

JWORKS
POWERED BY ORDINA

LIVE WITH YOUR
SQL-FETISH

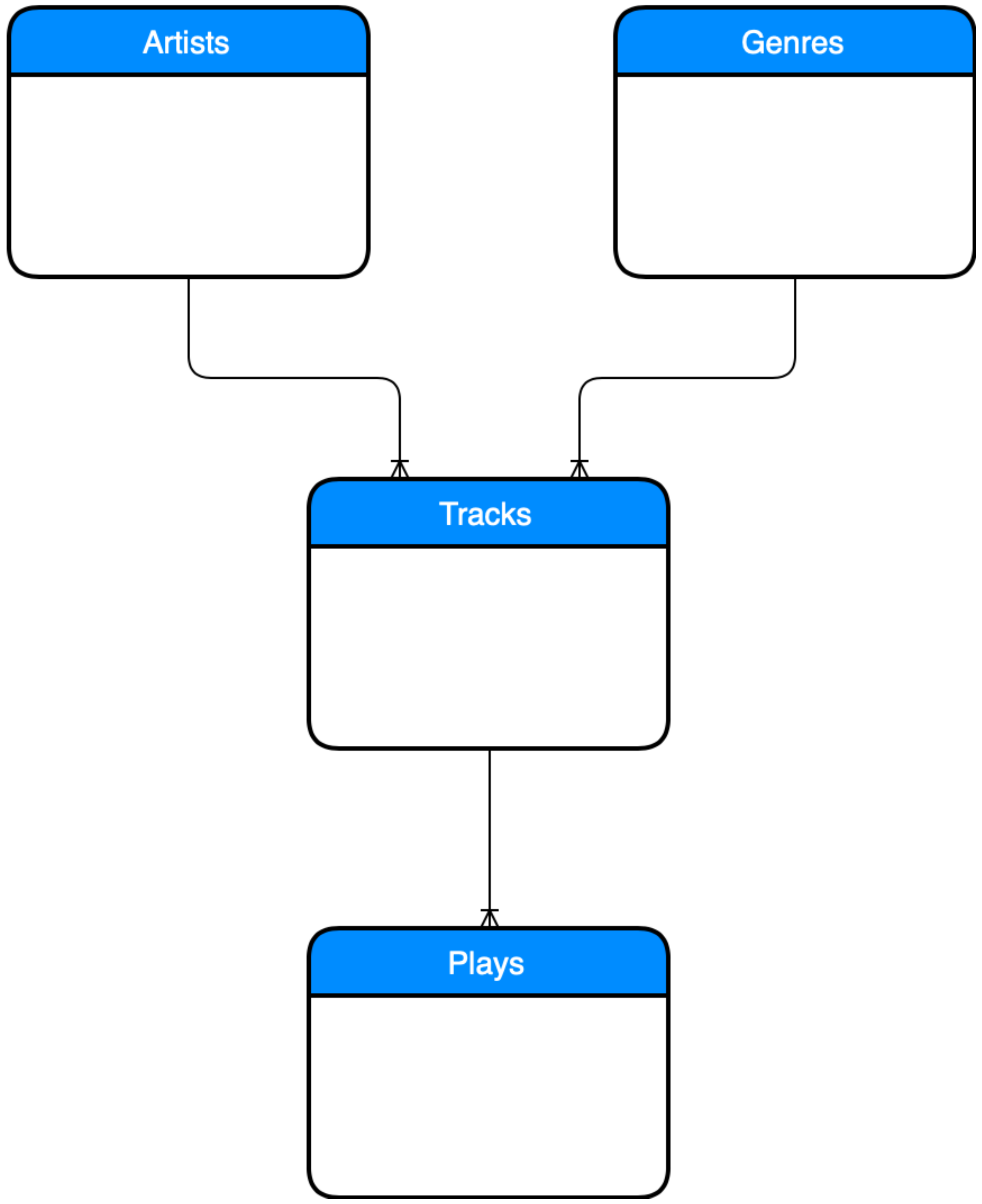
Known for



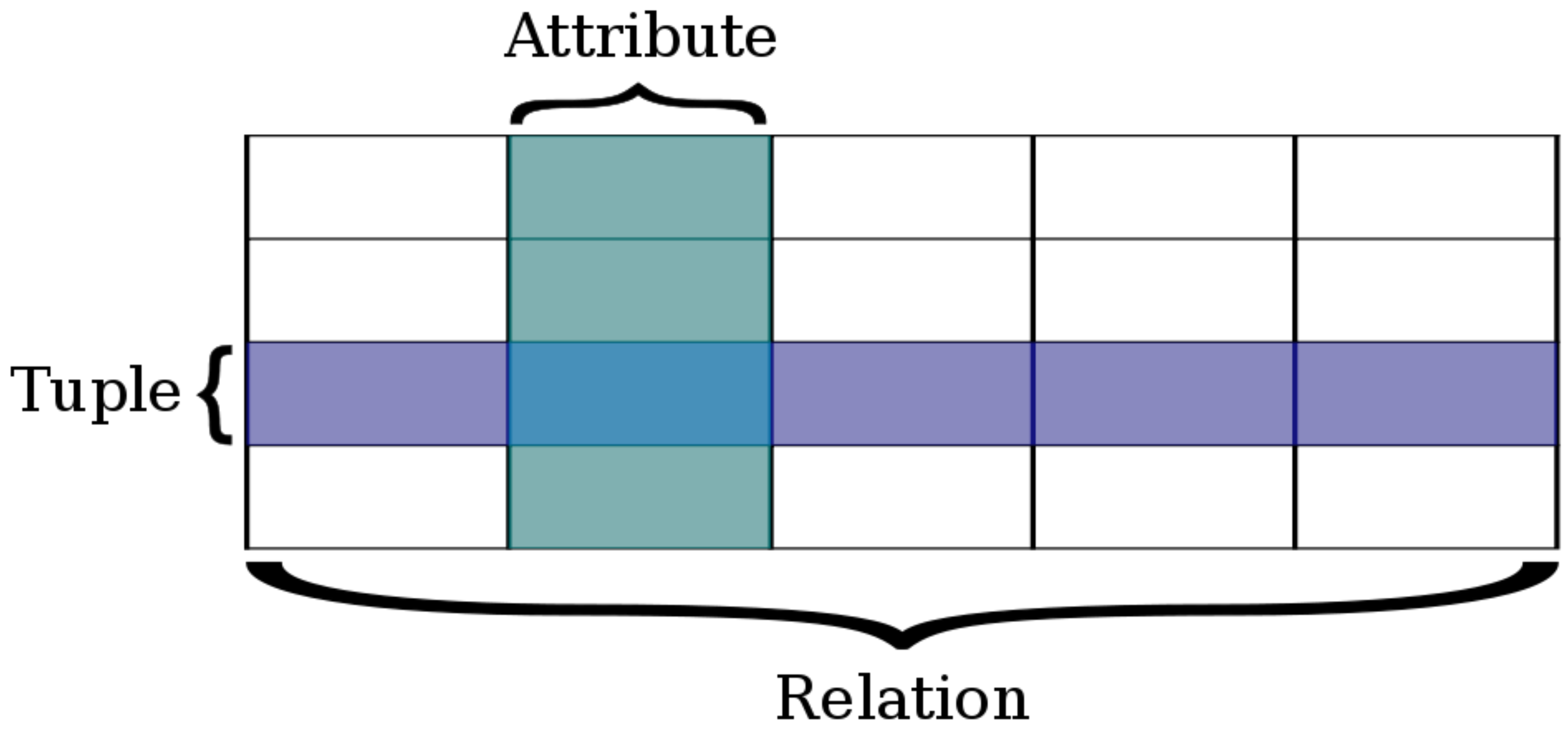
My „business“ domain

neo4j

Tracking musical data



Tracking musical data



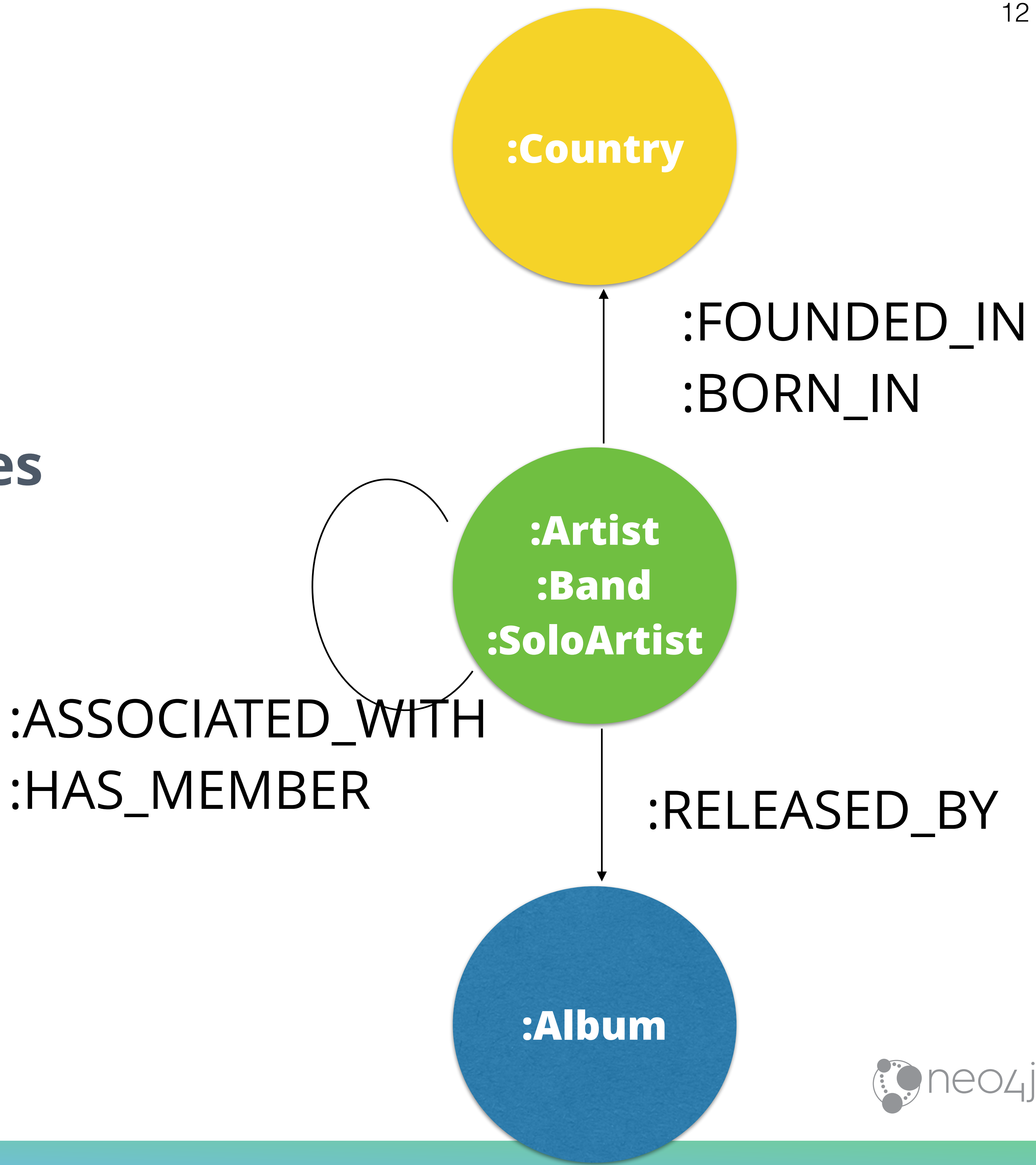
Logical vs physical model

- Logical model designed as ER diagram
- Then normalized
  - All about being free of redundancies
  - UNF (Unnormalized)
  - 1NF: Atomic
  - 2NF: + No partial dependencies
  - 3NF: + No transitive dependencies

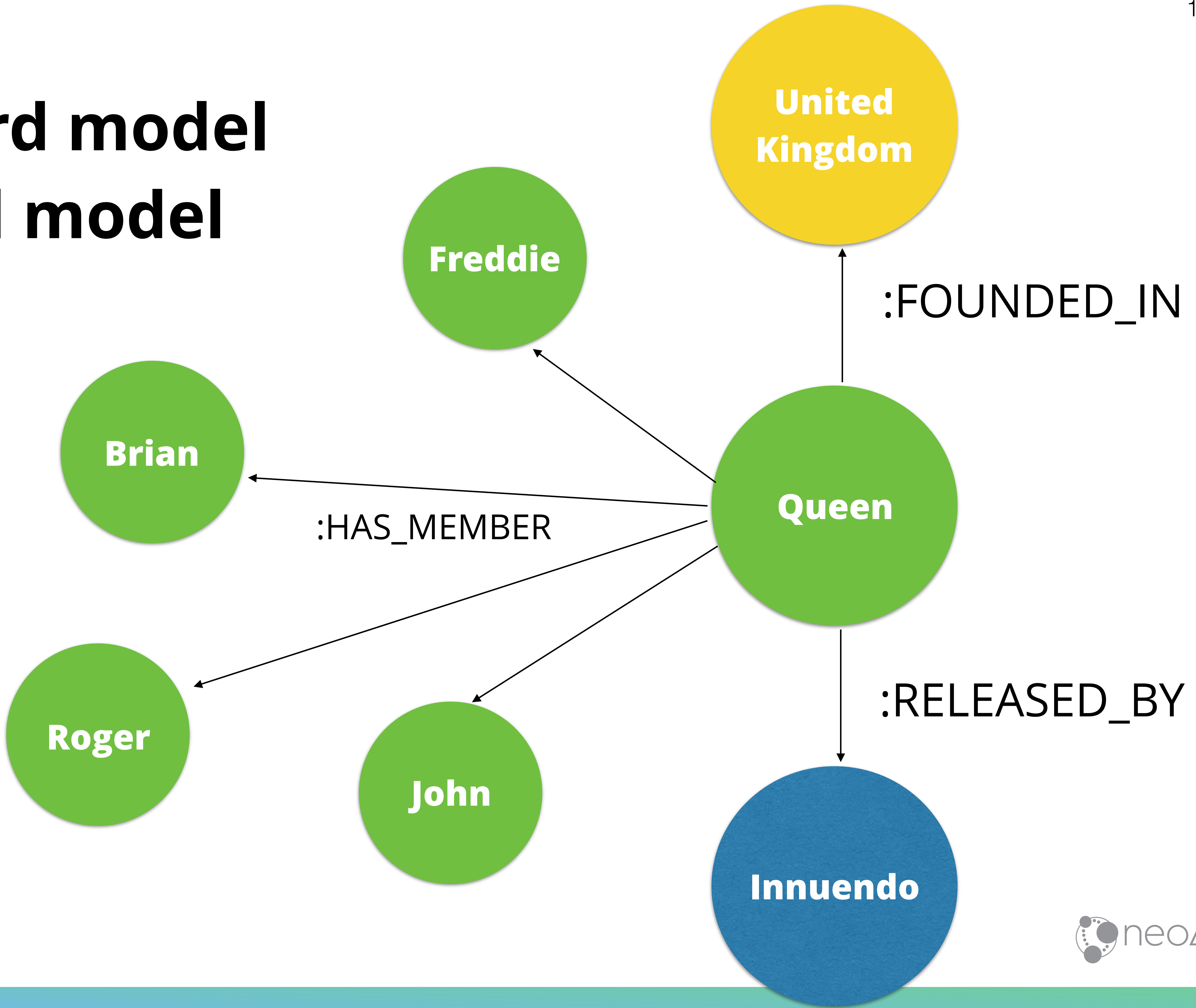
Foreign keys between tables aren’t relations!
The tables itself and every query result are.

The whiteboard model IS the physical model

- Bands are **founded in** and solo artists are **born in countries**
- Sometimes Artists are **associated with** other Artists and bands **have member**
- Artists used to release **Albums**

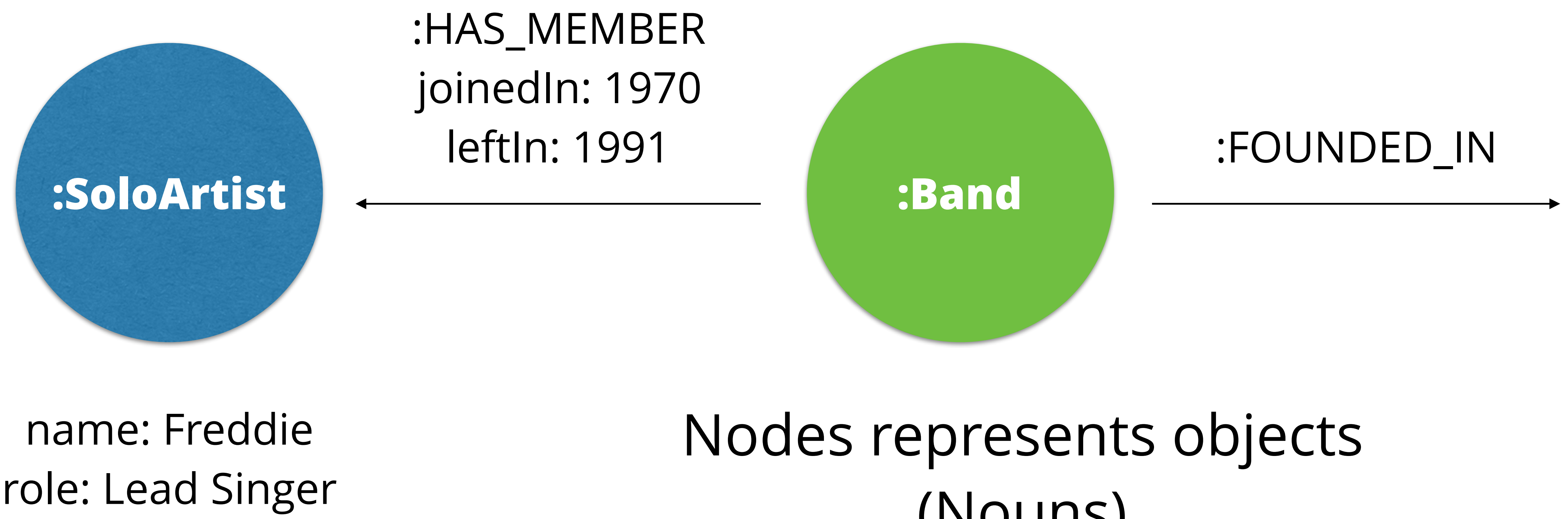


The whiteboard model IS the physical model



A Property Graph

Relationships connect nodes and represent actions (verbs)



Nodes represents objects (Nouns)

Both nodes and relationships can have properties

Querying

- Cypher is to Neo4j what SQL is to RDBMS:
  A declarative, powerful query language
- https://www.opencypher.org / The GQL Manifesto

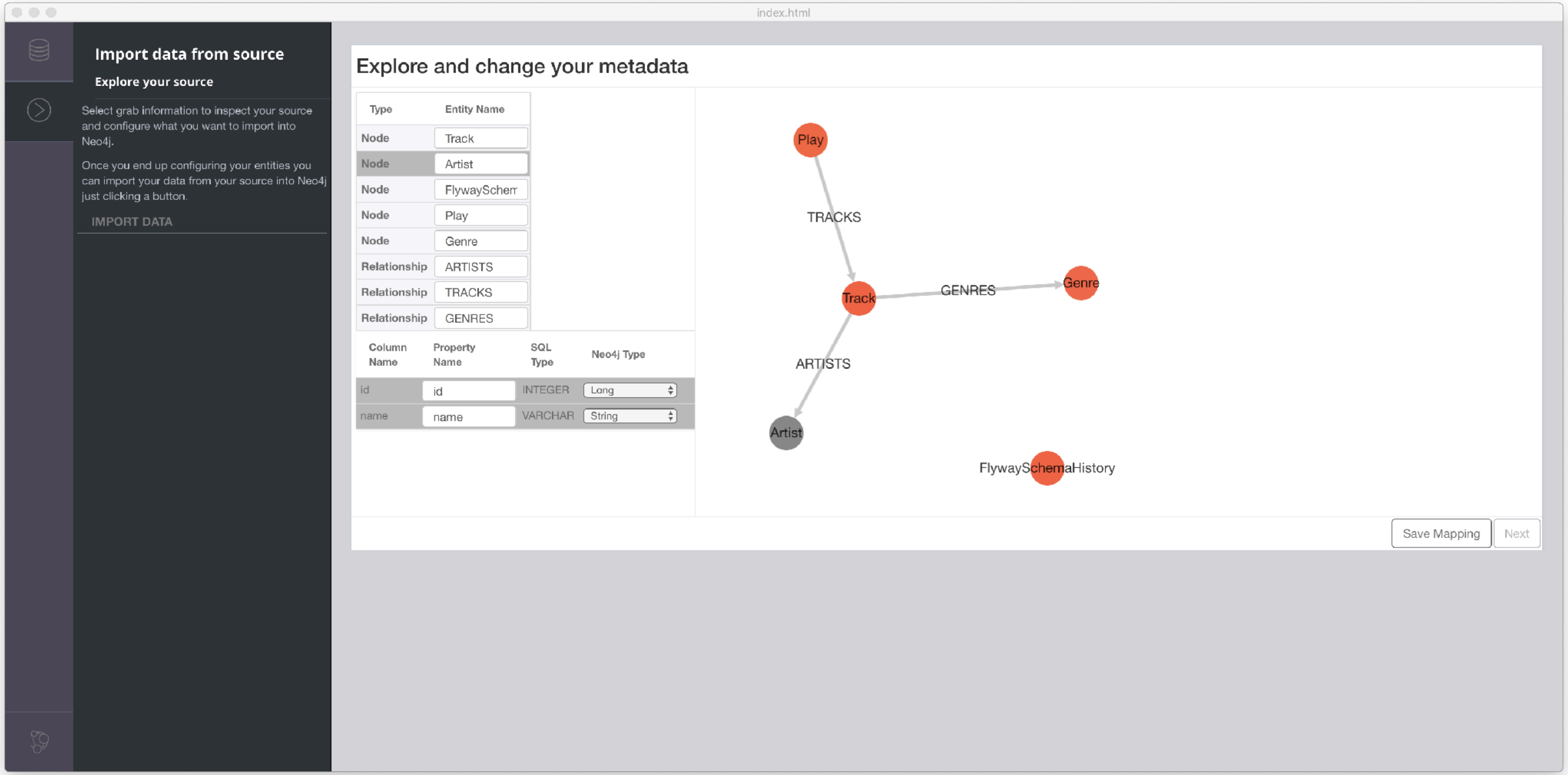
```
MATCH (a:Album) -[:RELEASED_BY]→ (b:Band),
      (c) ←[:FOUNDED_IN]- (b) -[:HAS_MEMBER]→ (m) -[:BORN_IN]→ (c2)
WHERE a.name = 'Innuendo'
RETURN a, b, m, c, c2
```

Demo

Getting data into Neo4j

neo4j

The Neo4j-ETL Tool



index.html

Import data from source

Explore your source

Select grab information to inspect your source and configure what you want to import into Neo4j.

Once you end up configuring your entities you can import your data from your source into Neo4j just clicking a button.

IMPORT DATA

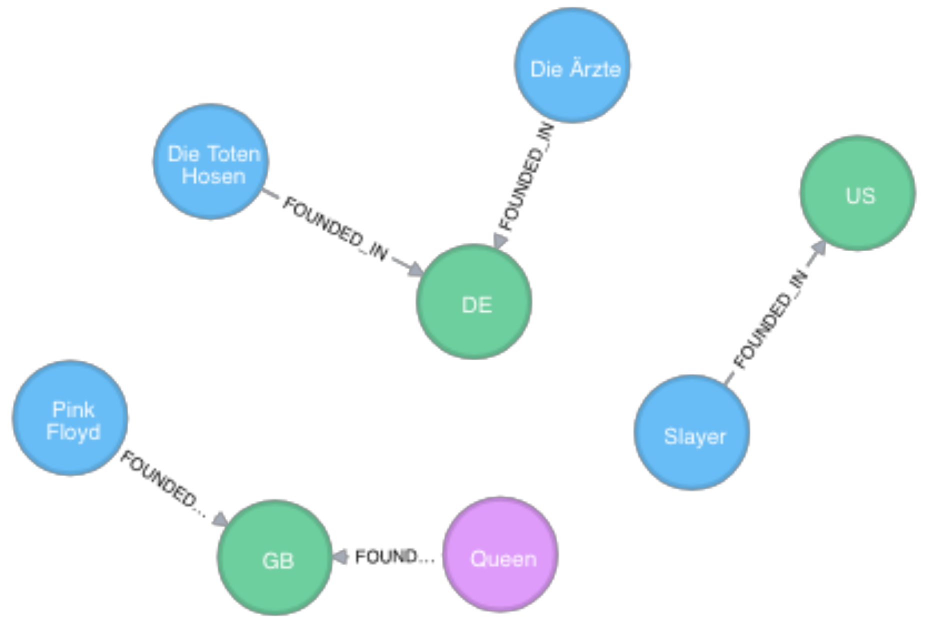
Explore and change your metadata

Type	Entity Name
Node	Track
Node	Artist
Node	FlywaySchem
Node	Play
Node	Genre
Relationship	ARTISTS
Relationship	TRACKS
Relationship	GENRES

Column Name	Property Name	SQL Type	Neo4j Type
id	id	INTEGER	Long
name	name	VARCHAR	String

LOAD CSV

```
Name;Founded in
Slayer;US
Die Ärzte;DE
Die Toten Hosen;DE
Pink Floyd;GB
```



```
LOAD CSV WITH HEADERS FROM 'http://localhost:8001/data/artists.csv'
AS line FIELDTERMINATOR ';'
MERGE (a:Artist {name: line.Name})
MERGE (c:Country {code: line.`Founded in`})
MERGE (a) -[:FOUNDED_IN]→ (c)
RETURN *
```

Building your own importer

```
public class StatsIntegration {

  @Context public GraphDatabaseService db;

  @Procedure(name = "stats.loadArtistData", mode = Mode.WRITE)
  public void loadArtistData(
      @Name("userName") final String userName,
      @Name("password") final String password,
      @Name("url") final String url) {

    try (var connection = DriverManager.getConnection(url, userName, password);
       var neoTransaction = db.beginTx()) {

      DSL.using(connection)
          .selectFrom(ARTISTS)
          .forEach(a →
            db.execute("MERGE (artist:Artist {name: $artistName}) ", Map.of("artistName", a.getName()))
          );
      neoTransaction.success();
    } catch (Exception e) {}
  }
}
```

APOC

- Not only a guy from the movie „The Matrix“

APOC

- Not only a guy from the movie „The Matrix“
- Also not that guy
- „A Package Of Components“ for Neo4j
- „Awesome Procedures on Cypher“

A huge set of all kinds of extension for Neo4j
https://neo4j-contrib.github.io/neo4j-apoc-procedures/

`apoc.load.jdbc`

- Use with single tables
- Or custom SQL statements

apoc.load.jdbc

```
WITH "jdbc:postgresql://localhost:5432/bootiful-music?user=statsdb-dev&password=dev" as url,
     "SELECT DISTINCT a.name as artist_name, t.album, g.name as genre_name, t.year
      FROM tracks t JOIN artists a ON a.id = t.artist_id JOIN genres g ON g.id = t.genre_id
      WHERE t.compilation = 'f'" as sql
CALL apoc.load.jdbc(url,sql) YIELD row
MERGE (decade:Decade {value: row.year-row.year%10})
MERGE (year:Year {value: row.year})
MERGE (year) -[:PART_OF]→ (decade)
MERGE (artist:Artist {name: row.artist_name})
MERGE (album:Album {name: row.album}) -[:RELEASED_BY]→ (artist)
MERGE (genre:Genre {name: row.genre_name})
MERGE (album) -[:HAS]→ (genre)
MERGE (album) -[:RELEASED_IN]→ (year)
```

Demo

Using Neo4j from the JVM

neo4j

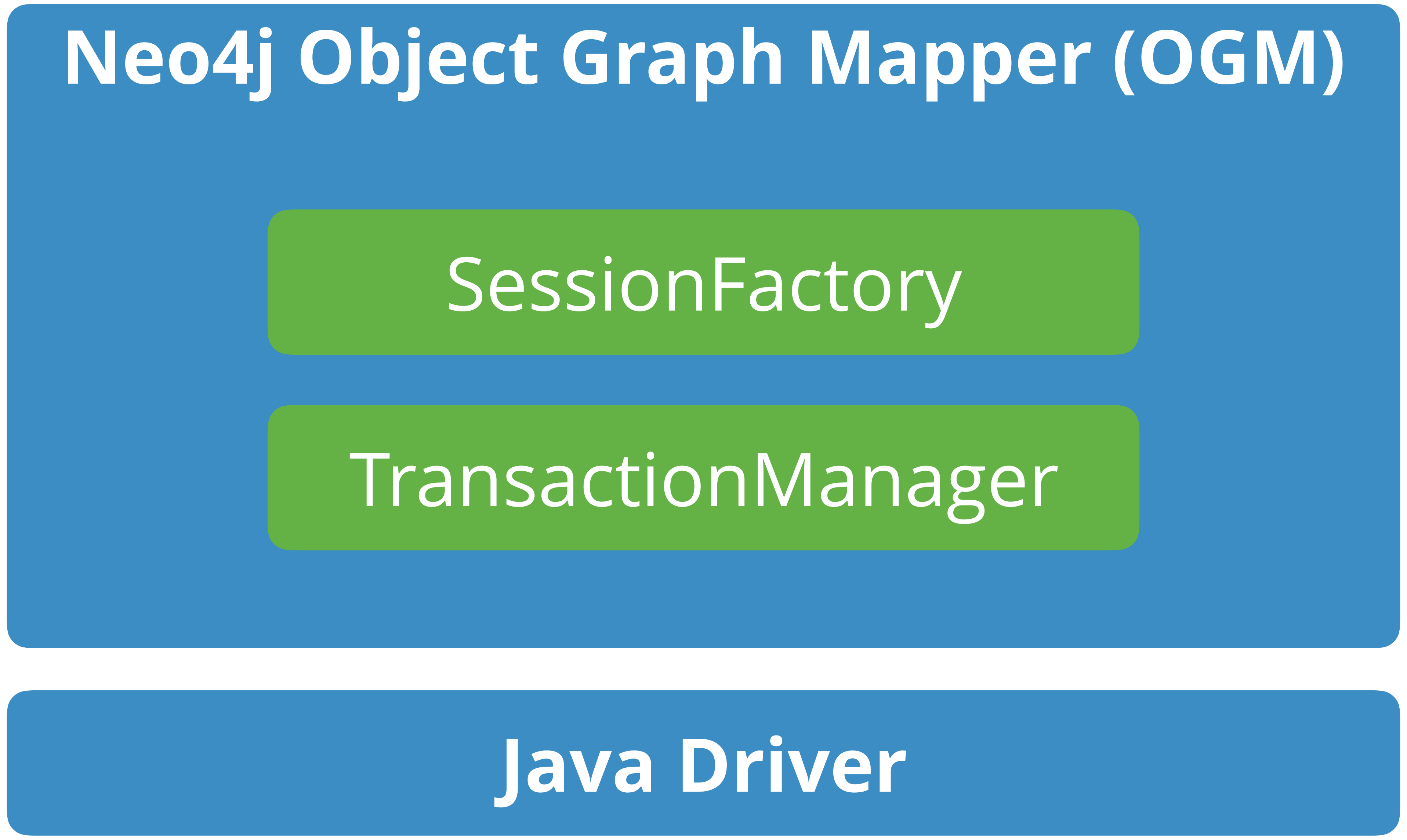
Different endpoints

- Neo4j can run embedded in the same VM
- Has an HTTP endpoint
- Offers the binary **Bolt protocol**
  - Drivers for Java, Go, C#, Seabolt (C), Python, JavaScript

Working directly with the driver

```java
try (
  Driver driver = GraphDatabase.driver(uri, AuthTokens.basic(user, password));
  Session session = driver.session()
) {
  List<String> artistNames =
    session
      .readTransaction(tx -> tx.run("MATCH (a:Artist) RETURN a", emptyMap()))
      .list(record -> record.get("a").get("name").asString());
}
```

Using Neo4j-OGM



Using Neo4j-OGM

- Unified configuration
- Annotation based
  - Mapping between Classes and Graph Model
- Data access
  - Domain based
  - Through custom queries

Annotations

```
@NodeEntity("Band")
public class BandEntity extends ArtistEntity {

  @Id @GeneratedValue
  private Long id;

  private String name;

  @Relationship("FOUNDED_IN")
  private CountryEntity foundedIn;

  @Relationship("ACTIVE_SINCE")
  private YearEntity activeSince;

  @Relationship("HAS_MEMBER")
  private List<Member> member = new ArrayList<>();
}
```

Annotations

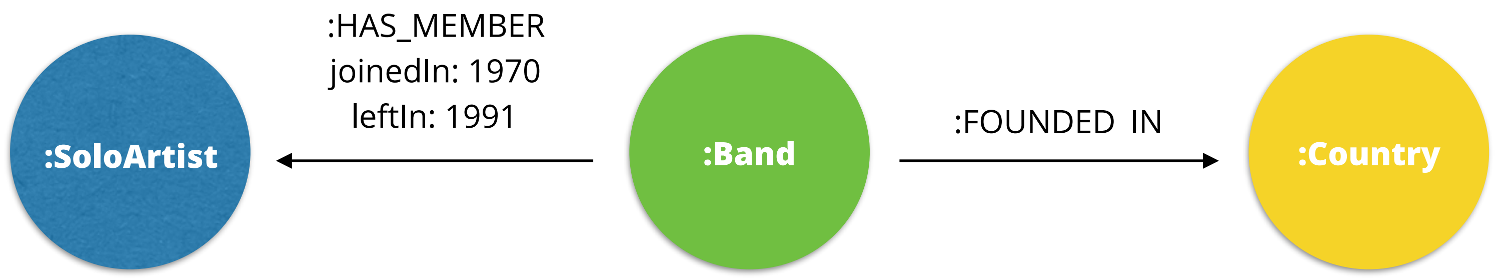
```
@RelationshipEntity("HAS_MEMBER")
public static class Member {
  @Id @GeneratedValue
  private Long memberId;

  @StartNode
  private BandEntity band;

  @EndNode
  private SoloArtistEntity artist;

  @Convert(YearConverter.class)
  private Year joinedIn;

  @Convert(YearConverter.class)
  private Year leftIn;
}
```



Domain based data access

```java
var artist = new BandEntity("Queen");
artist.addMember(new SoloArtistEntity("Freddie Mercury"));

var session = sessionFactory.openSession();
session.save(artist);
```

Domain based data access

```
var queen = session.load(BandEntity.class, 4711);

var allBands = session.loadAll(BandEntity.class);
```

Domain based data access

```
session.delete(nickelback);

session.deleteAll(BandEntity.class);
```

Data access with custom queries

```
var britishBands = session.query(
     ArtistEntity.class,
     "MATCH (b:Band) -[:FOUNDED_IN]→ (:Country {code: 'GB'})", emptyMap());

Result result = session.query(
  "MATCH (b:Artist) ←[r:RELEASED_BY]- (a:Album) -[:RELEASED_IN]→ () -
[:PART_OF]→ (:Decade {value: $decade})"
  "WHERE b.name = $name" +
  "RETURN b, r, a",
  Map.of("decade", 1970, "name", "Queen")
);
```

Works with

- „Plain“ Java
- Micronaut
- Spring
- Spring Boot

Spring Data Neo4j

neo4j

Spring Data Neo4j

- Very early Spring Data Module
    - First Version ~2010 (Emil Eifrem, Rod Johnson)
- Build on top of Neo4j-OGM
- Part of the Spring Data release trains
- Offers
    - Derived finder methods
    - Custom results and projections
    - Domain Events
- Integrated in Spring Boot

Spring Data Neo4j

- Can be used store agnostic
- Without Cypher
- Or „Graph aware“
  - limiting the fetch size
  - Custom Cypher

Domain based data access revised

```
interface BandRepository extends Repository<BandEntity, Long> {
}
```

Domain based data access revised

```
interface BandRepository extends Neo4jRepository<BandEntity, Long> {
}
```

- CRUD Methods
  - (save, findById, delete, count)
- Supports `@Depth` annotation as well as `depth` argument

Domain based data access revised

```
var artist = new BandEntity("Queen");
artist.addMember(new SoloArtistEntity("Freddie Mercury"));

artist = bandRepository.save(artist);
```

Domain based data access revised

```
var artist = bandRepository.findByName("Nickelback")

artist.ifPresent(bandRepository::delete);
```

Derived finder methods

```
interface AlbumRepository extends Neo4jRepository<AlbumEntity, Long> {

  Optional<AlbumEntity> findOneByName(String x);

  List<AlbumEntity> findAllByNameMatchesRegex(String name);

  List<AlbumEntity> findAllByNameMatchesRegex(
    String name, Sort sort, @Depth int depth);

  Optional<AlbumEntity> findOneByArtistNameAndName(
     String artistName, String name);
}
```

Custom queries

```
interface AlbumRepository extends Neo4jRepository<AlbumEntity, Long> {
  @Query(value
    = " MATCH (album:Album) - [:CONTAINS] -> (track:Track)"
    + " MATCH p=(album) - [*1] - ()"
    + " WHERE id(track) = $trackId"
    + "   AND ALL(relationship IN relationships(p) "
    + "             WHERE type(relationship) <> 'CONTAINS')"
    + " RETURN p"
  )
  List<AlbumEntity> findAllByTrack(Long trackId);
}
```

Custom results

```
@QueryResult
public class AlbumTrack {
  private Long id;

  private String name;

  private Long discNumber;

  private Long trackNumber;
}
```

Custom results

```
interface AlbumRepository extends Neo4jRepository<AlbumEntity, Long> {
  @Query(value
    = " MATCH (album:Album) - [c:CONTAINS] → (track:Track) "
    + " WHERE id(album) = $albumId"
    + " RETURN id(track) AS id, track.name AS name, "
    + "         c.discNumber AS discNumber, c.trackNumber AS trackNumber"
    + " ORDER BY c.discNumber ASC, c.trackNumber ASC"
  )
  List<AlbumTrack> findAllAlbumTracks(Long albumId);
}
```

Spring Transactions

```
public class ArtistService {

  @Transactional
  public void deleteArtist(Long id) {

    this.bandRepository.findById(id).ifPresent(a → {
      session.delete(a);
      session.query("MATCH (a:Album) WHERE size((a)-[:RELEASED_BY]→(:Artist))=0 DETACH DELETE a", emptyMap());
      session.query("MATCH (t:Track) WHERE size((:Album)-[:CONTAINS]→(t))=0 DETACH DELETE t", emptyMap());
    });
  }
}
```

Spring Transactions

```
TransactionTemplate transactionTemplate;

return transactionTemplate.execute(t → {
  ArtistEntity artist = this.findArtistById(artistId).get();

  var oldLinks = artist.updateWikipediaLinks(newLinks);
  session.save(artist);
  oldLinks.forEach(session::delete);

  return artist;
});
```

With Spring Boot: Configuration properties and auto config

```
org.springframework.boot:spring-boot-starter-neo4j
```

```
spring.data.neo4j.username=neo4j
spring.data.neo4j.password=music
spring.data.neo4j.uri=bolt://localhost:7687

spring.data.neo4j.embedded.enabled=false
```

With Spring Boot: Test-Slice

```
@DataNeo4jTest
~~@TestInstance~~(Lifecycle.PER_CLASS)
class CountryRepositoryTest {

  private final Session session;

  private final CountryRepository countryRepository;

  @Autowired
  CountryRepositoryTest(Session session, CountryRepository countryRepository) {
    this.session = session;
    this.countryRepository = countryRepository;
  }

  @BeforeAll
  void createTestData() {}

  @Test
  void getStatisticsForCountryShouldWork() {}
}
```

Spring Data Neo4j: Don'ts

- Not for batch processing
- Don’t abuse derived method names

  i.e. `Optional<AlbumEntity> findOneByArtistNameAndNameAndLiveIsTrueAndReleasedInValue(String artistName, String name, long year)`
- Don’t follow your Graph model blindly while modeling the domain
  - Graph model usually tailored to answer specific question
  - Domain often follows a different use-case

Don’t follow your Graph model blindly while modeling the domain

```java
@NodeEntity("Artist")
public class ArtistEntity {

  private String name;

  @Relationship(
    value = "RELEASED_BY",
    direction = INCOMING)
  private List<AlbumEntity> albums;
}
```

```java
@NodeEntity("Album")
public class AlbumEntity {

  @Relationship("RELEASED_BY")
  private ArtistEntity artist;

  @Relationship("CONTAINS")
  private List<TrackEntity> tracks;
}

@NodeEntity("Track")
public class TrackEntity {

  @Relationship(
    value = "CONTAINS", direction = INCOMING)
  private List<AlbumEntity> tracks;
}
```

Better approach

```java
@NodeEntity("Artist")
public class ArtistEntity {

  private String name;
}

@NodeEntity("Album")
public class AlbumEntity {

  @Relationship("RELEASED_BY")
  private ArtistEntity artist;
}

@QueryResult
public class AlbumTrack {

  private String name;

  private Long trackNumber;
}
```

```java
interface AlbumRepository extends Repository<AlbumEntity, Long> {
  List<AlbumEntity> findAllByArtistNameMatchesRegex(
    String artistName,
    Sort sort);

  @Query(value
    = " MATCH (album:Album) - [c:CONTAINS] → (track:Track) "
    + " WHERE id(album) = $albumId"
    + " RETURN track.name AS name, c.trackNumber AS trackNumber"
    + " ORDER BY c.discNumber ASC, c.trackNumber ASC"
  )
  List<AlbumTrack> findAllAlbumTracks(long albumId);
}
```

Demo

What are your top devices?
Where are your users?
Sessions by device
Sessions by country
COHORT ANALYSIS REPORT

Some advanced queries

neo4j

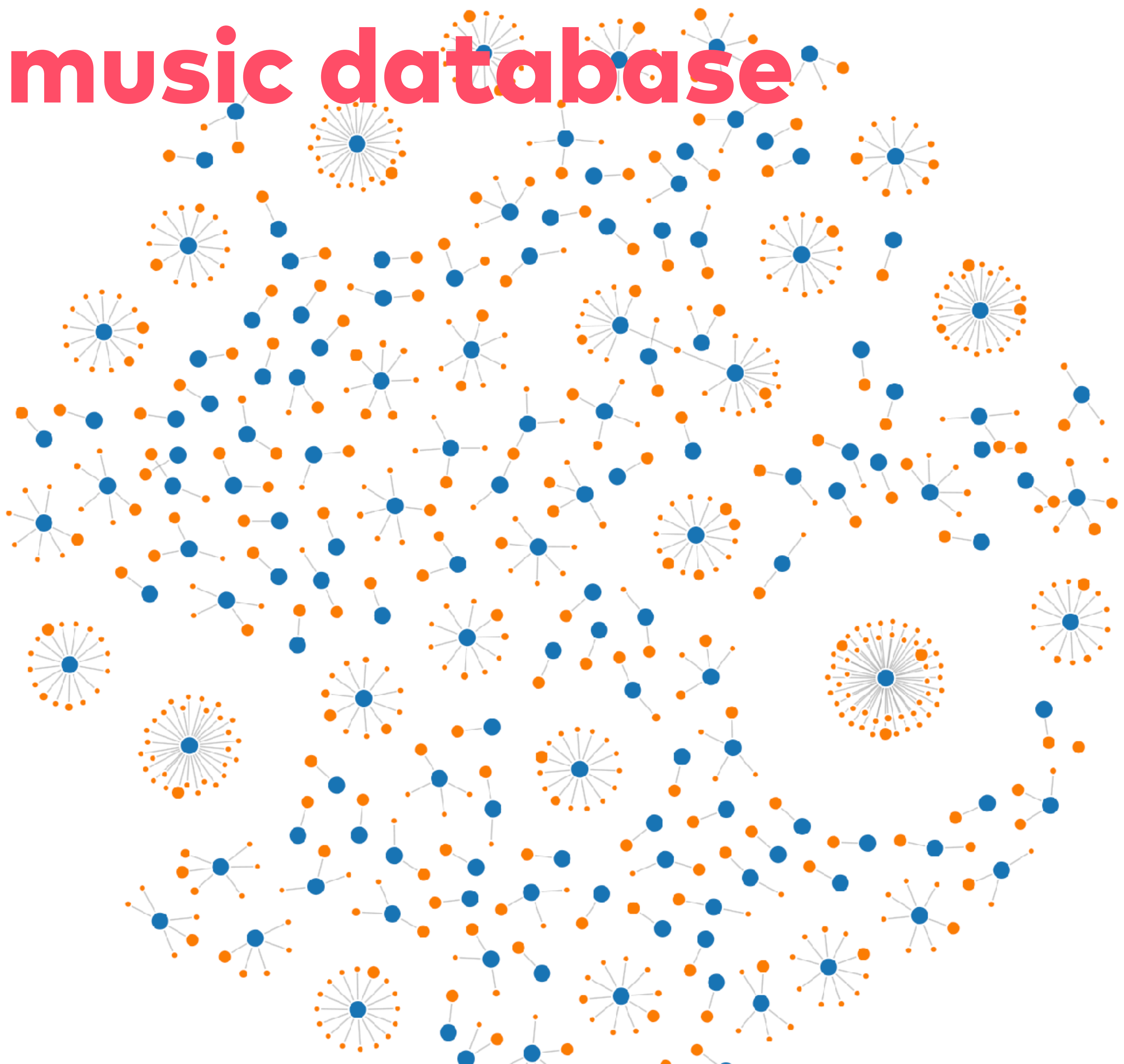
More Cypher

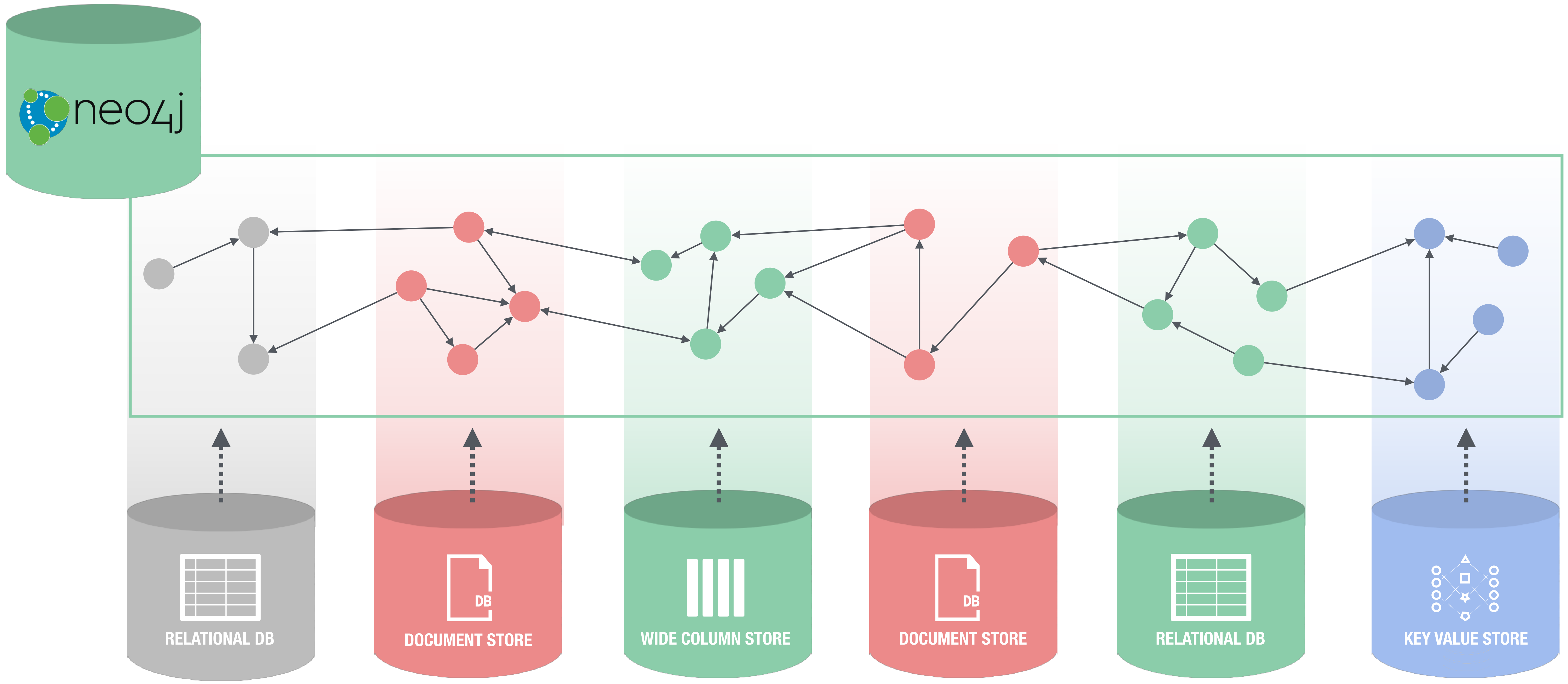
Putting it all together

My personal music database

Genre

Name	
2[illegible] Germany Punk Rock	1[illegible]74
2010 Germany Punk Rock	8271
1990 Germany Punk Rock	6919
2010 Germany Rock	6778
2000 United Kingdom Rock	5116
1970 United Kingdom Rock	3554
1980 United Kingdom Rock	3433
2010 United Kingdom Rock	3224
2000 United Kingdom Heavy Metal	2370
1990 United States Heavy Metal	2314





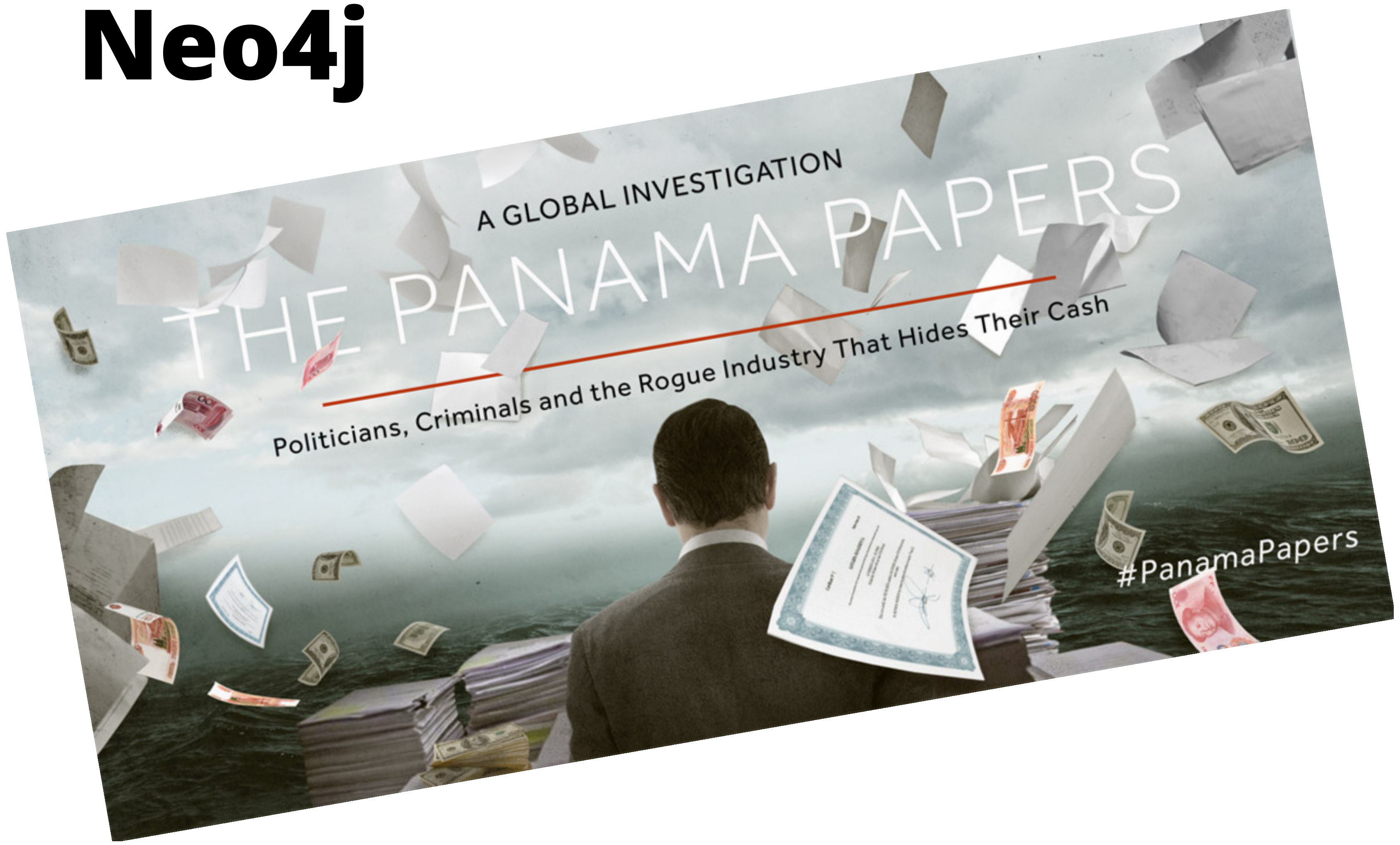
Leveraging Cross-Silo Connections

Real use-cases

neo4j

Neo4j

ICIJ - International Consortium of Investigative Journalists


A GLOBAL INVESTIGATION
THE PANAMA PAPERS
Politicians, Criminals and the Rogue Industry That Hides Their Cash
#PanamaPapers

https://neo4j.com/blog/icij-neo4j-unravel-panama-papers/

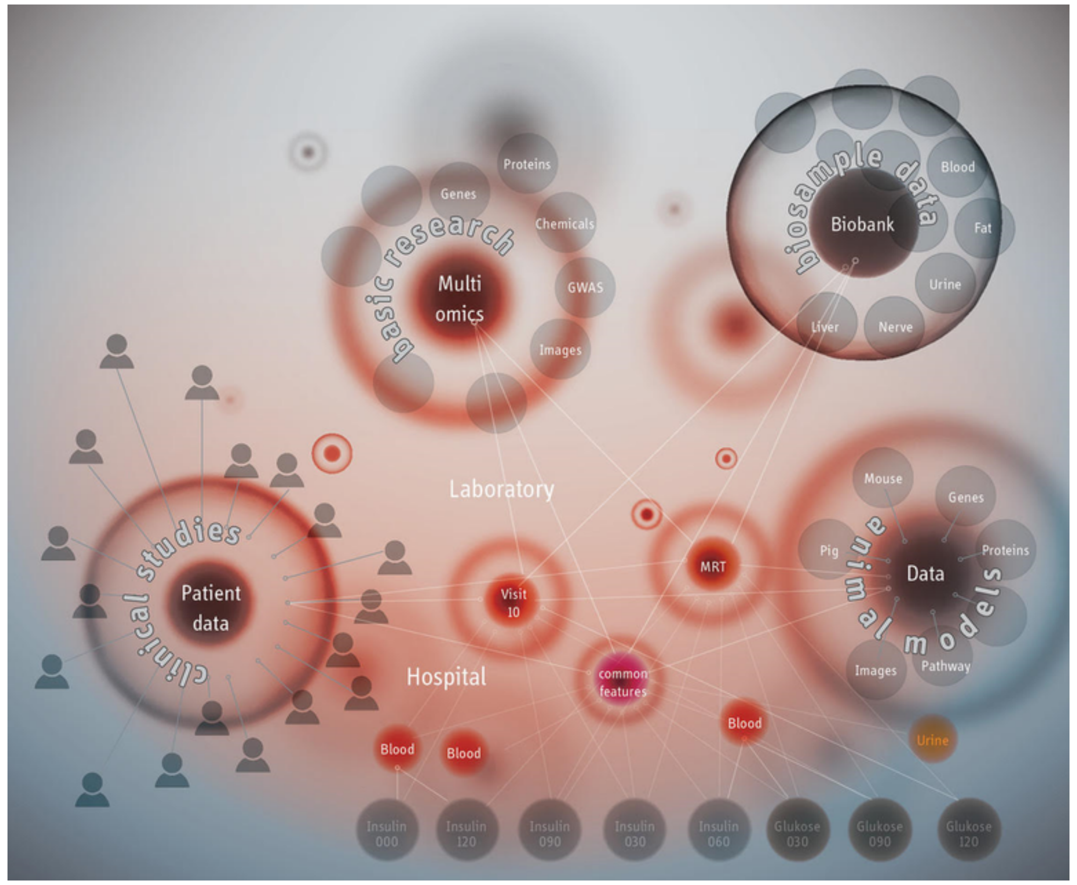
https://neo4j.com/blog/analyzing-panama-papers-neo4j/

https://neo4j.com/blog/analyzing-paradise-papers-neo4j/

Neo4j

„In biology or medicine, data is connected. You know that entities are connected -- they are dependent on each other. The reason why we chose graph technology and Neo4j is because all the entities are connected.“

Dr Alexander Jarasch, DZD German centre of diabetic research

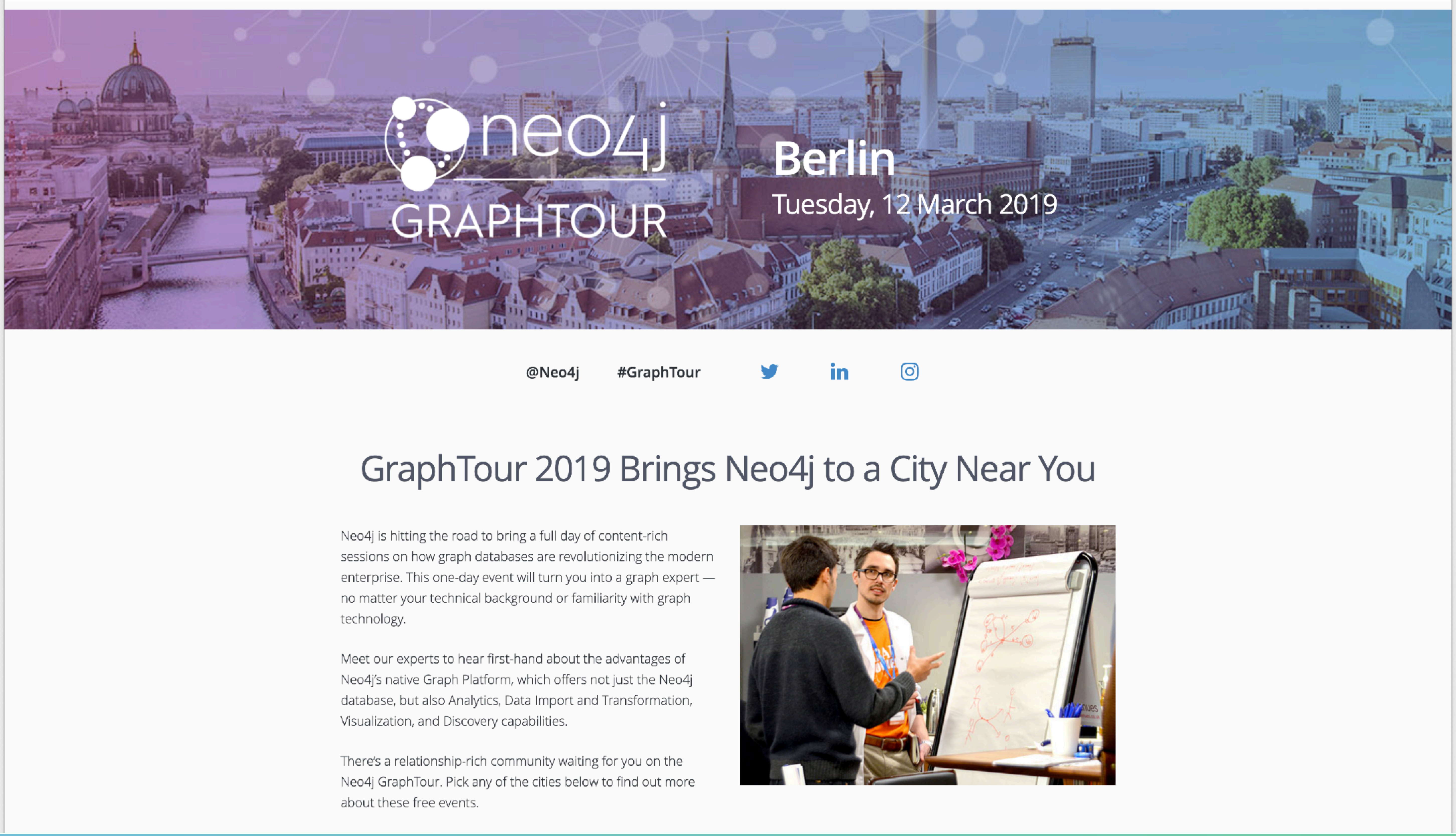


https://www.zdnet.com/article/using-graph-database-technology-to-tackle-diabetes/

Try yourself

neo4j

neo4j.com/graphtour



@Neo4j #GraphTour

GraphTour 2019 Brings Neo4j to a City Near You

Neo4j is hitting the road to bring a full day of content-rich sessions on how graph databases are revolutionizing the modern enterprise. This one-day event will turn you into a graph expert — no matter your technical background or familiarity with graph technology.

Meet our experts to hear first-hand about the advantages of Neo4j's native Graph Platform, which offers not just the Neo4j database, but also Analytics, Data Import and Transformation, Visualization, and Discovery capabilities.

There's a relationship-rich community waiting for you on the Neo4j GraphTour. Pick any of the cities below to find out more about these free events.

Neo4j

- https://neo4j.com/download/
  - Neo4j Desktop (Analyst centric)
  - Neo4j Server (Community and Enterprise Edition)
    Community Edition: GPLv3
    Enterprise Edition: Proprietary

Neo4j Datasets

- https://neo4j.com/sandbox-v2/
  - Preconfigured instance with several different datasets
- https://neo4j.com/graphgists/
  - Neo4j Graph Gists, Example Models and Cypher Queries
- https://offshoreleaks.icij.org/
  - Data convolutes mentioned early

My „Bootiful Music“ project

- https://github.com/michael-simons/bootiful-music
    - Contains docker-compose-scripts for both relational database and Neo4j Instances
- Two Spring Boot applications
    - charts: the relational part of the application
    - knowledge: the graph application
- etl: the custom Neo4j plugin
- A Micronaut demo as well

Resources

- Demo:
  github.com/michael-simons/bootiful-music
- A series of blog posts: From relational databases to databases with relations
  https://info.michael-simons.eu/2018/10/11/from-relational-databases-to-databases-with-relations/
- Slides: speakerdeck.com/michaelsimons
- Curated set of SDN / OGM tips
  https://github.com/michael-simons/neo4j-sdn-ogm-tips
- GraphTour 2019: https://neo4j.com/graphtour/
- (German) Spring Boot Book
  @SpringBootBuch // springbootbuch.de

Thank you!

neo4j

Images

- Medical graph: DZD German centre of diabetic research
- Codd: Wikipedia
- Apoc and Cypher: Stills from the motion picture „The Matrix“
- Demo:
  https://unsplash.com/photos/Uduc5hJX2Ew
  https://unsplash.com/photos/FlPc9_VocJ4
  https://unsplash.com/photos/gp8BLyaTaA0