Graphdatenbanksysteme

Ein Überblick

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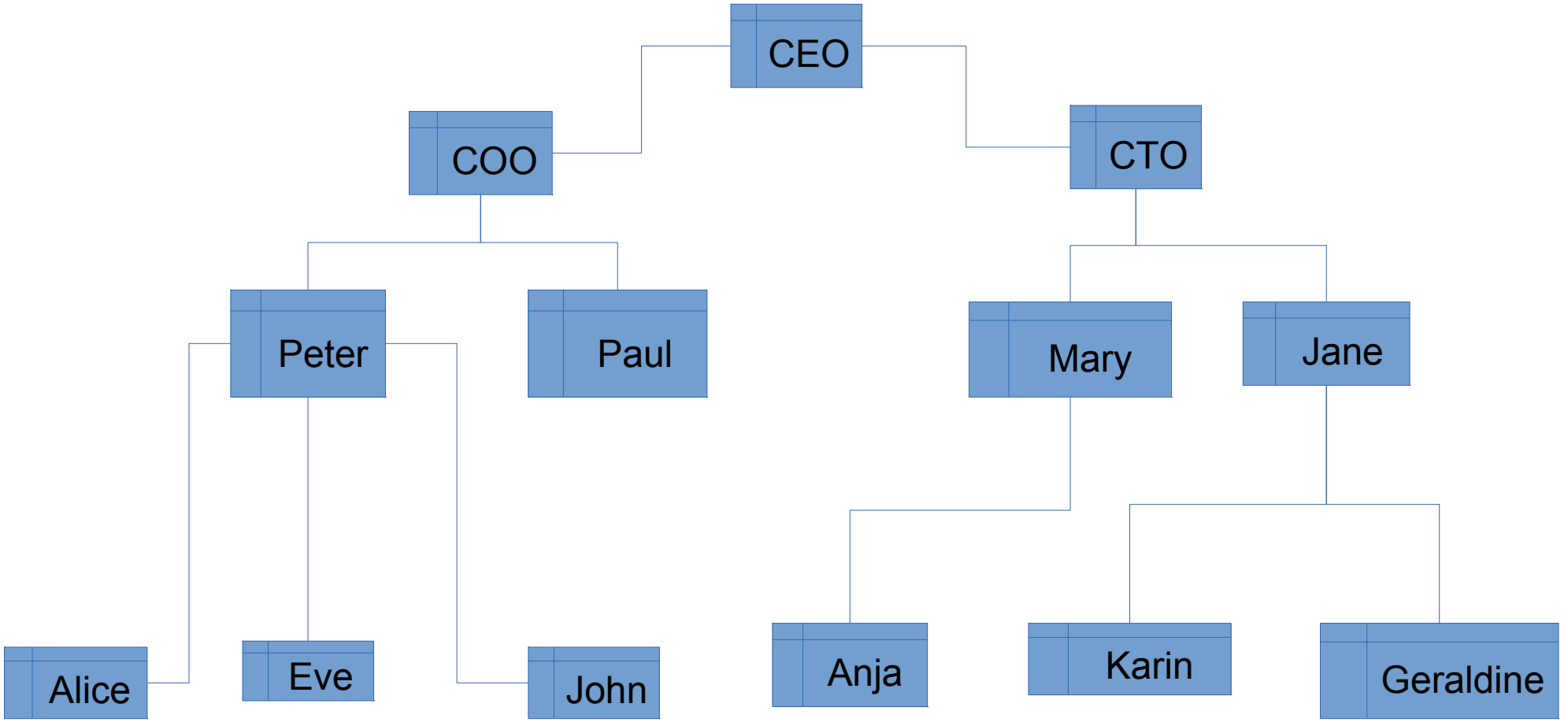
Was ist das?

```
WITH RECURSIVE manager ( level, managerId) AS (
   SELECT
      1                       AS depth,
      employees.managerId     AS managerId
   FROM employees
   WHERE employees.employeeId=13
    UNION ALL
   SELECT
      manager.depth+1,
      employees.managerId
   FROM manager
   INNER JOIN employees
   ON employees.employeeId=manager.managerId
)
SELECT
manager.depth,
manager.employeeId
FROM manager
ORDER BY manager.depth ASC;
```

Relationale Datenbank

employeeId	*employeeName*	*managerId*
1	Alice	6
2	Anja	11
3	CEO	null
4	COO	3
5	CTO	3
6	Peter	4
7	Geraldine	8
8	Jane	5
9	John	6
10	Karin	8
11	Mary	11
12	Paul	4
13	Eve	6

Graph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COO
CTO
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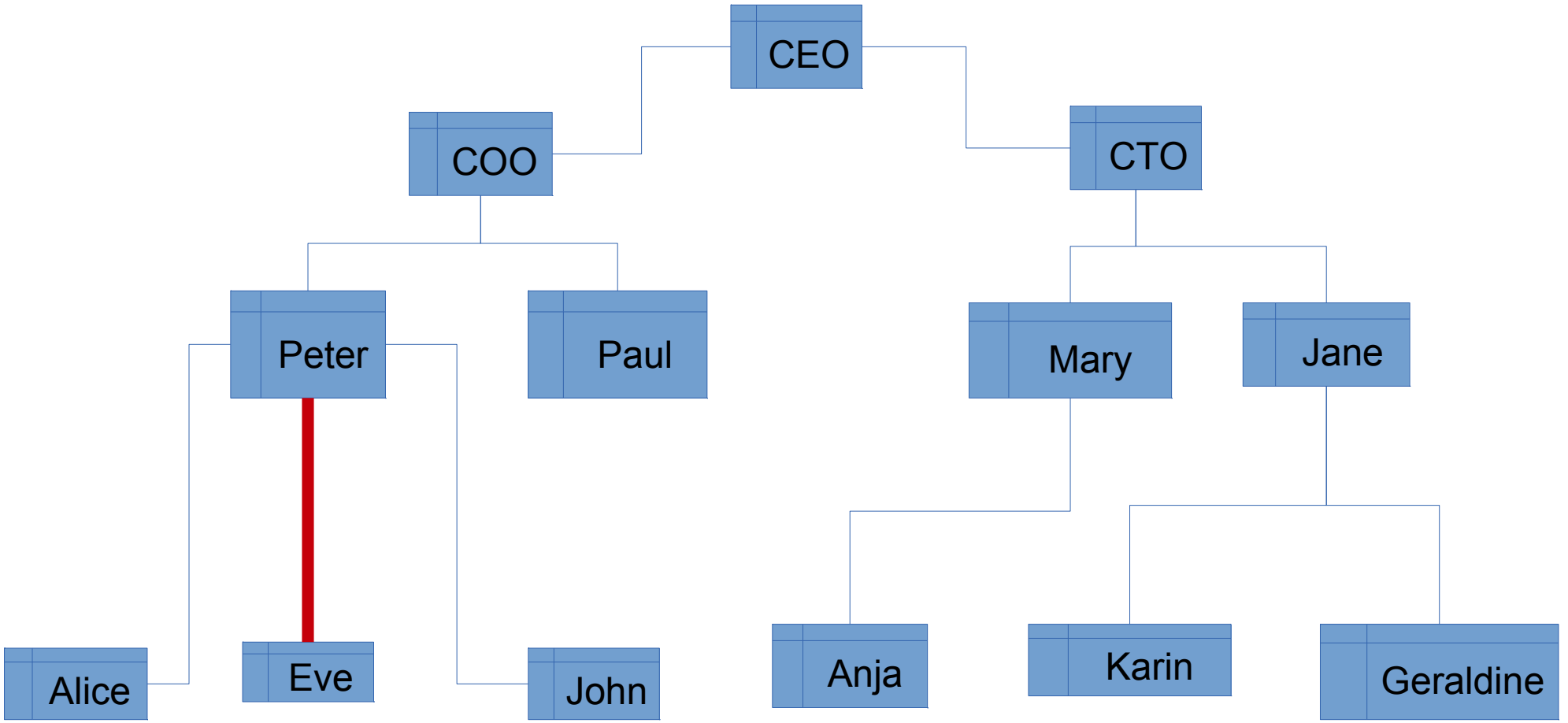
Paul
Mary
Jane
Alice
Eve
John
Anja
Karin
Geraldine

Graph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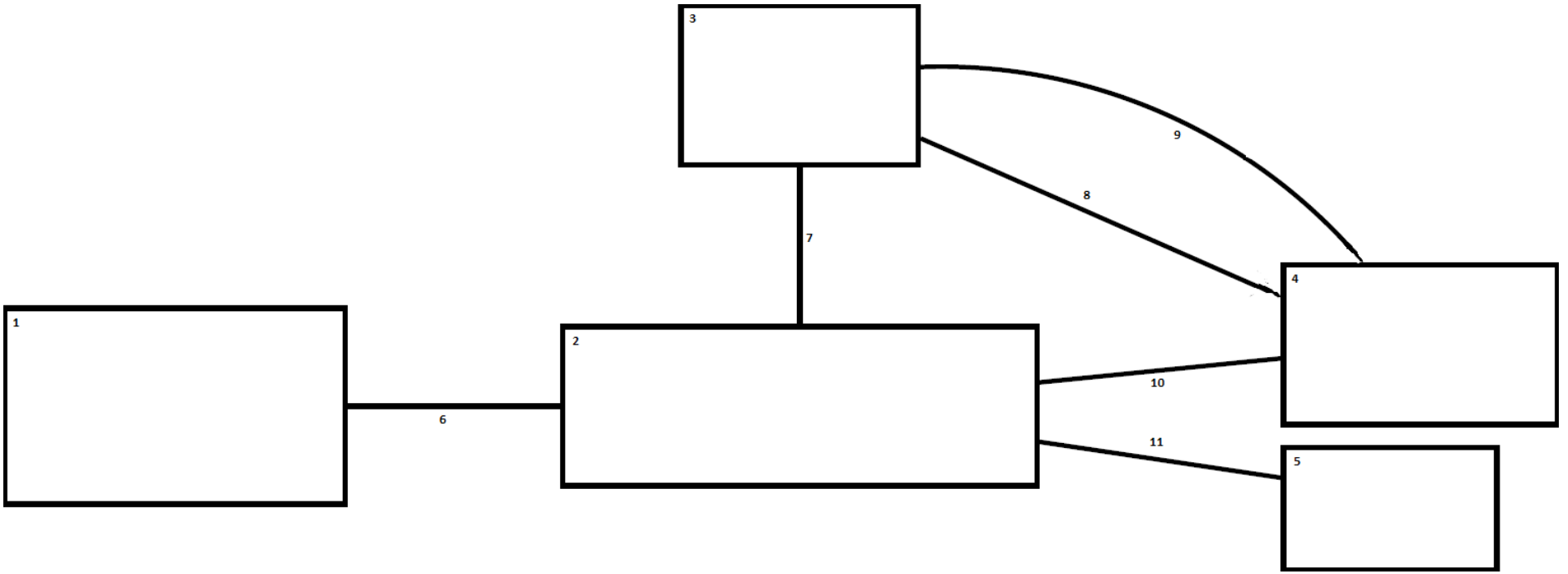
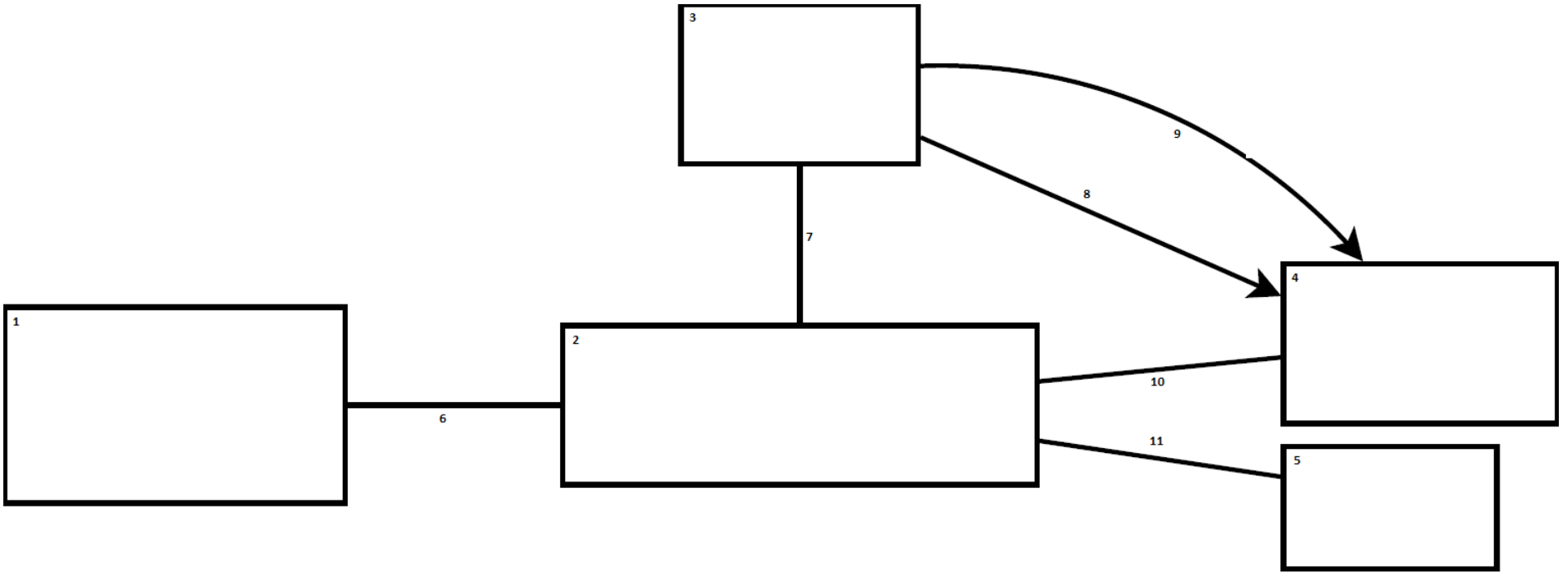
Graphdatenbanken

Datenmodell



Datenmodell



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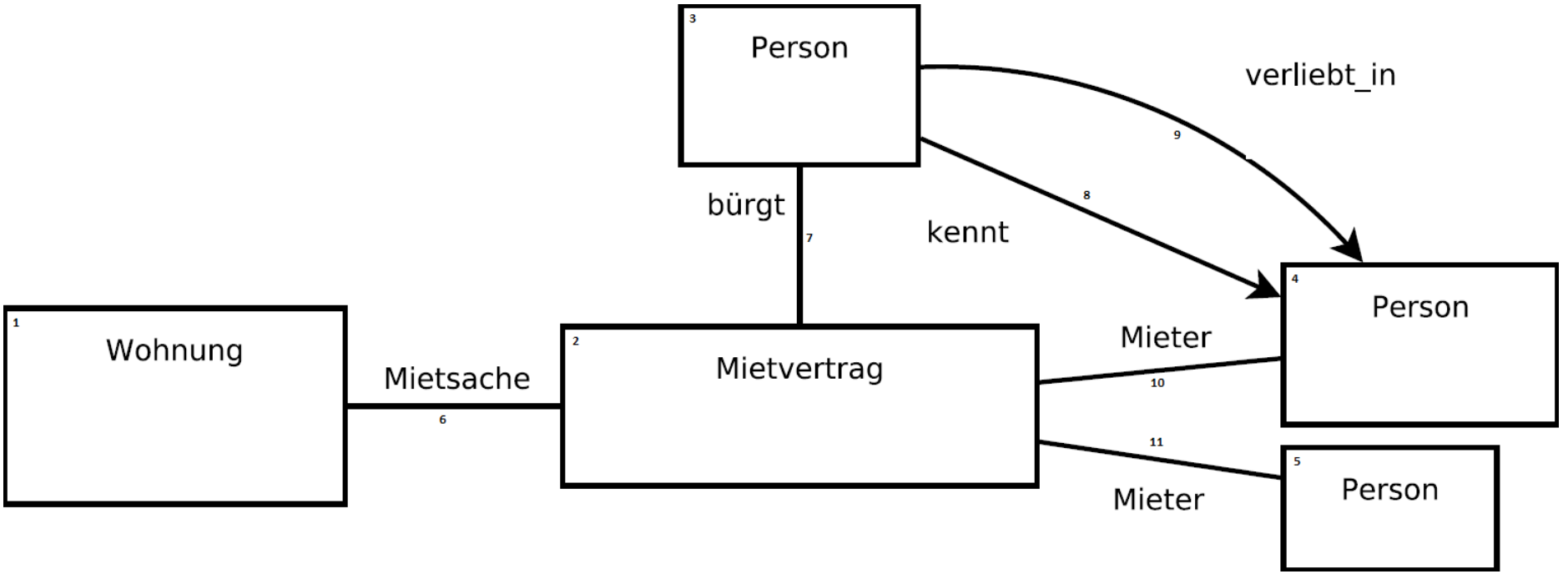
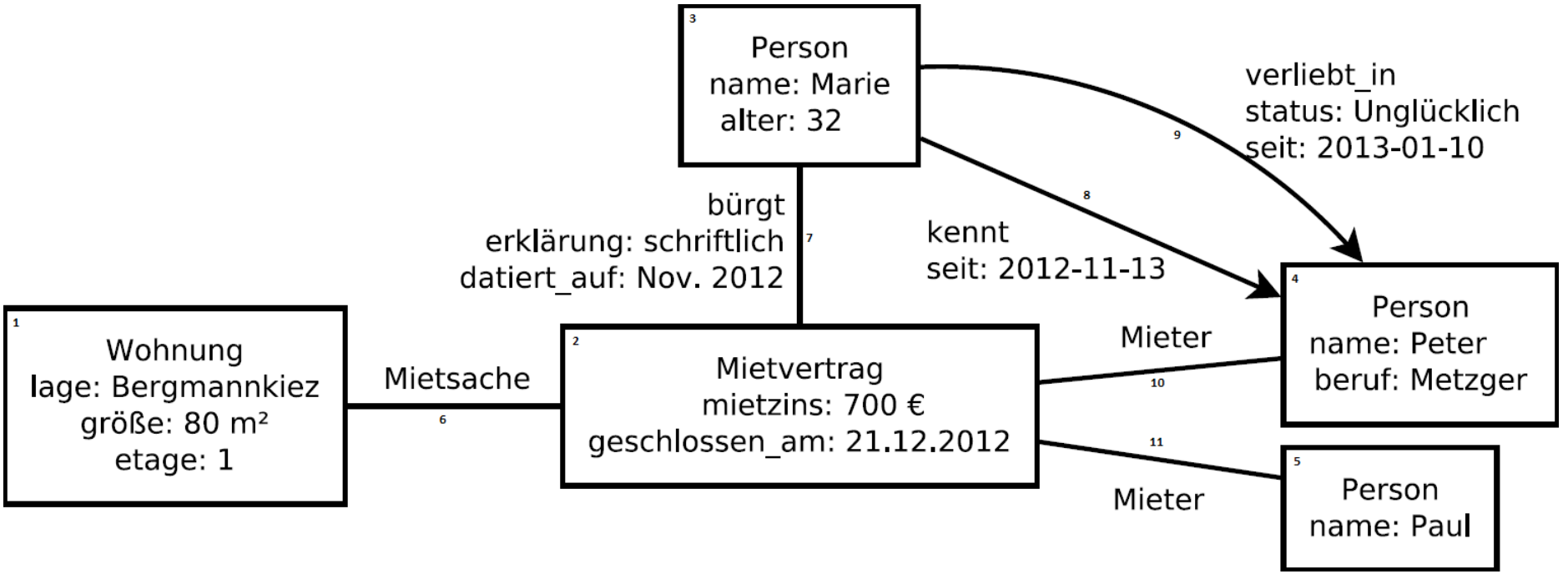


Datenmodell



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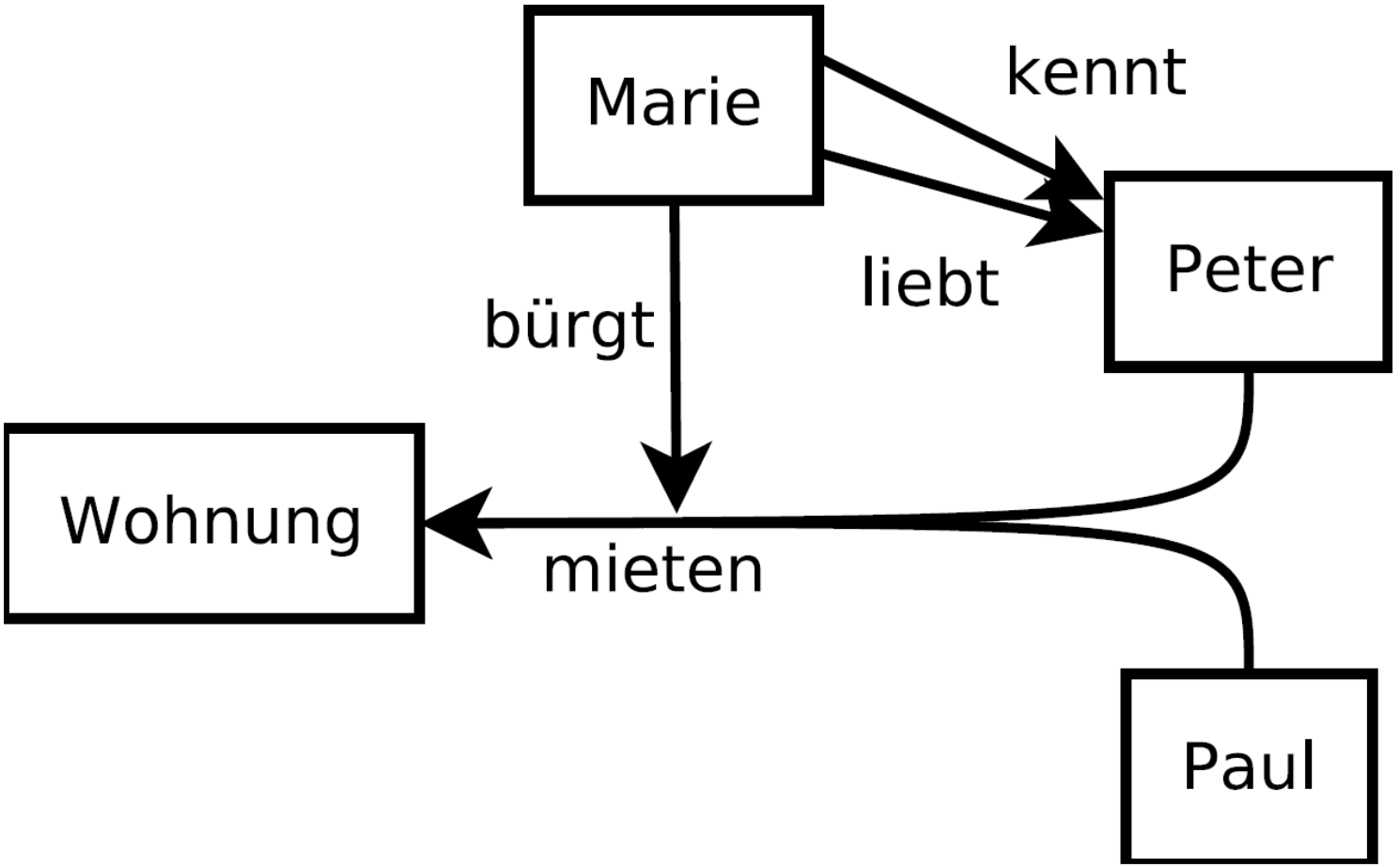

Graphdatenbanksysteme

- Neo4j
- DEX
- HyperGraphDB
- FlockDB
- OrientDB
- InfoGrid
- InfiniteGraph
- Allegro Graph
- Sones GraphDB
- VertexDB
- Apache Giraph
- GraphLab

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Anfragemechanismen

Anfragemechanismen

Elementare Operationen

Lesend

- node by id
- edge by id
- Attribute
- Eingehende Kanten
- Ausgehende Kanten
- Nachbarknoten
- Indizes

Schreibend

- CRUD node
- CRUD edge
- CRUD attribute
- CRUD label
- Indexupdates

Anfragemechanismen

Mengenbasierte Anfragen

```
List<PagedNodeIdList> result = myFlockDBConnection
.select(
  difference(
    intersect(
      simpleSelection(personAId, FOLLOWS, INCOMING),
      simpleSelection(personBId, FOLLOWS, INCOMING)
    ),
    simpleSelection(personCId, BLOCKS, OUTGOING)
  )
)
.execute();
```

Anfragemechanismen

Traversierende Anfragen

```
Iterable<Path> traverser = traversal().breadthFirst()
  .relationships(withName("LIKE"), OUTGOING)
  .relationships(withName("FRIEND"), INCOMING)
  .relationships(withName("LOVES"), BOTH)
  .evaluator(includingDepths(1,3))
  .traverse(startNodes);


for (Path traversedPath : traverser)
  System.out.println(traversedPath);
```

Anfragemechanismen
SPARQL

- Für RDF und Semantic Web entwickelt

```
PREFIX abc: <http://example.com/ontology#>
SELECT ?capital ?country
  WHERE {
    ?x abc:cityname ?capital ;
       abc:isCapitalOf ?y .
    ?y abc:countryname ?country ;
       abc:isInContinent abc:Africa .
  }
```

Anfragemechanismen

Gremlin

```
g.v(1).outE.filter{it.weight<1.0}.inV
```

Anfragemechanismen

Cypher

```
START employee=node(13)
MATCH manager-[pfad:MANAGES*]->employee
RETURN manager.id, length(pfad) AS depth
ORDER BY depth ASC
```

Anfragemechanismen

Cypher

```
START person = node:personen(name="John Doe"),
      c = node(15)
MATCH a-[:LIEBT]->b,
      b-[:LIEBT]->c,
      c-[:LIEBT]->a,
      p=shortestPath(person-[:FREUND_VON*3]-a)
WHERE c.alter < 18
RETURN a, b, c, c.alter, LENGTH(p) AS abstand
ORDER BY abstand ASC
```

Die Graphdatenbanksysteme im Einzelnen

HyperGraphDB

- Entwicklerin: Kobrix Software
- Embedded (Java); LGPL

- Gerichteter Multihypergraph (wow)
- Forciert Schemata
- Automatisches Mapping von Java-Beans
- Mächtige Indizierungsmöglichkeiten
- Unterstützt Traversierung und Mengenbasierte Anfragen

DEX

- Entwicklerin: Sparsity Technologies
- Embedded (Java, C++, .Net); Kommerziell

- Unglaublich schnell.
- Unterstützt Atomare Anfragen, Traversierung und einige Mitgelieferte Graphalgorithmen
- Master-Slave-Replikation
- Schlechte Transaktionskontrolle
- Forciert Schema

Neo4j

- Entwicklerin: Neo Technologies
- Embedded (Java) & REST;
  GPL/AGPL/Kommerziell

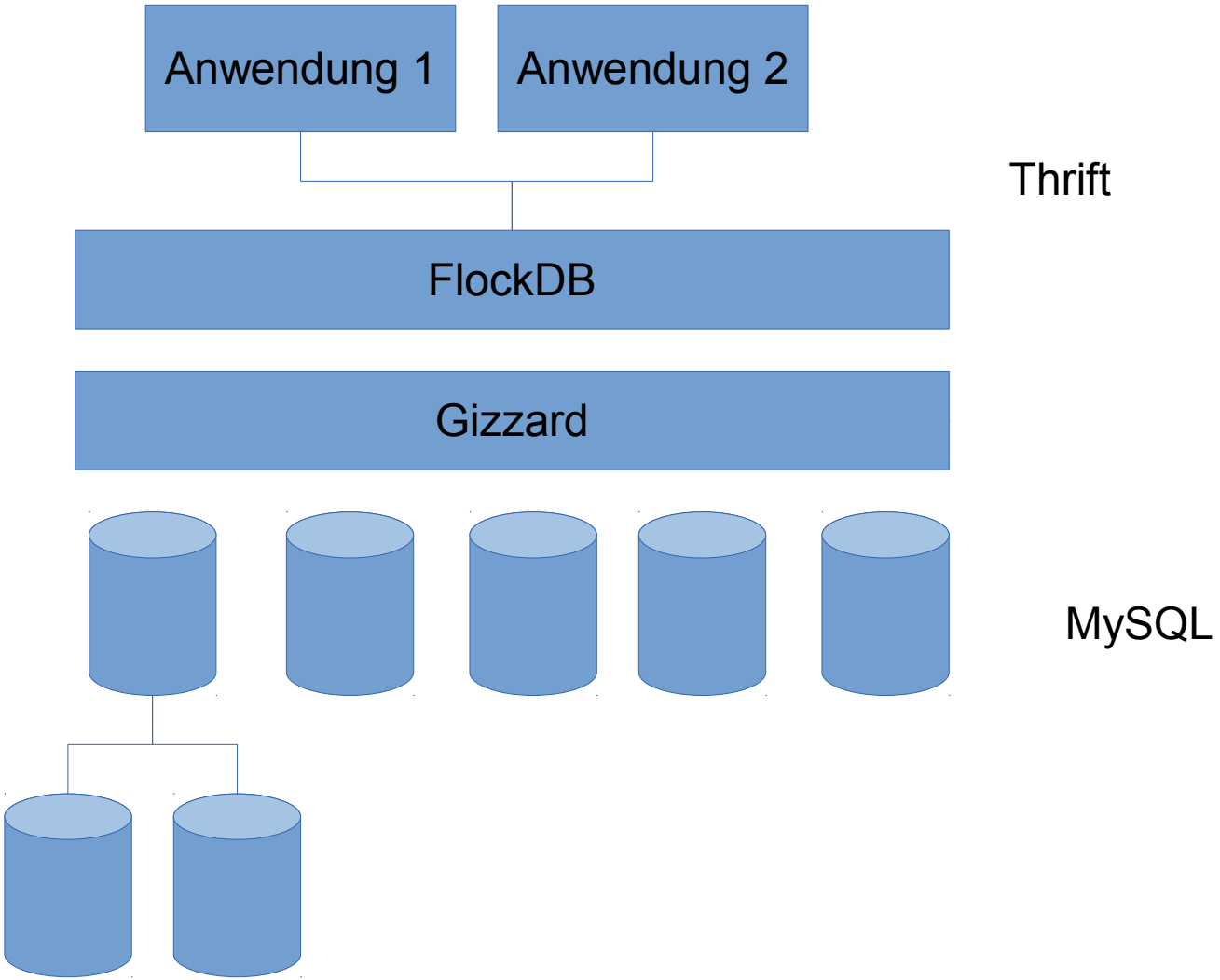
- Traversierende Anfragen, Cypher (!)
- Master-Slave-Replikation
- Leider kaum Anfrageoptimierung bei Cypher
- Schemalos, ACID-Transaktionen

FlockDB

- Entwicklerin: Twitter Inc.
- Thrift-API; Apache License 2.0

- Skaliert Horizontal bzgl. Schreiblast (Sharding)
- Sehr mageres Datenmodell (gelabelte Graphen)
- Basiert auf MySQL

FlockDB



FlockDB

- Sharding anhand von
  - Kantenlabel
  - Knoten-ID ranges
- Eingehende und ausgehende Kanten stets im selben Shard
  - Redundant

Anfragemechanismen

Mengenbasierte Anfragen

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)
.execute();
```

Graphen & Big Data

Pregel, GraphLab und Apache Giraph

- Verlagerung des Algorithmus in die Knoten

I. (Neu-) Berechnung des Knotenwertes
II. Voting: Berechnung beenden?
III. Messaging: Nachrichten an Nachbarknoten
IV. Zurück zu I.

- Dezentrale Berechnung direkt auf den Verteilten Daten
- Flüsterpost-Algorithmen
- Giraph basiert auf Hadoop, bestehende Infrastruktur nutzbar

Graphen & Big Data

PageRank

```
public void compute(Iterable<DoubleWritable> msgIterator) {
    if (getSuperstep() >= 1) {
        double sum = 0;
        for ( DoubleWritable msg : msgIterator ) {
            sum += msg.get();
        }
        DoubleWritable vertexValue = new DoubleWritable( (0.15f/getTotalNumVertices()) + 0.85f*sum );
        setValue(vertexValue);
    }

    if (getSuperstep() < NUM_ITERATIONS) {
        long edges = getNumEdges();
        sendMessageToAllEdges(new DoubleWritable(getValue().get() / edges));
    } else {
        voteToHalt();
    }
}
```

Framework-Unterstützung

Spring Data Neo4j

```
@NodeEntity
public class Movie {
   @GraphId Long id;

   @Indexed(type = FULLTEXT, indexName = "search")
   String title;

   Person director;

   @RelatedTo(type="ACTS_IN", direction = INCOMING)
   Set<Person> actors;

   @Query("start movie=node({self}) match
           movie-->genre<--similar return similar")
   Iterable<Movie> similarMovies;
}
```

Spring Data Neo4j

```
interface MovieRepository extends GraphRepository<Movie> {
  @Query("start movie={0} match m<-[rating:RATED]-user
        return rating")
  Iterable<Rating> getRatings(Movie movie);
}
```

```
@Autowired MovieRepository repo;

Iterable<Movie> movies = repo.findAll();
Movie movie = repo.findByPropertyValue("title","Matrix");
repo.save(movie);

Iterable<Rating> ratings = repo.getRatings(movie);
```

Tinkerpop Blueprints

```
Graph graph = new Neo4jGraph("/tmp/my_graph");
Vertex a = graph.addVertex(null);
Vertex b = graph.addVertex(null);
a.setProperty("name","marko");
b.setProperty("name","peter");
Edge e = graph.addEdge(null, a, b, "knows");
e.setProperty("since", 2006);
graph.shutdown();
```

Tinkerpop Blueprints

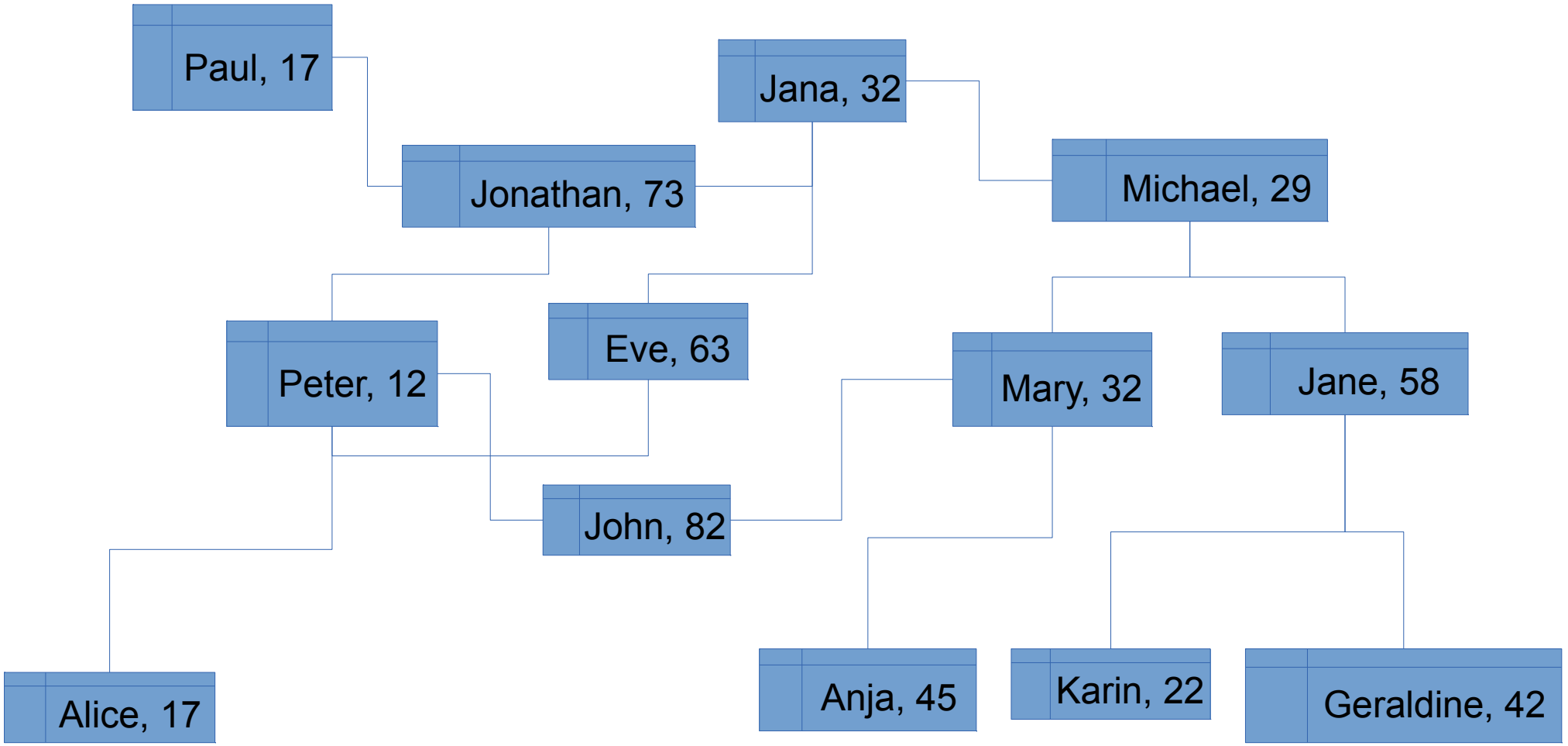
- Besteht aus mehreren Komponenten:
  - Blueprints: Einheitliche low-level API
  - Frames: OO-Mapping
  - Gremlin: Anfragesprache
  - Furnace: Sammlung von Graphalgorithmen
  - Rexter: REST-Server

Tinkerpop Blueprints Frames

```
public interface Person {
  @Property("name")
  public String getName();
  @Adjacency(label="knows")
  public Iterable<Person> getKnowsPeople();
  @Adjacency(label="knows")
  public void addKnowsPerson(final Person person);
  @GremlinGroovy("it.out('knows').out('knows').dedup")
  public Iterable<Person> getFriendsOfAFriend()
}

public class Frames {
  public Frames() {
   FramedGraph<NeoGraph> graph = new FramedGraph<NeoGraph>(new NeoGraph("local:/path/to/db"));
   Person person = graph.getVertex(1, Person.class);
   person.getName(); // equals "marko"
  }
}
```

Eine Letzte Aufgabe



Danke!

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