

# COMP318

## Ontologies and Semantic Web

# Knowledge Graphs - Part 2

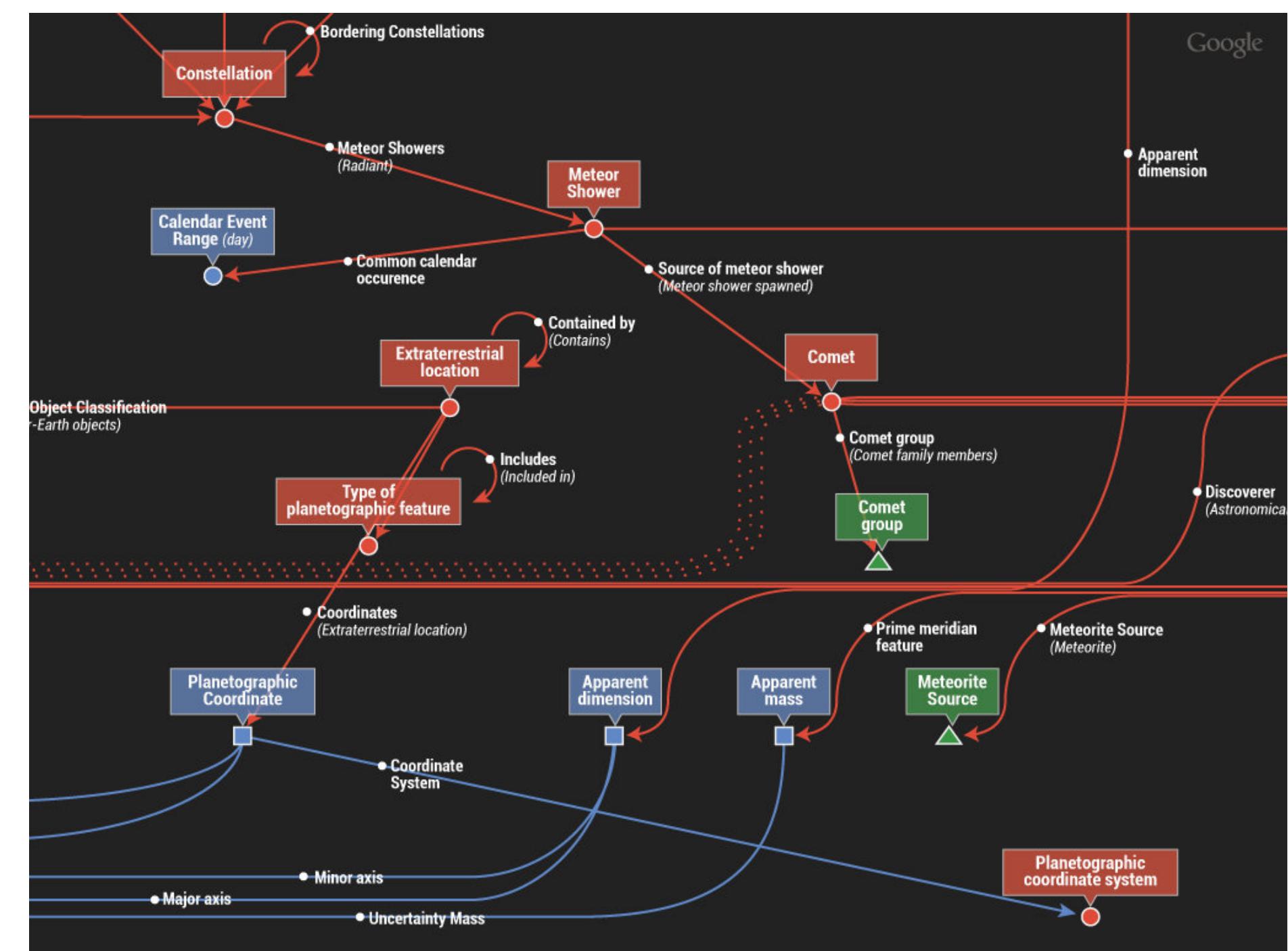
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# What is a knowledge graph

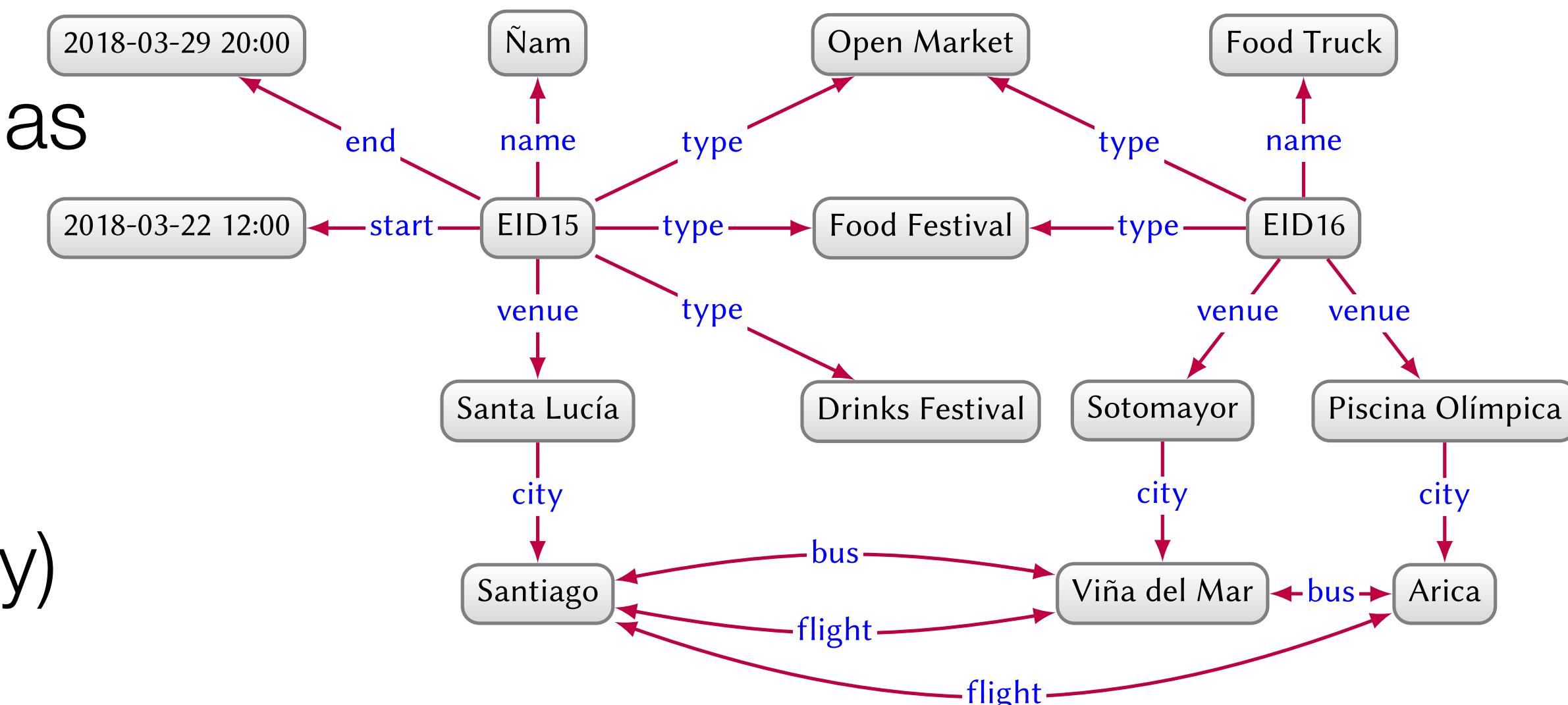
- Given a set of entities E, and relations R, a KG is a directed multi-relational graph G that contains triples of type (s, p, o)
  - $G \subseteq E \times R \times E : (s, p, o) \in G$
  - describes entities and relations
  - defines a schema interrelating arbitrary entities on various topical domains



# Knowledge Graph Models

- **Directed edge-labelled graphs:**

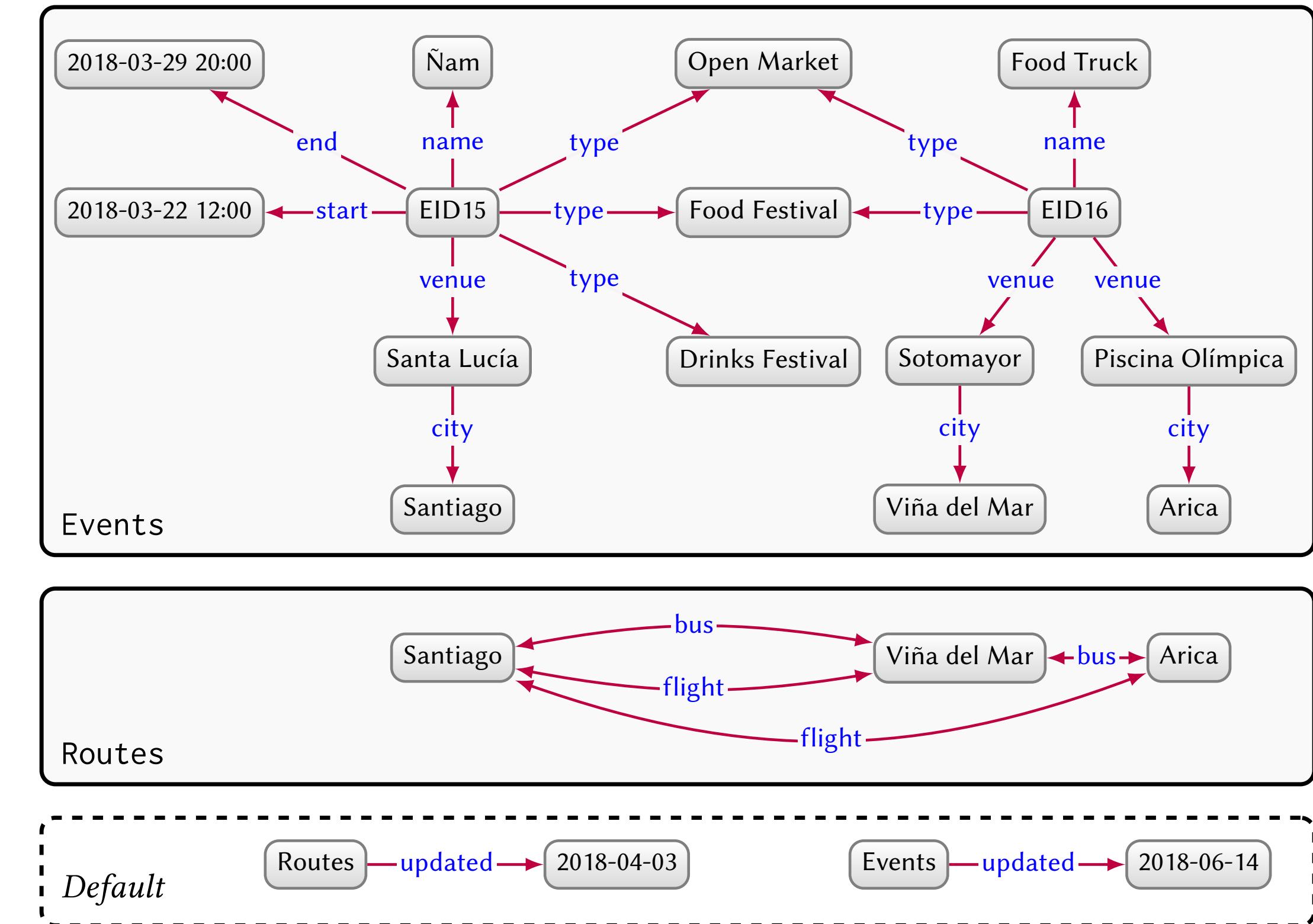
- A directed edge-labelled graph is defined as a set of nodes, representing entities:
  - Santiago, Arica , EID16 , 2018-03-22 12:00 – a
- and a set of directed labelled edges between those nodes, representing (binary) relations between those entities.
  - Santa Lucía city Santiago .



# Knowledge Graph Models

## ● Graph Dataset:

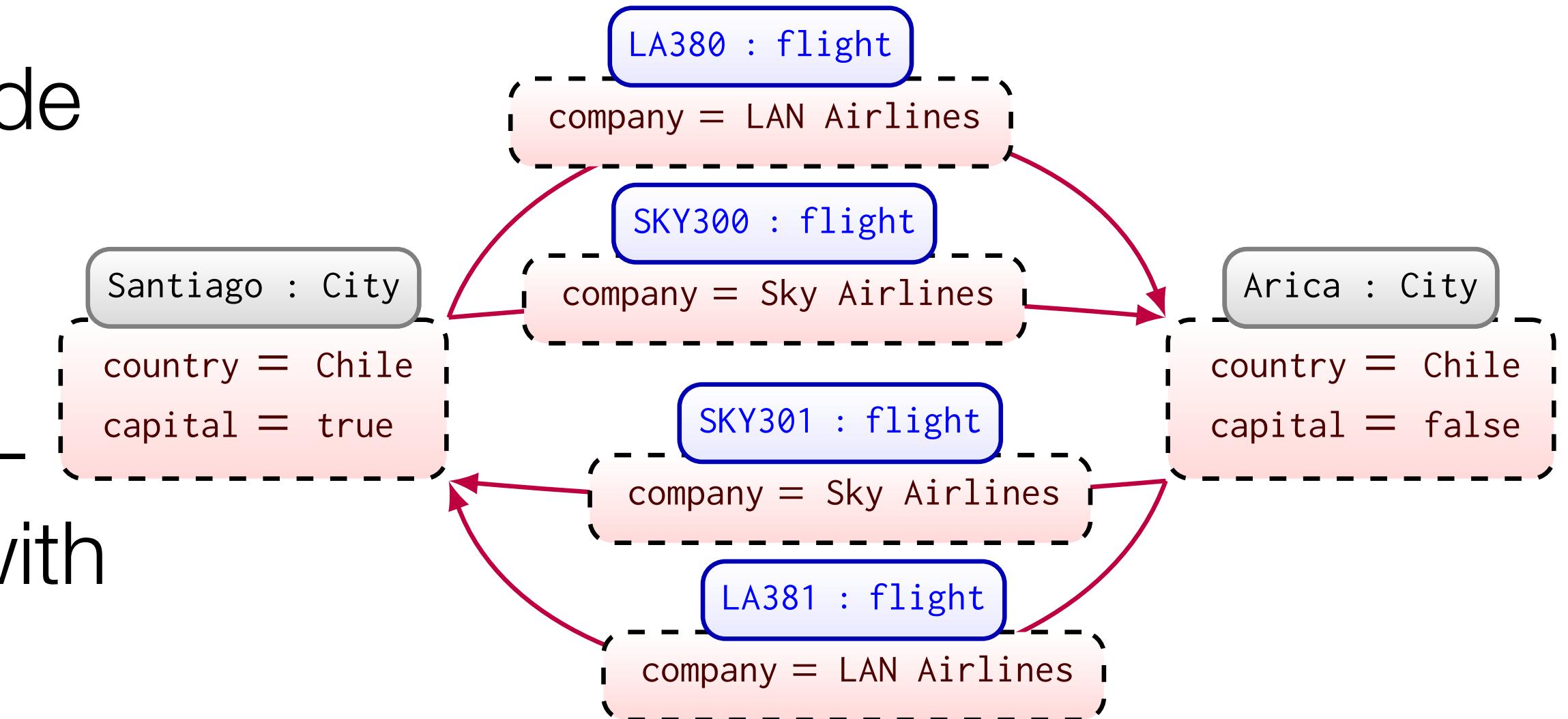
- It is often desirable to manage several graphs rather than one monolithic graph
  - e.g. manage multiple graphs from different sources, making it possible to update or refine data from one sourceA graph dataset is a set of named graphs and a default graph.
  - Each named graph is a pair: graph ID, graph
  - The default graph is a graph without an ID, and is referenced “by default” if a graph ID is not specified



# Knowledge Graph Models

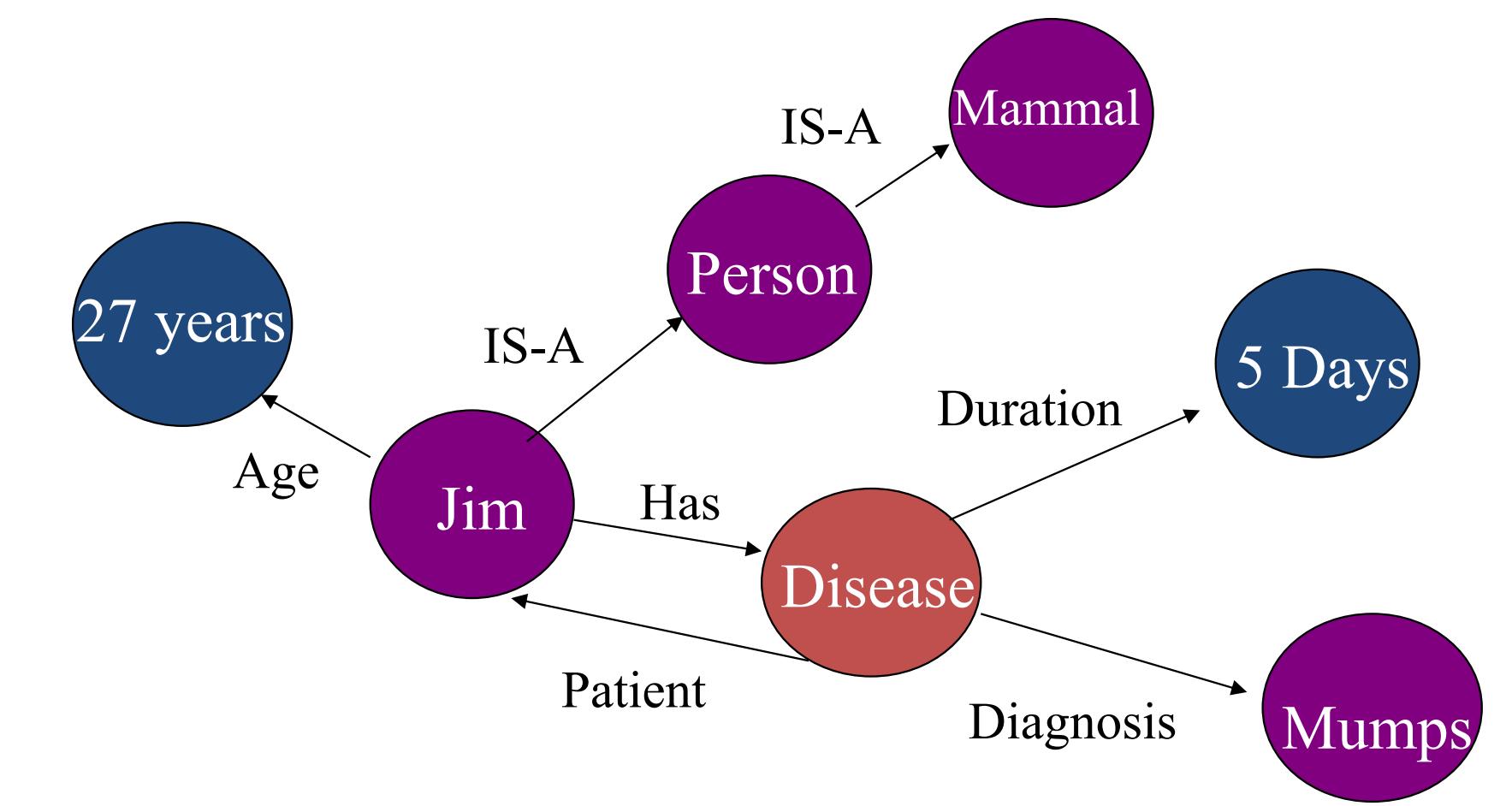
## ● Property graphs:

- Property graphs were introduced to provide additional flexibility when modelling more complex relations.
- A property graph allows a set of property-value pairs and a label to be associated with both nodes and edges
  - They translate to RDF triples (Node Properties and Edges) and Reified edge + Triples (Edge Properties)

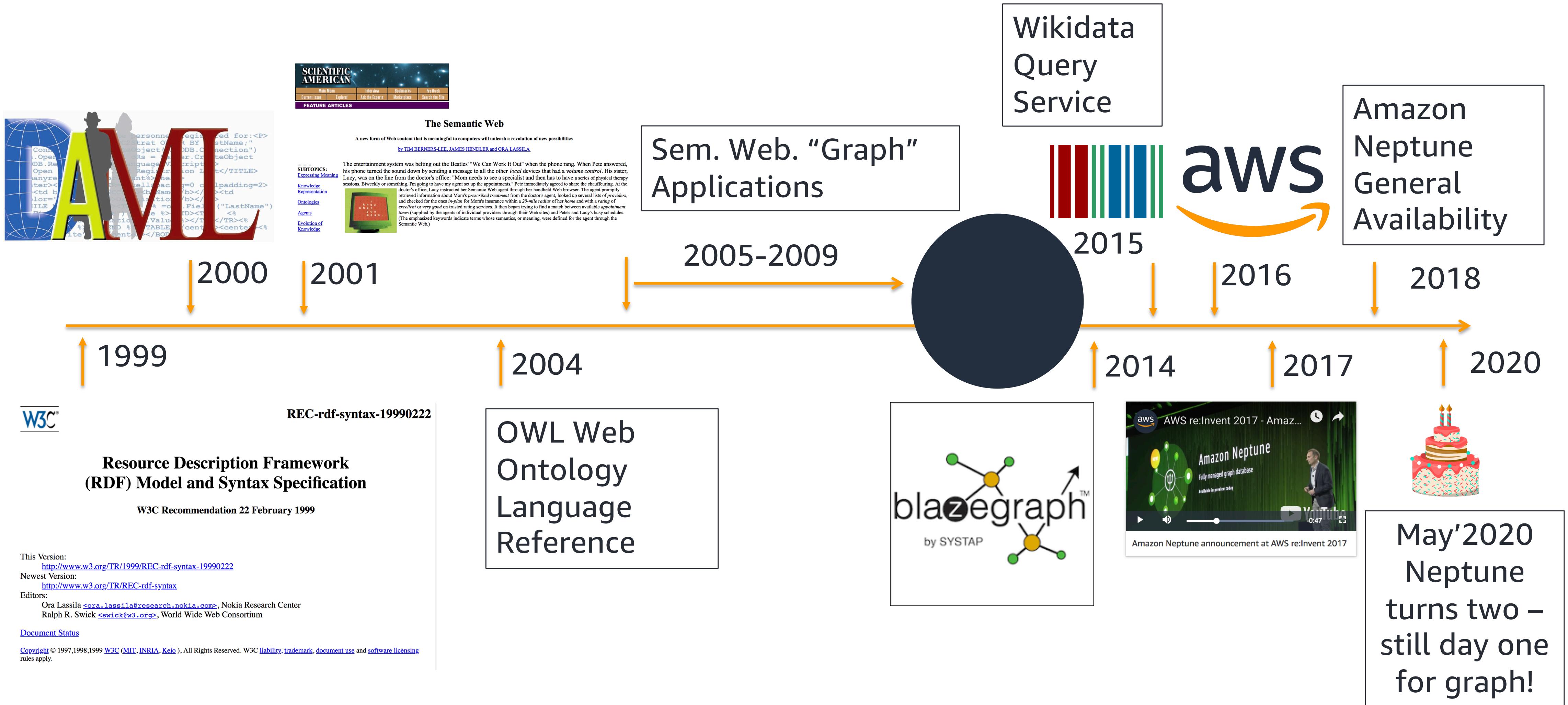


# But graphs have been used in AI before

- Semantic networks (ca 1970)
  - A directed graph where vertices are concepts and edges are relations
  - Entities and relationships define our **domain of discourse**
- But also
  - DLs
  - Rule languages
  - Graphical models



# Knowledge graphs timeline according to Amazon



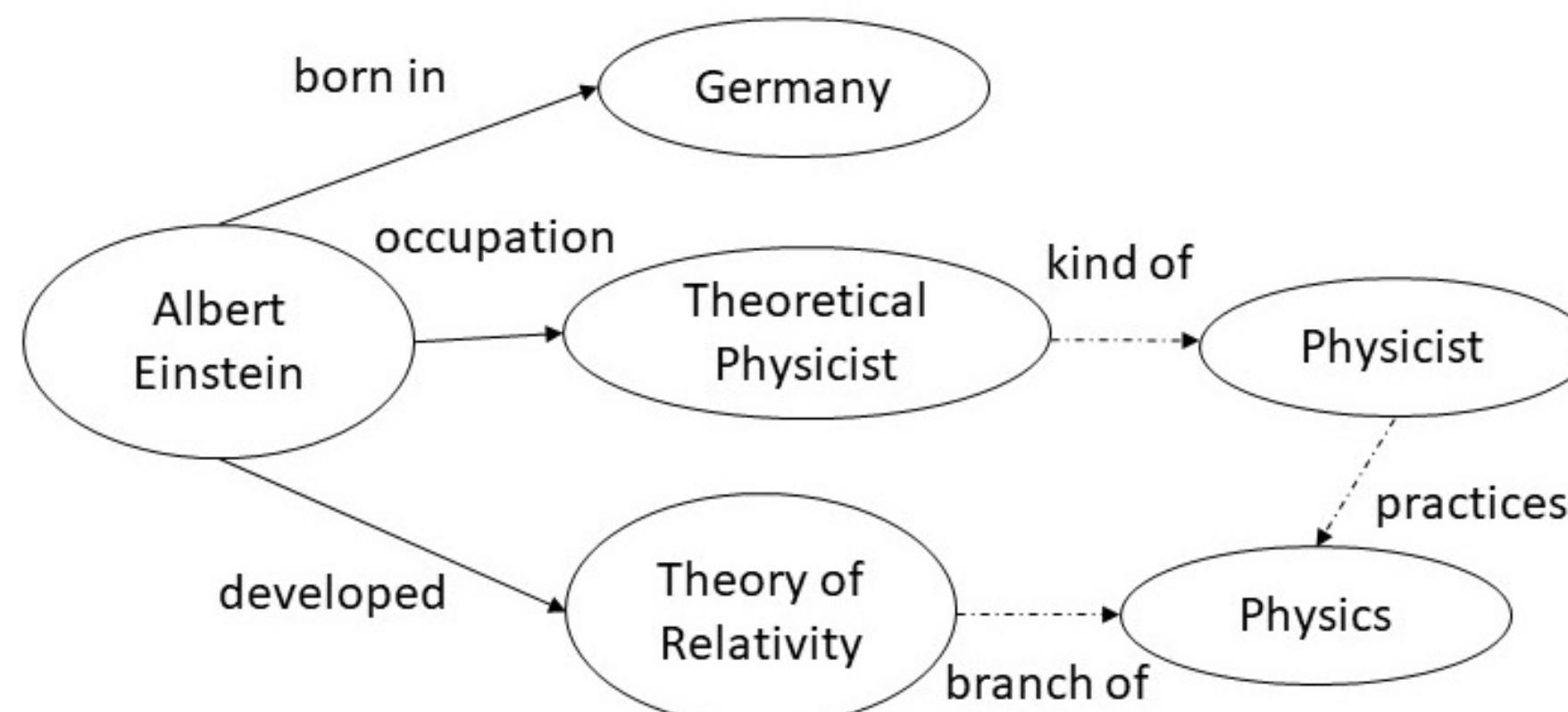
# Knowledge Graph representation

**Symbolic**

$s, p, o$

$p(s, o)$

$(s, p, o)$



**Vector**

$s, p, o \in \mathbb{R}^d$

**Symbols encode entities and relations**

**Entities and relations encoded in a (high) dimensional vector space**

# Symbolic vs Vector representation

- Tasks using symbolic representation:

- Description logic tasks & Reasoning tasks
  - to build some logical inference system
- Database and data integration tasks

Open World Assumption

- Tasks using vector based representation:

- Natural Language Processing
- Computer Vision

Closed World Assumption

Temporal / Evolution

# Orthogonal dimensions

- Open world vs Closed world assumptions:

- open world means that everything which is not explicitly stated in the knowledge graph might be true and it is not false by default

- closed world assumes that everything which is not explicitly stated in the knowledge graph is false by default



2008



2016

- Temporally evolving:

- that your facts can change the truth value over time
    - e. g. president of a certain country is a valid president only when they serve their term
    - Who is the president of the USA



2020

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# End Knowledge Graphs - Part 2

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