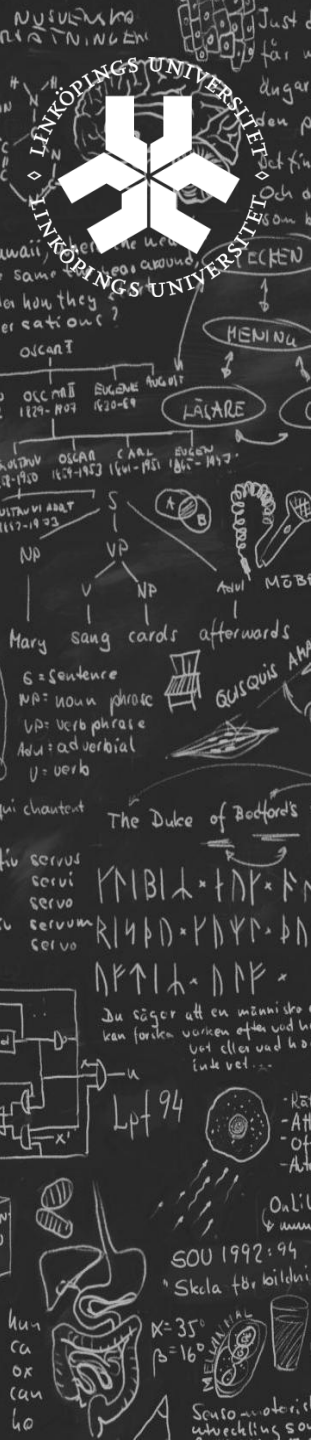


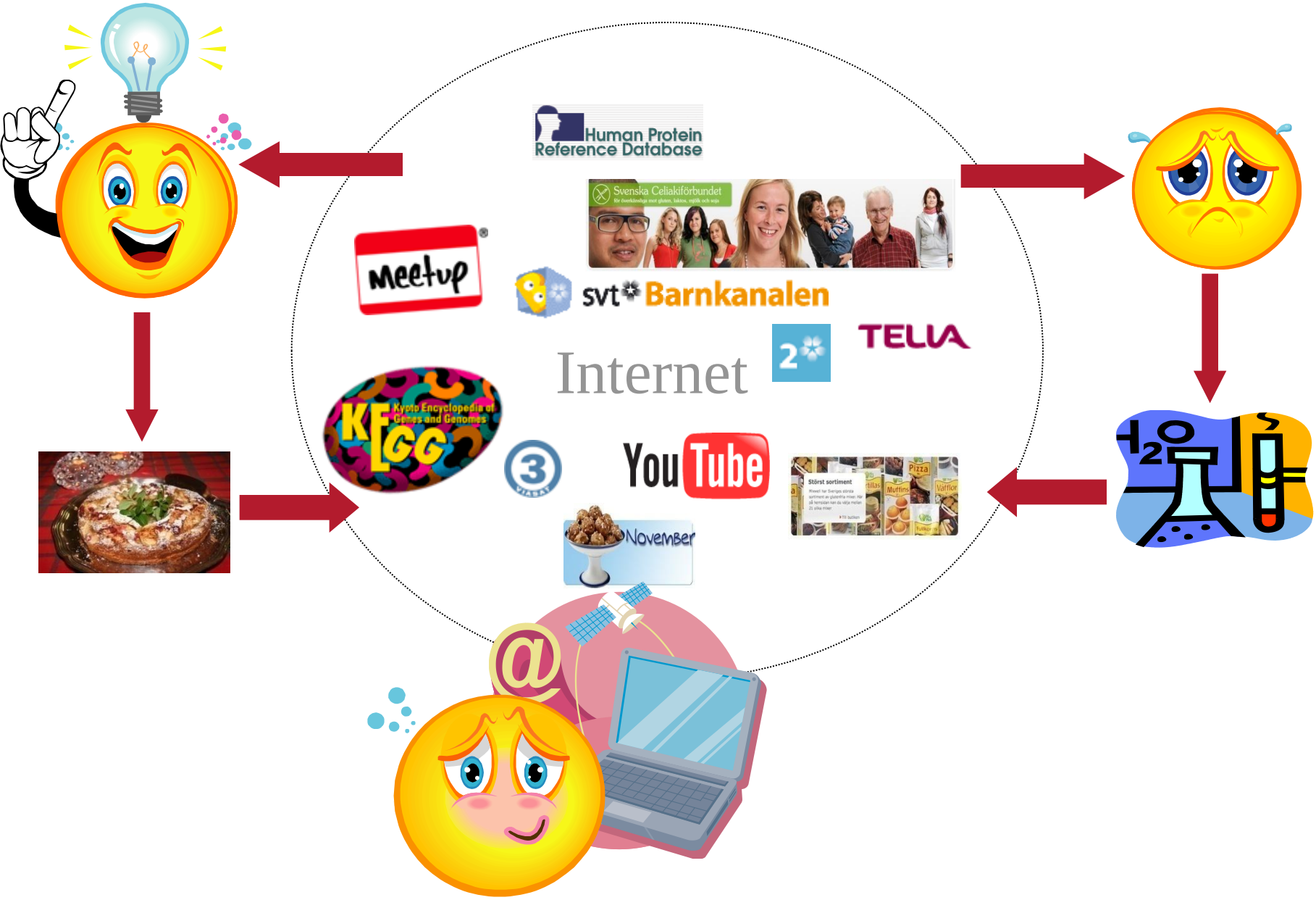
Advanced databases and data models

Theme1: Semi structured data, XML and RDF

Lecture 1: Modeling

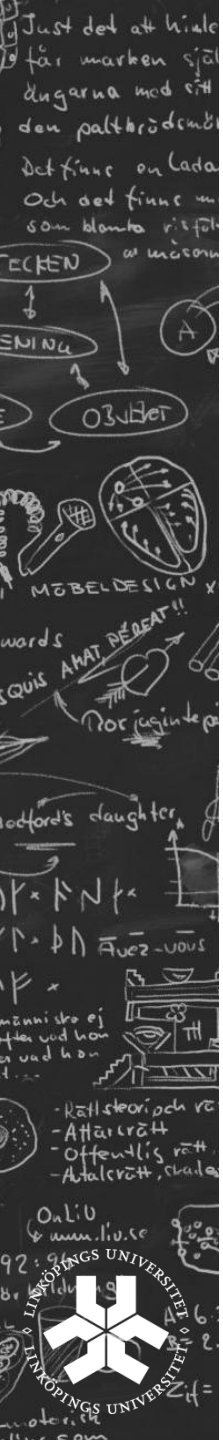
Lena Strömbäck

LiU expanding reality


Human Protein Reference Database
Svenska Celiakiförbundet
Meetup
svt Barnkanalen
TELIA
Internet
KEGG
Kyoto Encyclopedia of Genes and Genomes
YouTube
November
Störst sortiment
Pizza
Muffins
Våfflor
H2O

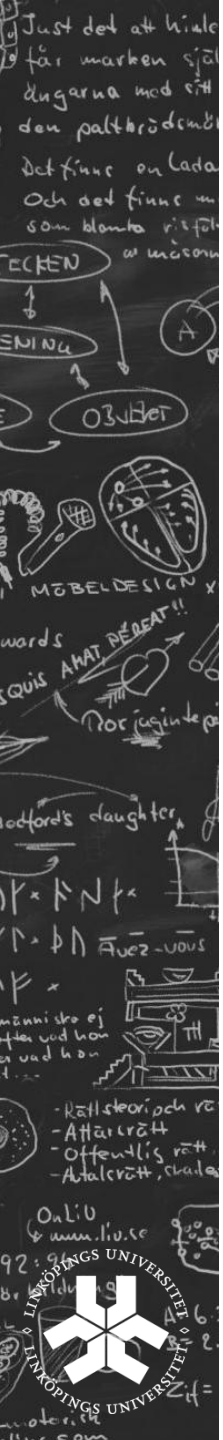
What is the problem?

- The user's effort is not enough for the task
- The data describes complex real world objects
- The data is not easily human interpretable
- There is a need for integration and comparison of data



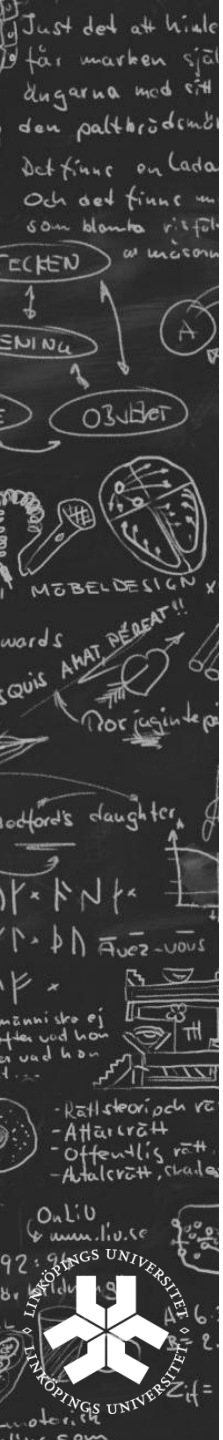
In this course:

- What are the particular requirements for storing data on the web?
- Why are traditional databases not enough?
- Explore technologies for data management on the web.
- Four themes
  - Semi structured data, XML and RDF
  - Data base management systems
  - Semantic web: Ontologies and OWL
  - Data integration for the web



Personell and Course Information:

Available at: www.ida.liu.se/~TDDD43



Today´s lecture

Introduction to semi-structured data

Technologies

- XML/RDF

Defining the data model

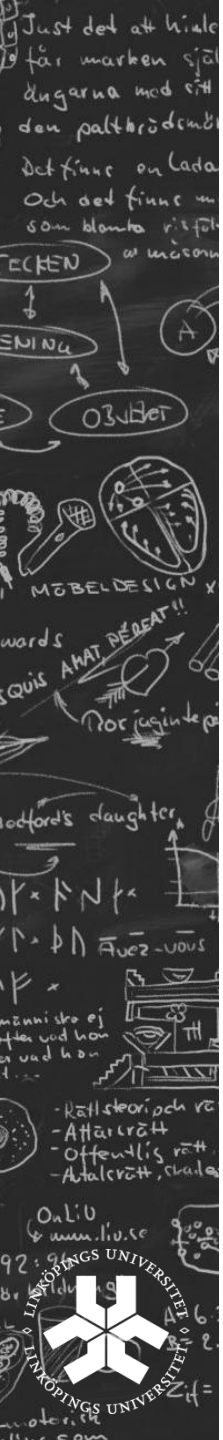
- Data model vs. Data guides

Technologies

- DTD/XML Schema/RDF Schema

Data modeling in XML

Other DB models



Semi-structured data

Data is not just text, but is not as well-structured as data in databases

Occurs often in web databanks

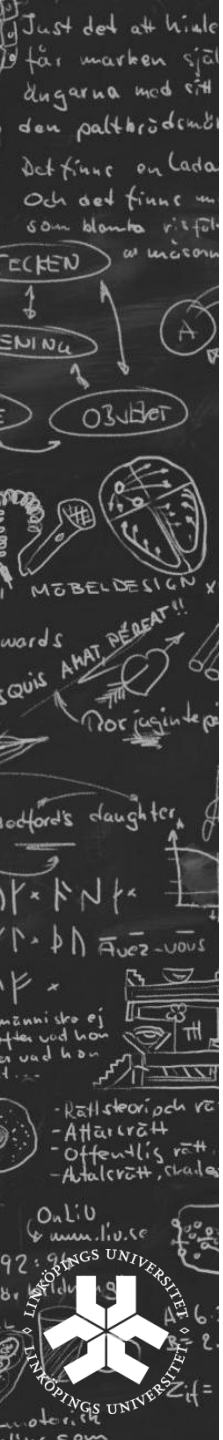
Occurs often in integration of databanks

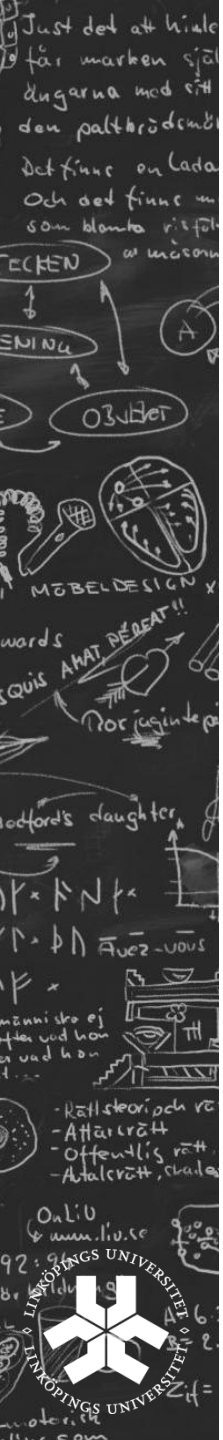
Semi-structured data - properties

irregular structure

implicit structure

partial structure





Semi-structured data - model

network of nodes

object model (oid)

OEM (Object Exchange Model)

Graph

Nodes: objects

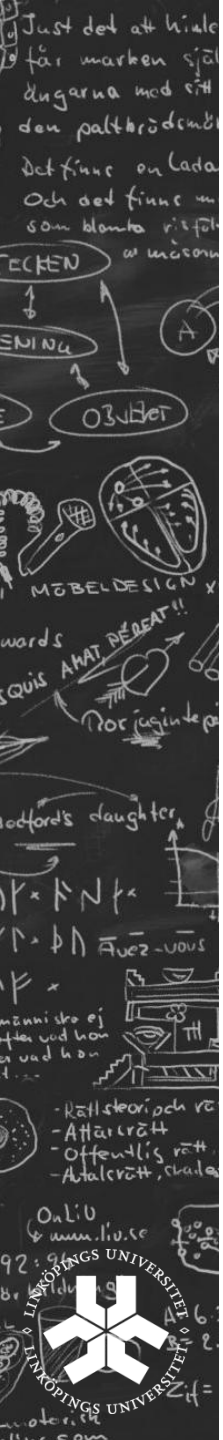
oid

atomic or complex

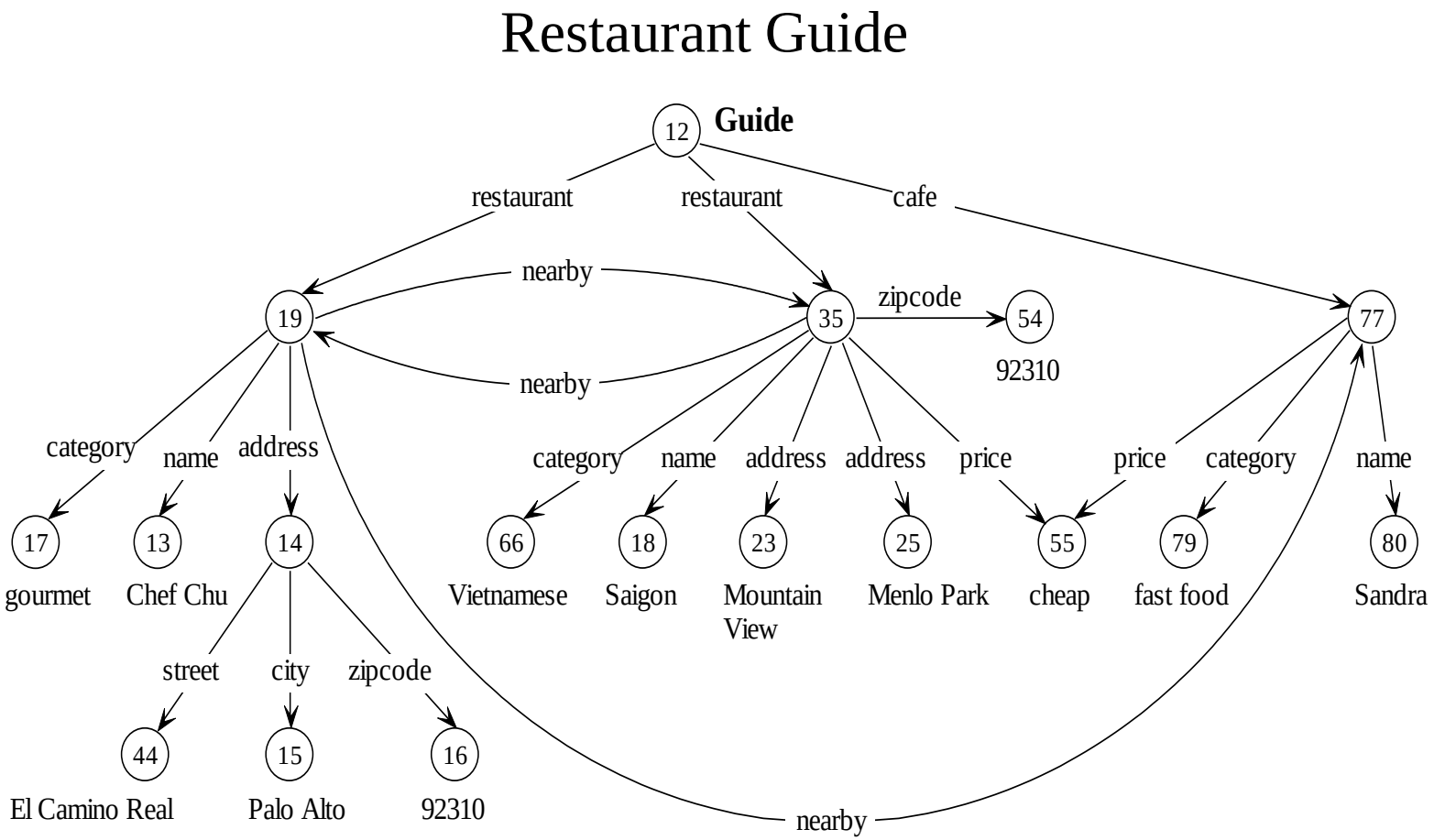
- atoms: integer, string, gif, html, …
- value of a complex object is a set of object references (label, oid)

Edges have labels

OEM is used by a number of systems (ex. Lorel)



OEM example


Restaurant Guide
12
Guide
restaurant
restaurant
cafe
nearby
19
35
zipcode
54
92310
77
nearby
category
name
address
category
name
address
address
price
price
category
name
17
13
14
66
18
23
25
55
79
80
gourmet
Chef Chu
Vietnamese
Saigon
Mountain View
Menlo Park
cheap
fast food
Sandra
street
city
zipcode
44
15
16
El Camino Real
Palo Alto
92310
nearby

Exercise 1

Represent the relations below using the OEM data model.

r_id	name
r1	Hamlet
r2	Normandie
r3	McDonald's

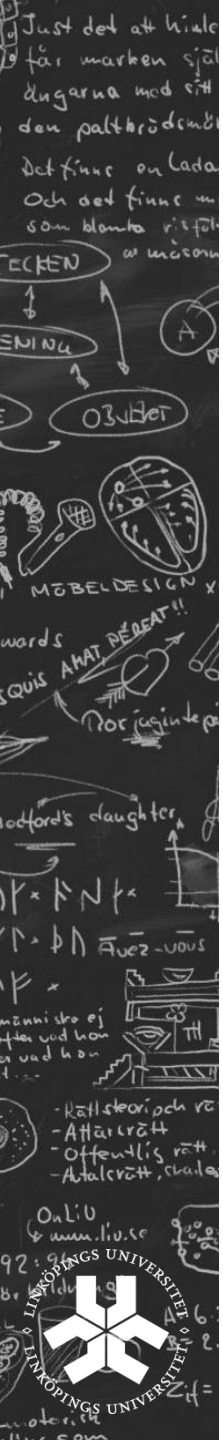
Restaurants

c_id	name
c1	Linkoping
c2	Norkoping

Cities

r_id	c_id	street
r1	c1	Storgatan
r2	c1	St.Larsgatan
r3	c2	Kungsgatan

Restaurants&Cities



Technologies: XML and RDF

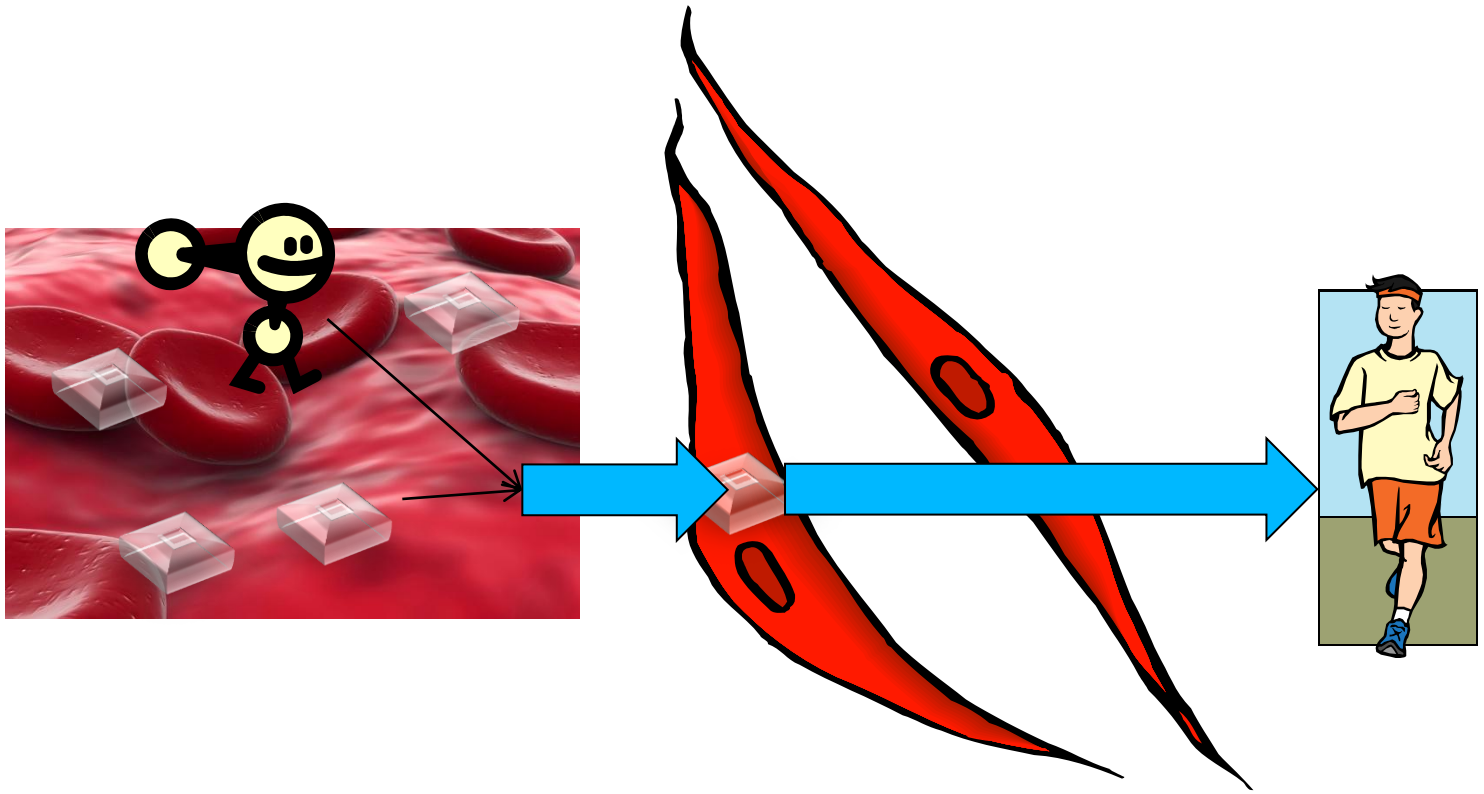
Why not relational databases?

Technologies:
XML
RDF

Definition of datamodel:
DTD
XMLschema
RDFSchema

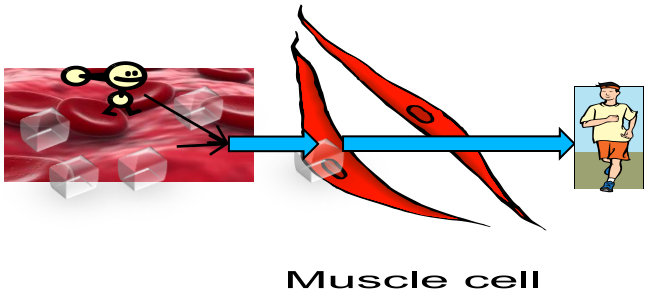
Semantic models: Ontoligies and OWL later in the course.

Example



Muscle cell

Relational representation



Compartment	
Id	Name
Blood	Inblood
Cell	Musclecell

Reaction	
Id	Name
Tocell	Sugartocell
Move	Makemovement

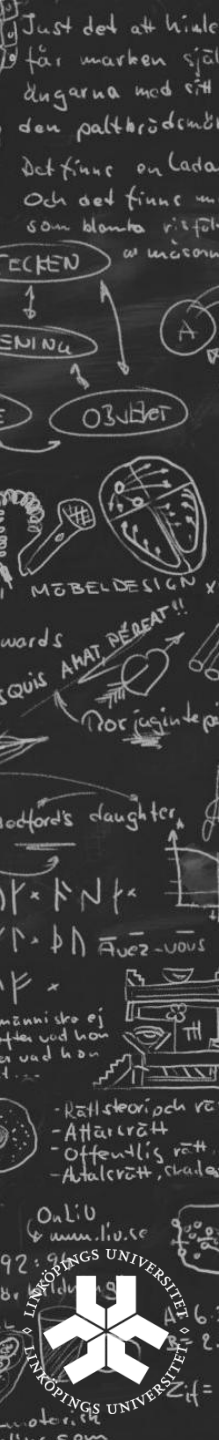
Reactant	
Reaction	Species
ToCell	Sug1
ToCell	Ins
Move	Sug2

Species		
Id	Name	Compartment
Sug1	Sugar	Blood
Ins	Insulin	Blood
Sug2	Suga	Cell
En	Energy	Cell

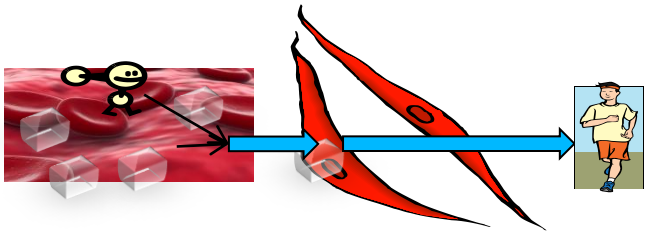
Product	
Reaction	Species
ToCell	Sug2
Move	En

Relational model - drawbacks

- Far from semi-structured proposal
  - Not suitable for descibing tree structure
  - Too general or many tables
- Static – all attributes typed
- All data entries atomic – in principle



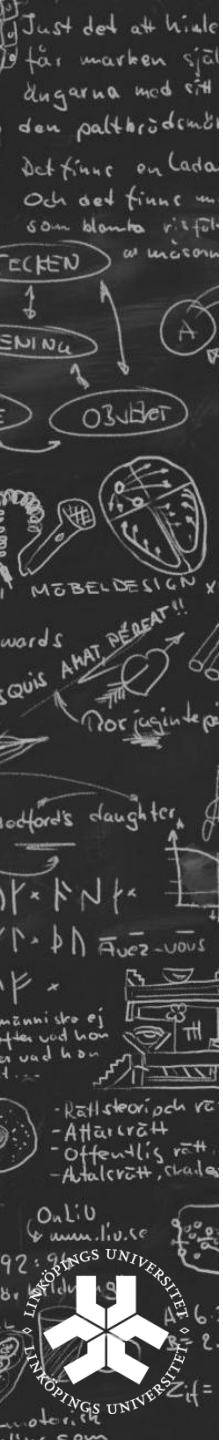
XML representation



Muscle cell

- Ordered tree
  Similar to semi-structured proposal
- Element vs. Attribute
- Extensible
  New kinds of data can be integrated
- Flexible
  Easy to mix different kinds of data

```
<?xml version="1.0" encoding="UTF-8"?>
<minimodel name="sugartransport"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xsi:noNamespaceSchemaLocation="minimodel.xsd">
   <listOfCompartments>
      <compartment id="blood" name="inblood" />
      <compartment id="cell" name="musclecell" />
   </listOfCompartments>
   <listOfSpecies>
      <species id="sug1" name="sugar" compartment="blood" />
      <species id="ins" name="insulin" compartment ="blood"/>
      <species id="sug2" name="sugar" compartment ="cell"/>
      <species id="en" name="energy" compartment ="cell"/>
   </listOfSpecies>
   <listOfReactions>
      <reaction id="tocell" name="sugartocell">
         <listOfReactants>
            <speciesReference species="sug1"/>
            <speciesReference species="ins"/>
         </listOfReactants>
         <listOfProducts>
            <speciesReference species="sug2"/>
         </listOfProducts>
      </reaction>
      <reaction id="move" name="makemovement">
         <listOfReactants>
            <speciesReference species="sug2"/>
         </listOfReactants>
         <listOfProducts>
            <speciesReference species="en"/>
         </listOfProducts>
      </reaction>
   </listOfReactions>
</minimodel>
```



RDF: **R**esource **D**escription **F**ramework

Framework for describing resources on the web

Designed to be read and understood by computers

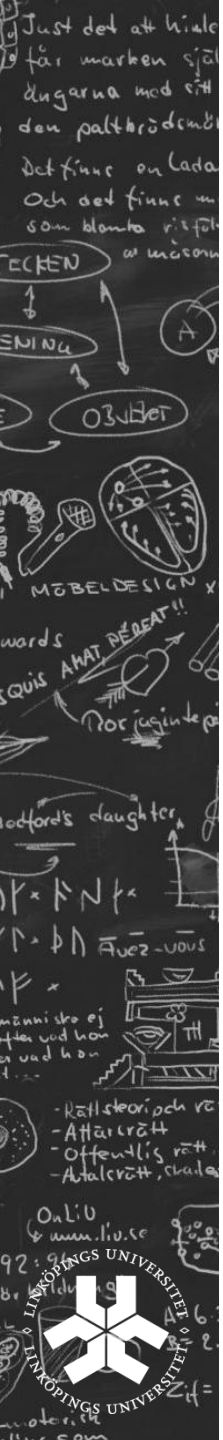
Not designed for being displayed to people

Written in XML

RDF is a W3C Recommendation

RDF: **R**esource **D**escription **F**ramework

```
<?xml version="1.0" encoding="UTF-8"?>

<species metaid="_506372" id="E1" name="MAPKKK activator"
compartment="compartment"
 initialConcentration="3e-05">
 <annotation>
  <rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
   xmlns:bqbiol="http://biomodels.net/biology-qualifiers/"
   xmlns:bqmodel="http://biomodels.net/model-qualifiers/">
   <rdf:Description rdf:about="#_506372">
    <bqbiol:isVersionOf>
     <rdf:Bag>
      <rdf:li rdf:resource="http://www.ebi.ac.uk/interpro/#IPR003577"/>
     </rdf:Bag>
    </bqbiol:isVersionOf>
   </rdf:Description>
  </rdf:RDF>
 </annotation>

</species>
```



RDF Data model: Triples

A **Resource** is anything that can have a URI, such as our molecule "_506372 "

A **Property** is a Resource that has a name, such as “isVersionof"

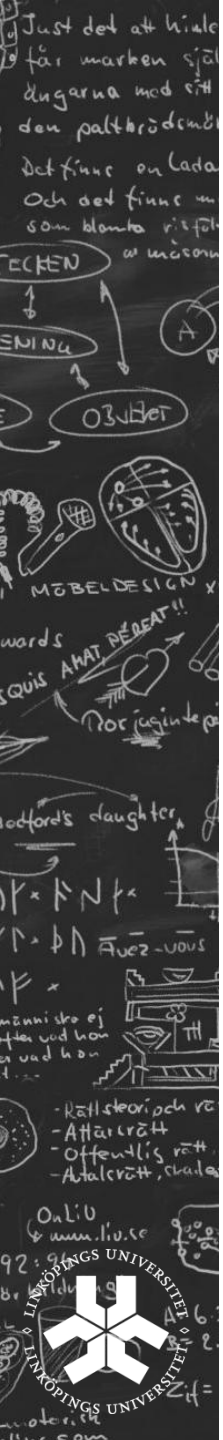
A **Property value** is the value of a Property, such as " IPR003577 "

(note that a property value can be another resource)

Suitable for semi-structured data.

Part of our example model as RDF triples

1 blood	#name	"in blood"
3 sug1	#name	"sugar in blood"
4 sug1	#compartment	blood
11 st	#name	"sugartransport"
12 genid:A71987	#type	Bag
13 st	#reactants	genid:A71987
14 genid:A71987	1	sug1
15 genid:A71987	2	ins
16 genid:A71988	#type	#Bag
17 st #products	genid:A7	1988
18 genid:A71988	1	sug2

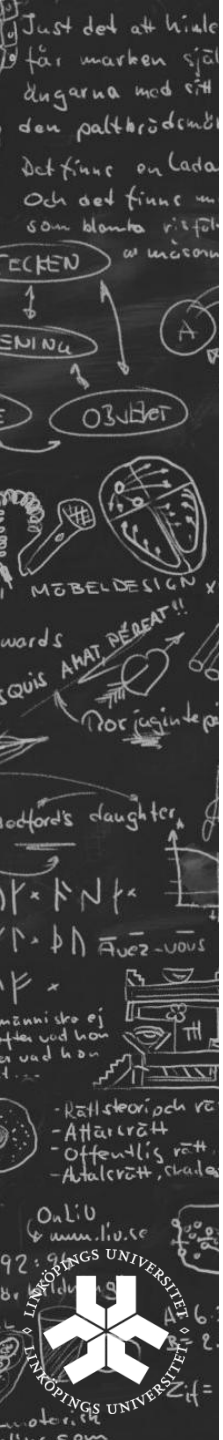


Semi-structured data - properties

Data model/guide changes commonly

Object can change type/class

The distinction between data and schema is blurred



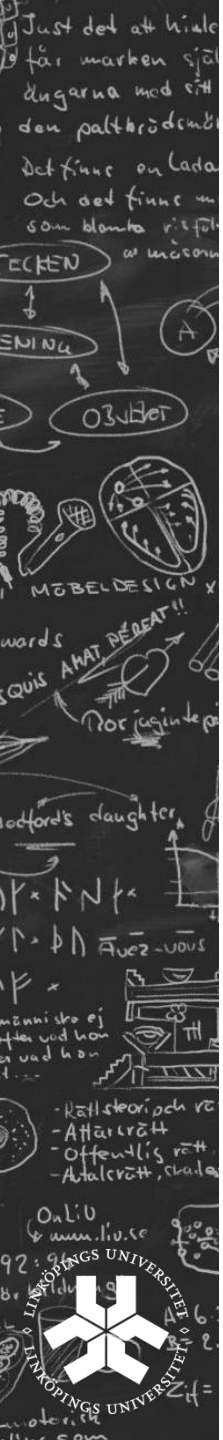
Semi-structured data – data models vs data guides

a posteriori ’data guide’ versus a priori schema

Data model/data guide could be supportive or a hinder while querying

Definition of data model for XML – DTD or XML Schema

Data model for RDF – RDF schema



Data Guides

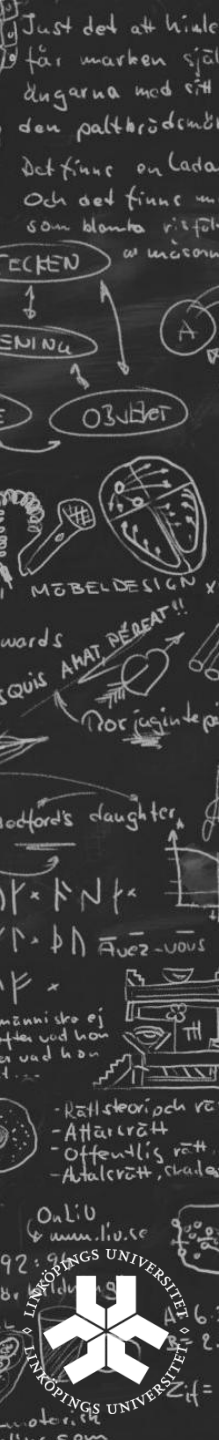
A structural summary over a databank that is used as a dynamic schema

Is used in query formulation and optimization

Is often created a posteriori

Properties:

- concise
- accurate
- convenient



Defining the XML model: DTD

A Document Type Definition (DTD) defines the legal building blocks of an XML document.

It defines the document structure with a list of legal elements and attributes.

In the DTD all XML documents are one of:

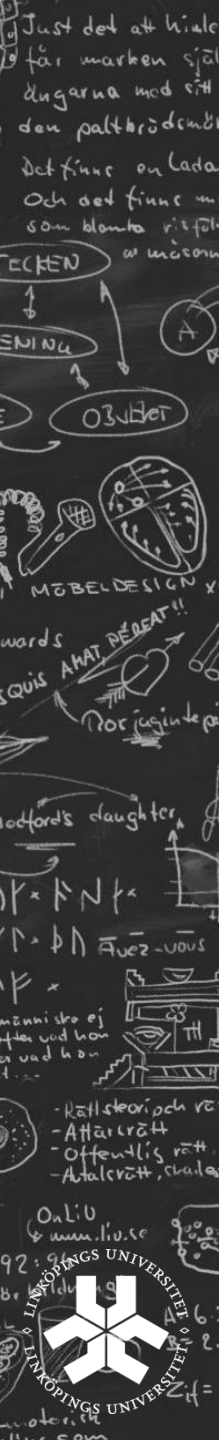
- Elements
- Attributes
- Entities
- PCDATA
- CDATA

Defining the XML model: XML Schema

The XML Schema defines the legal building blocks of an XML document.

An XML Schema:

- defines elements
- defines attributes
- defines which elements are child elements
- defines the order of child elements
- defines the number of child elements
- defines data types for elements and attributes
- defines default and fixed values for elements and attributes



XML Schema vs. DTD

XML Schemas are extensible to future additions

extend element definitions

XML Schemas are richer and more powerful than DTDs

XML Schemas are written in XML

XML Schemas support data types

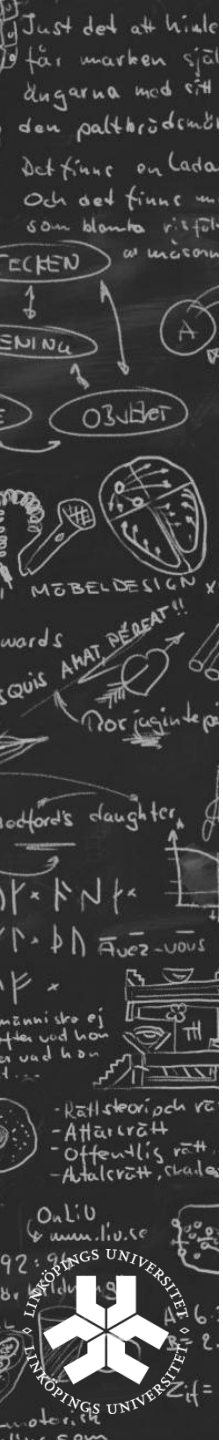
XML Schemas support namespaces

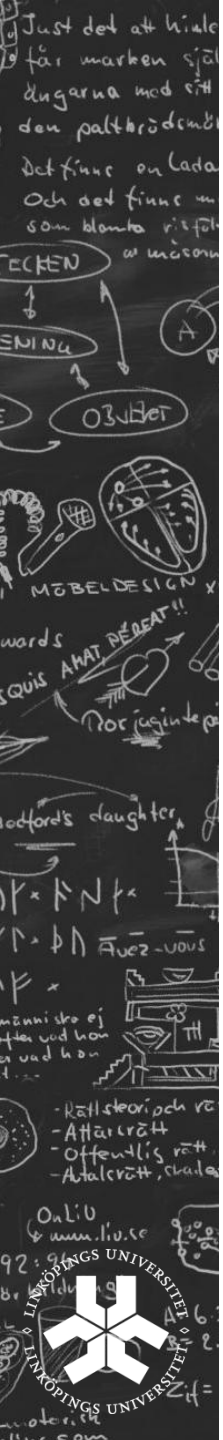
RDF Schema – define relations between objects

```
<?xml version="1.0" encoding="UTF-8"?>

<rdf:RDF
   xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
   xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">

   <rdf:Description rdf:ID="species">
      <rdf:type rdf:resource="http://www.w3.org/2000/01/rdf-schema#Class"/>
   </rdf:Description>

   <rdf:Description rdf:ID="protein">
      <rdf:type rdf:resource="http://www.w3.org/2000/01/rdf-schema#Class"/>
      <rdfs:subClassOf rdf:resource="#species"/>
   </rdf:Description>

</rdf:RDF>
```

Data modelling with XML

- Element s vs. Attributes
- Keys
- Many to many relations



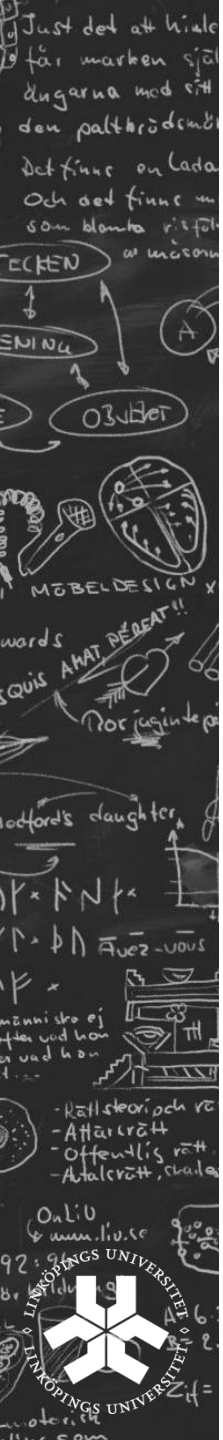


Lab exercises:

Construct a data model in relational model and XML.

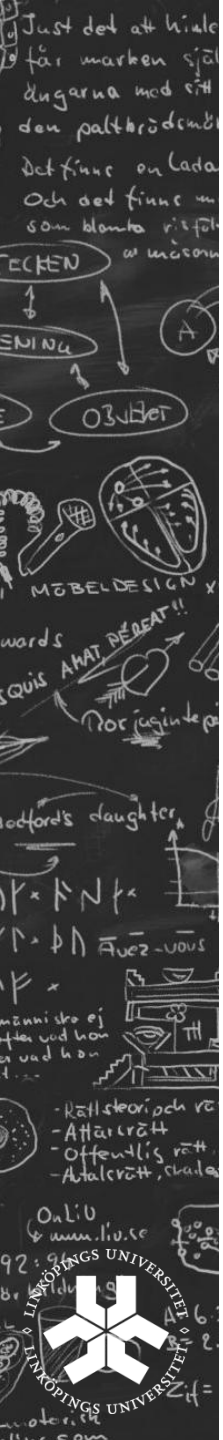
Answer questions, compare and write report.

Tools: Oxygen XML and MS Server



XML in relational databases

```
create table person(
    id integer primary key,
    namn varchar(15),
    description XML);
```



Neo

Neo4j is a **graph database**. It is an embedded, disk-based, fully transactional Java persistence engine that stores data structured in graphs rather than in tables.

Linköping related company.

Interesting for semi-structured data.

The Neo Persistence Engine

Primitives:

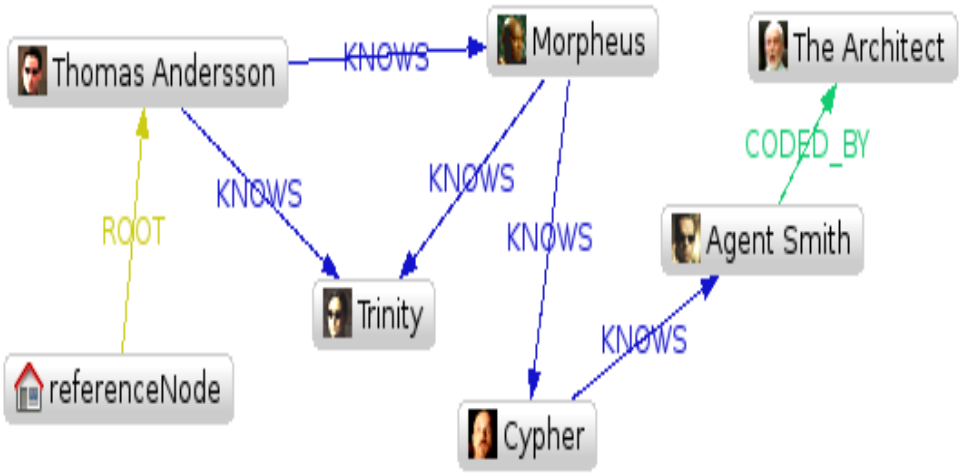
- nodes,
- relationships
- properties

Features

- ACID transaction
- Durable persistence
- Transaction recovery

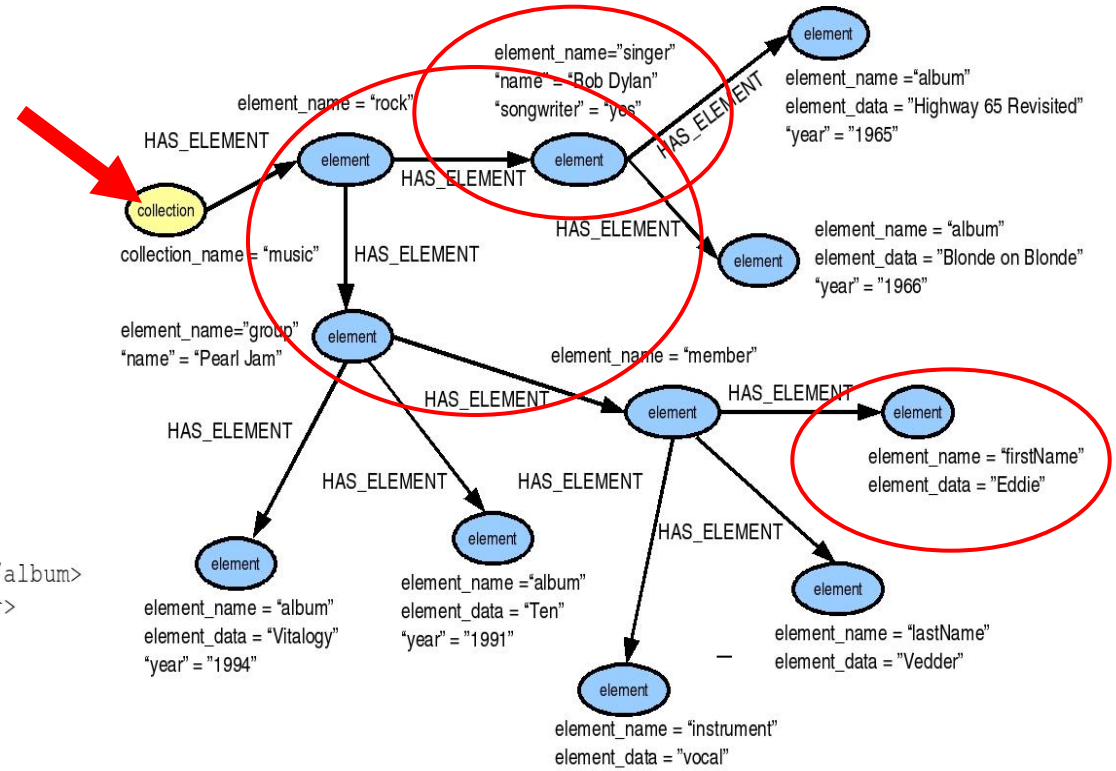
Implementation

- Java



Representing XML in Neo: Basic solution

```
<rock>
  ...
  <group name="Pearl Jam">
    <member>
      <firstName>Eddie</firstName>
      <lastName>Vedder</lastName>
      <instrument type="vocal"/>
    </member>
    ...
    <album year="1991">Ten</album>
    <album year="1994">Vitalogy</album>
    ...
  </group>
  ...
  <singer name="Bob Dylan" songwriter="yes">
    <album year="1965">Highway 65 Revisited</album>
    <album year="1966">Blonde on Blonde</year>
    ...
  </singer>
  ...
</rock>
```



Representing XML in Neo: Customizations