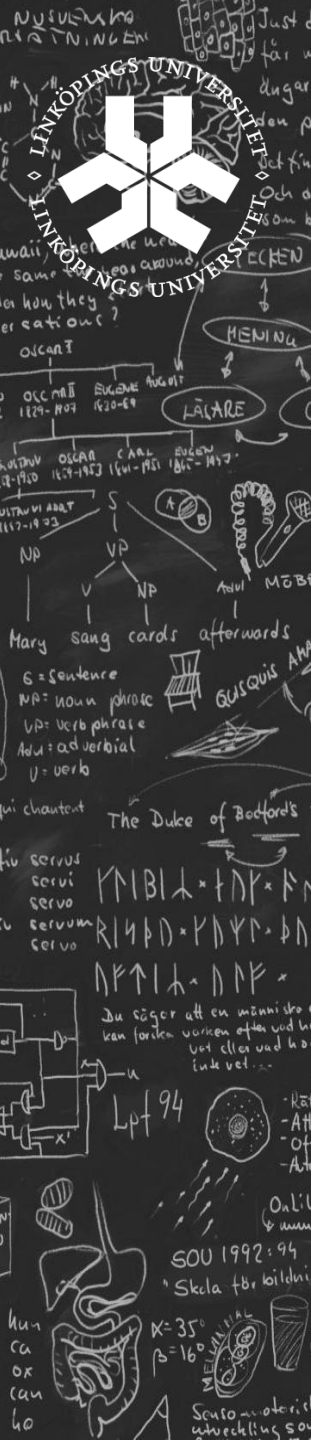
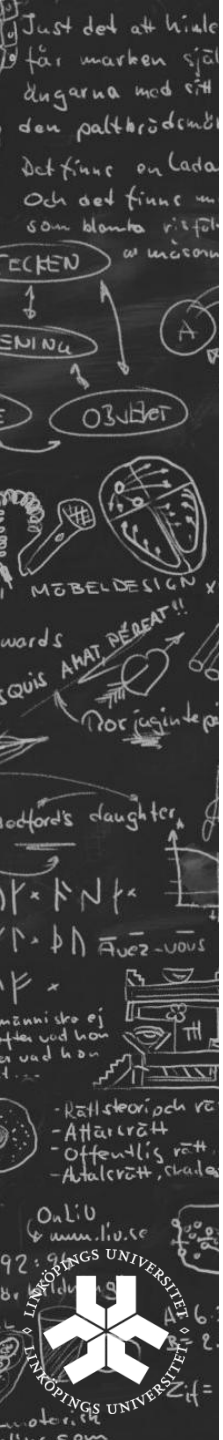


Advanced databases and data models:

Theme1 lecture 2:
Query languages

Lena Strömbäck



Today´s lecture

Different kinds of query languages

Languages

- Lorel
- XPath
- XQuery
- SPARQL

Transformation of data

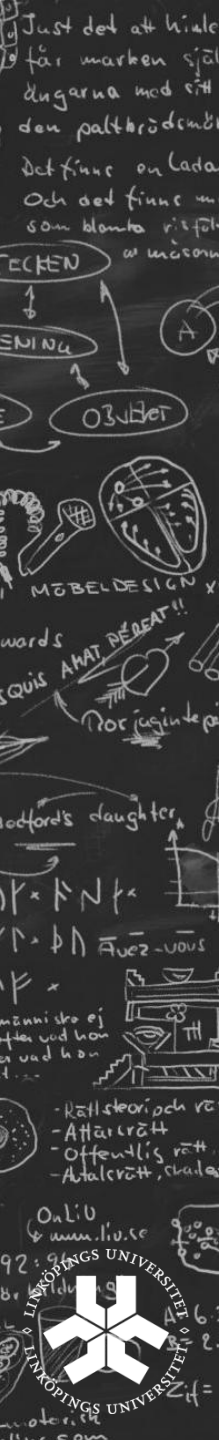
- XSL
- FOR XML

Data guides – why and what

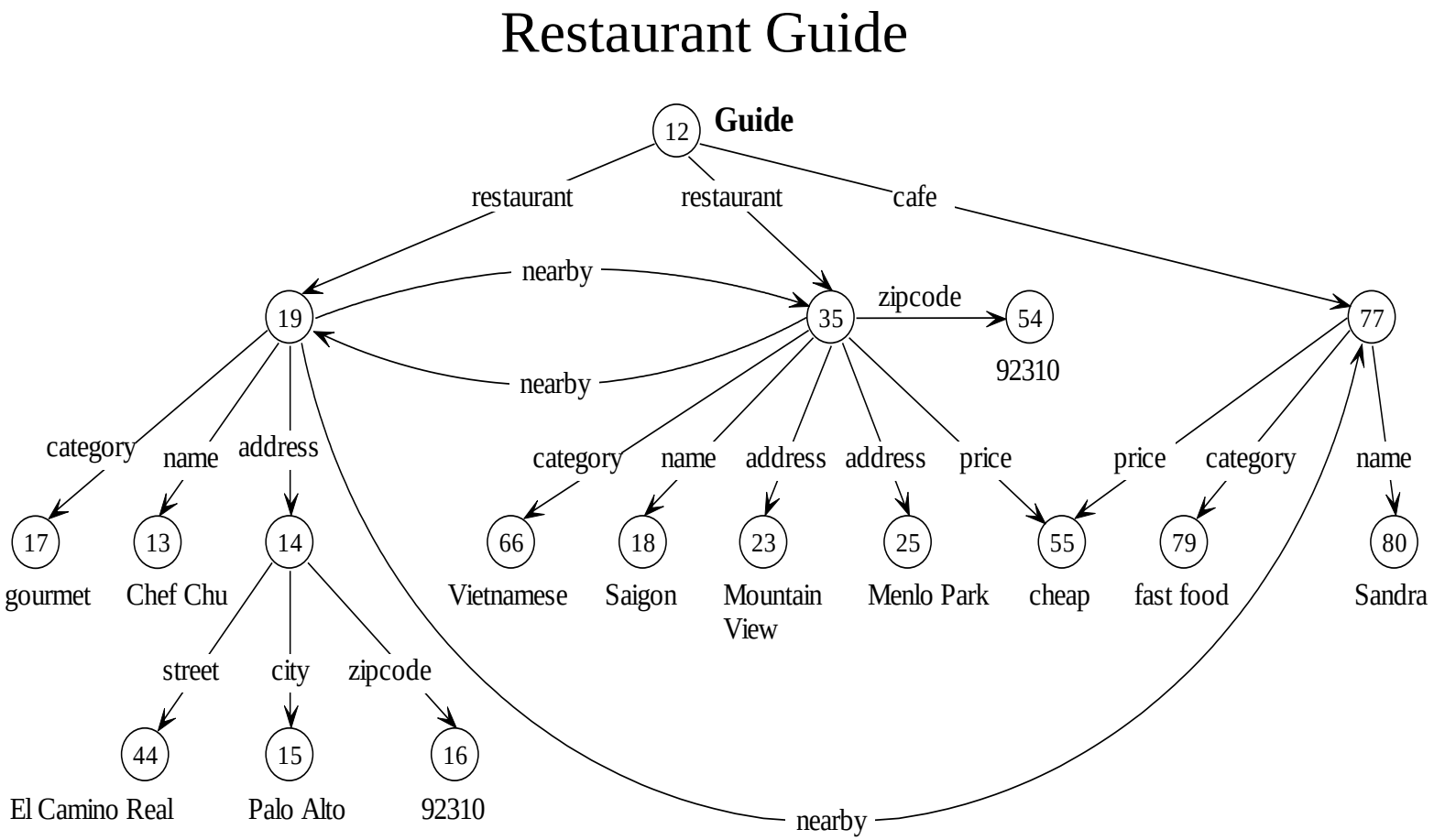
Types of query languages

Typically:

Data	Unstructured	Semi-structured	Structured
Example	Text	XML, RDF, OEM	Relational database
Typical query language	Keywords	XPath, XQuery, Lorel …	SQL, ….
Typical user	Every day		Expert



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

Lorel query language

Wildcards and variables

? - 0 or 1 path

+ - 1 or more paths

* - 0 or more paths

- any path

% - 0 or more chars

- object variables

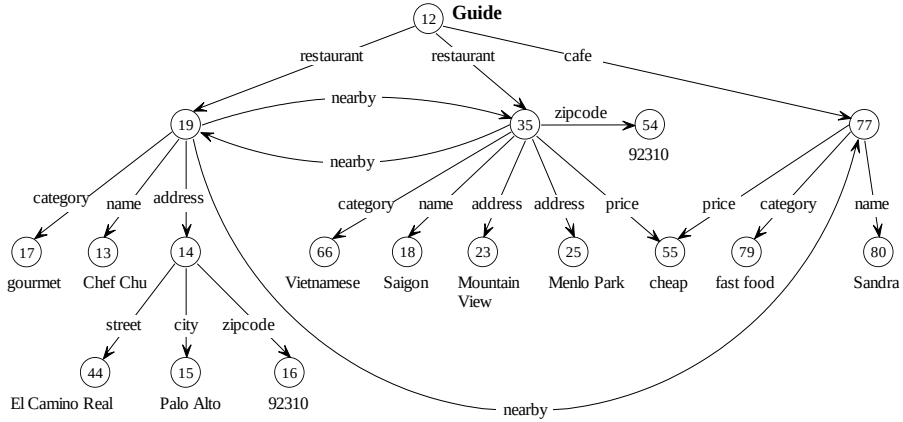
  select P from Guide.% P

  select A from #.address{A}

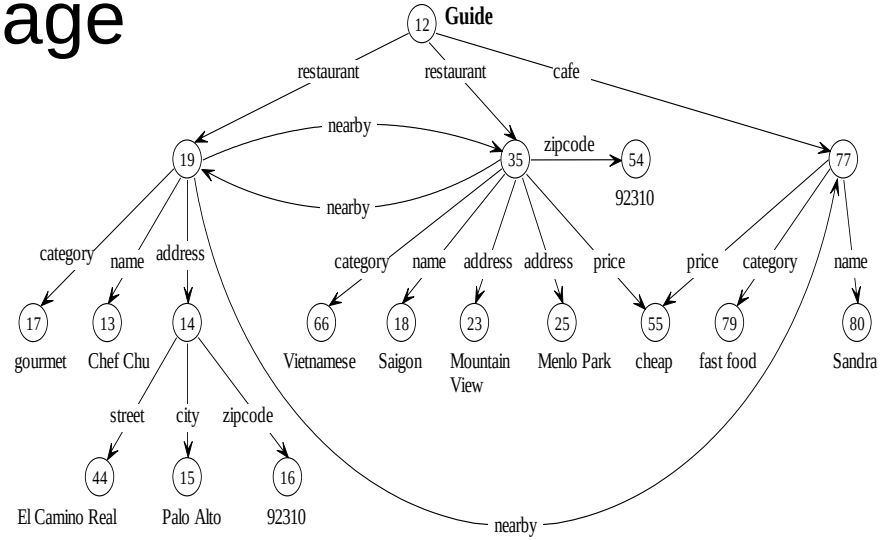
- path variables

  select Guide.#@P.name

Do your recognize this??



Lorel query language



1. Find all places to eat Vietnamese food

```
select P
from Guide.% P
where P.category grep “ietnamese”
```

2. Find the names and streets of all restaurants in Palo Alto

```
select R.name, A.street
from Guide.restaurant{R}.address A
where A.city = “Palo Alto”
```

3. Find all restaurants with zipcode 92310

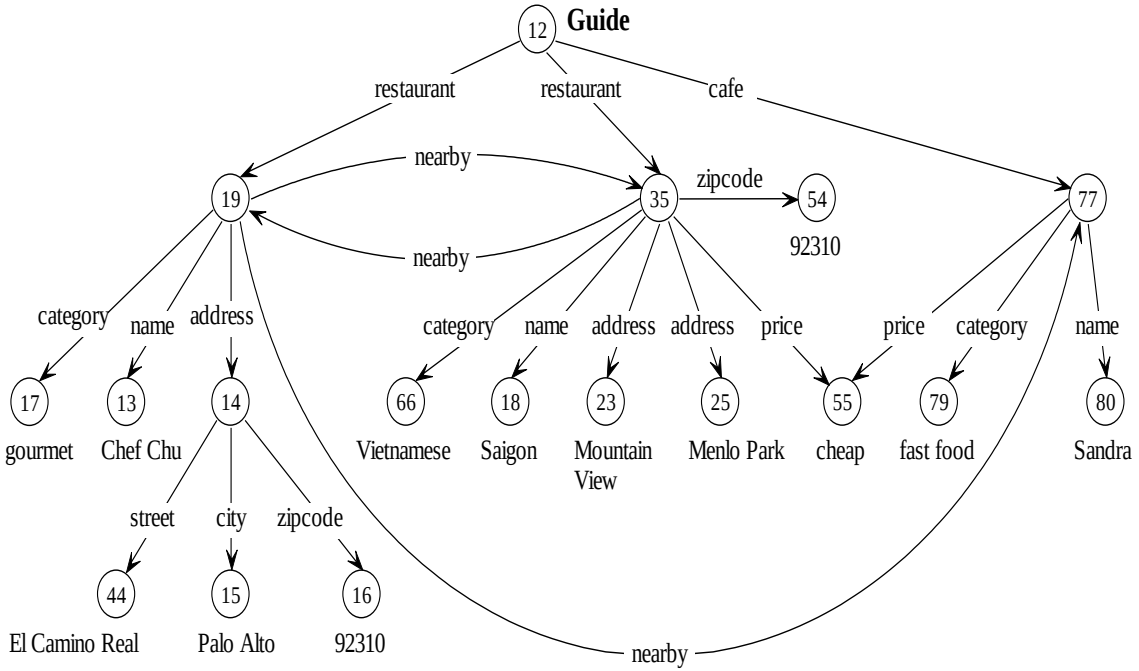
```
select Guide.restaurant
where Guide.restaurant(.address)?.zipcode = 92310
```

Exercise

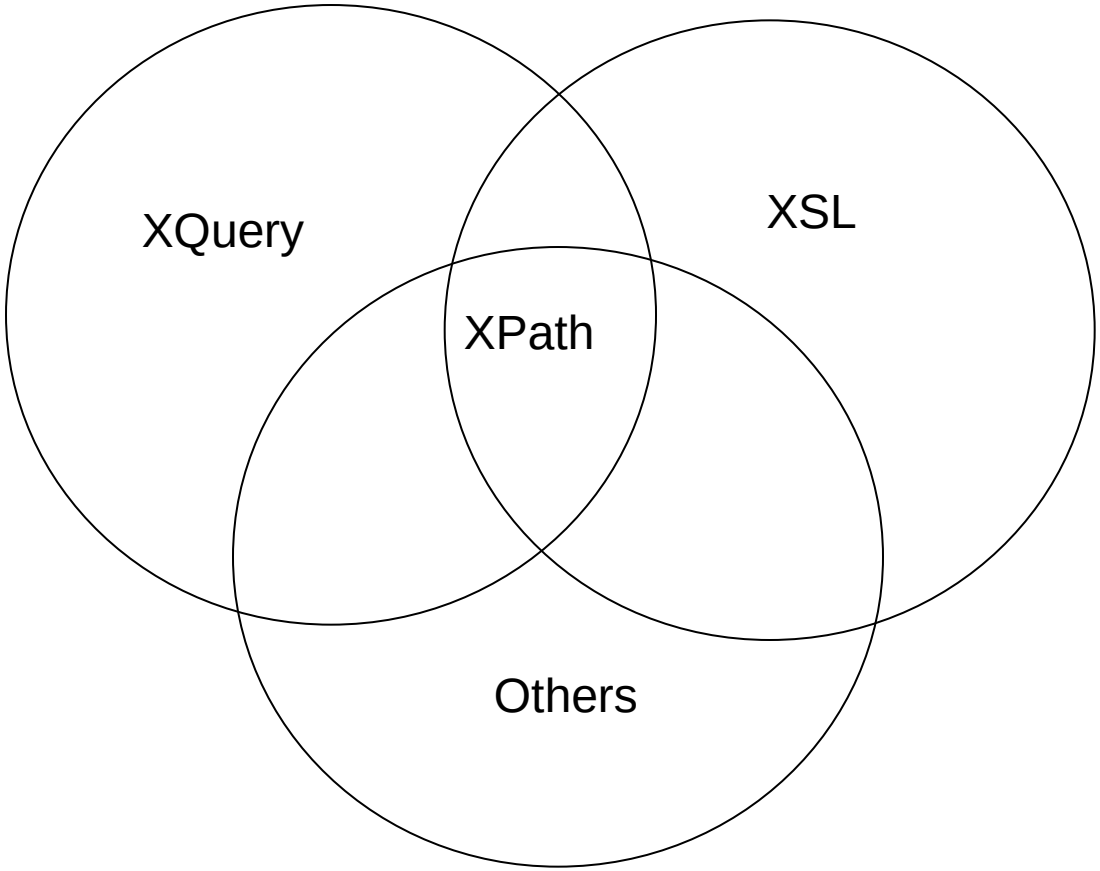
Using the data model from the previous question, formulate the following queries using Lorel:

find all the restaurants that are located in Palo Alto

find the address (city and street) of the “Chef Chu” restaurant



XPath/XQuery/XSLT



XPath

Objects:

- Nodes
- Atomicvalues
- Items

Relations:

- Parent
- Children
- Ancestor
- Descendants

```
<minimodel name="sugartransport" >
   <listOfCompartments>
      <compartment id="blood" name="inblood" />
      <compartment id="cell" name="musclecell" />
   </listOfCompartments>
   <listOfSpecies>
      <species id="sug1" name="sugarinblood" compartment="blood" />
      <species compartment="ins" id="insulin" name="blood"/>
      <species compartment="sug2" id="sugarincell" name="cell"/>
      <species compartment="en" id="energy" name="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>
```

XPath

Node selection:

/minimodel

//species

//species/@id

//species/..

Predicates:

//species[@id='ins']

Wildcards:

//*

//reaction/@*

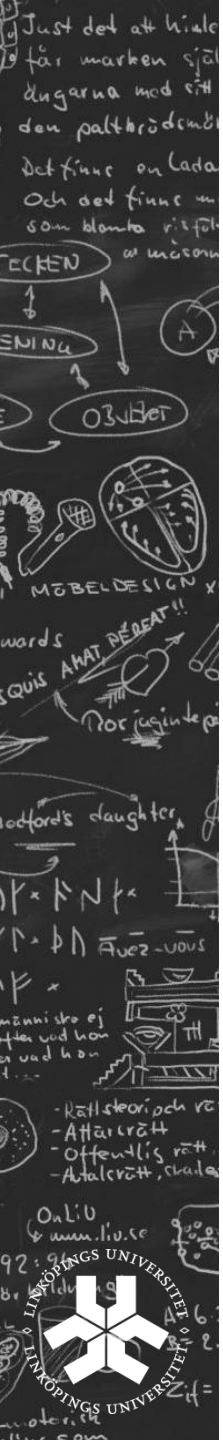
Several paths:

//species|//compartment

And a lot of functions for selecting ancestors etc.

```
<minimodel name="sugartransport" >
  <listOfCompartments>
    <compartment id="blood" name="inblood" />
    <compartment id="cell" name="musclecell" />
  </listOfCompartments>
  <listOfSpecies>
    <species id="sug1" name="sugarinblood"
                                    compartment="blood" />
    <species compartment="ins" id="insulin" name="blood"/>
    <species compartment="sug2" id="sugarincell"
                                          name="cell"/>
    <species compartment="en" id="energy" name="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>
```

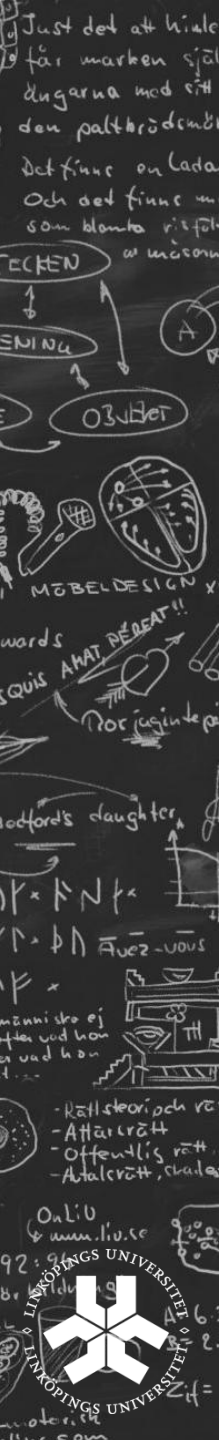
```
data(doc('minimodel.xml')//compartment[@id='blood']/@name)
```



XQuery

XML Query language

```
for $x in doc('minimodel.xml')//species
    where data($x/@compartment)="blood"
    return $x
```



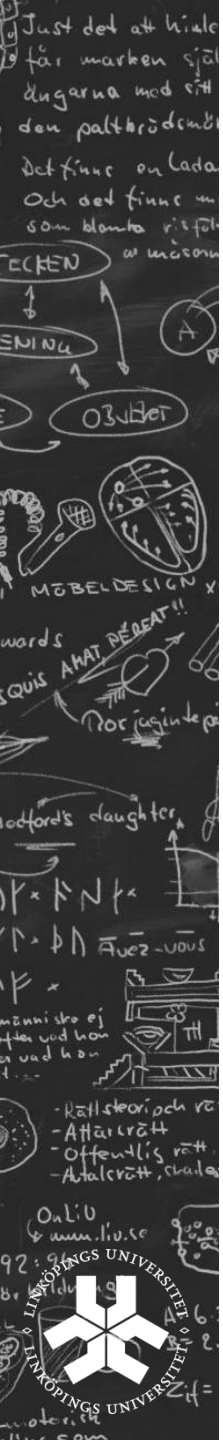
XPath vs. XQuery

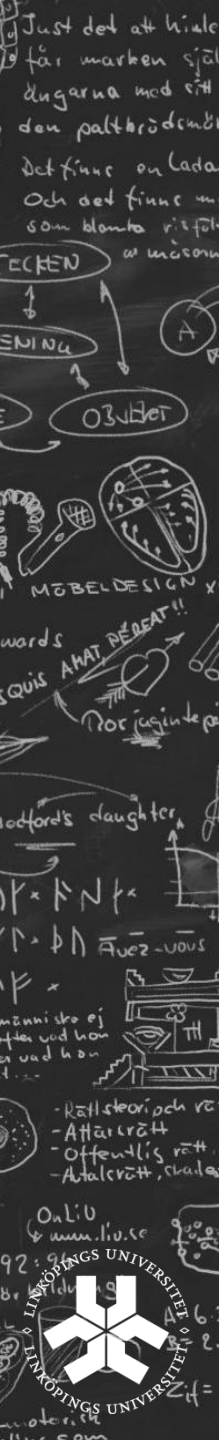
When do you need XQuery?

XQuery allows many variations

```
for $x in doc('minimodel.xml')//species,
    $y in doc('minimodel.xml')//compartment
where data($x/@compartment)=data($y/@id)
return
    <pair> {data($x/@name)} is inside {data($y/@name)} </pair>

for $x in doc('minimodel.xml')//species,
    $y in doc('minimodel.xml')//compartment
          [@id=data($x/@compartment)]
return
    <pair> {data($x/@name)} is inside {data($y/@name)} </pair>
```





XQuery functions

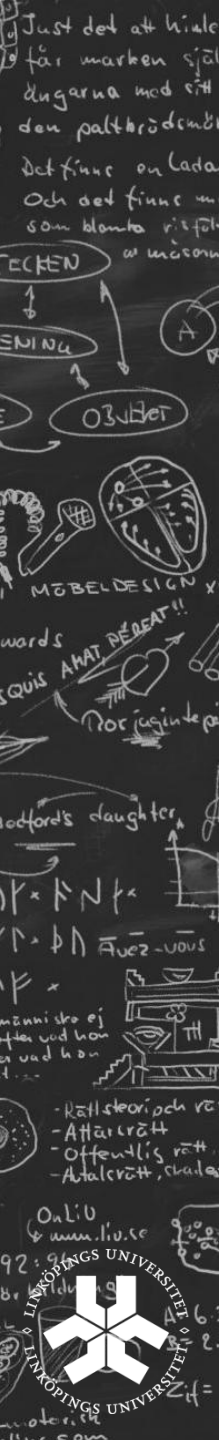
Declare local functions

Can be recursive!

```
declare function local:fak($n)
    {if ($n=1)
       then 1
       else ($n * local:fak($n - 1))
    };
<res>{local:fak(3)}</res>
```

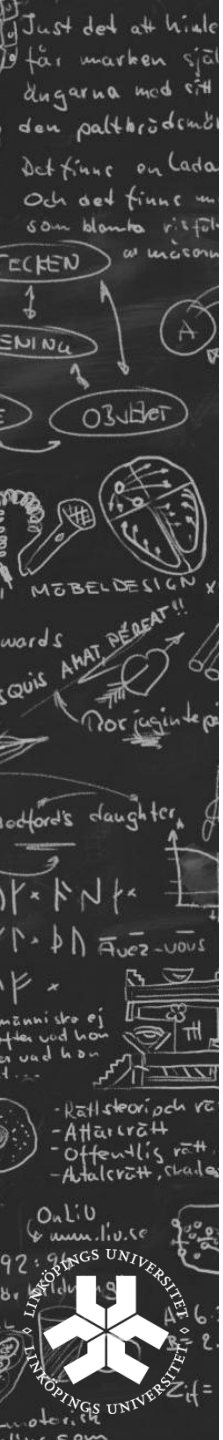
XQuery functions

```
declare function local:next($r)
    { <next>
    {data($r/listOfProducts/speciesReference/@species)}
    {for $x in $r/listOfProducts/speciesReference,
         $y in doc('minimodel.xml')
                  //listOfReactants/speciesReference
                  [@species=data($x/@species)]
    return local:next($y/../..)}
    </next>};
for $x in doc('minimodel.xml')//species,
    $y in doc('minimodel.xml')
           //listOfReactants/speciesReference
           [@species=data($x/@id)]
return  <answer> {data($x/@id)} leads to
                        {local:next($y/../..)} </answer>
```



XQuery - tips

- The Xpath expressions can return many answers.
- Attribute values – use data()
- Start from something simple – build on it.



SPARQL – Query language for RDF

```
PREFIX books:   <http://example.org/book/>
PREFIX dc:    <http://purl.org/dc/elements/1.1/>
SELECT ?book ?title
WHERE   { ?book dc:title ?title }

PREFIX dc:    <http://purl.org/dc/elements/1.1/>
CONSTRUCT { $book dc:title $title }
WHERE   { $book dc:title $title }
```

Transformation: XSL

```
<catalog>
  <cd>
    <title>Empire Burlesque</title>
    <artist>Bob Dylan</artist>
    <country>USA</country>
    <company>Columbia</company>
    <price>10.90</price>
    <year>1985</year>
</cd>
….
```

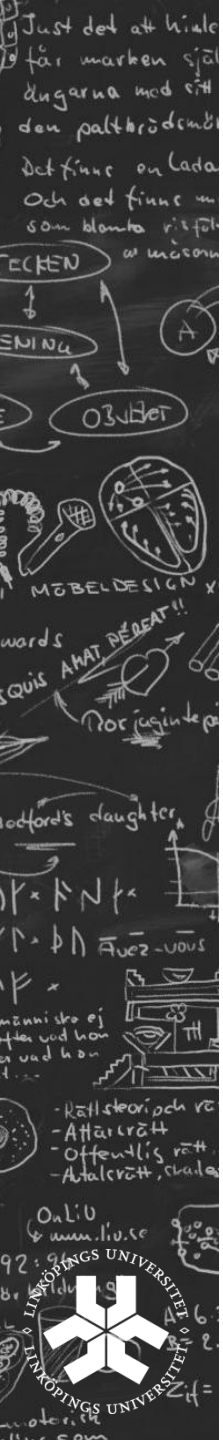
Transform XML to another format

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!-- Edited by XMLSpy® -->
<xsl:stylesheet version="1.0"
xmlns:xsl="http://www.w3.org/1999/XSL/Transform">
<xsl:template match="/">
 <html>
 <body>
  <h2>My CD Collection</h2>
  <table border="1">
   <tr bgcolor="#9acd32">
    <th>Title</th>
    <th>Artist</th>
   </tr>
   <xsl:for-each select="catalog/cd">
   <tr>
    <td><xsl:value-of select="title" /></td>
    <td><xsl:value-of select="artist" /></td>
   </tr>
   </xsl:for-each>
  </table>
 </body>
 </html>
</xsl:template>
</xsl:stylesheet>
```

Transformation: Relations -> XML

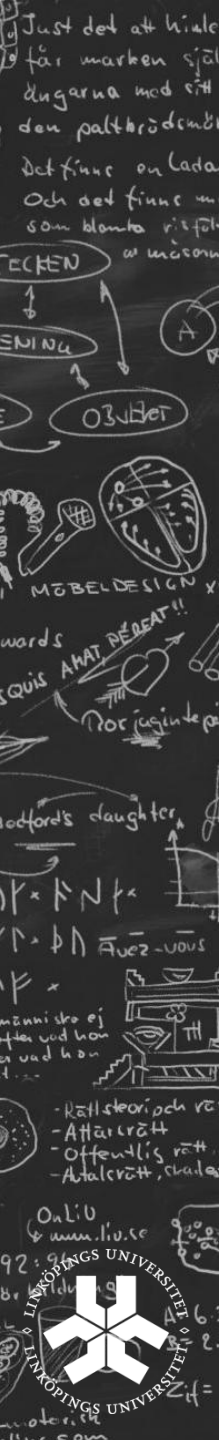
```
select xmlagg(xmlelement("speciesReference",
    xmlattributes(reactants.reactant as species))
from reactants where reaction.id=reactants.id)
```

<speciesReference species=”insulin”>



Transformation: Relations -> XML

```
select xmlelement("reaction", xmlattributes(reaction.reaction as
    name, reaction.id),
      xmlelement("listOfReactants",
        (select xmlagg(xmlelement("speciesReference",
    xmlattributes(reactants.reactant as species))
         from reactants where reaction.id=reactants.id))
      xmlelement("listOfProducts",
        (select xmlagg(xmlelement("speciesReference",
    xmlattributes(products.product as species))
         from products  where reaction.id=products.id))
from reaction
```



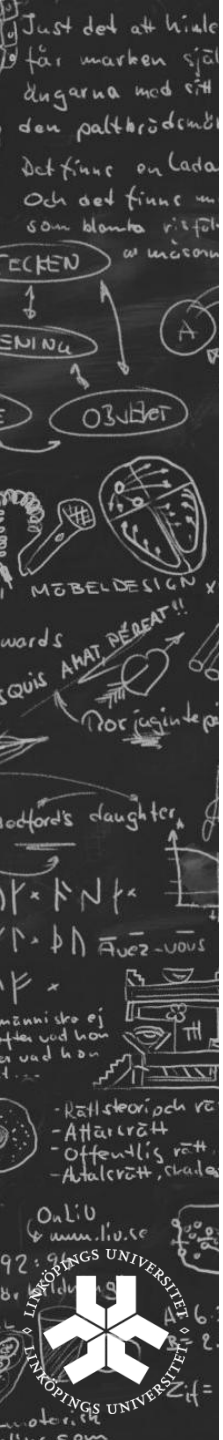
Transformation: Relations -> XML

```
select speciesReference.reactant as species
from reactants speciesReference
where reaction.id = speciesReference.id
for XML auto, type
```

```
<speciesReference  species=”insulin”>
```

Transformation: Relations -> XML

```
select reaction.reaction as name, reaction.id,
  (select  (select speciesReference.reactant as species from
     reactants speciesReference where reaction.id =
     speciesReference.id
           for XML auto, type)
   from emptyXML as listOfReactants for XML auto, type),
  (select    (select speciesReference.product as species from
     products speciesReference where reaction.id =
     speciesReference.id
           for XML auto, type)
   from emptyXML as listOfProducts for XML auto, type) ,
from reaction
for XML auto, type
```



Lab exercises:

Construct queries for your relational and XML data.

Record what is hard or easy.

Answer questions, compare and write report.

For +: XSLT and XML generation for XML

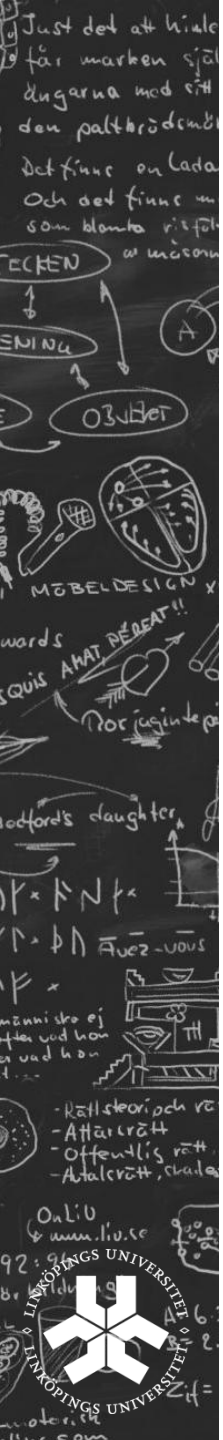
Types of query languages

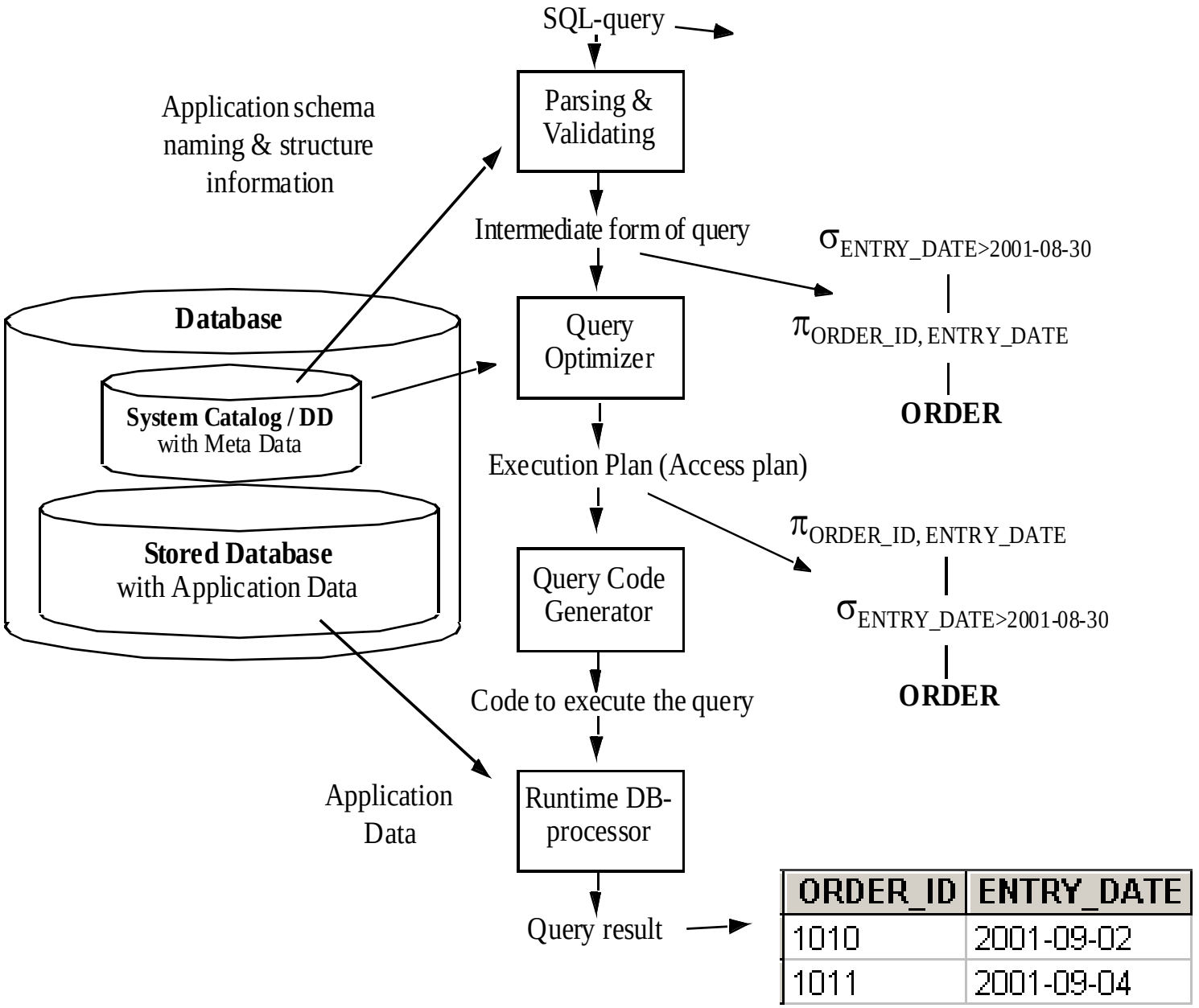
Typically:

Data	Unstructured	Semi-structured	Structured
Example	Text	XML, RDF, OEM	Relational database
Typical query language	Keywords	XPath, XQuery, Lorel …	SQL, ….
Typical user	Every day		Expert

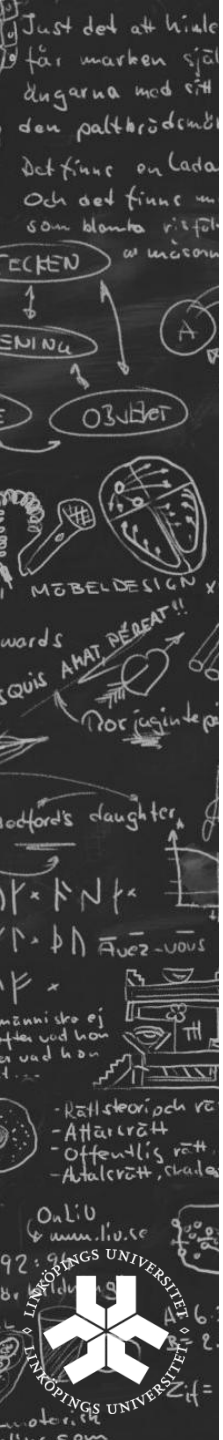
For efficient query processing,

the data structure is important.





ORDER_ID	ENTRY_DATE
1010	2001-09-02
1011	2001-09-04

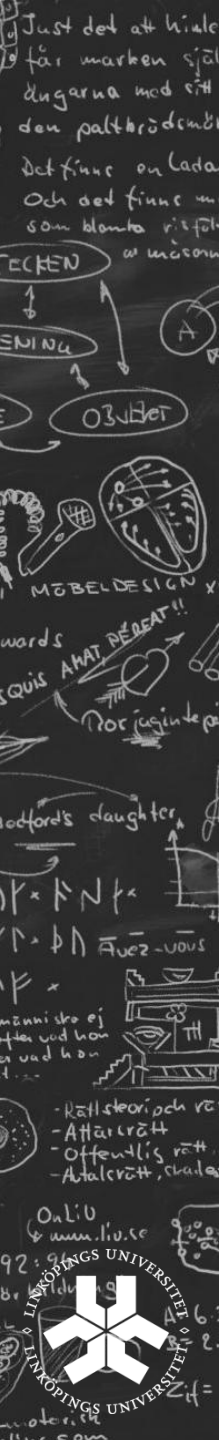


Heuristic optimisation

Idéa: Do selection and projection first, join as late as possible

Algorithm:

- **Break up conjunctive select into cascades**
- **Move down select as far as possible in the tree**
- **Rearrange select operations – most restrictive first**
- **Convert cross product to join with the appropriate join condition from a selection**
- **Move down project operations as far as possible in the tree**
- **Identify subtrees that can be executed by a single algorithm**



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:

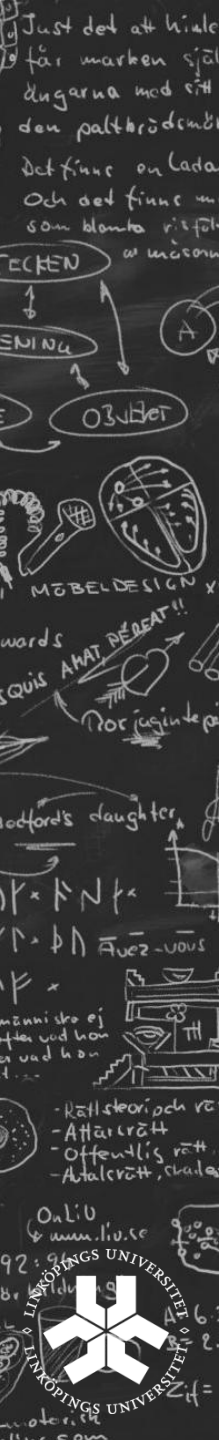
- concise
- accurate
- convenient

Data Guides - definitions

Label path: sequence of labels L1.L2. … .Ln

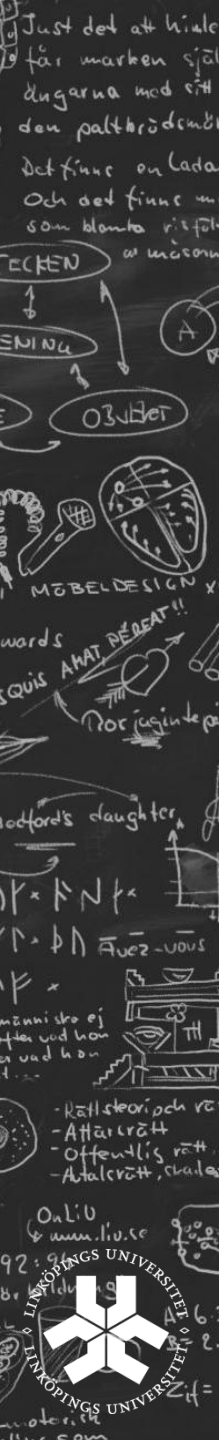
Data path: alternating sequence of labels and oid:s L1.o1.L2.o2. … .Ln.on

Data path *d* is an instance of label path *l* if the sequences of labels are identical in *l* and *d*.



Data Guides - definition

A data guide for object *s* is an object *d* such that every label path of *s* has exact one data path instance in *d*, and each label path in *d* is a label path of *s*.

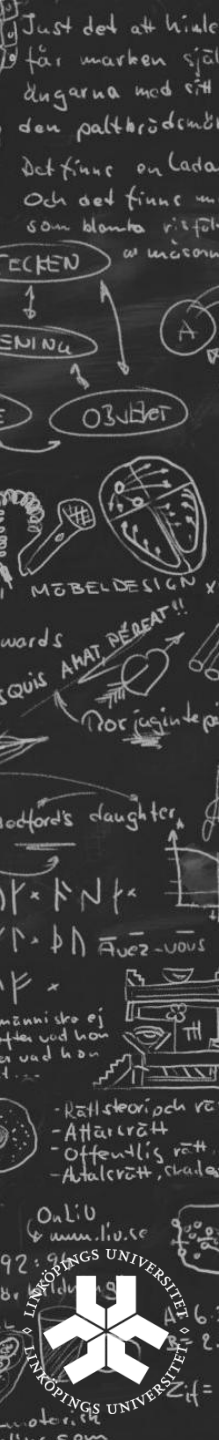


Data Guides

A databank can have several data guides

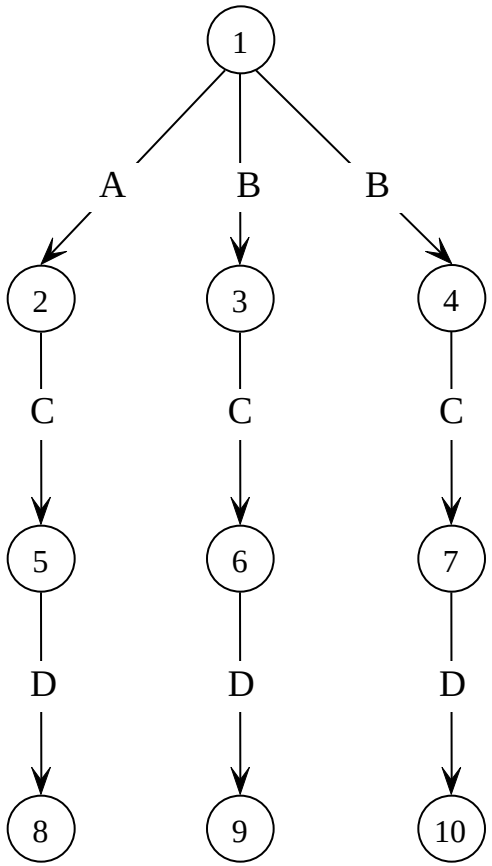
Minimal data guides

the smallest data guides



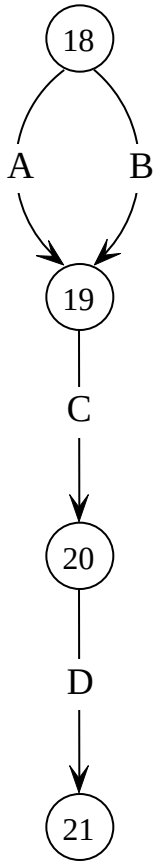
Data Guides - example

Data model

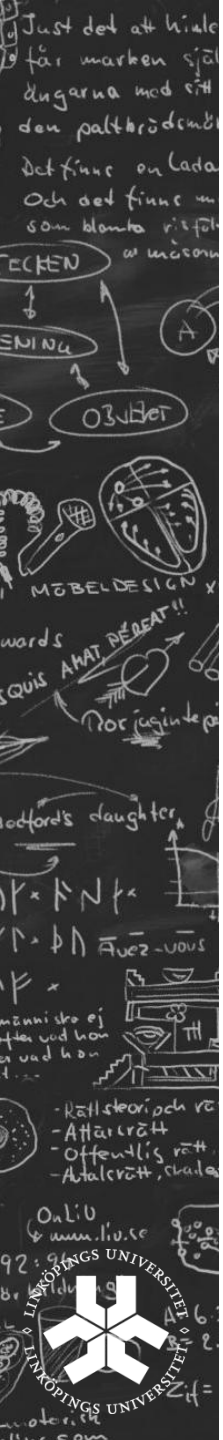


(a)

minimal Data Guide



(c)

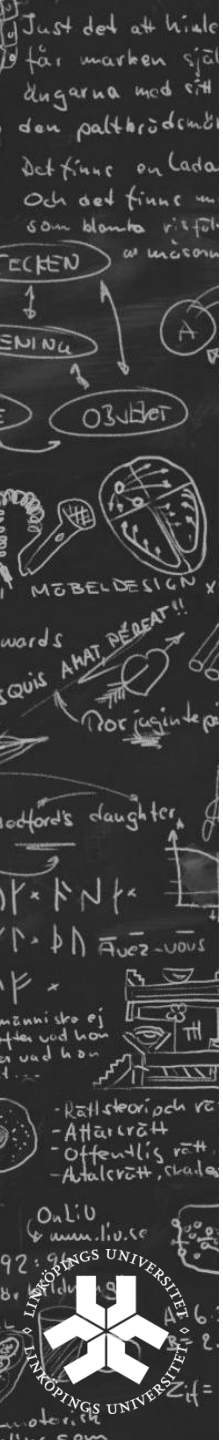


Minimal Data Guides

Concise

May be hard to maintain

- Example: child node for 10 with label E



Strong Data Guides

Intuitively:

”label paths that reach the same set of objects in the data model = label paths that reach the same objects in the data guide”

Strong Data Guides - definitions

An object *o* can be reached from *s* via *l* if there is a data path of *s* that is an instance of *l* and that has *o* as last oid

(L1.o1.L2.o2. … Ln.o)

The target set for label path *l* in object *s* is the set of objects that can be reached from *s* via *l*. *Notation: T(s,l)*

L(s,l): set of label paths of *s* that have the same target set in *s* as *l*.

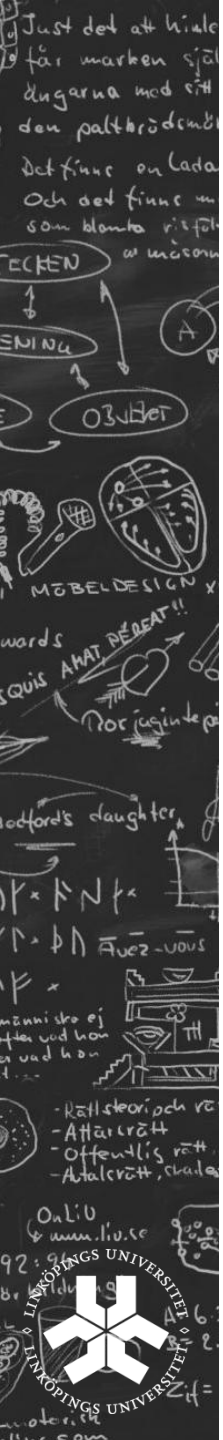
Strong Data Guides - definitions

Definition:

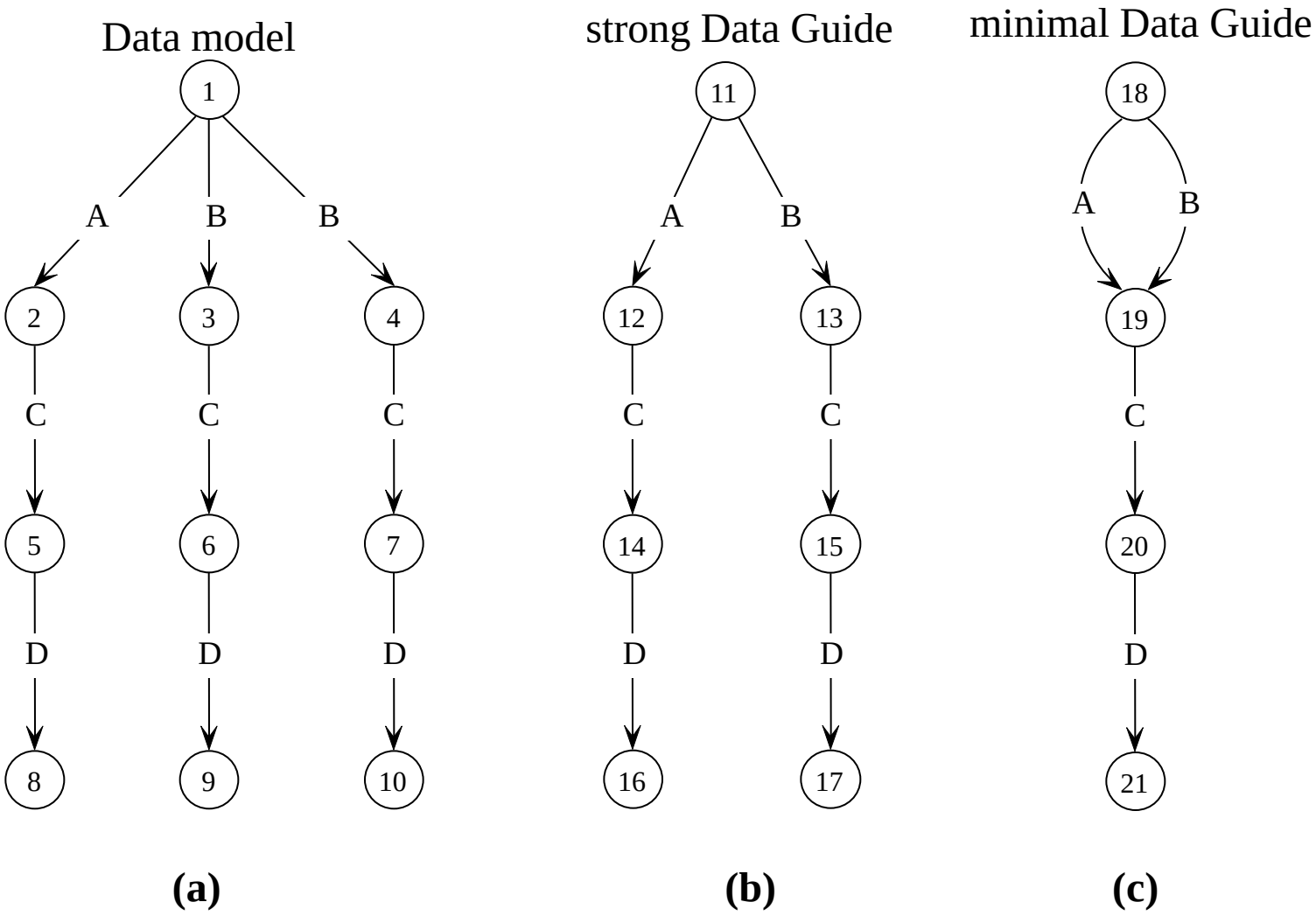
d is a strong data guide for *s* if

for all label paths *l* of *s* it holds that $L(s,l) = L(d,l)$

There is a 1-1-mapping between target sets in the data model and nodes in a strong data guide.



Data Guides - example



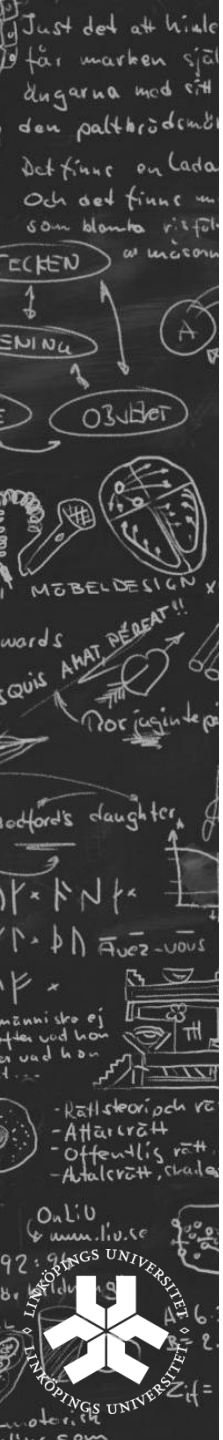
Strong Data Guides - algorithm

Implementation:

Traverse data model depth-first.

Each time you find a new target set for label path *l*, create a new object in the data guide.

If the target set is already represented in the data guide, do not create a new object, but link to the existing object.

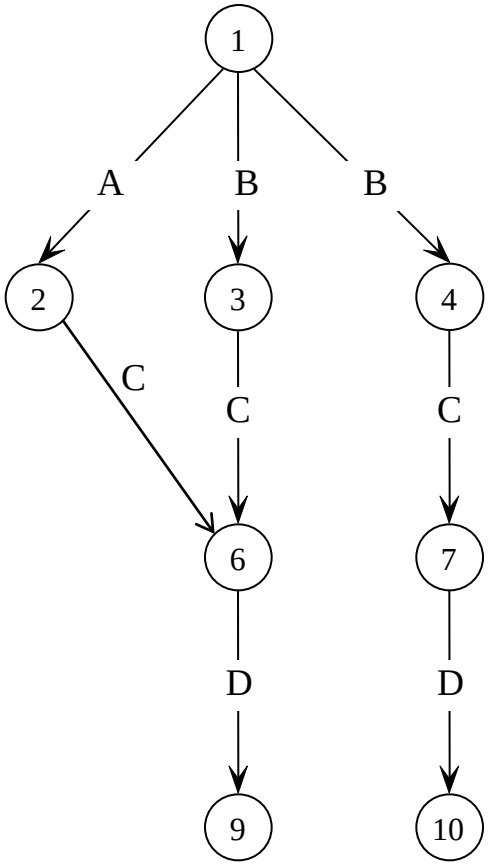


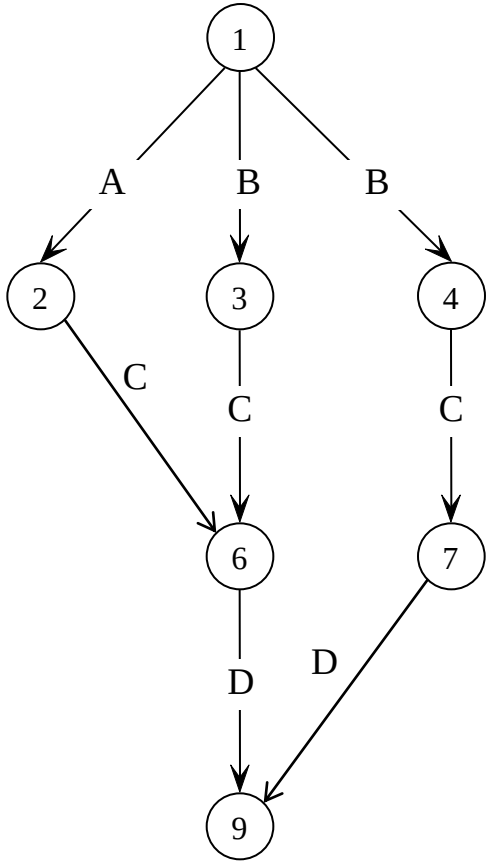
Strong Data Guides - use

Easier to maintain

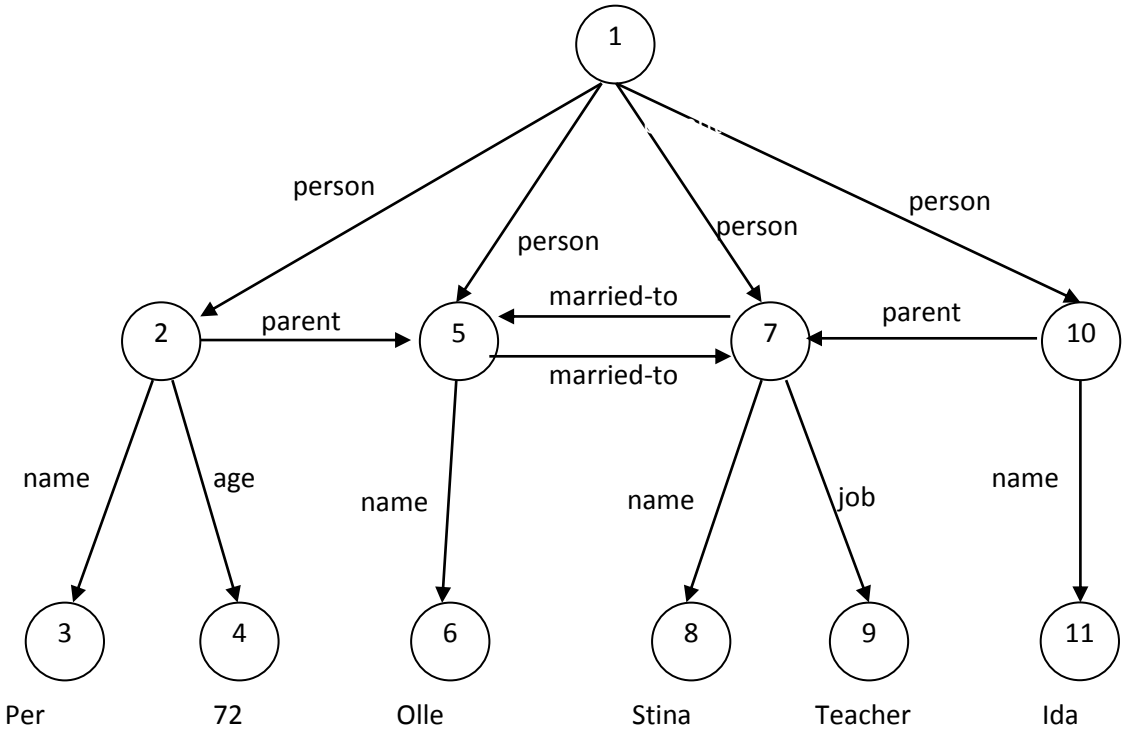
Used as path index for query optimization

Construct the strong data guide

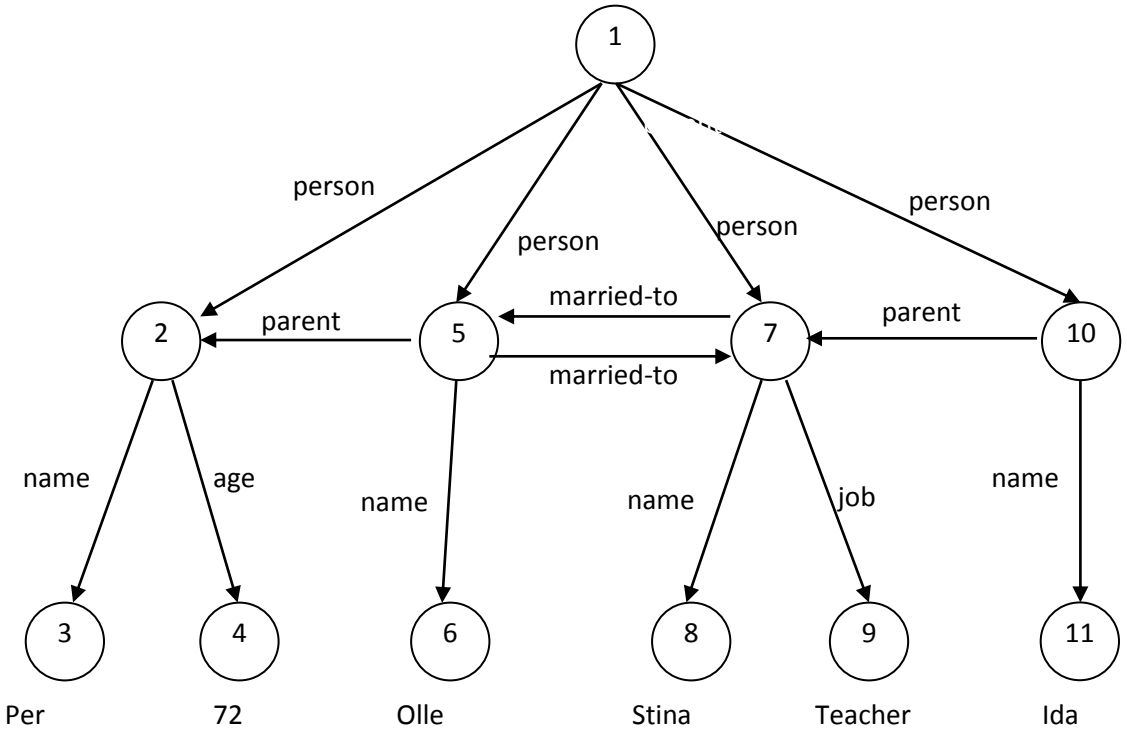




Exercise: Construct the minimal and strong data guides.



Exercise: Construct the minimal and strong data guides.



Exercise

Draw the strong Data Guide for
the restaurant guide data model below.