PatManQL: A language to manipulate patterns and data in hierarchical catalogs

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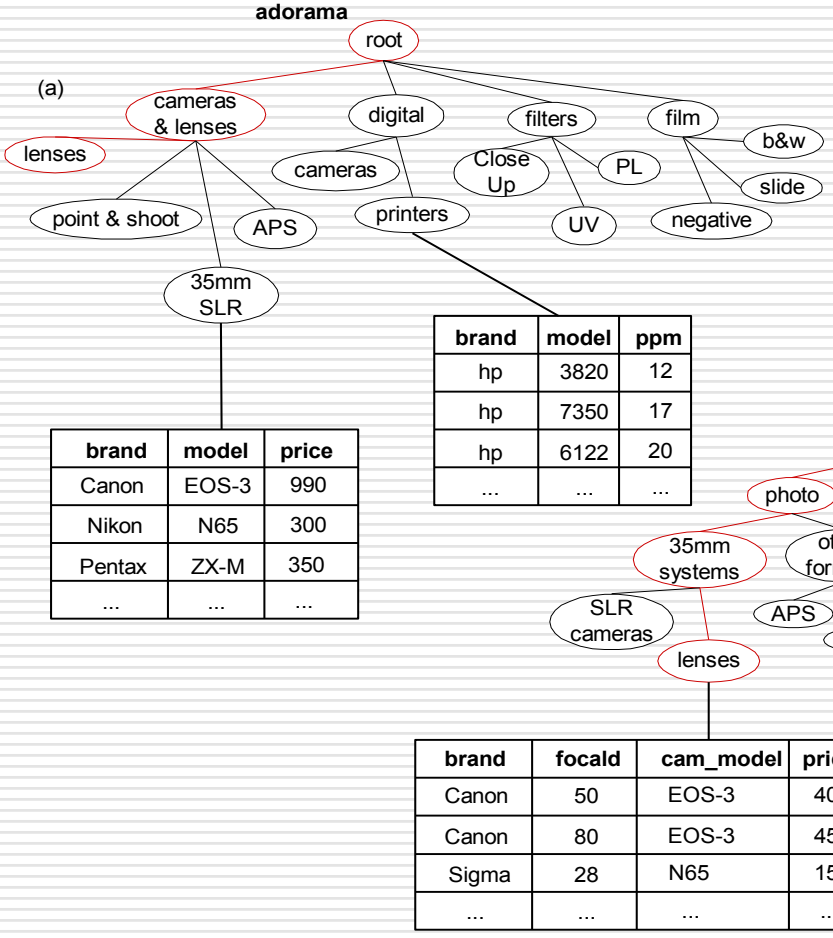
Outline

- Introduction
- Contribution
- Structures
- Operators
- Prototype
- Related work
- Conclusion

Introduction

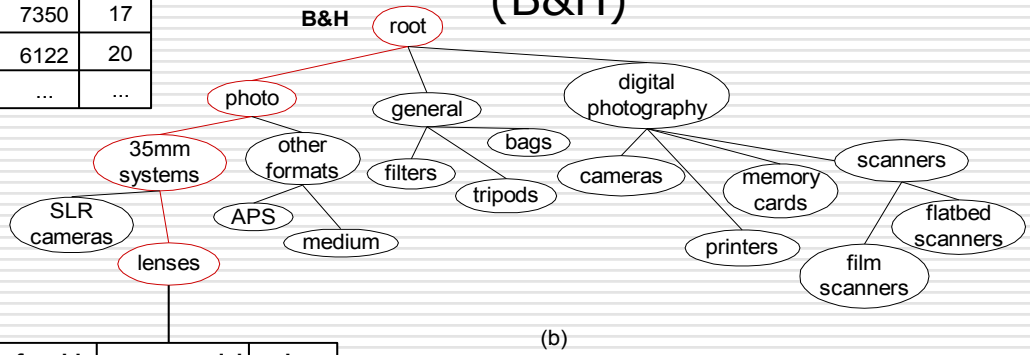
- Huge volumes of data on the Web
- Hierarchical structures and catalogs
- Paths → **knowledge artifacts**
  - Represent group of data
    - ⇨ Conceptual clustering of raw data based on common properties
  - Semantic guides
- Example: **Portal catalogs**

Introduction



brand	model	price
Canon	EOS-3	990
Nikon	N65	300
Pentax	ZX-M	350
...	...	...

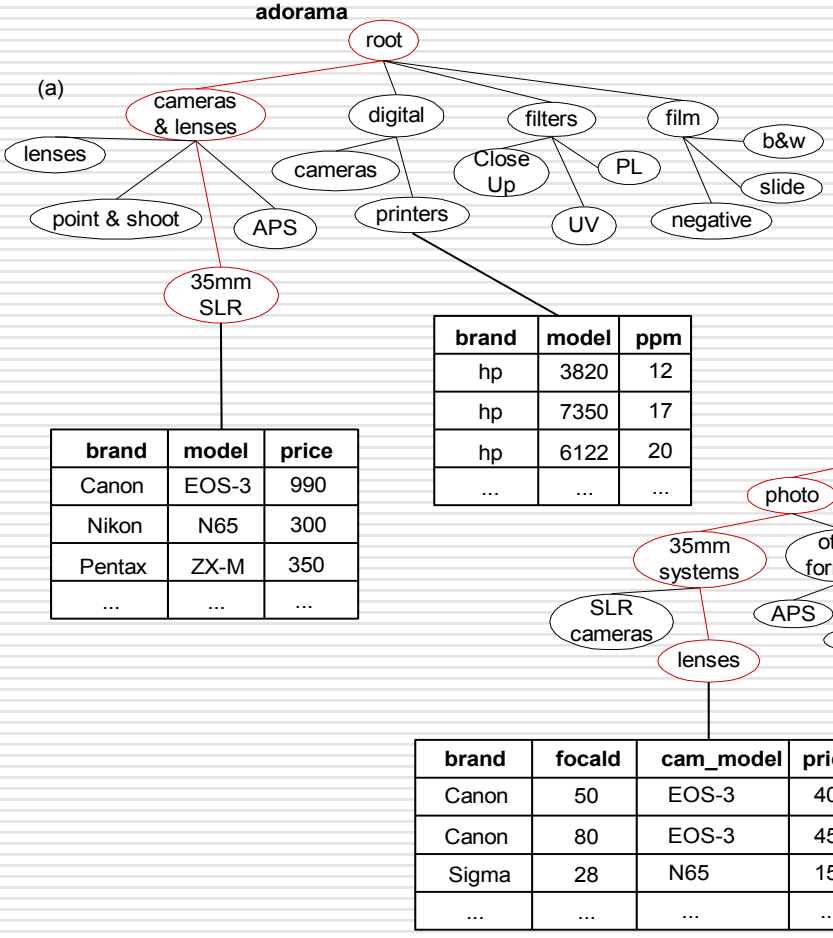
brand	model	ppm
hp	3820	12
hp	7350	17
hp	6122	20
...	...	...



brand	focald	cam_model	price
Canon	50	EOS-3	400
Canon	80	EOS-3	450
Sigma	28	N65	150
...	...	...	...

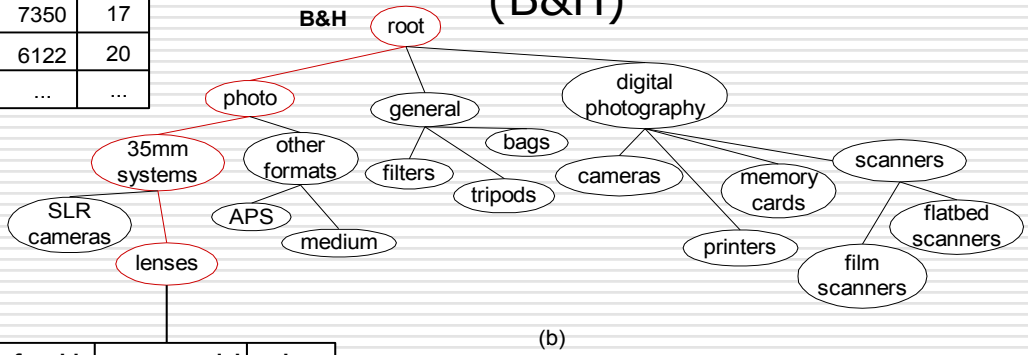
- Paths → **alternative pattern versions** for the same group of data
- Example: searching for lenses
  - /cameras & lenses/lenses (adorama)
  - /photo/35mm systems/lenses (B&H)

Introduction



brand	model	price
Canon	EOS-3	990
Nikon	N65	300
Pentax	ZX-M	350
...	...	...

brand	model	ppm
hp	3820	12
hp	7350	17
hp	6122	20
...	...	...



brand	focald	cam_model	price
Canon	50	EOS-3	400
Canon	80	EOS-3	450
Sigma	28	N65	150
...	...	...	...

- Paths → **complex pattern**
- Example: searching for integrated photo systems
  - /cameras & lenses/35mm SLR (adorama)
  - /photo/35mm systems/lenses (B&H)

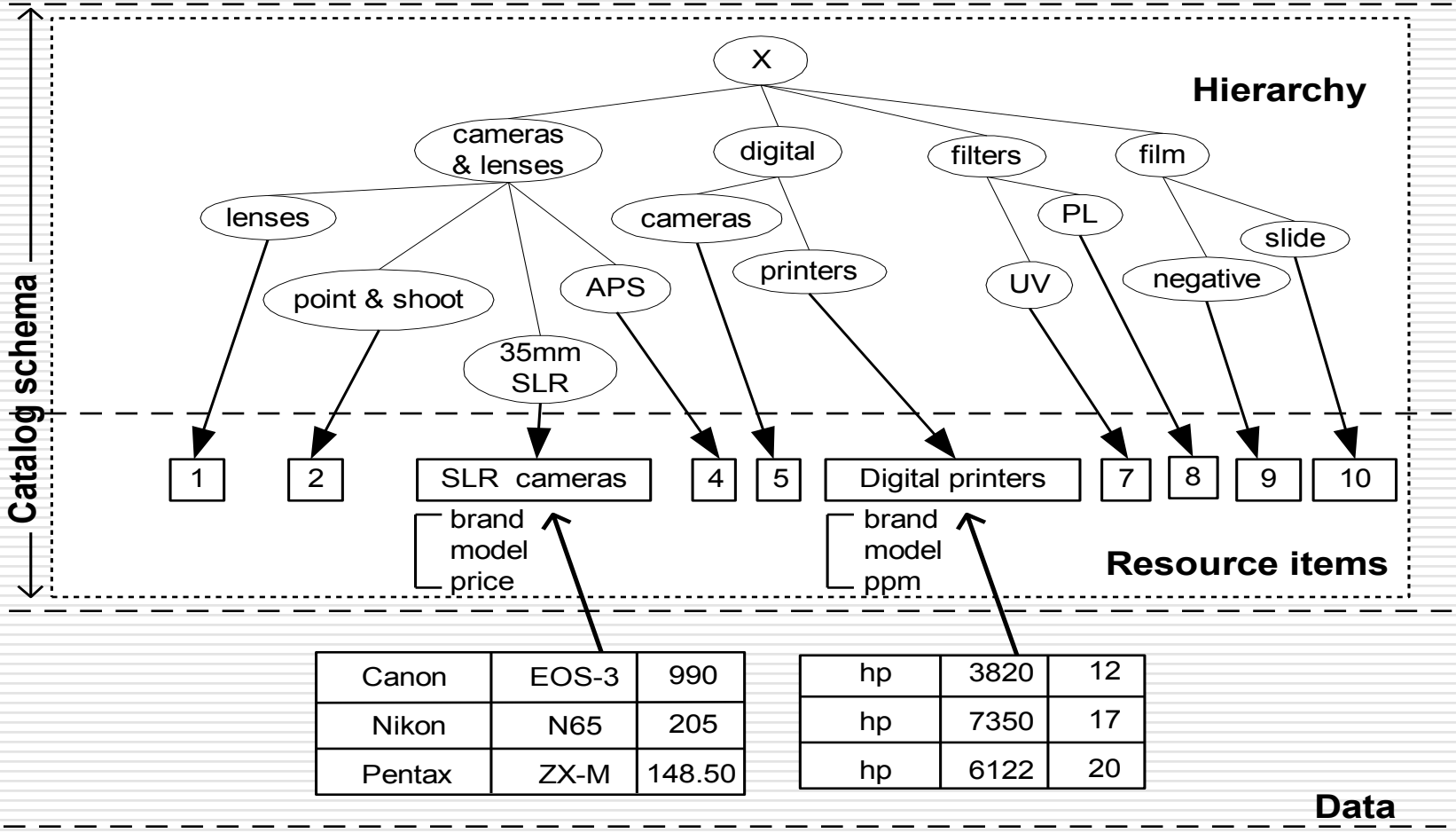
Contribution

- A model to represent paths as knowledge artifacts
- The **PatManQL** language:
  - Operators to manipulate path-like patterns
  - Relational operators for data
- A prototype

Catalog Schema

- A tree with:
  - a root (⊗)
  - a set of non-leaf nodes (○)
  - a set of **resource items** as leaves (□)
- Data: instances (records) of resource item
  - Resource item: **Relation** R(a1, a2, …, an), where a1, a2, … **attributes**

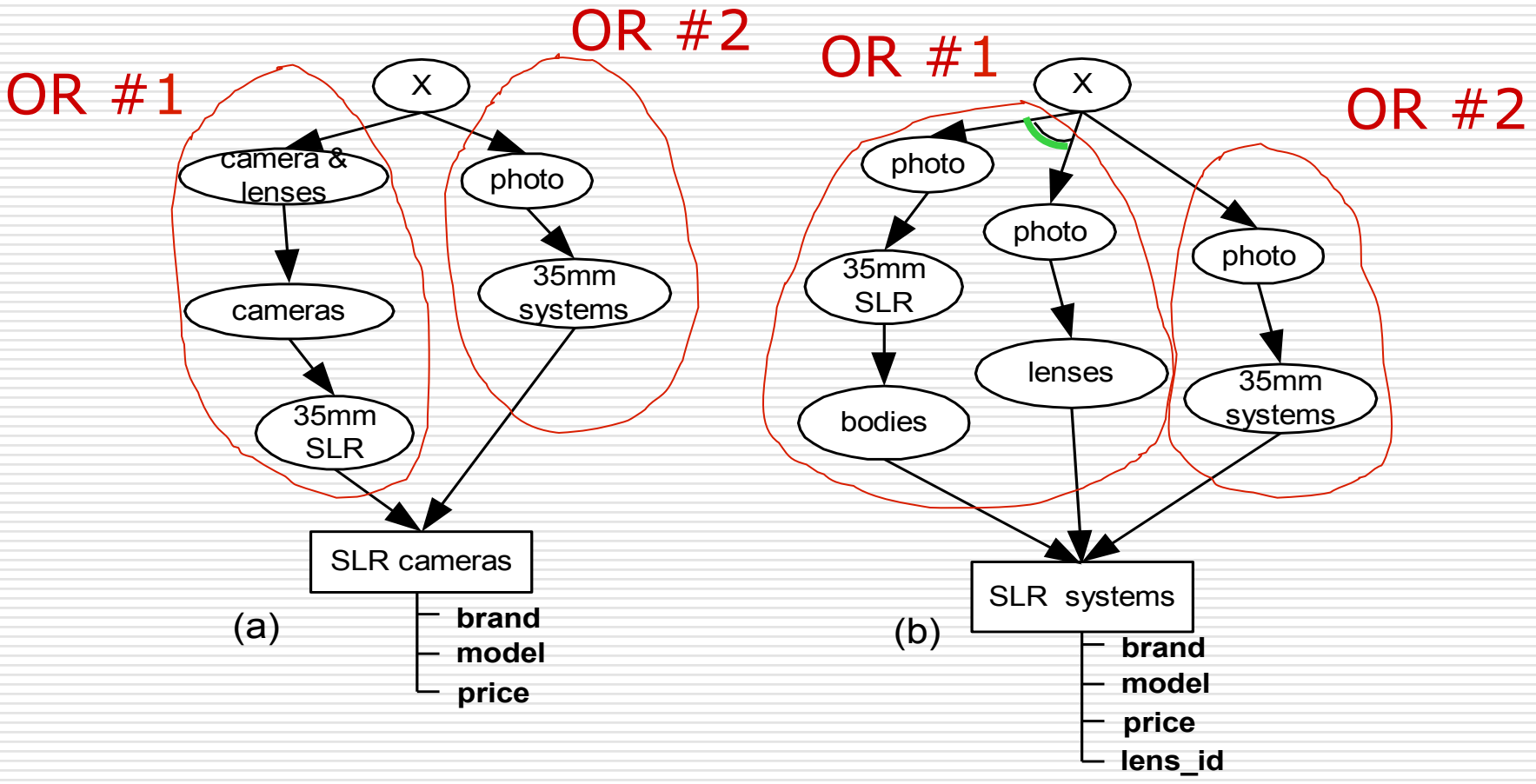
Catalog Schema



Tree-Structure Relations (TSRs)

- Combining catalog schemas with common resource item
- Tree-Structure Relation (AND/OR-like graph):
  - **One** resource item
  - Paths organized in **OR components**
    - OR component: group of one or more paths (AND group)
    - OR components are alternative ways to access the common resource item
  - **Paths = patterns**

Tree-Structure Relations (TSRs)



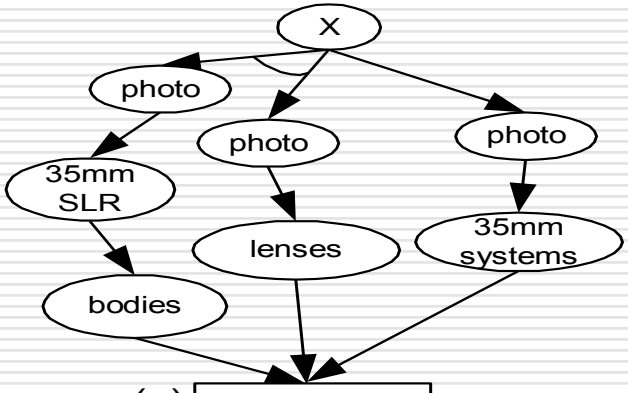
Operators

- **Select** (σ)
  - $\sigma_{\text{<attribute condition><path condition>}}$ (TSR)
    - ⇨ attribute condition: {=, ≠, <}
    - ⇨ path condition: {=, ≠, ⊂, ∠}
  - Filters instances of resource items and OR components

Select example

'Select all non Pentax cameras with price greater than 200Euros, having "/photo/35mm systems" in their paths':

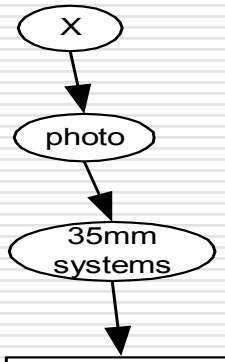
$\sigma_{<brand !="Pentax", price > 200><"/photo/35mm systems" \subset \$\_>}$(SLR systems)



(a)

SLR systems

brand	model	price	lens_id
Canon	EOS-3	990	1
Nikon	N65	205	2
Pentax	ZX-M	148.5	3
...	...	...	...



(b)

SLR systems

brand	model	price	lens_id
Canon	EOS-3	990	1
Nikon	N65	205	2
...	...	...	...

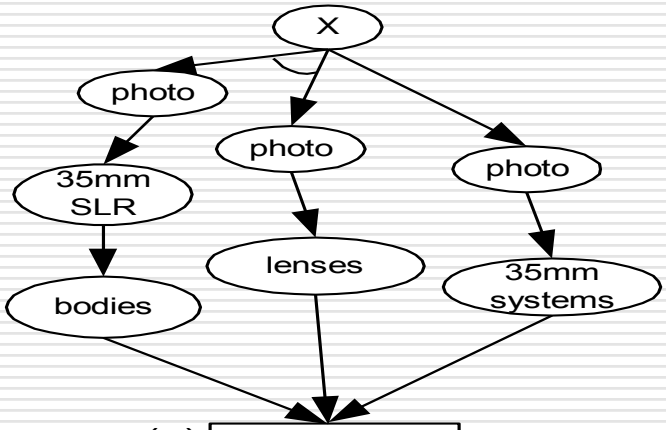
Operators

- **Project** (π)
  - $\pi_{\text{<attribute list><variable list>}}$ (TSR)
    - ⇨ attribute list: {attribute}
    - ⇨ variable list: {$i (path variable), #i (OR variable)}
  - Keeps attributes of resource item and paths of each OR component or OR components on the whole

Project example

'Cameras with only the model and lens_id attributes and the rightmost component':

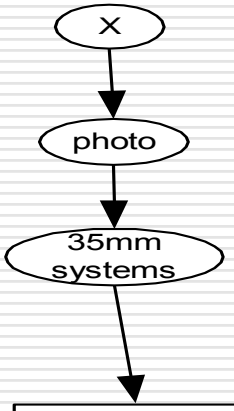
$$\Pi_{<model,\ lens\_id><\#2>}(\text{SLR systems})$$



(a)

SLR systems

brand	model	price	lens_id
Canon	EOS-3	990	1
Nikon	N65	205	2
Pentax	ZX-M	148.5	2
...	...	...	...



(b)

SLR systems

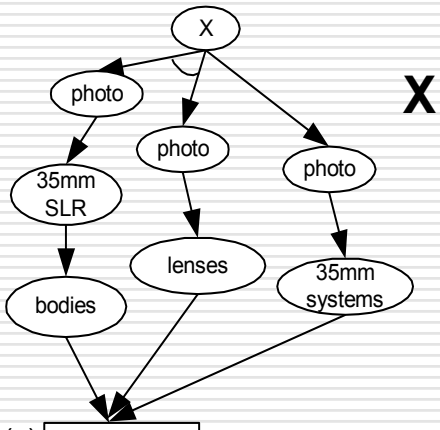
model	lens_id
EOS-3	1
N65	2
ZX-M	2
... ...	...

Operators

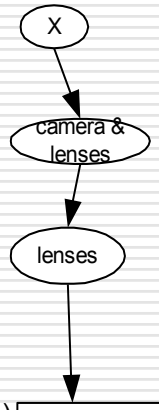
- **Cartesian product** (X)
  - (TSR1) X (TSR2)
  - Combine instances of resources and OR components

Cartesian product example

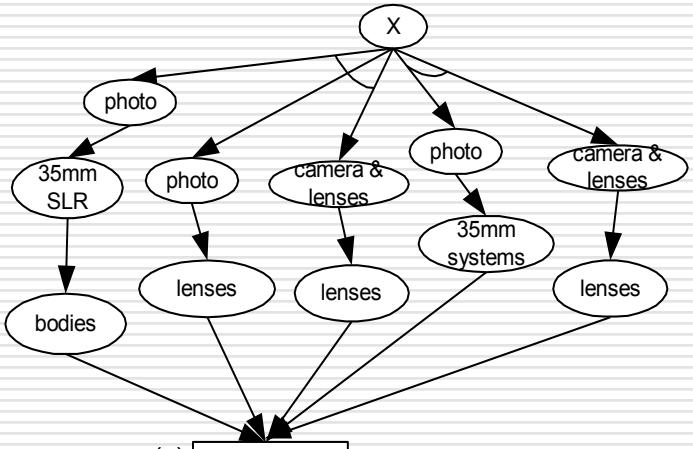
(SLR systems) X (Lenses)



X



=



(a) SLR systems

cbrand	cmodel	cprice	clensid
Canon	EOS-3	990	1
Nikon	N65	205	1
Pentax	ZX-M	148.5	2
...	...	...	...

(b) Lenses

lbrand	lensid	lprice
Sigma	1	200
Tamron	2	100
...	...	...

(c) SLR systems

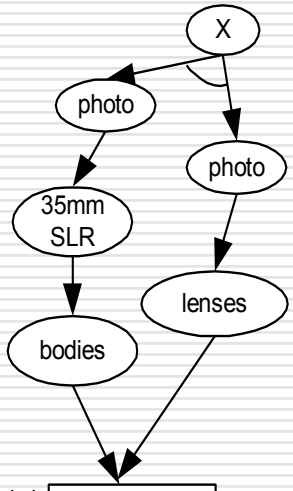
cbrand	cmodel	cprice	clensid	lbrand	lensid	lprice
Canon	EOS-3	990	1	Sigma	1	200
Canon	EOS-3	990	1	Tamron	2	100
Nikon	N65	205	1	Sigma	1	200
Nikon	N65	205	1	Tamron	2	100
Pentax	ZX-M	148.5	2	Sigma	1	200
Pentax	ZX-M	148.5	2	Tamron	2	100
...	...	...	...	...	...	...

Operators

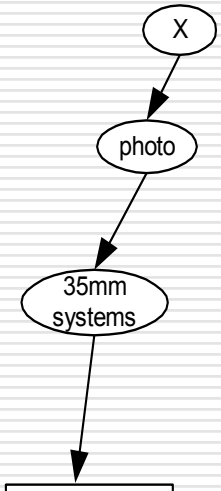
- **Union** (U)
  - (TSR) U (TSR)
  - Union of instances and all OR components
- **Intersection** (∩)
  - (TSR) ∩ (TSR)
  - Intersection of instances and all OR components
- **Difference** (–)
  - (TSR) – (TSR)
  - Instances of the first TSR not present in the second one and all OR components of the first TSR

Union example

(SLR systems) U (SLR systems)



U



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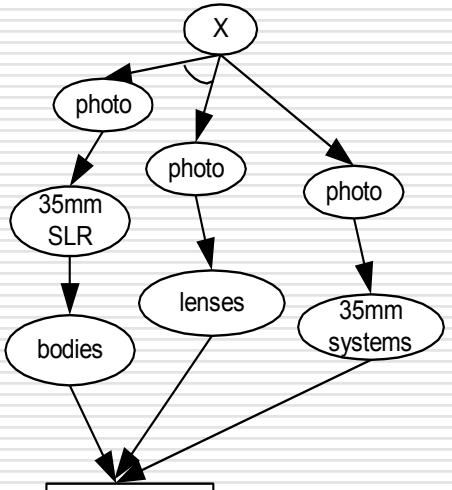


(a) SLR systems

cbrand	cmodel	cprice	clensid
Canon	EOS-3	990	1
Nikon	N65	205	1
Pentax	ZX-M	148.5	2
...	...	...	...

(b) SLR systems

cbrand	cmodel	cprice	clensid
Canon	EOS-3	990	1
Nikon	FM2	800	1
Pentax	ZX-M	148.5	2
...	...	...	...

(c) SLR systems

cbrand	cmodel	cprice	clensid
Canon	EOS-3	990	1
Nikon	N65	205	1
Pentax	ZX-M	148.5	2
Nikon	FM2	800	1
...	...	...	...

Prototype

- Interpreter
- Query Execution Engine
- Storage mechanism
  - XML files
  - MySQL RDBMS
    - ⇨ All-edges-in-one-table storage approach
- Graphical Interface

Related work

- Pattern management (PANDA project) (S. Rizzi et al.)
- Inductive databases framework (Tomasz Imielinski et al.)
  - DMQL (Jiawei Han et al.), MINE RULE(R.Meo et al.)
    - ⇨ Descriptive rules
- Tree algebras
  - TAX (H. V. Jagadish et al.)
    - ⇨ Selecting – reconstructing bulk XML data
  - YAT (V. Christophides et al.)
    - ⇨ Tuple-based, not tree-based

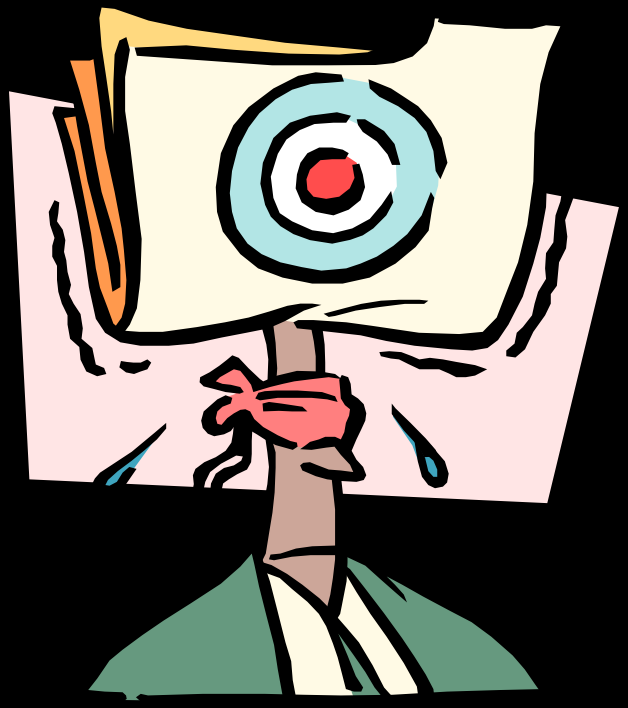
Conclusion

- A model to represent paths as knowledge artifacts (patterns)
  - Catalog schema
  - Tree-Structure Relations (TSRs)
- The PatManQL language:
  - Operators to manipulate paths as patterns and data
- A prototype system

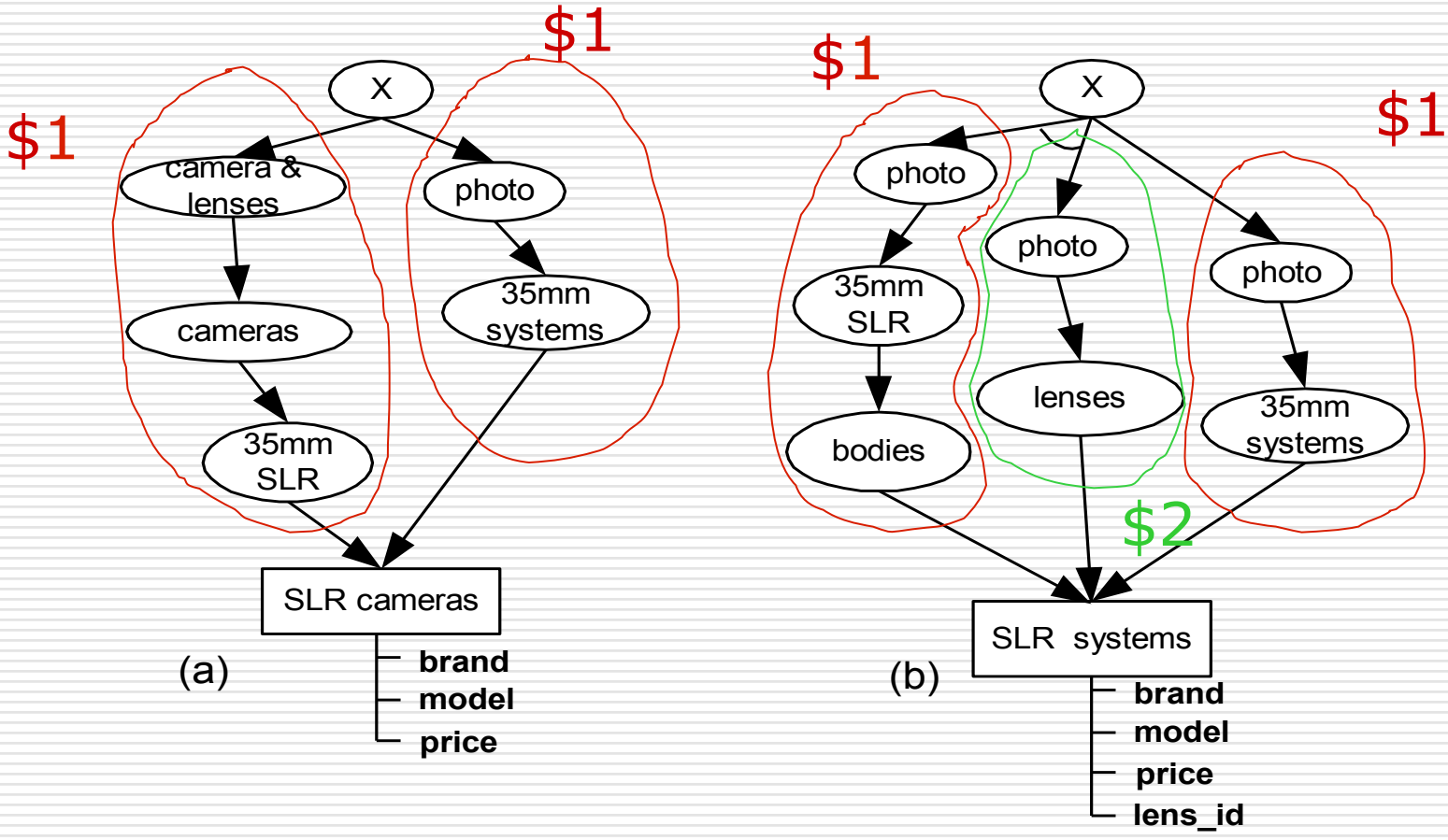
Future Work

- Properties of the Operators
- Restructure operators
- Join operator

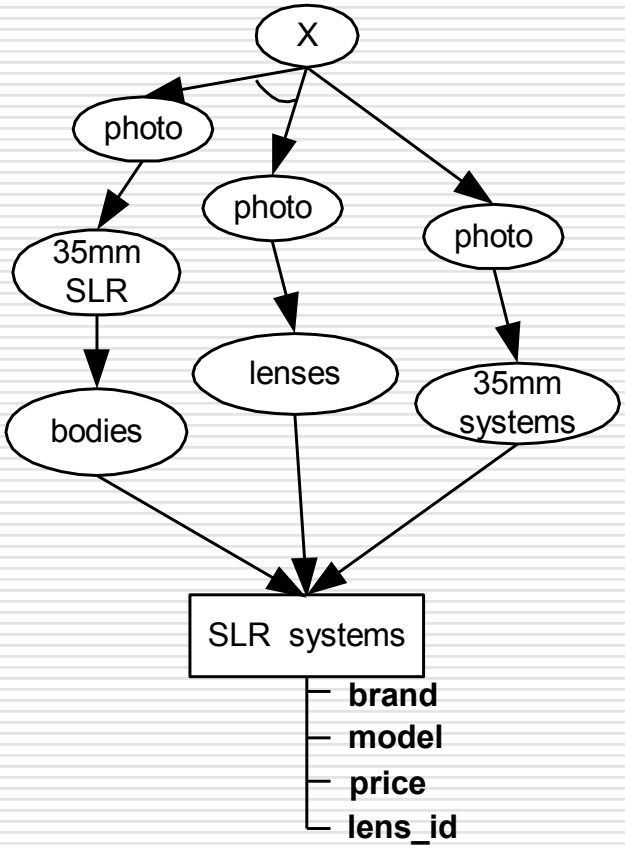
Questions (?)



Tree-Structure Relations (TSRs)



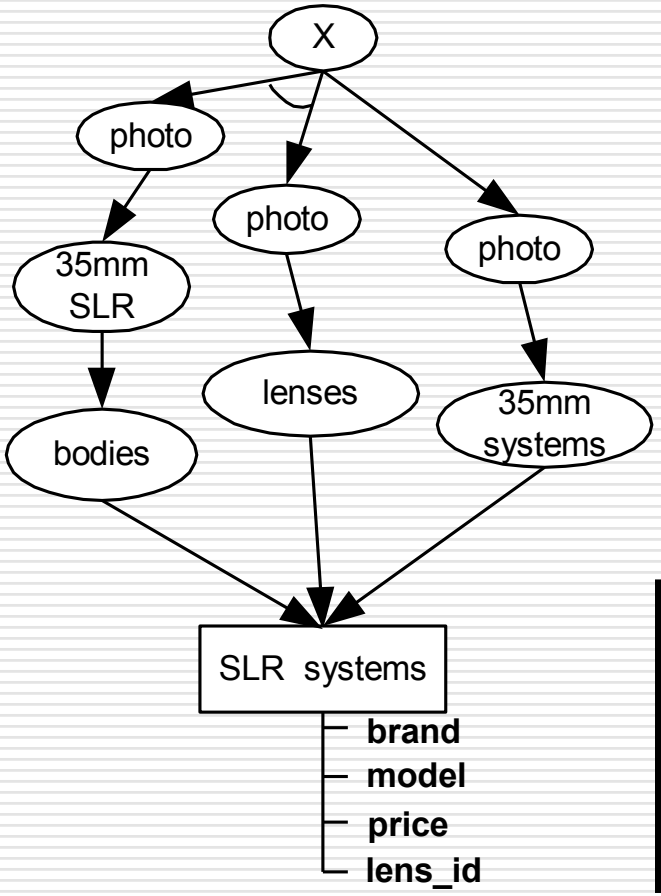
Storage mechanism



- XML file

```
<tsr name="SLR systems">
    <or>
        <and>/photo/35mm SLR/bodies</and>
        <and>/photo/lenses</and>
    </or>
    <or>
        <and>/photo/35mm systems</and>
    </or>
    <item>
        <attribute name="brand" type="…"/>
        <attribute name="model" type="…"/>
        …
        <tuple>…</tuple>
        …
    </item>
</tsr>
```

Storage mechanism



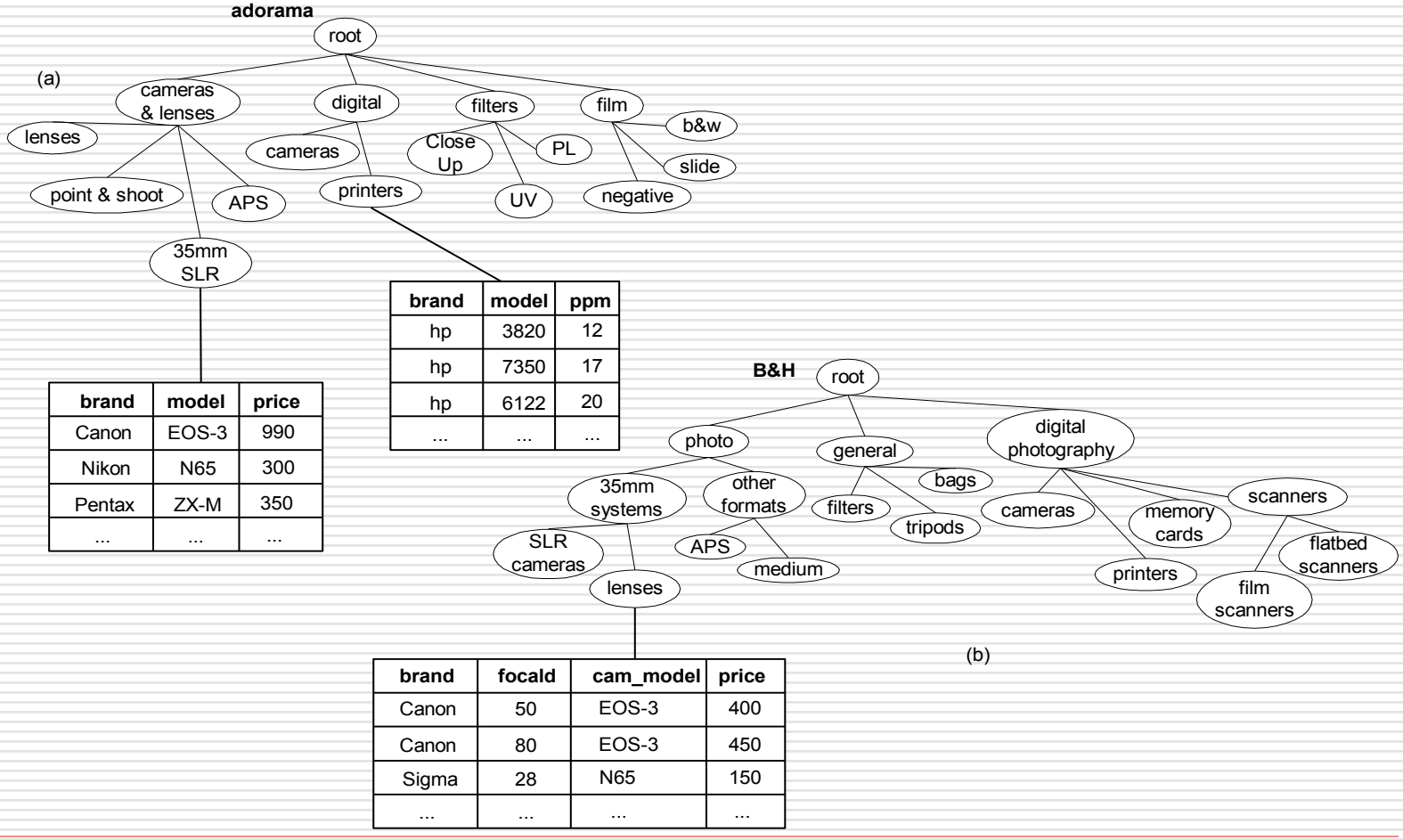
- Database

tid	name	file
1	SLR systems	portal.xml

brand	model	price	lens_id
...	...	...	...

tid	orid	andid	path
1	1	1	/photo/35mm SLR/bodies
1	1	2	/photo/lenses
1	2	1	/photo/35mm systems

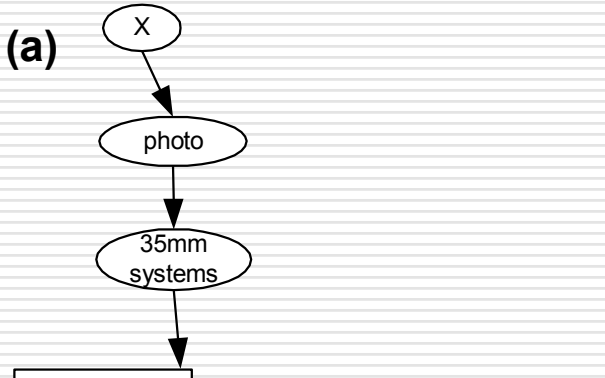
Catalog Schemas examples



Catalog Schema Manipulation

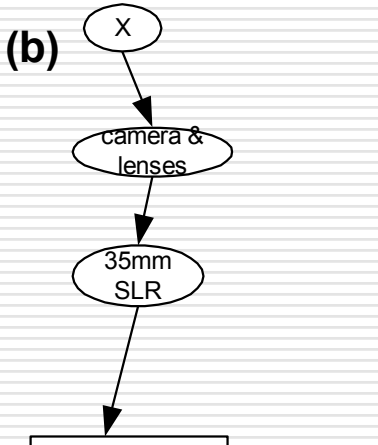
- SLR integrated systems from X – fig. (a)
- SLR cameras from Adorama – fig. (b)
- Lenses from B&H – fig. (c)
- Scenario for X:
  - New lenses out in the market
  - Lenses provided by B&H,
    that fit in Canon bodies provided by Adorama
  - Above SLR systems not present in her stock

Catalog Schema Manipulation



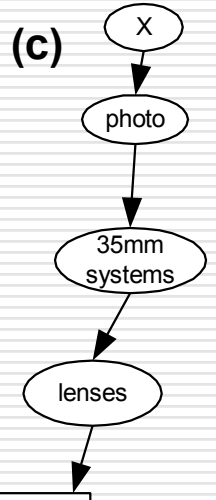
SLR systems

cbrand	cmodel	cprice	lmodel	lprice
Canon	EOS-3	990	100	390
Nikon	N65	205	340	160
...	...	...	...	...



SLR cameras

cbrand	cmodel	cprice
Canon	EOS-3	990
Nikon	N65	300
Pentax	ZX-M	350
...	...	...



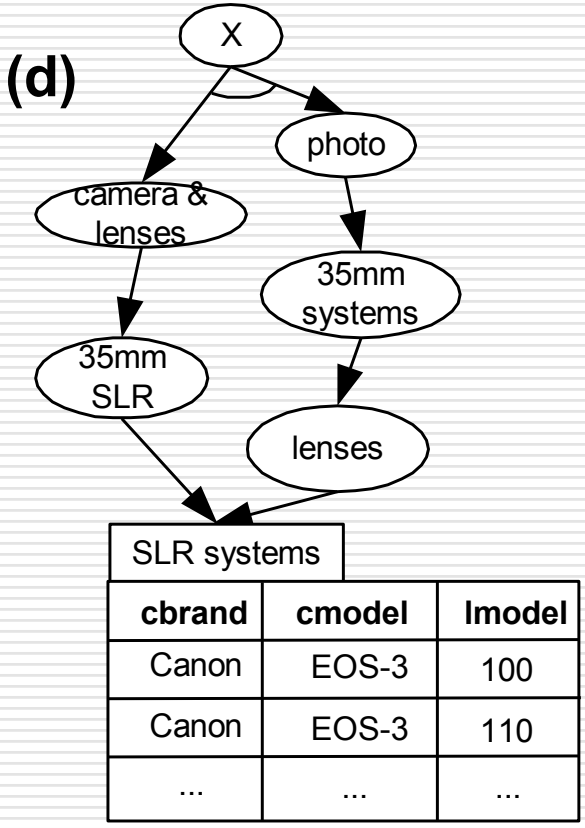
Lenses

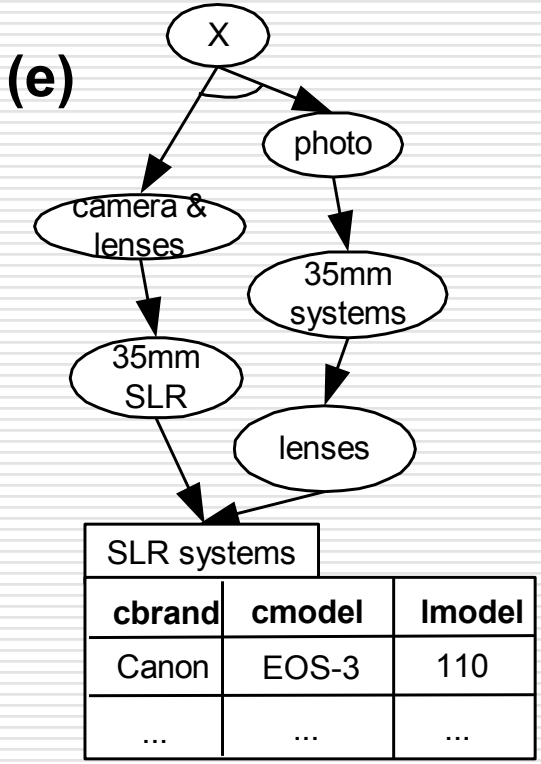
lbrand	lmodel	focald	cam_model	lprice
Canon	100	50	EOS-3	400
Canon	110	80	EOS-3	450
Sigma	340	28	N65	150
...	...	...	...	

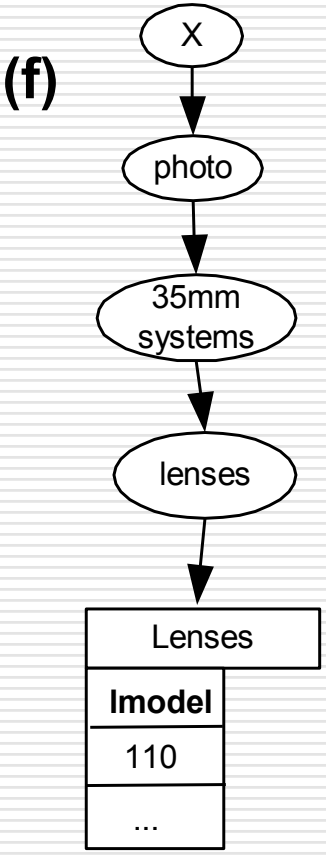
Catalog Schema Manipulation

- Systems with Canon bodies from Adorama and lenses from B&H – fig. (d):
  - $q1 = \Pi_{<cbrand,cmodel,lmodel><>}(\sigma_{<cmodel=cam\_model,\ cbrand="Canon"><>}((SLR\ cameras)\ X\ (lenses)))$
- Systems with Canon bodies from Adorama and lenses from B&H which are not in X's catalog – fig. (e):
  - $q2 = (q1) - \Pi_{<cbrand,cmodel,lmodel><>}(SLR\ cameras)$
- Lenses only without the appropriate camera bodies – fig. (f):
  - $\Pi_{<lmodel><\$2>}(q2)$

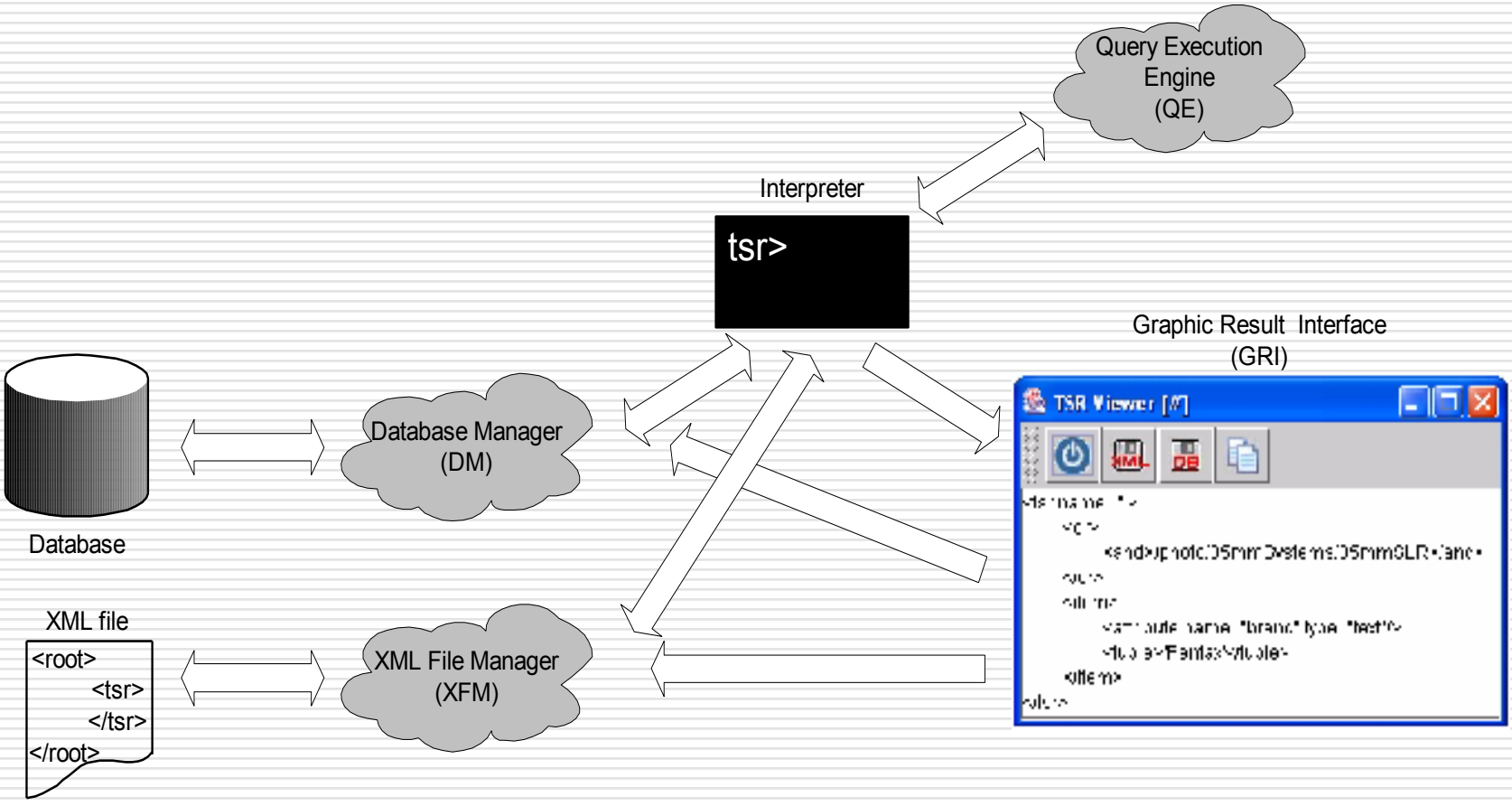
Catalog Schema Manipulation



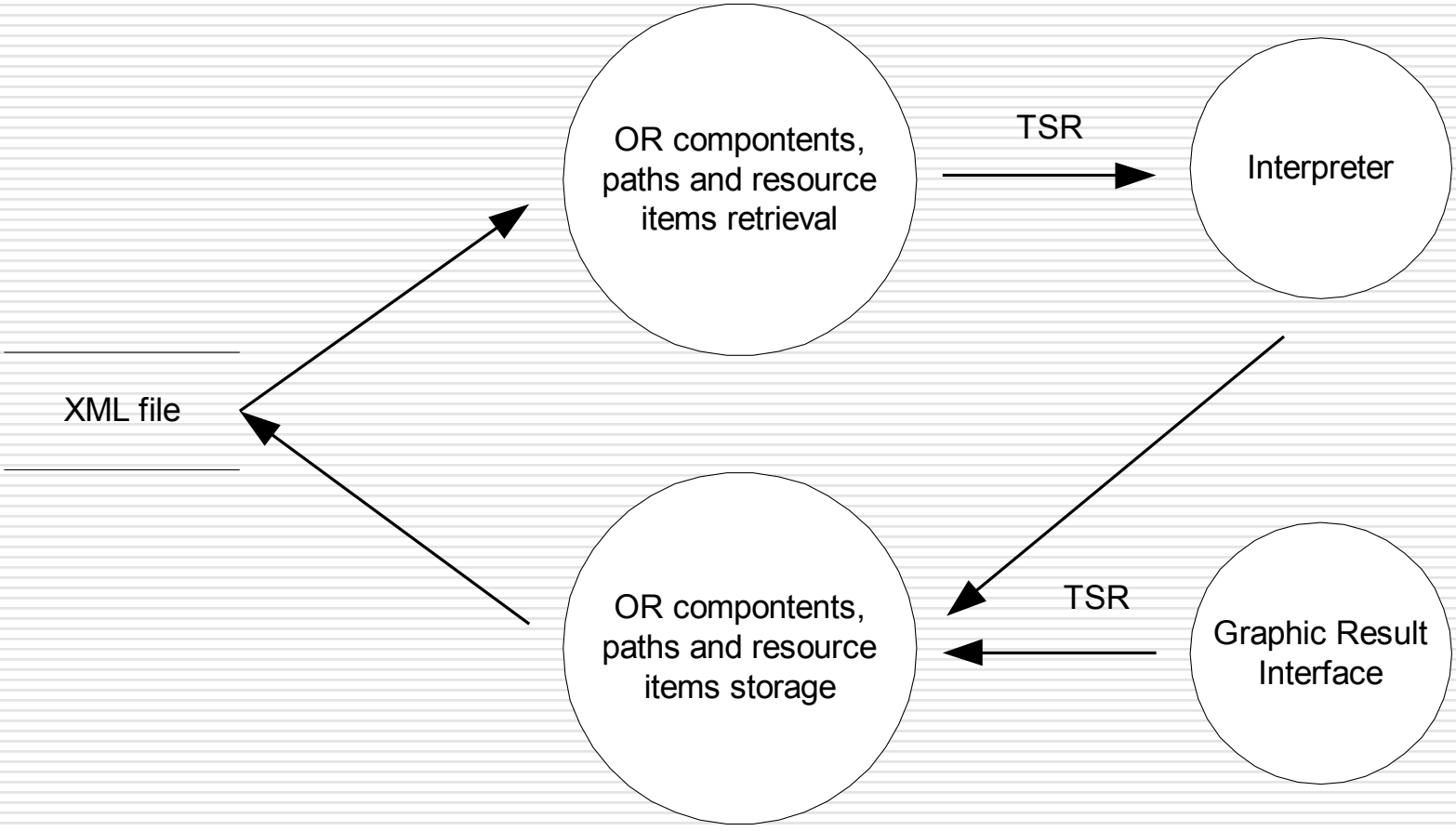




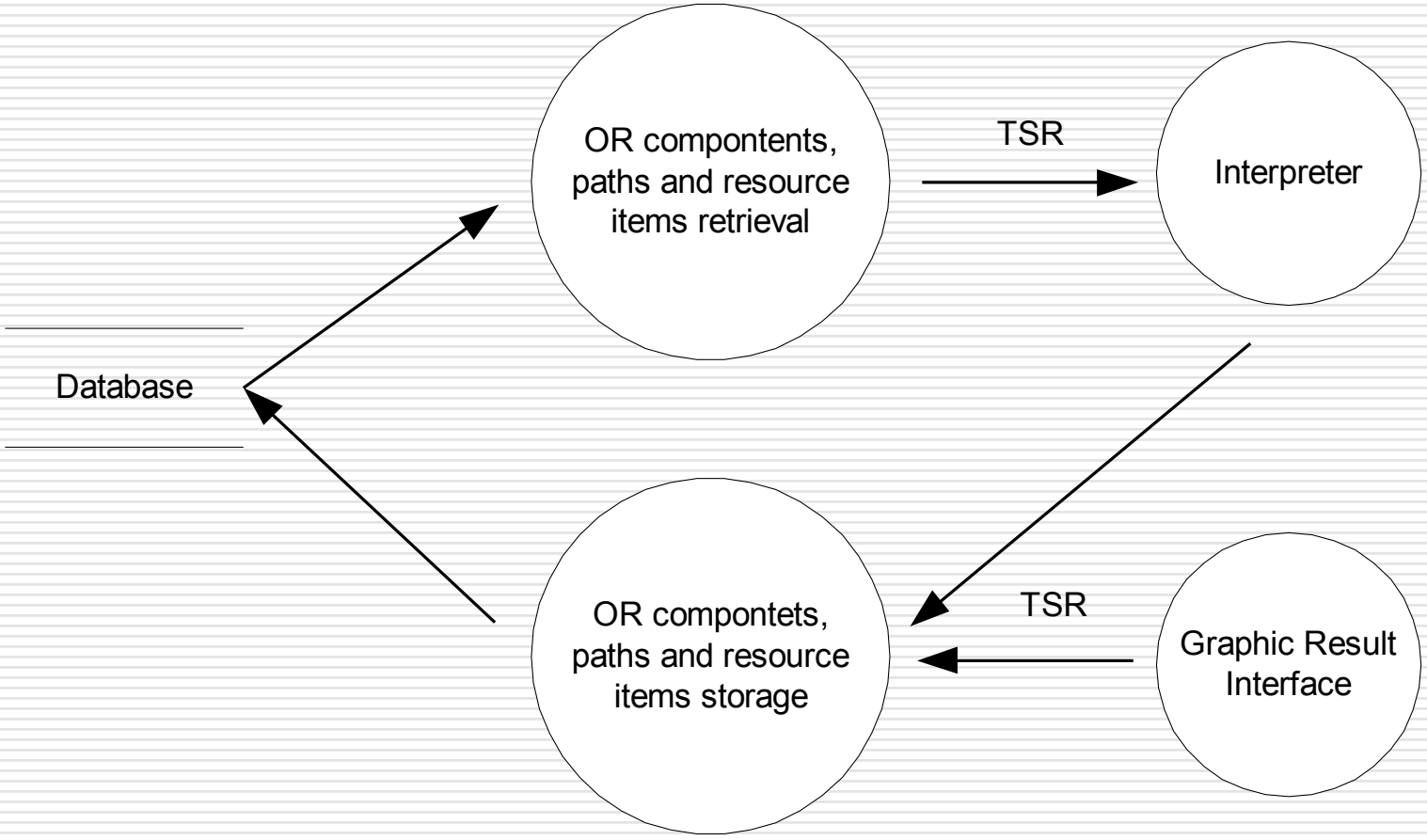
Prototype Architecture



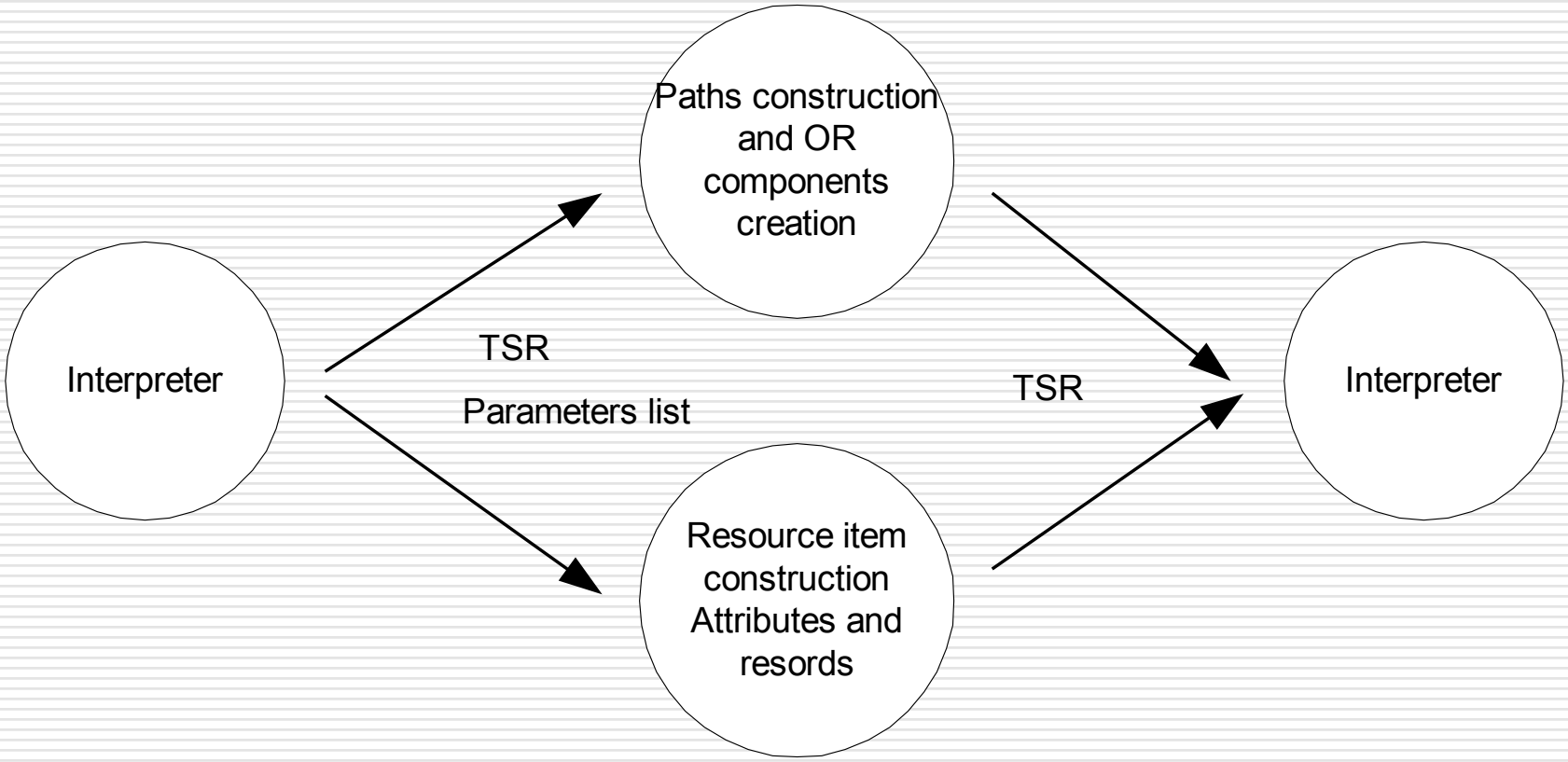
XML File Manager (XFM)



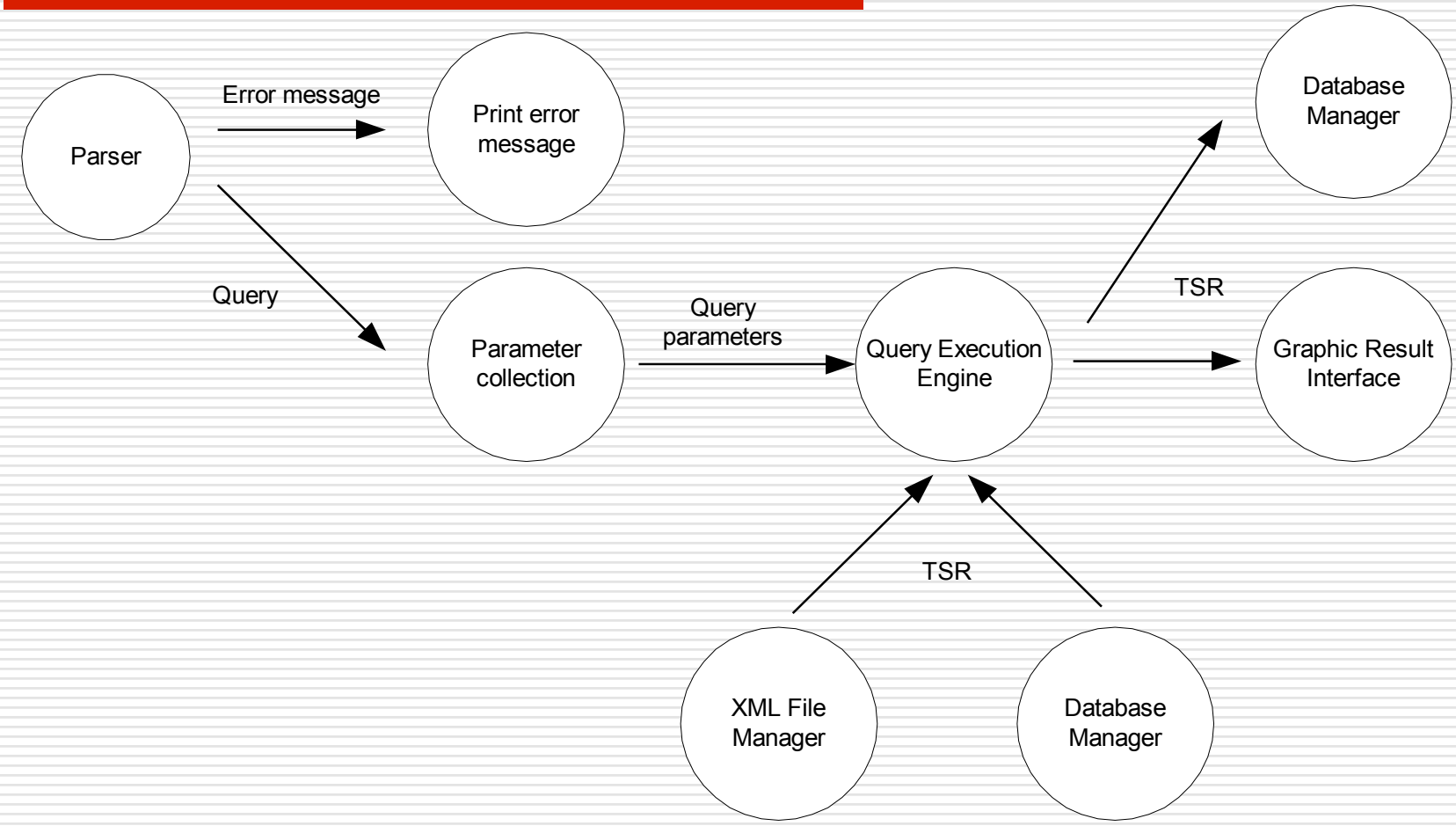
Database Manager (DM)



Query Execution Engine (QE)



Interpreter



Graphic Result Interface (GRI)