DATABASE INTEGRATION FOR DATA MINING

Databases and DBMS

B. Thuraisingham. "Data Mining. Technologies, Techniques, Tools, and Trends". CRC, 1998.

Data Warehousing

Jennifer Widom, "Research Problems in Data Warehousing", Int'l Conf. on Information and Knowledge Management '95.

Data Mediation

Levy, A., Ullman, J. "The database perspective on knowledge representation and information integration" Tutorial Notes, AAAI'97. 1997.

INTEGRATION OF HETEROGENEOUS DATA SOURCES

LU97 Levy, A., Ullman, J. "The database perspective on knowledge representation and information integration" Tutorial Notes, AAAI'97. 1997.

Ull97 Ullman, J. "Information Integration Using Logical Views" Invited paper for ICDT '97. 1997.

Uetal97 Ullman, J., et al. "The TSIMMIS Approach to Mediation: Data Models and Languages" J. Intelligent Information Systems 8:2, pp. 117-132, March, 1997.

Setal95 Subrahmanian, V.S., et al. "HERMES: Heterogeneous Reasoning and Mediator System"

AKH96 Arens, Y., Knoblock, C. Hsu, C-H. "Query Processing in the SIMS Information Mediator" Advanced Planning Technology, editor, Austin Tate, AAAI Press, Menlo Park, CA, 1996.

BRU96 Buneman, P., Rashid, L., Ullman, J. "Mediator Languages – a Proposal for a Standard" Report of an I^3/POB working group held at the Univ. of Maryland. April, 1996.

LRO96 Levy, A., Rajaraman, A., Ordille, J. "Querying Heterogeneous Information Sources using Source Descriptions" Proc. of VLDB'96. 1996.

Databases:

- DBMS: Data + Management system
- (Some) Data models:
  - relational
  - network
  - hierarchical
  - entity–relationship (ER)
  - object–oriented
  - object–relational
  - logic–based
- Management Systems:
  - query processing
  - transaction management
  - metadata management
  - storage management
  - maintaining integrity and security
  - fault tolerance

Relational Data Model [Codd70]

- A database is a collection of relations:

EMP

SS#	Ename	Salary	D#
1	John	20K	10
2	Paul	30K	20
3	Mary	40K	20

DEPT

D#	Dname	Mgr
10	Math	Smith
20	Physics	Jones

Relational Data Model (cont.)

- Query language: SQL (Structured Query Language)

  The query:

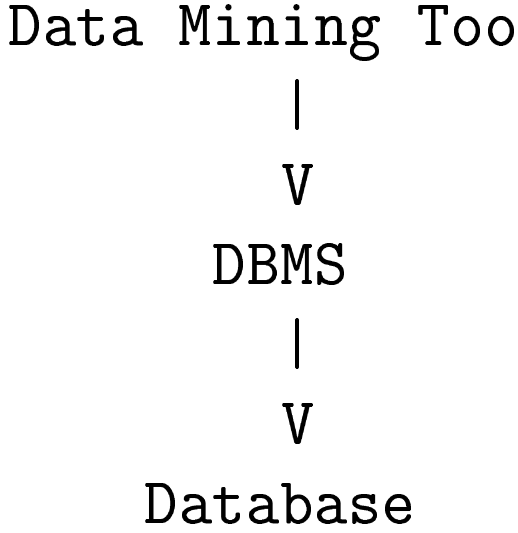
```
SELECT E.Ename, D.Dname
FROM   EMP E, DEPT D
WHERE  E.Salary < 35K and E.D# = D.D#
```

  returns:

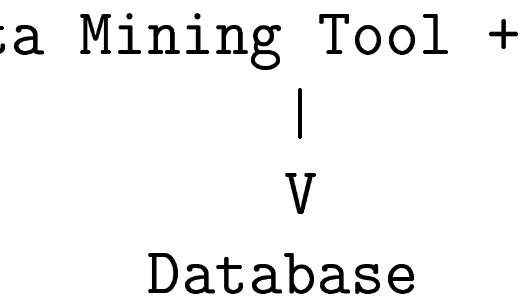
```
-----------------
 Ename   Dname
-----------------
 John    Math
 Paul    Physics
-----------------
```

Integrating Databases with Data Mining

Approach 1: Loose Integration between DBMS and data mining tool



Approach 2: Tight Integration between DBMS and data mining tool



Approaches to Integration

Data Warehouses vs. Mediators

- **Data Warehouse**

  Data is normalized and copied into a central, single database

  + Static normalization of the data
  - Not up-to-date data

- **Mediators**

  Virtual integration of the data ("integration-on-demand")

  + Up-to-date data
  - Dynamic normalization of data

Data Warehousing

Data Warehouse: (central) database that brings together selected data from multiple databases

- replicates information: alternatives:
  - no pre–processing
  - eliminating inconsistencies/redundancies
  - selecting a subset of the data
  - pre–analyzing data for predictable uses
- persistent
- in–advance integration
- information might be out–of–date
- application–oriented
- historic data
- aggregated and summarized information
- data sources are usually operated independently of the D.W.
- facilitates mining (but is not essential)

Data Warehouse – Architecture

Data Warehouse – Architecture

Wrapper/Monitor:

- translating information from source format into warehouse format
- automatically detecting changes of interest in the source data
  - cooperative sources
  - logged sources
  - queryable sources
  - snapshot sources
- reporting changes in the source data to the integrator

Data Warehouse – Architecture

Integrator:

- installing the reported information in the warehouse
  - filtering information
  - summarizing information
  - merging information

Mediators

- Proposed by Wiederhold [1992,1993]
- Current mediator/data integration projects:
  - TSIMMIS: Stanford Univ.
  - HERMES: Univ. of Maryland
  - INFORMATION MANIFOLD: AT&T Bell Labs.
  - SIMS: Information Sciences Institute (ISI/USC)
  - SOFTBOT: Univ. of Washington
  - DIGITAL LIBRARY PROJECT: Univ. Michigan
  - NOMENCLATOR: AT&T Bell Laboratories.
  - KQML: Univ. of Maryland, Baltimore.
  - WEBWATCHER: Carnegie Mellon Univ.
  - OCCAM: Univ. of Washington
  - KIF and Interoperable agents project, Stanford Univ.

Mediator Architecture

(Taken from [Ull97])

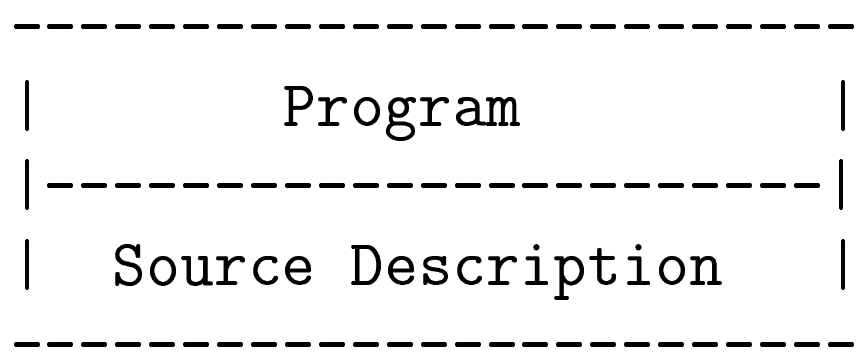
Queries and Query Languages

- **Languages**
  - **Mediators:**
    All mediators speak the same common query language.
  - **Wrappers:**
    Each wrapper translates between the mediators' language and the data source's language.

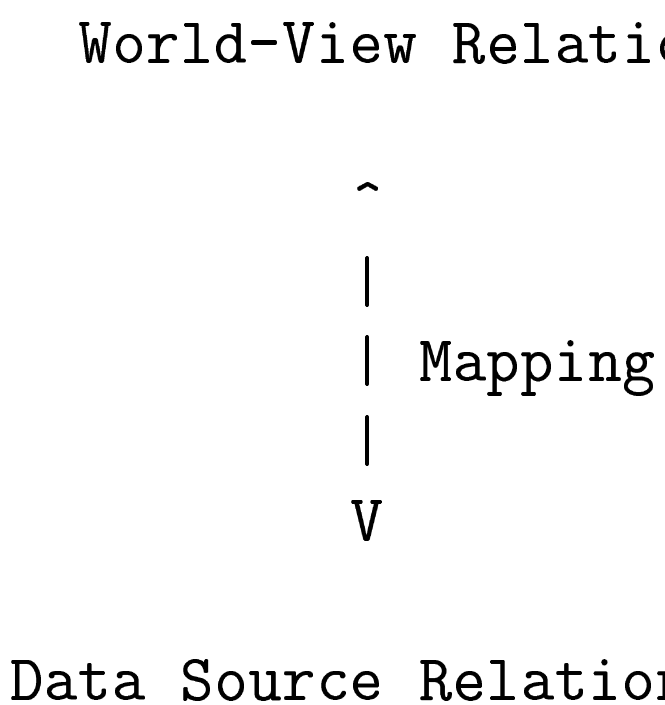
- **Queries and Query Reformulation**
  - **Users:** generate queries Q in the common language
  - **Mediators:** reformulate Q in terms of queries
    $Q_1, \ldots, Q_n$ (in the common language)
  - **Wrappers:** translate each Q_i into the source's language
  - **Data Sources:** answer queries $Q_1, \ldots, Q_n$

Mediator Components

- **Mediator**



- **Source Description**



Approaches to Mediation

- **Source-driven:**

  All mediators use the same program ("facilitator")

  + Easy to add new data sources
  - Potential conflict between answers from different mediators

- **Specification-driven:**

  Each mediator supports a different, fixed set of queries.

  + No conflicts between answers from different mediators
  - Laborious to add new data sources - may require to reprogram some mediators.

Query Reformulation Problem

Given:

a query Q in terms of world–view relations

Find:

a query Q' in terms of source relations only s.t. the answers to Q' provide all possible answers to Q.