Information Integration

Mediators

Warehousing

Answering Queries Using Views

Information Integration

- Information integration is the process of taking several databases and making the data in these sources work together as if they were a single database.
- The integrated database may be
  - Physical (”data warehouse”)
  - Virtual (”mediator”) that may be queried even though it does not exist physically
- Information-integration systems require special kinds of query-optimization techniques for their efficient operation.

Why Information Integration?

- If we could put data always in a single database, there would be no need for information integration.
- However, in the real world, matters are rather different..
  - Databases are created intependently, even if they later need to work together.
  - The use of databases evolves, so we cannot design a database to support every possible future use.

Example Applications

1. Enterprise Information Integration: making separate DB's, all owned by one company, work together.
2. Scientific DB's, e.g., genome DB's.
3. Catalog integration: combining product information from all your suppliers.

Challenges

1. *Legacy databases* : DB's get used for many applications.
   - ◆ You can't change its structure for the sake of one application, because it will cause others to break.
2. *Incompatibilities* (heterogenity problem): Two, supposedly similar databases, will mismatch in many ways.

Examples: Incompatibilities

- *Lexical* : `addr` in one DB is `address` in another.
- *Value mismatches* : is a "BL" car the same color in each DB (blue versus black)? Is 20 degrees Fahrenheit or Centigrade?
- *Semantic* : are "employees" in each database the same? What about consultants? Retirees? Contractors?
- *Query-Language heterogenity* : Relational database (SQL) verus XML (Xquery)
- *Data Type differences* : Serial numbers might be represented as *string* in one source and *integer* in another source.

Examples: Schema Heterogeneity

- One dealer might store cars in a single relation that look like:
  - `Cars(serialNo, model, color, autoTrans, navi, ...)`
- Another dealer might use a schema in which options are seperated out into a second relation, such as:
  - `Autos (serial, model, color)`
  - `Options (serial, option)`

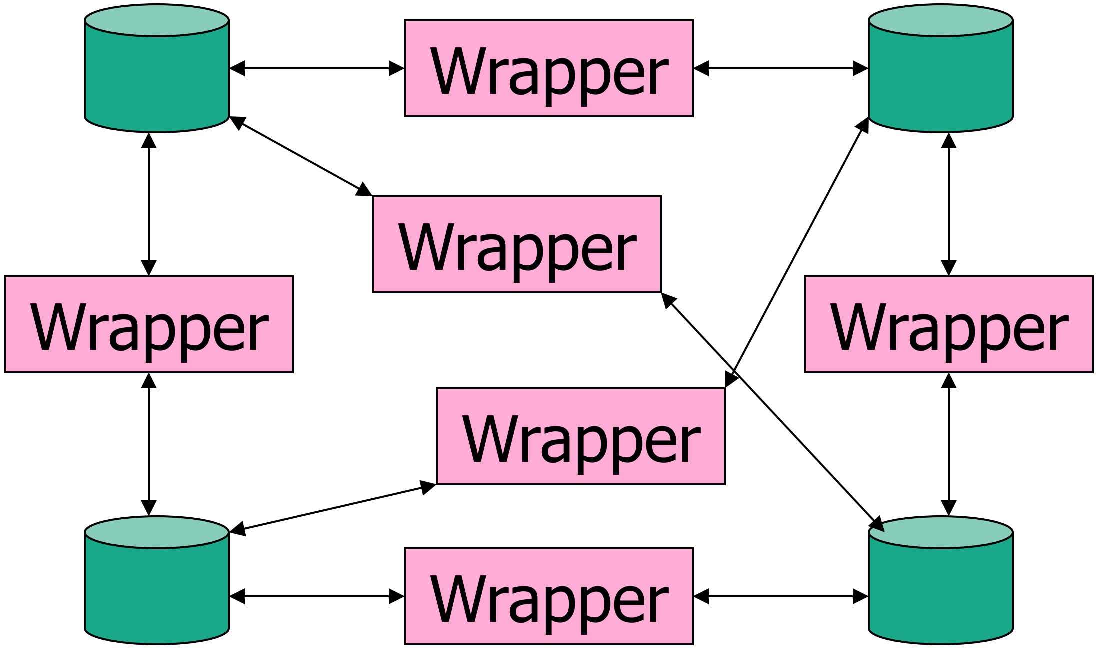
What Do You Do About It?

- Grubby, handwritten translation at each interface.
  - Some research on automatic inference of relationships.
- *Wrapper* (aka "adapter") translates incoming queries and outgoing answers.

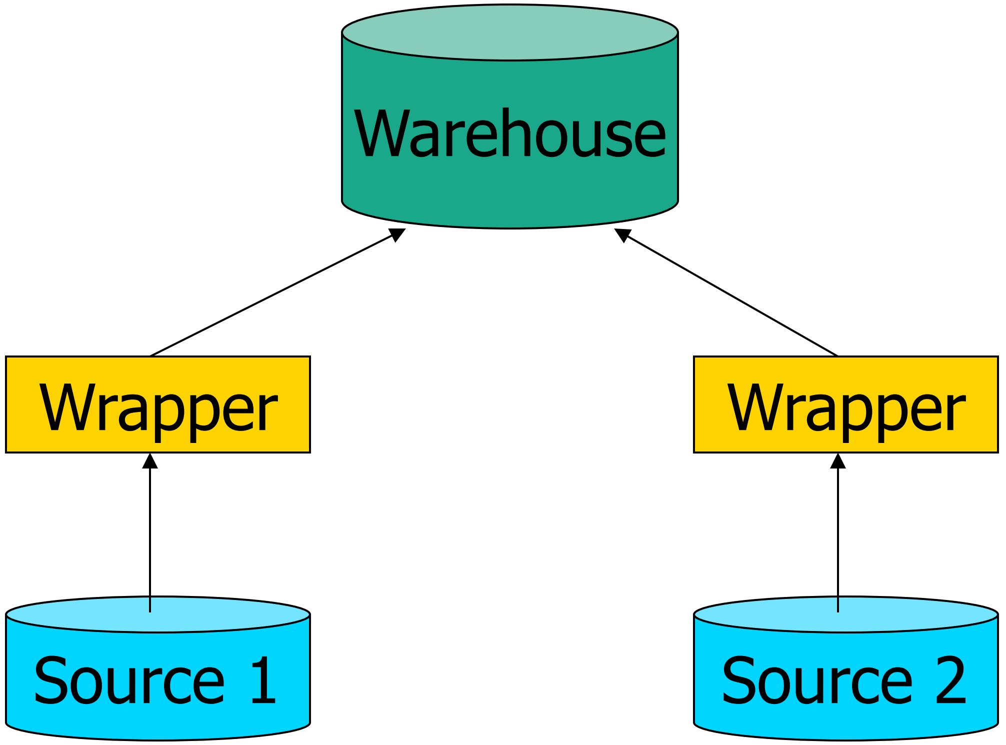
Integration Architectures

1. *Federation* : everybody talks directly to everyone else.
2. *Warehouse* : Sources are translated from their local schema to a global schema and copied to a central DB.
3. *Mediator* : *Virtual warehouse* --- turns a user query into a sequence of source queries.

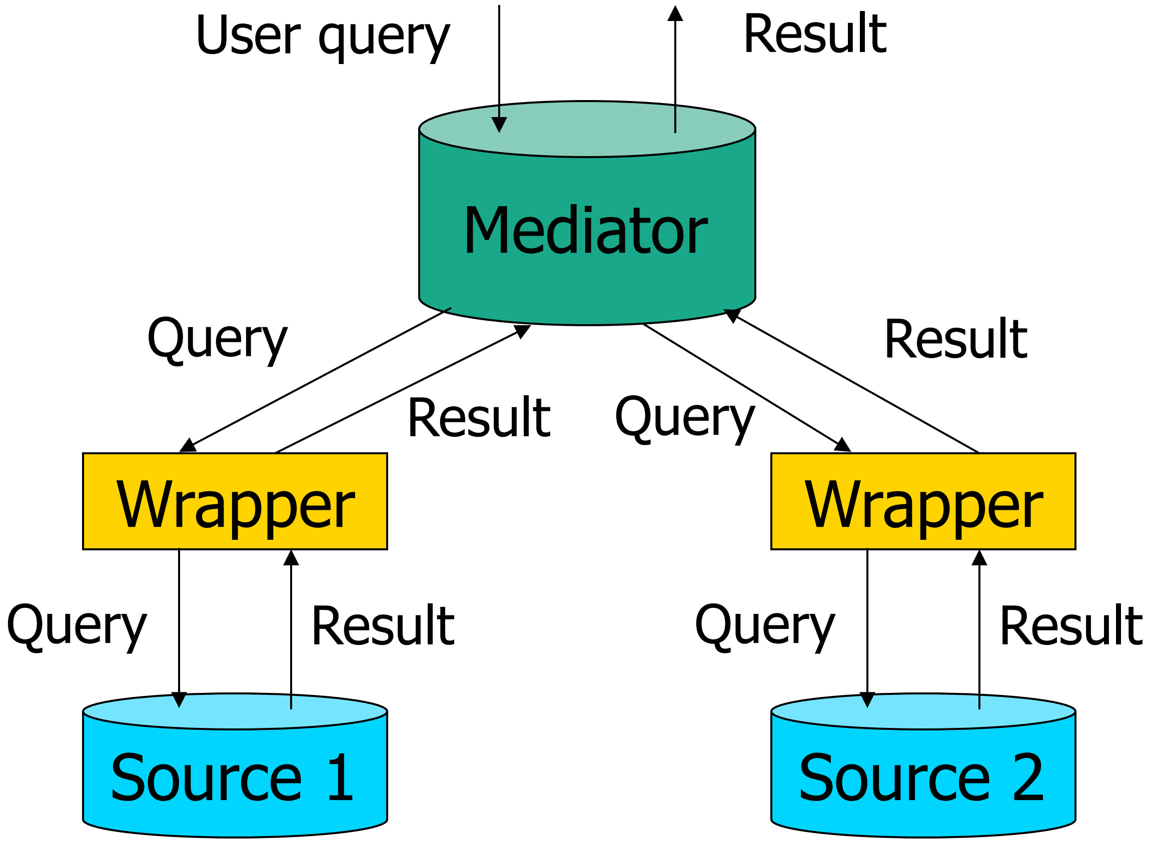
Federations



Warehouse Diagram



A Mediator


User query
Result
Mediator
Query
Result
Query
Result
Wrapper
Wrapper
Query
Result
Query
Result
Source 1
Source 2

Example: Mediatior

- Suppose mediator integrates the same two automobile sources into a view that is a single relation with schema:
  - `AutosMed (serialNo, model, color, autoTrans, dealer)`
- Assume the user asks the mediator about red cars, with the query:

```
SELECT serialNo, model

FROM AutosMed

WHERE color = ’red’;
```

Example: Mediatior

- The wrapper for Dealer 1 translates the query into the terms of the dealer’s schema:

```
        SELECT SerialNo, model
        FROM Cars
        WHERE color = ’red’
```

- At the same time, the wrapper for Dealer 2 translates the same query into the schema of that dealer:

```
SELECT serial, model
FROM Autos
WHERE color = ’red’;
```

- The mediator takes union of these sets and returns the result to the user.

Two Mediation Approaches

1. *Global as View* : Mediator processes queries into steps executed at sources.
2. *Local as View* : Sources are defined in terms of global relations; mediator finds all ways to build query from views.

Example: Catalog Integration

- Suppose Dell wants to buy a bus and a disk that share the same protocol.
- Global schema:

```
      Buses(manf,model,protocol)
      Disks(manf,model,protocol)
```

- Local schemas: each bus or disk manufacturer has a (model,protocol) relation --- manf is implied.

Example: Global-as-View

- Mediator might start by querying each bus manufacturer for model-protocol pairs.
  - The wrapper would turn them into triples by adding the manf component.
- Then, for each protocol returned, mediator queries disk manufacturers for disks with that protocol.
  - Again, wrapper adds manf component.

Example: Local-as-View

- Sources' capabilities are defined in terms of the global predicates.
  - E.g.,Quantum's disk database could be defined by QuantumView(M,P) = Disks('Quantum',M,P).
- Mediator discovers all combinations of a bus and disk "view," equijoined on the protocol components.

Actions

- Read Chapter *Information Integration* (21.1-2)