Forelæsning 10: Data warehousing og OLAP

14. april 2005

Forelæser: Rasmus Pagh

Today’s lecture

• Information integration and data warehousing.
• On-Line Analytical Processing (OLAP) vs On-Line Transaction Processing (OLTP).
• Data cubes and Relational OLAP.

Then guest lecture by Helen Lunau and Allan Hendeles, ATP.
On-Line Analytical Processing

Fueled by advances in information integration, there is an increasing demand for decision support systems supporting complex queries on large data sets.

The desired mode of operation is that answers to queries come “on-line”, i.e. almost immediately, hence the term:

- On-Line Analytical Processing (OLAP)

In contrast, in the classical use of databases for processing transactions, most updates and queries concern a small part of the database:

- On-Line Transaction Processing (OLTP)

Aggregates

OLAP queries are typically about aggregates such as sums and averages.

Some examples:

```sql
SELECT SUM(price) FROM Sales;

SELECT dealer, AVG(price) FROM Sales
GROUP BY dealer;

SELECT state, AVG(price)
FROM Sales, Dealers
WHERE dealer=name AND date>'2001-09-11'
GROUP BY state;
```
To compute aggregates over large data sets efficiently, OLAP systems precompute certain aggregates which can be used to derive the answers to queries quickly.

**Example:** In the previous queries, we don’t have to go through all sales if we precomputed the number of sales and average sales price for each dealer.

OLAP systems come in two flavors:

- **MOLAP** - specialized software tailored especially for OLAP.
- **ROLAP** - a relational database with features to make OLAP queries efficient. (To be discussed next.) Usually done on a data warehouse.

---

**Facts and measures**

Data for analysis can usually be thought of as a collection of facts about events or objects of interest.

A Relational OLAP system has a fact table with a tuple for each fact.

**Examples:** Sales, customers, web site clicks.

A fact will typically have associated with it one or more measures (or dependent attributes) that can be aggregated.

**Examples:** Sales price, customer debit, time to next click.
--- Dimensions ---

Facts will typically also contain other information than measures, which may be used to select certain facts of interest.

**Examples:** ID of sales person, name of shop, state of shop, ...

To limit redundancy, the fact table should not have any avoidable FDs, e.g.

```
salespersonID → shop state
```

When decomposing according to an FD, one gets a relation with the attributes mentioned in the FD. This is called a *dimension table* and referring attributes are called *dimension attributes*.

**Example:** The “date” dimension might contain information about which week, month, quarter, and year a date is in.

--- Normalizing the dimension tables ---

For efficiency reasons, one sometimes chooses not to normalize the dimension tables (they typically use much less space than the fact table). This is known as a *star schema*.

If dimension tables are normalized (to 3NF or 4NF), one obtains a *snowflake schema*.

Modern RDBMSs recognize star schemas and snowflake schemas, and use algorithms tailored to be efficient on such schemas when evaluating queries.
-- Using materialized views

Precomputation is essential to “on-line” answering of queries.

We specify what is to be precomputed through materialized views.

**Example:** If we create the following materialized view:

```sql
CREATE MATERIALIZED VIEW monthsales AS
SELECT month, year, SUM(price) FROM Sales, Dates
WHERE date=Dates.key
GROUP BY month, year;
```

...then subsequent queries for sales in quarters and years can be computed by just adding a few numbers in the materialized view.

Some DBMSs assist in choosing and using materialized views.

---

-- Most important points in this lecture

As a minimum, you should after this week:

- Know the meaning of some buzzwords: OLAP, information integration, data warehousing, multidimensional databases.
- Know how multidimensional databases can be organized and queried using relations (star schema, snowflake schema).