Chapter 10

Emerging Database Technologies & Applications

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Distributed Databases & Client-Server Architectures

- Distributed Database Concepts
- Data Fragmentation, Replication and Allocation
- Query Processing
- Concurrency Control and Recovery
- 3-Tier Client-Server Architecture
Distributed Database Concepts

- A transaction can be executed by multiple networked computers in a unified manner.
- A distributed database (DDB) processes a unit of execution (a transaction) in a distributed manner.
- DDB is a collection of multiple logically related database distributed over a computer network, and a distributed database management system as a software system that manages a distributed database while making the distribution **transparent** to the user.
Distributed Database System
Distributed Database System

Data distribution and replication among distributed databases.

- **EMPLOYEES**: San Francisco and Los Angeles
- **PROJECTS**: San Francisco
- **WORKS_ON**: San Francisco employees
  - **San Francisco**
- **WORKS_ON**: Los Angeles employees
  - **Los Angeles**

**Communications Network**

- **EMPLOYEES**: New York
- **PROJECTS**: All
- **WORKS_ON**: New York employees
  - **New York**
- **EMPLOYEES**: Atlanta
- **PROJECTS**: Atlanta
- **WORKS_ON**: Atlanta employees
  - **Atlanta**
Distributed Database System

- **Types of Transparency:**
  - **Data organization transparency (Distribution and Network transparency)**
    - Users do not have to worry about operational details of the network.
    - *Location transparency* refers to freedom of issuing command from any location without affecting its working.
    - *Naming transparency* allows access to any names object (files, relations, etc.) from any location.
Distributed Database System

- Types of Transparency:
  - **Replication transparency**:
    - It allows to store copies of a data at multiple sites.
    - It minimizes access time to the required data.
  - **Fragmentation transparency**:
    - Allows to fragment a relation horizontally (create a subset of tuples of a relation) or vertically (create a subset of columns of a relation).
Distributed Database System

Types of Transparency:

- **Design transparency:**
  - Refer to freedom from knowing how the distributed database is designed

- **Execution transparency:**
  - Refer to freedom from knowing where a transaction executes
Distributed Database System

Advantages of Distributed Database System

• Improved ease and flexibility of application development
  • Developing and maintaining applications at geographically distributed sites of an organization is facilitated owing to transparency of data distribution and control.
Distributed Database System

Advantages of Distributed Database System

- **Increased reliability and availability:**
  - Reliability refers to system live time, that is, system is running efficiently most of the time. Availability is the probability that the system is continuously available (usable or accessible) during a time interval.
  - A distributed database system has multiple nodes (computers) and if one fails then others are available to do the job.
Distributed Database System

Advantages of Distributed Database System

• **Improved performance:**
  • A distributed DBMS fragments the database to keep data closer to where it is needed most.
  • This reduces data management (access and modification) time significantly.

• **Easier expansion (scalability):**
  • Allows new nodes (computers) to be added anytime without chaining the entire configuration.
Data Fragmentation, Replication and Allocation

- **Data Fragmentation**
  - Split a relation into logically related and correct parts. A relation can be fragmented in two ways:
    - **Horizontal Fragmentation**: It is a horizontal subset of a relation which contain those of tuples which satisfy selection conditions
    - **Vertical Fragmentation**: It is a subset of a relation which is created by a subset of columns.
Data Fragmentation, Replication and Allocation

- **Fragmentation schema**
  - A definition of a set of fragments (horizontal or vertical or horizontal and vertical) that includes all attributes and tuples in the database that satisfies the condition that the whole database can be reconstructed from the fragments by applying some sequence of UNION (or OUTER JOIN) and UNION operations.

- **Allocation schema**
  - It describes the distribution of fragments to sites of distributed databases. It can be fully or partially replicated or can be partitioned.
Data Fragmentation, Replication and Allocation

- **Data Replication**
  - Database is replicated to all sites.
  - In full replication the entire database is replicated and in partial replication some selected part is replicated to some of the sites.
  - Data replication is achieved through a replication schema.

- **Data Distribution (Data Allocation)**
  - This is relevant only in the case of partial replication or partition.
  - The selected portion of the database is distributed to the database sites.
Query Processing in Distributed Databases

- Cost of transferring data (files and results) over the network is usually high so some optimization is necessary.

- Example: Employee at site 1 and Department at Site 2
  - Employee at site 1. 10,000 rows. Row size = 100 bytes. Table size = $10^6$ bytes.
  - Department at Site 2. 100 rows. Row size = 35 bytes. Table size = 3,500 bytes.
  - Q: For each employee, retrieve employee name and department name Where the employee works.

\[
\pi_{\text{Fname}, \text{Lname}, \text{Dname}}(\text{EMPLOYEE} \bowtie_{\text{Dno}=\text{Dnumber}} \text{DEPARTMENT})
\]
**Query Processing in Distributed Databases**

### Site 1:

**EMPLOYEE**

<table>
<thead>
<tr>
<th>Fname</th>
<th>Minit</th>
<th>Lname</th>
<th>Ssn</th>
<th>Bdate</th>
<th>Address</th>
<th>Sex</th>
<th>Salary</th>
<th>Super_ssn</th>
<th>Dno</th>
</tr>
</thead>
</table>

10,000 records  
each record is 100 bytes long  
Ssn field is 9 bytes long  
Dno field is 4 bytes long

Fname field is 15 bytes long  
Lname field is 15 bytes long

### Site 2:

**DEPARTMENT**

<table>
<thead>
<tr>
<th>Dname</th>
<th>Dnumber</th>
<th>Mgr_ssn</th>
<th>Mgr_start_date</th>
</tr>
</thead>
</table>

100 records  
each record is 35 bytes long  
Dnumber field is 4 bytes long  
Mgr_ssn field is 9 bytes long

Dname field is 10 bytes long
Query Processing in Distributed Databases

Result

- The result of this query will have 10,000 tuples, assuming that every employee is related to a department.
- Suppose each result tuple is 40 bytes long. The query is submitted at site 3 and the result is sent to this site.
- Problem: Employee and Department relations are not present at site 3.
Query Processing in Distributed Databases

- Strategies:
  1. Transfer Employee and Department to site 3.
     - Total transfer bytes = 1,000,000 + 3500 = 1,003,500 bytes.
  2. Transfer Employee to site 2, execute join at site 2 and send the result to site 3.
     - Query result size = 40 * 10,000 = 400,000 bytes. Total transfer size = 400,000 + 1,000,000 = 1,400,000 bytes.
  3. Transfer Department relation to site 1, execute the join at site 1, and send the result to site 3.
     - Total bytes transferred = 400,000 + 3500 = 403,500 bytes.

- Optimization criteria: minimizing data transfer.
  - Preferred approach: strategy 3.
Query Processing in Distributed Databases

Now suppose the result site is 2. Possible strategies:

1. Transfer Employee relation to site 2, execute the query and present the result to the user at site 2.
   • Total transfer size = 1,000,000 bytes.

2. Transfer Department relation to site 1, execute join at site 1 and send the result back to site 2.
   • Total transfer size = 400,000 + 3500 = 403,500.
Query Processing in Distributed Databases

- Semijoin:
  - Objective is to reduce the number of tuples in a relation before transferring it to another site.

- Example execution of Q (suppose the result site is 2):
  1. Project the join attributes of Department at site 2, and transfer them to site 1. For Q, \( 4 \times 100 = 400 \) bytes are transferred.
  2. Join the transferred file with the Employee relation at site 1, and transfer the required attributes from the resulting file to site 2. For Q, \( 34 \times 10,000 = 340,000 \) bytes are transferred.
  3. Execute the query by joining the transferred file with Department and present the result to the user at site 2.
Concurrency Control and Recovery

- Distributed Databases encounter a number of concurrency control and recovery problems which are not present in centralized databases.
  - Dealing with multiple copies of data items
  - Failure of individual sites
  - Communication link failure
  - Distributed commit
  - Distributed deadlock
Concurrency Control and Recovery

- Dealing with multiple copies of data items:
  - The concurrency control must maintain global consistency. Likewise the recovery mechanism must recover all copies and maintain consistency after recovery.

- Failure of individual sites:
  - Database availability must not be affected due to the failure of one or two sites and the recovery scheme must recover them before they are available for use.
Concurrency Control and Recovery

- Communication link failure:
  - This failure may create network partition which would affect database availability even though all database sites may be running.

- Distributed commit:
  - A transaction may be fragmented and they may be executed by a number of sites. This require a two or three-phase commit approach for transaction commit.

- Distributed deadlock:
  - Since transactions are processed at multiple sites, two or more sites may get involved in deadlock. This must be resolved in a distributed manner.
Concurrency Control and Recovery

- Distributed Concurrency control based on a distributed copy of a data item
  - **Primary site technique**: A single site is designated as a primary site which serves as a coordinator for transaction management.
Concurrent Control and Recovery

- Distributed Concurrency control based on a distributed copy of a data item
  - **Primary site approach with backup site**: Suspends all active transactions, designates the backup site as the primary site and identifies a new backup site. Primary site receives all transaction management information to resume processing.
  - **Primary Copy Technique**: In this approach, instead of a site, a data item partition is designated as primary copy. To lock a data item just the primary copy of the data item is locked.
Concurrency Control and Recovery

- Concurrency control based on voting:
  - There is no primary copy of coordinator.
  - Send lock request to sites that have data item.
  - If majority of sites grant lock then the requesting transaction gets the data item.
  - Locking information (grant or denied) is sent to all these sites.
  - To avoid unacceptably long wait, a time-out period is defined. If the requesting transaction does not get any vote information then the transaction is aborted.
Client-Server Database Architecture

- It consists of clients running client software, a set of servers which provide all database functionalities and a reliable communication infrastructure.
Client-Server Database Architecture

- Clients reach server for desired service, but server does reach clients.
- The server software is responsible for local data management at a site, much like centralized DBMS software.
- The client software is responsible for most of the distribution function.
- The communication software manages communication among clients and servers.
The processing of a SQL queries goes as follows:

- Client parses a user query and decomposes it into a number of independent sub-queries. Each subquery is sent to appropriate site for execution.
- Each server processes its query and sends the result to the client.
- The client combines the results of subqueries and produces the final result.
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Temporal Database Concepts

- Time Representation
- Calendars
- Time Dimensions
Temporal Database Concepts

- Time Representation
  - Time is considered ordered sequence of points in some granularity
  - Use the term chronon instead of point to describe minimum granularity
  - A calendar organizes time into different time units for convenience.
  - Accommodates various calendars
    - Gregorian (western), Chinese, Islamic, Hindu, etc.
Temporal Database Concepts

- Time Representation
  - Point events
    - Single time point event
      - E.g., bank deposit
    - Series of point events can form a time series data
  - Duration events
    - Associated with specific time period
    - Time period is represented by start time and end time
Temporal Database Concepts

- **Time Representation**
  - Transaction time
    - The time when the information from a certain transaction becomes valid
  - Bitemporal database
    - Databases dealing with two time dimensions
Temporal Database Concepts

- Incorporating Time in Relational Databases Using Tuple Versioning
  - Add to every tuple
    - Valid start time
    - Valid end time
## Temporal Database Concepts

**Table 26.7**
Different types of temporal relational databases. (a) Valid time database schema. (b) Transaction time database schema. (c) Bitemporal database schema.

### (a) EMP_VT

<table>
<thead>
<tr>
<th>Name</th>
<th>Ssn</th>
<th>Salary</th>
<th>Dno</th>
<th>Supervisor_ssn</th>
<th>Vst</th>
<th>Vet</th>
</tr>
</thead>
</table>

### (b) EMP_TT

<table>
<thead>
<tr>
<th>Name</th>
<th>Ssn</th>
<th>Salary</th>
<th>Dno</th>
<th>Supervisor_ssn</th>
<th>Tst</th>
<th>Tet</th>
</tr>
</thead>
</table>

### (c) EMP_BT

<table>
<thead>
<tr>
<th>Name</th>
<th>Ssn</th>
<th>Salary</th>
<th>Dno</th>
<th>Supervisor_ssn</th>
<th>Vst</th>
<th>Vet</th>
<th>Tst</th>
<th>Tet</th>
</tr>
</thead>
</table>

### DEPT_VT

<table>
<thead>
<tr>
<th>Dname</th>
<th>Dno</th>
<th>Total_sal</th>
<th>Manager_ssn</th>
<th>Vst</th>
<th>Vet</th>
</tr>
</thead>
</table>

### DEPT_TT

<table>
<thead>
<tr>
<th>Dname</th>
<th>Dno</th>
<th>Total_sal</th>
<th>Manager_ssn</th>
<th>Tst</th>
<th>Tet</th>
</tr>
</thead>
</table>

### DEPT_BT

<table>
<thead>
<tr>
<th>Dname</th>
<th>Dno</th>
<th>Total_sal</th>
<th>Manager_ssn</th>
<th>Vst</th>
<th>Vet</th>
<th>Tst</th>
<th>Tet</th>
</tr>
</thead>
</table>
Figure 26.8
Some tuple versions in the valid time relations EMP_VT and DEPT_VT.

**EMP_VT**

<table>
<thead>
<tr>
<th>Name</th>
<th>Ssn</th>
<th>Salary</th>
<th>Dno</th>
<th>Supervisor_ssn</th>
<th>Vst</th>
<th>Vet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smith</td>
<td>123456789</td>
<td>25000</td>
<td>5</td>
<td>333445555</td>
<td>2002-06-15</td>
<td>2003-05-31</td>
</tr>
<tr>
<td>Smith</td>
<td>123456789</td>
<td>30000</td>
<td>5</td>
<td>333445555</td>
<td>2003-06-01</td>
<td>Now</td>
</tr>
<tr>
<td>Wong</td>
<td>333445555</td>
<td>25000</td>
<td>4</td>
<td>999887777</td>
<td>1999-08-20</td>
<td>2001-01-31</td>
</tr>
<tr>
<td>Wong</td>
<td>333445555</td>
<td>30000</td>
<td>5</td>
<td>999887777</td>
<td>2001-02-01</td>
<td>2002-03-31</td>
</tr>
<tr>
<td>Wong</td>
<td>333445555</td>
<td>40000</td>
<td>5</td>
<td>888665555</td>
<td>2002-04-01</td>
<td>Now</td>
</tr>
<tr>
<td>Brown</td>
<td>222447777</td>
<td>28000</td>
<td>4</td>
<td>999887777</td>
<td>2001-05-01</td>
<td>2002-08-10</td>
</tr>
<tr>
<td>Narayan</td>
<td>666884444</td>
<td>38000</td>
<td>5</td>
<td>333445555</td>
<td>2003-08-01</td>
<td>Now</td>
</tr>
</tbody>
</table>

**DEPT_VT**

<table>
<thead>
<tr>
<th>Dname</th>
<th>Dno</th>
<th>Manager_ssn</th>
<th>Vst</th>
<th>Vet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>5</td>
<td>888665555</td>
<td>2001-09-20</td>
<td>2002-03-31</td>
</tr>
<tr>
<td>Research</td>
<td>5</td>
<td>333445555</td>
<td>2002-04-01</td>
<td>Now</td>
</tr>
</tbody>
</table>

...
Temporal Database Concepts

- Incorporating Time in Object-Oriented Databases Using Attribute Versioning
  - A single complex object stores all temporal changes of the object
  - Time varying attribute
    - An attribute that changes over time
    - E.g., salary
  - Non-Time varying attribute
    - An attribute that does not changes over time
    - E.g., date of birth
Temporal Database Concepts

class TEMPORAL_SALARY
{ attribute Date Valid_start_time;
  attribute Date Valid_end_time;
  attribute float Salary; }

class TEMPORAL_DEPT
{ attribute Date Valid_start_time;
  attribute Date Valid_end_time;
  attribute DEPARTMENT_VT Dept; }

class TEMPORAL_SUPERVISOR
{ attribute Date Valid_start_time;
  attribute Date Valid_end_time;
  attribute EMPLOYEE_VT Supervisor; }
Common operations used in queries

\[ [T.\text{Vst}, T.\text{Vet}] \text{ INCLUDES} [T1, T2] \]
\[ \iff T1 \geq T.\text{Vst} \text{ AND } T2 \leq T.\text{Vet} \]
\[ [T.\text{Vst}, T.\text{Vet}] \text{ INCLUDED\_IN} [T1, T2] \]
\[ \iff T1 \leq T.\text{Vst} \text{ AND } T2 \geq T.\text{Vet} \]
\[ [T.\text{Vst}, T.\text{Vet}] \text{ OVERLAPS} [T1, T2] \]
\[ \iff (T1 \leq T.\text{Vet} \text{ AND } T2 \geq T.\text{Vst}) \]
\[ [T.\text{Vst}, T.\text{Vet}] \text{ BEFORE} [T1, T2] \iff T1 \geq T.\text{Vet} \]
\[ [T.\text{Vst}, T.\text{Vet}] \text{ AFTER} [T1, T2] \iff T2 \leq T.\text{Vst} \]
\[ [T.\text{Vst}, T.\text{Vet}] \text{ MEETS\_BEFORE} [T1, T2] \iff T1 = T.\text{Vet} + 1 \]
\[ [T.\text{Vst}, T.\text{Vet}] \text{ MEETS\_AFTER} [T1, T2] \iff T2 + 1 = T.\text{Vst} \]
Spatial Database Concepts

- Keep track of objects in a multi-dimensional space
  - Maps
  - Geographical Information Systems (GIS)
  - Weather
- In general spatial databases are n-dimensional
  - This discussion is limited to 2-dimensional spatial databases
Spatial Databases

- **Typical Spatial Queries**
  - **Range** query: Finds objects of a particular type within a particular distance from a given location
    - Example, find all hospitals within the M.A. city area, or find all ambulances within five miles of an accident location.
  - **Nearest Neighbor** query: Finds objects of a particular type that is nearest to a given location
    - Example, find the police car that is closest to the location of crime.
  - **Spatial joins** or overlays: Joins objects of two types based on some spatial condition (intersecting, overlapping, within certain distance, etc.)
    - Example, find all homes that are within two miles of a lake.
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Multimedia Database

- In the years ahead multimedia information systems are expected to dominate our daily lives.
  - Our houses will be wired for bandwidth to handle interactive multimedia applications.
  - Our high-definition TV/computer workstations will have access to a large number of databases, including digital libraries, image and video databases that will distribute vast amounts of multisource multimedia content.
Multimedia Databases

- Types of multimedia data are available in current systems
  - **Text**: May be formatted or unformatted. For ease of parsing structured documents, standards like SGML and variations such as HTML are being used.
  - **Graphics**: Examples include drawings and illustrations that are encoded using some descriptive standards (e.g. CGM, PICT, postscript).
Multimedia Databases

Types of multimedia data are available in current systems (cont.)

- **Images**: Includes drawings, photographs, and so forth, encoded in standard formats such as bitmap, JPEG, and MPEG. Compression is built into JPEG and MPEG.
  - These images are not subdivided into components. Hence querying them by content (e.g., find all images containing circles) is nontrivial.
- **Animations**: Temporal sequences of image or graphic data.
Multimedia Databases

Types of multimedia data are available in current systems (cont.)

- **Video**: A set of temporally sequenced photographic data for presentation at specified rates— for example, 30 frames per second.
- **Structured audio**: A sequence of audio components comprising note, tone, duration, and so forth.
Multimedia Databases

- Types of multimedia data are available in current systems (cont.)
  - **Audio**: Sample data generated from aural recordings in a string of bits in digitized form. Analog recordings are typically converted into digital form before storage.
Multimedia Databases

- Types of multimedia data are available in current systems (cont.)
  - **Composite** or mixed multimedia data: A combination of multimedia data types such as audio and video which may be physically mixed to yield a new storage format or logically mixed while retaining original types and formats. Composite data also contains additional control information describing how the information should be rendered.
Multimedia Databases

Multimedia applications dealing with thousands of images, documents, audio and video segments, and free text data depend critically on

- Appropriate modeling of the structure and content of data
- Designing appropriate database schemas for storing and retrieving multimedia information.
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Geographic Information Systems

Geographic information systems (GIS) are used to collect, model, and analyze information describing physical properties of the geographical world.
Geographic Information Systems

- The scope of GIS broadly encompasses two types of data:
  - **Spatial** data, originating from maps, digital images, administrative and political boundaries, roads, transportation networks, physical data, such as rivers, soil characteristics, climatic regions, land elevations, and
  - **Non-spatial** data, such as socio-economic data (like census counts), economic data, and sales or marketing information. GIS is a rapidly developing domain that offers highly innovative approaches to meet some challenging technical demands.
Geographic Information Systems
Spatial data
GIS Applications

- It is possible to divide GISs into three categories:
  - Cartographic applications
  - Digital terrain modeling applications
  - Geographic objects applications
GIS Applications

Cartographic
- Irrigation
- Crop yield analysis
- Land Evaluation
- Planning and Facilities management
- Landscape studies
- Traffic pattern analysis

Digital Terrain Modeling Applications
- Earth science
- Civil engineering and military evaluation
- Soil Surveys
- Air and water pollution studies
- Flood Control
- Water resource management

Geographic Objects Applications
- Car navigation systems
- Geographic market analysis
- Utility distribution and consumption
- Consumer product and services – economic analysis

Emerging Database Technologies & Applications
Data Modeling and Representation

- GIS data can be broadly represented in two formats:
  - **Vector** data represents geometric objects such as points, lines, and polygons.
  - **Raster** data is characterized as an array of points, where each point represents the value of an attribute for a real-world location.
Specific GIS Data Operations

- The functionality of a GIS database is also subject to other considerations:
  - Extensibility
  - Data quality control
  - Visualization

- Such requirements clearly illustrate that standard RDBMSs or ODBMSs do not meet the special needs of GIS.
  - Therefore it is necessary to design systems that support the vector and raster representations and the spatial functionality as well as the required DBMS features.
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Although **HTML** is widely used for formatting and structuring *Web documents*, it is not suitable for specifying *structured data* that is extracted from databases.

A new language—namely **XML** (eXtended Markup Language) has emerged as the standard for structuring and exchanging data over the Web.

- XML can be used to provide more information about the structure and meaning of the data in the Web pages rather than just specifying how the Web pages are formatted for display on the screen.
Example 1:

```xml
<note>
  <to>Tove</to>
  <from>Jani</from>
  <heading>Reminder</heading>
  <body>Don't forget me this weekend!</body>
</note>
```

Example 2:

```xml
<root>
  <Customer cid="C1" name="Janine" city="Issaquah">
    <Order oid="01" date="1/20/1996" amount="3.5"/>
    <Order oid="02" date="4/30/1997" amount="13.4">Customer was very satisfied</Order>
  </Customer>
  <Customer cid="C2" name="Ursula" city="Oelde">
    <Order oid="03" date="7/14/1999" amount="100" note="Wrap it blue white red">
      <Urgency>Important</Urgency>
    </Order>
    <Order oid="04" date="1/20/1996" amount="10000"/>
  </Customer>
</root>
```
The basic object is XML is the **XML document**.

There are two main structuring concepts that are used to construct an XML document:
- **Elements**
- **Attributes**

Attributes in XML provide additional information that describe elements.
Elements are identified in a document by their **start tag** and **end tag**.
- The tag names are enclosed between angled brackets `<…>`, and end tags are further identified by a backslash `</…>`.

**Complex** elements are constructed from other elements hierarchically, whereas **simple** elements contain data values.

It is straightforward to see the correspondence between the XML textual representation and the tree structure.
- In the tree representation, internal nodes represent complex elements, whereas leaf nodes represent simple elements.
- That is why the XML model is called a **tree** model or a **hierarchical** model.
Outline

- Multimedia Databases
- Geographic Information Systems
- XML
- Data Warehousing
- Outsourcing database
- Spatial and Temporal Database
The data warehouse is a historical database designed for decision support.

Data mining can be applied to the data in a warehouse to help with certain types of decisions.

Proper construction of a data warehouse is fundamental to the successful use of data mining.
Data Warehousing (2)

- Purpose of Data Warehousing
  - Traditional databases are not optimized for data access only they have to balance the requirement of data access with the need to ensure integrity of data.
  - Most of the times the data warehouse users need only read access but, need the access to be fast over a large volume of data.
  - Most of the data required for data warehouse analysis comes from multiple databases and these analysis are recurrent and predictable to be able to design specific software to meet the requirements.
Data Warehousing (3)

Applications that data warehouse supports are:

• **OLAP** (Online Analytical Processing) is a term used to describe the analysis of complex data from the data warehouse.

• **DSS** (Decision Support Systems) also known as EIS (Executive Information Systems) supports organization’s leading decision makers for making complex and important decisions.

• **Data Mining** is used for knowledge discovery, the process of searching data for unanticipated new knowledge.
Definitions of Data Mining

- The discovery of new information in terms of patterns or rules from vast amounts of data.
- The process of finding interesting structure in data.
- The process of employing one or more computer learning techniques to automatically analyze and extract knowledge from data.
Knowledge Discovery in Databases (KDD)

- Data mining is actually one step of a larger process known as **knowledge discovery in databases** (KDD).
- The KDD process model comprises six phases
  - Data selection
  - Data cleansing
  - Enrichment
  - Data transformation or encoding
  - Data mining
  - Reporting and displaying discovered knowledge
Comparison with Traditional Databases

- Data Warehouses are mainly optimized for appropriate data access.
  - Traditional databases are transactional and are optimized for both access mechanisms and integrity assurance measures.
- Data warehouses emphasize more on historical data as their main purpose is to support time-series and trend analysis.
- Compared with transactional databases, data warehouses are nonvolatile.
- In transactional databases transaction is the mechanism change to the database. By contrast information in data warehouse is relatively coarse grained and refresh policy is carefully chosen, usually incremental.
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Traditional model:
- Client owns and manages database server
- Benefits: Full access control
- Disadvantages: Initial cost, maintenance cost
INTRODUCTION TO OUTSOURCING DATABASE SERVICES (ODBS)

- Outsourcing database model
  - Client outsources his data management needs to an external service provider
INTRODUCTION TO OUTSOURCING DATABASE SERVICES (ODBS)

- Two categories:
  - Hosting service
  - Housing service
INTRODUCTION TO OUTSOURCING DATABASE SERVICES (ODBS)

- Two categories:
  - Hosting service
  - Housing service
SOME DATABASE OUTSOURCING VENDORS

- OBM
- Oracle
- EDS
- DbDirect
- Ntirety
- Pythian
- TCS
- Satyam
- Wipro
BENEFITS OF OUTSOURCING DATABASE

- Save money:
  - Initial cost: hardware and software resources, facilities, technical staff
  - Maintenance cost
- Concentrate on core business
- Save time to set up the database system
- Share expertise
- Stable environments, with minimal changes
- Get resources that are not available internally
- …
… AND CHALLENGES

- Poor response time, poor turnaround time
- Hidden cost for advance services
- Quality of service
- Communication issues
- Lack of depth in troubleshooting
- Lack of full access control
- …
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