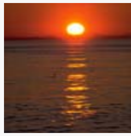
Introduction

ITEV DBMS – 1st Seminar, Sep. 6, 2008

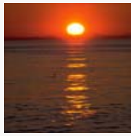
Original slides are from

Silberschatz, Korth and Sudarshan



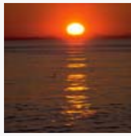
Today's Agenda

- 09.00 – 09.30 Introduction
- 09.30 – 11.00 Relational Model
- 11.00 – 12.00 SQL (1)
- 12.00 – 12.45 Lunch
- 12.45 – 13.45 SQL (2)
- 13.45 – 15.00 Entity-Relationship Model
- 15.00 – 15.45 Mini-Project, exam and assignments
- 15.45 – 16.00 Summary of the day



Administration Info

- Course lecturer
  - Hua Lu (luhua@cs.aau.dk, Tel: 9940 9973)
- Course website
  - http://www.cs.aau.dk/~luhua/courses/itev-db08/
- Seminar dates
  - September 6, 2008
  - September 13, 2008
  - October 4, 2008
- Oral exam and mini-project
  - Exam date: October 18, 2008
  - Mini-project report deadline: October 16, 2008 at 14.00
    - 2-4 people a group is preferred
    - Form groups in the lunch break if possible (deadline: Monday, Sept. 8)
    - No report, no exam!
  - More details about exam and mini-project in the afternoon



Course Structure

Day 1

- Introduction to DBMS
- Relational Databases and Database Design
  - Relational Model
  - SQL
  - Entity-Relationship (E-R) Model → *Conceptual Design*

  - Normalization → *Logical Design*

Day 2

- Data Storage and Querying
  - Storage and File Structure
  - Indexing and Hashing

  } → *Physical Design*

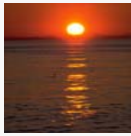
  - Query Processing and Optimization

Day 3

- Transaction Management
  - Transactions
  - Concurrency Control
  - Recovery

Introduction to DBMS

- Purpose of Database Systems
- View of Data
- Database Languages
- Relational Databases
- Database Design
- Data Storage and Querying
- Transaction Management

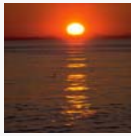


Database Management System (DBMS)

- DBMS contains information about a particular organization
  - Collection of interrelated data
  - Set of programs to access the data
  - An environment that is both *convenient* and *efficient* to use
- Database Applications:
  - Banking: all transactions
  - Airlines: reservations, schedules
  - Universities: registration, grades
  - Sales: customers, products, purchases
  - Online retailers: order tracking, customized recommendations
  - Manufacturing: production, inventory, orders, supply chain
  - Human resources: employee records, salaries, tax deductions
- Databases touch all aspects of our lives

Purpose of Database Systems

- In the early days, database applications were built directly on top of file systems
- Drawbacks of using file systems to store data:
  - Data redundancy and inconsistency
    - Multiple file formats, duplication of information in different files
  - Difficulty in accessing data
    - Need to write a new program to carry out each new task
  - Data isolation — multiple files and formats
    - Interoperability issue
  - Integrity problems
    - Integrity constraints (e.g. account balance > 0) become "buried" in program code rather than being stated explicitly
    - Hard to add new constraints or change existing ones



Purpose of Database Systems (Cont.)

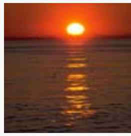
- Drawbacks of using file systems (cont.)
  - Atomicity of updates
    - Failures may leave database in an inconsistent state with partial updates carried out
    - Example: Transfer of funds from one account to another should either complete or not happen at all
  - Concurrent access by multiple users
    - Concurrent accessed needed for performance
    - Uncontrolled concurrent accesses can lead to inconsistencies
      - Example: Two people reading a balance and updating it at the same time
  - Security problems
    - Hard to provide user access to some, but not all, data
- Database systems offer solutions to all the above problems

Levels of Abstraction

- **Physical level:** describes how a record (e.g., customer) is stored.
- **Logical level:** describes data stored in database, and the relationships among the data.

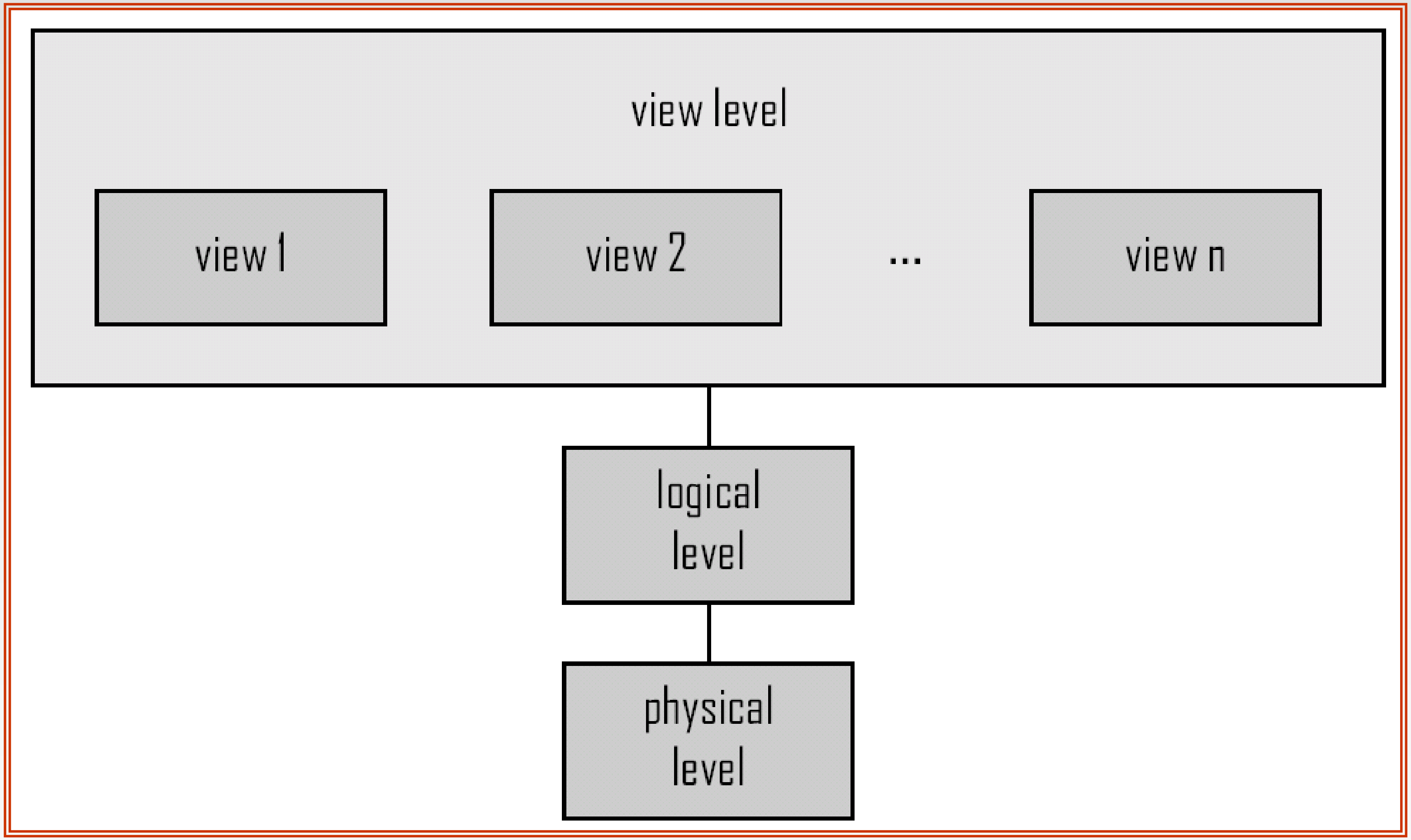
```
type customer = record
            customer_id : string;
            customer_name : string;
            customer_street : string;
            customer_city : integer;
        end;
```

- **View level:** application programs hide details of data types. Views can also hide information (such as an employee’s salary) for security purposes.



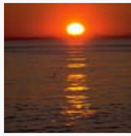
View of Data

An architecture for a database system



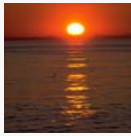
Instances and Schemas

- Similar to types and variables in programming languages
- **Schema** – the logical structure of the database
  - Example: The database consists of information about a set of customers and accounts and the relationship between them)
  - Analogous to type information of a variable in a program
  - **Physical schema**: database design at the physical level
  - **Logical schema**: database design at the logical level
- **Instance** – the actual content of the database at a particular point in time
  - Analogous to the value of a variable
- **Physical Data Independence** – the ability to modify the physical schema without changing the logical schema
  - Applications depend on the logical schema
  - In general, the interfaces between the various levels and components should be well defined so that changes in some parts do not seriously influence others.



Data Models

- A collection of tools for describing
  - Data
  - Data relationships
  - Data semantics
  - Data constraints
- Relational model
- Entity-Relationship data model (mainly for database design)
- Object-based data models (Object-oriented and Object-relational)
- Semistructured data model (XML)
- Other older models:
  - Network model
  - Hierarchical model



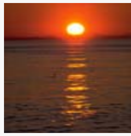
Data Definition Language (DDL)

- Specification notation for defining the database schema

  Example:

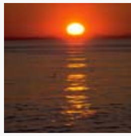
  ```
  create table account (
                        account-number    char(10),
                        balance           integer)
  ```

- DDL compiler generates a set of tables stored in a *data dictionary*
- Data dictionary contains metadata (i.e., data about data)
  - Database schema
  - Data *storage and definition* language
    - Specifies the storage structure and access methods used
  - Integrity constraints
    - Domain constraints
    - Referential integrity (**references** constraint in SQL)
    - Assertions
  - Authorization



Data Manipulation Language (DML)

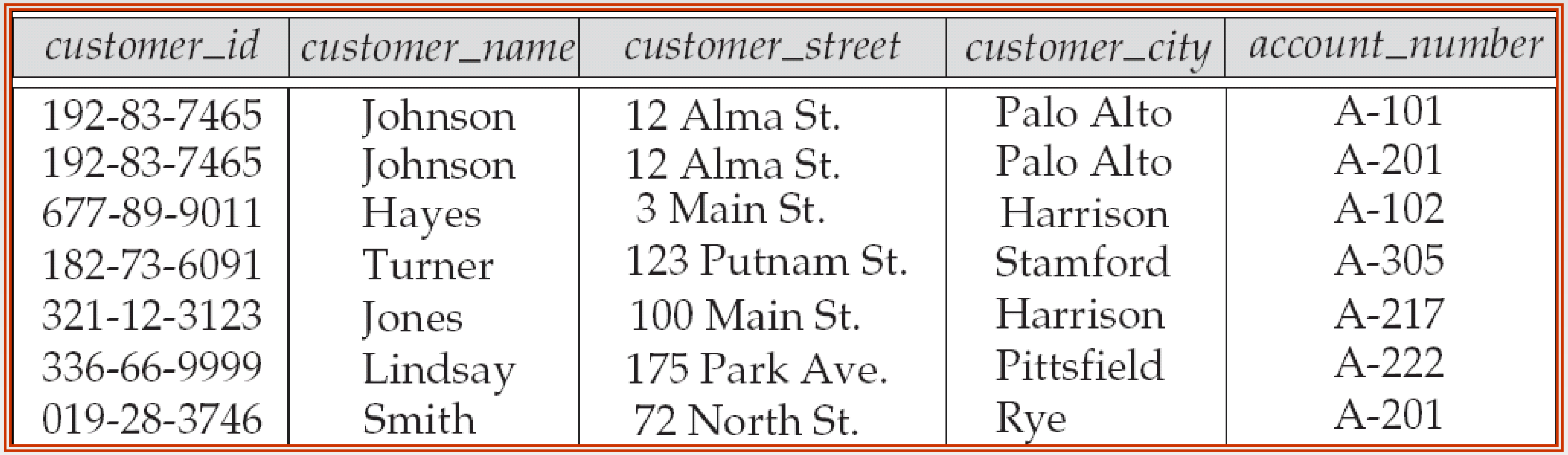
- Language for accessing and manipulating the data organized by the appropriate data model
  - DML also known as query language
- Two classes of DMLs
  - **Procedural DML** – user specifies what data is required and how to get those data
  - **Declarative (nonprocedural) DML** – user specifies what data is required without specifying how to get those data
- SQL is the most widely used query language
  - Set-based, declarative
  - But procedural extensions are offered by different database systems



Relational Model

- Example of tabular data in the relational model

Attributes



customer_id	*customer_name*	*customer_street*	*customer_city*	*account_number*
192-83-7465	Johnson	12 Alma St.	Palo Alto	A-101
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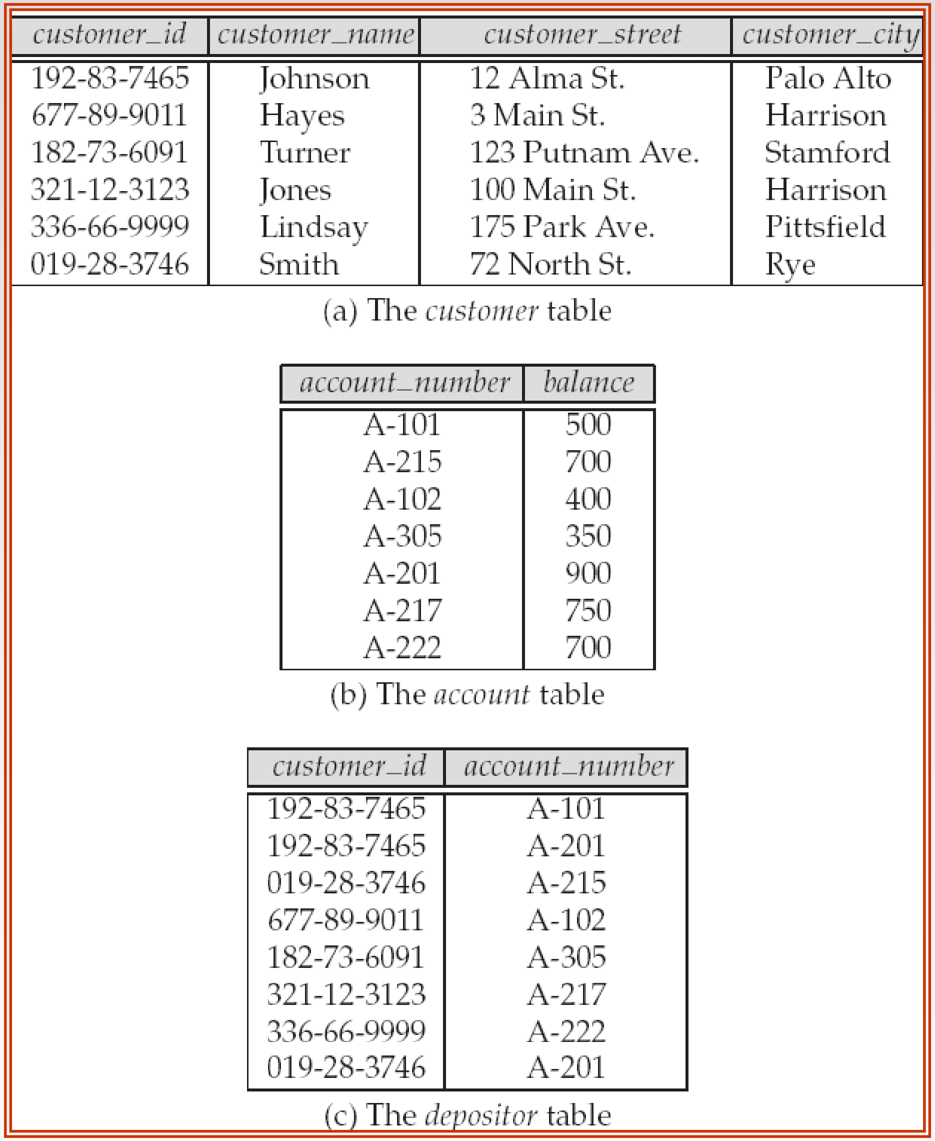
677-89-9011	Hayes	3 Main St.	Harrison	A-102
182-73-6091	Turner	123 Putnam St.	Stamford	A-305
321-12-3123	Jones	100 Main St.	Harrison	A-217
336-66-9999	Lindsay	175 Park Ave.	Pittsfield	A-222
019-28-3746	Smith	72 North St.	Rye	A-201

A Sample Relational Database



customer_id	*customer_name*	*customer_street*	*customer_city*
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336-66-9999	Lindsay	175 Park Ave.	Pittsfield
019-28-3746	Smith	72 North St.	Rye

(a) The *customer* table

account_number	*balance*
A-101	500
A-215	700
A-102	400
A-305	350
A-201	900
A-217	750
A-222	700

(b) The *account* table

customer_id	*account_number*
192-83-7465	A-101
192-83-7465	A-201
019-28-3746	A-215
677-89-9011	A-102
182-73-6091	A-305
321-12-3123	A-217
336-66-9999	A-222
019-28-3746	A-201

(c) The *depositor* table

SQL

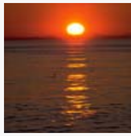
- SQL: widely used non-procedural language
  - Example: Find the name of the customer with customer-id 192-83-7465

```
select   customer.customer_name
from     customer
where    customer.customer_id = ‘192-83-7465’
```

  - Example: Find the balances of all accounts held by the customer with customer-id 192-83-7465

```
select   account.balance
from     depositor, account
where    depositor.customer_id = ‘192-83-7465’ and
         depositor.account_number = account.account_number
```

- Application programs generally access databases through one of
  - Language extensions to allow embedded SQL
  - Application program interface (e.g., ODBC/JDBC) which allow SQL queries to be sent to a database



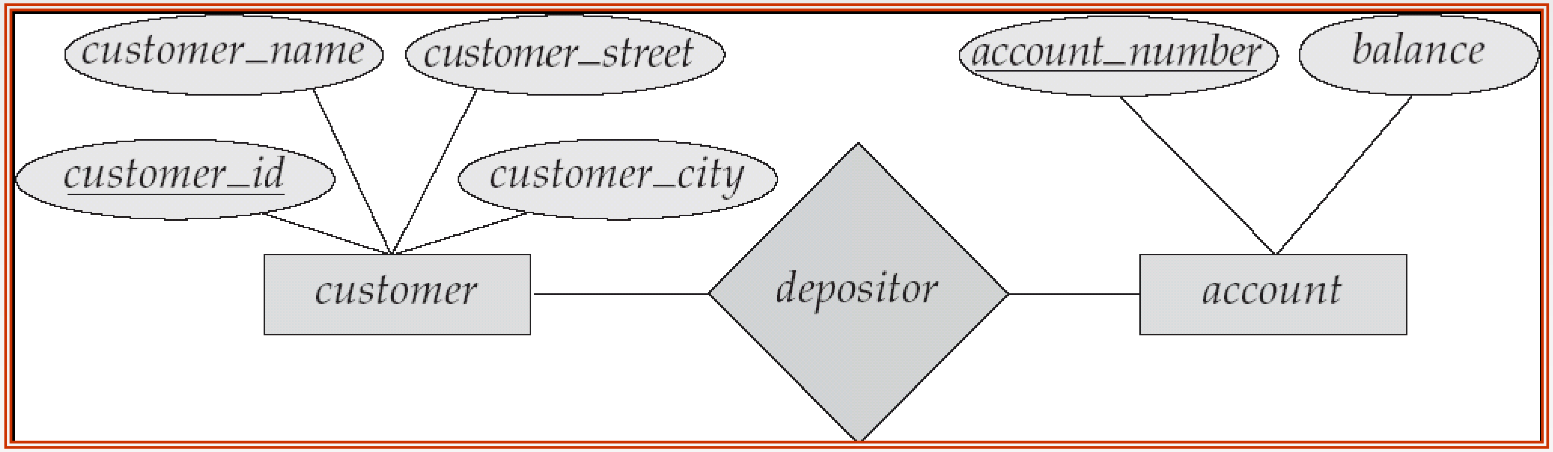
Database Design

The process of designing the general structure of the database:

- Conceptual and Logical Designs – Deciding on the database schema. Database design requires that we find a “good” collection of relation schemas.
  - Business decision – What attributes should we record in the database?
  - Computer Science decision – What relation schemas should we have and how should the attributes be distributed among the various relation schemas?
- Physical Design – Deciding on the physical layout of the database

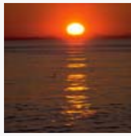
The Entity-Relationship Model

- Models an organization as a collection of *entities* and *relationships*
  - Entity: a "thing" or an "object" in the organization that is distinguishable from other objects
    - Described by a set of *attributes*
  - Relationship: an association among several entities
- Represented diagrammatically by an *entity-relationship diagram:*



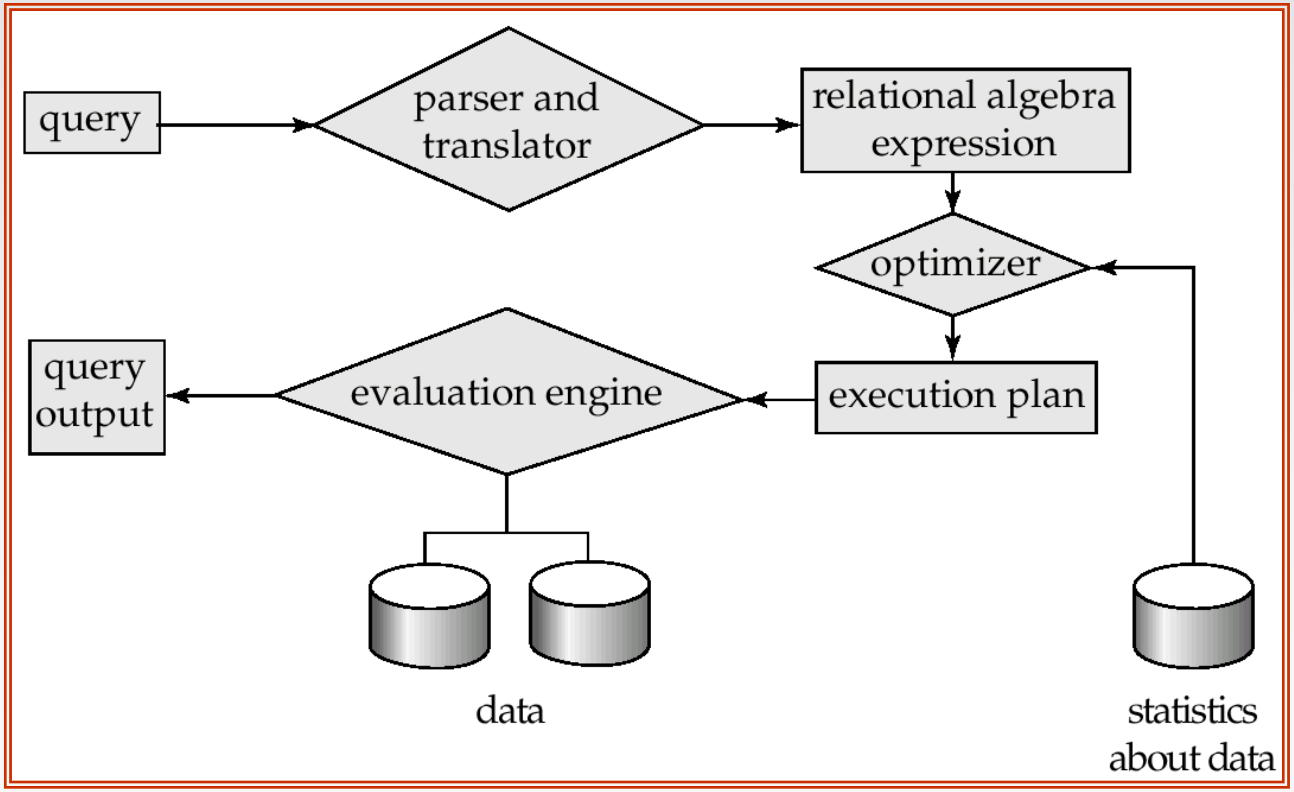
Storage Management

- **Storage manager** is a program module that provides the interface between the low-level data stored in the database and the application programs and queries submitted to the system.
- The storage manager is responsible to the following tasks:
  - Interaction with the file manager
  - Efficient storing, retrieving and updating of data
- Issues:
  - Storage access
  - File organization
  - Indexing and hashing



Query Processing

1. Parsing and translation
2. Optimization
3. Evaluation



Query Processing (Cont.)

- Alternative ways of evaluating a given query
  - Equivalent expressions
  - Different algorithms for each operation
- Cost difference between a good and a bad way of evaluating a query can be enormous
- Need to estimate the cost of operations
  - Depends critically on statistical information about relations which the database must maintain
  - Need to estimate statistics for intermediate results to compute cost of complex expressions

Transaction Management

- A **transaction** is *a collection of operations* that performs a single logical function in a database application
- **Transaction management component** ensures that the database remains in a consistent (correct) state despite system failures (e.g., power failures and operating system crashes) and transaction failures.
- **Concurrency control manager** controls the interaction among the concurrent transactions, to ensure the consistency of the database.

End of Introduction

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Acknowledgements

- Slides from the SKS book site
- Slides from Kristian Torp, course lecturer in 2006

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