Database Fundamentals

Intensive
Program

Objective

This course is designed to introduce the fundamentals of Databases. The students will develop skills in the design, construction, modification, and use of databases. Structured Query Language (SQL) will be emphasized.

Course Duration

Lectures: 15 hrs.

Labs: 15 hrs.

References

Ramez Elmasri, Fundamentals of Database Systems

C. J. Date: An Introduction to Database Systems,

Grading System

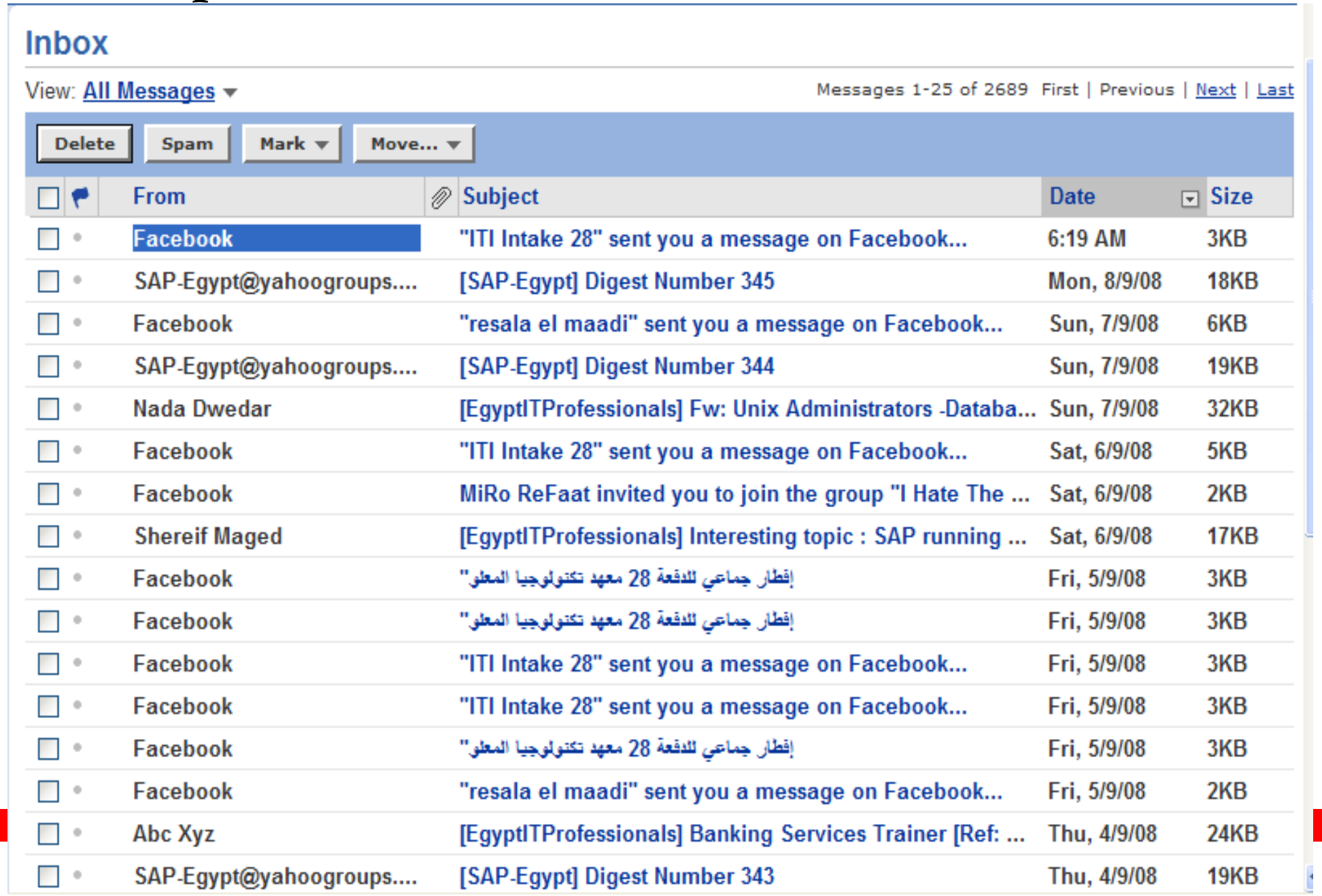
Assignments and Lab Work	**50%**
Final Exam	**50%**

Chapter 1 : Introduction

After Completing this chapter, you should be able to do the following:

- Define Database, Database System
- Identify the Database Properties
- Define DBMS
- Functions of DBMS
- Advantages and Disadvantages of Database Systems
- Types of different Databases

Example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Example


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الزيارات
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File Based System

- It is a collection of programs that perform services for the end user.
- Each Program defines and manages its own data
- The simplest definition of a (flat) file is a plain text file, with no relational information to other files or database information. This can be a plain text file, a tabular format such as CSV, TSV, or Excel spreadsheet, or a binary file.

Limitations Of File based System Approach

- Separation & Isolation Of data
- Duplication Of data
- Program Data Dependence
- Incompatible File Formats
- Frequent Null Values

Basic Definitions

- Database: A collection of related data.
- Database: A Structured collection of Records.
- Databases can be classified into two primary types: Relational and NoSQL Databases.

- Database Management System (DBMS): A software package/ system to facilitate the creation and maintenance of a computerized database.

- Database System: The DBMS software together with the data itself. Sometimes, the applications are also included. (Software + Database)

What is DBMS??

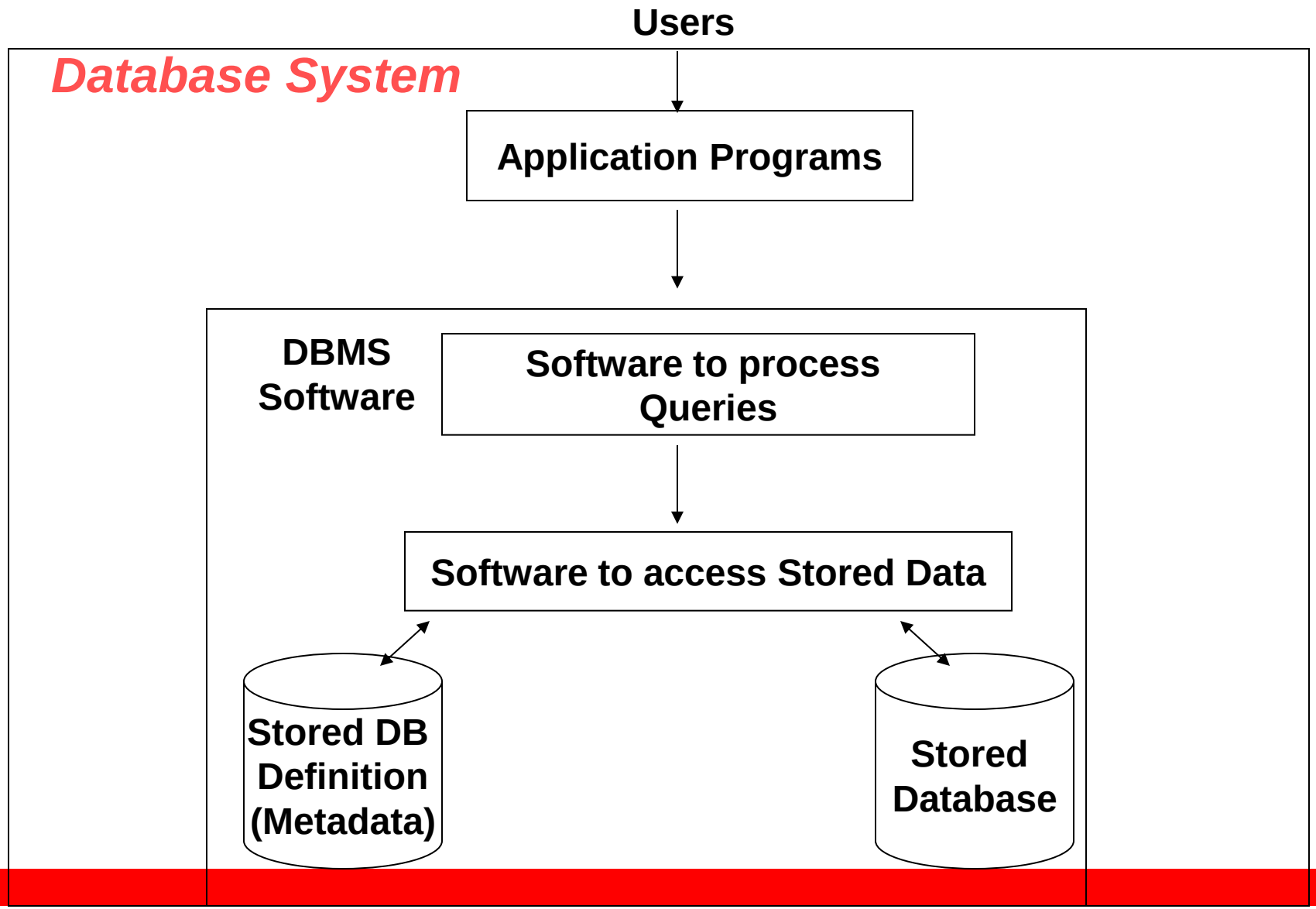
The DBMS is a software system that facilitates the process of defining, constructing, and manipulating databases for various applications.

Defining a database involves specifying the data types, and constraints for the data to be stored in the database.

Constructing the database is the process of storing the data itself on some storage medium.

Manipulating a database includes such functions as querying the database to retrieve, update, delete specific data.

Database Management System (DBMS)



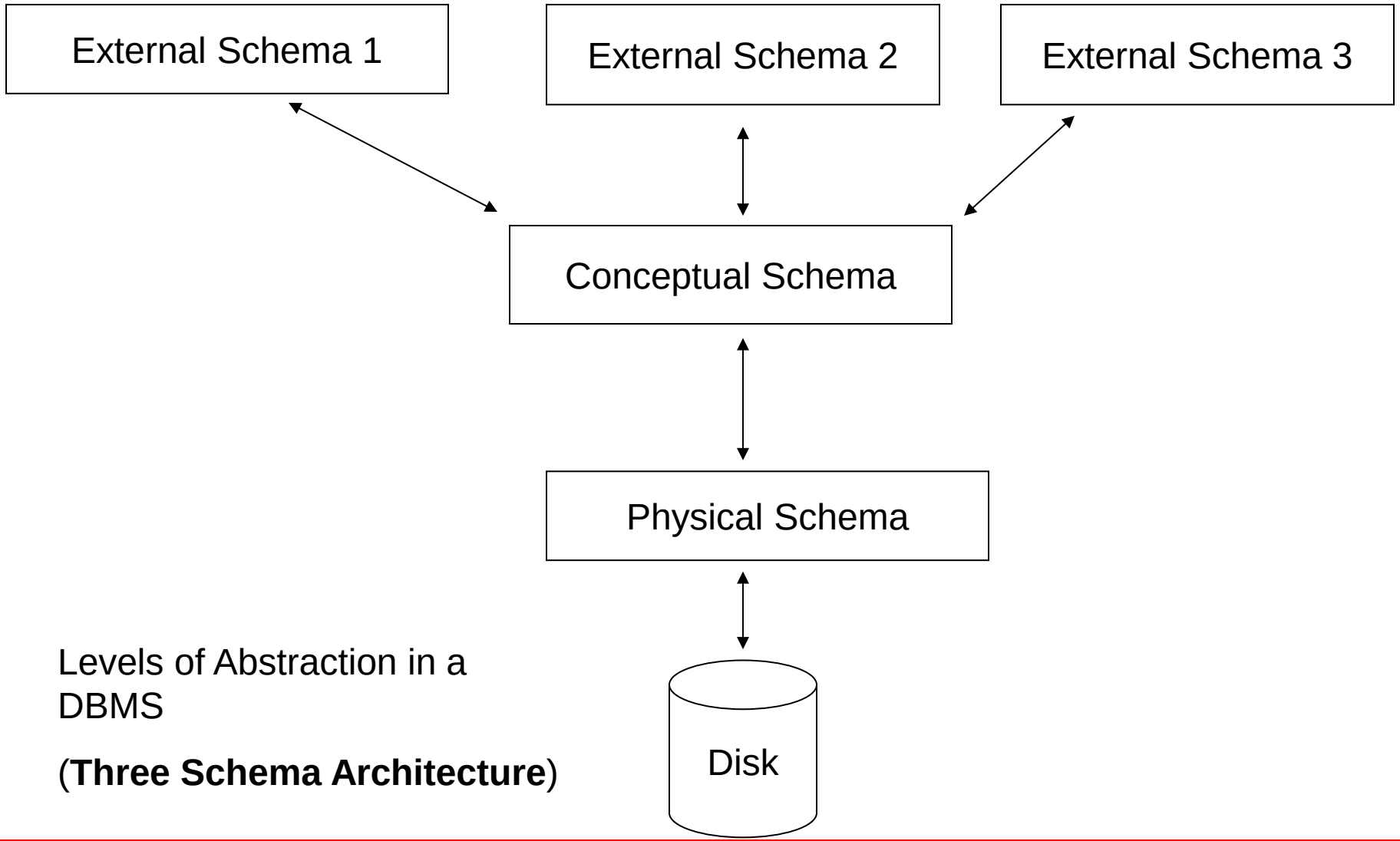
DBMS Advantages

- Controlling Redundancy.
- Restricting Unauthorized Access.
- Sharing data.
- Enforcing Integrity Constraints
- Inconsistency can be avoided.
- Providing Backup and Recovery.

DBMS Disadvantages

- DBMS is expensive
- May be incompatible with any other available DBMS
- The DBMS may be incompatible with any other available DBMS

DBMS Architecture



Levels of Abstraction in a DBMS

(**Three Schema Architecture**)

Data Models

- High Level or Conceptual data models provide concepts that are close to the way many users perceive data, entities, attributes and relationships. (Ex. ERD)

- Physical data models describes how data is stored in the computer and the access path needed to access and search for data.

Three Level/Schema Architecture

- **External – What the user sees:** focus on what different types of users will see when viewing the database. They are concerned with what data the user will see and how the data will be presented to the user.

- **Conceptual – The logical model:** focus on the logical nature of the data representation. They are concerned with *what* is represented rather than *how* it is represented.(define database structures such as tables and constraints)

- **Internal – The physical model:** place the emphasis on *how* the data are represented in the database or on *how* the data structures are implemented.

Mappings

- Definition: It is the processes of transforming requests and results between levels.

- These mappings may be time-consuming. However, a certain amount of mapping between the conceptual and internal levels is necessary.

Data Independence

- The capacity to change the schema at one level without having to change the schema at the next higher level

Database Users

Physical Schema

- Database Administrator (DBA)

Conceptual Schema

- System Analysts
- Database Designer

Before external schema

- Application programmers
- Testing Unit
- Analyze & Calculate &Summary Data (BI)

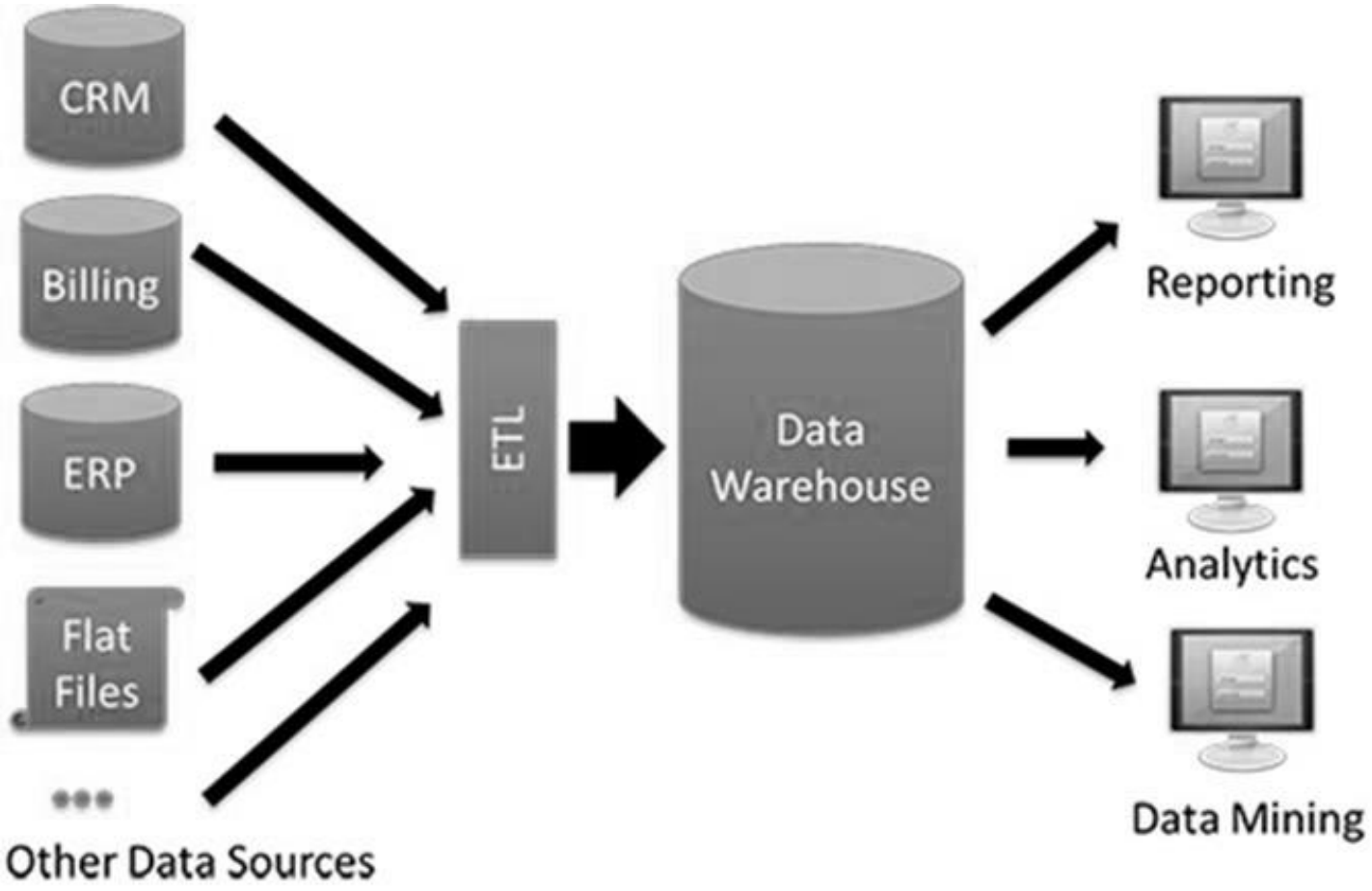
Extenal Schema

- End users (Customer , Managers, Application User..etc.

Non-relational Database / NoSQL

- Non-Relational Database: unlike the relational database, there are no tables, rows, primary keys or foreign keys. Instead, the non-relational database uses a storage model optimized for specific requirements of the type of data being stored.
- Also Known as NoSQL Database.
  - NoSQL databases stands for Not Only SQL.
  - NoSQL can use other types of query language rather than SQL.

Data Warehouse



Big Data

- ***"Big Data" is data whose scale, distribution, diversity, and/or timeliness require the use of new technical architectures and analytics to enable insights that unlock new sources of business value.***

- Key Characteristics
  1. Volume
  2. Velocity
  3. Variety

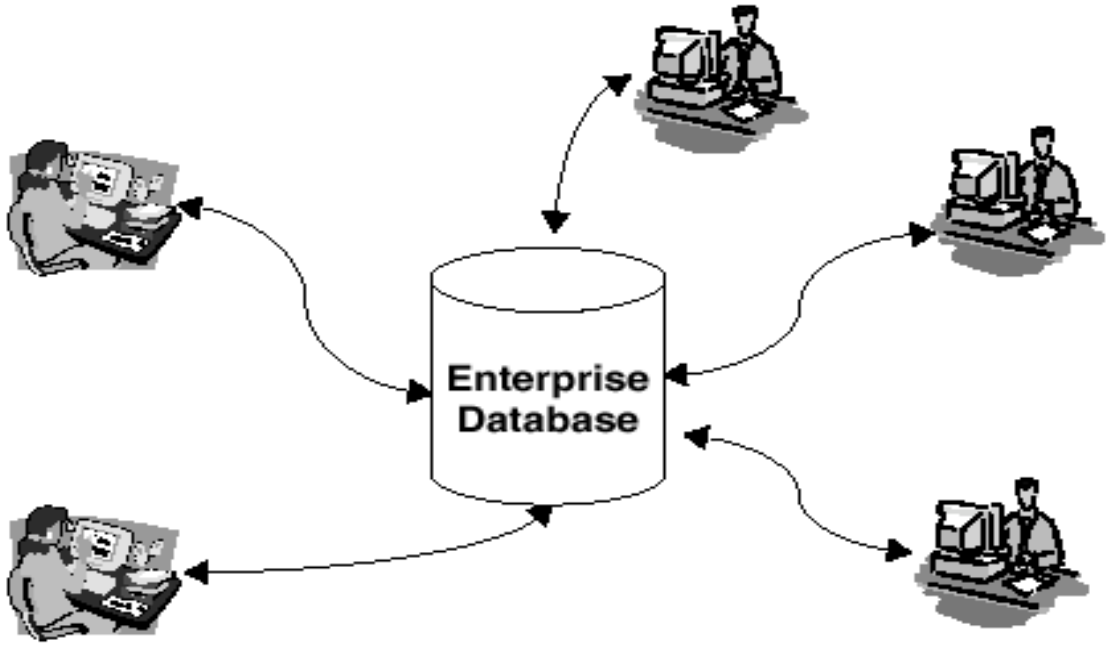
Source: McKinsey May 2011 article *Big Data: The next frontier for innovation, competition, and productivity*

Big Data

- Key Characteristics

1. Volume
2. Velocity
3. Variety

Database Environment



All data at a single site.

Data access from remote sites through communication links.

Easy to administer.

Uncertain data availability.

Common Examples:

Personal Database

Central Computer Database

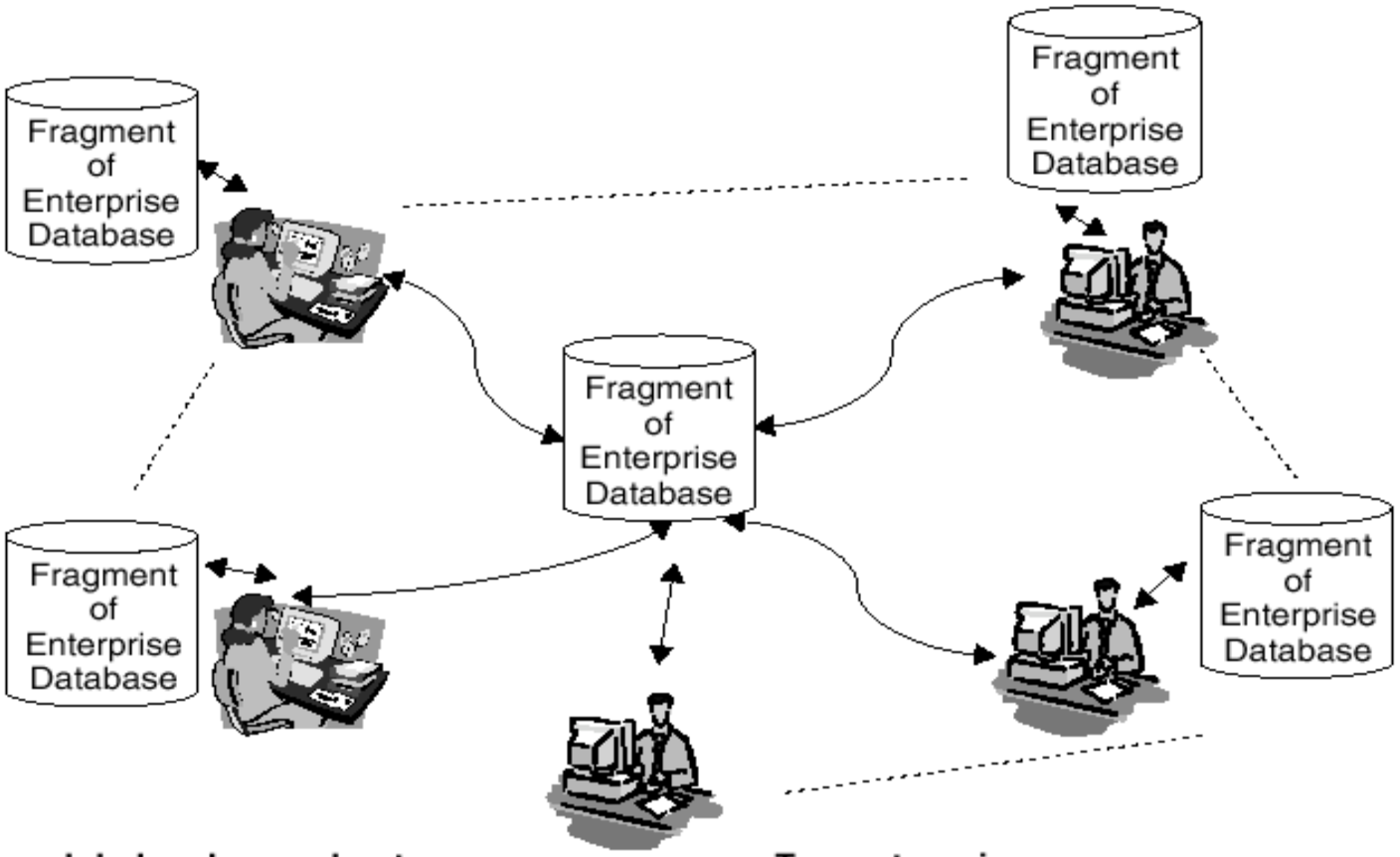
Client/Server Database

Centralized database.

Centralized Database Environment

- **Mainframe environment**
- **Client/Server environment**
- **Internet Computing environment:**

Distributed Database



For global and spread-out organizations, centralized databases not economical.

Enterprise data distributed across multiple computer systems.

Two categories:

Homogeneous databases

Heterogeneous databases

Relational Database

Relational Database

Relational database Lifecycle divided into these stages:

- ERD
- Mapping
- Implementation of database (Using SQL server)
- Querying Data

Database design may be performed using two approaches: bottom-up or top-down.

Entity Relationship Modeling

Entity-Relationship Diagram (ERD): identifies information required by the business by displaying the relevant entities and the relationships between them.

Entity Relationship Modeling (Cont'd)

- In building a data model a number of questions must be addressed:
  - What entities need to be described in the model?
  - What characteristics or attributes of those entities need to be recorded?
  - Can an attribute or a set of attributes be identified that will uniquely identify one specific occurrence of an entity?
  - What associations or relationships exist between entities?

Definitions

- **Entity** - An entity is a *thing* in the real world with an independent existence. Physical existence (for example, a particular person, car) or conceptual existence (for instance, a job, or a university course).
  Types of entities: Weak- Regular
- **Main Entity and the most used is the Regular/Strong Entity**
- **Presents as:** 

- **Entity Instance** - An instance is a particular occurrence of an entity. For example, each person is an instance of an entity, each car is an instance of an entity, etc.

- **Attribute** - The particular properties that describe the entity. An EMPLOYEE entity may be described by the employee's name, age, address and salary attributes.

Weak Entity Types

- An entity that does not have a key attribute

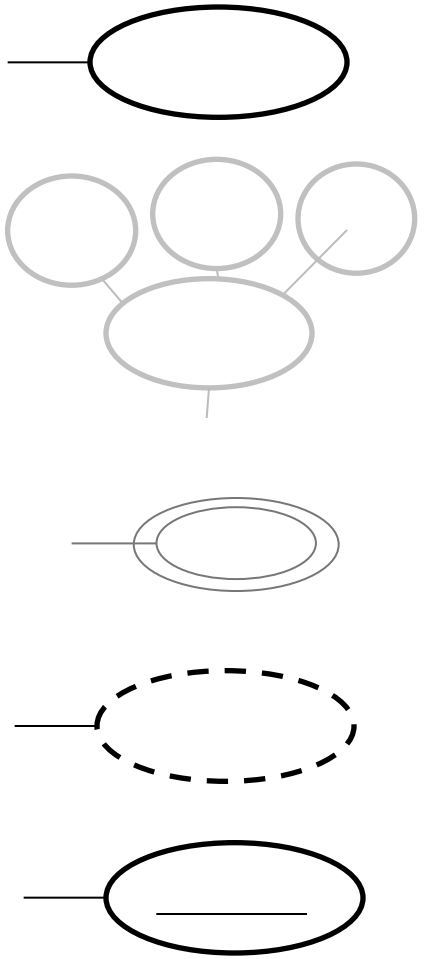
Presented as :

- A weak entity must participate in an identifying relationship type with an owner or identifying entity type

- Entities are identified by the combination of:
  - A partial key of the weak entity type
  - The particular entity they are related to in the identifying entity type

Types of Attributes

- **Single/Simple**: Attributes that are not divisible and have a single value for a particular entity instance
- **Composite**: can be divided into smaller subparts
- **Multi-valued**: has a set of values for the same entity instance
- **Derived**: can be calculated from another attribute or entity
- **Key**: an attribute whose values are distinct (unique) for each entity and can be used to uniquely identify the record



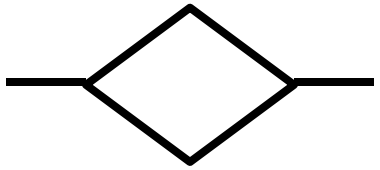
Key Attribute

- **Single Key**: For example, SSN of EMPLOYEE
- **Composite Key**: c**onsisting of two or more attributes** that uniquely identify a record, as in students_ grades table (student_id and subject _id) is a composite key
- **Candidate Key**: when an entity type has more than one key, those are candidate keys

Relationships

- **Relationships** - A relationship is a connection between entity classes.

Presents as:



1. **Degree of a Relationship:** is the number of participating entity

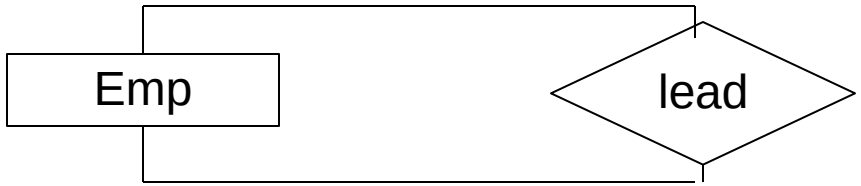
2. **Cardinality Ratio**: specifies the maximum number of relationship

3. **Participation**: specifies the minimum number of relationship instances that each entity can participate with.

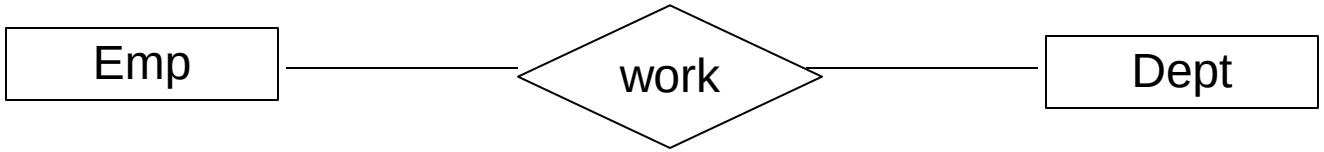
Relationships (cont.)

1. Degree of a Relationship

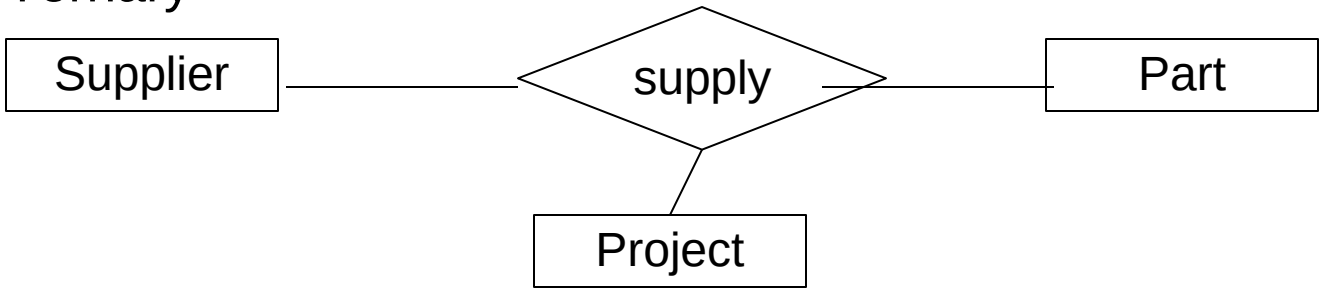
a. Unary/ Recursive



b. Binary



c. Ternary

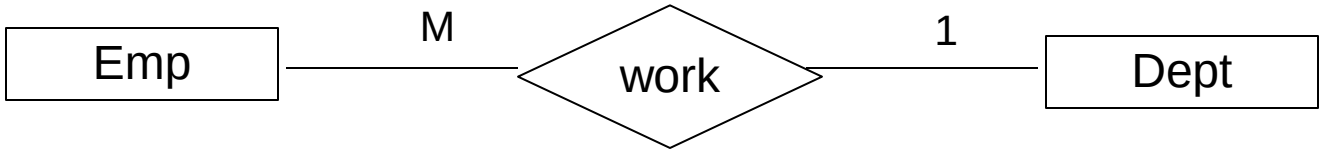


Relationships (cont.)

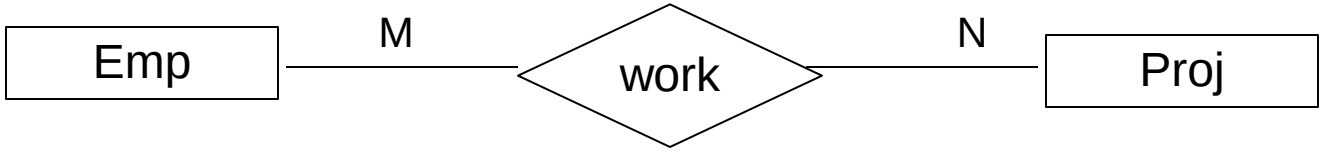
2. Cardinality Ratio (number)

a. One to one

b. One to many



c. Many to many



Relationships (cont.)

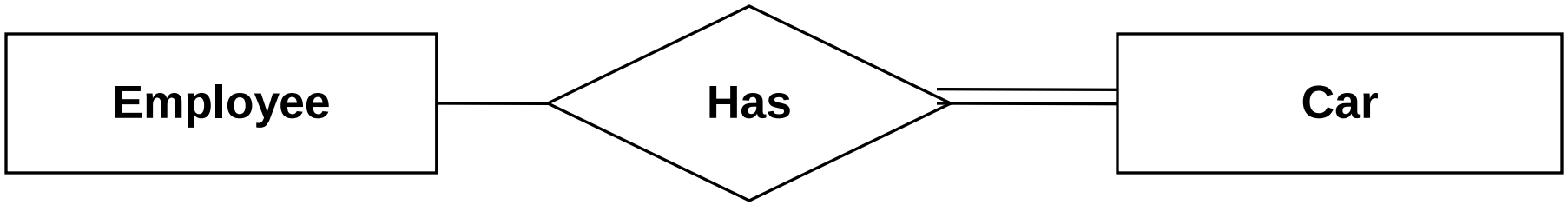
2. **Participation type**

   a. Total/ Full Dependency/ Mandatory

   b. Partial/ Partial Dependency/ Optional

Partial Total

Participation Example



-An Employee may have a car.

-A Car must be assigned to particular employee

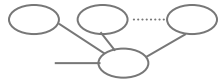
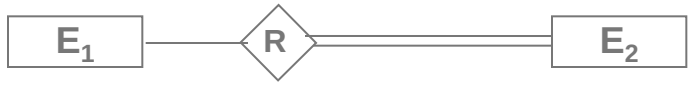
Participation Example

- A department may hire many employees (Zero or more)

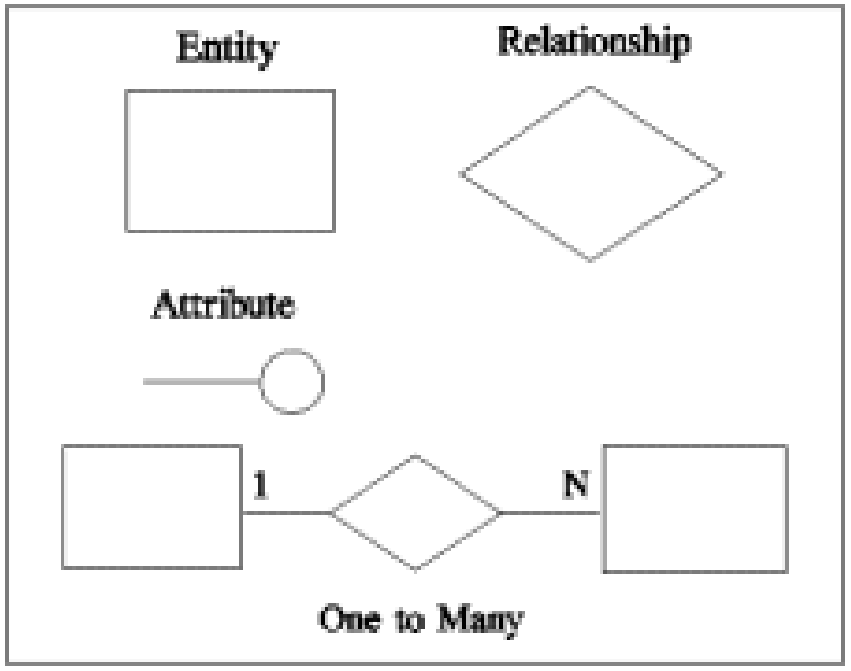
- An employee must be employed by a department

(Department membership is Optional, Employee membership is Mandatory)

SUMMARY OF ERD NOTATION

Symbol	Meaning
	ENTITY TYPE
	WEAK ENTITY TYPE
	RELATIONSHIP TYPE
	IDENTIFYING RELATIONSHIP TYPE
	ATTRIBUTE
	KEY ATTRIBUTE
	MULTIVALUED ATTRIBUTE
	COMPOSITE ATTRIBUTE
	DERIVED ATTRIBUTE
	TOTAL PARTICIPATION OF E_2 IN R
	CARDINALITY RATIO 1:N FOR E_1:E_2 IN R
	STRUCTURAL CONSTRAINT (min, max) ON PARTICIPATION OF E IN R

ERD Notations



- Rectangles represent ENTITY CLASSES
- Circles represent ATTRIBUTES
- Diamonds represent RELATIONSHIPS
- Arcs - Arcs connect entities to relationships. Arcs are also used to connect attributes to entities. Some styles of entity-relationship diagrams use arrows and double arrows to indicate the one and the many in relationships. Some use forks etc.
- Underline - Key attributes of entities are underlined.

An Example

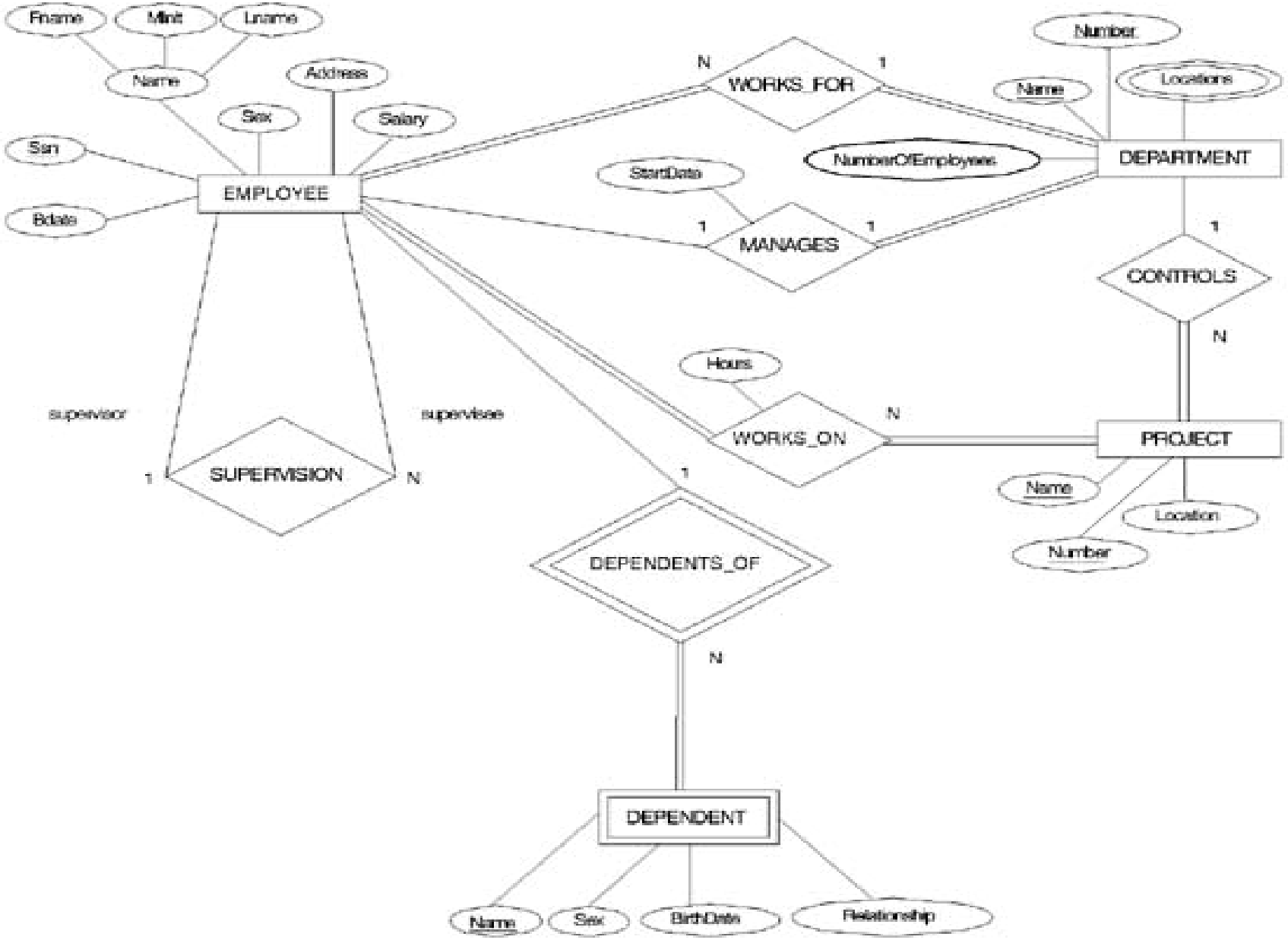
- A company is organized into departments. Each department has a unique name, a unique number, and a particular employee who manages the department. A department may have several locations.

- A department may control a number of projects, each of which has a unique name, a unique number, and a single location. A project must controlled by department

An Example (Cont'd)

- We store employee's name, social security number, address, salary, gender and birth date. An employee must be assigned to one department and must work on one or more projects, which are not necessarily controlled by the same department. We keep track of the number of hours per week that an employee works on each project. We also keep track of the direct supervisor of each employee.

- We want to keep track of the dependents of each employee for insurance purposes. We keep each dependent's first name, gender, birth date and relationship to that employee.


Fname
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1
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Questions ?