Relational Database Systems
I . Introduction

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Outline

1. Introduction
2. Relational Algebra
3. SQL : a Simple Query Language ??

4. SQL Data Definition Language
5. SQL : advanced concepts

6. Data integrity
7. Database Design

8. PL/SQL : Programming Language / SQL
9. External PL and Oracle (JDBC, ProC…)

Bibliography

- **Books**
  - Bases de données Objet et relationnel de Georges Gardarin (Edition Eyrolles)
- **Web:**
  - http://www-inf.int-evry evry.fr/COURS/BD/accueil-ext.html .(modèle relationnel, SQL, Conception Entité-Association)
  - http://esesa1.supelec.fr/www/yb/poly_bd/sql/tdm_sql.html (language SQL)
  - http://cui.unige.ch/~nerima/index_bd.html (modèle relationnel, SQL, Conception Entité-Association)
  - http://cs.utsa.edu/~jortiz (slides used in SQL section of this course)

1. Introduction

Definition

- Database : structured data
  - recorded with minimal redundancy
  - to simultaneously satisfy multiple users
  - in a selective manner
  - with fast response time
- Data storage
  - using a permanent media
- Data adminisitration
  - Data Base Management System (DBMS)

Data Base Management System

- A DBMS is a software set that allows to search, update and save data on secondary storage
- Serves as additional layer between OS and user

DBMS

- **A DBMS ensures**
  - **data** description
  - search **and** update **of data**
  - safety : **check user access rights, limit unauthorized access, crypt of sensitive information**
  - security : **saving and restoring data, limit impact of manipulation errors**
  - integrity : **define rules to maintain data integrity (depends on the nature of data stored)**
  - concurrency : **detect and offer resolution mechanisms for simultaneous/concurrent data access (transactions...)**

DBMS

- **Application Domain :**
  - **Knowledge base**
  - **Expert systems**
  - **Geographical Information System**
  - **Accounting and management**
  - **Digital content management**
  - **Genome projects**
  - **...**
- **Any domain in which (large amounts) of structured data need to be manipulated**
- **The actual DBMS system used depends on the application and its needs**

Data Description

- Three levels of description are distinguished:
  - External level (most abstract)
    - *views on a database for instance*
  - Conceptual level
    - *data structures of DBMS, basic types, access rights..*
  - Internal level (physical constraints)
    - *data storage media, file system, indexes...*

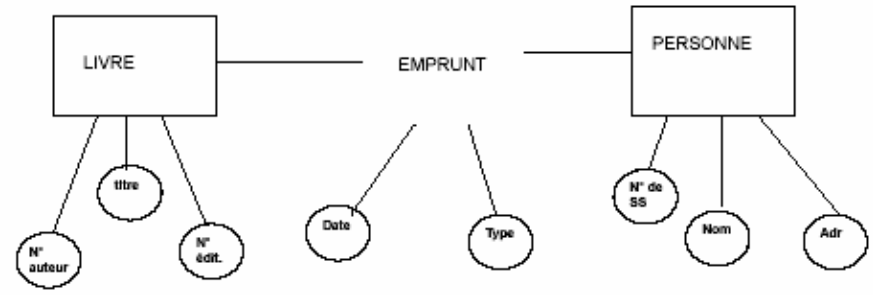
Internal Level

- Specifies how the data is physically stored (disk, tape storage...). The physical data model defines how the data is organized
- e.g. data files (name, size, data organization)

Conceptual level

- **Describes data** independently of physical storage **constraints**
  - **Elementary data types**
    - *e.g. book title, author name, …*
  - **Composite data types**
    - *e.g. book, person*
  - **Data associations between composite types**
    - *e.g. a book is borowed by a person*
  - **Some data integrity rules**
    - *e.g. a person may not borrow more than 3 documents …*

An example conceptual description

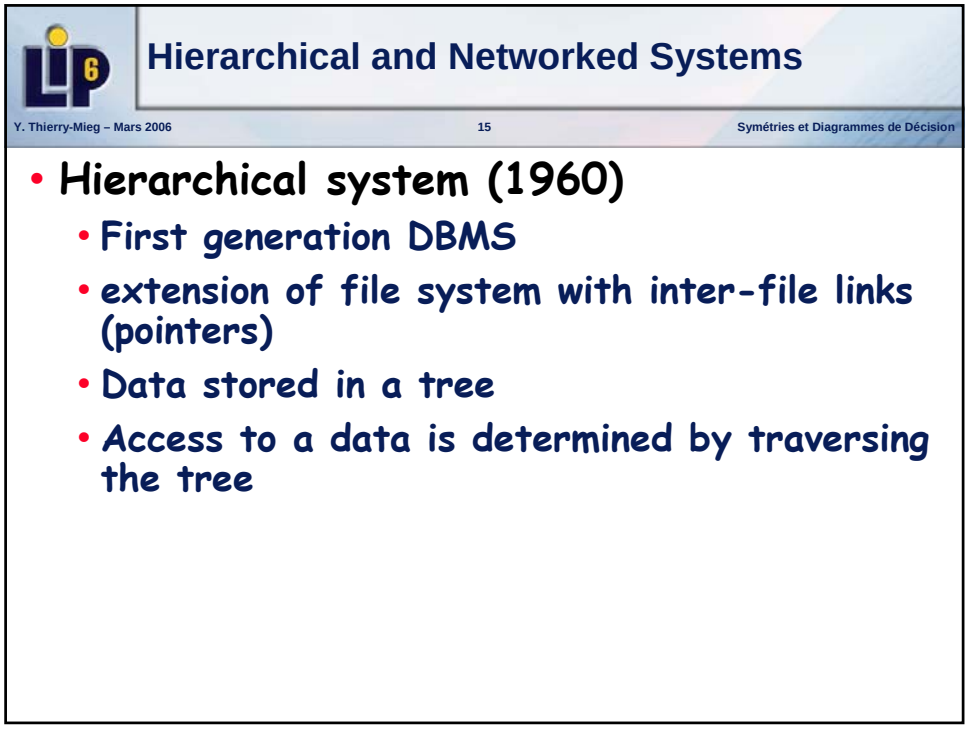


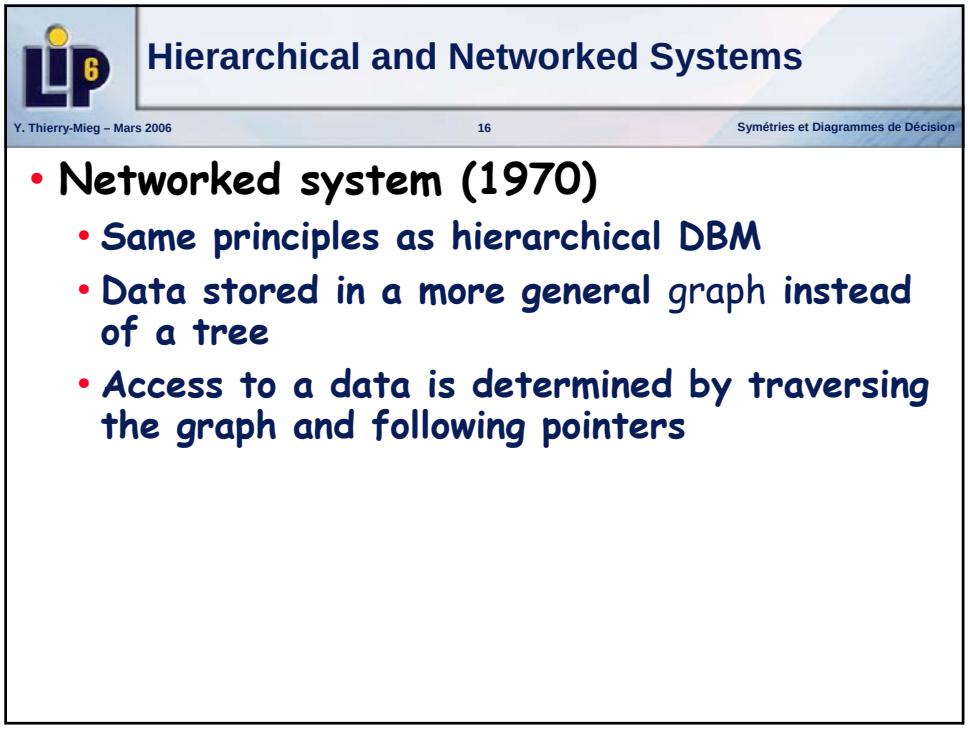
External Level

- Most abstract description level
- Contains views, which may be specific to a single user or user group, and only presents a partial view of the conceptual level
- Many views of a single database schema may coexist

History of DBMS

- Three main evolutions, each has its own data model
  - Hierarchical and network systems
  - Relational DBMS (90 % of DBMS today)
    - *Oracle, DB2, MySQL, ...*
  - Object-Oriented DBMS


Hierarchical and Networked Systems
Y. Thierry-Mieg – Mars 2006
15
Symétries et Diagrammes de Décision
• Hierarchical system (1960)
• First generation DBMS
• extension of file system with inter-file links (pointers)
• Data stored in a tree
• Access to a data is determined by traversing the tree


Hierarchical and Networked Systems
Y. Thierry-Mieg – Mars 2006
16
Symétries et Diagrammes de Décision
• Networked system (1970)
• Same principles as hierarchical DBM
• Data stored in a more general graph instead of a tree
• Access to a data is determined by traversing the graph and following pointers

Relational DBMS

- Second generation DBM
- Based on relations <=> set theory
- Vast majority of DBM today (Oracle, DB2,...)
  - '70 : relational model is defined
  - '80 : first commercial RDBMS
  - '90 : Over 50% of DBMs based on relational
- Supports very large data sets, very efficiently

Relational DBMS

- RDBMS are based on relational theory
- Data represented as TABLES composed of ROWS and COLUMNS

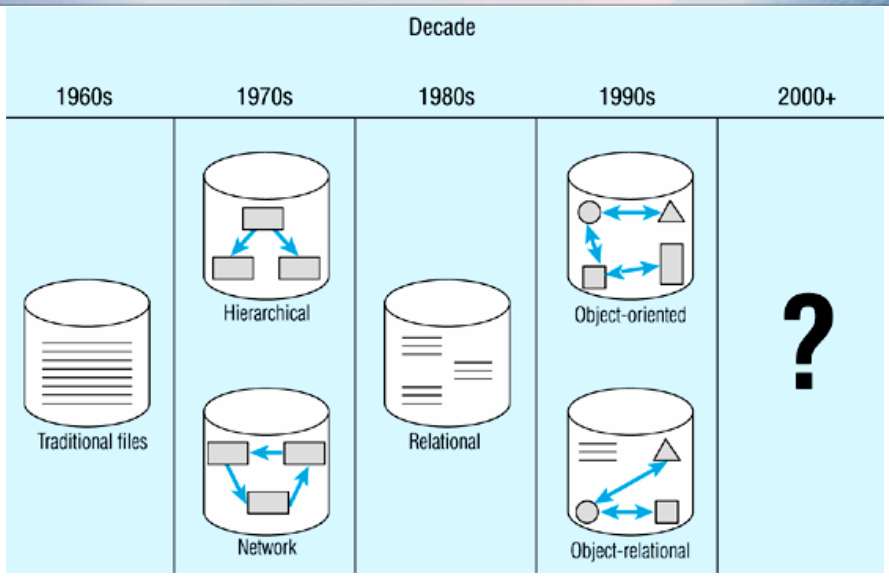
BOOK	
BOOK_ID	TITLE
8399	"Tom Sawyer"
1664	"Lord of the Rings"

PERSON	
PERS_ID	NAME
A1234	"John Smith"
E3456	"J. F. Kennedy"

Object-Oriented DBMS

- O-O DBMS are based on the object model ('90s)
- Pro :
  - flexibility of schema definition
  - efficiency of cross indexing
- Con :
  - Object loading less efficient
  - poor commercial support
- Alternative : SQL3, OO-drivers for RDBMS (Oracle 10)

Evolution of database technologies



RDBMS

- Basic Concepts
  - Relational model due to Codd 1970
- Definition :
  - A domain is a set of values
- e.g:
  - integer domain
  - string of length 25 domain

Relational basic concepts

- Definition
  - A relation is a subset of a Cartesian product of domains, characterized by it's name
- Example
  - let Country={China, USA, France} and Money={dollar, yuan, euro, florin} be two domains

CURRENCY	
COUNTRY_NAME	MONEY_NAME
China	Yuan
France	Euro
USA	dollar

Relational Schema

- **Definition**
  - an attribute of a relation is one of it's columns, characterized by a domain and a name
- e.g. COUNTRY_NAME:COUNTRY
- **Definition:**
  - A relational schema is noted by the relation name, followed by the definition of it's attributes in the form NAME:DOMAIN
- R(A1:D1,A2:D2,....An:Dn)

Key and Unicity

- **Definition :**
  - a subset of a relation's attributes (columns) is a KEY for a relation if it allows to uniquely identify a row of the relation
  - In other wortds, for any two rows of a relation, the columns forming the key have distinct values
- Any relation has at least one KEY = PRIMARY KEY
  - at worst, use all columns of the relation
  - usually, choose a minimal key, such that if you remove one element from the key, the unicity property is not preserved

Key Unicity

- **Examples :**
  - **PERSON(ss_num, name, address, birth_date)**
  - **GRADE(student_id, course_id, grade)**
    - *note that this means a student may not have more than one grade for a given course !!*

Acknowledgement

- The first version of these slides was based on a loose translation of Eric Cestari's course at ECE, Paris.