Introduction to Database Systems

References

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  http://www.db-book.com
- Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom,
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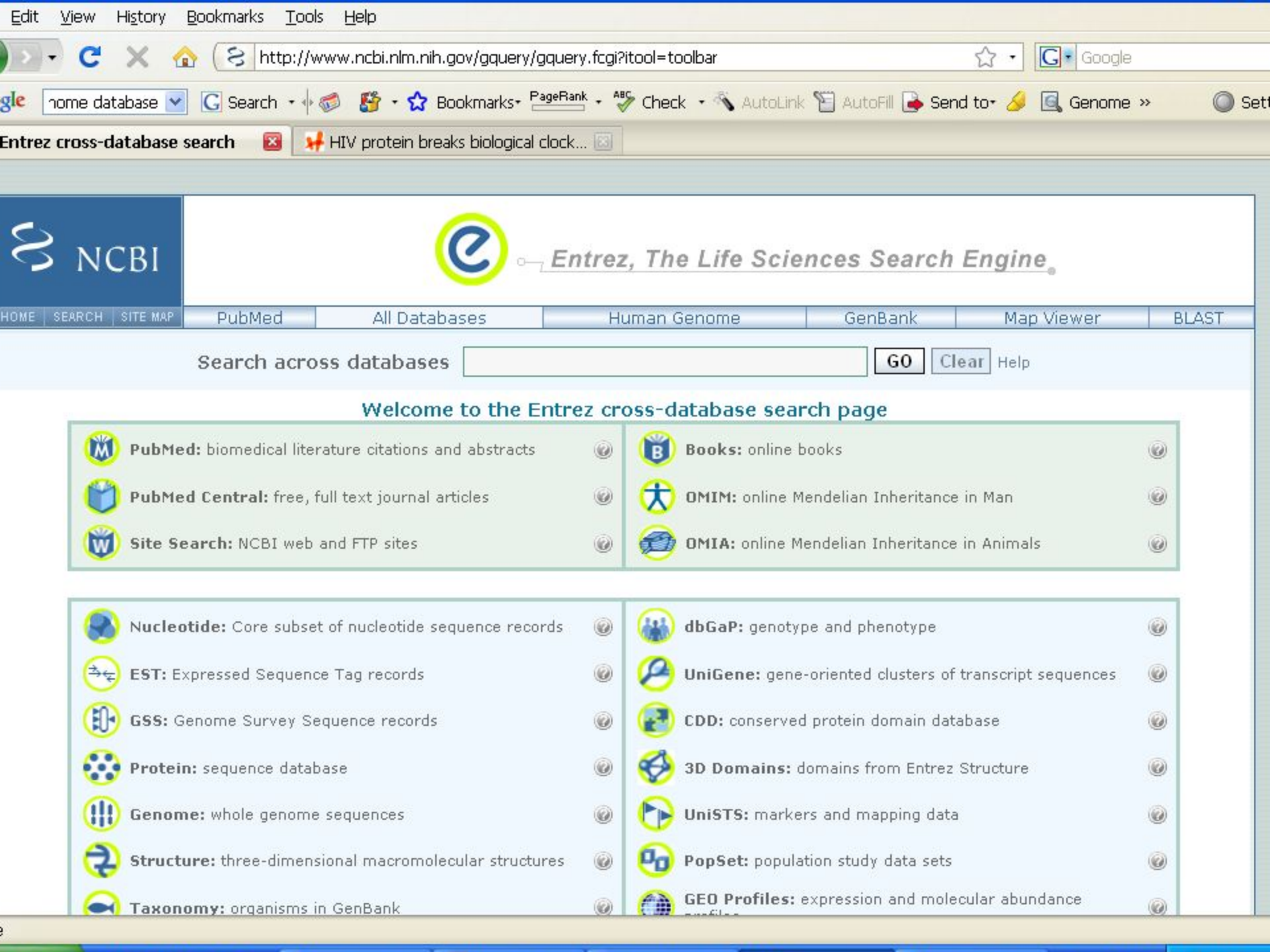
  http://www-db.stanford.edu/~ullman/dscb.html
- Class notes

Database Overview

- File Management vs Database Management (why do we need database?)
  - Advantages of Database systems: storage persistence, programming interface, transaction management
- Data Model (What is Data?)
- Database Language (How to manipulate data?)
- DBMS Architecture and Database System Components (How can you build a billion-dollar software, like Oracle? Or you can get it free, mySQL?)
- Users classification (What you can do and what you cannot do?)

Where are databases?

- You cannot avoid it and it's everywhere!
- You can say it actually makes the current society and your life work!
- Banking/Credit card /Social Security Info…
- Online shopping/booking…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Site Search: NCBI web and FTP sites
Books: online books
OMIM: online Mendelian Inheritance in Man
OMIA: online Mendelian Inheritance in Animals
Nucleotide: Core subset of nucleotide sequence records
EST: Expressed Sequence Tag records
GSS: Genome Survey Sequence records
Protein: sequence database
Genome: whole genome sequences
Structure: three-dimensional macromolecular structures
Taxonomy: organisms in GenBank
dbGaP: genotype and phenotype
UniGene: gene-oriented clusters of transcript sequences
CDD: conserved protein domain database
3D Domains: domains from Entrez Structure
UniSTS: markers and mapping data
PopSet: population study data sets
GEO Profiles: expression and molecular abundance

The DBMS Marketplace

- Relational DBMS companies – Oracle, Sybase – are among the largest software companies in the world.
- IBM offers its relational DB2 system. With IMS, a nonrelational system, IBM is by some accounts the largest DBMS vendor in the world.
- Microsoft offers SQL-Server, plus Microsoft Access for the cheap DBMS on the desktop, answered by “lite” systems from other competitors.
- OpenSource: mySQL, postgreSQL

Pre-Database Era: Stone Age of Data

- Imagine you want build an online shopping website
  - Maintain products/categories (price, picture, properties, …)
  - Customers accounts
- File is uninterpreted, unstructured collection of information
- File operations: delete, catalog, create, rename, open, close, read, write, find, …
- Access methods: Algorithms to implement operations along with internal file organization
- Examples: File of Customers, File of Products; Access method: implementation of a set of operations on those files

File Management System Problems

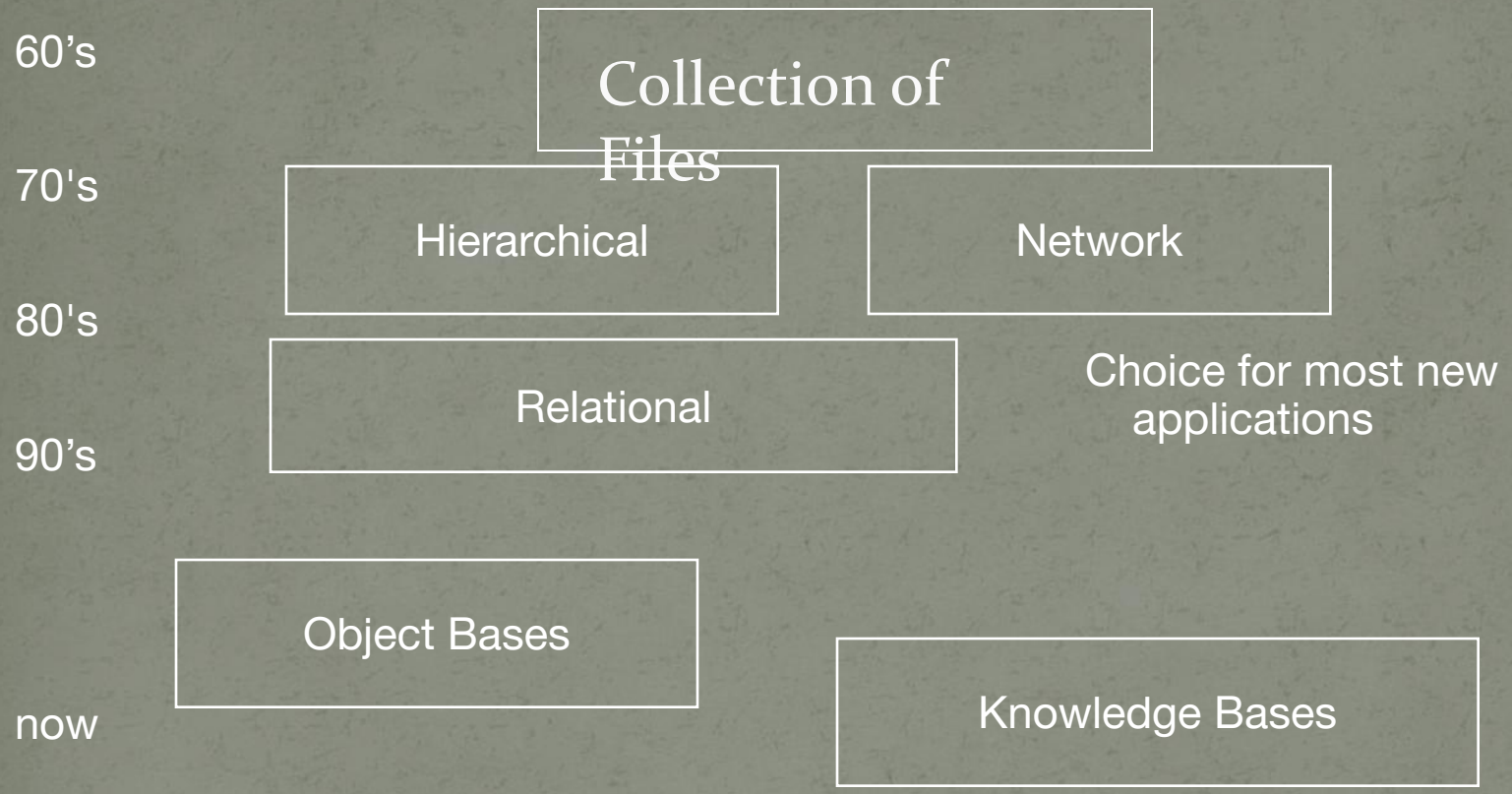
- Any question (access) on the data is a small program!!
- Data redundancy
- Data is not isolated from the access implementation (different format…)
- Multiple application (concurrent program) on the same file

Security Problems

- Allow access to the file only to the authorized personnel
- Ability to restrict access to parts of the record
- Ability to control operation usage by different users
- Protection from unauthorized use
- Protection from the derivation of unauthorized information

Data Integrity

- A database constraint is a logical constraint about the data expressed in a logical language.
  - **STUDENT.AGE >15**
  - ***If*** **(STUDENT.CLASS ==cs43005)** ***then*** **(STUDENT.PRIOR_CLASS ==cs31001)**
- Database is consistent if data at each time satisfies all integrity constraints.
- Input to any application is a set of consistent data. An application output is a set of consistent data.


60’s
Collection of Files
70's
Hierarchical
Network
80's
Relational
Choice for most new applications
90’s
Object Bases
Knowledge Bases
now

Advantages of Databases

- ***Persistent Storage*** – Database not only provides persistent storage but also efficient access to large amounts of data
- ***Programming Interface*** – Database allows users to access and modify data using powerful query language. It provides flexibility in data management
- ***Transaction Management*** – Database supports a concurrent access to the data

Early Database Applications

- Airline Reservation Systems – Data items are: single passenger reservations; Information about flights and airports; Information about ticket prices and tickets restrictions.
- Banking Systems – Data items are accounts, customers, loans, mortgages, balances, etc. Failures are not tolerable. Concurrent access must be provided
- Corporate Records – Data items are: sales, accounts, bill of materials records, employee and their dependents

Modern Database Applications

- Client – Server architecture
  - DBMS serves as a server and client queries are sent to servers
  - Where to locate servers
- Multimedia Applications
- Multidatabase Applications
- Data Warehouses
- It's everywhere!!

Data Administrator

- Coordinates all the activities of the database system; the database administrator has a good understanding of the enterprise's information resources and needs.
- Database administrator's duties include:
  - Schema definition
  - Storage structure and access method definition
  - Schema and physical organization modification
  - Granting user authority to access the database
  - Specifying integrity constraints
  - Acting as liaison with users
  - Monitoring performance and responding to changes in requirements

Database Users

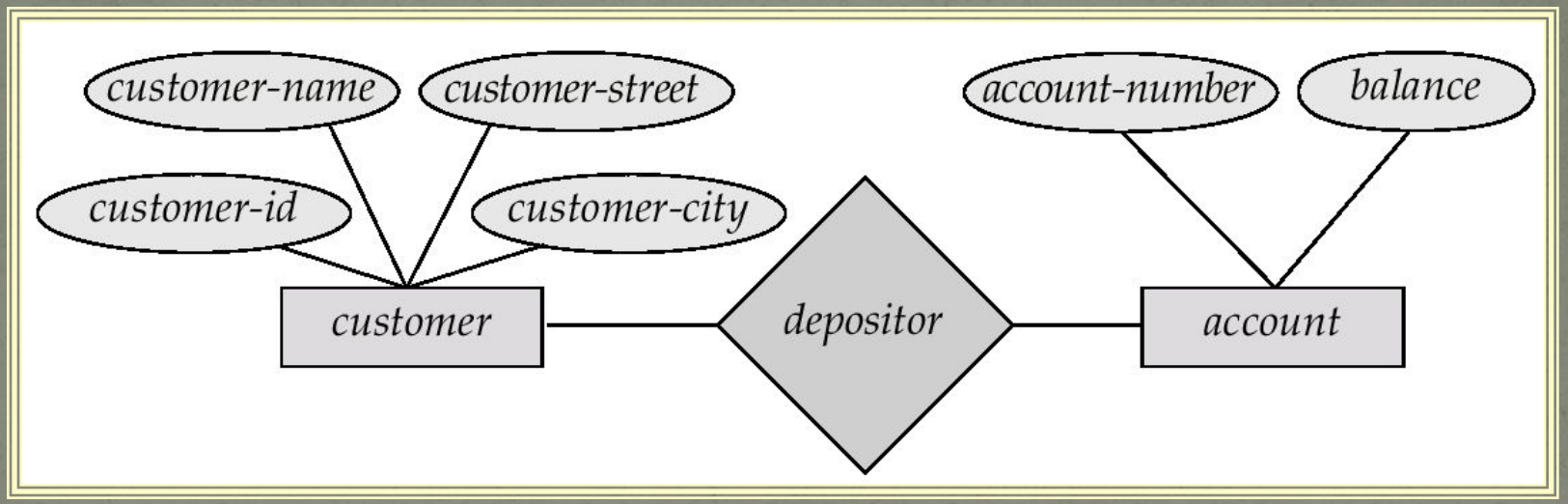
- Naïve – do not know about database too much, invoke application programs that are prepared already
- Application Programmers – know how to interact with the system but may not know how DBMS is designed
- Sophisticated users that know advanced use of the system and can use the system and packages on the top of the system
- DBMS system users – write specialized database applications that do not fit into the traditional data processing framework

A Little Design Methodology: Entity-Relationship Model

- The enterprise data can be described as a set of entities and a set of relationships between them.
- **Entity** – a data that pertains to, or describes some component of the enterprise
- Each entity is characterized by a set of **attributes**
- **Relationship** – describes an interconnection between different entities
- **Entity Set** – a set of entities that are characterized by the same entity definition
- **Relationship Set** – a set of relationships of the same type

Entity-Relationship Model

Example of schema in the entity-relationship model



Thank you