

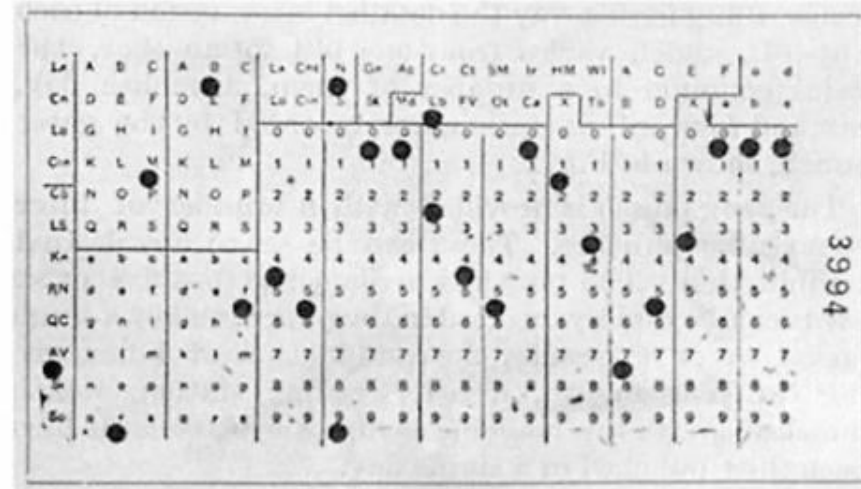
Outline

- **Storage hardware**
- **Database technologies**
- **Relational model**
 - Fundamentals
 - Codd's Twelve Rules
- **Types of data models**
 - Conceptual
 - Logical
 - Physical



Development of storage hardware

- Punch cards



http://commons.wikimedia.org/wiki/File:Hollerith_punched_card.jpg

Development of storage hardware

- Punch cards
- Punch tape



http://commons.wikimedia.org/wiki/File:Paper_tape-5x118_Hole.jpg



http://commons.wikimedia.org/wiki/File:Hololite_FSS_Teletype1954.jpg

Development of storage hardware

- Punch cards
- Punch tape
- Magnetic tape



http://commons.wikimedia.org/wiki/File:Quarter-Inch_Cartridges.jpg



http://commons.wikimedia.org/wiki/File:IBM_System_360_tape_drives.jpg

Development of storage hardware

- Punch cards
- Punch tape
- Magnetic tape
- Spinning disc
 - Hard disk
 - Floppy disk



http://commons.wikimedia.org/wiki/File:Floppy_disk_2009_G1.jpg



http://commons.wikimedia.org/wiki/File:Hard_disk_rodda.jpg

Development of storage hardware

- Punch cards
- Punch tape
- Magnetic tape
- Spinning disc
 - Hard disk
 - Floppy disk
- Optical disc
 - Compact disc
 - DVD
 - Blu-Ray



<http://en.wikipedia.org/wiki/File:DVD-4.5-scan.png>

Development of storage hardware

- Punch cards
- Punch tape
- Magnetic tape
- Spinning disc
 - Hard disk
 - Floppy disk
- Optical disc
 - Compact disc
 - DVD
 - Blu-Ray
- Solid State Drive (SSD)



<http://commons.wikimedia.org/wiki/File:Hp-ic-accelerator-kinetic.gif>



http://commons.wikimedia.org/wiki/File:SanDisk_Cruzer_Micro.png

Database technologies

- **Database**
 - Not necessarily a relational database

Database:

“a usually large collection of data organized especially for rapid search and retrieval (as by a computer)”

(<http://www.merriam-webster.com/dictionary/database>)

Database technologies

- Evolution of database technologies

- Sequential ("flat") files

Record type O = Order information

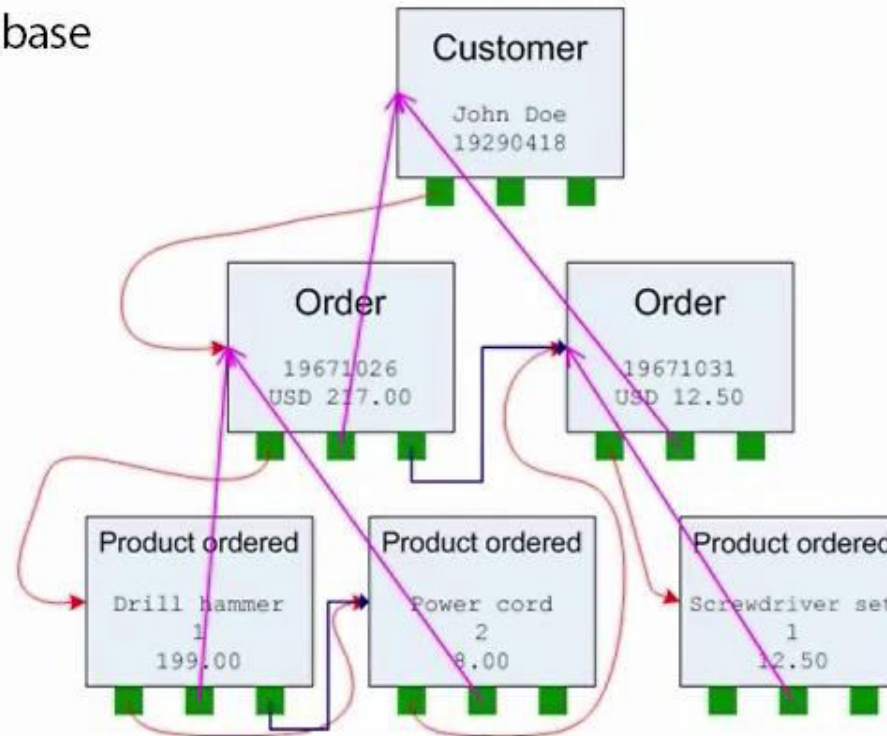
Record type P = Product ordered

```
C John Doe                19290418
A 18 Pivot Drive          Nowhereville
A PO box 39773            Somewhereelse
O 19671026 USD 217.00
P Drill hammer           1    199.00
P Power cord             2     8.00
O 19671031 USD  12.50
P Screwdriver set       1    12.50
...
```

Database technologies

- Evolution of database technologies

- Sequential ("flat") files
- Hierarchical database



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Database technologies

- Evolution of database technologies

- Sequential ("flat") files
- Hierarchical database
- Network database
- Relational database
- Object database
- XML database
- "Big data"
- ?????

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The Relational Model

- Based on mathematics
 - Set theory
 - First-order predicate logic

The diagram illustrates a relational database table with the following structure and annotations:

CustomerID	FirstName	LastName	Birthdate
XY001	John	Doe	April 18, 1929
BR092	Mary	Green	March 4, 1980
PD500	Francesca	de la Gillebert	September 12, 1959
WI308	John	Green	March 4, 1980

Annotations and their corresponding parts in the table:

- Table (relation):** Points to the entire table structure.
- Column (attribute):** Points to the header row (CustomerID, FirstName, LastName, Birthdate).
- Row (tuple):** Points to the first data row (XY001, John, Doe, April 18, 1929).
- Primary key:** Points to the CustomerID column.
- Data value:** Points to the value 'Green' in the LastName column of the last row.

The Relational Model

- **Based on mathematics**
 - Set theory
 - First-order predicate logic
- **Relationships between elements based on data values (primary key)**
 - NOT on storage order
 - NOT with pointers to physical location
- **Rules for relational databases describe behavior**
 - Actual implementation can be chosen by vendor

The Relational Model

- **Codd's twelve rules**

- 0: Foundation Rule
- 1: Information Rule
- 2: Guaranteed Access Rule
- 3: Systematic Treatment of Null Values
- 4: Dynamic On-line Catalog Based on the Relational Model
- 5: Comprehensive Data Sublanguage Rule
- 6: View Updating Rule
- 7: High-level Insert, Update, and Delete
- 8: Physical Data Independence
- 9: Logical Data Independence
- 10: Integrity Independence
- 11: Distribution Independence
- 12: Nonsubversion Rule

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Data modeling

- **Conceptual data model**
 - All information in the organization
 - Not necessarily stored in computers
- **Logical data model**
 - For storing in computers
 - For a specific database technology
 - Implementation independent
- **Physical data model**
 - Optimized for specific vendor
 - Based on logical model

