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Data models

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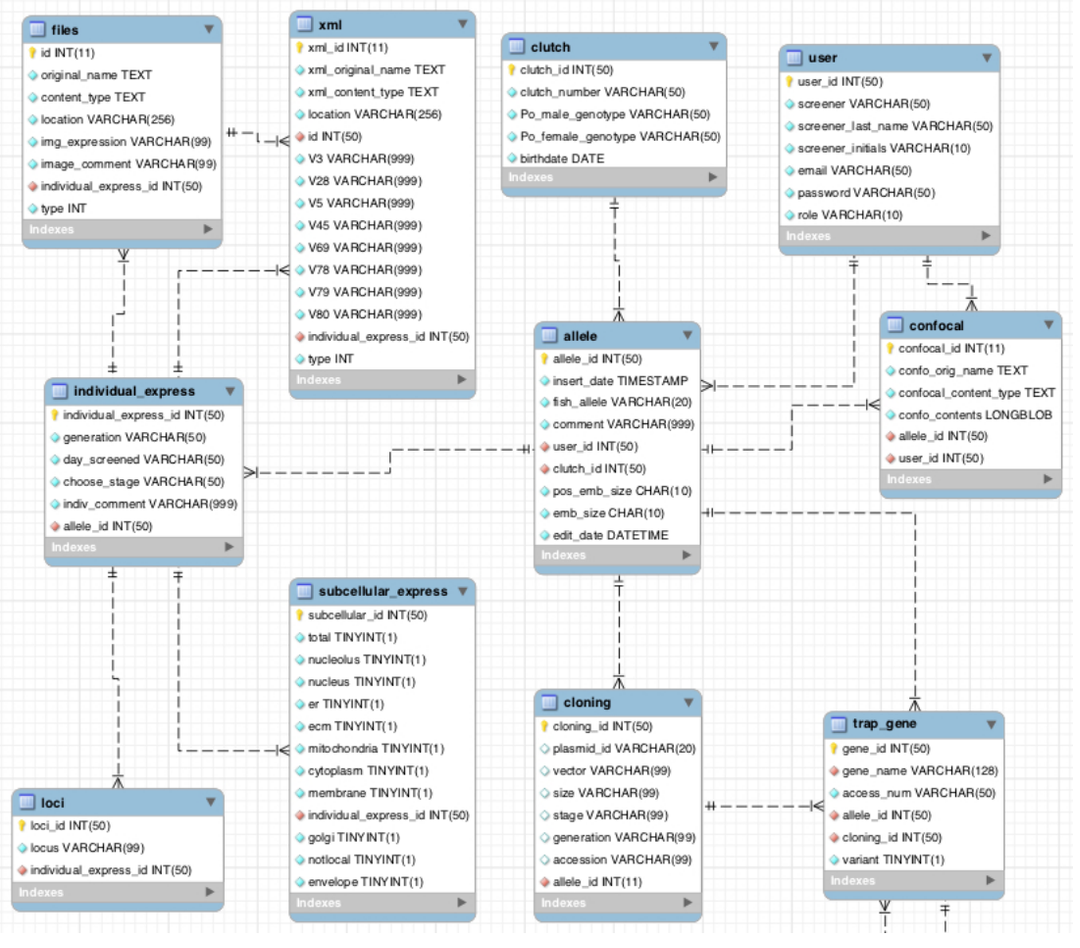
data models

- A collection of concepts describing how structured data is represented and accessed
- Within a data model, the **schema** is a set of descriptions of a particular collection of data
- The schema is stored in a **data dictionary** and can be represented in SQL, XML, RDF, etc.
- In semantics a data model is equivalent to an ontology - "a formal, explicit specification of a shared conceptualisation"

data model example



flat (file) model

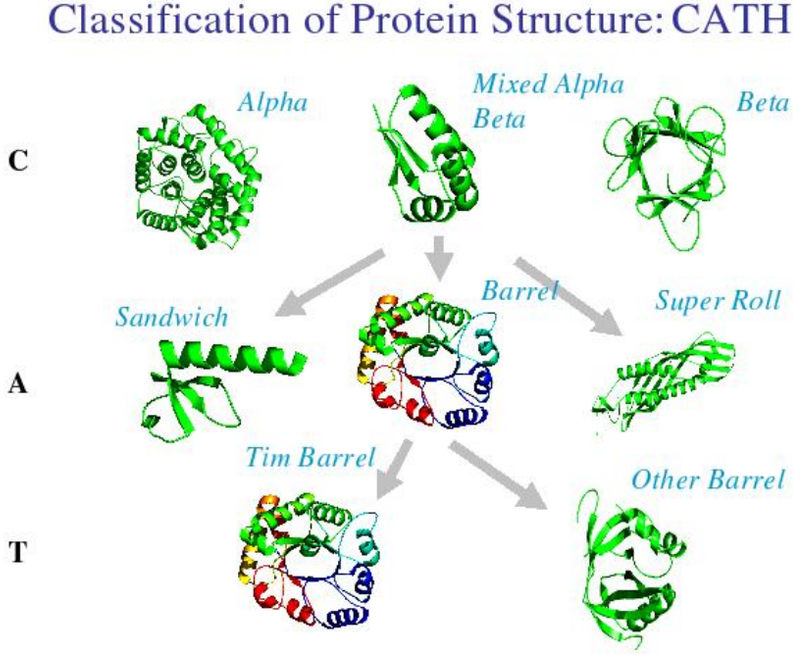
- Data files that contain records with no structural relationships
- Additional information is required to interpret these files such as the file format properties
- Hollerith 1889 patent "Art of Compiling Statistics" describes how every US resident can be represented by a string of 80 characters and numbers
- Examples: delimiter-separated data (CSV, TSV), HTML table

hierarchical model

- Data is organized in a tree structure
- Levels consist of records of the same type - same set of field values - with a sort field to ensure a particular order
- 1:N (parent-child) relationship between two record types: child may only have one parent but a parent can have many children
- Popular in the late 1960s/1970s with IBM's Information Management System (IMS)
- Structure of XML documents

hierarchical example

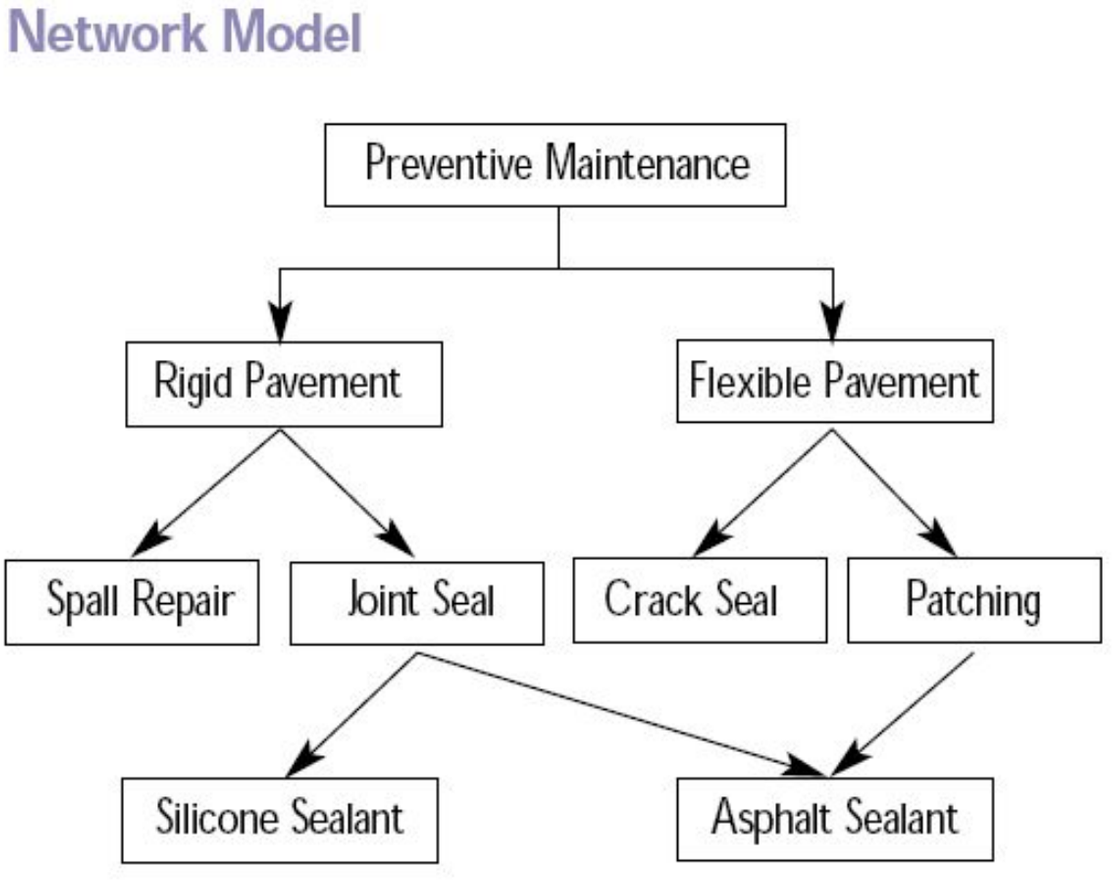
CATH database of protein structures in the Protein Data Bank: Levels: Class, Architecture, Topology, Homologous Superfamily, Sequence Family



network model

- Data is organized as sets and records
- A set has an owner, a name and one-or-more members
- A record may be an owner in any numbers of sets and a member in any number of sets
- Allows modelling of many-to-many relationships
- Formally defined by the Conference on Data Systems Languages (CODASYL) specification in 1971

network example

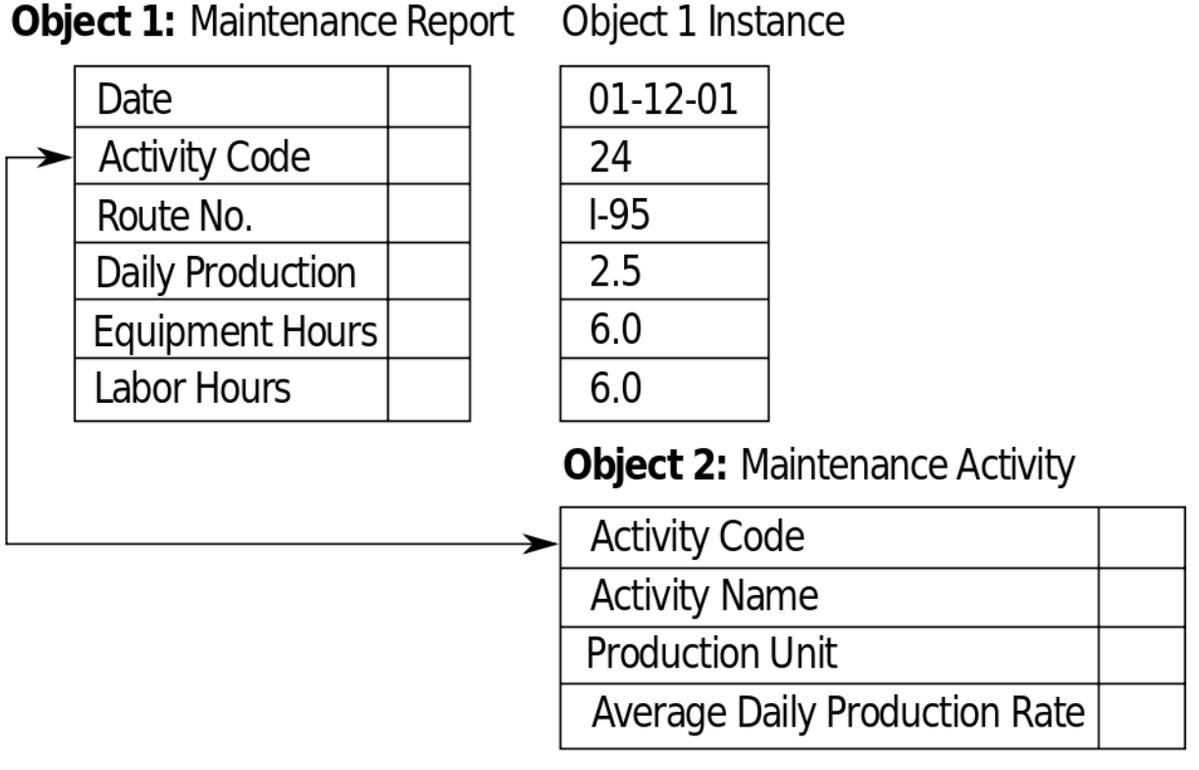


object-oriented model

- Adds database functionality to object-oriented languages by allowing persistent storage of programming objects
- Avoids overhead of converting information from database representation to application representation (impedance mismatch)
- Applications require less code and use more natural data modelling
- Good for complex data and relationships between data

object-oriented example

Object-Oriented Model



relational model

- Data is organized as **relations**, **attributes** and **domains**
- A **relation** is a table with columns (attributes) and rows (tuples)
- The **domain** is the set of values that the attributes are allowed to take
- Within the relation, each row is unique, the column order is immaterial and each row contains a single value for each of its attributes
- Proposed by E. F. Codd in 1969/70

relational example

Relational Model

Activity Code	Activity Name
23	Patching
24	Overlay
25	Crack Sealing

Key = 24

Activity Code	Date	Route No.
24	01/12/01	I-95
24	02/08/01	I-66

Date	Activity Code	Route No.
01/12/01	24	I-95
01/15/01	23	I-495
02/08/01	24	I-66

associative model

- Data is modelled as entities - having a discrete independent existence - and associations

- It is organised as items - an identifier, name and type - and links - an identifier, source, verb and target

Example:

Flight BA1234 arrived at LAX on 10-Apr-12 at 1:25pm
Items: Flight BA1234, LAX, 10-Apr-12, 1:25pm, arrived at, on, at
Links: (((Flight BA1234 arrived at LAX) on 10-Apr-12) at 1:25pm)

other models

- semi-structured model
  - -- graph-based for information that cannot be constrained by schema, e.g., Web
- object-relational
  - -- adds object capabilities to relational systems, e.g., GIS data