Semantic models for data models, Application of Semantic models

Data Models and its types

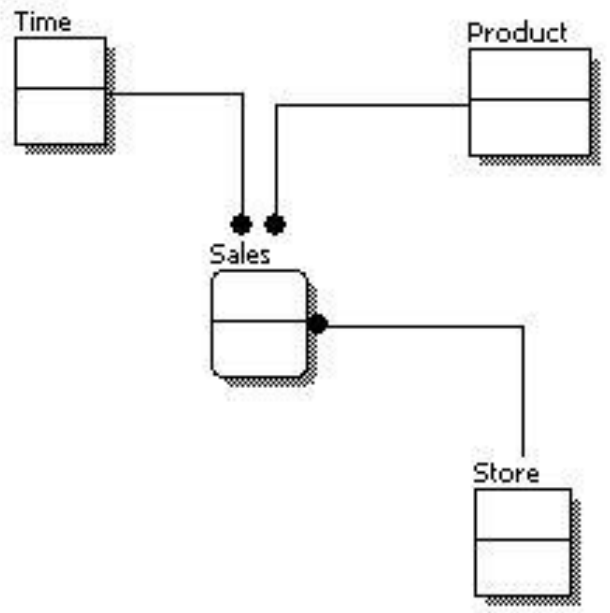
- **Data models** are used to represent the data and how it is stored in the database and to set the relationship between data items. Three types of data models
- **Conceptual Data Model:** This Data Model defines **WHAT** the system contains. This model is typically created by Business stakeholders and Data Architects. The purpose is to organize, scope and define business concepts and rules.
- **Logical Data Model:** Defines **HOW** the system should be implemented regardless of the DBMS. This model is typically created by Data Architects and Business Analysts. The purpose is to developed technical map of rules and data structures.
- **Physical Data Model**: This Data Model describes **HOW** the system will be implemented using a specific DBMS system. This model is typically created by DBA and developers. The purpose is actual implementation of the database.

Conceptual Data Model

- A **Conceptual Data Model** is an organized view of database concepts and their relationships. The purpose of creating a conceptual data model is to establish entities, their attributes, and relationships. In this data modeling level, there is hardly any detail available on the actual database structure. **Business stakeholders and data architects typically create a conceptual data model.**
- The 3 basic tenants of Conceptual Data Model are
  - **Entity**: A real-world thing
  - **Attribute**: Characteristics or properties of an entity
  - **Relationship**: Dependency or association between two entities
- Data model example:
  - Customer and Product are two entities. Customer number and name are attributes of the Customer entity
  - Product name and price are attributes of product entity
  - Sale is the relationship between the customer and product

Conceptual data model

- Highest level relationship between different entities.
- Shows the important entities and relation between them.
- Entities that describe the data and relation between those entities shown. No other information.
- No attribute is specified.
- No primary key



Logical data model

- A logical data model describes how the data will be physically implemented in the database. More information than conceptual.
- Includes all entities and relation between them
- All attributes of each entry specified.
- Primary and foreign key specified.
- Foreign keys are specified.

Steps for designing logic data model:

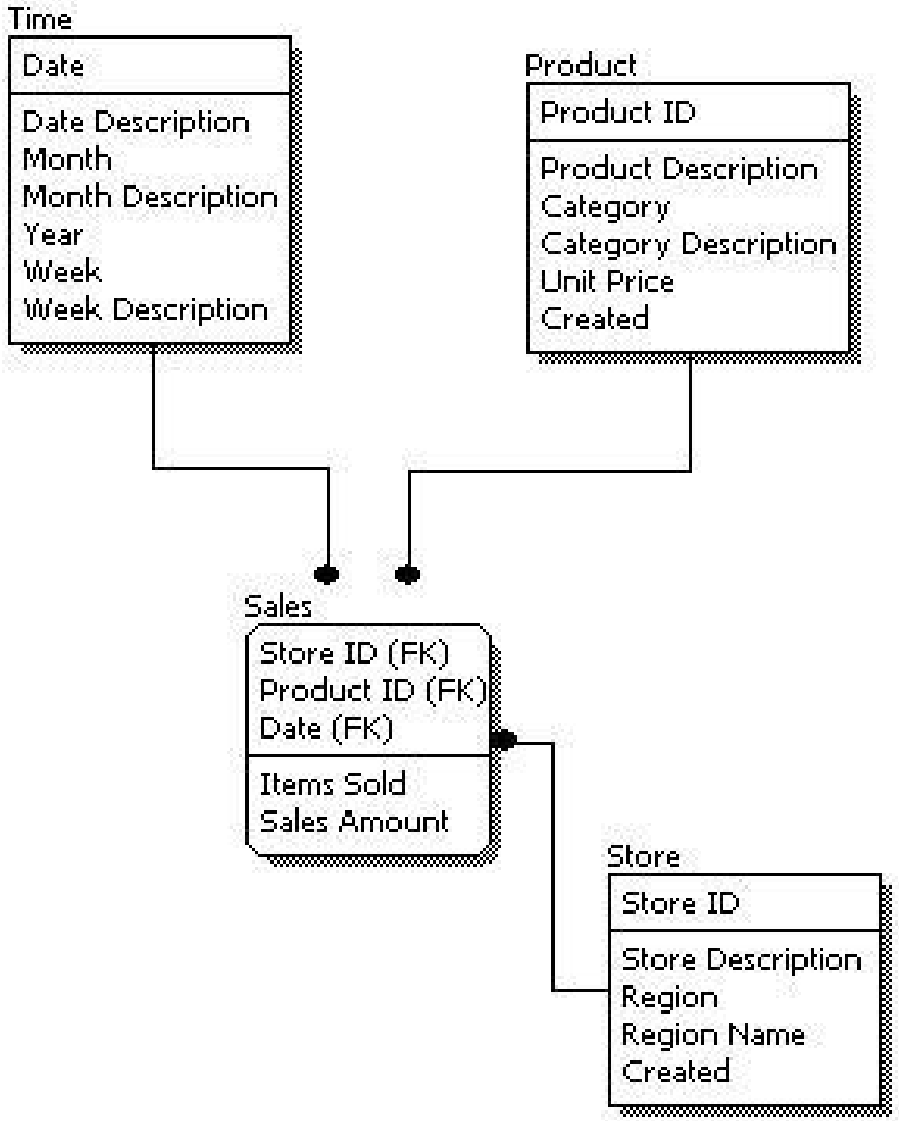
Specify primary keys and find relation between entities.

Find all attributes for each entity.

Resolve many-to-many relationship.

Normalization.

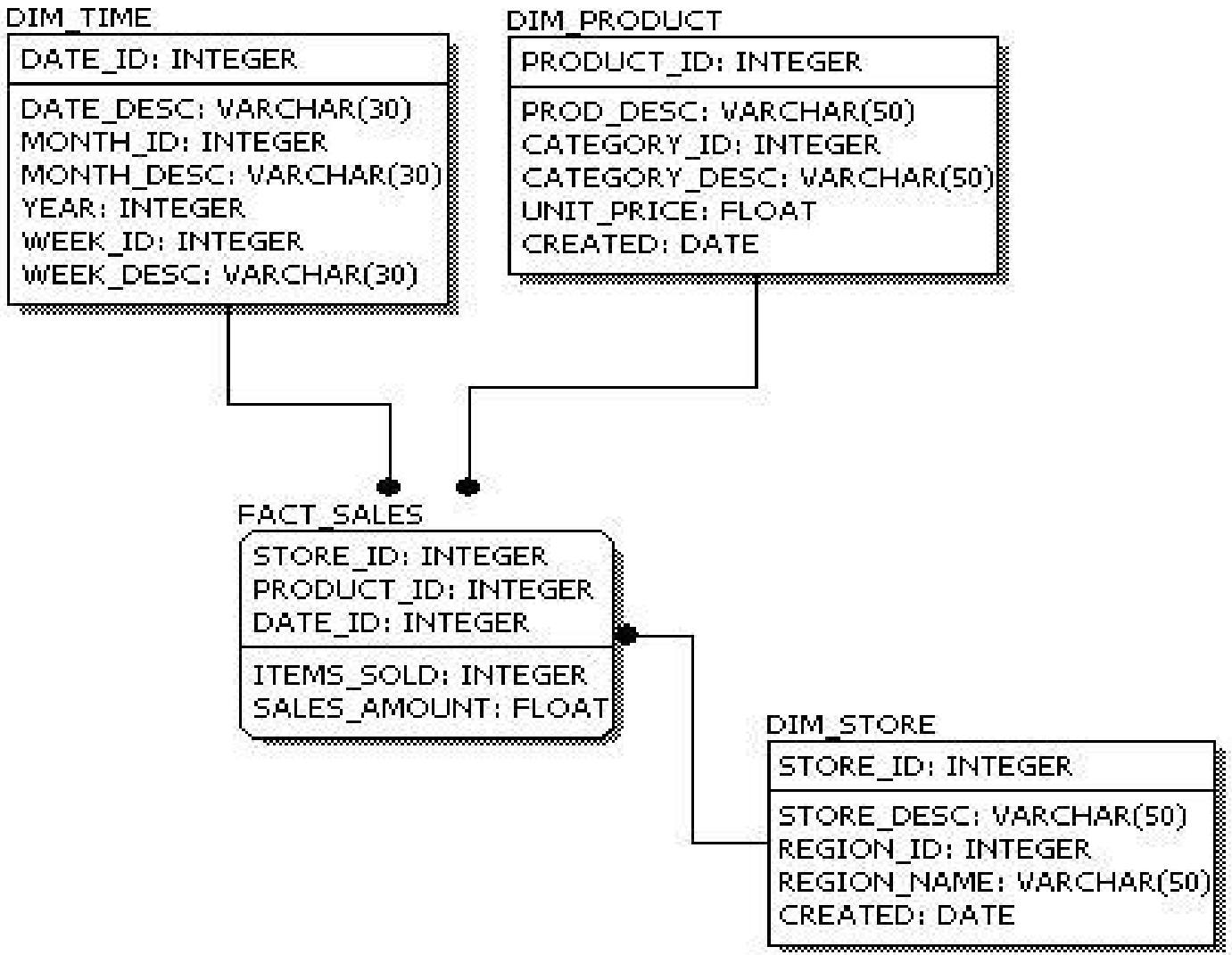
Logical data model



Physical data model

- How the model will be built in the database.
- A physical database model shows all table structures, including column name, column data type, column constraints, primary key, foreign key, and relationships between tables.
- Specification all tables and columns.
- Foreign keys are used to identify relationships between tables.
- Physical considerations may cause the physical data model to be quite different from the logical data model.
- Physical data model will be different for different RDBMS

Physical data model



Characteristics of a physical data model:

- The physical data model describes data need for a single project or application though it maybe integrated with other physical data models based on project scope.
- Data Model contains relationships between tables that which addresses cardinality and null ability of the relationships.
- Developed for a specific version of a DBMS, location, data storage or technology to be used in the project.
- Columns should have exact data types, lengths assigned and default values.
- Primary and Foreign keys, views, indexes, access profiles, and authorizations, etc. are defined.

Advantages of Data model:

- The main goal of a designing data model is to make certain that data objects offered by the functional team are represented **accurately**.
- The data model should be **detailed enough** to be used for building the physical database.
- The information in the data model can be used for defining the **relationship** between tables, primary and foreign keys, and stored procedures.
- Data Model helps business to **communicate** within and across organizations.
- Data model helps to **document** data mappings.
- Help to **recognize correct sources** of data to populate the model

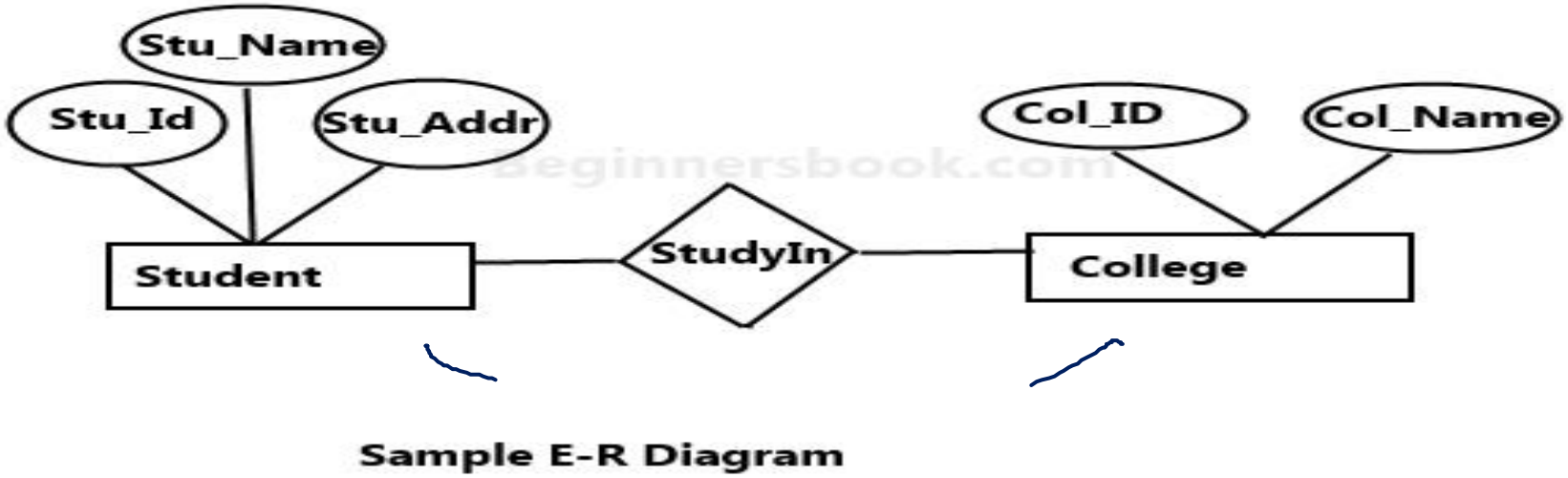
Challenges of Data model:

- To develop Data model one should know physical **data stored characteristics**.
  - Eg. In a navigational system application development, management - requires a knowledge of the biographical truth.
- Even **smaller change** made in structure require modification in the entire application.
  - There is no set data manipulation language in DBMS.

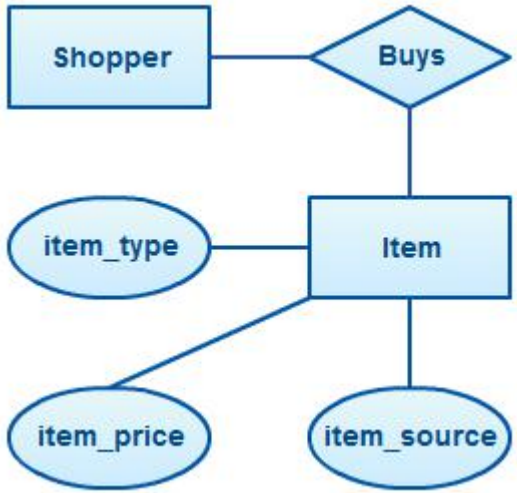
Entity Relationship (E-R) Model (Technique)

- An Entity–relationship model (ER model) **describes the structure of a database** with the help of a diagram, which is known as Entity Relationship Diagram (ER Diagram). An ER model is a design or blueprint of a database that can later be implemented as a database. The main components of E-R model are: **entity set and relationship set.**

Example of E-R Model



Sample E-R Diagram



Sample E-R Diagram

E-R Model

- Advantages:
  - Simple and easy to understand
  - Popular

  Disadvantages:

  Not formally defined.

  Deals with integrity constraints

  Difficult to distinguish entities from relationships

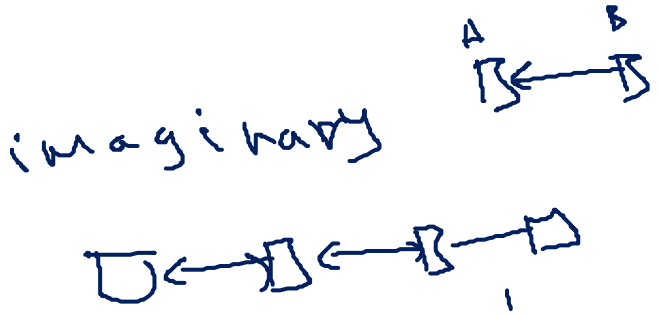
  Has redundant modelling information.

Semantic models for data models

- Semantic data model is **a method of structuring data in order to represent it in a specific logical way**. It is a conceptual data model that includes semantic information that adds a basic meaning to the data and the relationships that lie between them.
- Why? Need to define data in a conceptual view.
- Semantic Data Modelling is a technique used to **define the meaning of data** within the context of its **interrelationships with other data**. In terms of resources, ideas, events, etc., the real world is symbolically defined within physical data stores.

  defines how the stored symbols relate to the real world.

Principles of semantic models



- Relationship exists between a data model and a part of the existing world.
- Also possible that a data model has a relationship with some imaginary and abstract world.
- Three abstractions: Classification, Aggregation, Generalisation.
- Classification: to model instance of relations. semantic data model can be represented graphically in an Abstraction Hierarchy diagram showing the types (as boxes) and their inter-relations (as lines). simple notation principle makes the diagrams very easy to read and understand, even for non-datamodellers.

Principles of semantic models

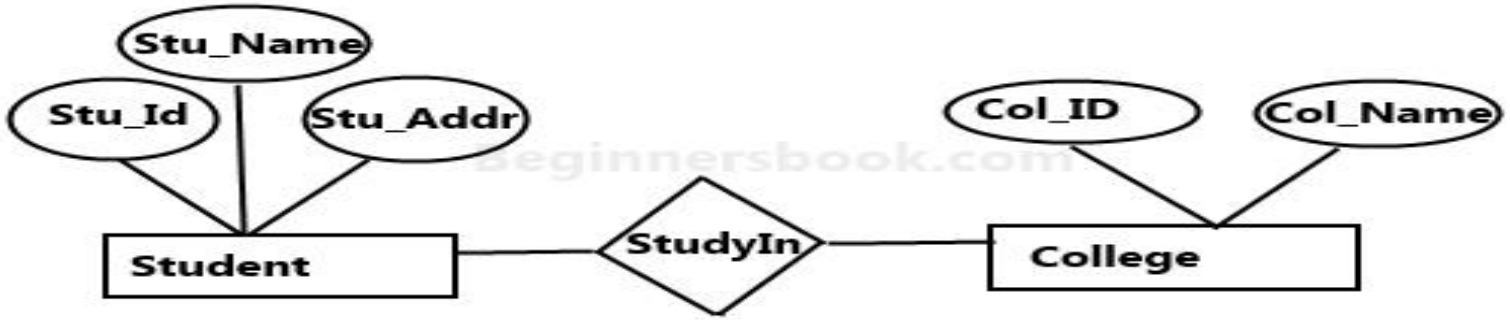
- Aggregation: A type can have attributes (properties), but attributes have a type of their own (for example the type “name”) and must be part of a composite type: thus an attribute defines a connection or aggregation of two types. For example, “name” can be an attribute of the type “employee”. Using the semantic language, this attribute can be specified as “employee its name”.
- Generalisation: The mandatory attribute fields are required. Each attribute field must be filled correctly and NULL-values are not allowed.

Data Integrity Rules in Semantic models

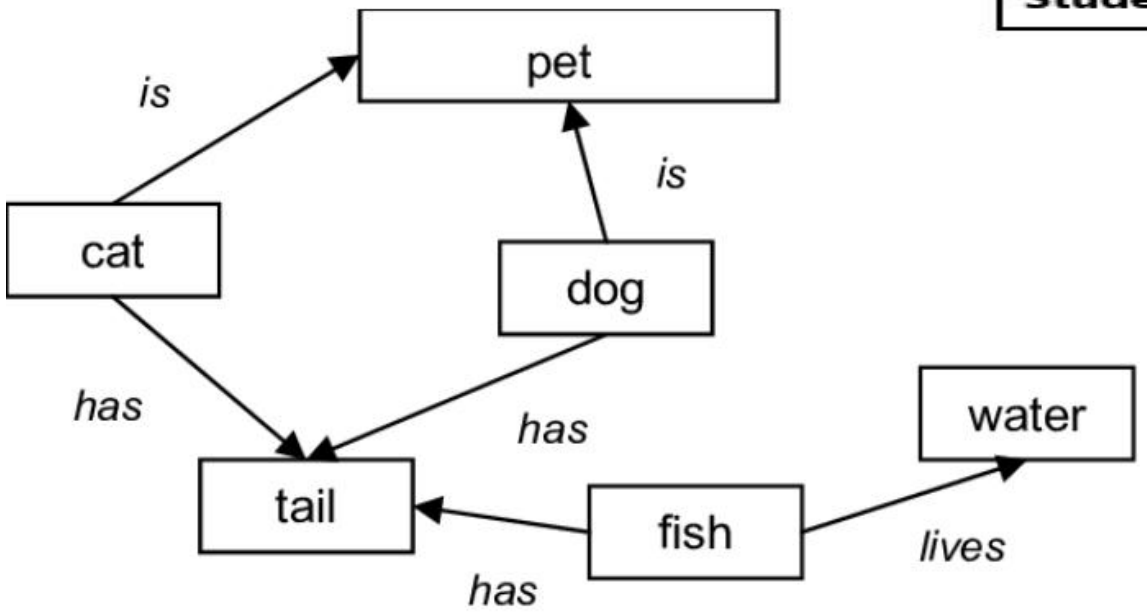
- **Relatability:** Each attribute in a type definition is related to one and only one equally named type, while each type may correspond with various attributes in other types.

- · **Convertibility:** Each type definition is unique: there are no type definitions carrying the same name or the same collection of attributes.

Semantic network vs E-R diagram



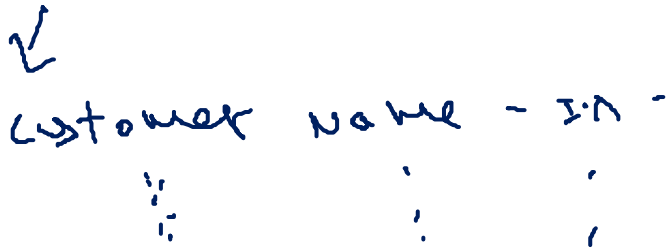
Sample E-R Diagram



Semantic network

Semantic Data Model Requirements

- allow to specify **well-defined schemata**
- be simple to use, make no assumptions about the semantics of the metadata.
- be platform independent and provide **interoperability** between applications that manage and exchange metadata
- facilitate integration with resources outside the file store and support exporting metadata to the web



Applications of Semantic Data Models

- **Planning of Data Resources:** A preliminary data model can be used to provide an overall view of the data required to run an enterprise.
- **Building of Shareable Databases:** A fully developed model can be used to define an application independent view of data which can be validated by users and then transformed into a physical database design for any of the various DBMS technologies. development costs can be drastically reduced

Applications of Semantic Data Models

- **Evaluation of Vendor Software:** vendor software can be evaluated against a company's data model in order to identify possible inconsistencies between the infrastructure implied by the software.

- **Integration of Existing Databases:** By defining the contents of existing databases with semantic data models, an integrated data definition can be derived.