KGE - Knowledge Graph Engineering

Informal Modelling
ER Model & EER model

Fausto Giunchiglia

Contents

ER Model - Definition

- An **Entity–Relationship (ER) Model** describes interrelated things of interest in a specific domain of knowledge.

- It is composed of **classes** / **entity types** (etypes) (which classify the things of interest, i.e. **entities**) and specifies **relationships** that can exist between entities (instances of those entity types).

- The ER model is, thus, an **abstract data model** that defines a data or information structure which can be implemented in a data/knowledge base.

- It is usually drawn in a graphical form as **boxes (classes)** that are connected by **lines (relationships)** which express the associations and dependencies between entities.

- An ER model is the **informal foundation** for the specification of domain-specific teleologies.

ER Model - Notations

Following are the main components and its symbols in ER Diagrams:

- **Rectangles**: This Entity Relationship Diagram symbol represents entity types.

- **Ellipses** : This symbol represents attributes.

- Diamonds: This symbol represents relationship types.

- **Lines**: It links attributes to entity types and entity types with other relationship types.

- **Identifying attributes** are underlined.

ER Model - A Simple Example

ER Model & Diagrams
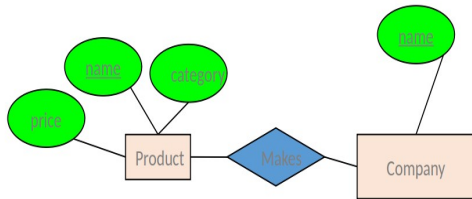
ER is a *visual syntax* for DB design which is ***precise enough*** for technical points, but ***abstracted enough*** for non-technical people.

Reference: M. Hahsler. DS1300: The ER Model.

ER Model - Entities and Entity Types

- **Entities** & **entity types** are the primitive units of the ER model

  - <u>Entities</u> are the individual objects (instances), which are members of entity types
  - <u>Entity type</u> are the *classes* or *types* of objects in our model
  - Example: Person is an entity type while Michael is an entity.
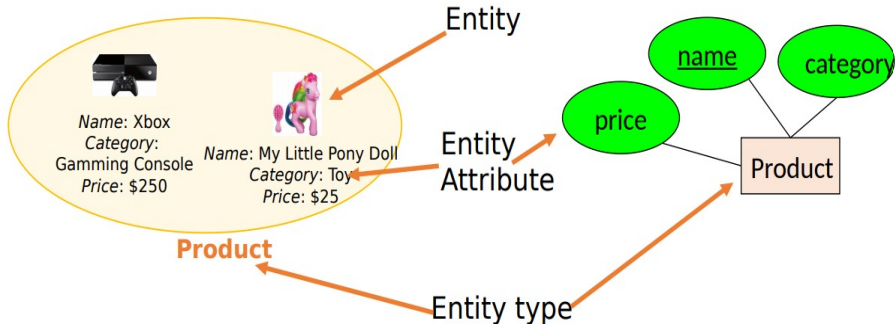 - *We **use entity types** in ER models*

Product

Person

Reference: M. Hahsler. DS1300: The ER Model.

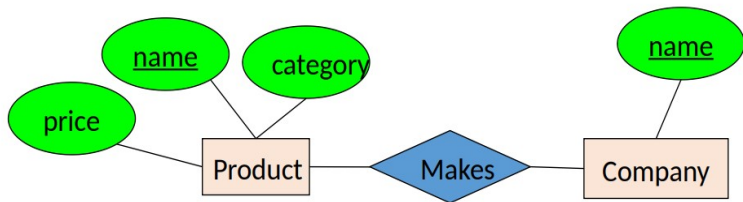# ER Model - Entities vs. Entity Types

Example:

Entities are **not** explicitly represented in ER diagrams!

Reference: M. Hahsler. DS1300: The ER Model.

ER Model - Relationships

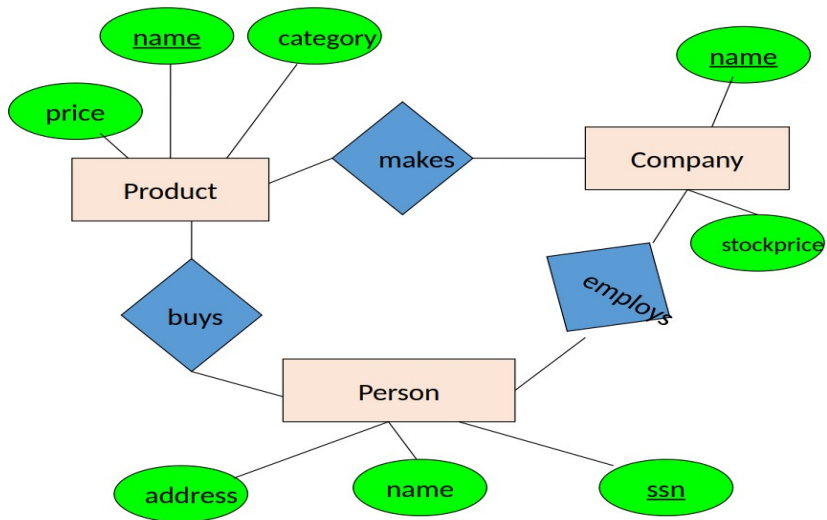- A **relationship type** is between two entity types

How to read a relationship in both directions:
1. A product is made by a company
2. A company makes a product

Reference: M. Hahsler. DS1300: The ER Model.

ER Model - Example


Reference: M. Hahsler. DS1300: The ER Model.

Contents

Extended ER (EER) Model

- The **Extended ER (EER) Model** includes all of the concepts introduced by the ER model.

- Additionally it includes the concepts of a **subclass and superclass ('is-a' relation)**. Super class is an entity that can be divided into further sub-classes. Sub class inherits the properties and attributes from super class.

- It also includes **Generalization / Specialization**. Generalization is a process of generalizing an entity which contains generalized attributes or properties of generalized entities. Specialization is a process of identifying subsets of an entity that share some different characteristic.

- It was developed to reflect more precisely the properties and constraints that are found in more **complex data/knowledge bases**.

Superclass/Subclass


Fig. Super class/Sub class Relationship

Image Source
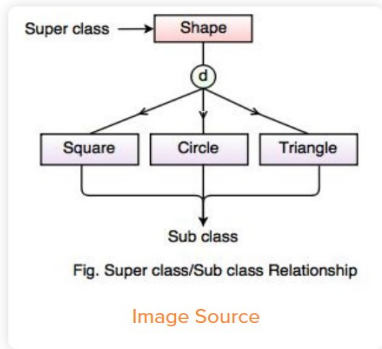
A superclass is a high-level entity that can be further segmented into subclasses or subsets. It is also referred to as a Parent class. For example, if Shape is considered an entity, then a Square, Circle, and Triangle are possible subclasses. A subclass can be referred to as a child or derived class. In this case, Shape is the superclass.

Note: 'd' stands for disjoint (subclasses).

EER Models - Characteristics

- A subclass is said to **inherit** from a superclass. A subclass can inherit from many superclasses in the hierarchy.

- When a subclass inherits from one or more superclasses, it inherits all their attributes.

- In addition to the inherited attributes, a subclass can also define its own specific attributes.

- The process of making a superclass from a group of subclasses is called generalization.

- The process of making subclasses from a general concept is called specialization.
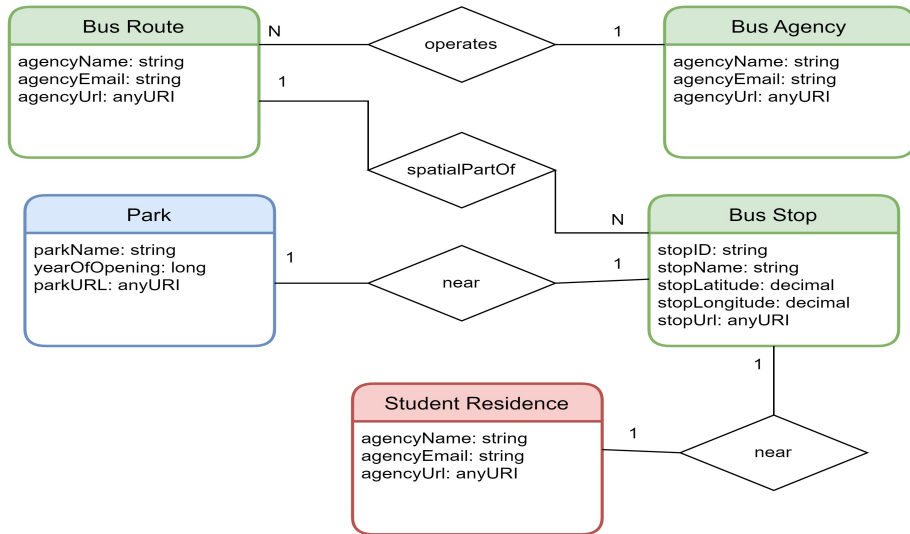
EER Model - Example
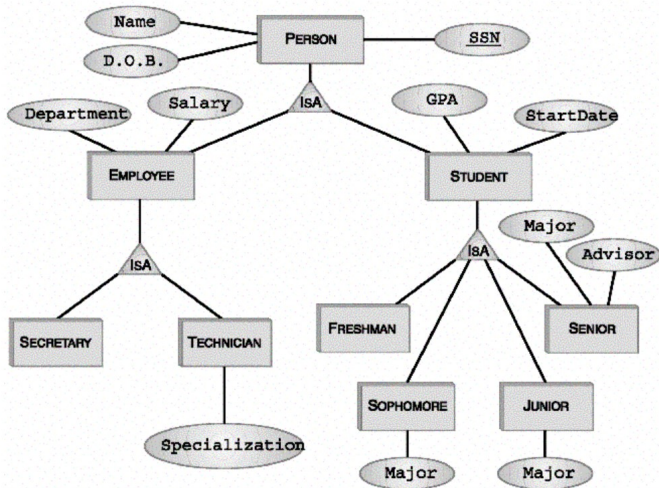
Reference: jcsites.juniata.edu

Contents

KGE ER Example - Transportation

KGE ER Notations

- Each rounded rectangle (e.g., Bus Route) denotes an entity type (etype) with data properties (e.g., agencyName)

- The rhombus denotes an object property (e.g., near) linking two etypes (e.g., 'Student Residence' *near* 'Bus Stop')

- The blue colored rounded rectangle (e.g., park) denotes a common entity type (e.g., with respect to Transportation domain).

- The green colored rounded rectangle (e.g., 'Bus Stop') denotes a core entity type (e.g., with respect to Transportation domain).

- The red colored rounded rectangle (e.g., 'Student Residence') denotes a contextual entity type (e.g., with respect to Transportation domain).

KGE ER Relationship Cardinality

CHEN notation

Cardinality – The number of entities to which another entity can be associated through a relationship
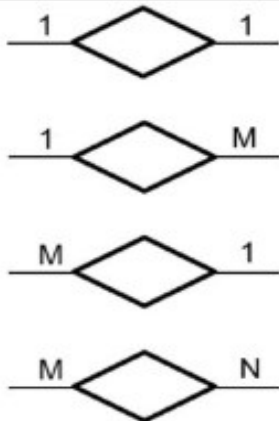
The diagrams on the right show, in order:

one-to-one

one-to-many

many-to-one

many-to-many

NOTE: CHEN notation is Peter PS. Chen's original ER diagram notation.

KGE ER Notation - Cardinality

- **One-to-One:** One entity from entity type X (e.g., 'Student Residence') can be associated (e.g., 'near') with one entity of entity type Y (e.g., 'Bus Stop').

- **One-to-Many:** One entity from entity type X (e.g., 'Bus Agency') can be associated (e.g., 'operates') with multiple entities of entity type Y (e.g., 'Bus Route').

- **Many-to-One:** Multiple entities from entity type X (e.g., 'Bus Stop') can be associated (e.g., 'spatialPartOf') with one entity of entity type Y (e.g., 'Bus Route').

- **Many-to-Many:** Multiple entities from entity type X can be associated with multiple entities of entity type Y, e.g., multiple students supervised by multiple faculty members, AND, multiple faculty members supervising mutiple students.

Contents

References

- Giunchiglia, Fausto, and Mattia Fumagalli. "Teleologies: Objects, actions and functions." International conference on conceptual modeling. Springer, Cham, 2017.

- Giunchiglia, Fausto, and Mattia Fumagalli. "Concepts as (Recognition) Abilities." In FOIS, pp. 153-166. 2016.

- tutorialspoint.com

- GeeksforGeeks

Fausto Giunchiglia

Informal Modelling
ER Model & EER model