# KDI
# EER: The Extended ER Model

Fausto Giunchiglia and Mattia Fumagallli

University of Trento

## Extended Entity Relationship Model

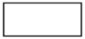
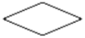
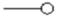
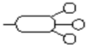
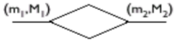
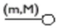
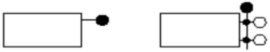
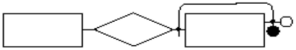
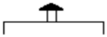
*The* ***Extended Entity-Relationship*** *(EER)* ***model*** *is a* ***conceptual*** *(or* ***semantic****) data model, capable of describing the data requirements for a new information system in a direct and easy to understand graphical notation.*

*Data requirements for a database are described in terms of a* ***conceptual schema,*** *using the EER model.*

*EER schemata are comparable to UML class diagrams.*

*Actually, what we will be discussing is an extension of Peter Chen's proposal (hence "extended" ER).*

## The Constructs of the EER Model

| Construct | Graphical representation |
|---|---|
| Entity |  |
| Relationship |  |
| Simple attribute |  |
| Composite attribute |  |
| Cardinality of a |  |
| Cardinality of an attribute |  |
| Internal identifier |  |
| External identifier |  |
| Generalization |  |
| Subset | |

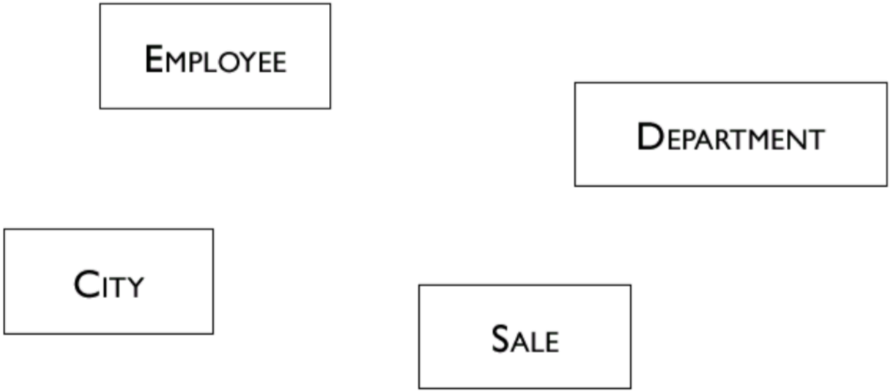
## Entities

*These represent classes of objects (facts, things, people,...) that have properties in common and an autonomous existence.* City, Department, Employee, Purchase *and* Sale *are examples of entities for a commercial organization.*

*An instance of an entity represents an object in the class represented by the entity. Stockholm, Helsinki, are examples of instances of the entity* City, *and the employees* Peterson *and* Johanson *are examples of instances of the* Employee *entity.*

*The EER model is very different from the relational model in a number of ways; for example, in EER it is not possible to represent an object without knowing its properties, but in the relational model you need to know its key attributes.*

## Example of Entities



## Relationship

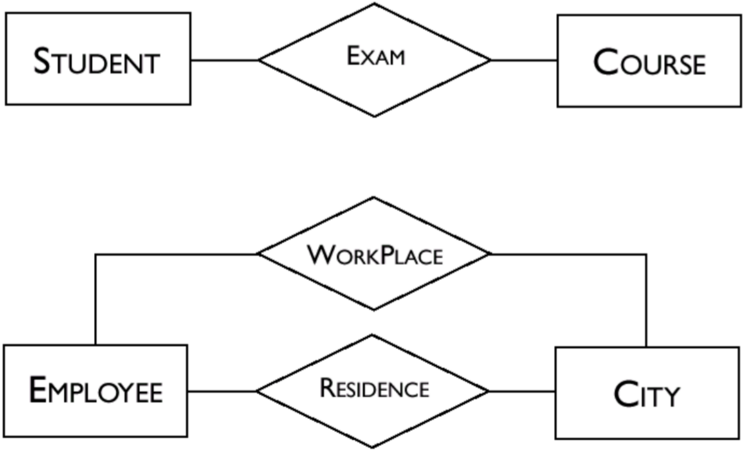
*They represent logical links between two or more entities.*

Residence *is an example of a relationship that can exist between the entities* City *and* Employee*; Exam is an example of a relationship that can exist between the entities Student and Course.*

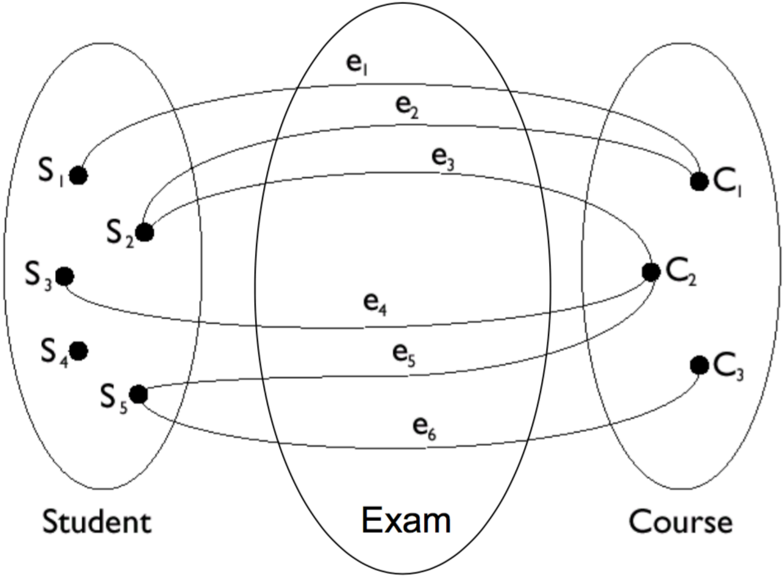
*An instance of a relationship is an n-tuple made up of instances of entities, one for each of the entities involved.*

*The pair (*Johanssen, Stockholm*), or the pair (*Peterson, Oslo*), are examples of instances of the relationship Residence.*

## Example of Relationship



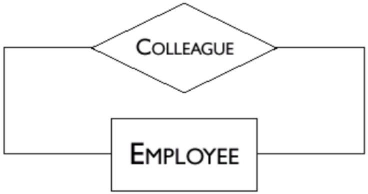
## Example of Instances (for exam)

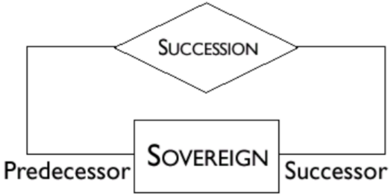


## Recursive relationship

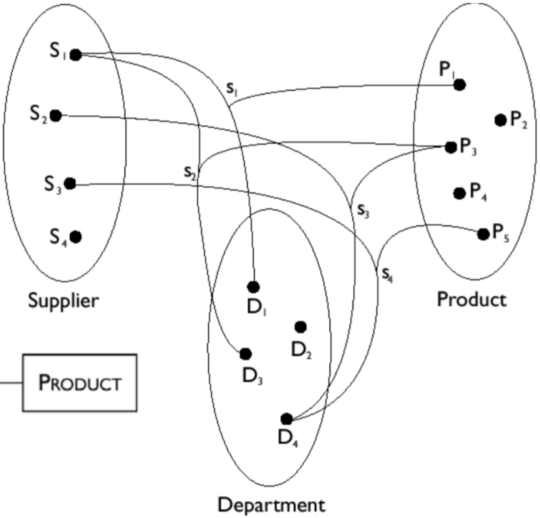
***Recursive*** *relationships are also possible, that is relationships between an entity and itself.*

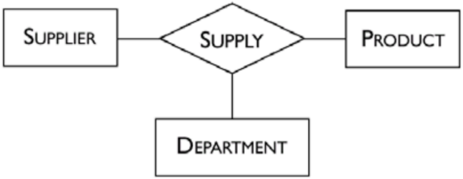
*Note in the second example that the relationship is not symmetric. In this case it is necessary to indicate the two* ***roles*** *that the entity involved plays in the relationship.*



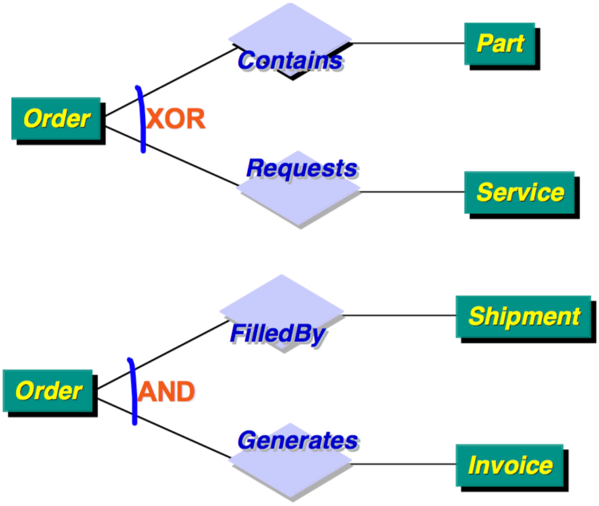


## Ternary relationship





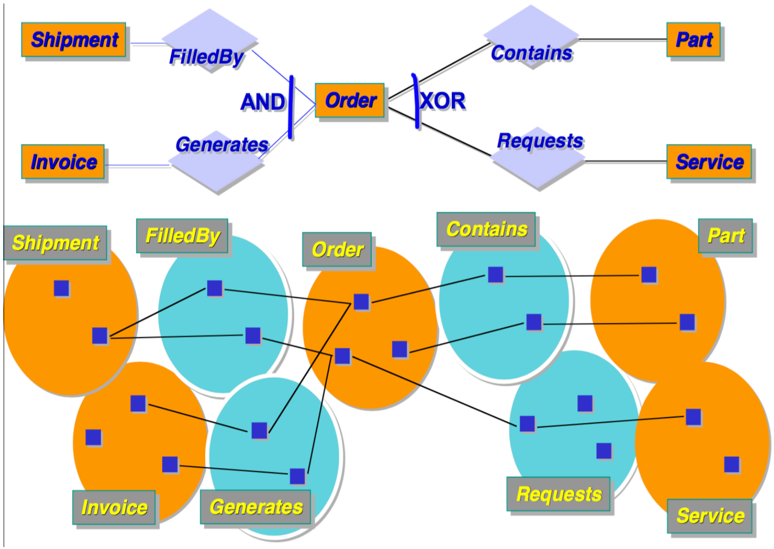
## AND/XOR for Relationships



"Orders either order a part or request a service, but not both"

"For any given order, whenever there is at least one invoice there is also at least one shipment and vice versa"

## AND/XOR for Relationships



## Attributes

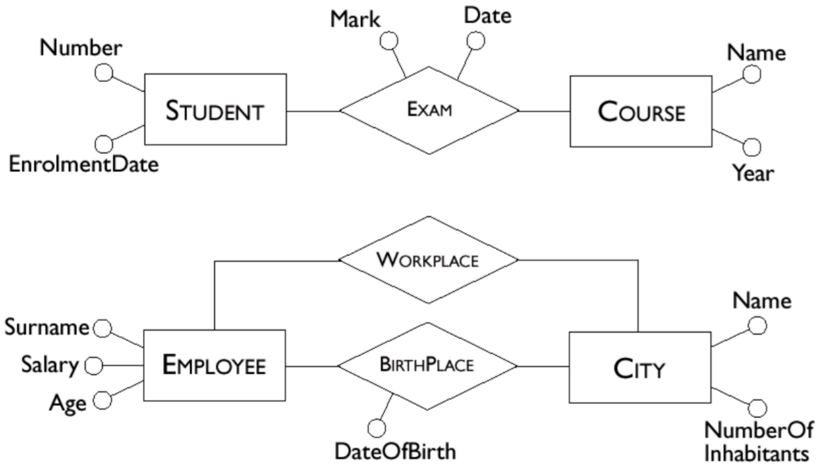
*Attribute describe the elementary properties of entities or relationships.*

*For example,* Surname, Salary *and* Age *are possible attributes of the* Employee *entity, while* Date *and* Mark *are possible attributes for the relationship* Exam *between* Student *and* Course.

*An attribute associates with each instance of an entity (or relationship) a value belonging to a set known as the* ***domain*** *of the attribute.*

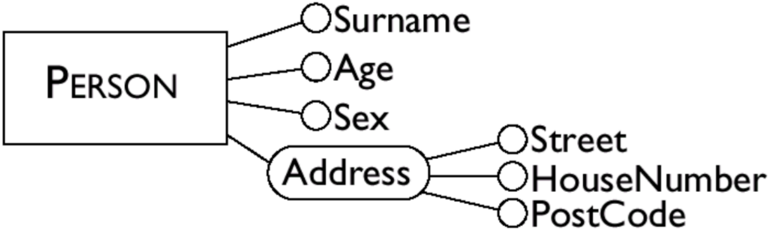
*The domain contains the admissible values for the attribute.*

## Attribute Example

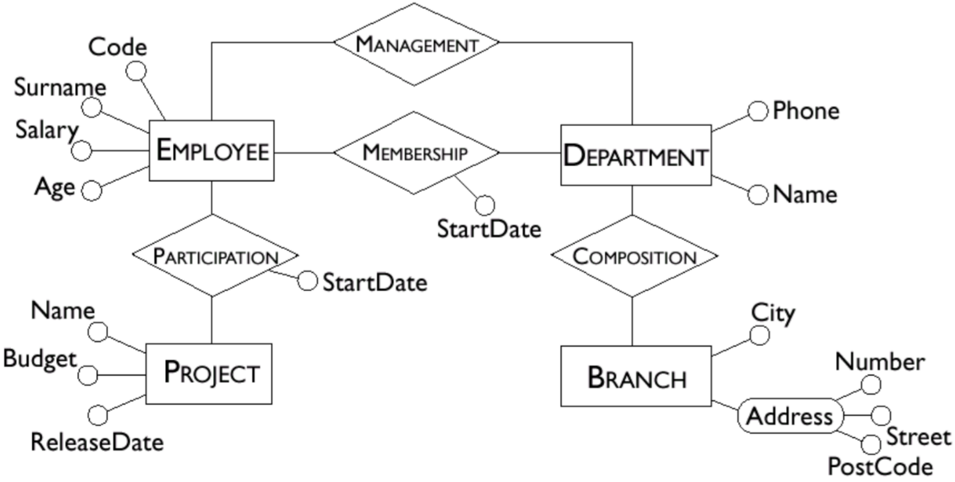


## Composite Attribute

*It is sometimes convenient to group attributes of the same entity or relationship that have closely connected meanings or uses. Such groupings are called **composite attributes** aka **complex attribute**.*

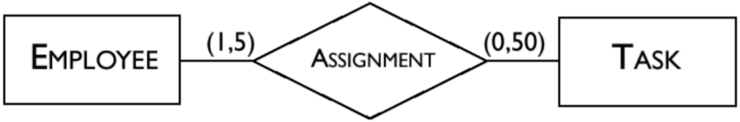


## Schema with Attributes



## Cardinalities

- *These are specified for each entity participating in a relationship and describe the maximum and minimum number of relationship occurrences in which an entity occurrence can participate.*
- *Cardinalities state how many times can an entity instance participate in instances of a given relationship.*



- *"An employee can participate in 1 to 5 assignments"*
- *"A task can participate in 0 to 50 assignments"*

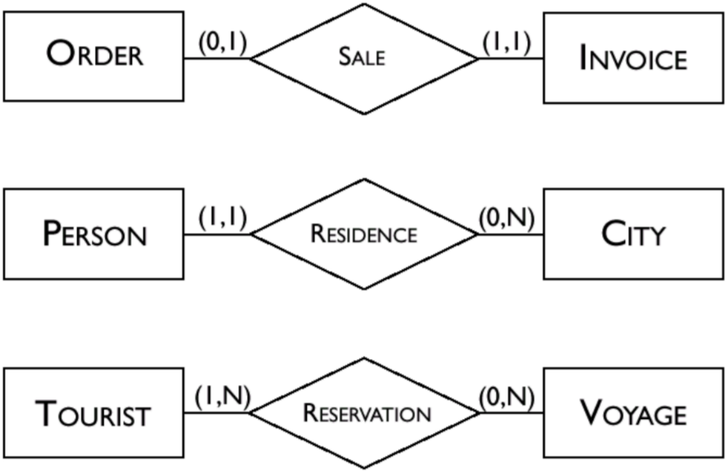
## Cardinalities

*In principle, a cardinality is any pair of non-negative integers (n,m) such that n≤m. or a pair of the form (n,N) where N means "any number".*

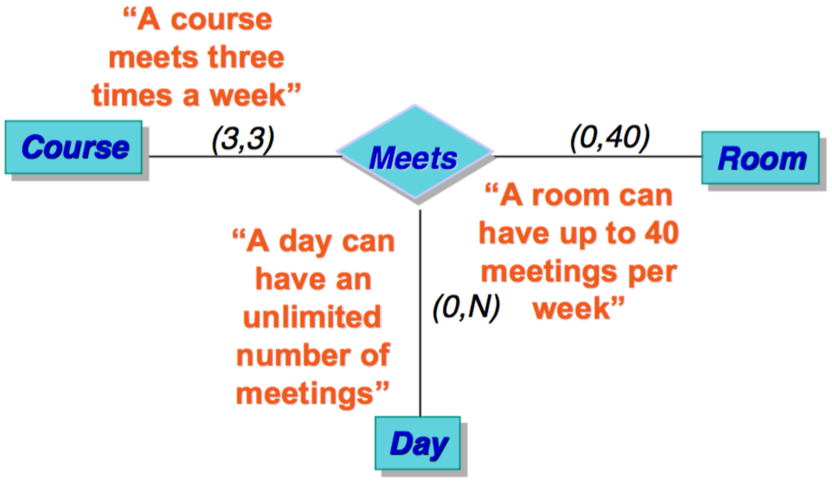
*If minimum cardinality is 0, we say that entity participation in a relationship is optional. If minimum cardinality is 1, we say that entity participation in a relationship is mandatory.*

*If maximum cardinality is 1, each instance of the entity is associated at most with a single instance of the relationship; if maximum cardinality is N, then each instance of the entity is associated with an arbitrary number of instances of the relationship.*

## Cardinality Examples

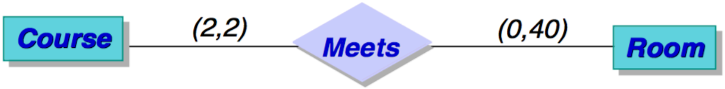


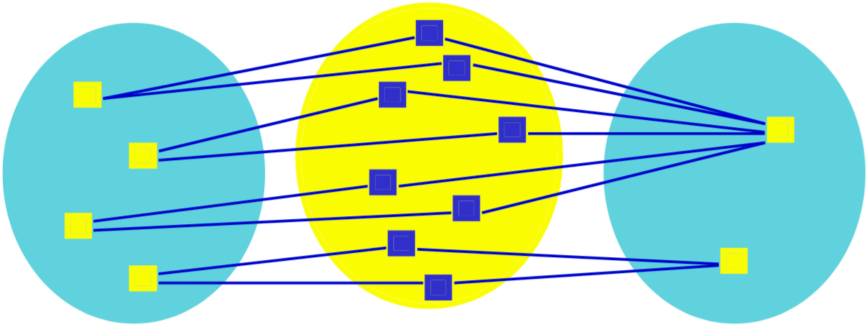
## Cardinality Examples


"A course meets three times a week"
Course
(3,3)
Meets
(0,40)
Room
"A room can have up to 40 meetings per week"
"A day can have an unlimited number of meetings"
(0,N)
Day

## Instantiating ER Diagrams

*An EER diagram specifies what states are possible in the world that is being modeled*



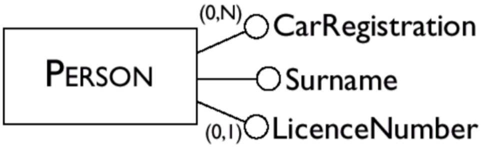


## Cardinalities of Attributes

*They are specified for the attributes of entities (or relationships) and describe the minimum and maximum number of values of the attribute associated with instances of an entity or a relationship.*

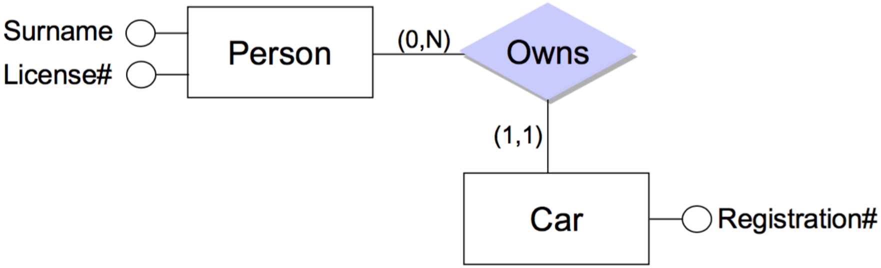
*In most cases, the cardinality of an attribute is equal to (1,1) and is omitted (**single-valued** attributes)*

*The value of a certain attribute however, may also be null, or there may exist several values of a certain attribute for an entity instance (**multi-valued** attributes)*



## Cardinalities of Attributes

*Multi-valued attributes should be used with great caution, because they represent situations that can be modelled in many cases with additional entities linked by one-to-many (or many-to-many) relationships to the entity to which they refer.*



## Identifiers

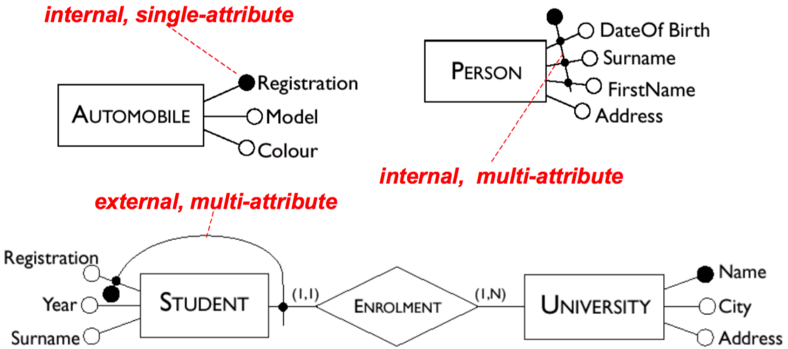
***Identifiers*** *(or* ***keys****) consist of one or more attributes which identify uniquely instances of an entity.*

*In many cases, an identifier is formed by one or more attributes of the entity itself: in this case we talk about an* ***internal*** *identifier.*

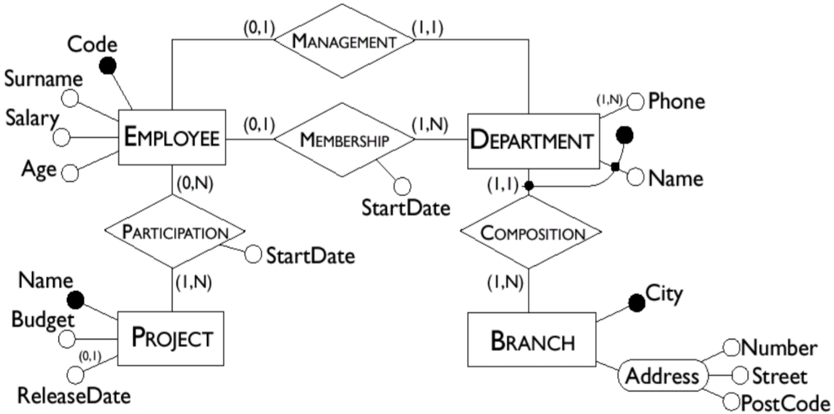
*Sometimes, however, the attributes of an entity are not sufficient to identify its instances unambiguously and other entities are involved in the identification. Identifiers of this type are called* ***external*** *identifiers.*

*An identifier for a relationship consists of identifiers for all the entities it relates. For example, the identifier for the relationship (Person-) Owns(-Car) is a combination of the Person and Car identifiers.*

## Examples of Identifiers



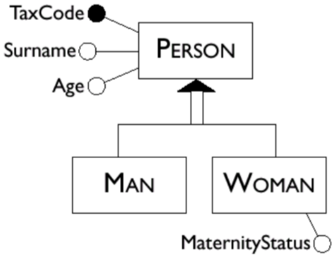
## Schema with Identifiers

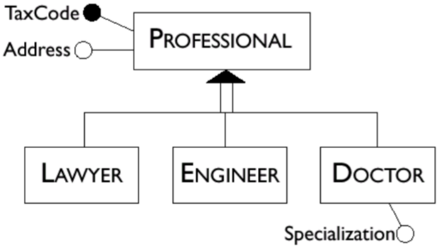


## Generalizations

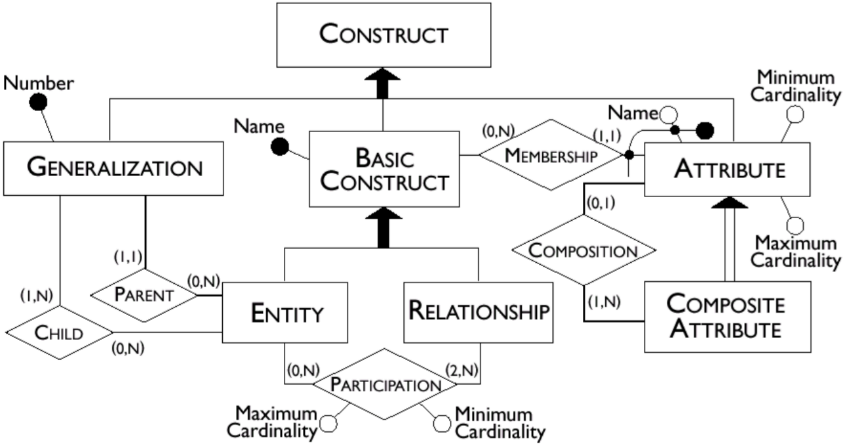
*These represent logical links between an entity E, known as* ***parent*** *entity, and one or more entities E1,…,En called* ***child*** *entities, of which E is more general, in the sense that they are a particular case.*

*In this situation we say that E is a* ***generalization*** *of E1,…,En and that the entities E1,…,En are* ***specializations*** *of E.*

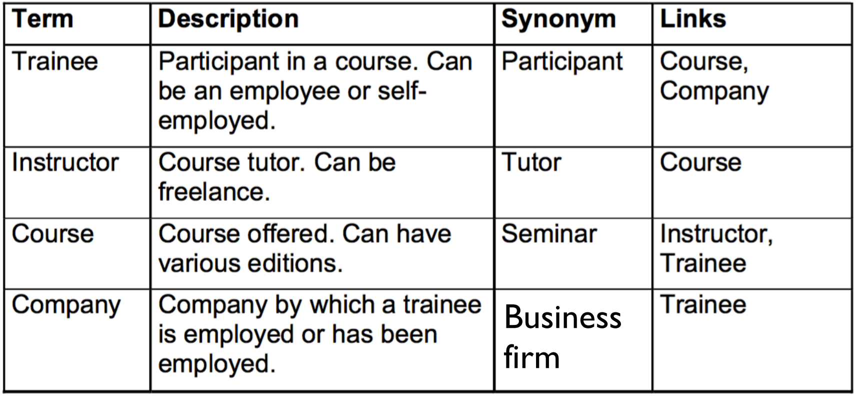




## The EER Model, as an EER Diagram



## Glossary Example



| Term | Description | Synonym | Links |
|---|---|---|---|
| Trainee | Participant in a course. Can be an employee or self-employed. | Participant | Course, Company |
| Instructor | Course tutor. Can be freelance. | Tutor | Course |
| Course | Course offered. Can have various editions. | Seminar | Instructor, Trainee |
| Company | Company by which a trainee is employed or has been employed. | Business firm | Trainee |

## Conceptual Modeling Strategies

*The design of a conceptual schema for a given set of requirements is an engineering process and, as such, can use design strategies from other disciplines:*

- ✓ *Top-down*
- ✓ *Bottom-up*
- ✓ *Middle-out*
- ✓ *Mixed*

## Qualities for a Conceptual Schema

***Correctness***. *Conceptual schema uses correctly the constructs made available by the conceptual model. As with programming languages, the errors can be* ***syntactic*** *or* ***semantic***.

***Completeness***. *Conceptual schema represents all data requirements and allows for the execution of all the operations included in the operational requirements.*

***Readability***. *Conceptual schema represents the requirements in a way that is natural and easy to understand. Therefore, the schema must be self-explanatory; for example, by choosing suitable names for concepts.*

***Minimality***. *Schema avoids redundancies, e.g., data that can be derived from other data.*

## References

❑[http://www.cs.toronto.edu/~jm/2507S/Notes04/EER.pdf](http://www.cs.toronto.edu/~jm/2507S/Notes04/EER.pdf)

❑*[Atzeni99] Atzeni, P., Ceri, S., Paraboschi, S., and Torlone, R.,. Database Systems, McGraw-Hill, 1999.*

❑*[Chen76] P. Chen, P., "The Entity-Relationship Model: Towards a Unified View of Data," ACM Transactions on Database Systems 1(1), 1976.*