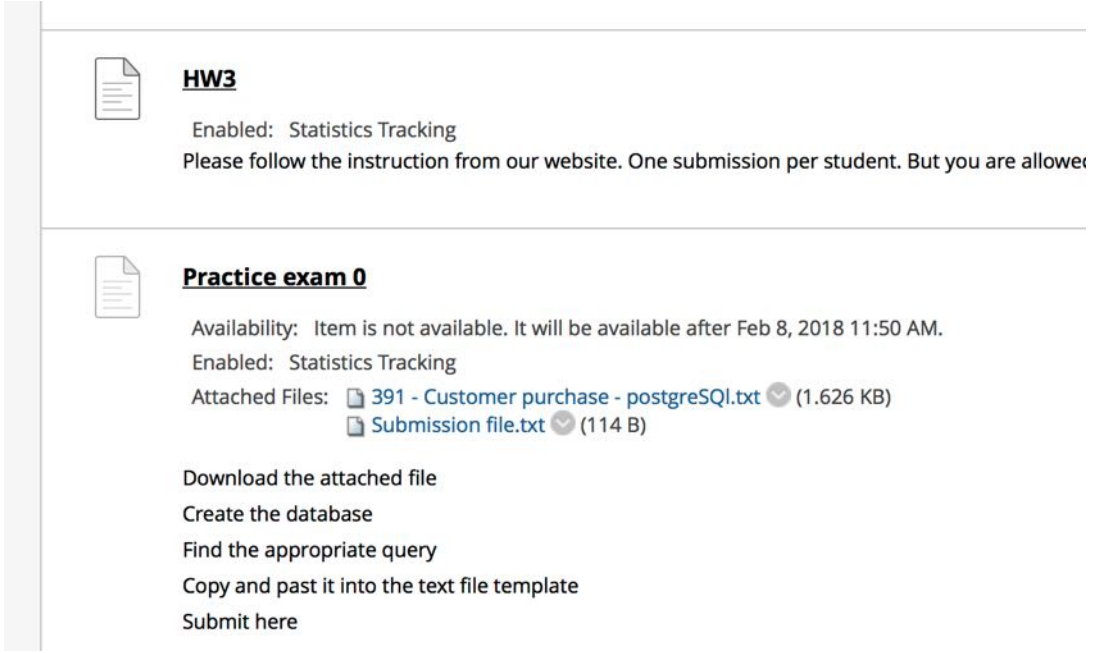
L09: ER modeling 2

CS3200 Database design (sp18 s2)

https://course.ccs.neu.edu/cs3200sp18s2/

2/8/2018

Announcements!

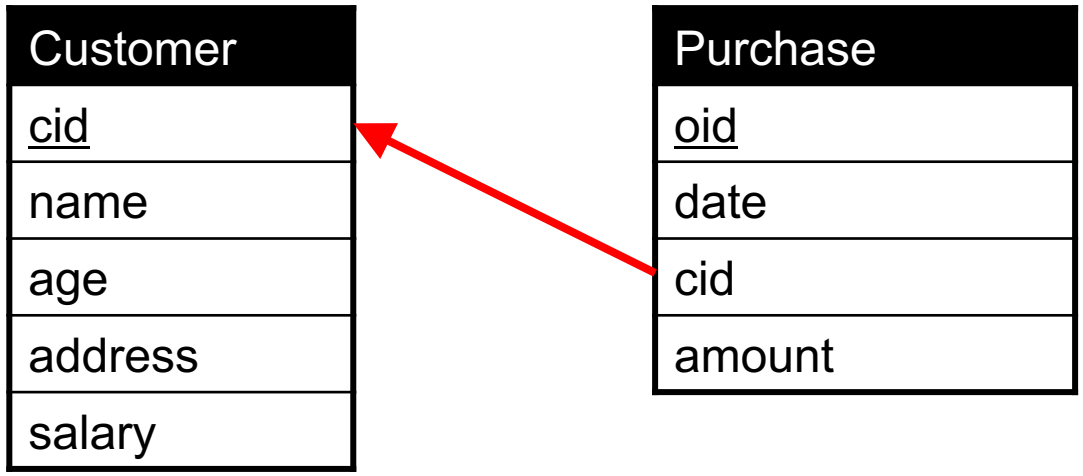


- Avoid sitting in the last row
- Slides are now split up per lecture
- Class attendance: Remaining name tags
- P1 to be released today
- HW collaboration policies
- Exam 1 next Monday. Practice exam 0 today!
  - BB: files available under "assignments" at 11:55
  - Next week: 60min, SQL only, 1 cheat sheet, to be handed in after class, sign honor code

- Outline
  - Practice exam 0
  - ER modeling

Customer/Purchase

391

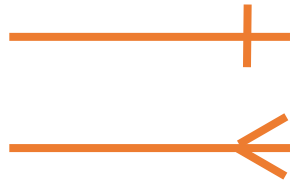


Q1: Find the number of purchases for each customer.
Return customer name and number of purchases.

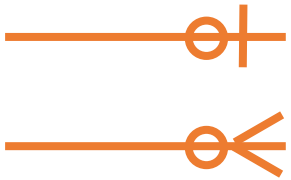
Back to ERDs: Relationships

Overview: 3 important concepts for relationships

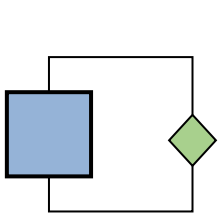
- **Cardinality** ("arity"): number of entity instances that participate (~mainly max)

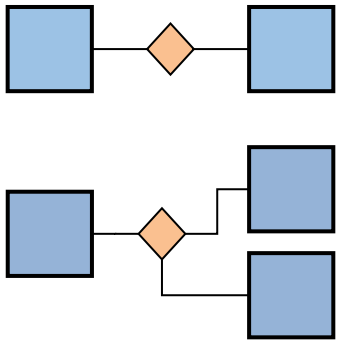


- **Participation constraints**: mandatory or optional (equivalent to minimum cardinality 0 or 1)



- **Degree**: number of entity types that participate





Random question: Why "relational model"?

1. Cardinality (multiplicity) of relationships

- Defines the number of entity instances that participate in it. Also called type of relationship (or "connectivity" at times).

- One-to-One

  - Each entity in the relationship will have exactly one related entity

- One-to-Many

  - An entity on one side of the relationship can have many related entities, but an entity on the other side will have a maximum of one related entity

- Many-to-Many

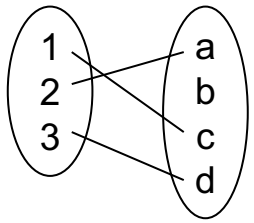
  - Entities on both sides of the relationship can have many related entities on the other side

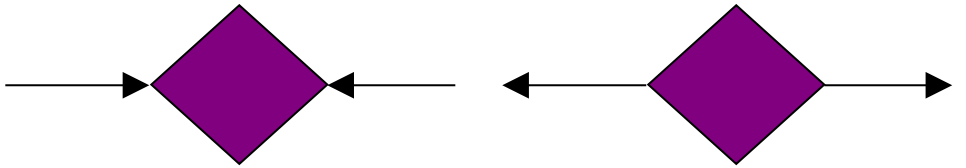
This notation is also called "crow's foot notation"

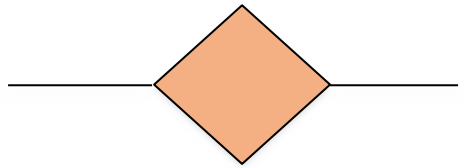
1. Cardinality (multiplicity) of E/R relationships

Stanford's Arrow notation **Crow's Feet**

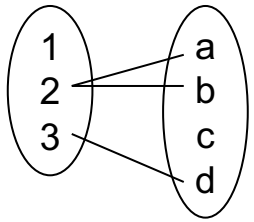
One-to-one:

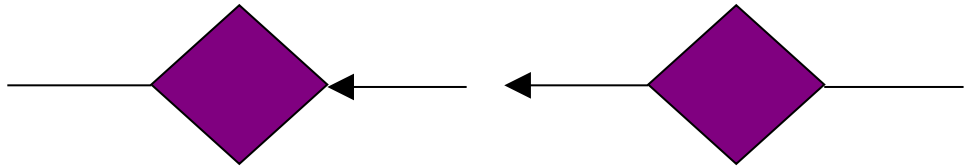


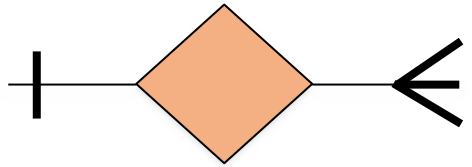




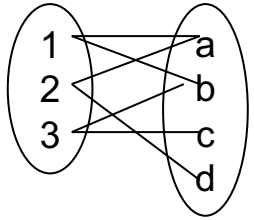
One-to-many:

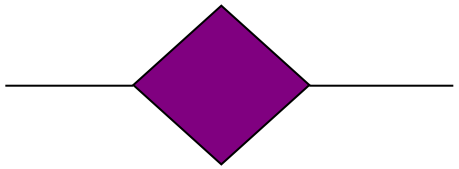


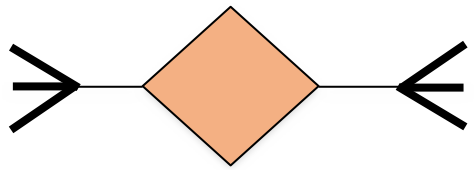




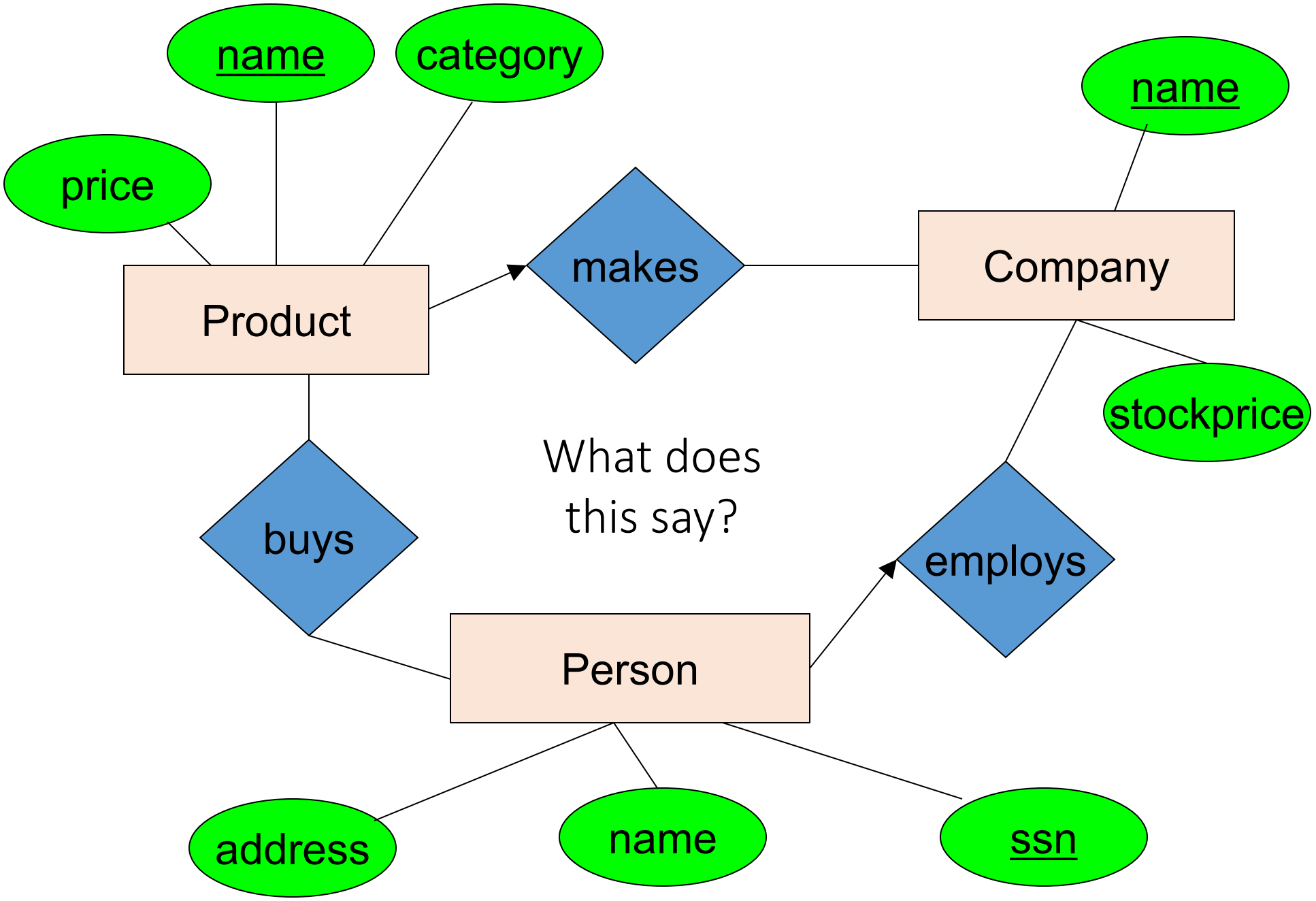
Many-to-many:







X -> Y means **there exists a function mapping from X to Y**
(*recall the definition of a function)*


name
category
price
Product
makes
Company
name
stockprice
What does this say?
buys
employs
Person
address
name
ssn

2. Participation constraints

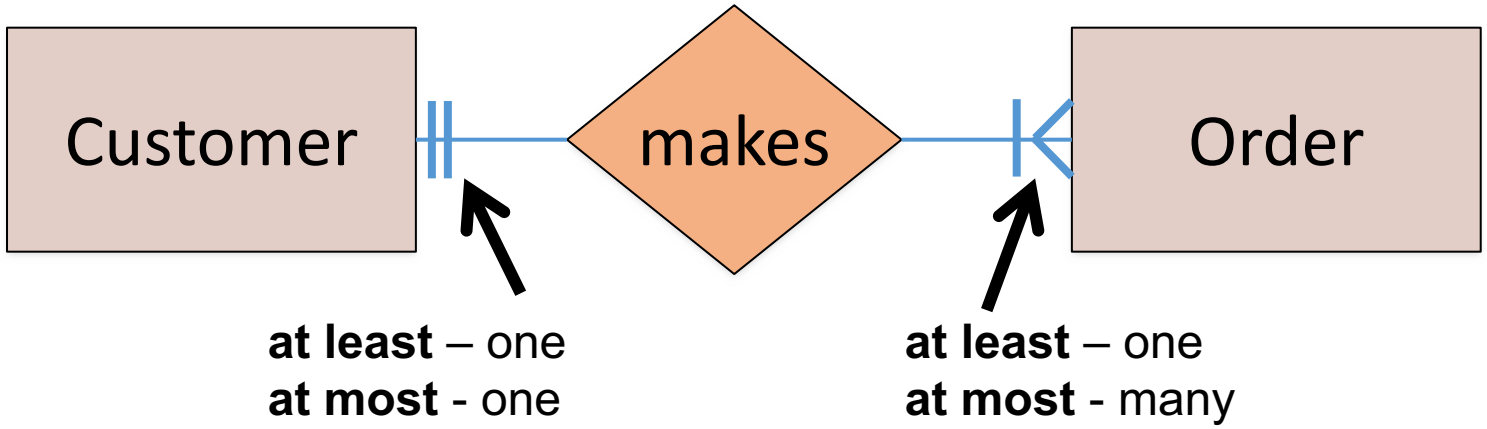
- The number of instances of one entity that can or must be associated with each instance of another entity
  - Minimum: if zero, then optional, if one or more, then mandatory
  - Maximum

  - **Mandatory** one 
  - Mandatory many 
  - **Optional** one 
  - Optional many 

Whether a relation is mandatory or optional is also sometimes called "participation constraints"

1./2. Cardinality + participation constraints

- Defines the rules of the association between entities



This is a one-to-many relationship: One customer can have many orders.

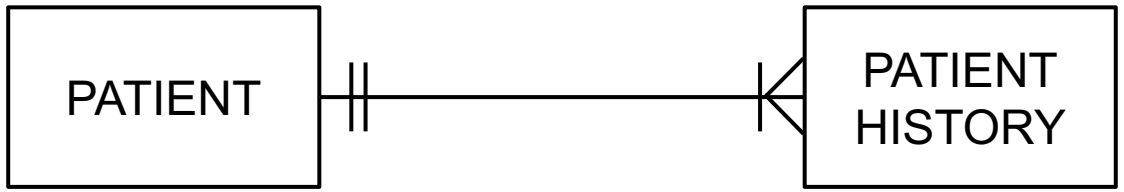
The symbols closest to the Order entity represents "one, or many", whereas an order has "one and only one" Customer.

Source: MIS5101, Data Management and Warehousing, Temple.

Ex: cardinality + participation constraints (1/2)

Cardinalities + Participation

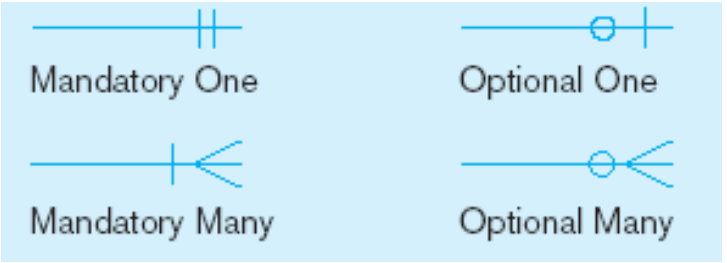
Please interpret the constraints
in the following ER diagram:



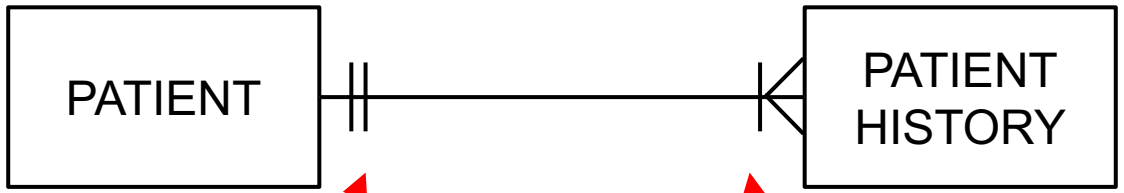
Source: Fig. 2.17: Hoffer, Ramesh, Topi, "Modern database management," 10th ed, 2010.

Ex: cardinality + participation constraints (1/2)

Cardinalities + Participation



Please interpret the constraints in the following ER diagram:



Alice — Visit 1

Bob — Visit 2, Visit 3

Charlie — Visit 4

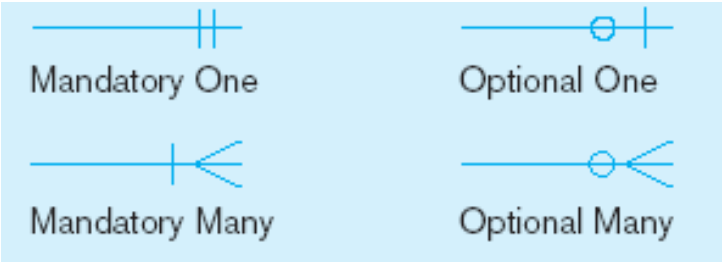
A patient history is recorded for one and only one patient

A patient must have recorded at least one history, and can have many

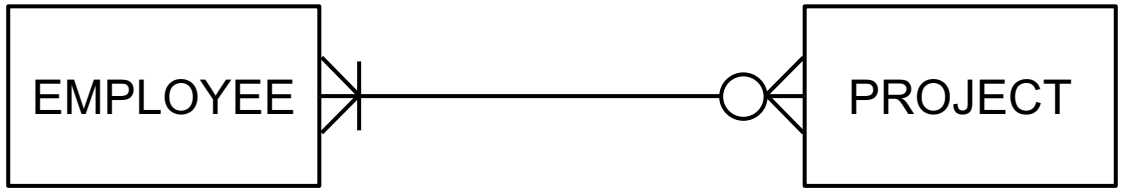
Source: Fig. 2.17: Hoffer, Ramesh, Topi, "Modern database management," 10th ed, 2010.

Ex: cardinality + participation constraints (2/2)

Cardinalities + Participation



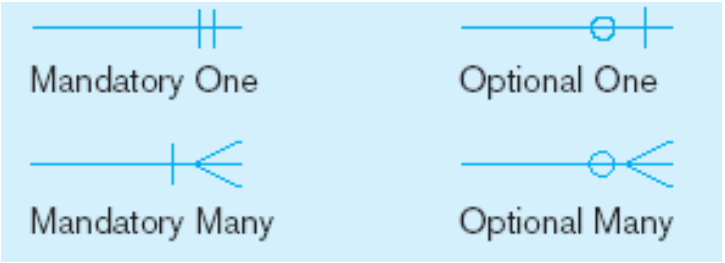
Please interpret the constraints in the following ER diagram:



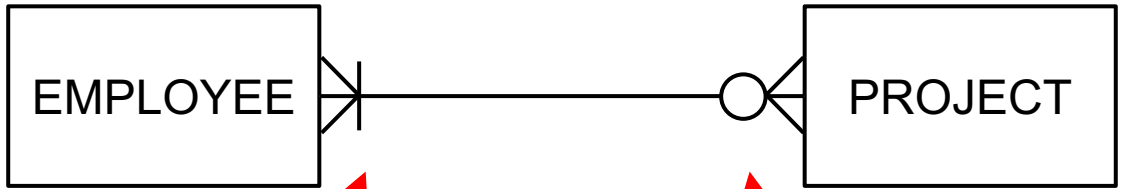
Source: Fig. 2.17: Hoffer, Ramesh, Topi, "Modern database management," 10th ed, 2010.

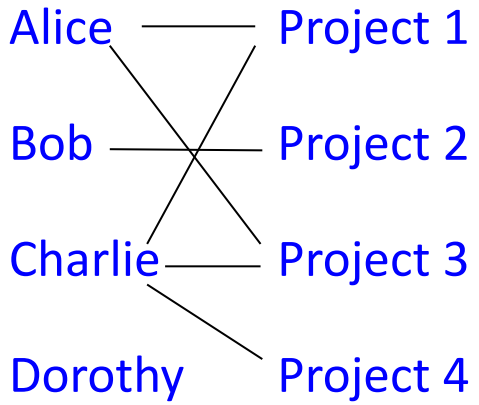
Ex: cardinality + participation constraints (2/2)

Cardinalities + Participation



Please interpret the constraints in the following ER diagram:



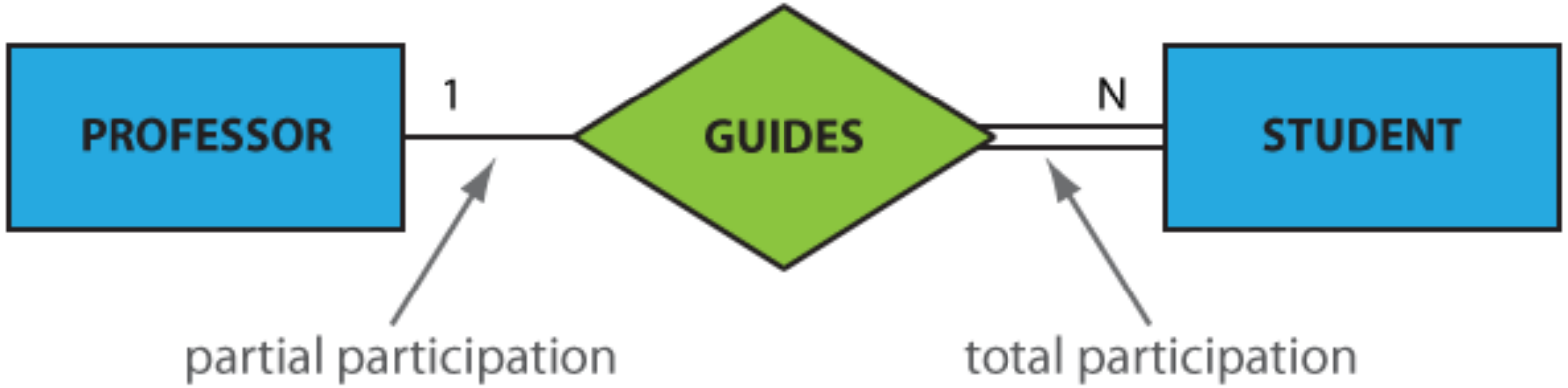


A project must be assigned to at least one employee, and may be assigned to many

An employee can be assigned to any number of projects, or may not be assigned to any at all

Source: Fig. 2.17: Hoffer, Ramesh, Topi, "Modern database management," 10th ed, 2010.

Participation constraints in Chen notation



Each student must be guided by one professor.
A professor professor can (but does not have to) guide one or more students

Total participation means that every entity in the set is involved in the relationship.

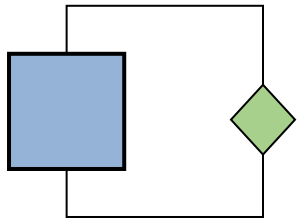
Source: http://www.vertabelo.com/blog/technical-articles/chen-erd-notation

3. Degree of Relationship

- Defines the number of entity types that participate in it

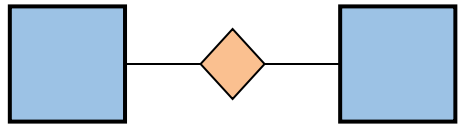
Unary Relationship

- One entity type related to itself



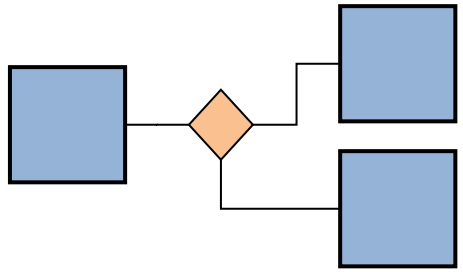
Binary Relationship

- Two entity types related to each other



Ternary Relationship

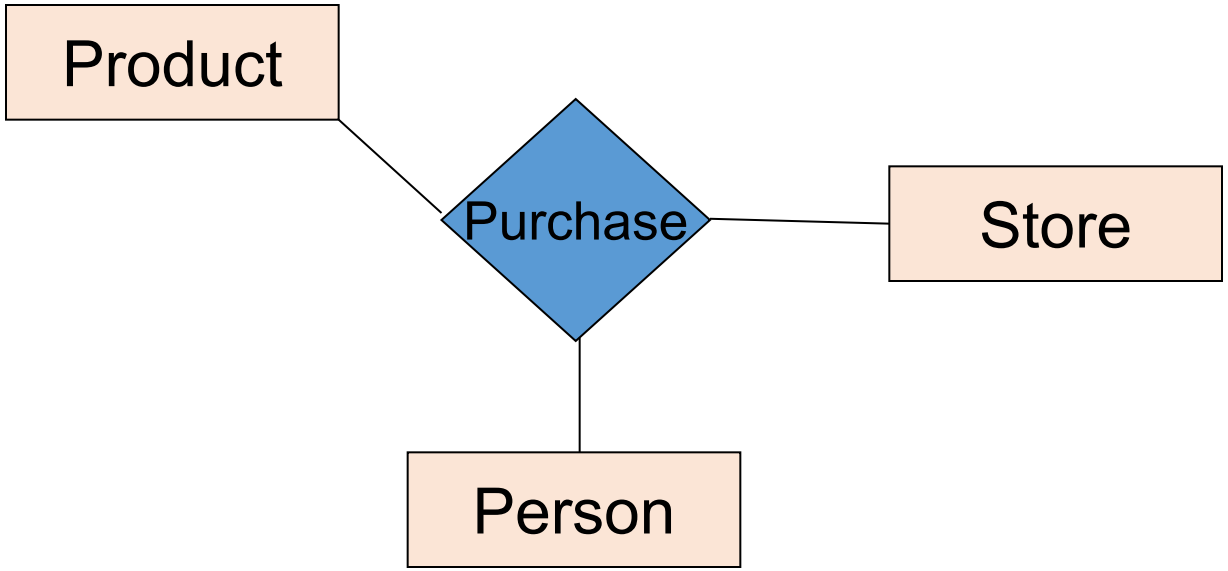
- Three entity types related to each other



- It is possible, but unusual, to have relationship types of larger than 3 entities

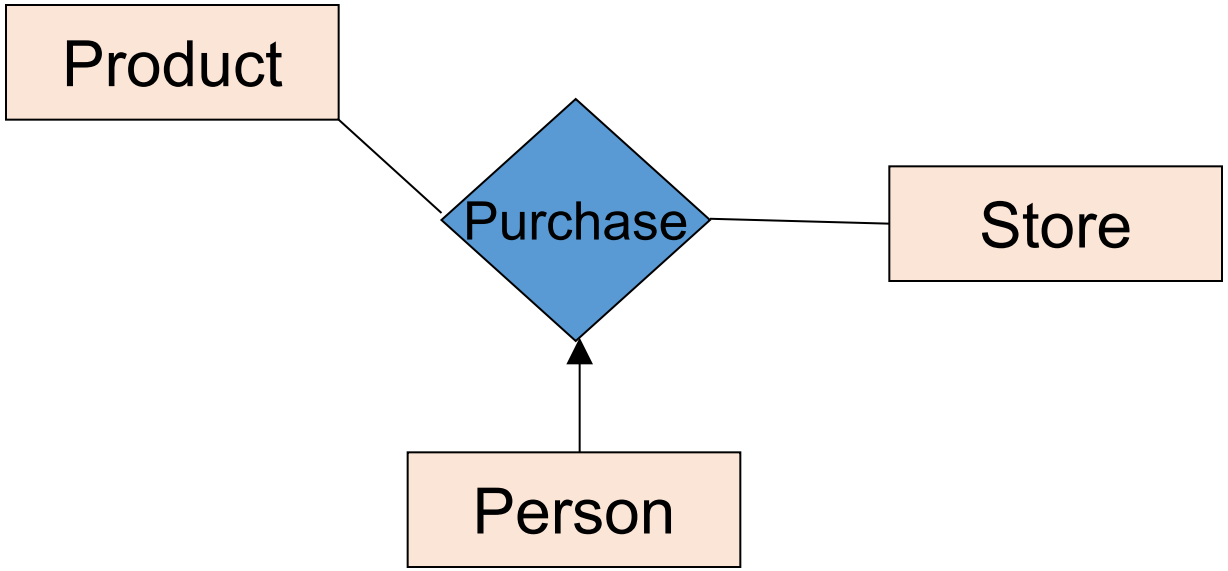
Multi-way Relationships

How do we model a purchase relationship between buyers, products and stores?



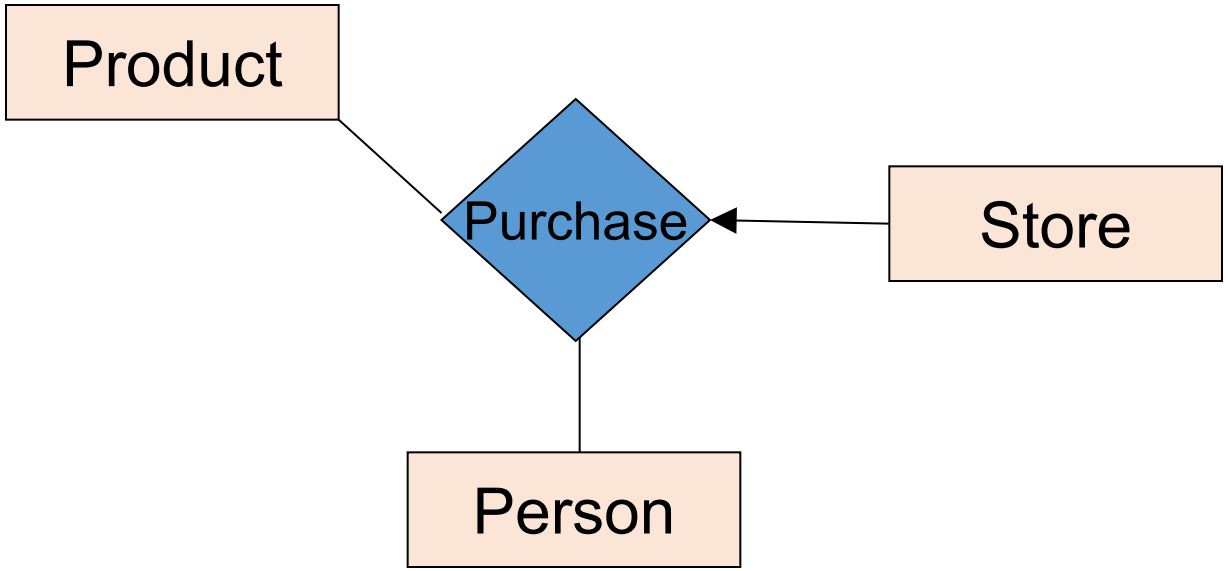
Arrows in Multiway Relationships

Q: What does the arrow mean ?



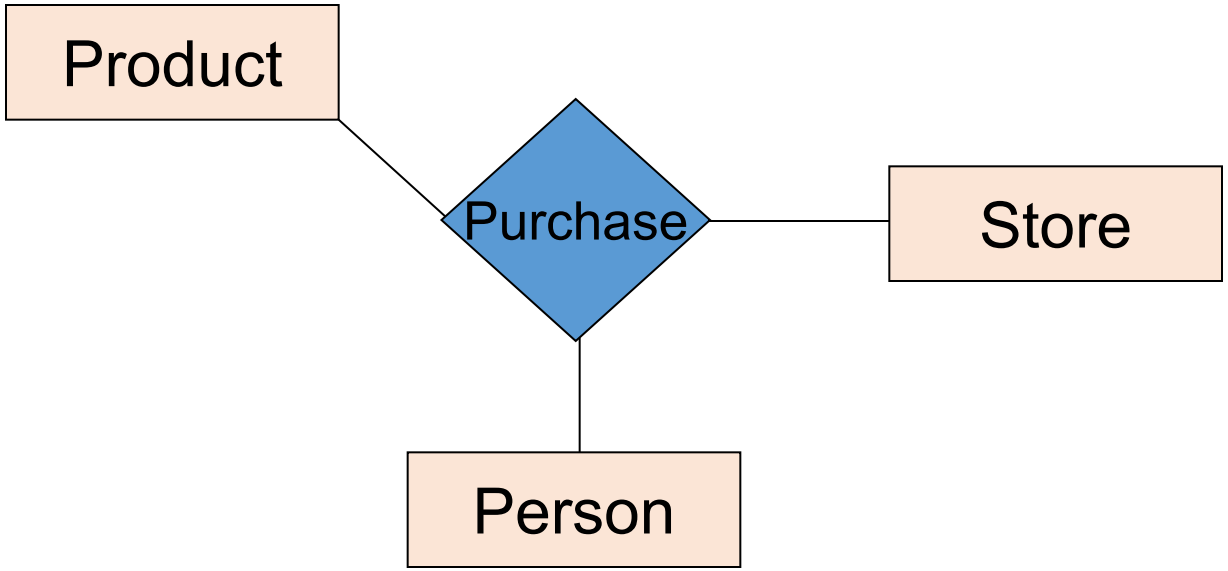
Arrows in Multiway Relationships

Q: What does the arrow mean ?



Arrows in Multiway Relationships

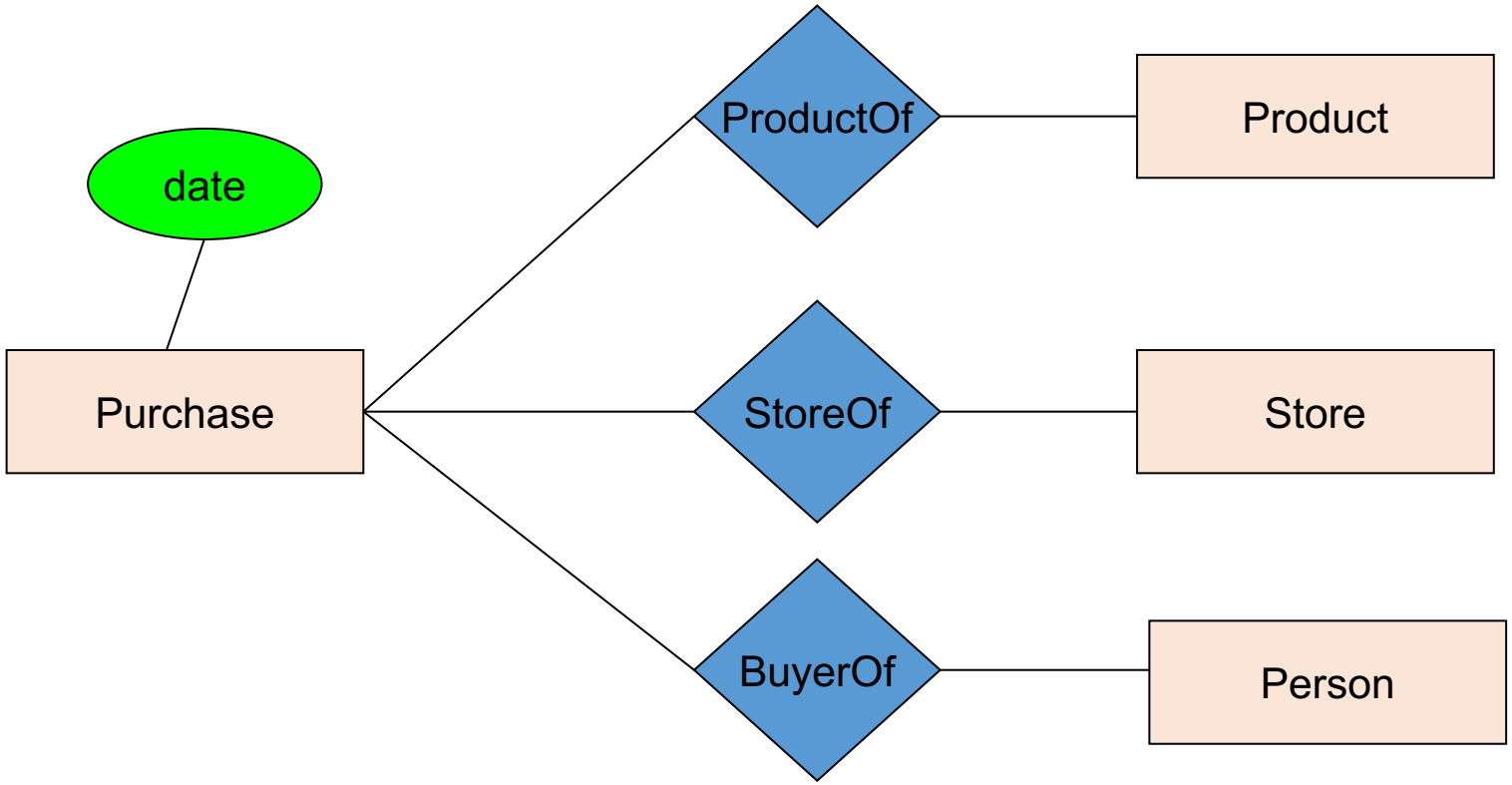
Q: How do we say that every person shops in at most one store ?



A: Cannot. This is the best approximation.
(Why only approximation ?)

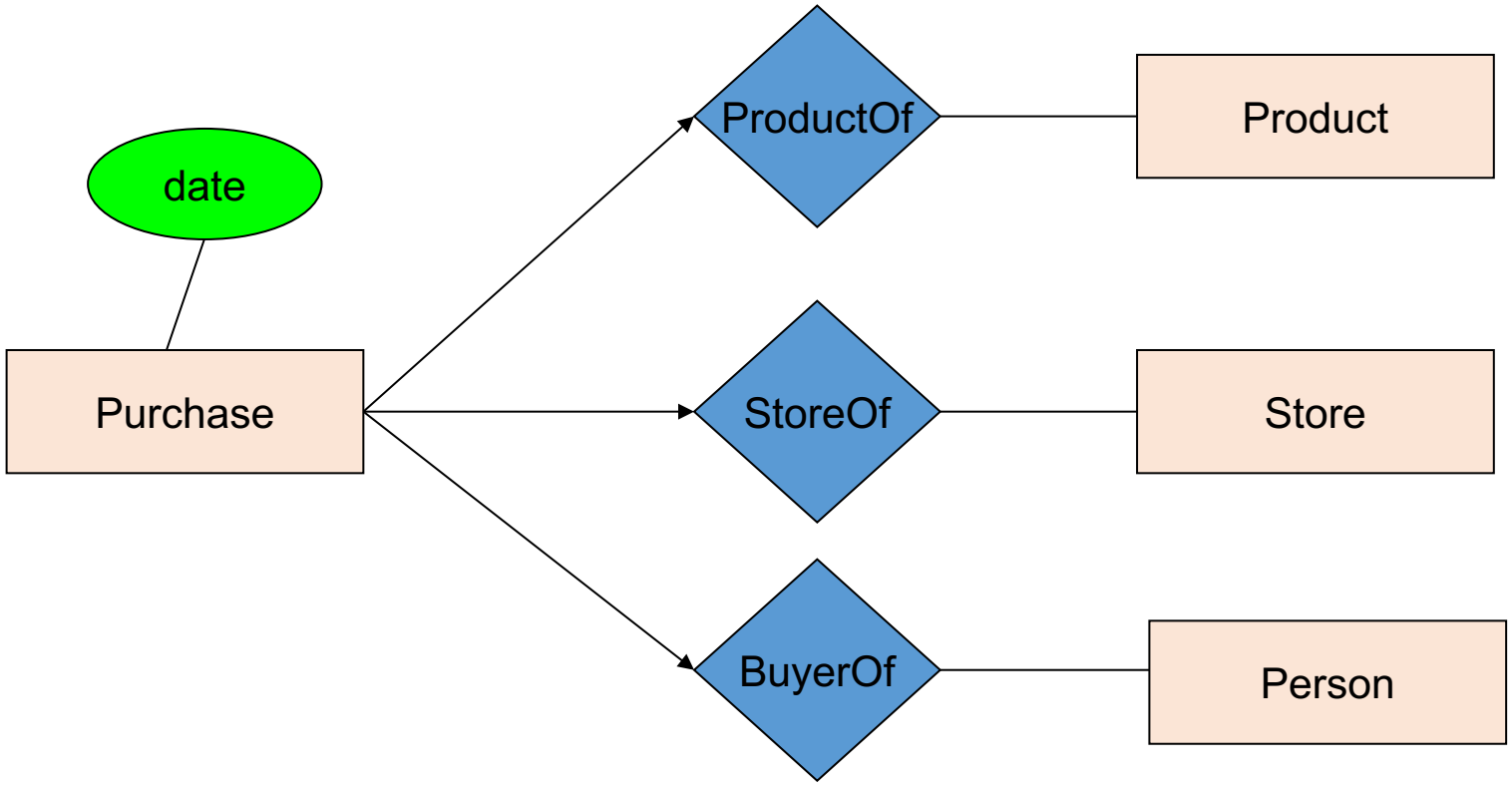
Converting Multi-way Relationships to Binary

From what we had on previous slide to this - what did we do?



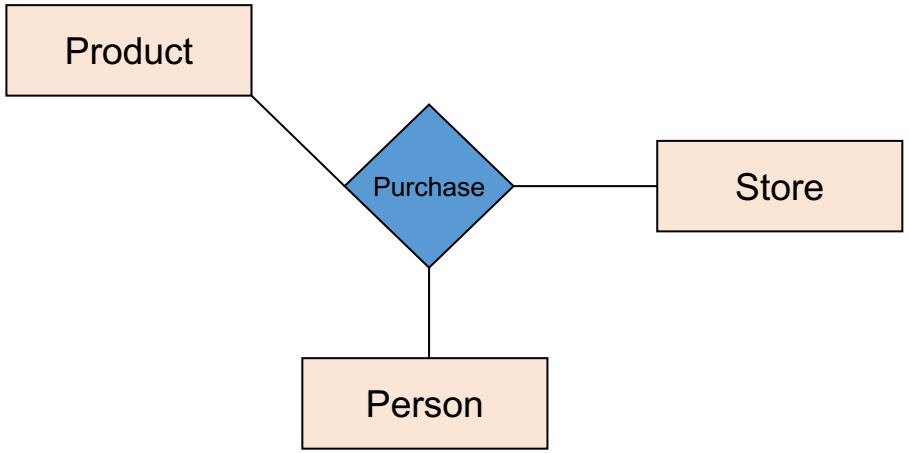
Converting Multi-way Relationships to New Entity + Binary Relationships

Side note:
What arrows should be added here?
Are these correct?

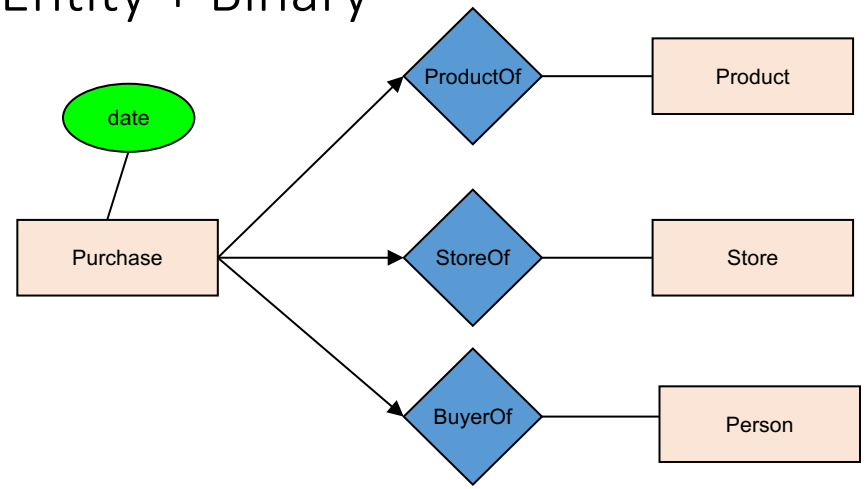


Decision: Multi-way or New Entity + Binary?

Multi-way Relationship



Entity + Binary

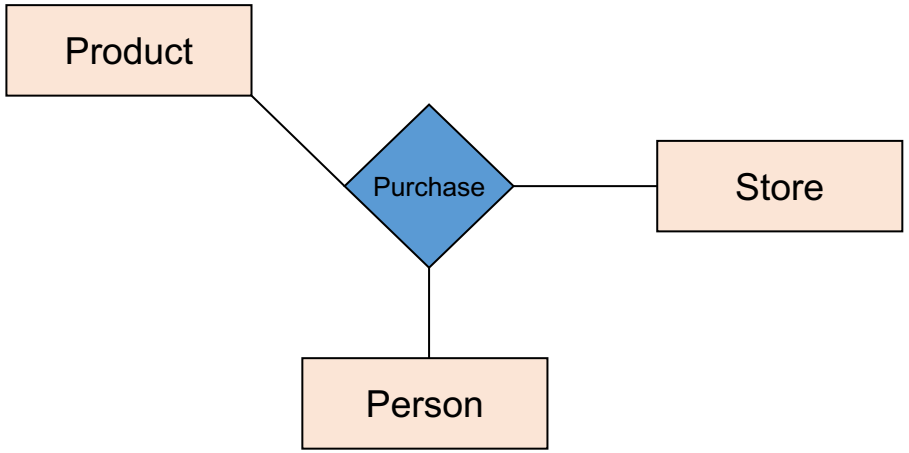


Should we use a single **multi-way relationship** or a ***new entity with binary relations?***

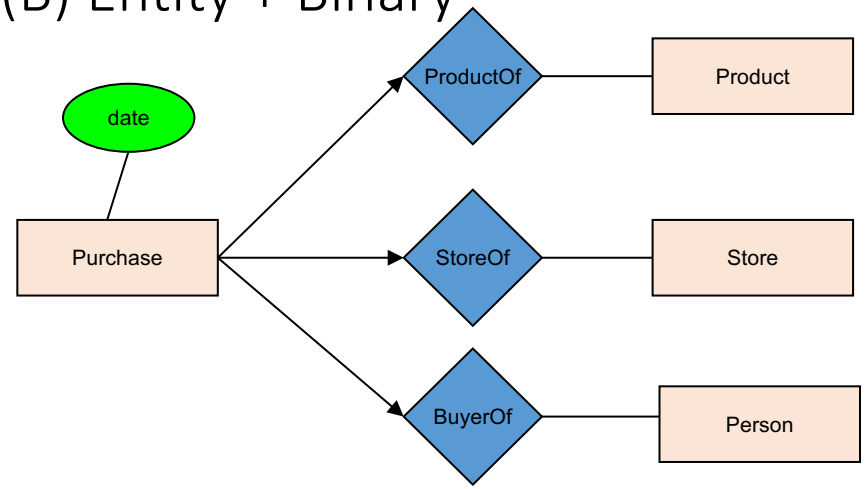
Decision: Multi-way or New Entity + Binary?

Multiple purchases per (product, store, person) combo possible here!

(A) Multi-way Relationship



(B) Entity + Binary



- (A) is useful when a relationship really is between multiple entities
  - Ex: A three-party legal contract

- Covered earlier: (B) is useful if we want to have multiple instances of the "relationship" per entity combination

Weak
(or dependent)
Entities

Strong vs. Weak (Dependent) Entities

- **Strong entities**
  - Can be identified ("exist") independently of other types of entities
  - Have their own unique identifier

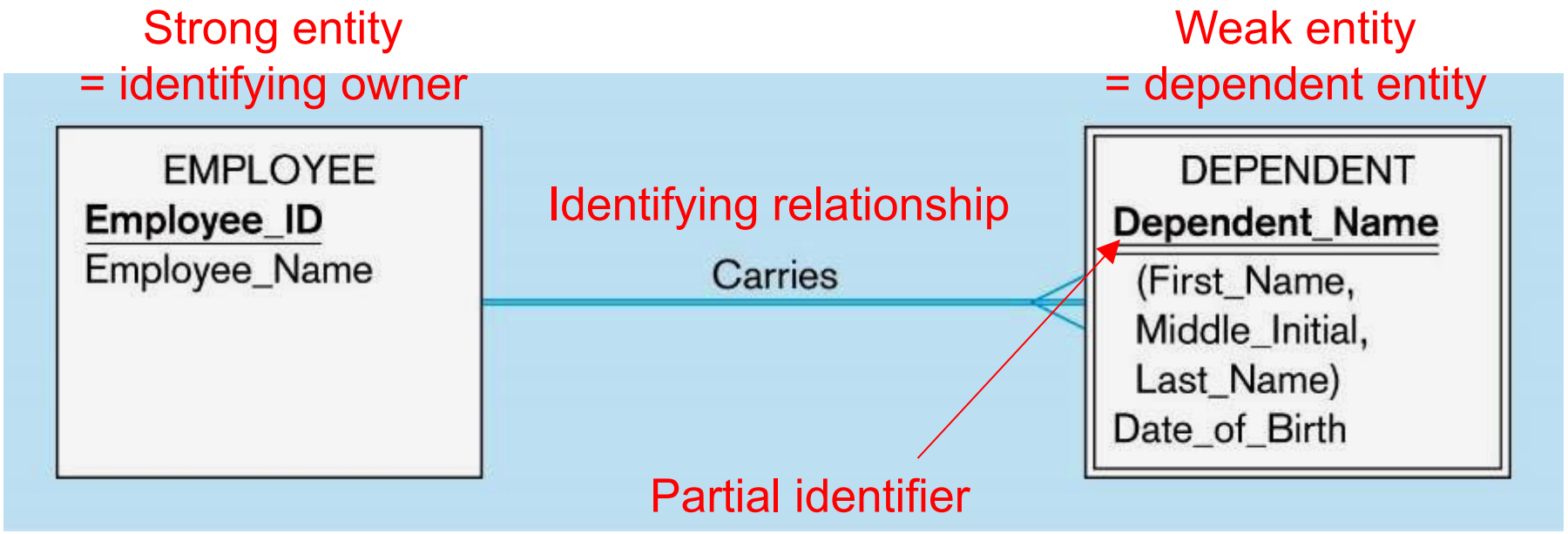
- **Weak entities**
  - Dependent on a strong entity, cannot exist on their own (better: cannot be identified independently)
  - Do not have unique identifiers: PK overlaps with parent's PK
  - (represented with double-line rectangle)

Entity sets are weak when part of their identifier comes from classes to which they are related

- **Identifying relationship**
  - Links strong entities to weak entities
  - Represented with double line relationship

Example: Strong and Weak Entities

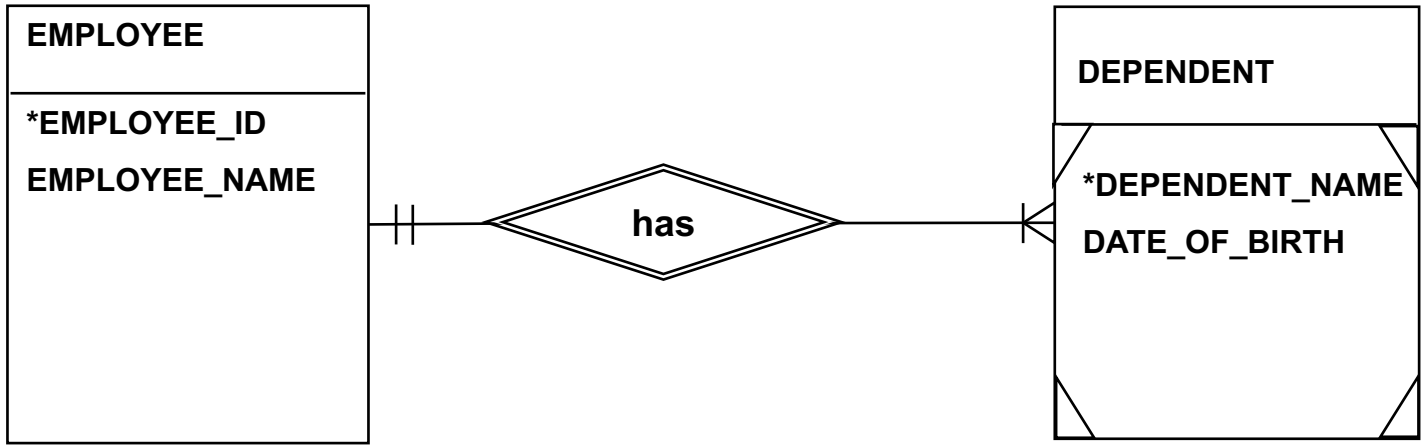
- Employee caries one dependent
  - Employee: ID, name
  - Dependent: name, Date_of_Birth

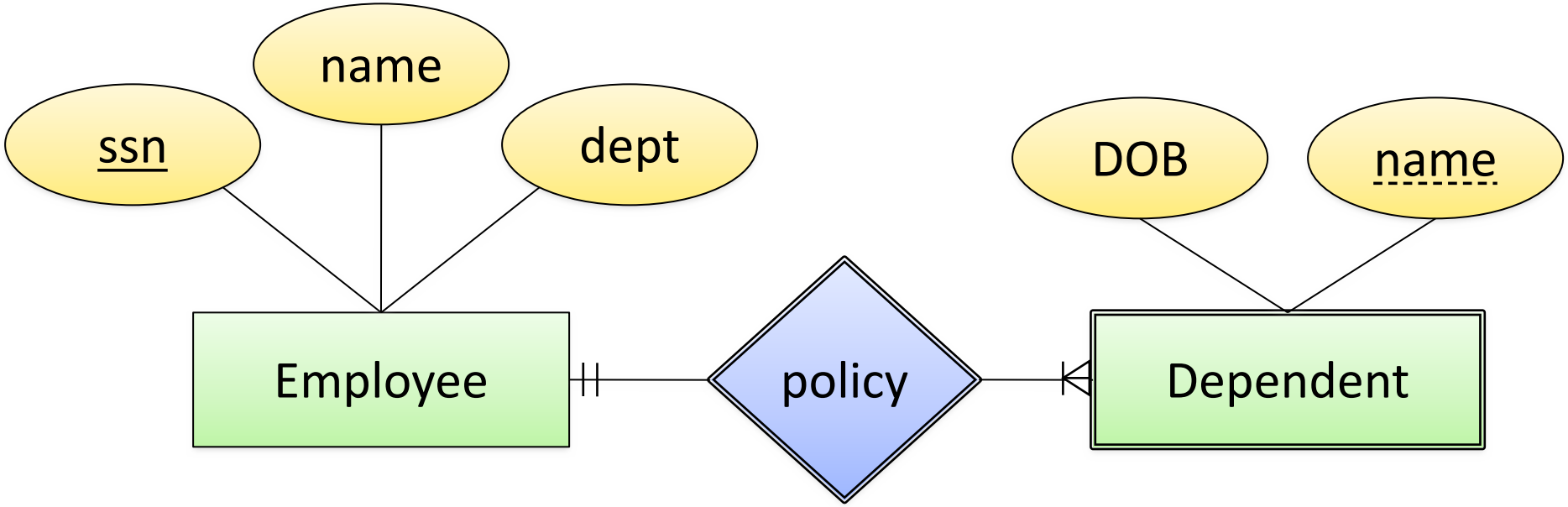


Note we need both EMPLOYEE_ID and DEPENDENT_NAME to uniquely identify a dependent

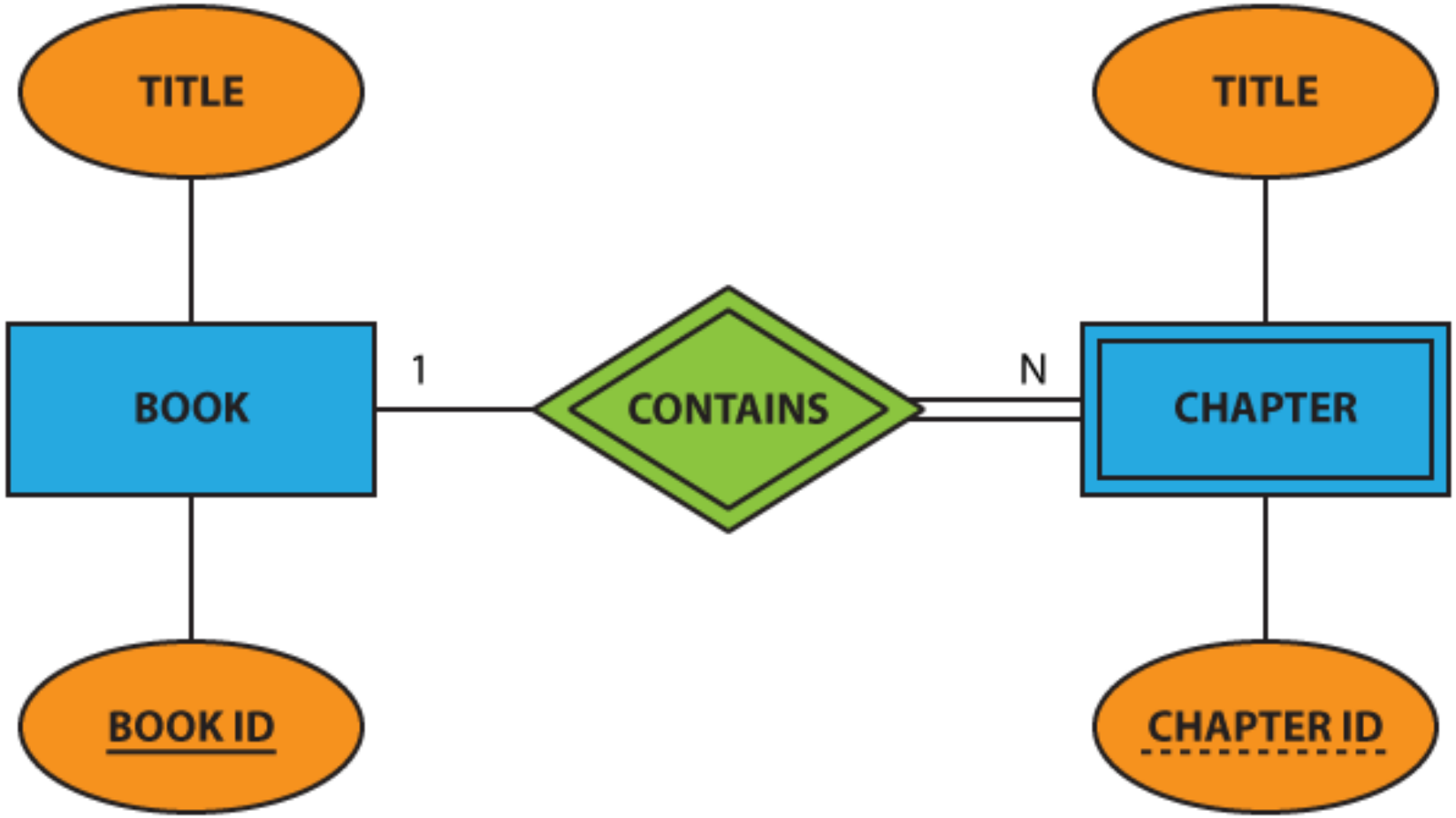
Source: Fig 2.5. Hoffer, Ramesh, Topi, "Modern database management," 10th ed, 2010.

Alternative notations for same scenario





Participation constraints and weak entities



Source: http://www.vertabelo.com/blog/technical-articles/chen-erd-notation

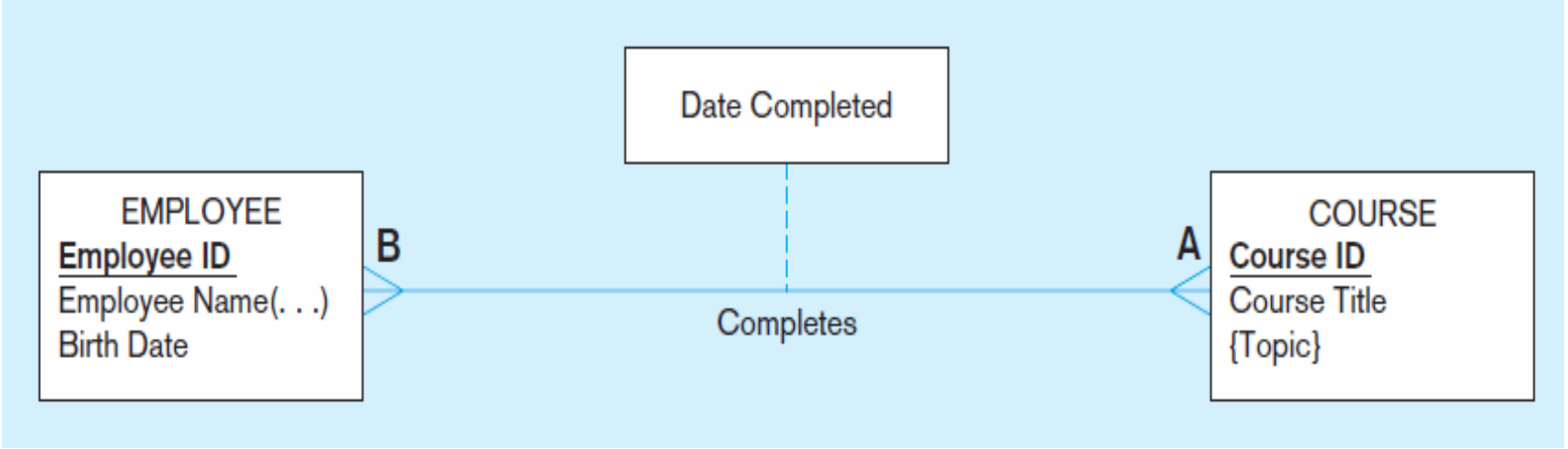
Associative Entities

Associative Entities

- It seems like a relationship: it links entities together
- Yet it seems like an entity: it has attributes
- When should a relationship with attributes instead be an associative entity?
  - All relationships for the associative entity should be many
  - The associative entity could have meaning independent of the other entities
  - The associative entity preferably has a unique identifier (but not necessarily), and should also have other attributes
  - Ternary relationships should be converted to associative entities
  - (The associative entity may participate in other relationships other than the entities of the associated relationship)

Example: Certificate Associative Entity (1/3)

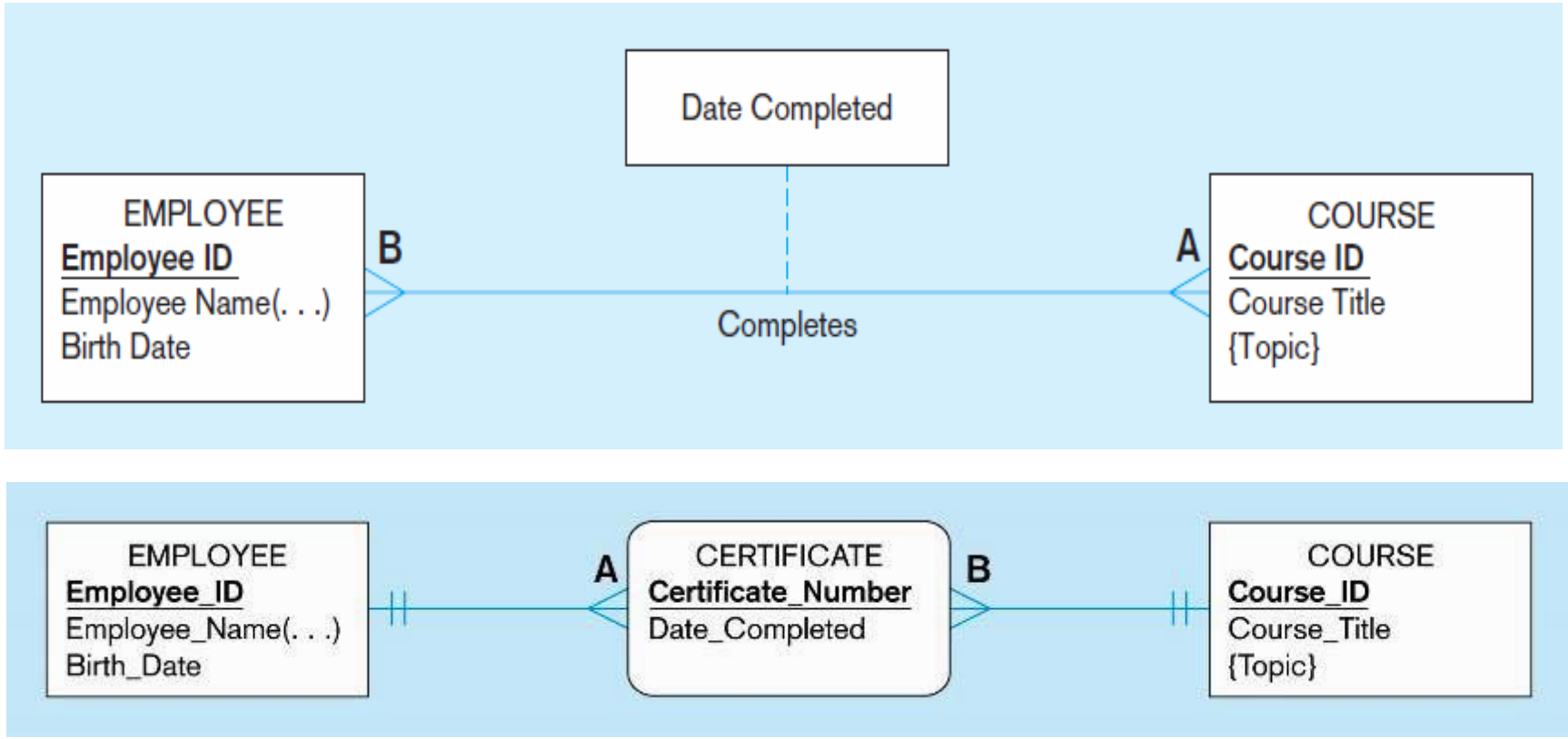
- Associative entity can be represented as rectangle with rounded corners (Hoffer notation)
- Note that the many-to-many cardinality symbols face toward the associative entity and not toward the other entities



Source: Hoffer, Ramesh, Topi, "Modern database management," 10th ed, 2010.

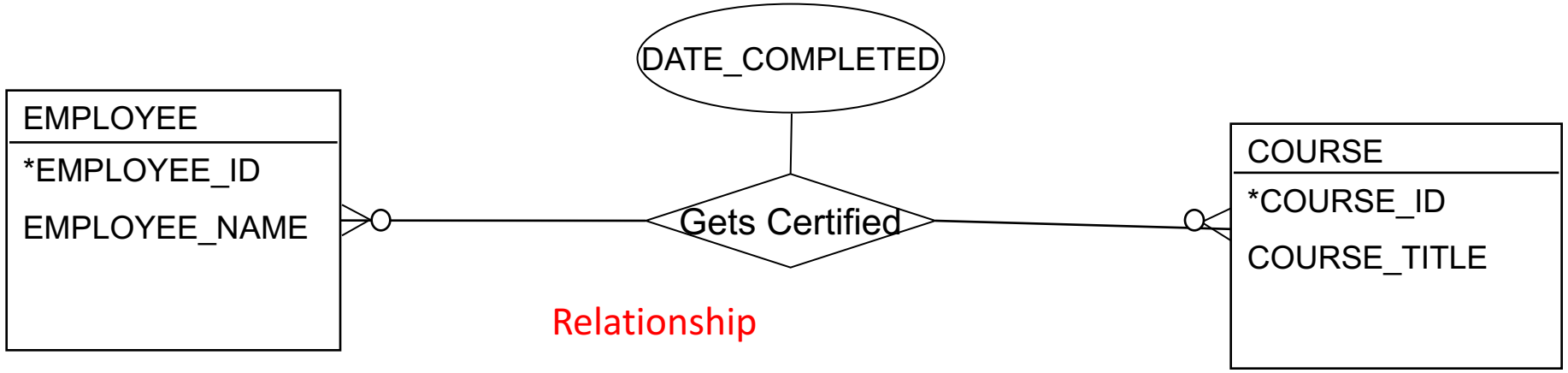
Example: Certificate Associative Entity (1/3)

- Associative entity can be represented as rectangle with rounded corners (Hoffer notation)
- Note that the many-to-many cardinality symbols face toward the associative entity and not toward the other entities

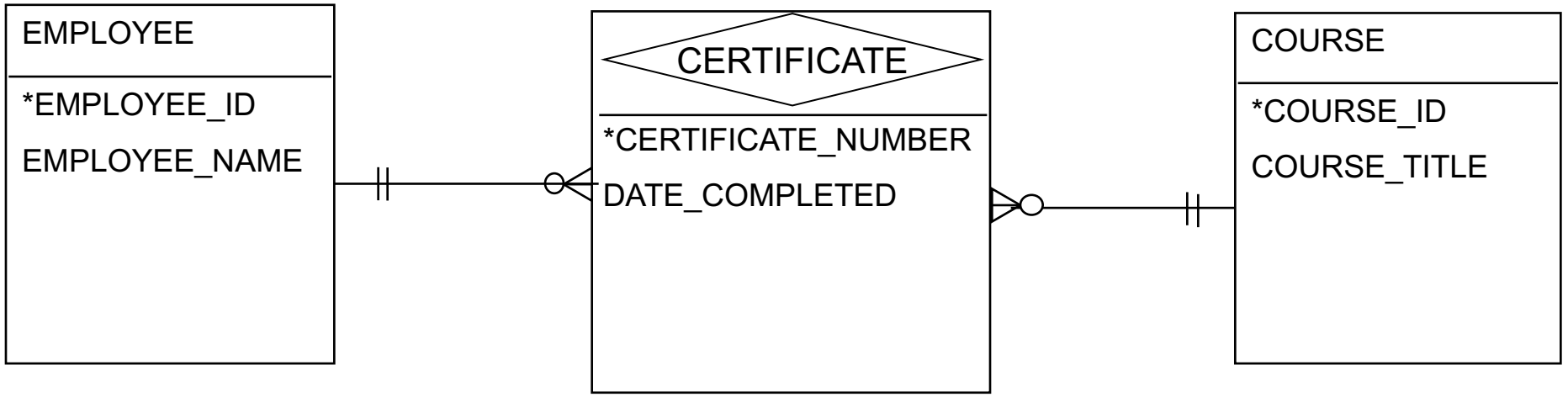


Source: Hoffer, Ramesh, Topi, "Modern database management," 10th ed, 2010.

Example: Certificate Associative Entity (2/3)



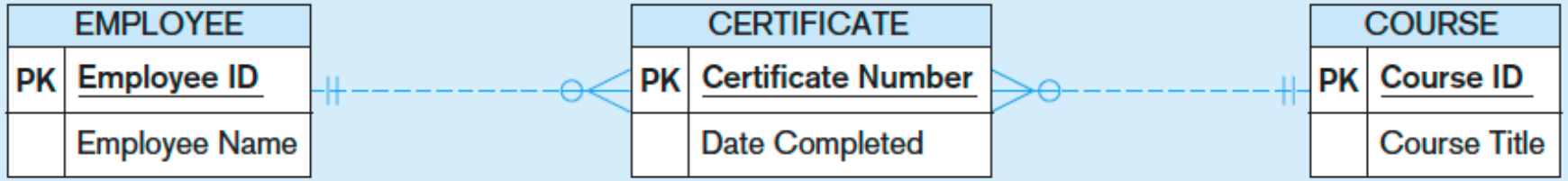
Relationship



Associative Entity

Example: Certificate Associative Entity (3/3)

Notation used by Microsoft Visio

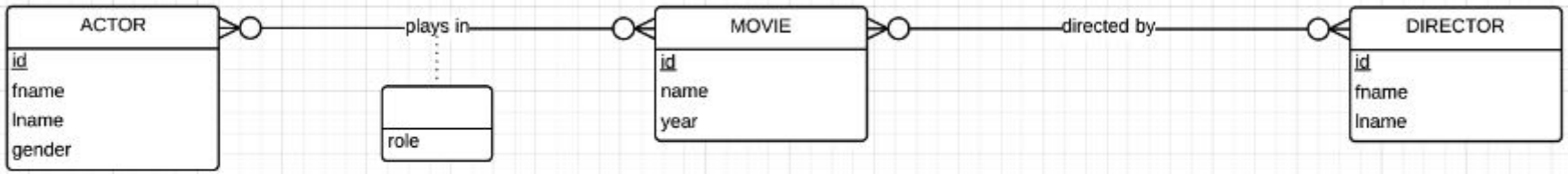


Important! Notice that ERDs do not show foreign keys!

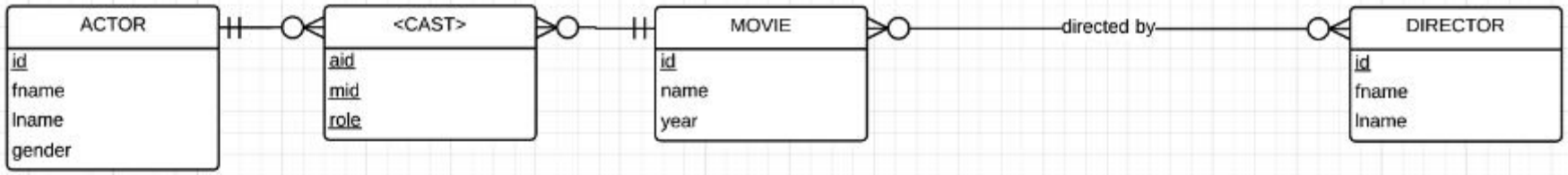
Source: Hoffer, Ramesh, Topi, "Modern database management," 10th ed, 2010.

CAST in our IMDB movie database

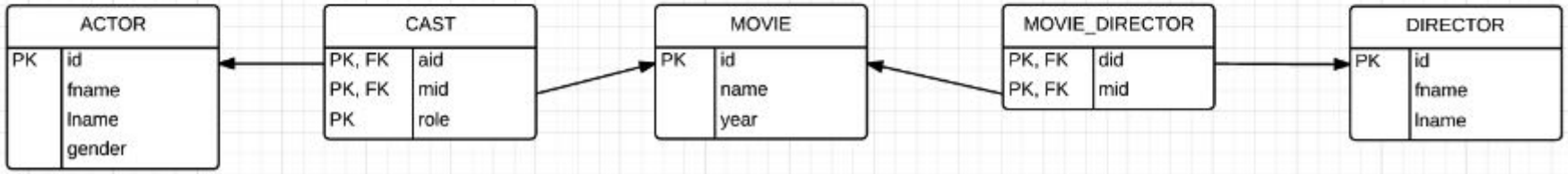
ER diagram: don't forget identifiers, but no FKs



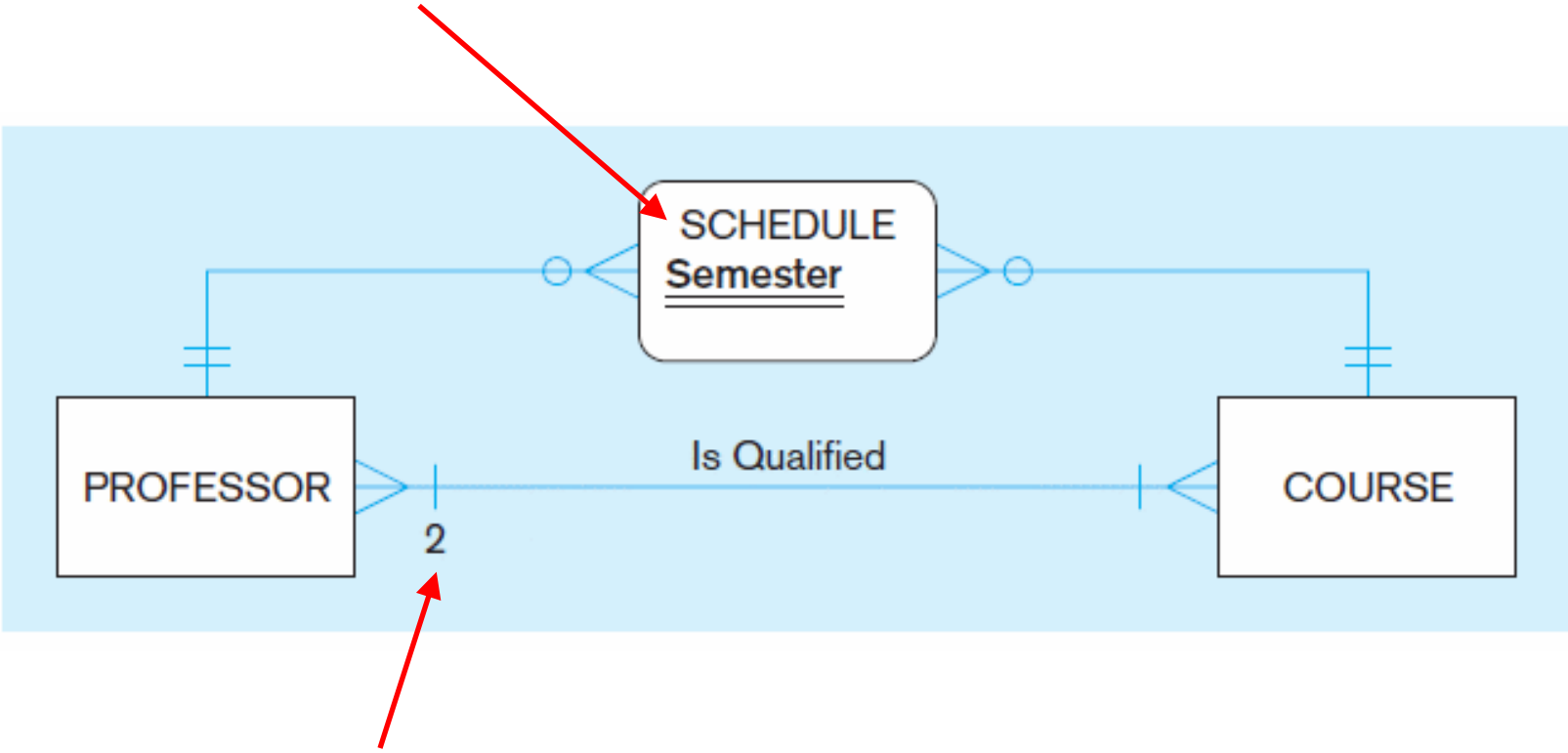
ER diagram: CAST as associative entity can be justified



Relational schema: don't forget PKs and FKs

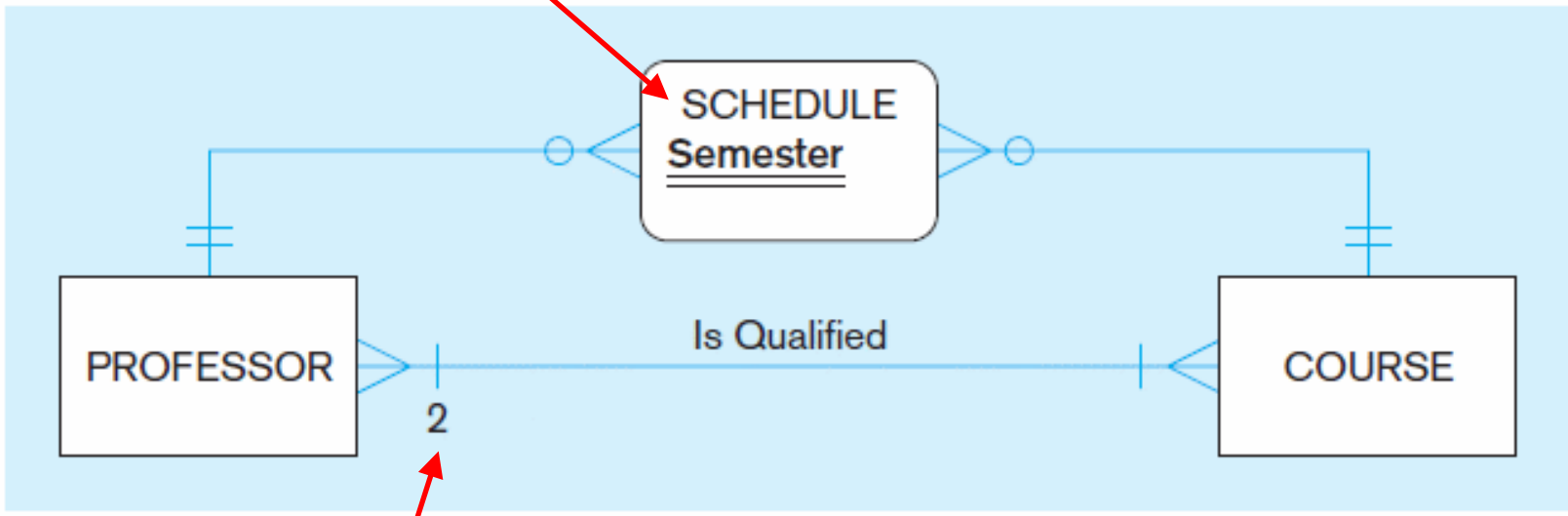


Multiple relationships



Source: Fig 2-21, Hoffer, Ramesh, Topi, "Modern database management," 10th ed, 2010.

Multiple relationships



Here, min cardinality constraint is 2: At least two professors must be qualified to teach each course

Source: Fig 2-21, Hoffer, Ramesh, Topi, "Modern database management," 10th ed, 2010.