Introduction to Database Systems
CSE 444

Lecture 5: E/R Diagrams

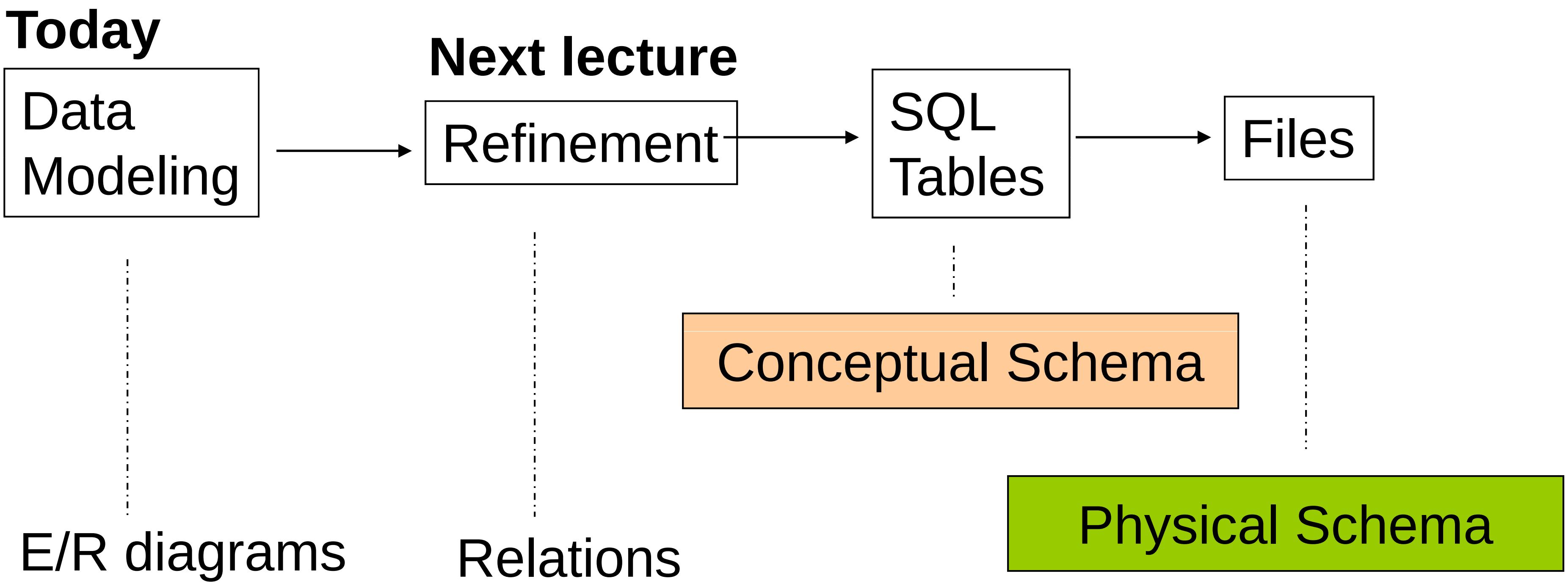
Outline

- E/R diagrams
  - – Sec. 4.1- 4.4 [Old edition: Chapter 2]
- From E/R diagrams to relations
  - – Sec. 4.5 and 4.6 [Old edition: Sec. 3.2 and 3.3]

Database Design

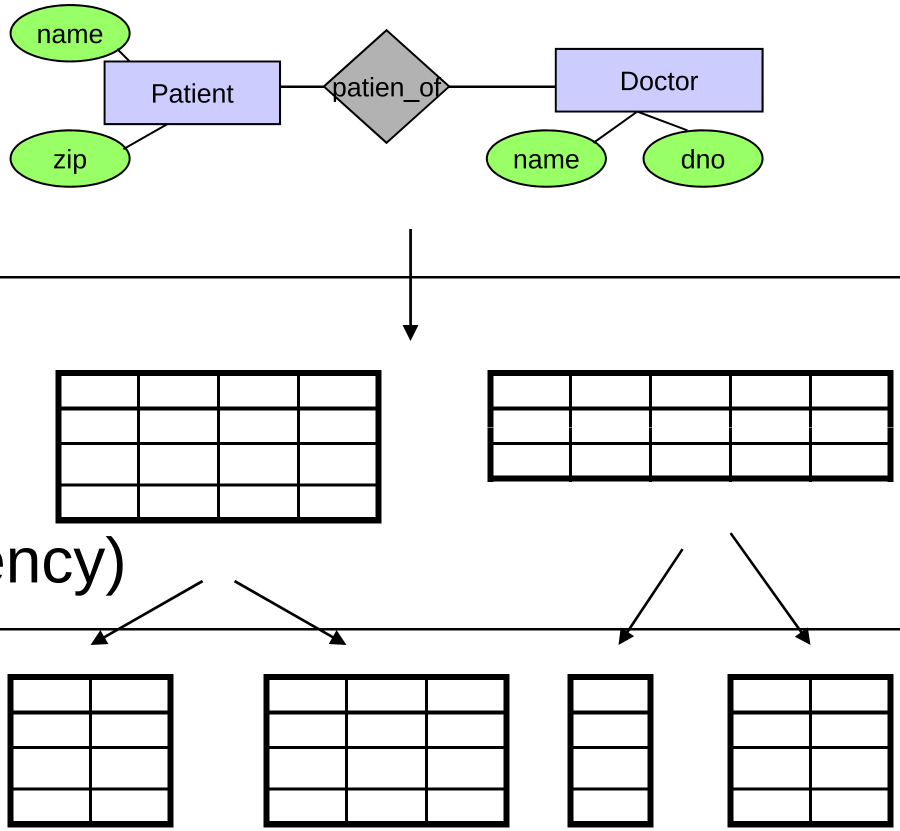
- Why do we need it?
  - Need a way to model real world entities in terms of relations
  - Not easy to go from real-world entities to a database schema
- Consider issues such as:
  - What entities to model
  - How entities are related
  - What constraints exist in the domain
  - How to achieve ***good*** designs
- Several formalisms exists
  - We discuss E/R diagrams

Database Design Process



Conceptual Schema Design

Conceptual Model:

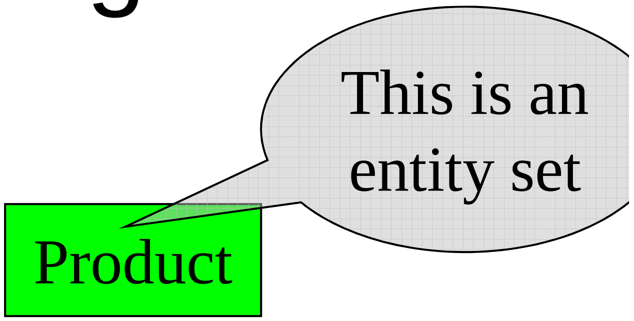


Relational Model:
plus FD’s
(FD = functional dependency)

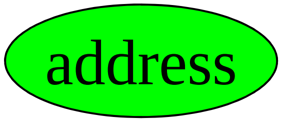
Normalization:
Eliminates anomalies

Entity / Relationship Diagrams

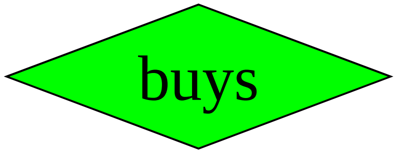
Objects → entities
Classes → entity sets



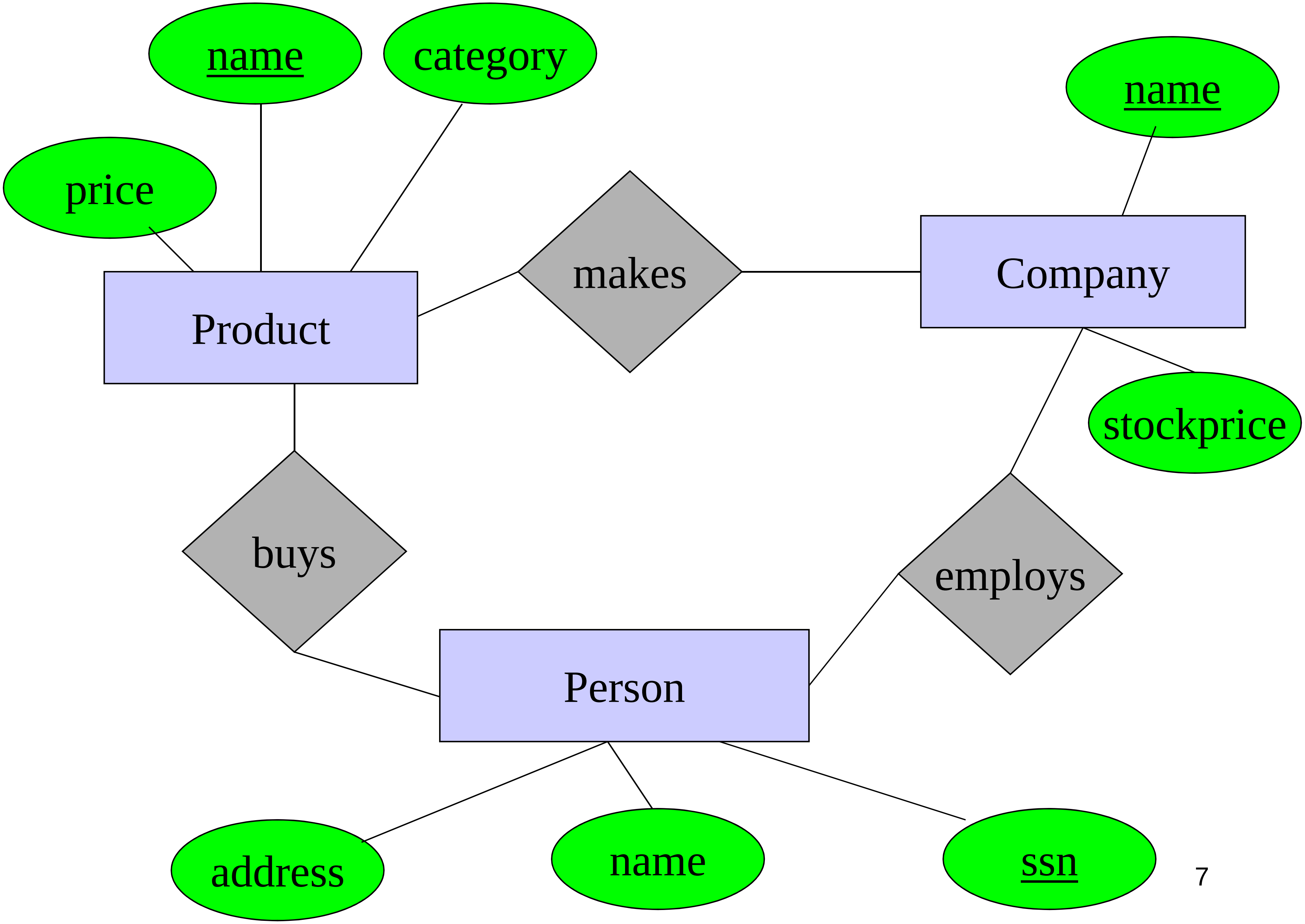
Attributes are like in ODL
(ODL = Object Definition Language)



Relationships: like in ODL except

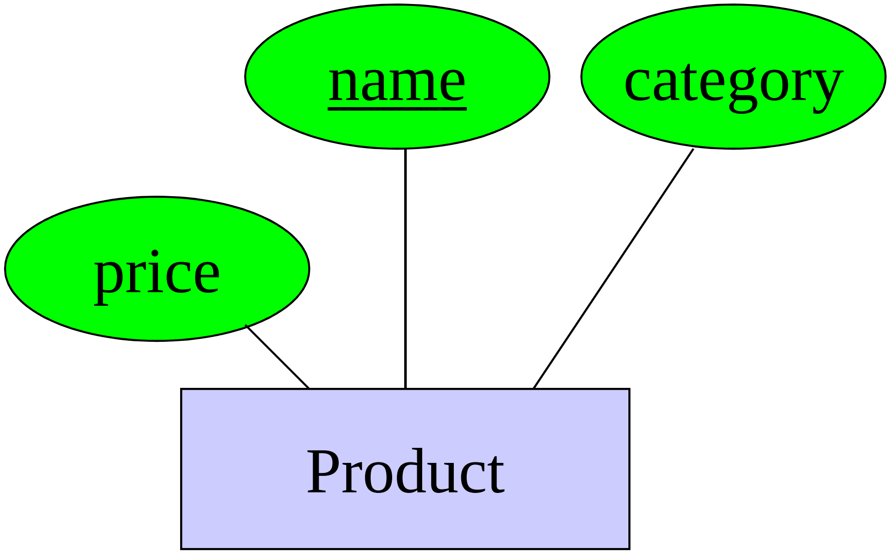


- first class citizens (not associated with classes)
- not necessarily binary


name
category
name
price
makes
Company
Product
stockprice
buys
employs
Person
address
name
ssn

Keys in E/R Diagrams

- Every entity set must have a key

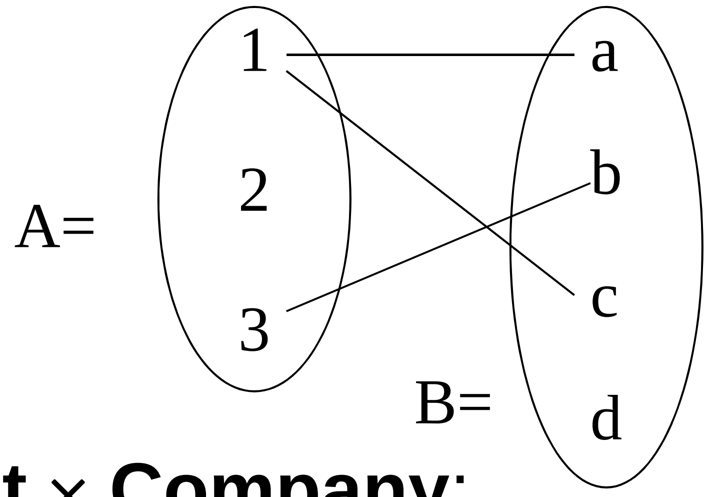


What is a Relation ?

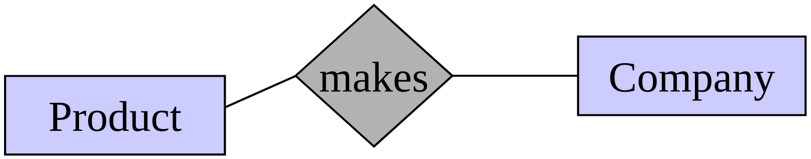
- A mathematical definition:
  - if A, B are sets, then a relation R is a subset of A × B
- A={1,2,3}, B={a,b,c,d},

  A × B = {(1,a),(1,b), . . ., (3,d)}

  R = {(1,a), (1,c), (3,b)}

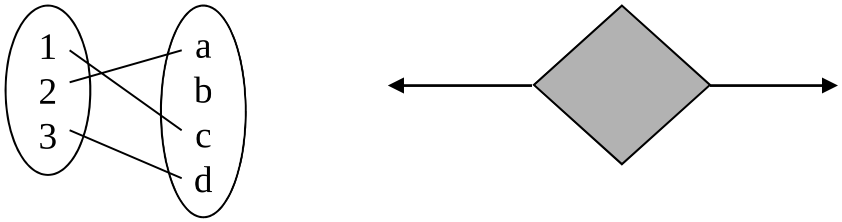


- **makes** is a subset of **Product** × **Company**:

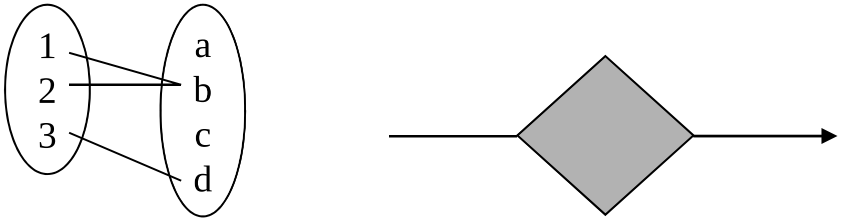


Multiplicity of E/R Relations

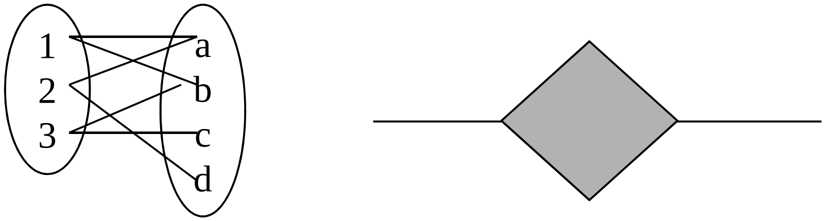
- one-one:

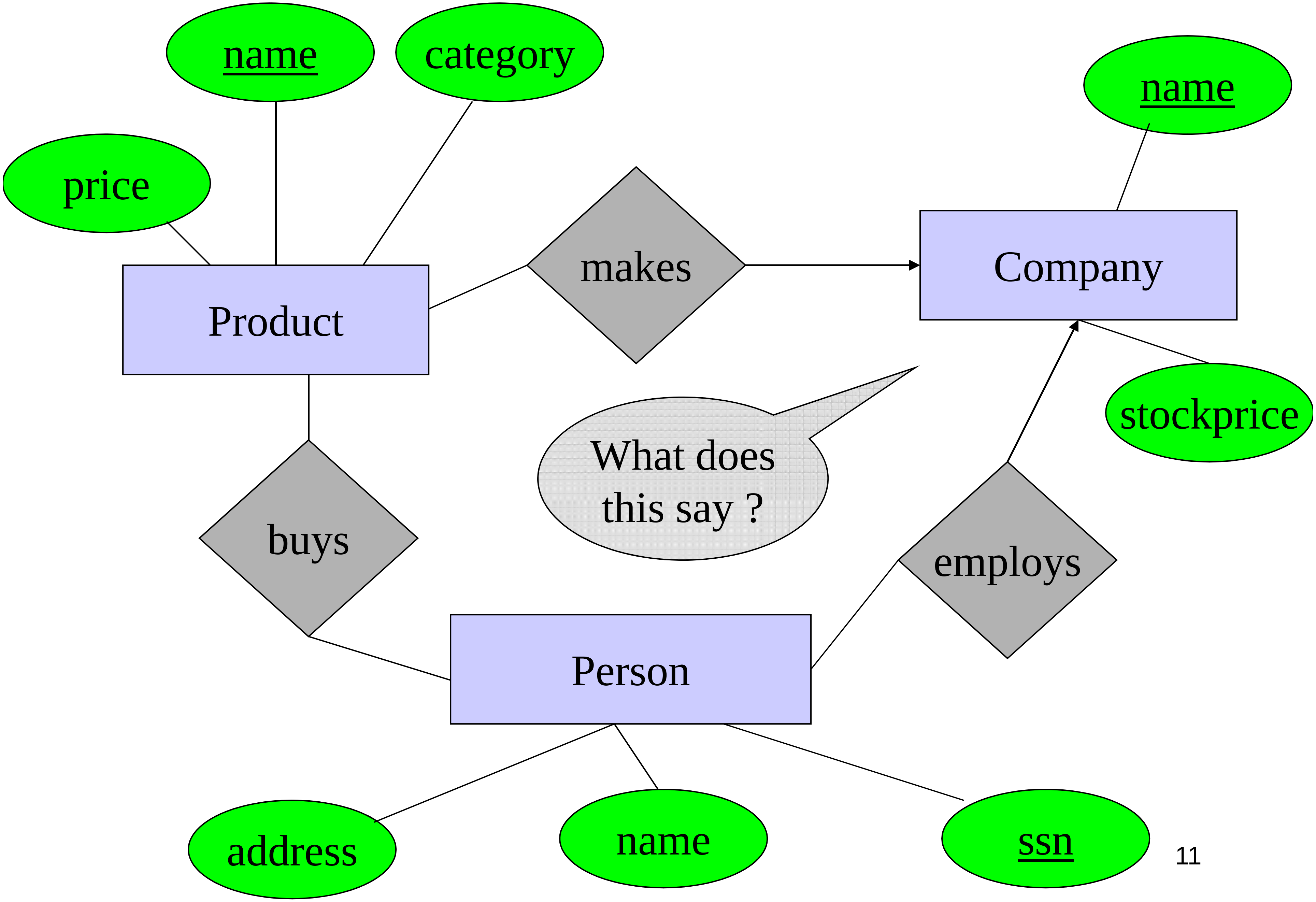


- many-one



- many-many

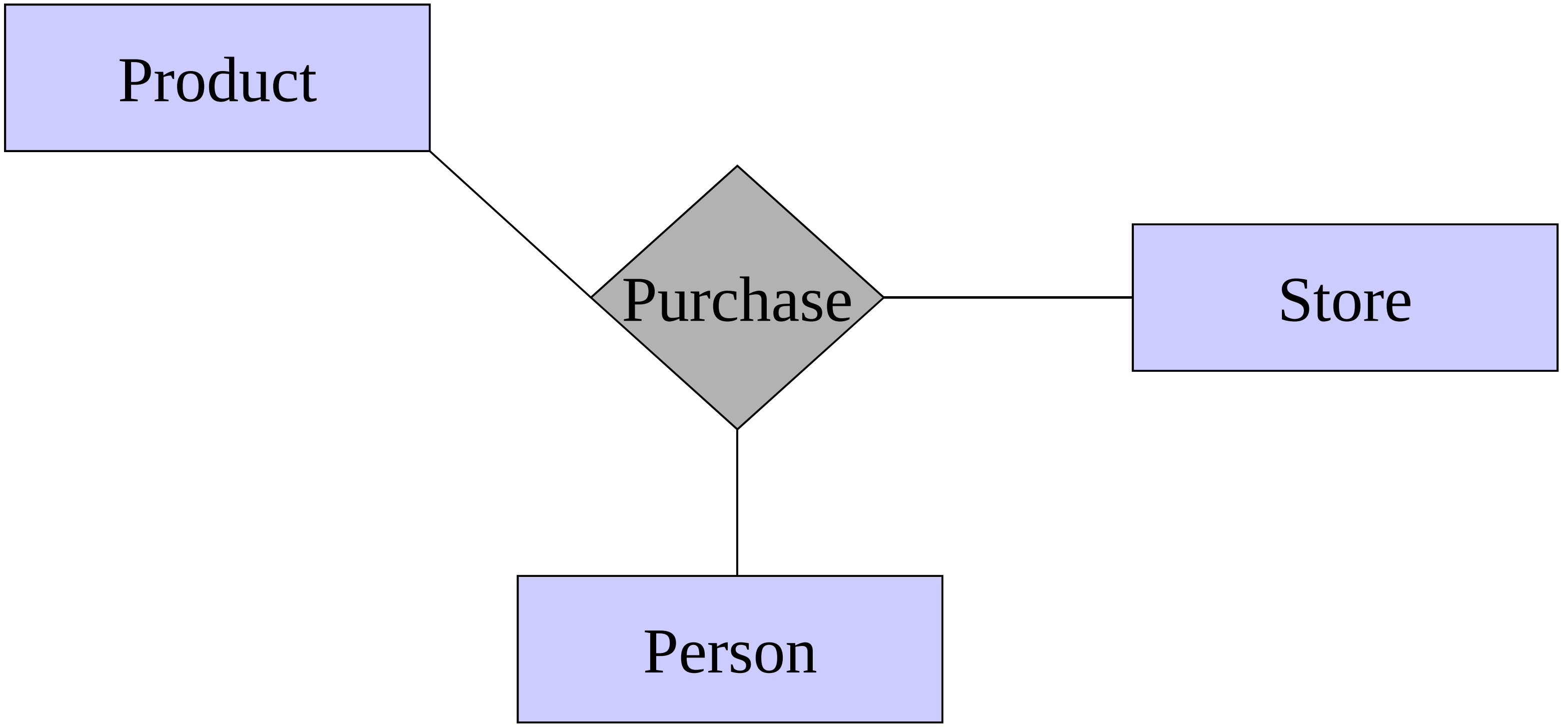




What does this say ?

Multi-way Relationships

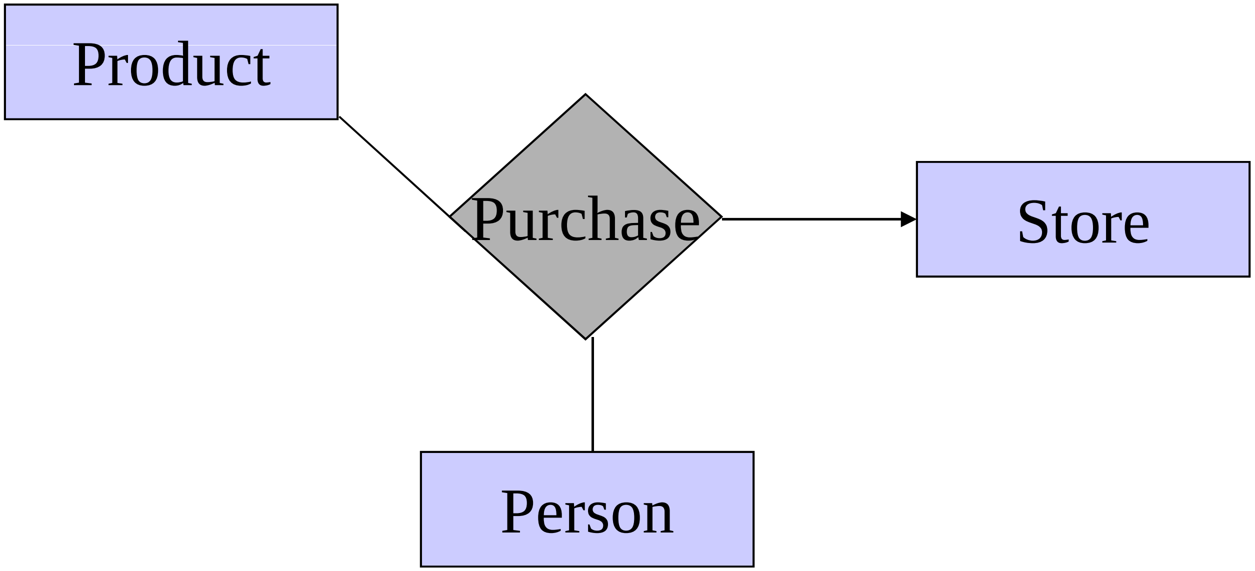
How do we model a purchase relationship between buyers, products and stores?



Can still model as a mathematical set (how ?)

Arrows in Multiway Relationships

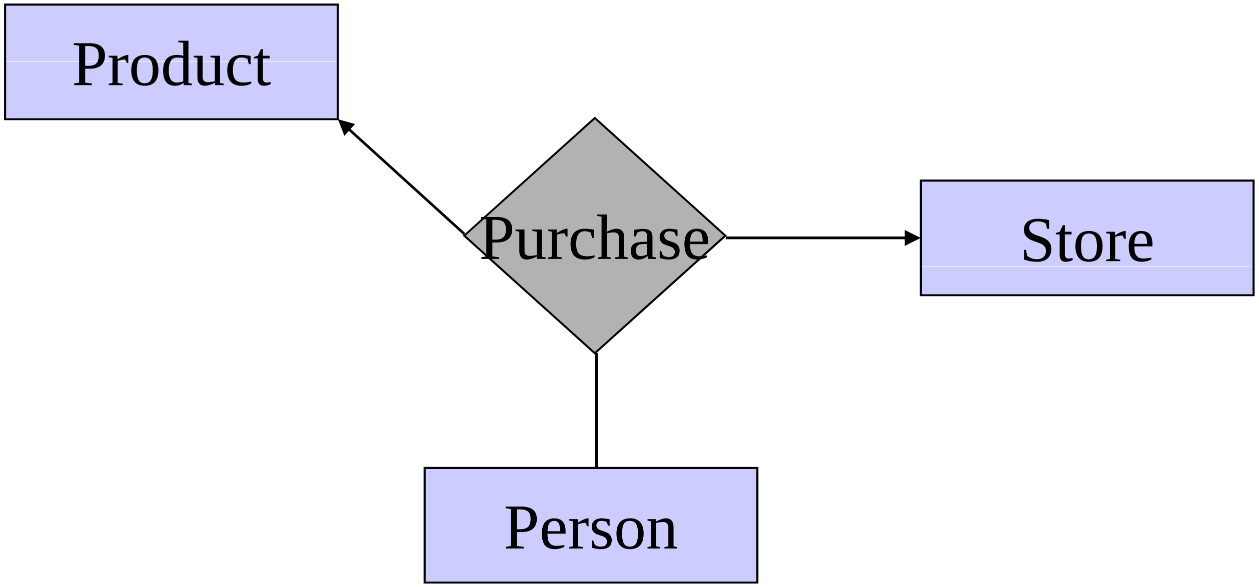
Q: What does the arrow mean ?



A: A given person buys a given product from at most one store

Arrows in Multiway Relationships

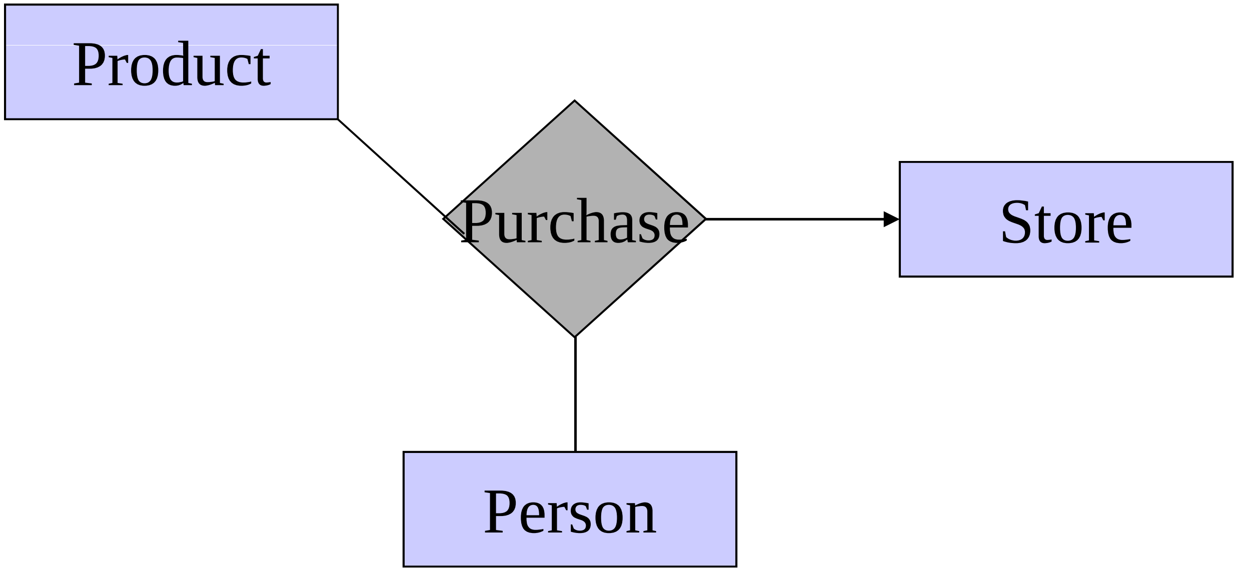
Q: What does the arrow mean ?



A: A given person buys a given product from at most one store AND every store sells to every person at most one product

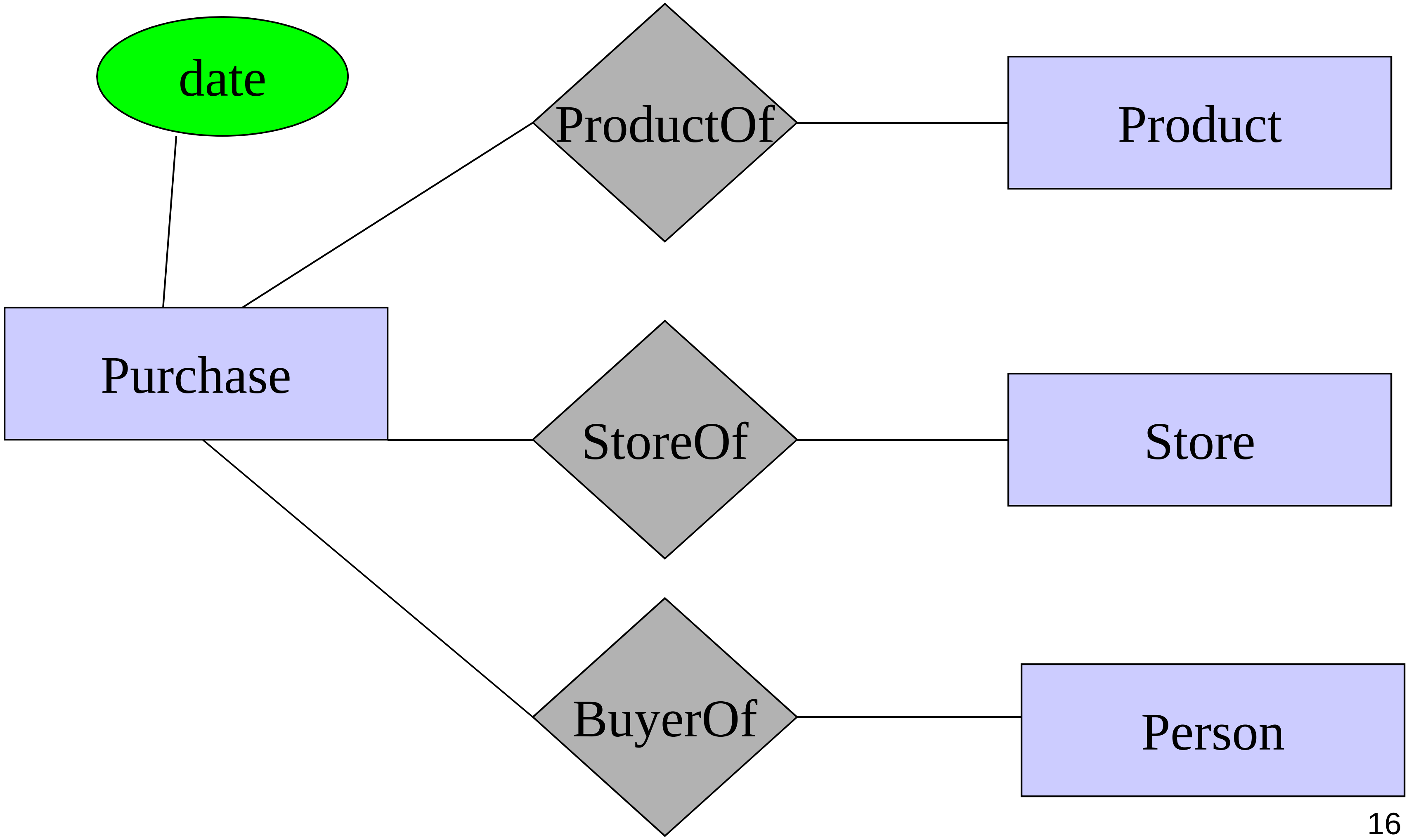
Arrows in Multiway Relationships

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



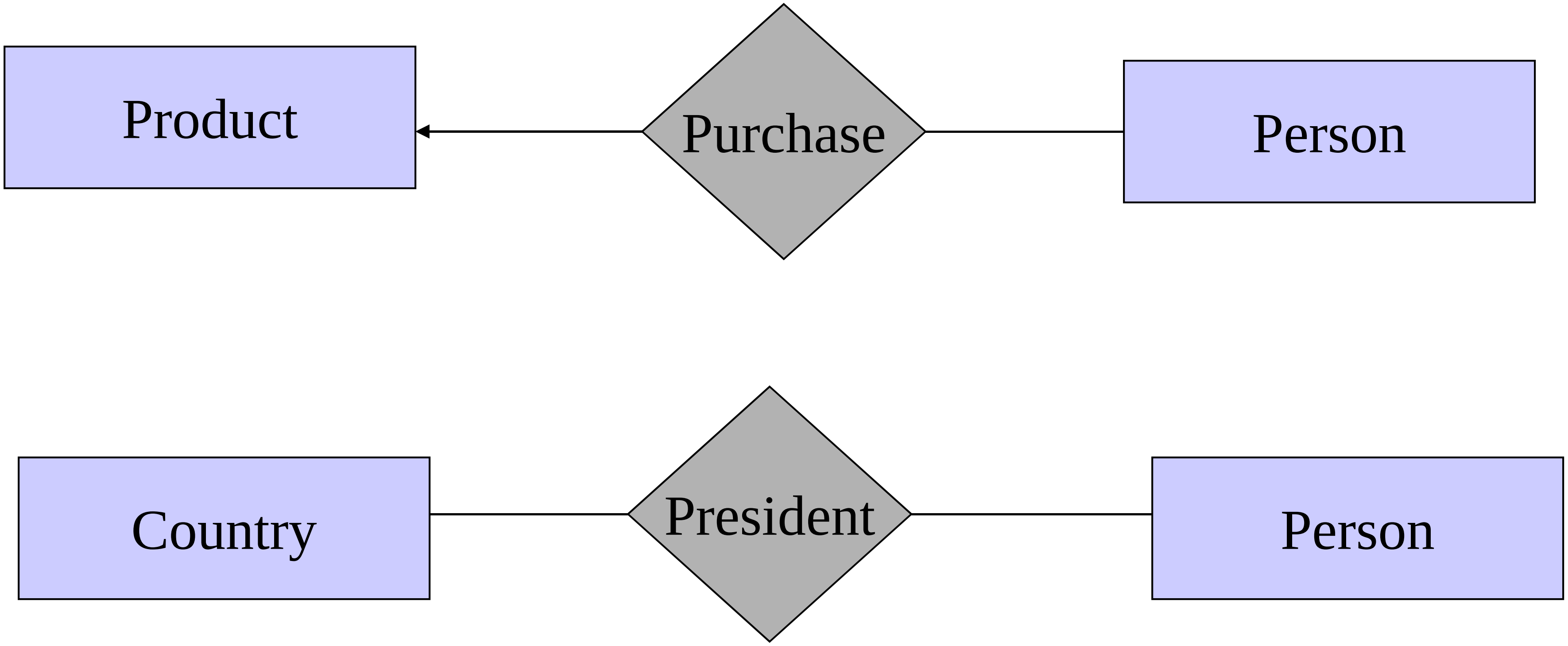
A: Cannot. This is the best approximation.
(Why only approximation ?)

Converting Multi-way Relationships to Binary



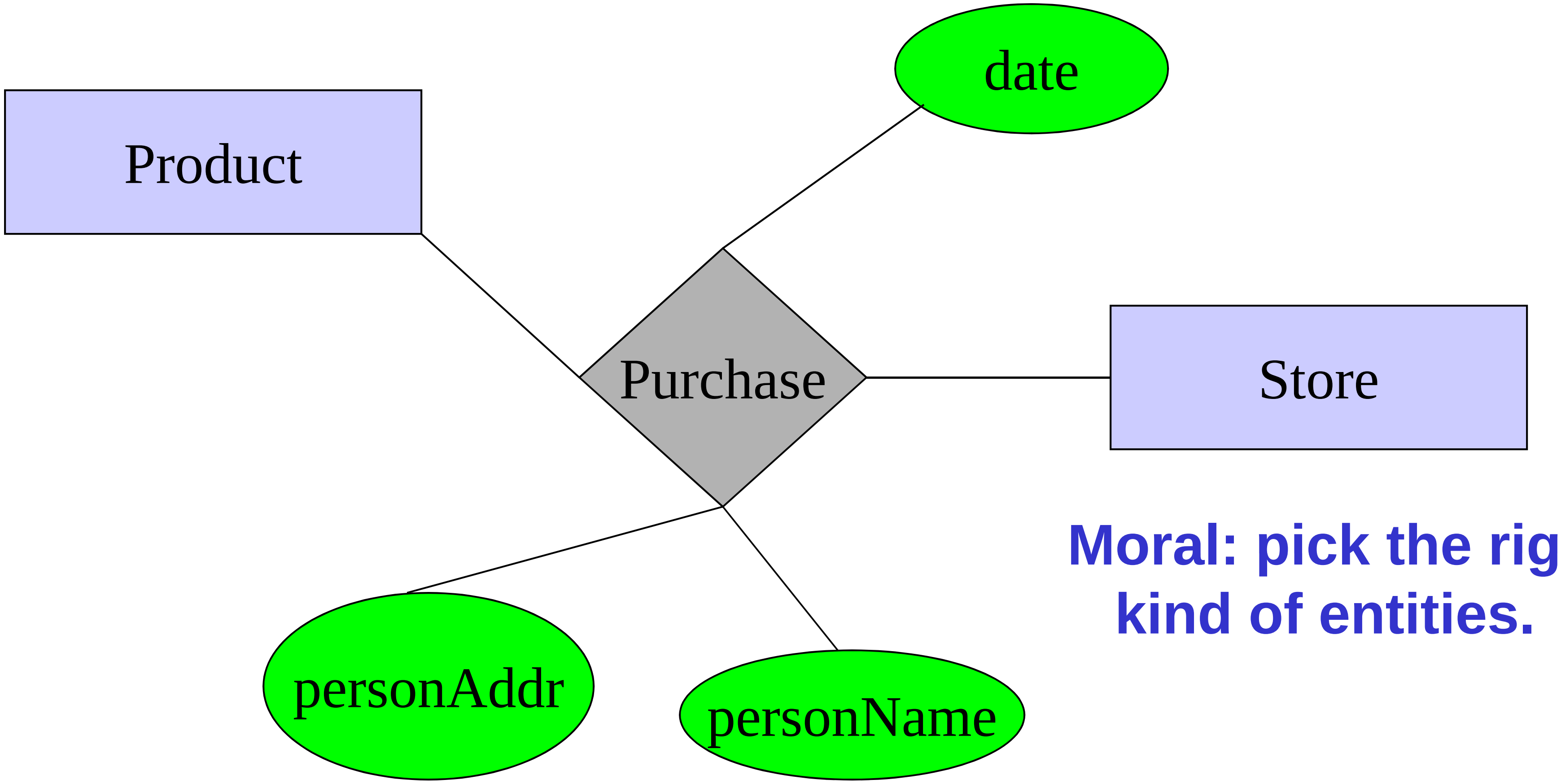
3. Design Principles

What's wrong?



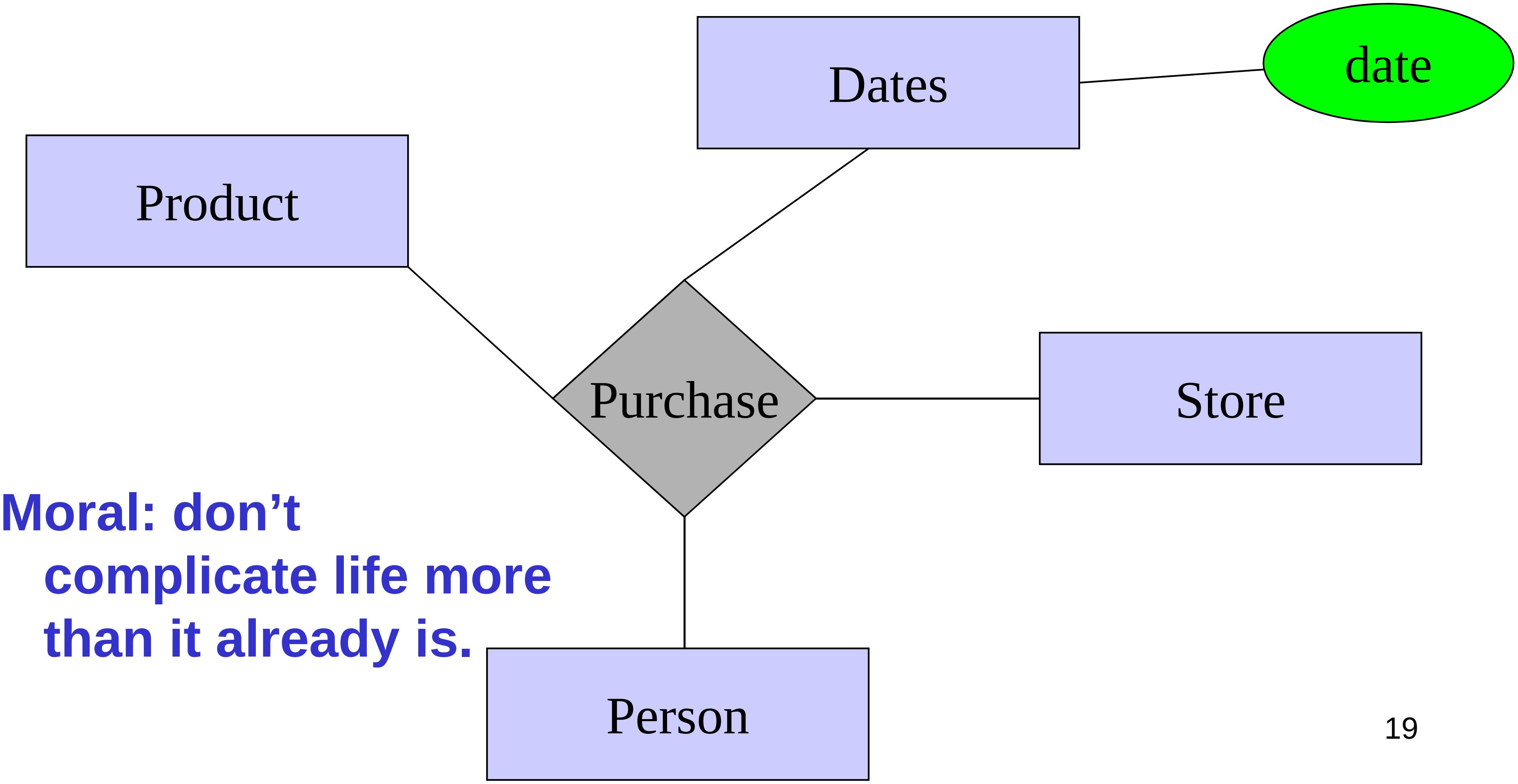
Moral: be faithful to the specifications of the app!

Design Principles: What's Wrong?



Moral: pick the right kind of entities.

Design Principles: What’s Wrong?

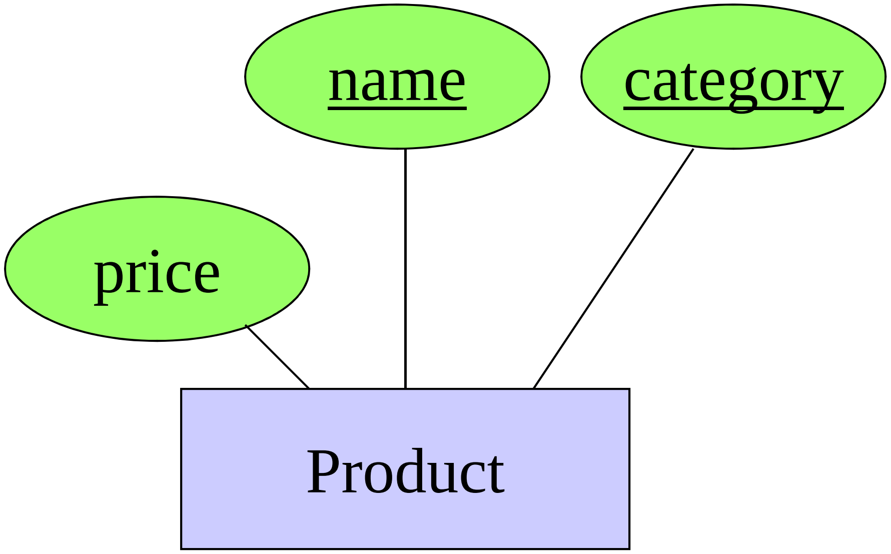


Moral: don’t complicate life more than it already is.

From E/R Diagrams to Relational Schema

- Entity set → relation
- Relationship → relation

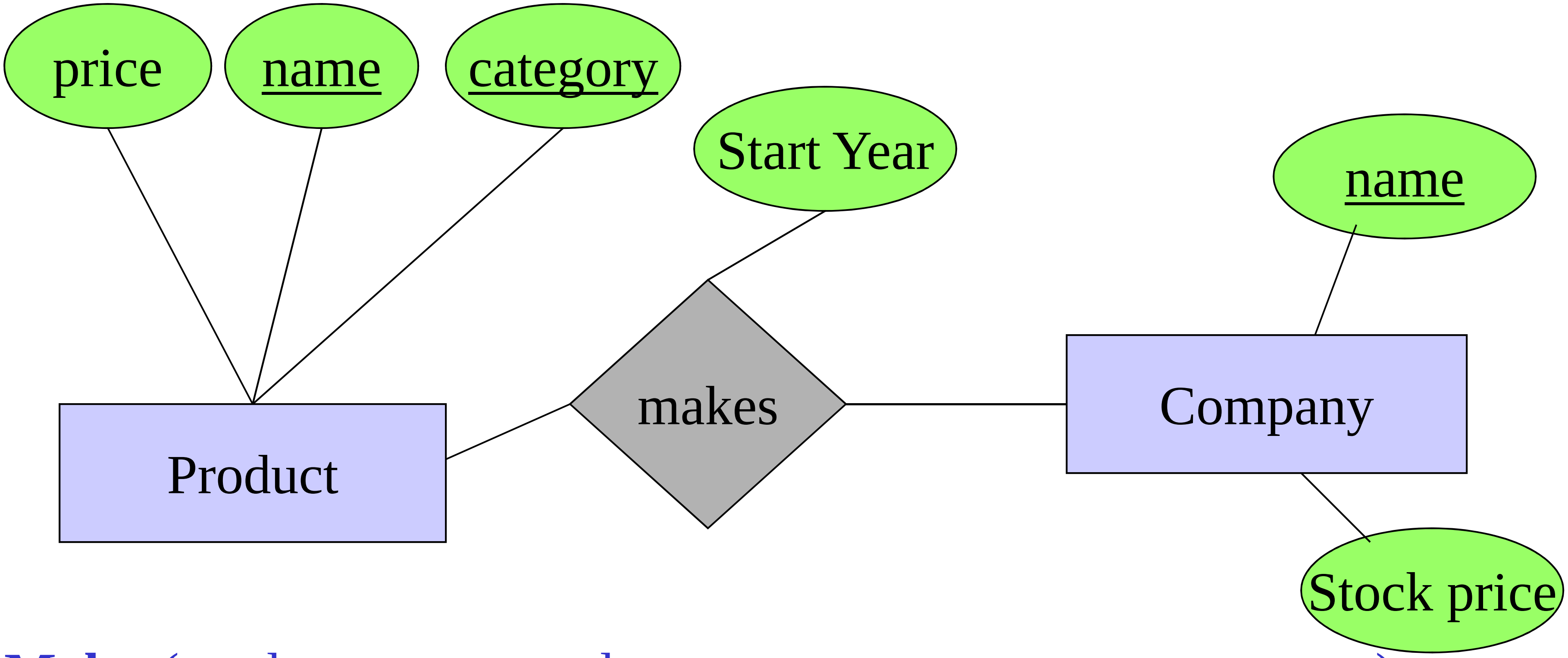
Entity Set to Relation



Product(name, category, price)

name	category	price
gizmo	gadgets	$19.99

Relationships to Relations

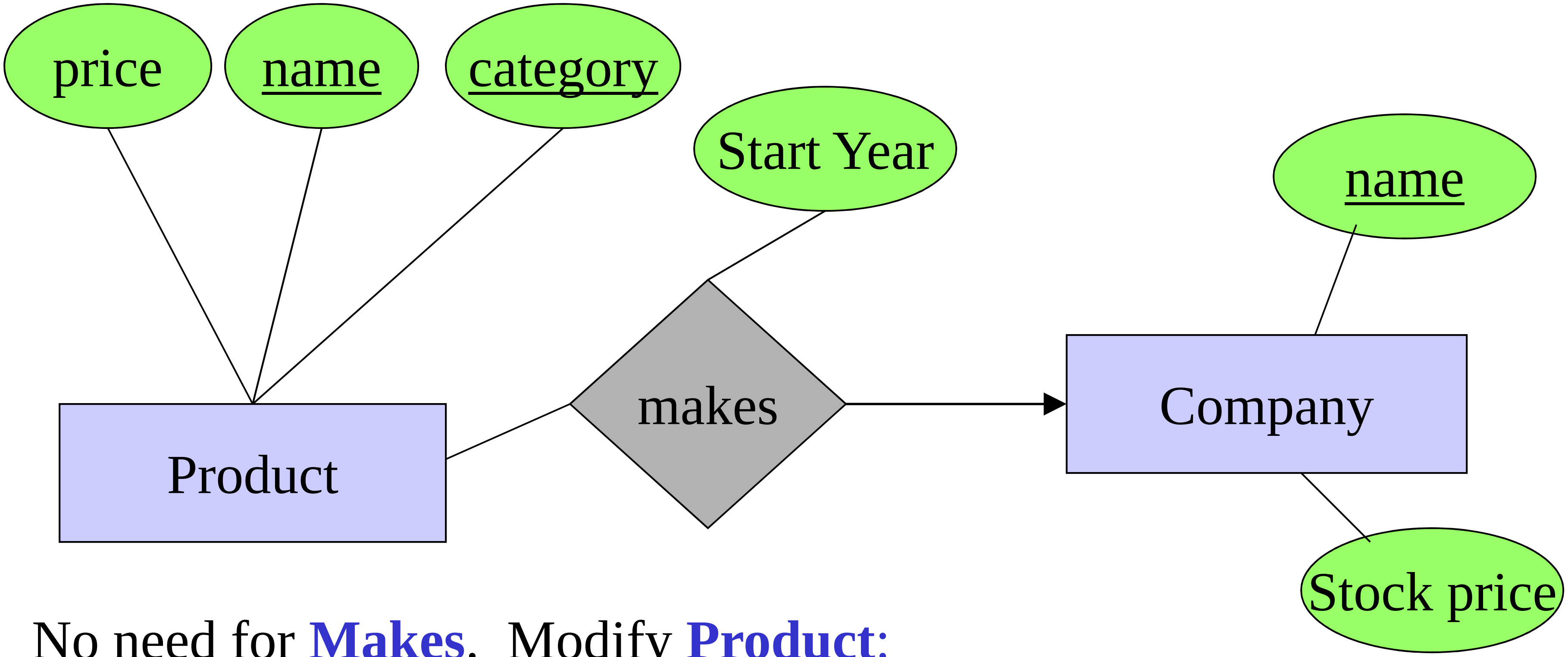


Makes(product-name, product-category, company-name, year)

Product-name	Product-Category	Company-name	Starting-year
gizmo	gadgets	gizmoWorks	1963

(watch out for attribute name conflicts)

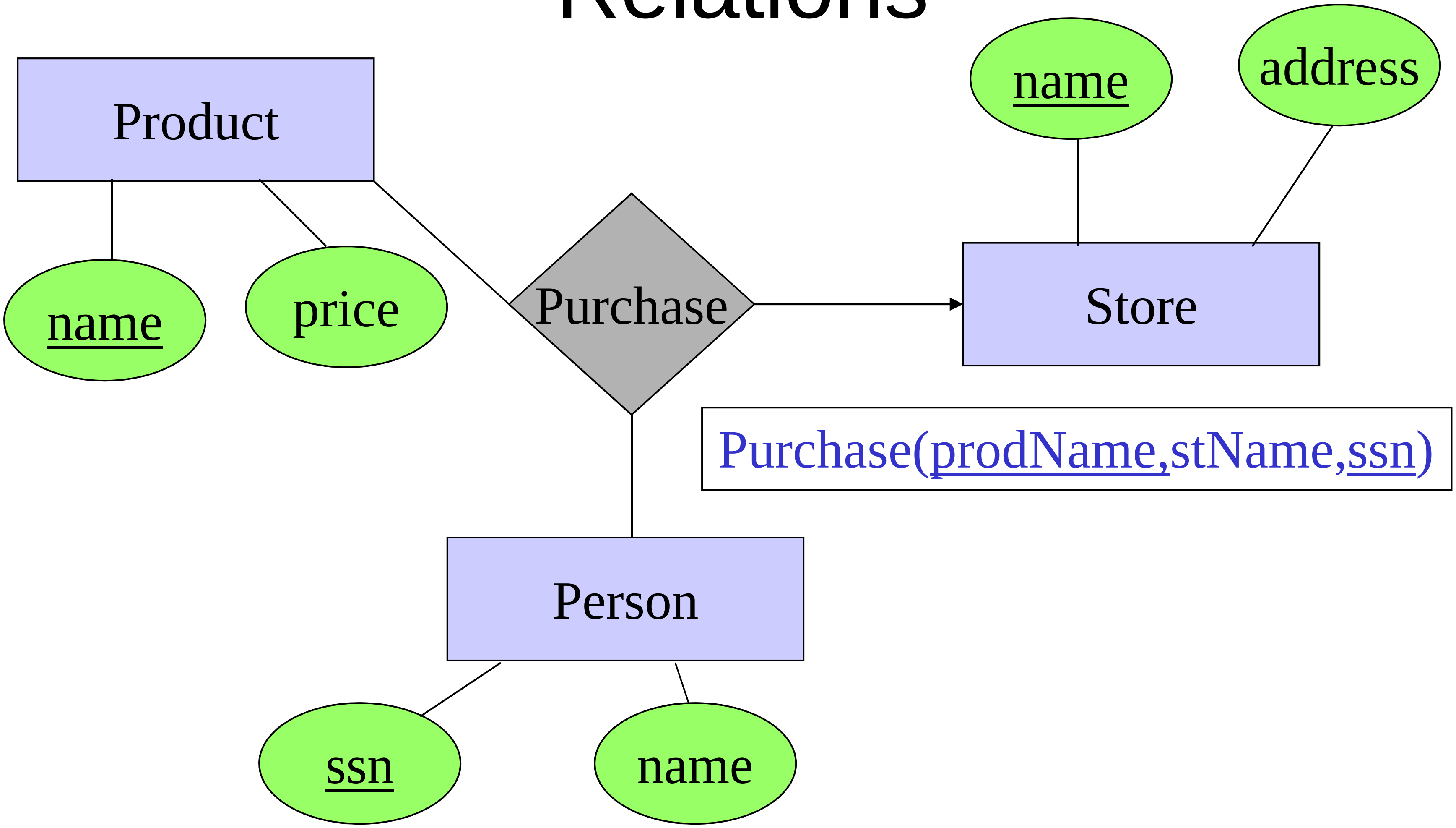
Relationships to Relations



No need for **Makes**. Modify **Product**:

name	category	price	StartYear	companyName
gizmo	gadgets	19.99	1963	gizmoWorks

Multi-way Relationships to Relations

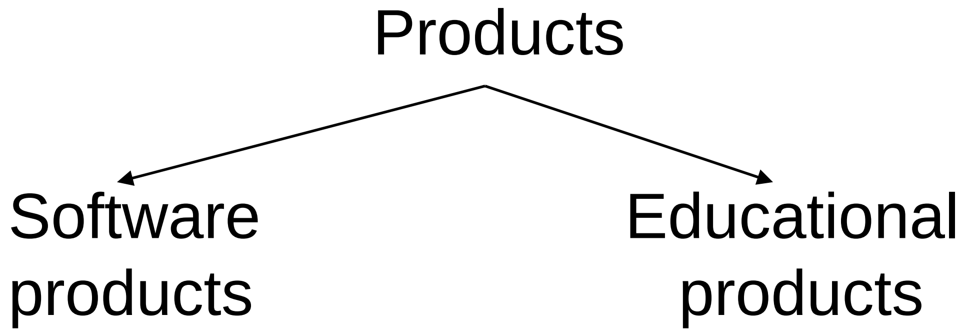


Purchase(prodName,stName,ssn)

Modeling Subclasses

Some objects in a class may be special

- define a new class
- better: define a *subclass*



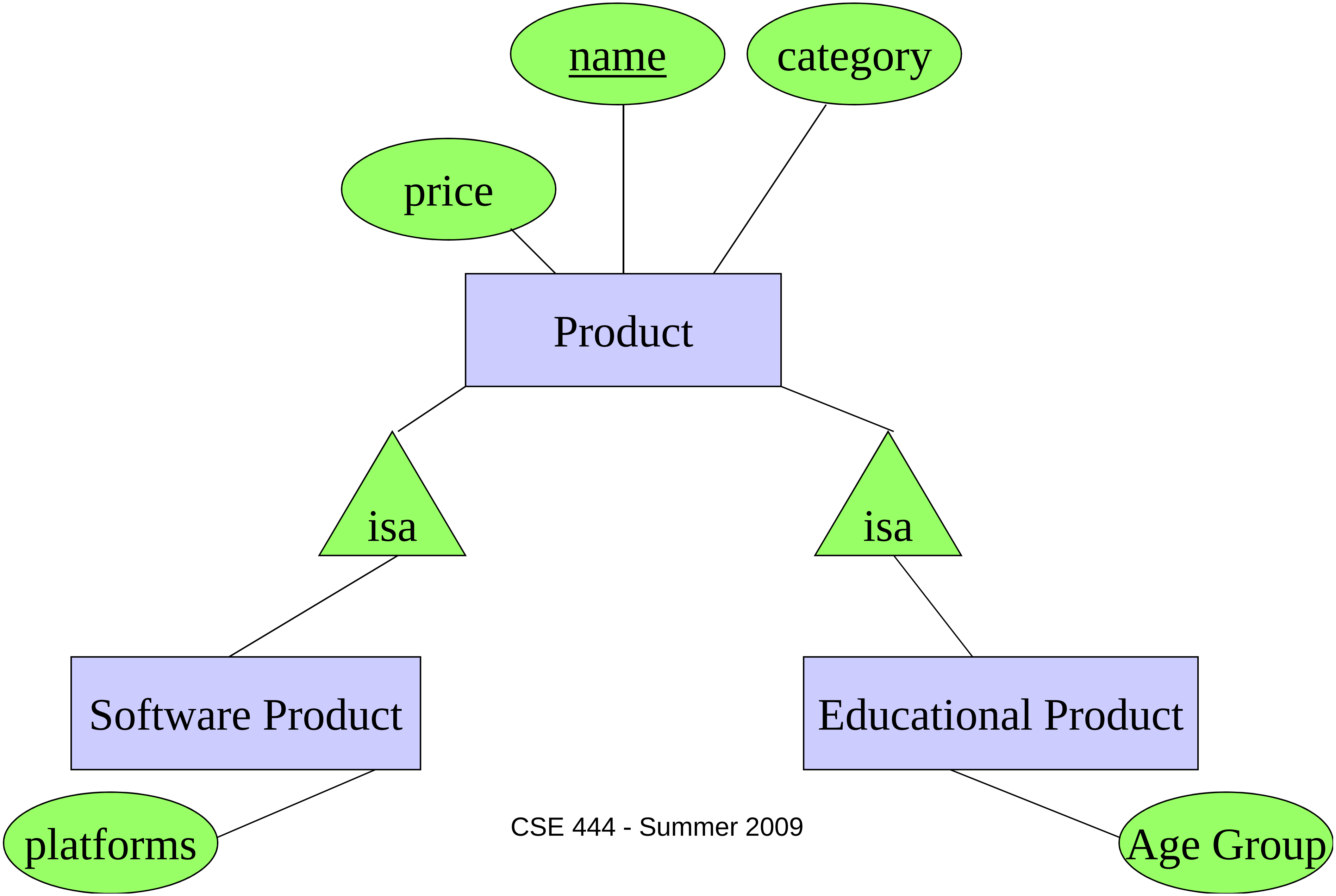
Products

Software products

Educational products

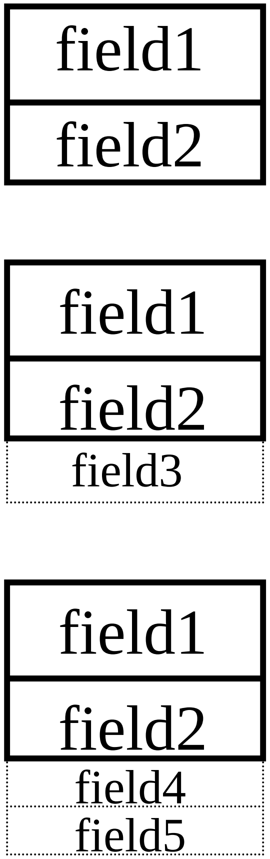
So --- we define subclasses in E/R

Subclasses


name
category
price
Product
isa
isa
Software Product
Educational Product
platforms
Age Group

Understanding Subclasses

- Think in terms of records:
  - Product
  - SoftwareProduct
  - EducationalProduct



field1

field2

field1

field2

field3

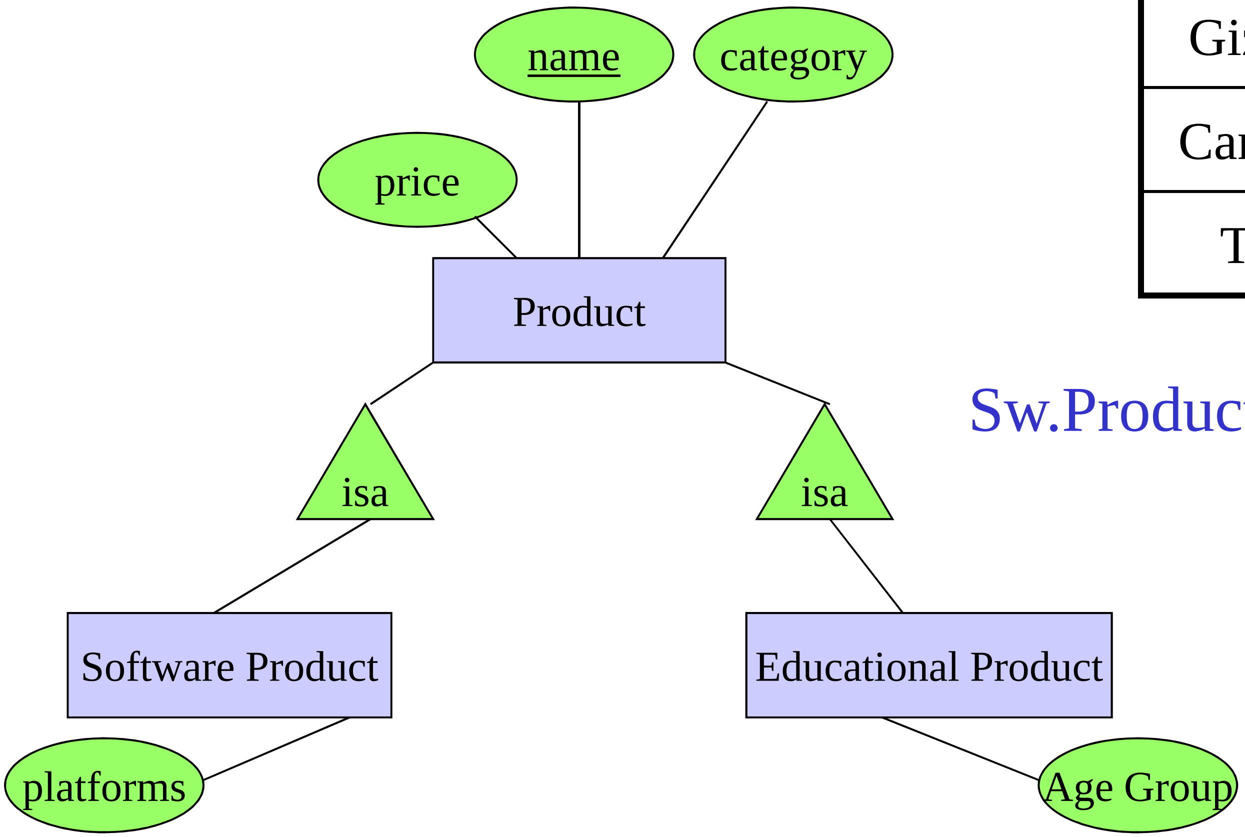
field1

field2

field4

field5

Subclasses to Relations



Other ways to convert are possible
See book sec 4.6 [Old ed: 3.3]

Product

Name	Price	Category
Gizmo	99	gadget
Camera	49	photo
Toy	39	gadget

Sw.Product

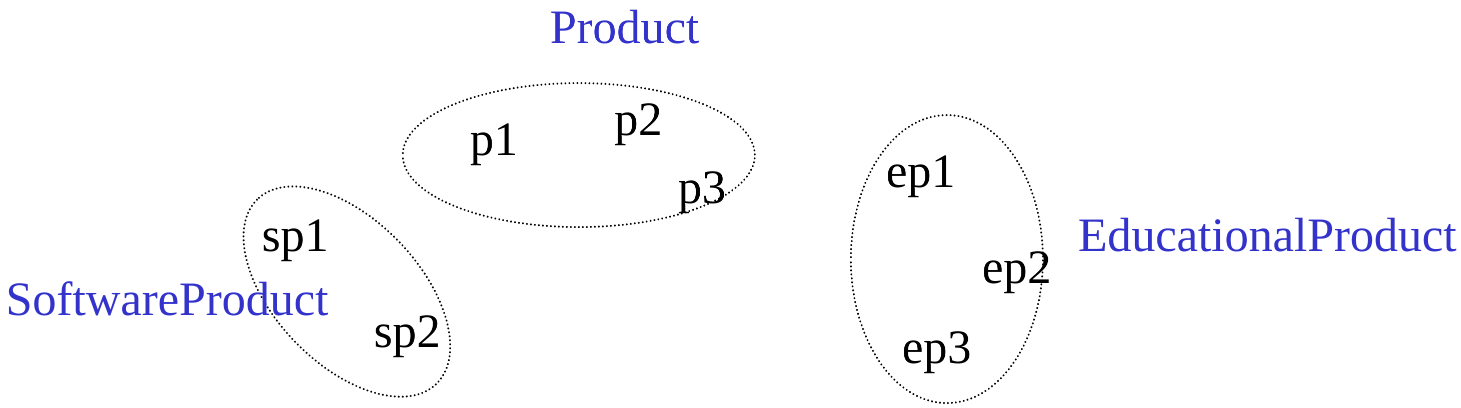
Name	platforms
Gizmo	unix

Ed.Product

Name	Age Group
Gizmo	toddler
Toy	retired

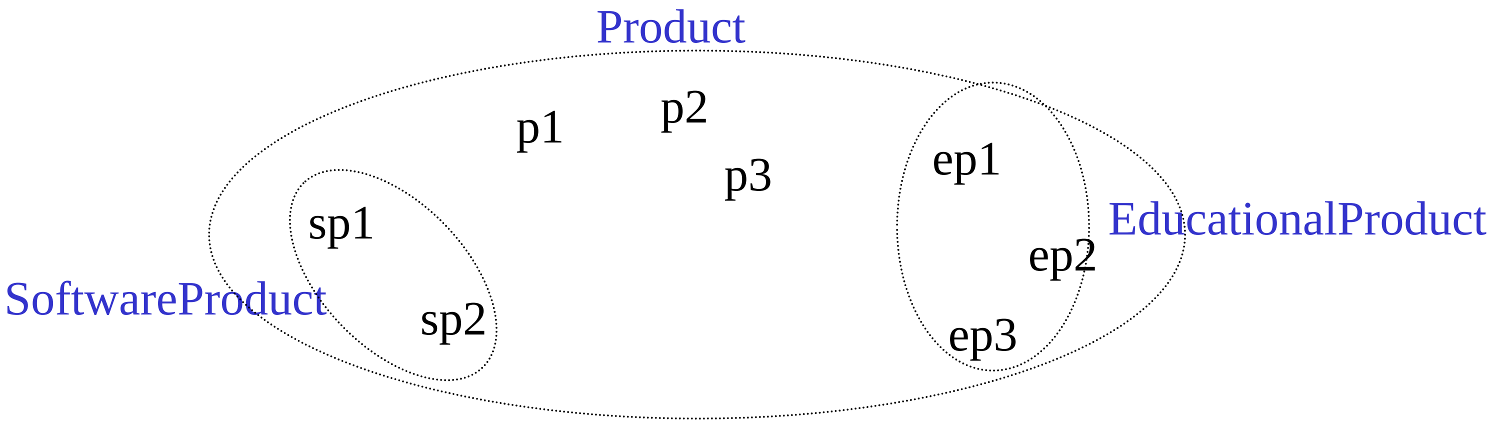
Difference between OO and E/R inheritance

- OO: classes are disjoint (same for Java, C++)



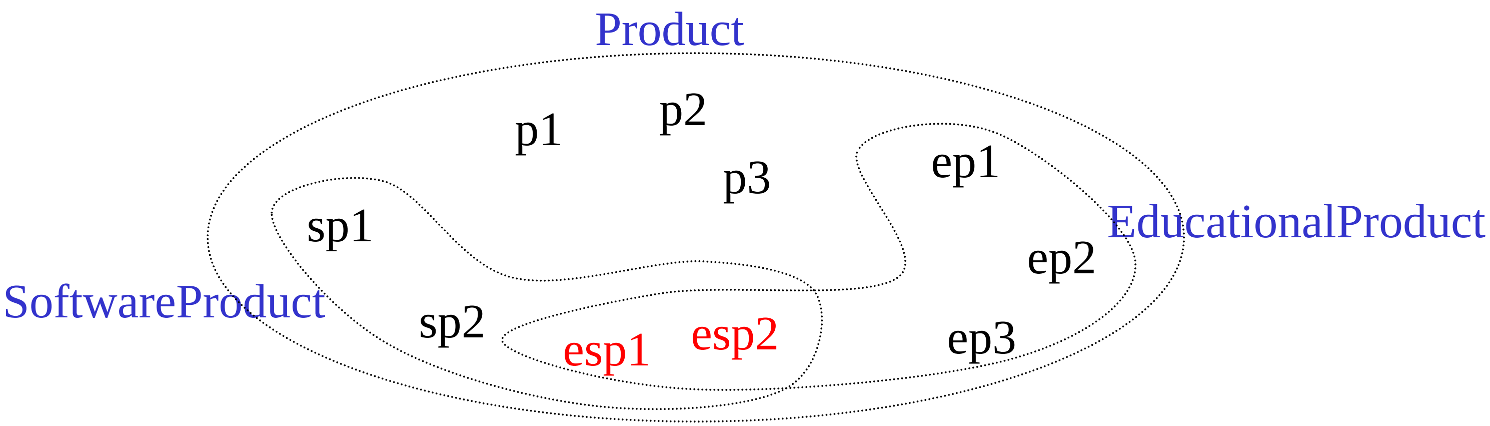
Difference between OO and E/R inheritance

- E/R: entity sets overlap



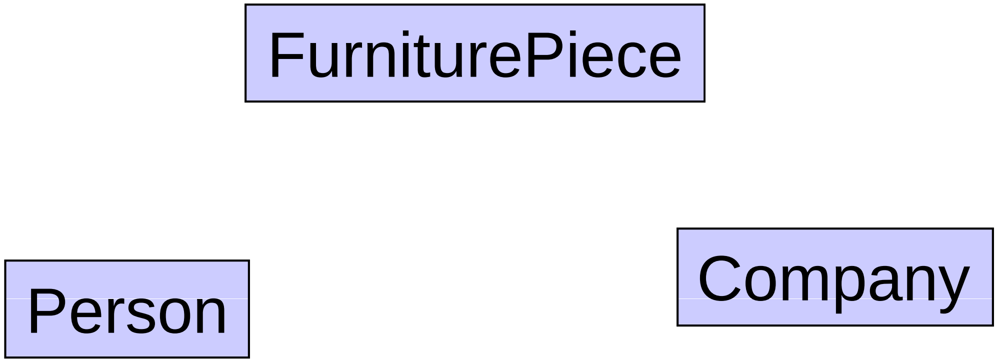
Difference between OO and E/R inheritance

No need for multiple inheritance in E/R



We have three entity sets, but four different kinds of objects.

Modeling UnionTypes With Subclasses



FurniturePiece

Person

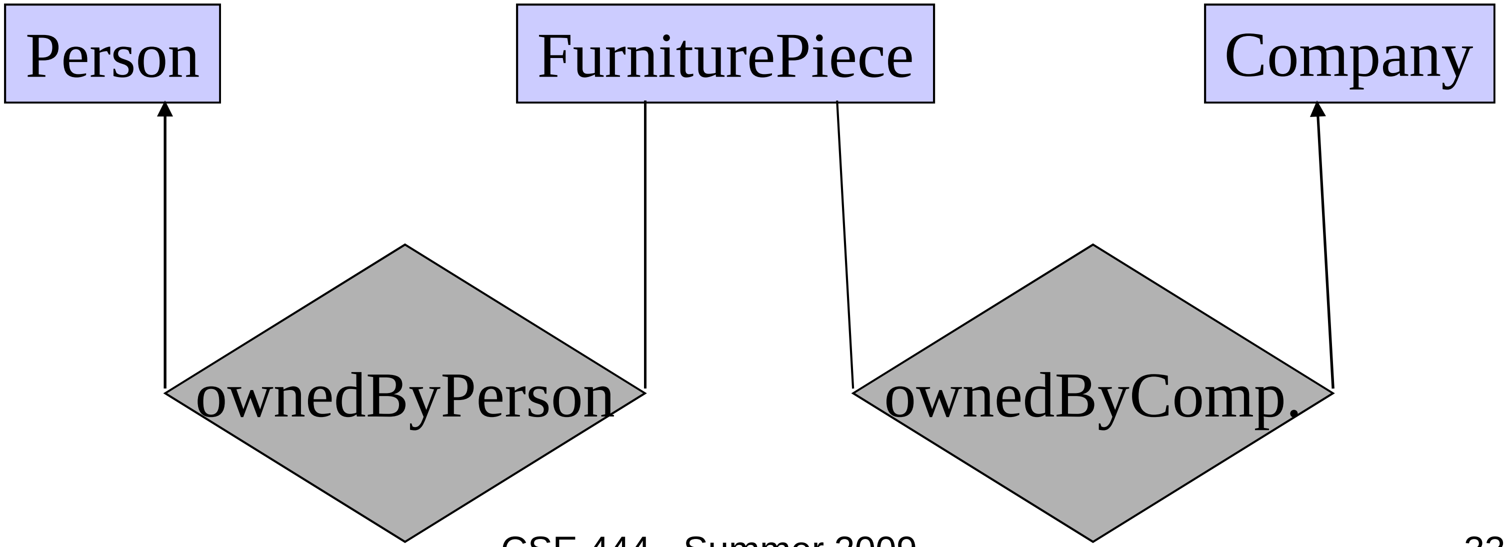
Company

Say: each piece of furniture is owned either by a person, or by a company

Modeling Union Types with Subclasses

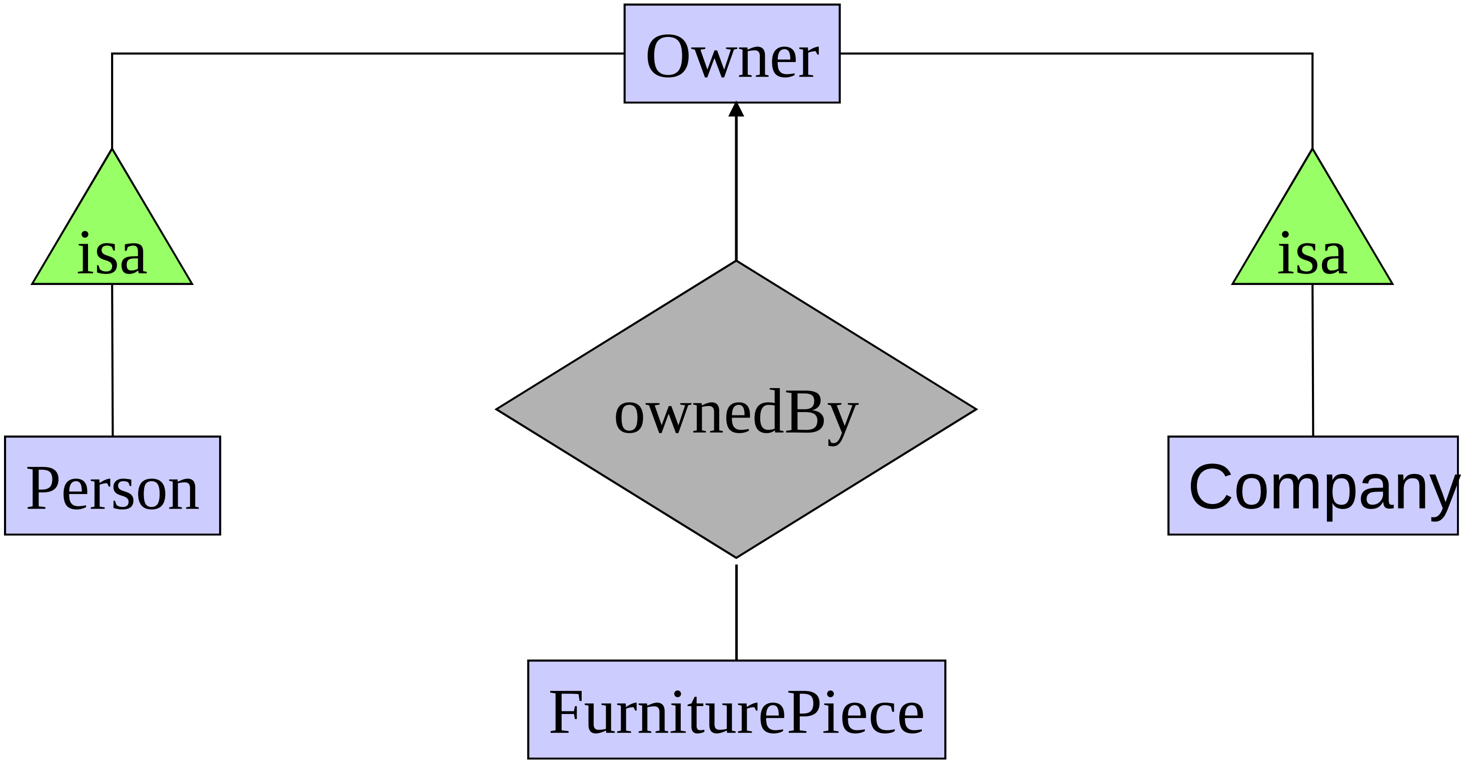
Say: each piece of furniture is owned either by a person, or by a company

Solution 1. Acceptable, imperfect (What’s wrong ?)



Modeling Union Types with Subclasses

Solution 2: better, more laborious



Constraints in E/R Diagrams

Finding constraints is part of the modeling process.
Commonly used constraints:

Keys: social security number uniquely identifies a person.

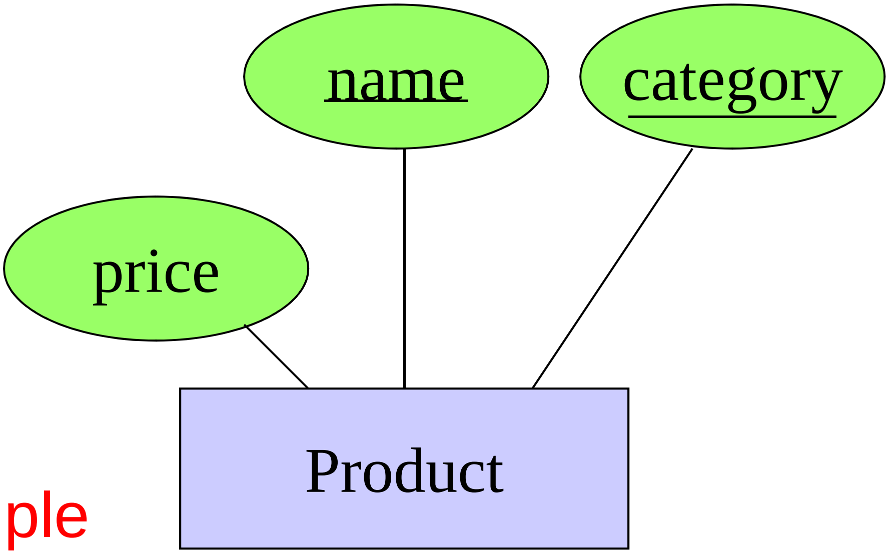
Single-value constraints: a person can have only one father.

Referential integrity constraints: if you work for a company, it must exist in the database.

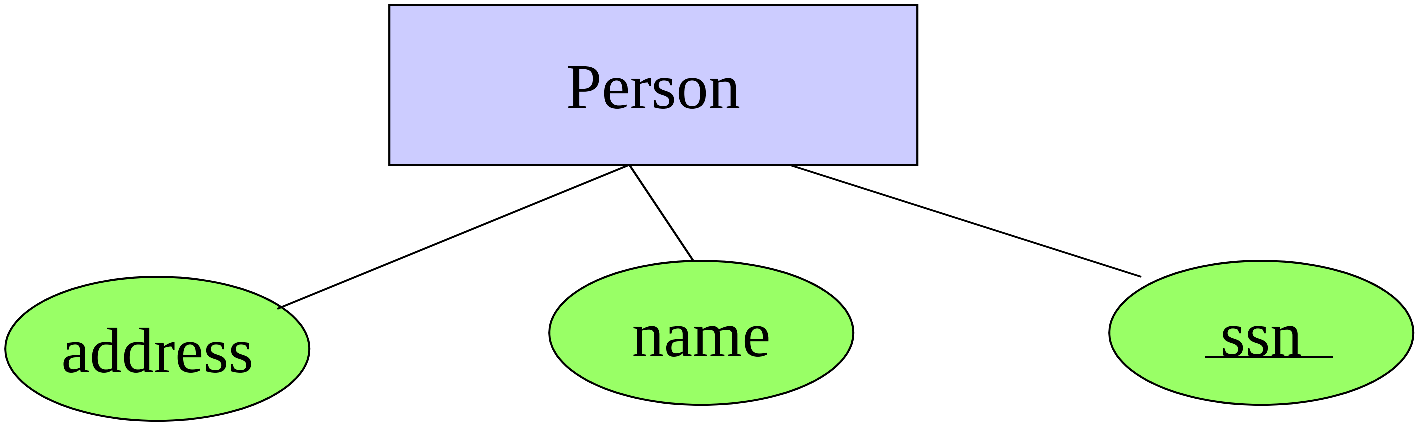
Other constraints: peoples' ages are between 0 and 150.

Keys in E/R Diagrams

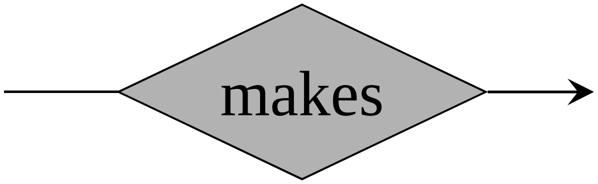
Underline:



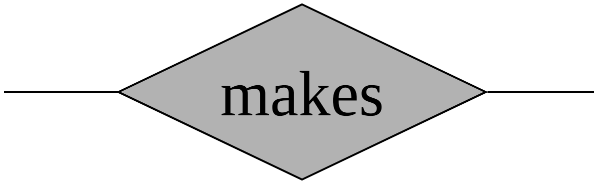
No formal way to specify multiple keys in E/R diagrams



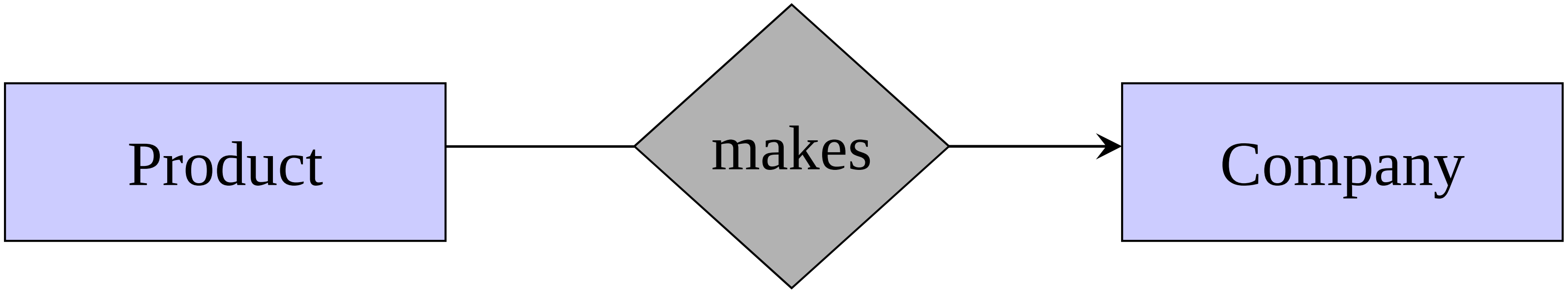
Single Value Constraints



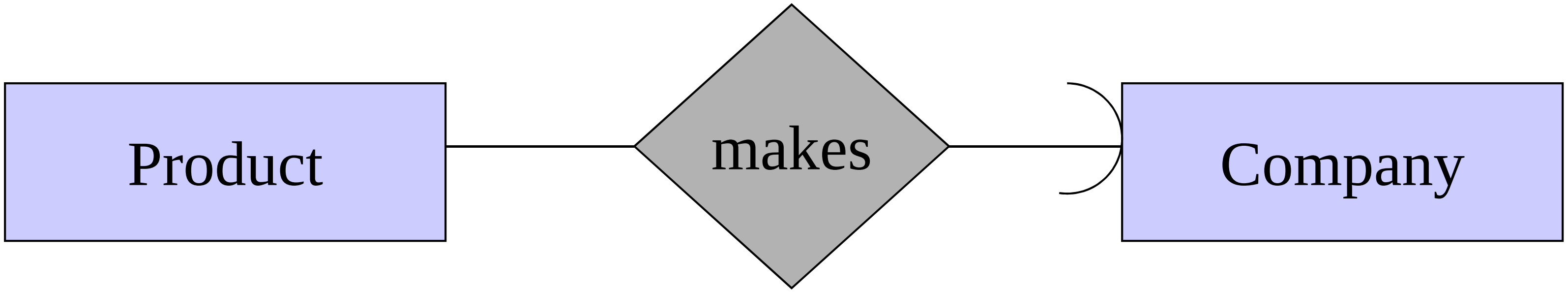
v. s.



Referential Integrity Constraints

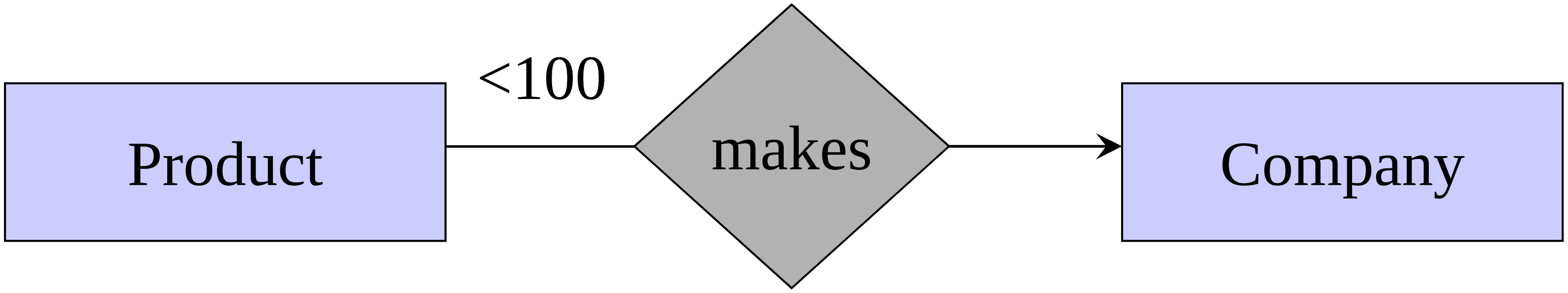


Each product made by at most one company.
Some products made by no company



Each product made by *exactly* one company.

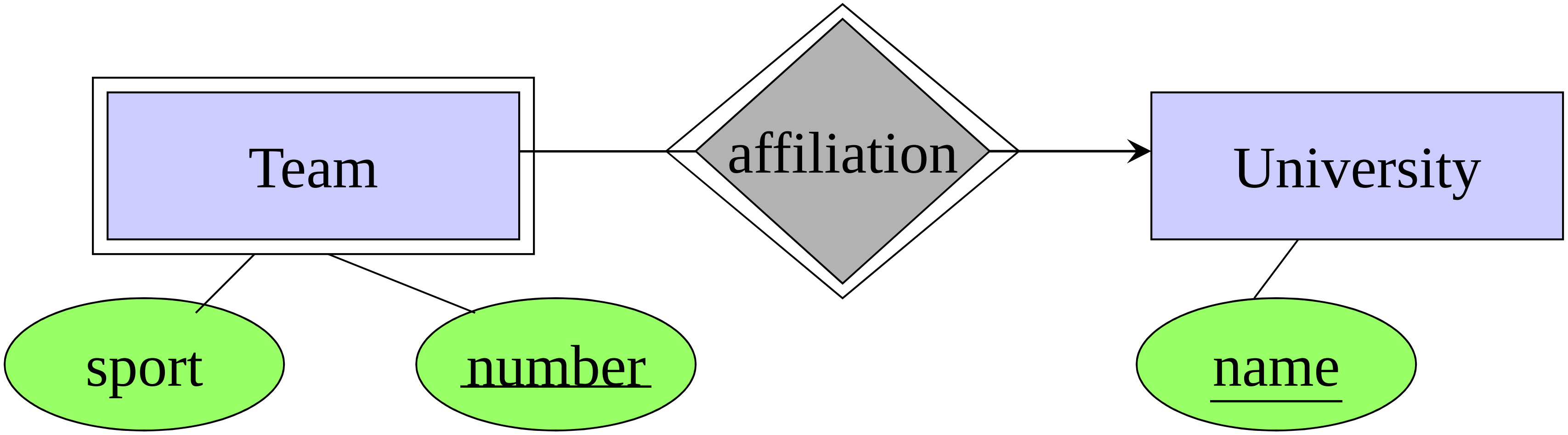
Other Constraints



What does this mean ?

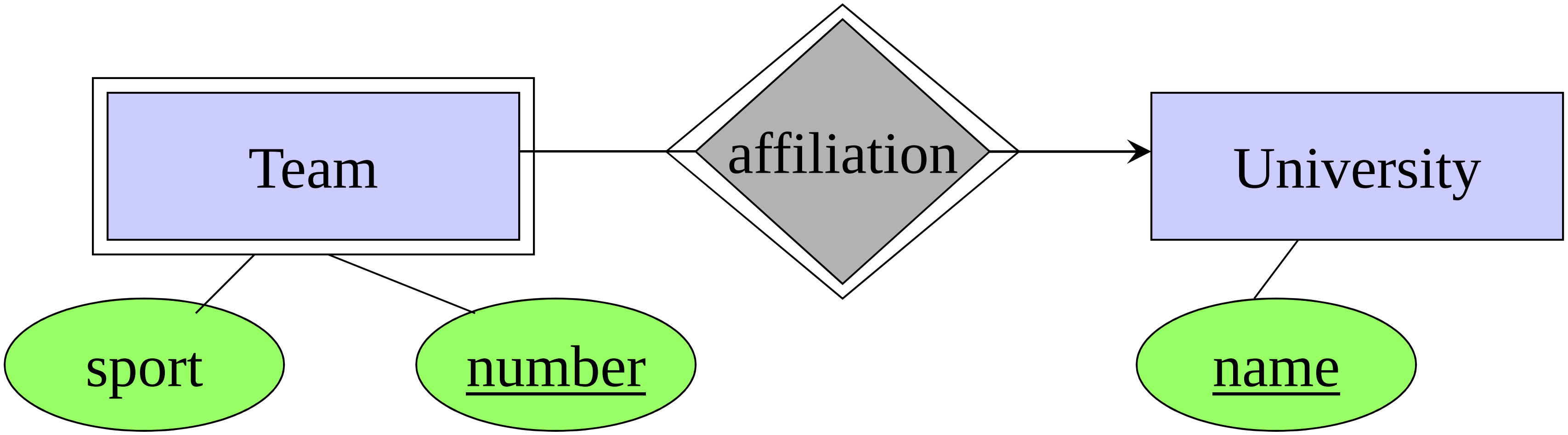
Weak Entity Sets

Entity sets are weak when their key comes from other classes to which they are related.



Notice: we encountered this when converting multiway relationships to binary relationships

Handling Weak Entity Sets



Convert to a relational schema

University(<u>name</u>)
Team(<u>number</u>,<u>universityName</u>,sport)
No need to represent affiliation separately