Introduction to Database Systems
CSE 444

Lecture 5: E/R Diagrams

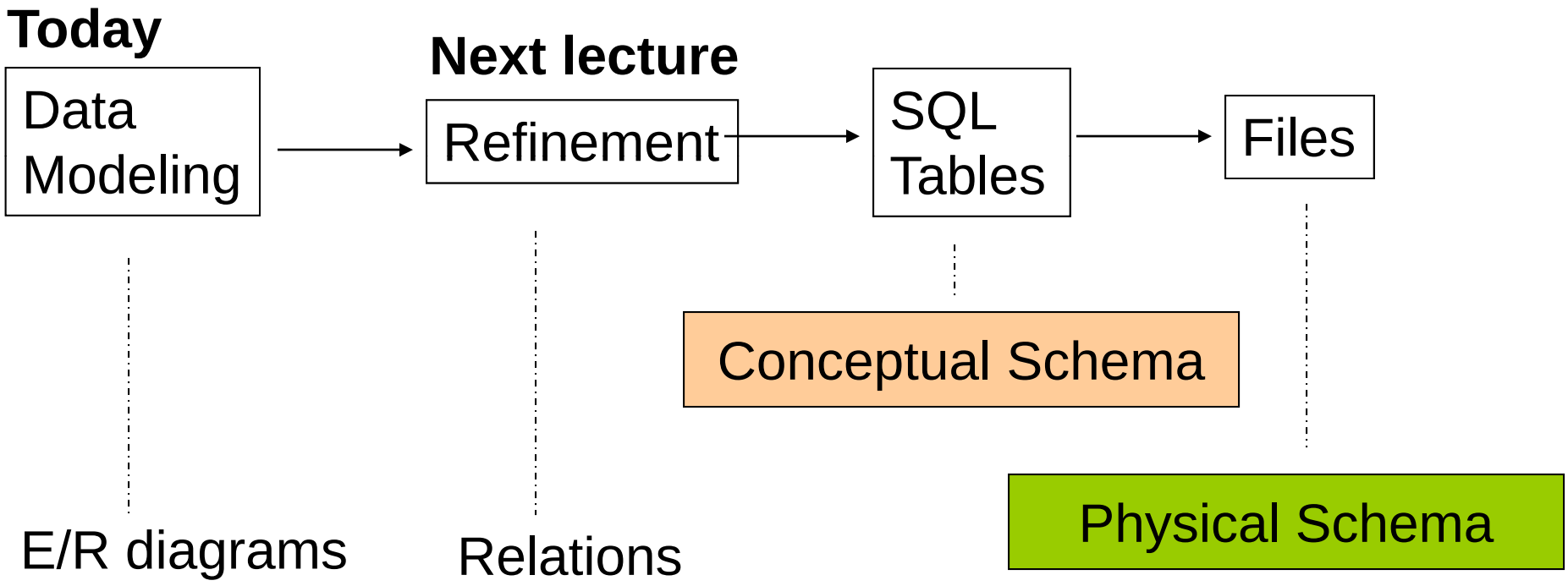
Outline

- 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

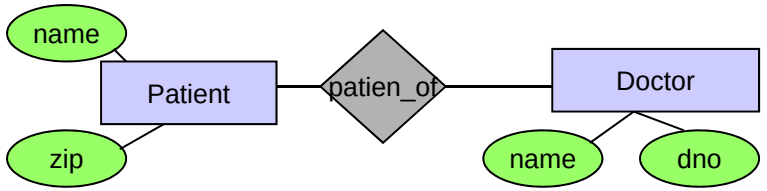
- Why do we need it?
  - Need a way to model real world entities in terms of relations
  - Not easy to go from real-world entities to a database schema
- Consider issues such as:
  - What entities to model
  - How entities are related
  - What constraints exist in the domain
  - How to achieve ***good***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

Database Design Process

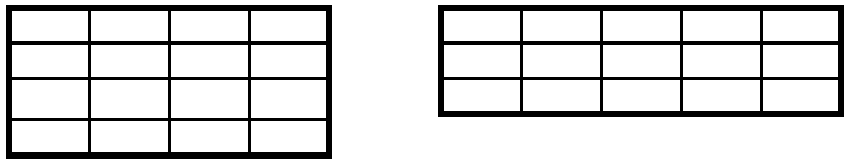


Conceptual Schema Design

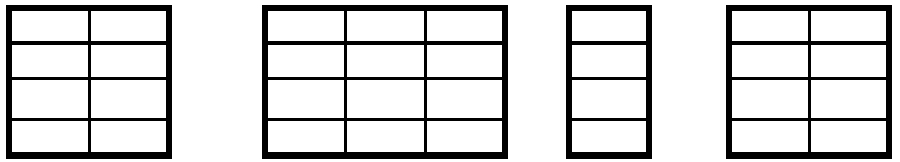
Conceptual Model:



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

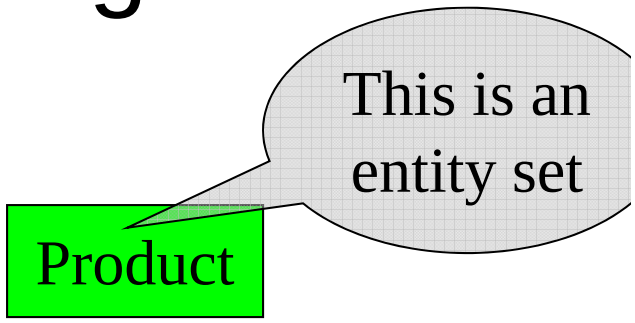


Normalization:
Eliminates anomalies



Entity / Relationship Diagrams

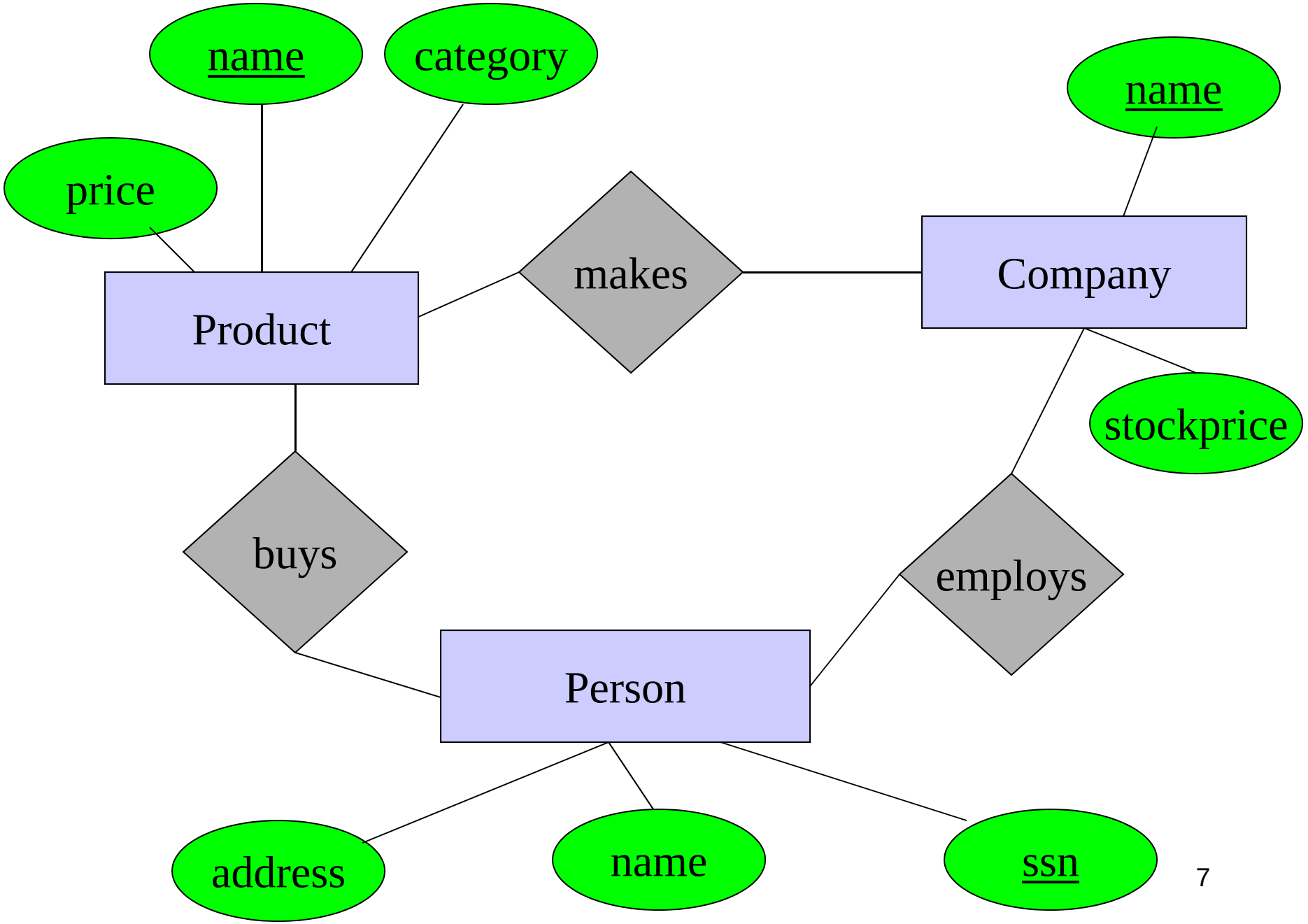
Objects ⟶ entities
Classes ⟶ entity sets



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

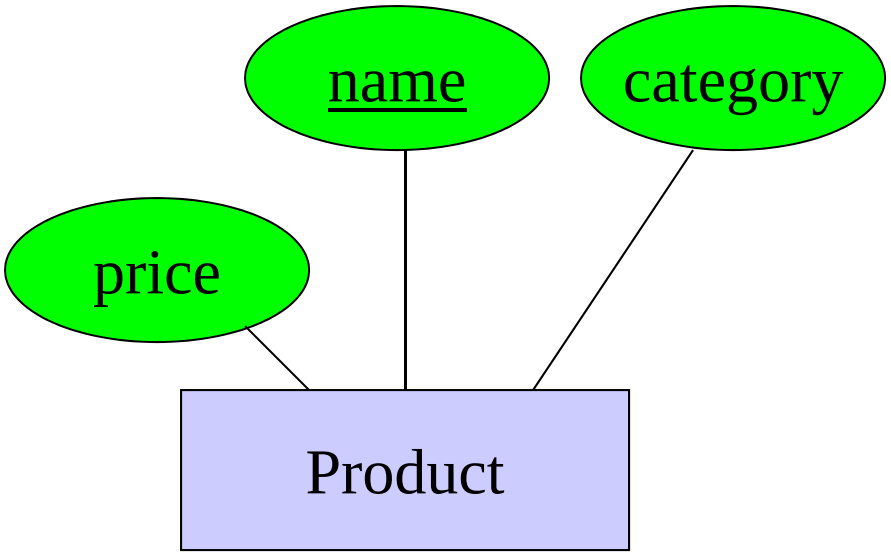
Relationships: like in ODL except

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


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

Keys in E/R Diagrams

- Every entity set must have a key

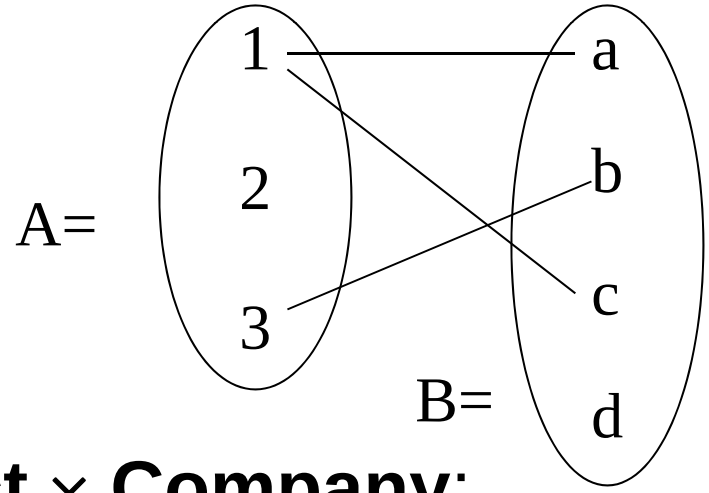


What is a Relation ?

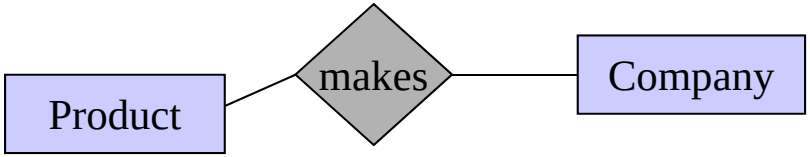
- A mathematical definition:
  - if A, B are sets, then a relation R is a subset of A × B
- A={1,2,3}, B={a,b,c,d},

  A × B = {(1,a),(1,b), . . ., (3,d)}

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

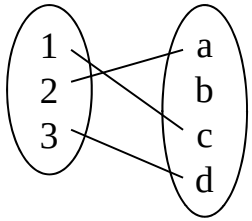


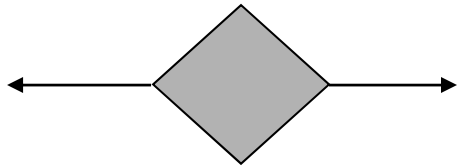
- **makes** is a subset of **Product** × **Company**:



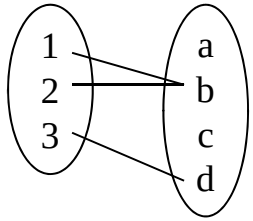
Multiplicity of E/R Relations

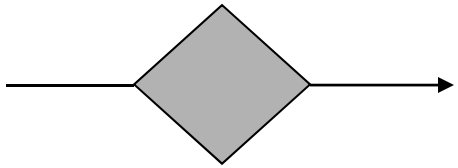
- one-one:



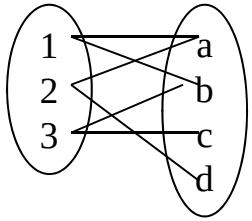


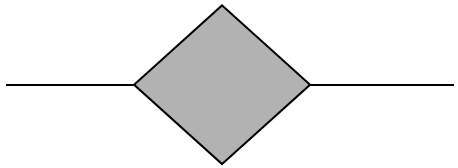
- many-one

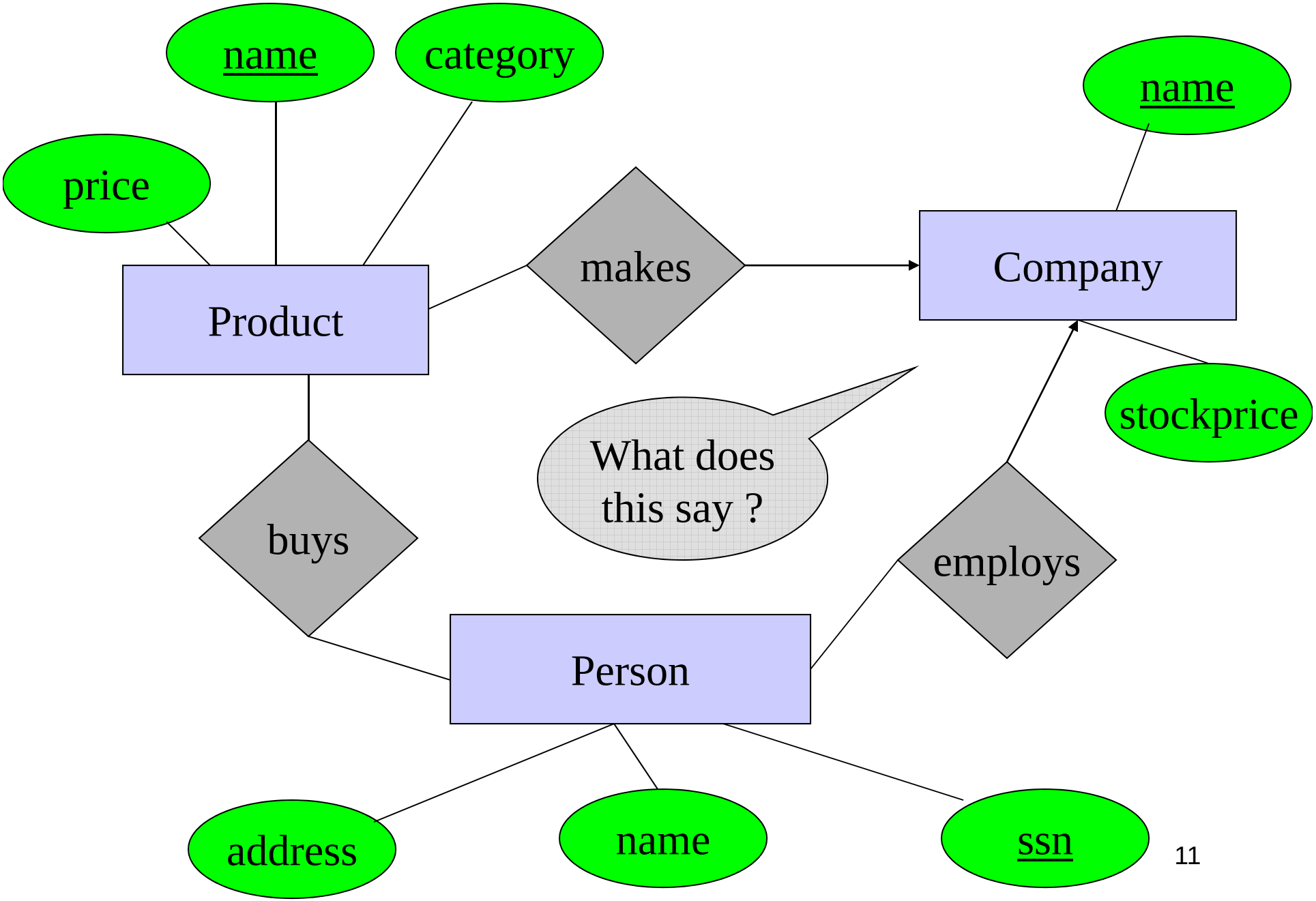




- many-many

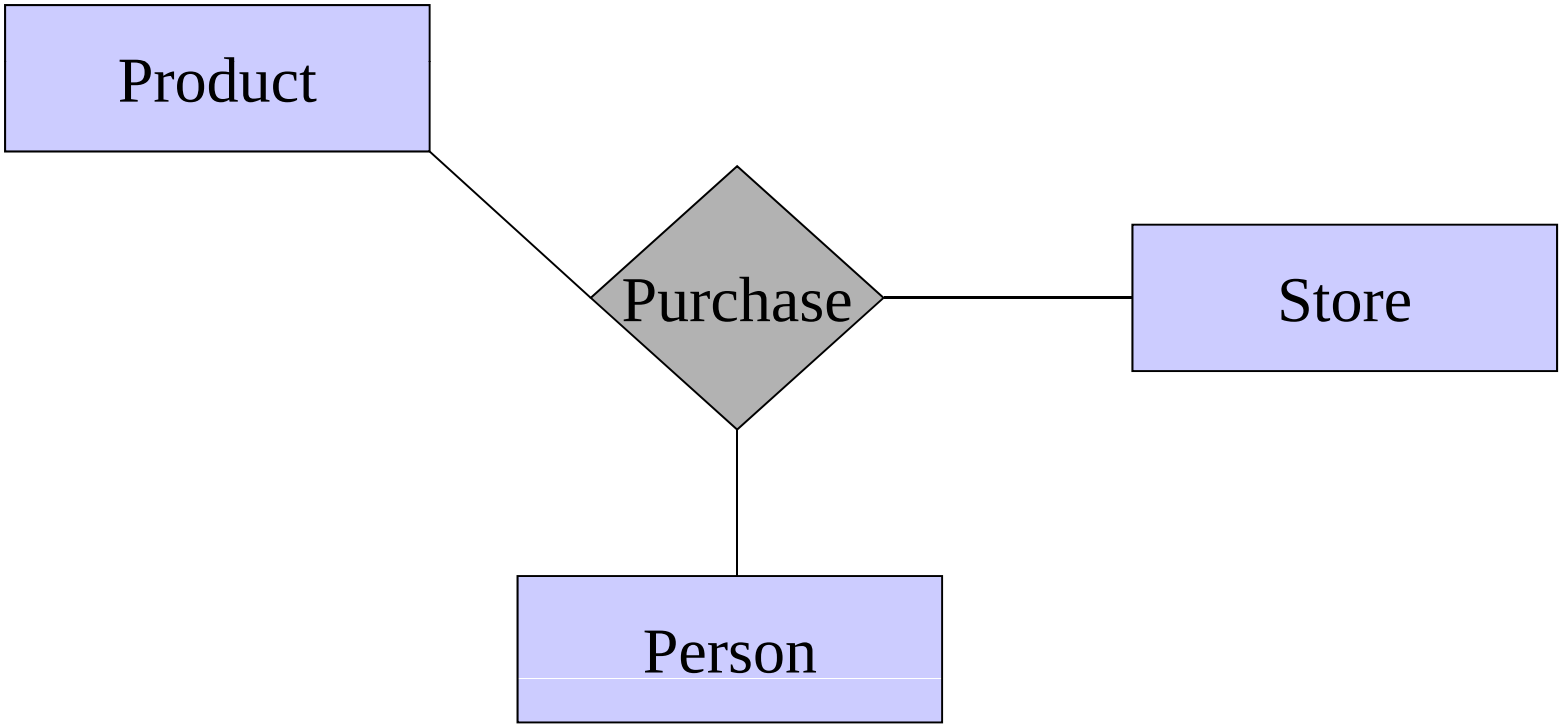





name
category
price
Product
makes
Company
name
stockprice
What does this say ?
buys
employs
Person
address
name
ssn

Multi-way Relationships

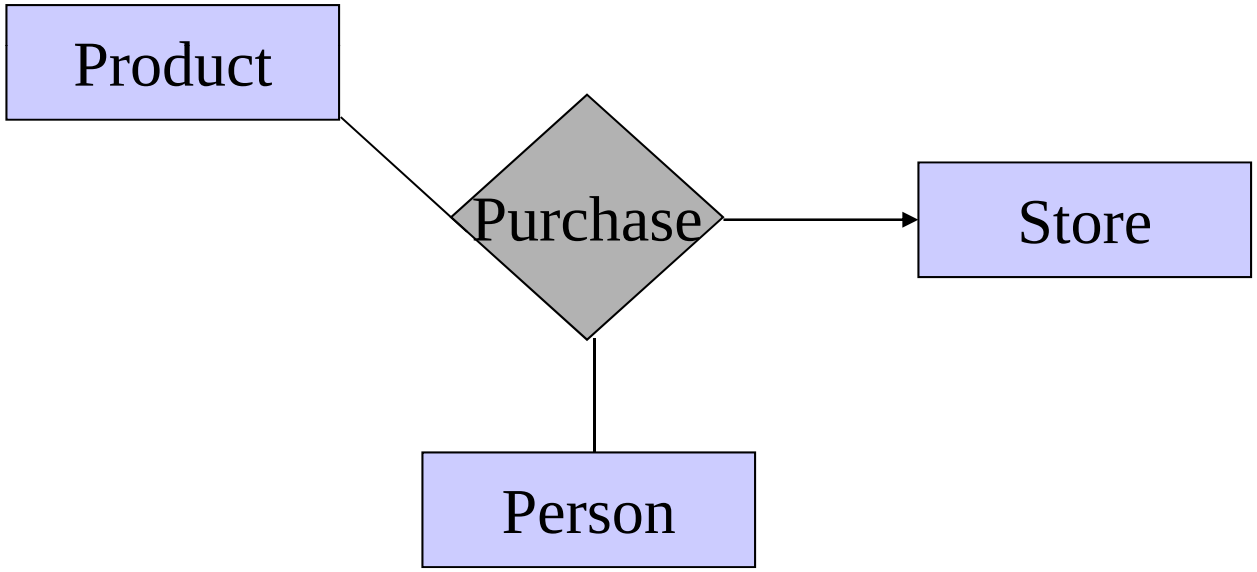
How do we model a purchase relationship between buyers, products and stores?



Can still model as a mathematical set (how ?)

Arrows in Multiway Relationships

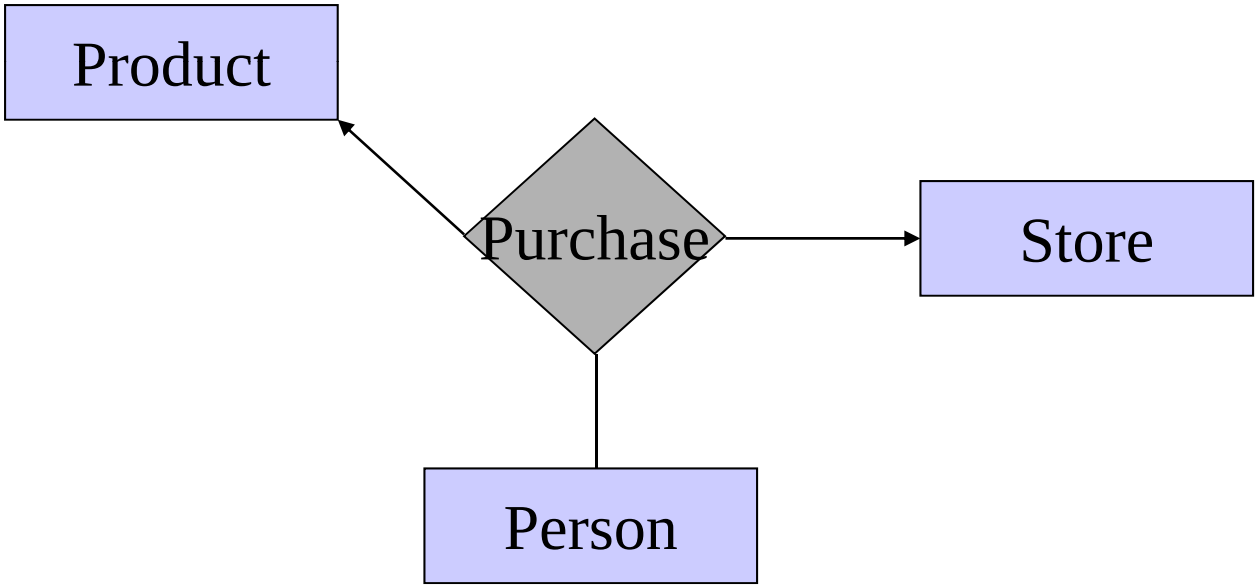
Q: What does the arrow mean ?



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

Arrows in Multiway Relationships

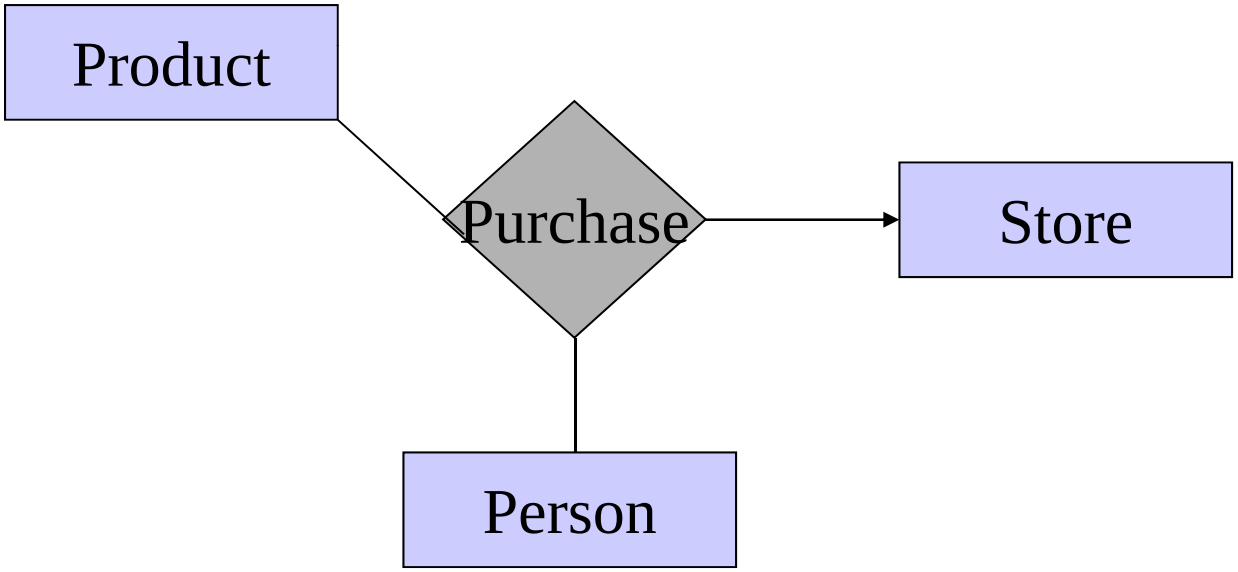
Q: What does the arrow mean ?



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

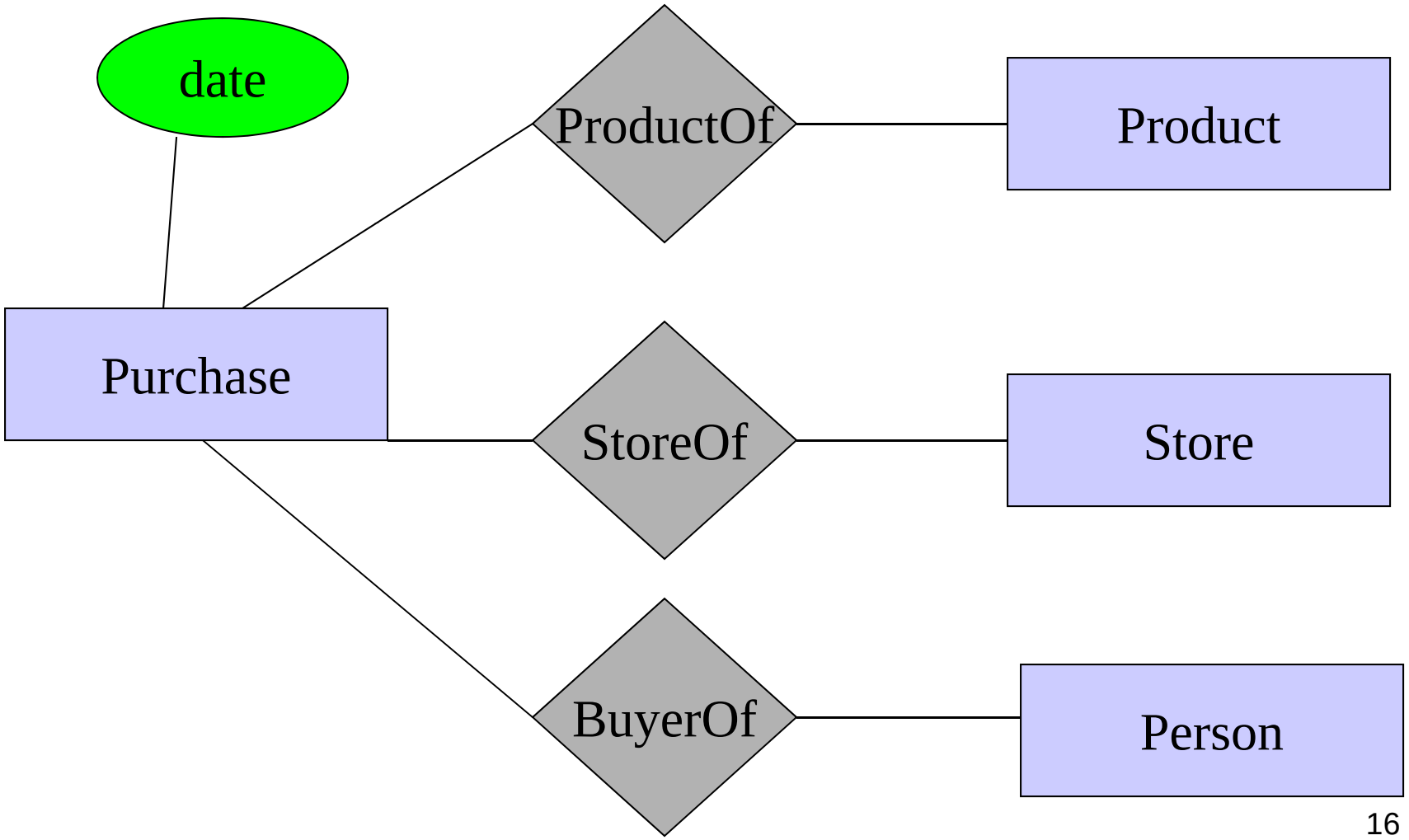
Arrows in Multiway Relationships

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



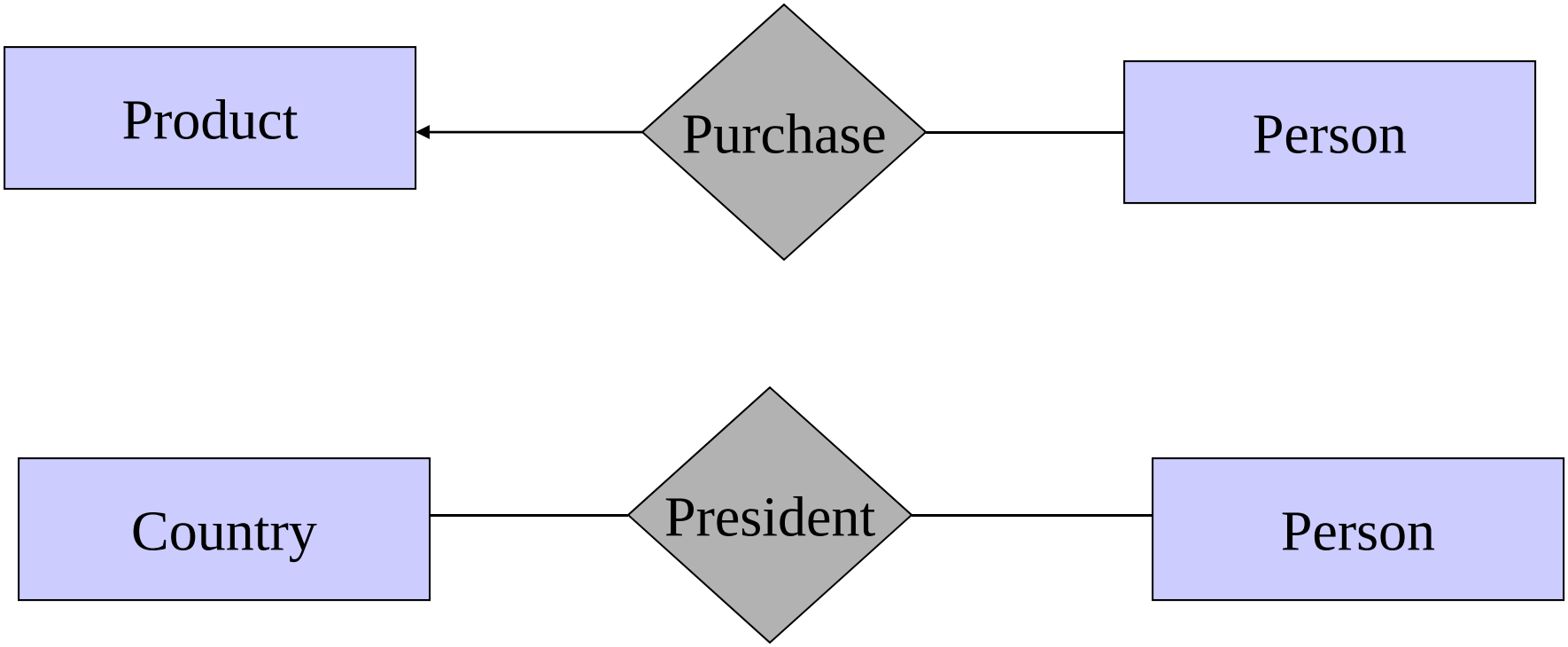
A: Cannot. This is the best approximation.
(Why only approximation ?)

Converting Multi-way Relationships to Binary



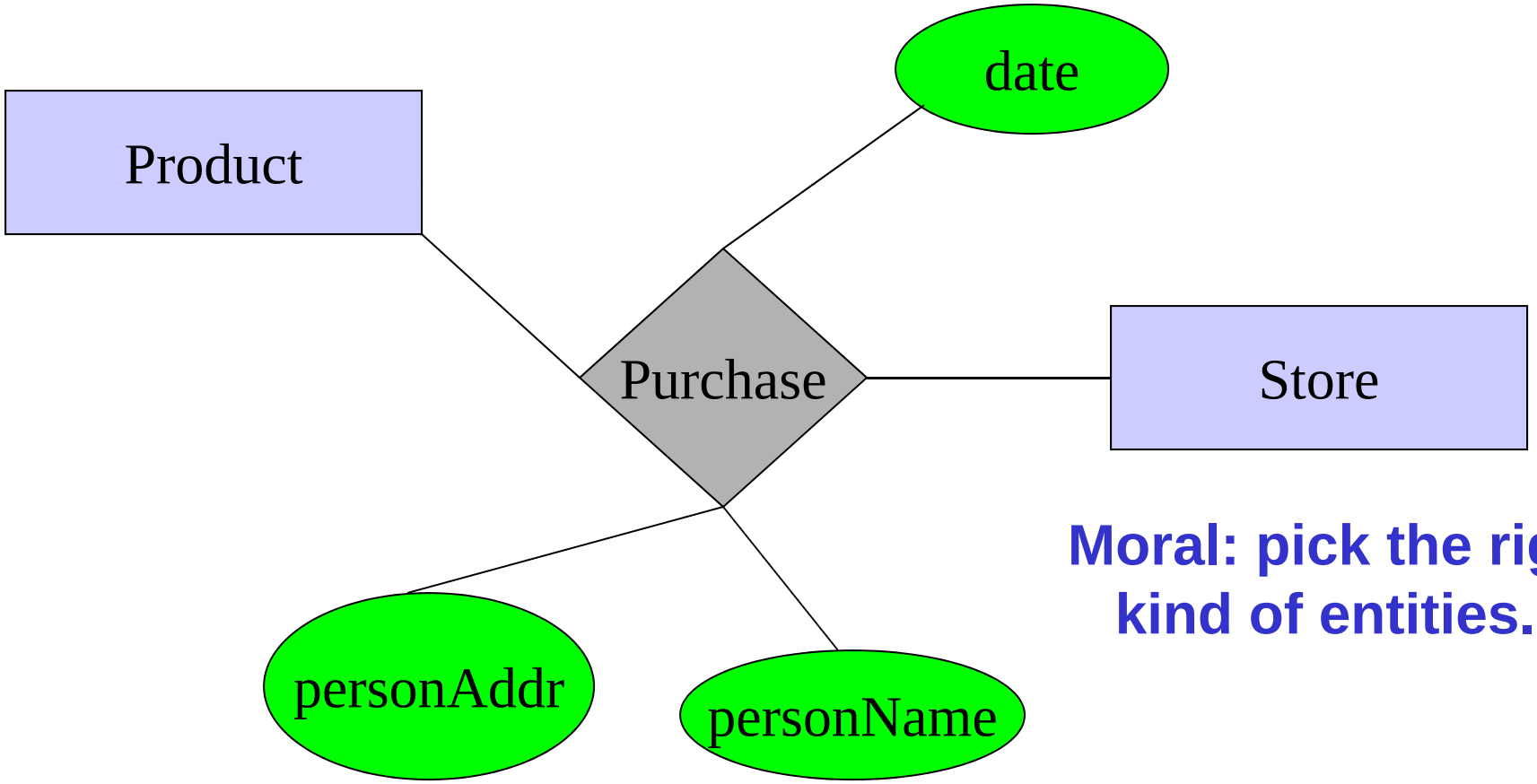
3. Design Principles

What's wrong?



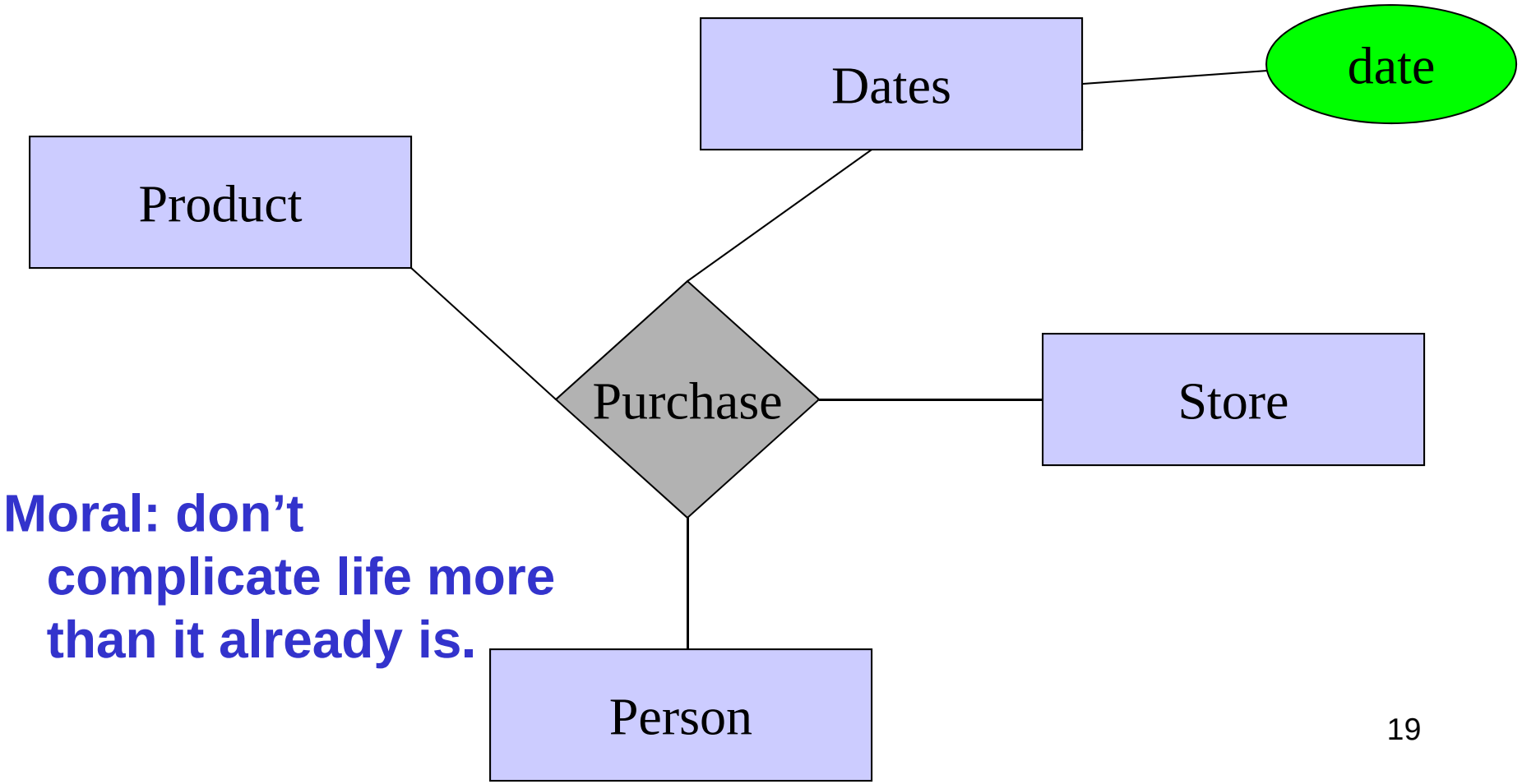
Moral: be faithful to the specifications of the app!

Design Principles: What's Wrong?



Moral: pick the right kind of entities.

Design Principles: What's Wrong?

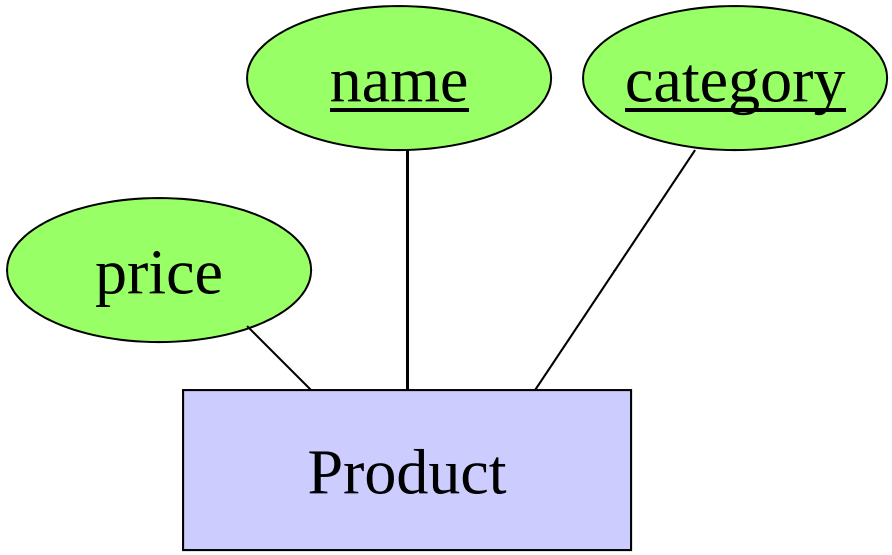


Moral: don't complicate life more than it already is.

From E/R Diagrams to Relational Schema

- Entity set → relation
- Relationship → relation

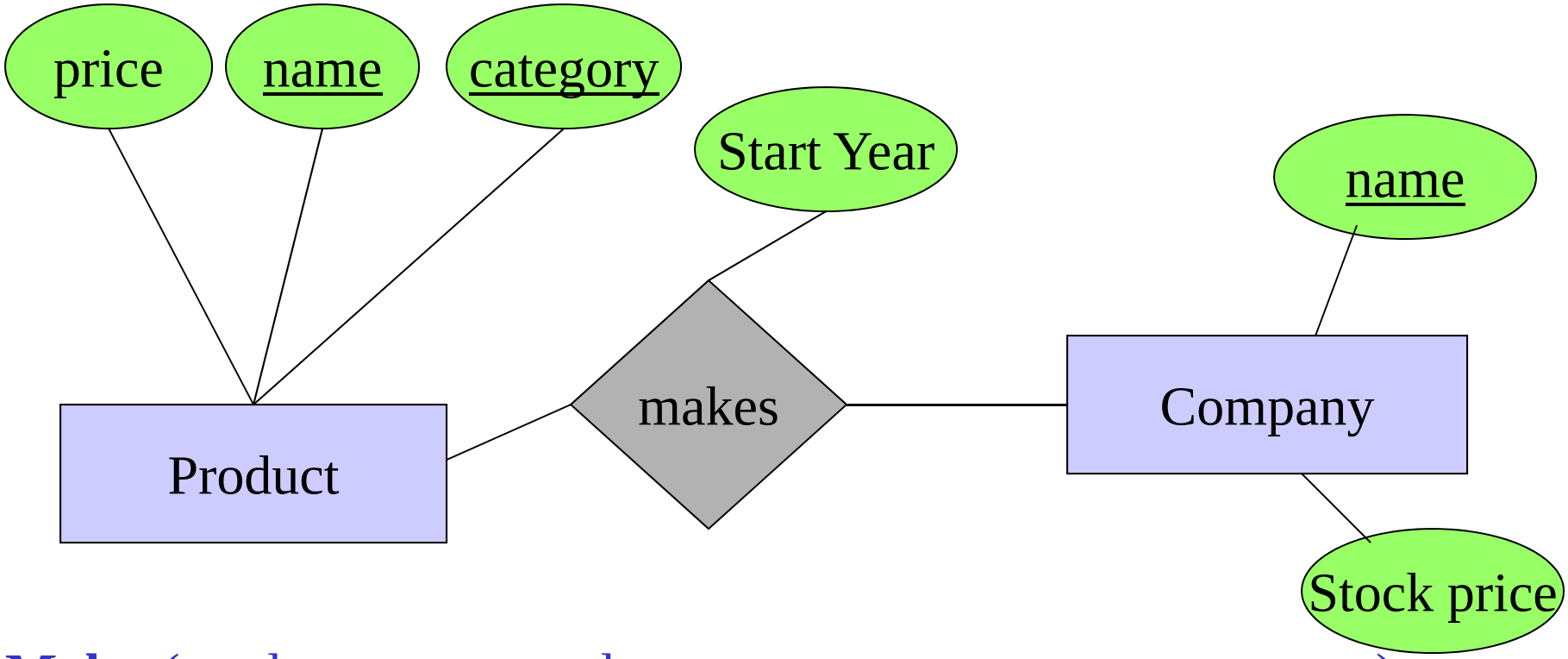
Entity Set to Relation



Product(name, category, price)

name	category	price
gizmo	gadgets	$19.99

Relationships to Relations

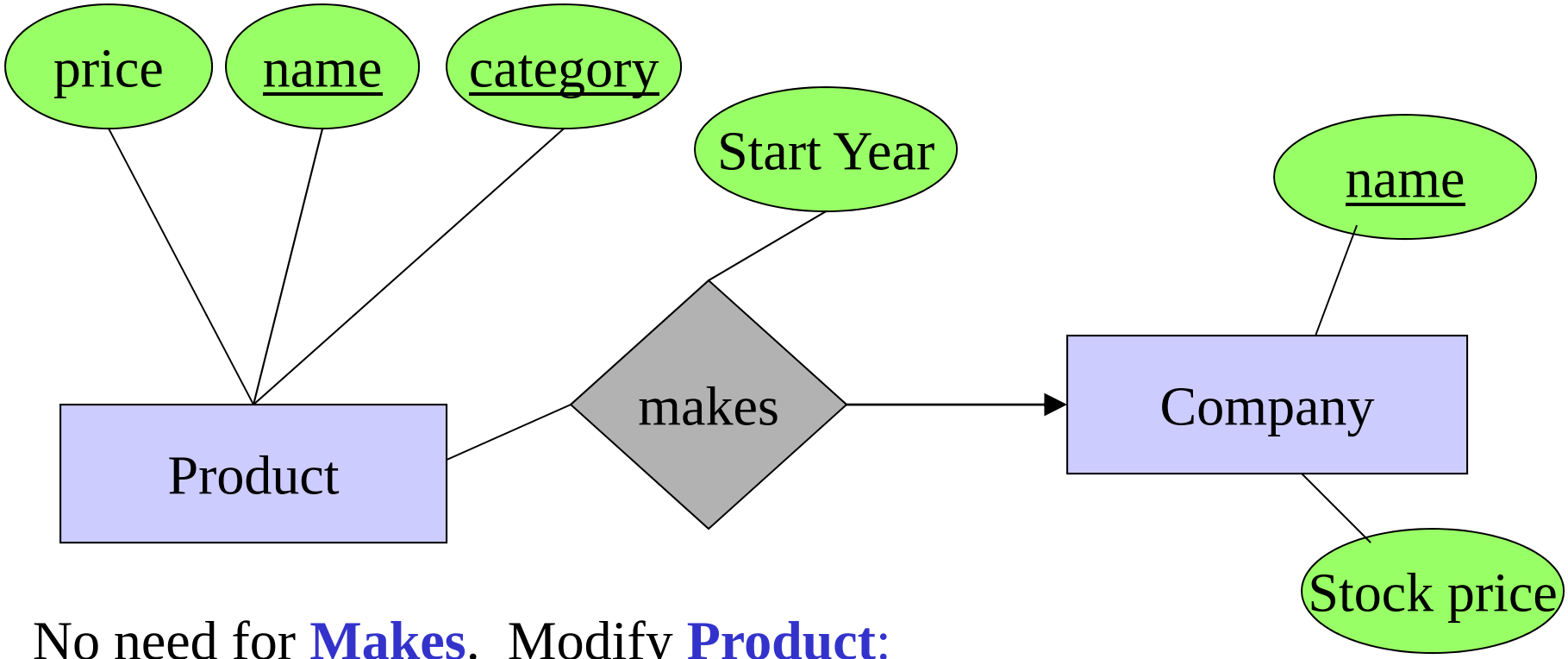


Makes(product-name, product-category, company-name, year)

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

(watch out for attribute name conflicts)

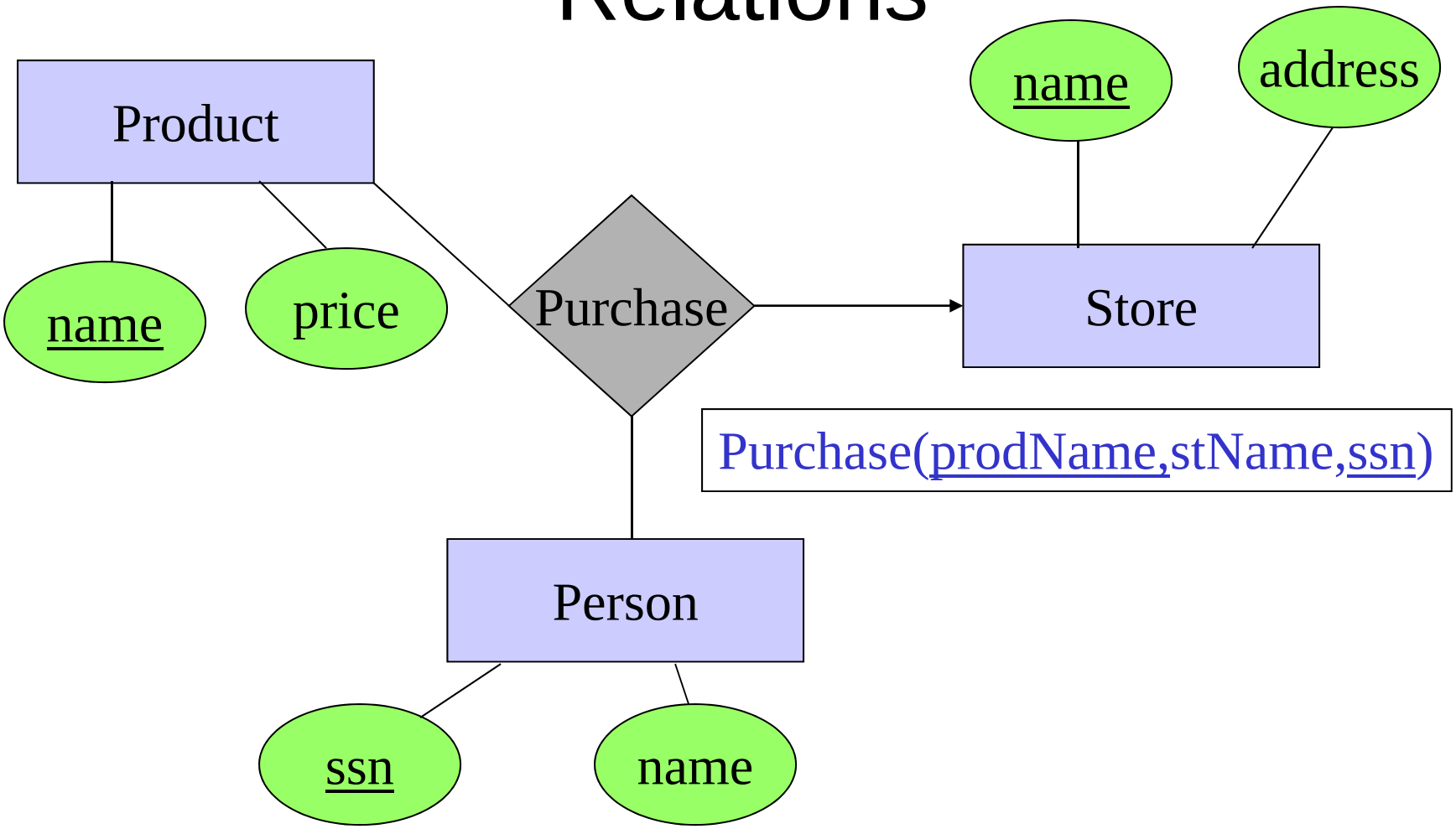
Relationships to Relations



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

name	category	price	StartYear	companyName
gizmo	gadgets	19.99	1963	gizmoWorks

Multi-way Relationships to Relations

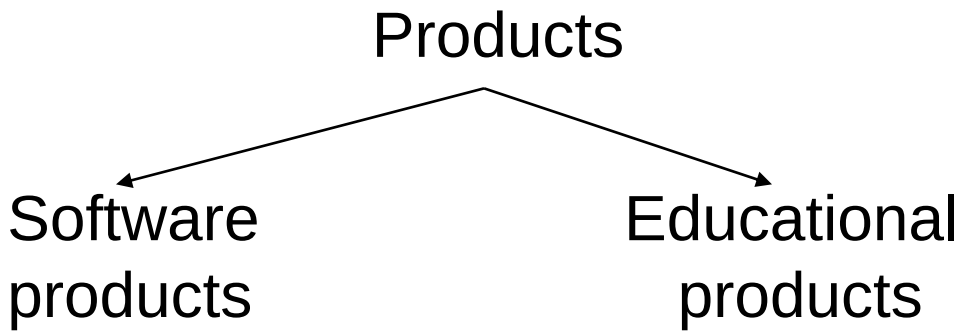


Purchase(prodName,stName,ssn)

Modeling Subclasses

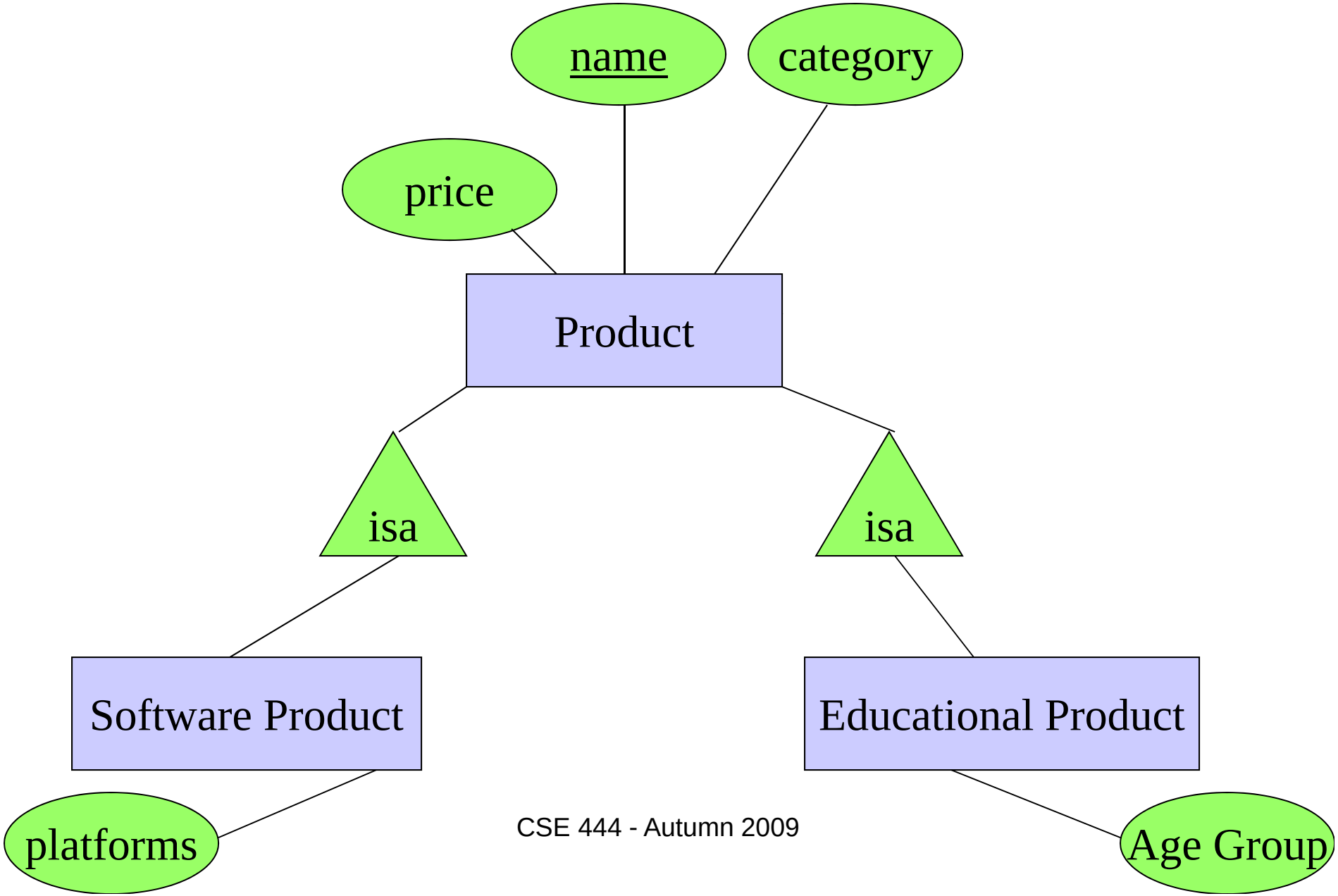
Some objects in a class may be special

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



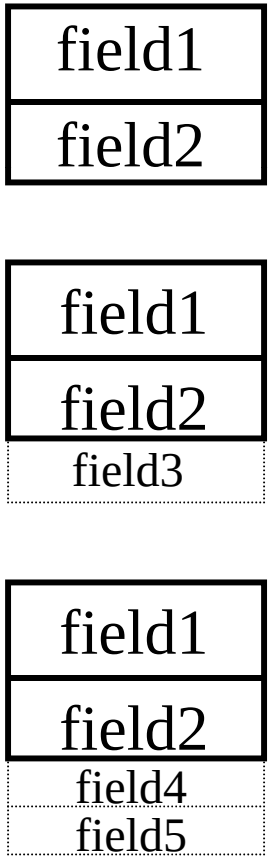
So --- we define subclasses in E/R

Subclasses

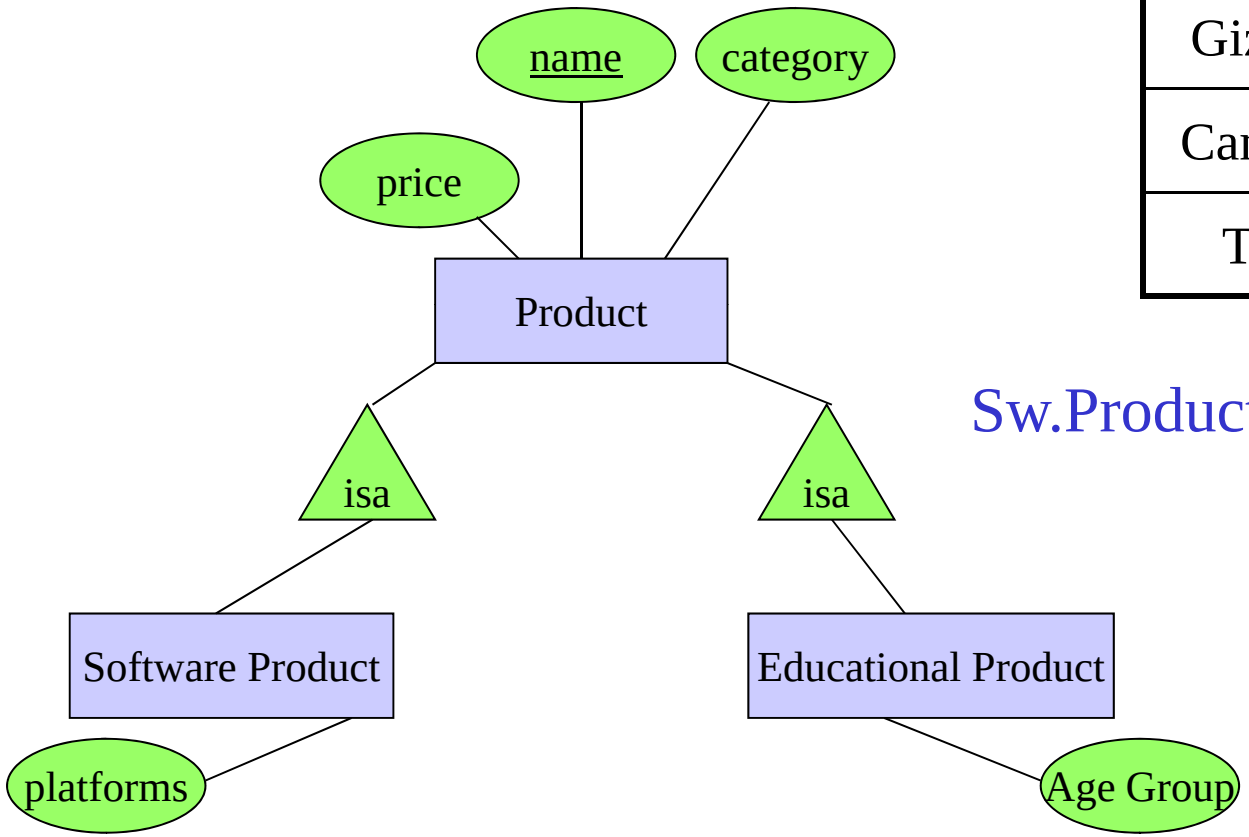

name
category
price
Product
isa
isa
Software Product
Educational Product
platforms
Age Group

Understanding Subclasses

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



Subclasses to Relations



Product

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

Sw.Product

Name	platforms
Gizmo	unix

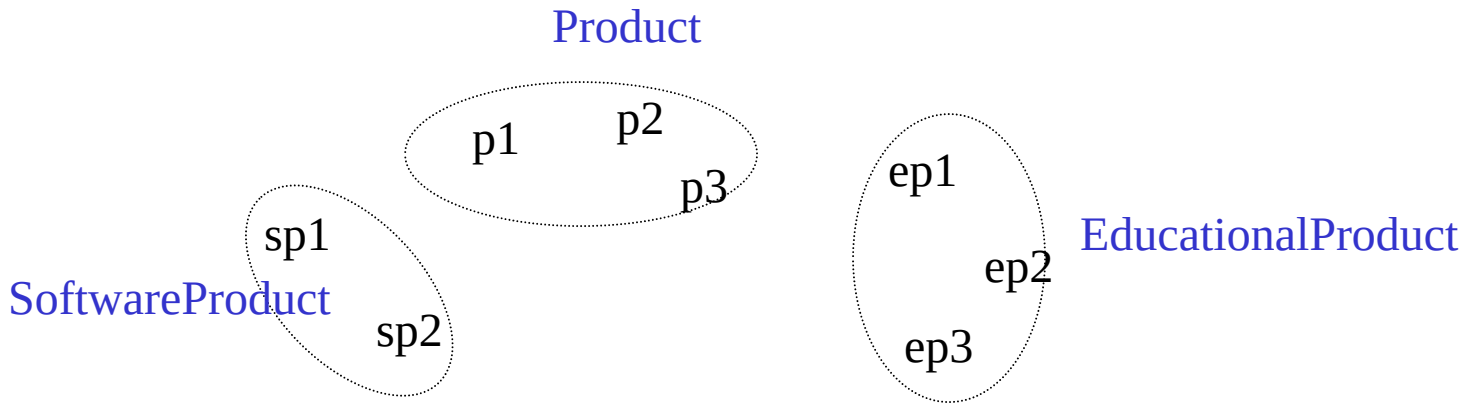
Ed.Product

Name	Age Group
Gizmo	todler
Toy	retired

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

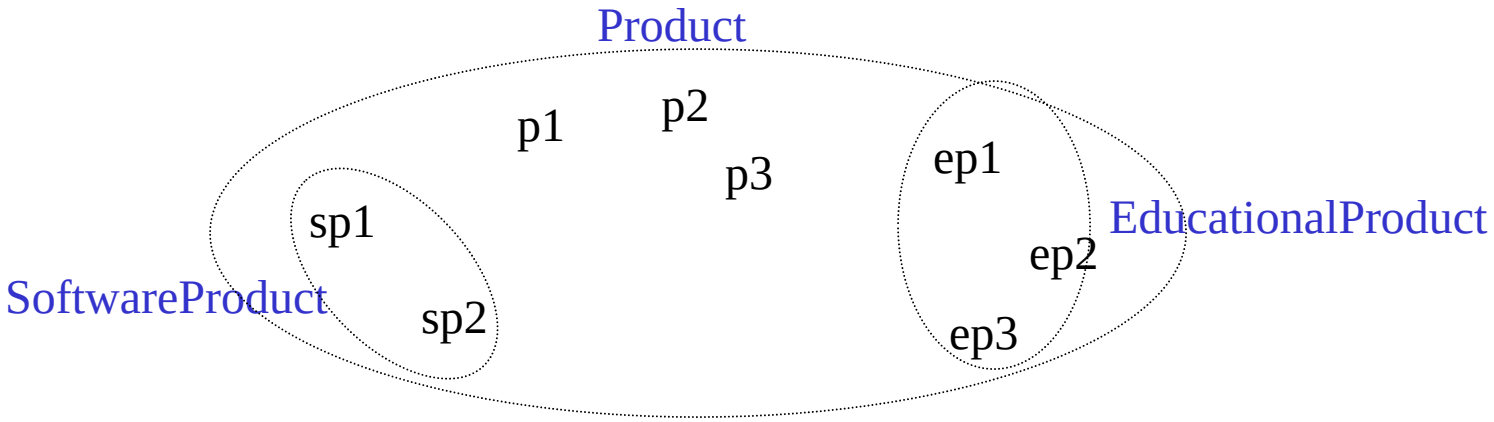
Difference between OO and E/R inheritance

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



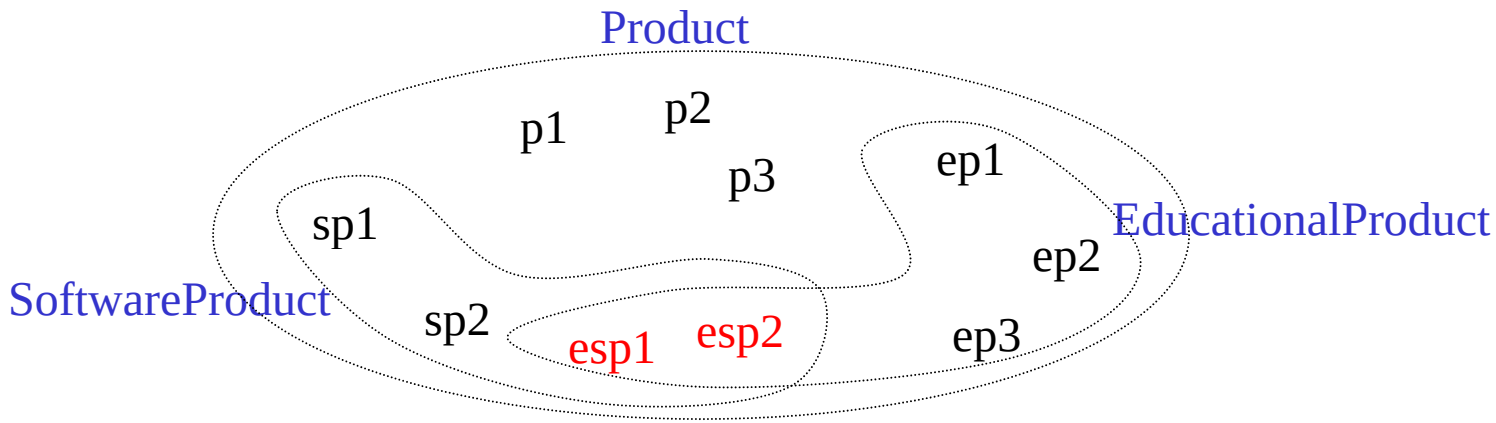
Difference between OO and E/R inheritance

- E/R: entity sets overlap



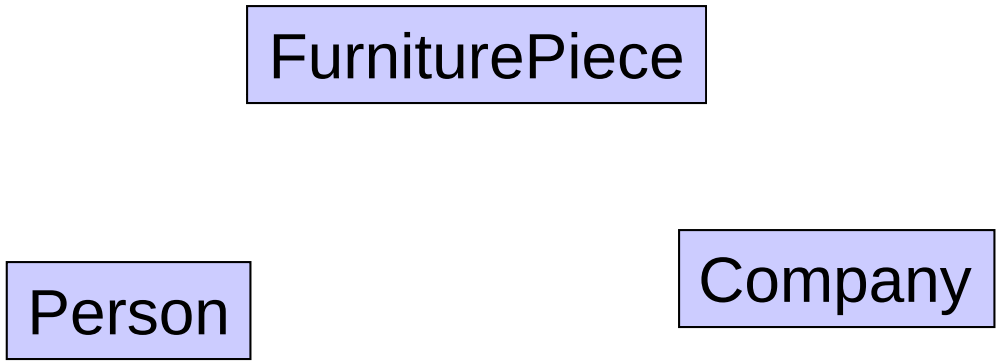
Difference between OO and E/R inheritance

No need for multiple inheritance in E/R



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

Modeling UnionTypes With Subclasses

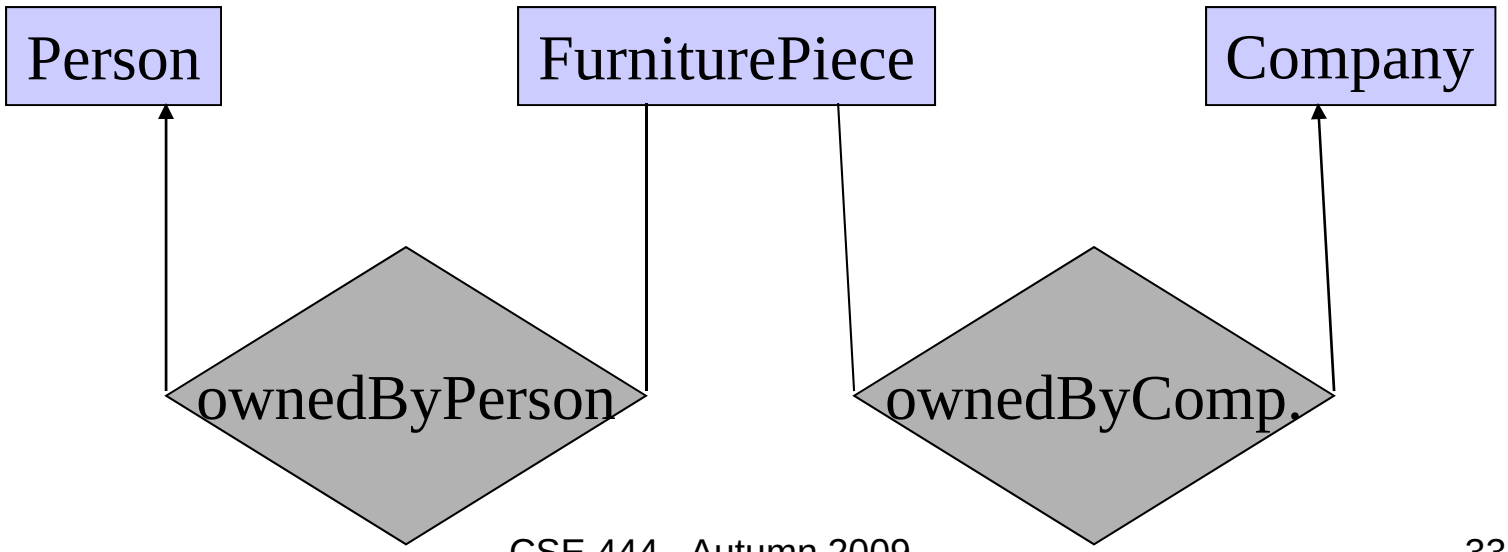


Say: each piece of furniture is owned either by a person, or by a company

Modeling Union Types with Subclasses

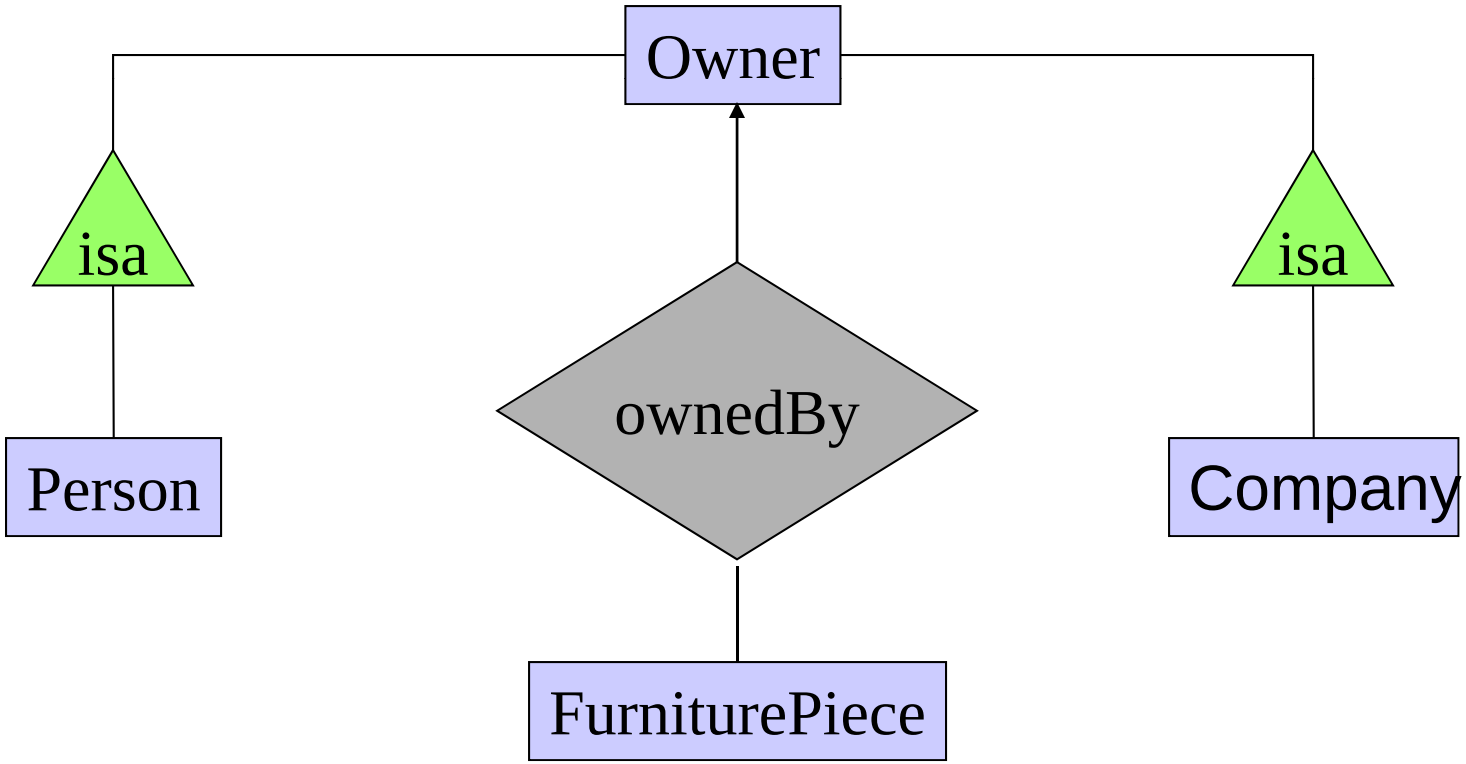
Say: each piece of furniture is owned either by a person, or by a company

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.

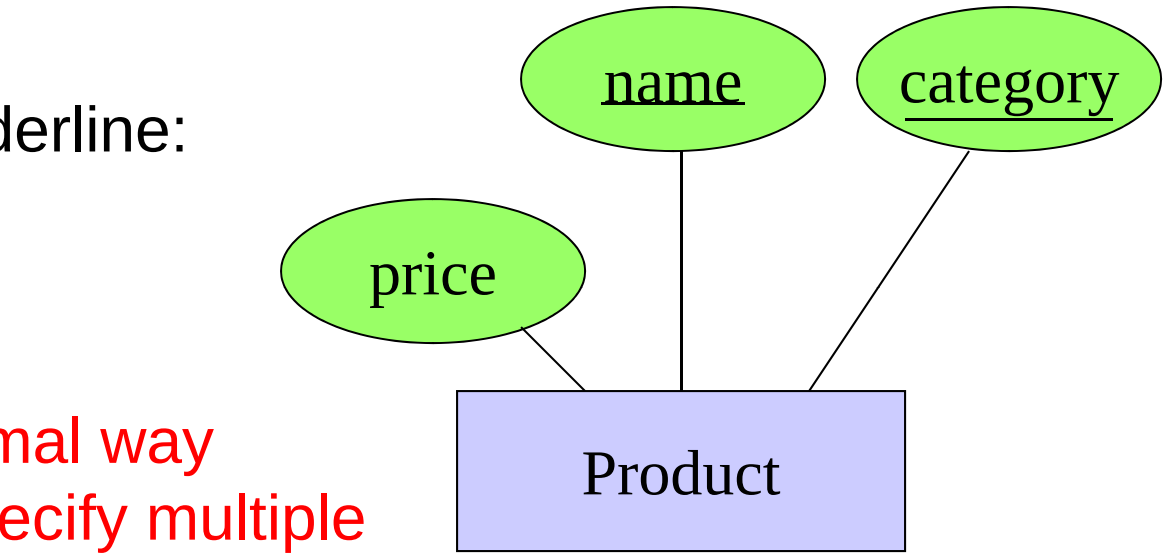
Single-value constraints: a person can have only one father.

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

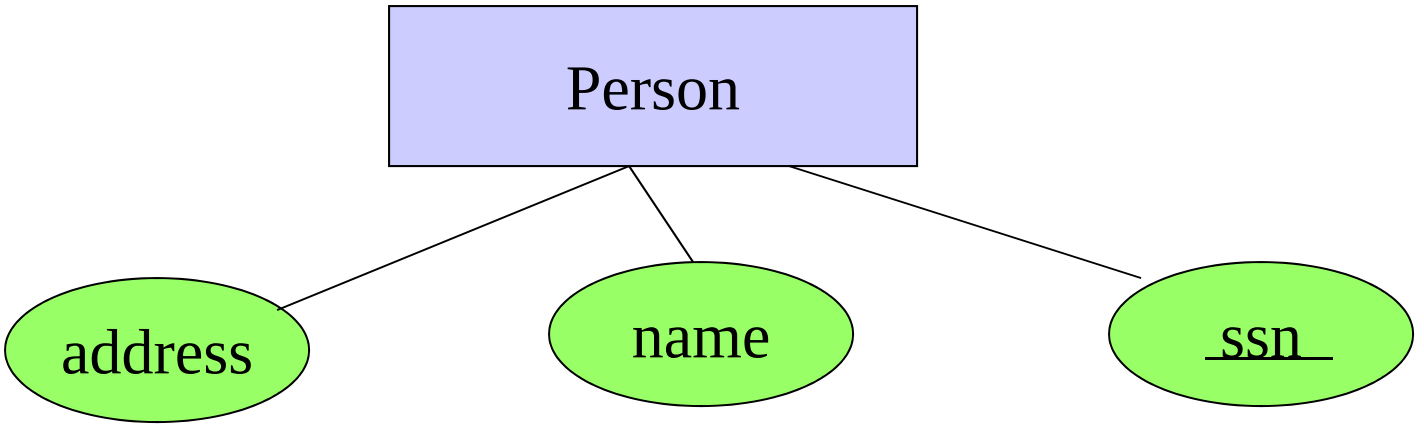
Other constraints: peoples' ages are between 0 and 150.

Keys in E/R Diagrams

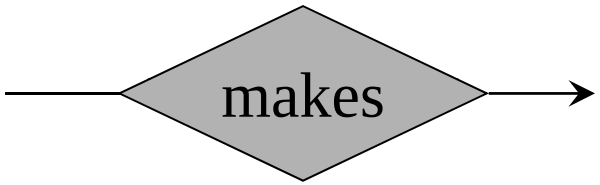
Underline:



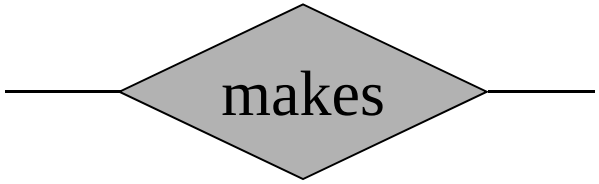
No formal way
to specify multiple
keys in E/R diagrams



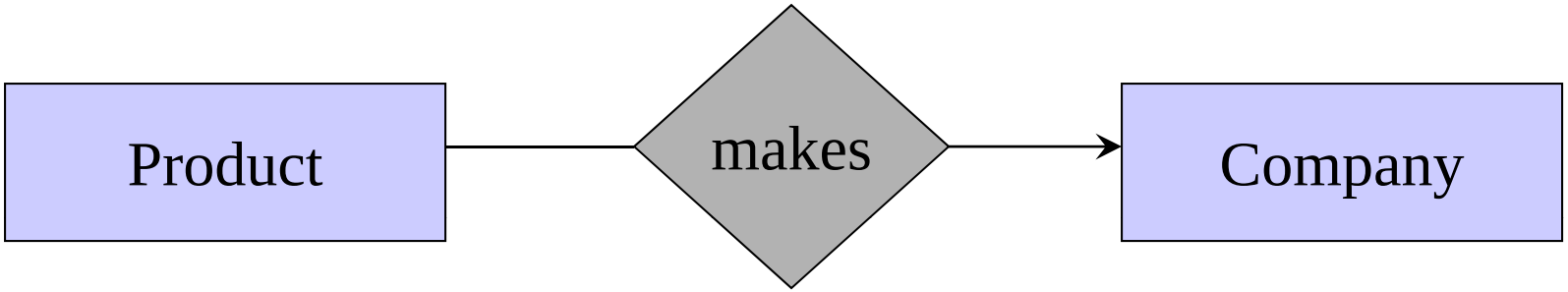
Single Value Constraints



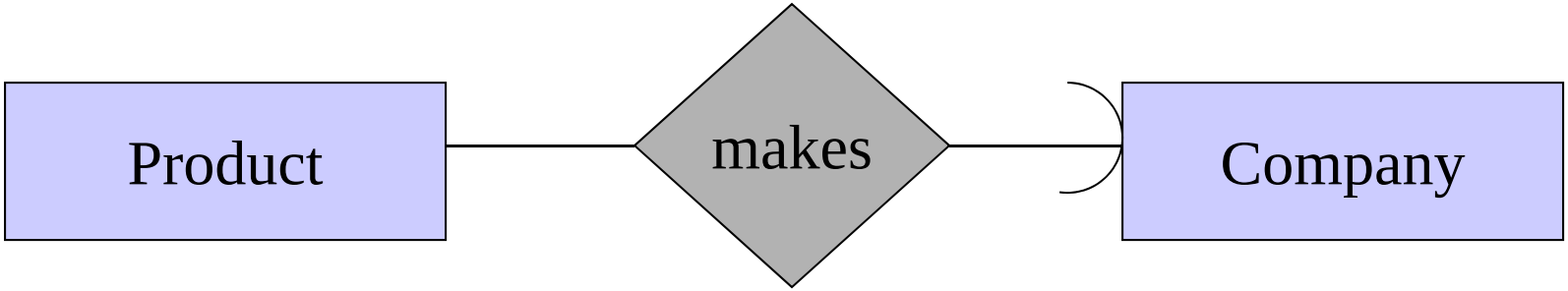
v. s.



Referential Integrity Constraints

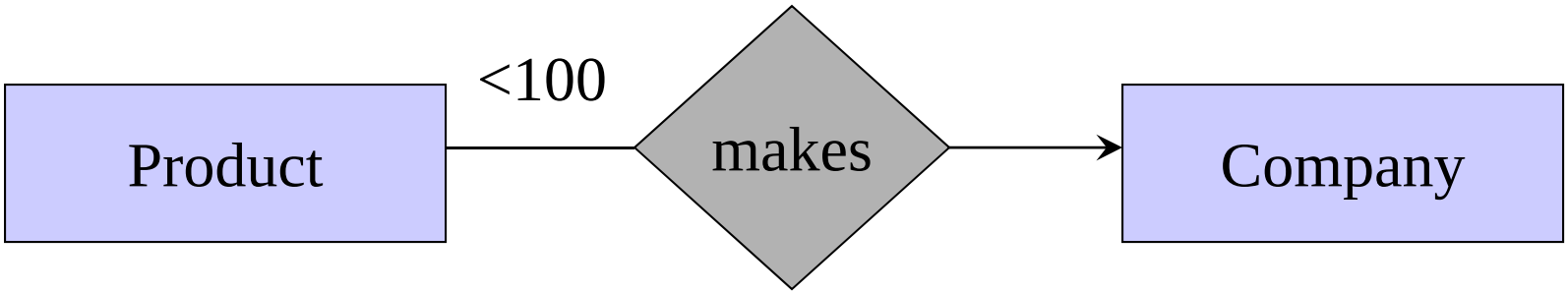


Each product made by at most one company.
Some products made by no company



Each product made by *exactly* one company.

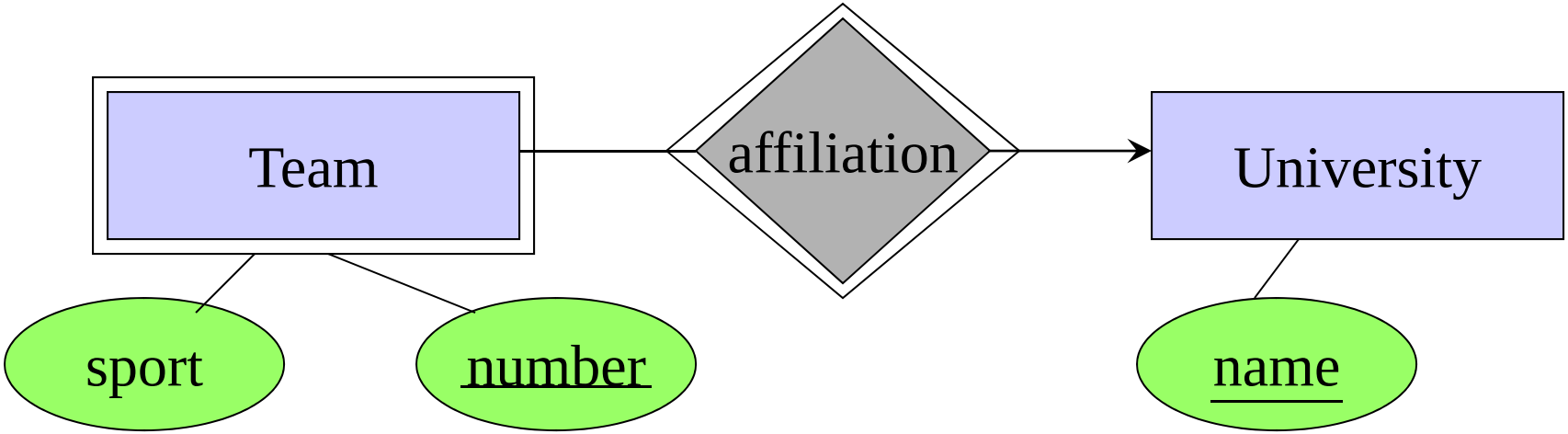
Other Constraints



What does this mean ?

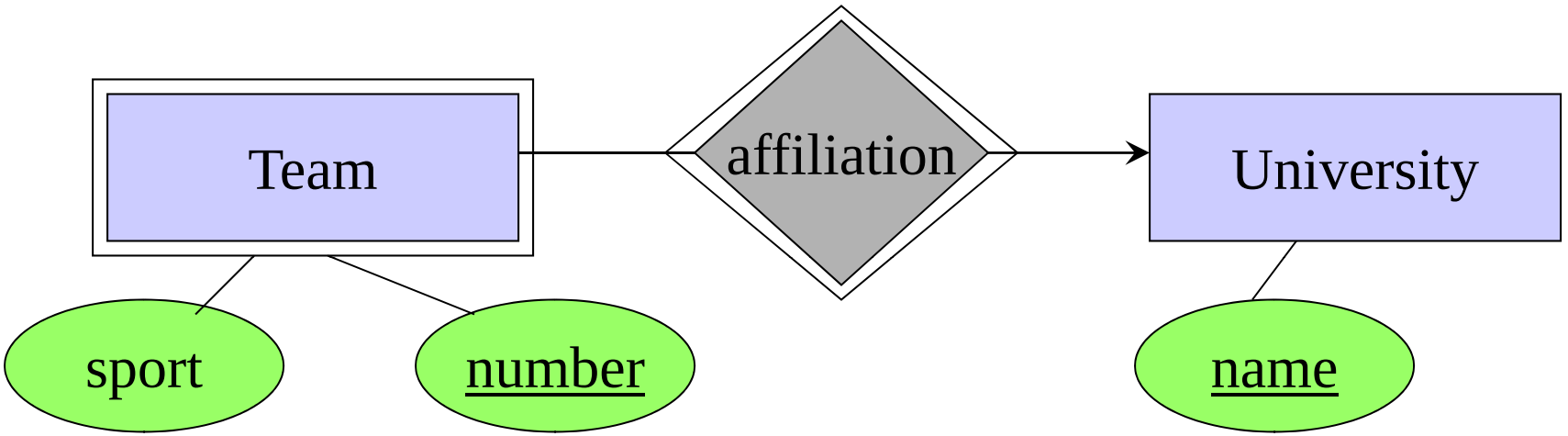
Weak Entity Sets

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(name)
Team(number,universityName,sport)
No need to represent affiliation separately