Lecture 07:
E/R Diagrams

Friday, January 20, 2006

Outline

- E/R diagrams (Chapter 2)
- From E/R diagrams to relations (3.2, 3.3)

- Next time: Functional dependencies, normal forms:
- Warning: this is hard, come to class

Database Design

- Why do we need it?
  - Agree on structure of the database before deciding on a particular implementation.
- Consider issues such as:
  - What entities to model
  - How entities are related
  - What constraints exist in the domain
  - How to achieve ***good*** designs

Database Design Formalisms

1. Object Definition Language (ODL):
   - Closer in spirit to object-oriented models
   - Will not cover in class
2. Entity/Relationship model (E/R):
   - More relational in nature.
   - Very widely used

- Both can be translated (semi-automatically) to relational schemas
- ODL to OO-schema: direct transformation (C++ or Smalltalk based system).

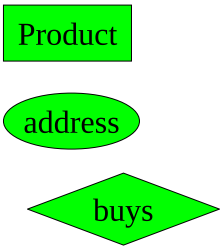
Entity / Relationship Diagrams

Objects → entities

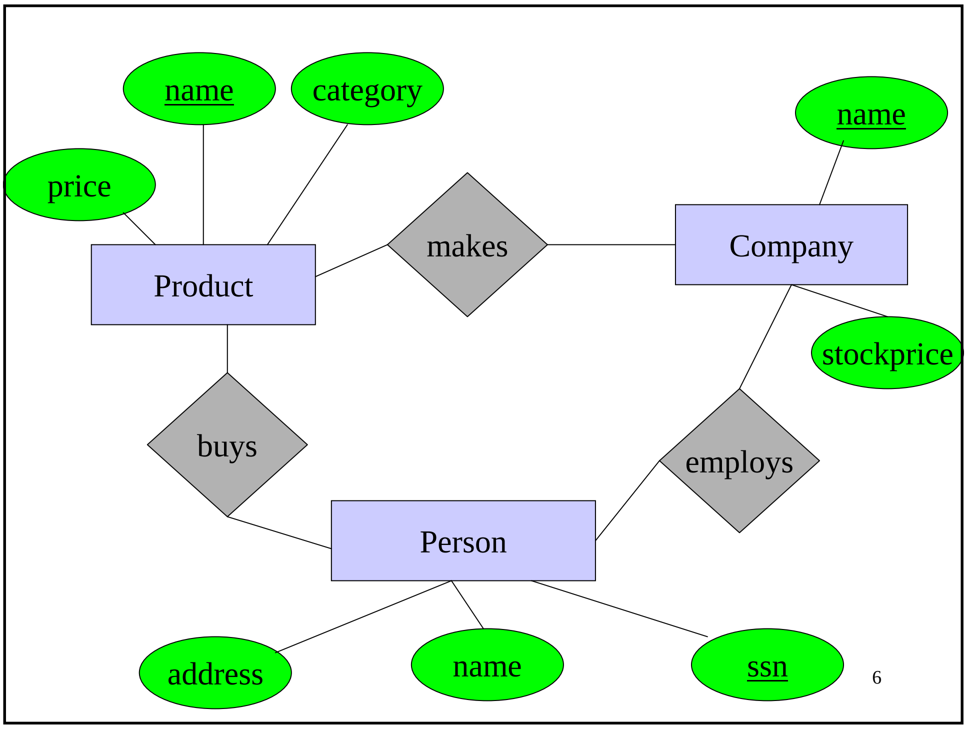
Classes → entity sets

Attributes are like in ODL.

Relationships: like in ODL except

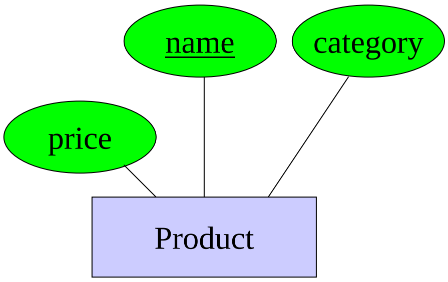


- first class citizens (not associated with classes)
- not necessarily binary



Keys in E/R Diagrams

- Every entity set must have a key

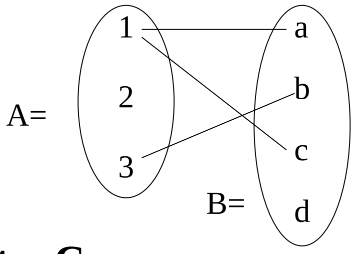


What is a Relation ?

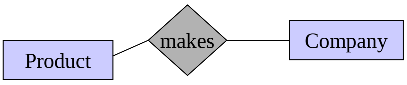
- A mathematical definition:
  – if A, B are sets, then a relation R is a subset of A × B
- A={1,2,3},   B={a,b,c,d},

  A × B = {(1,a),(1,b), . . ., (3,d)}

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

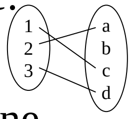


- **makes** is a subset of **Product** × **Company**:

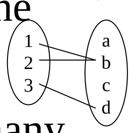


Multiplicity of E/R Relations

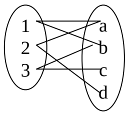
- one-one:

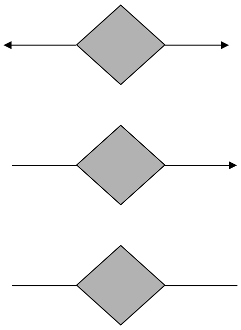


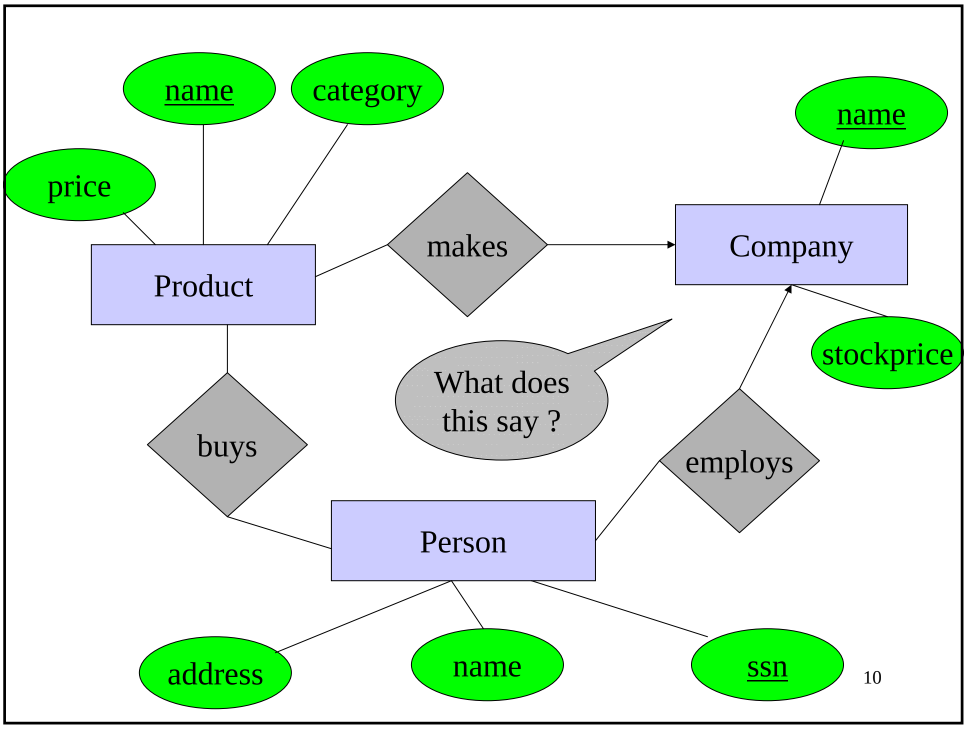
- many-one



- many-many

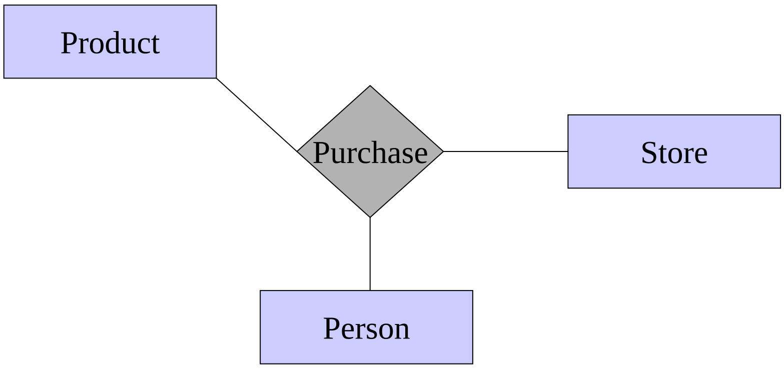






Multi-way Relationships

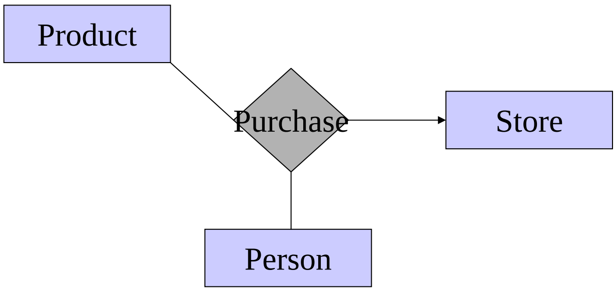
How do we model a purchase relationship between buyers, products and stores?



Can still model as a mathematical set (how ?)

Arrows in Multiway Relationships

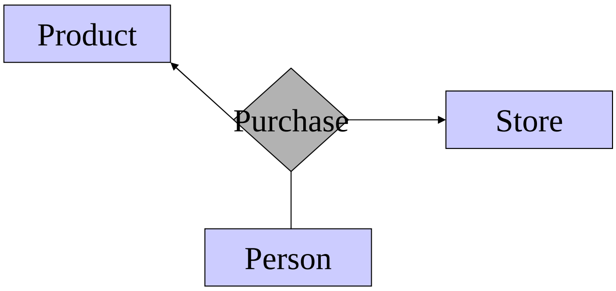
Q: what does the arrow mean ?



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

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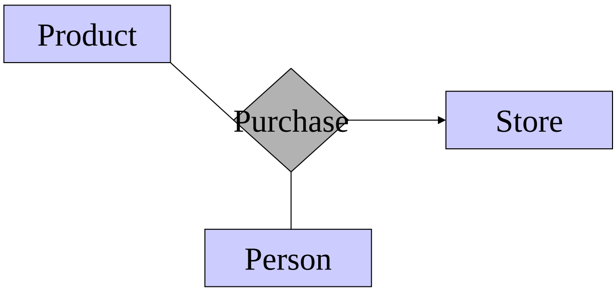
Arrows in Multiway Relationships

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



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

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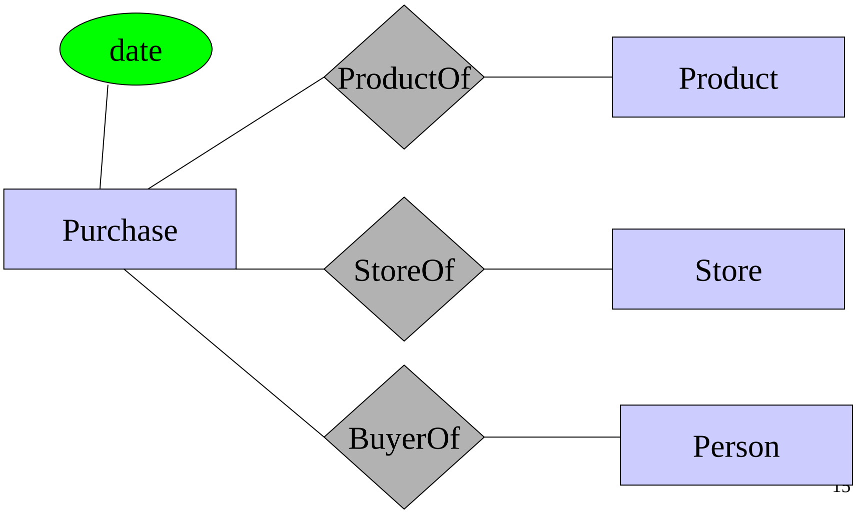
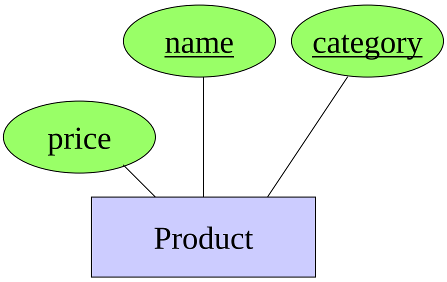
Converting Multi-way Relationships to Binary



From E/R Diagrams to Relational Schema

- Entity set → relation
- Relationship → relation

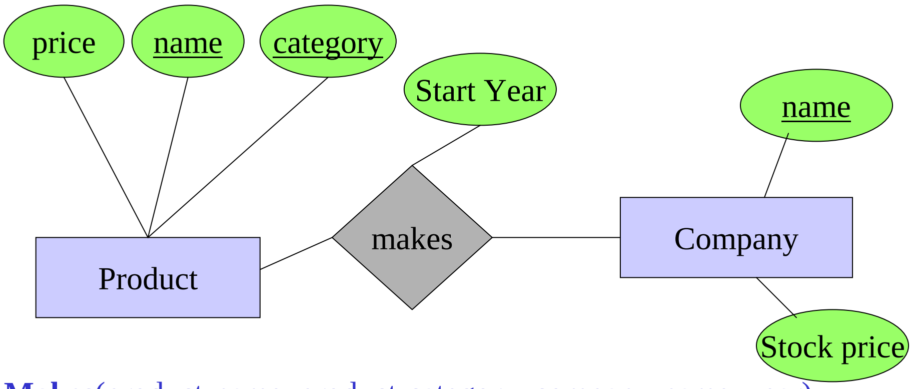
Entity Set to Relation



Product(name, category, price)

name	category	price
gizmo	gadgets	$19.99

Relationships to Relations

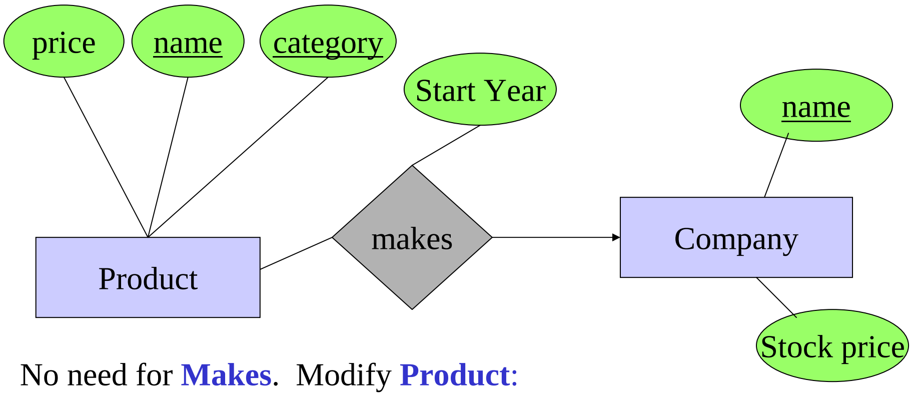


Makes(product-name, product-category, company-name, year)

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

(watch out for attribute name conflicts)

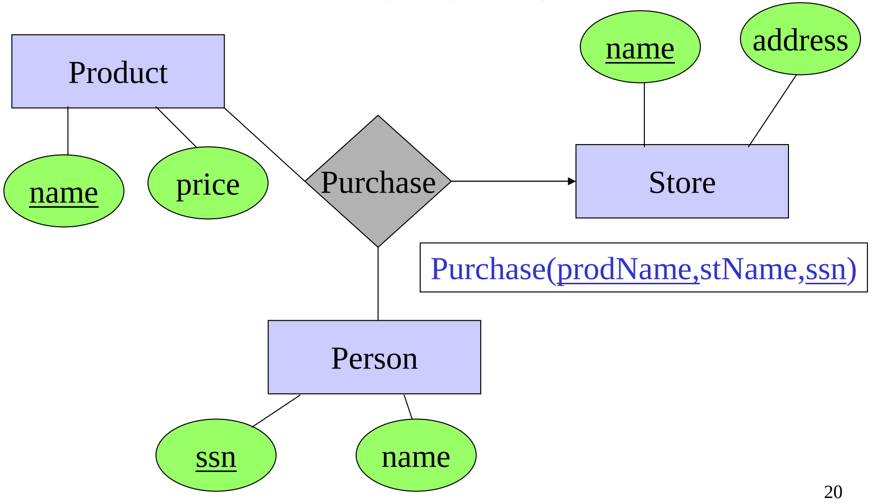
Relationships to Relations



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

name	category	price	StartYear	companyName
gizmo	gadgets	19.99	1963	gizmoWorks

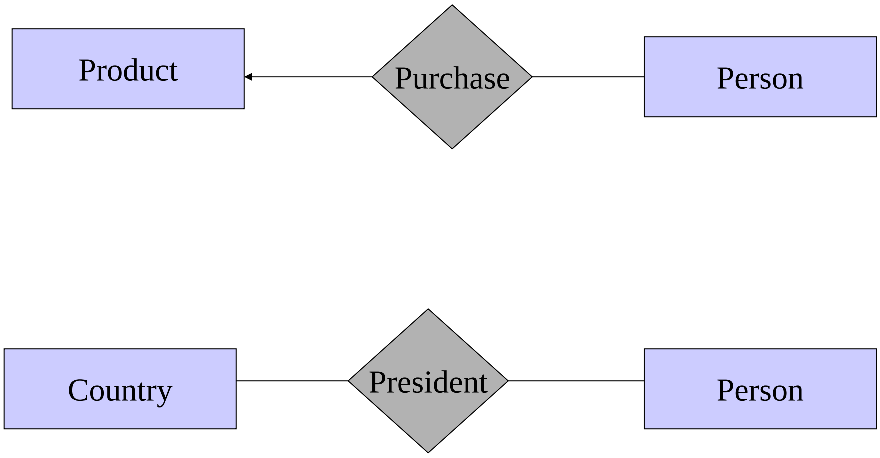
Multi-way Relationships to Relations



Purchase(prodName,stName,ssn)

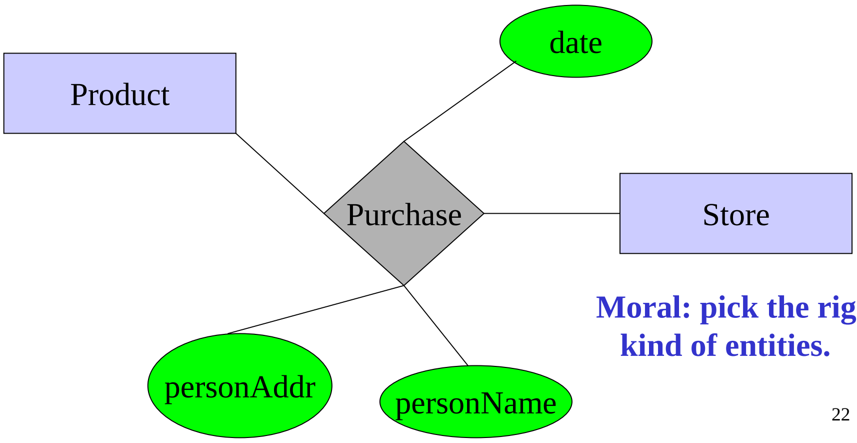
3. Design Principles

What's wrong?



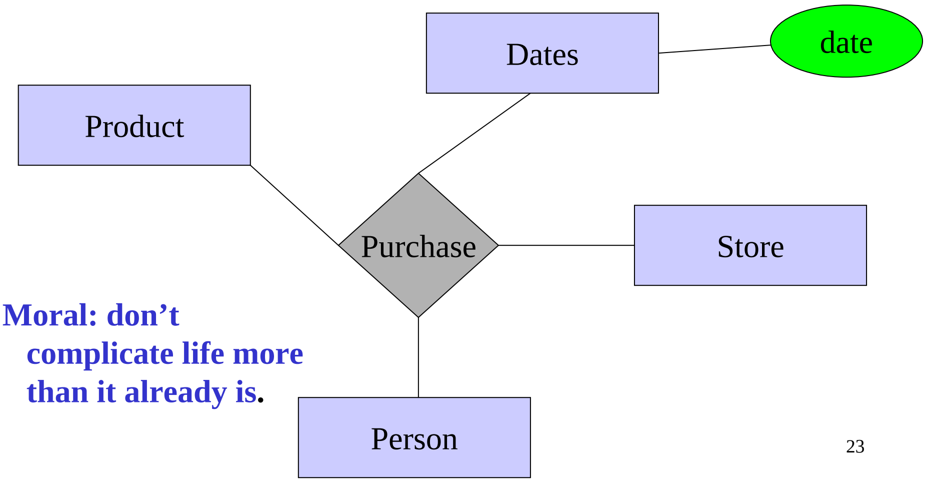
Moral: be faithful!

Design Principles: What's Wrong?



Moral: pick the right kind of entities.

Design Principles: What's Wrong?



Dates

date

Product

Purchase

Store

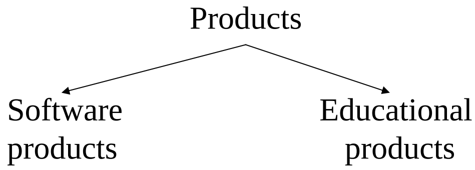
Person

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

Modeling Subclasses

Some objects in a class may be special

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



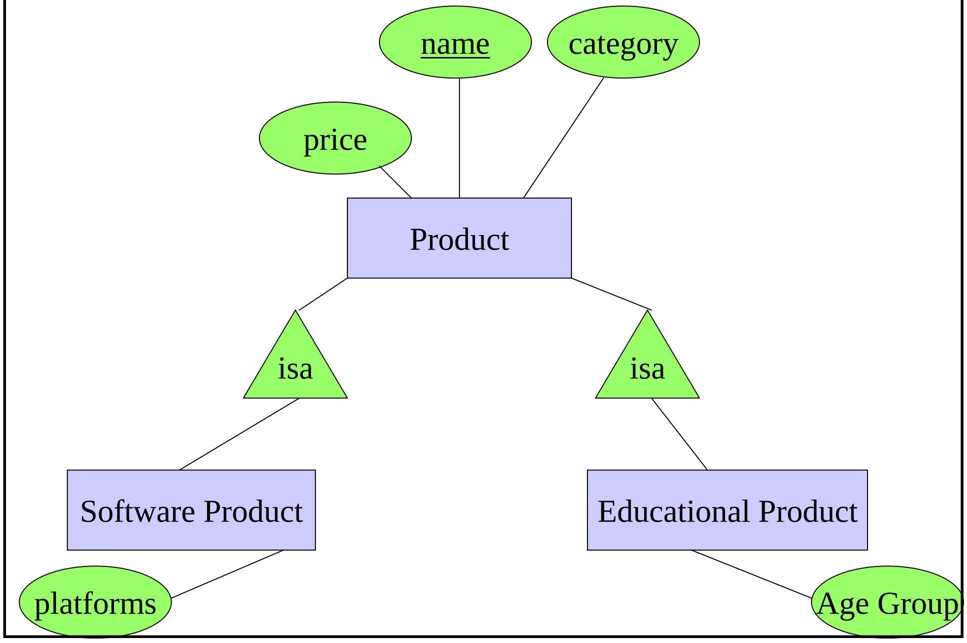
Products

Software products

Educational products

So --- we define subclasses in E/R

Subclasses



Understanding Subclasses

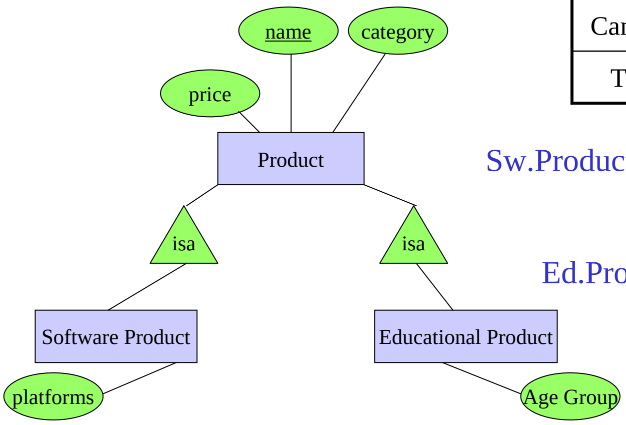
- Think in terms of records:
  - Product
  - SoftwareProduct
  - EducationalProduct

field1
field2

field1
field2
field3

field1
field2
field4
field5

Subclasses to Relations



Product

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

Sw.Product

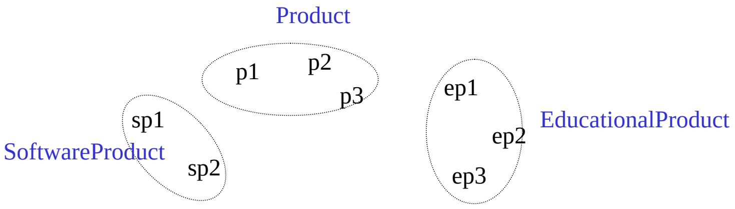
Name	platforms
Gizmo	unix

Ed.Product

Name	Age Group
Gizmo	toddler
Toy	retired

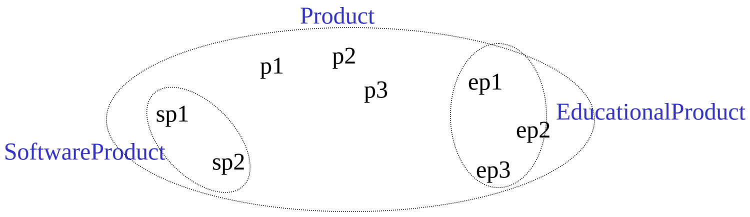
Difference between OO and E/R inheritance

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

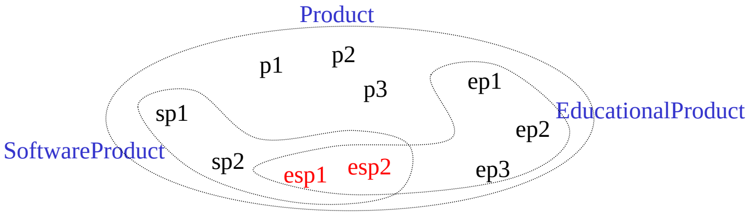


Difference between OO and E/R inheritance

- E/R: entity sets overlap

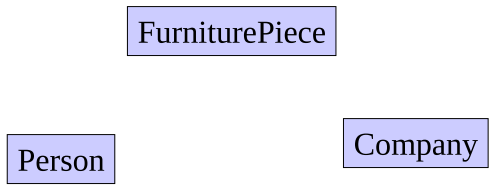


No need for multiple inheritance in E/R



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

Modeling UnionTypes With Subclasses

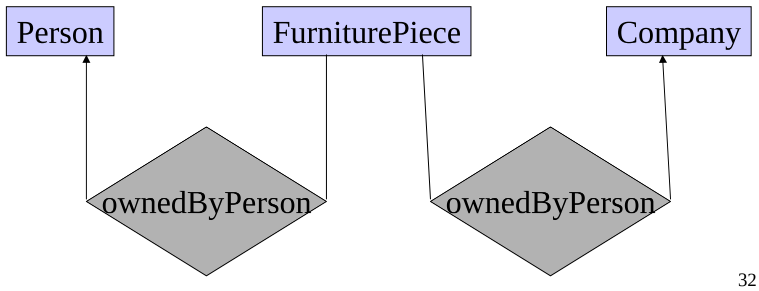


Say: each piece of furniture is owned either by a person, or by a company

Modeling Union Types with Subclasses

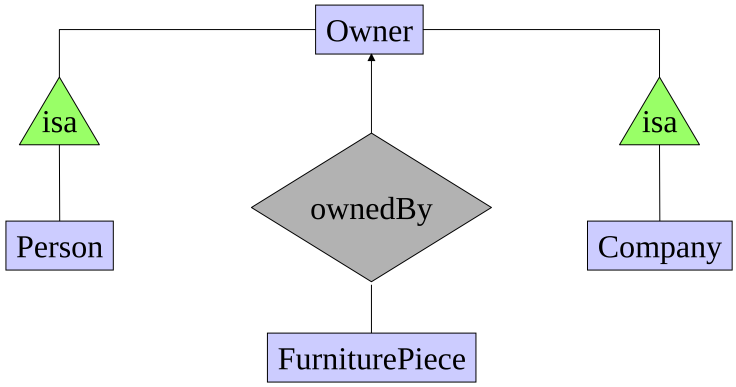
Say: each piece of furniture is owned either by a person, or by a company

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.

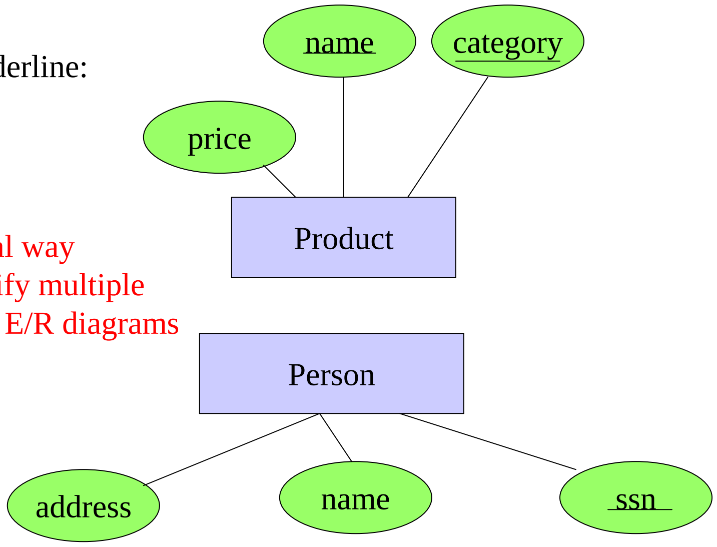
Single-value constraints: a person can have only one father.

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

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

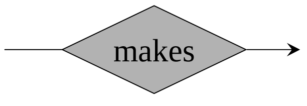
Keys in E/R Diagrams

Underline:

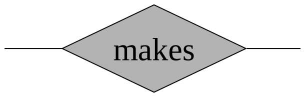


No formal way to specify multiple keys in E/R diagrams

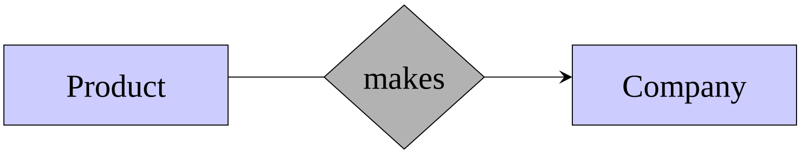
Single Value Constraints



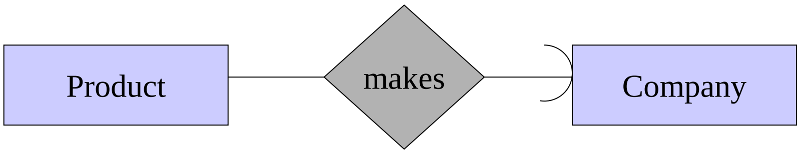
v. s.



Referential Integrity Constraints

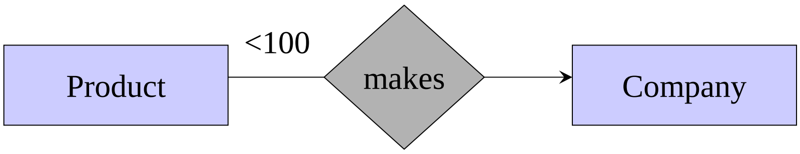


Each product made by at most one company.
Some products made by no company



Each product made by *exactly* one company.

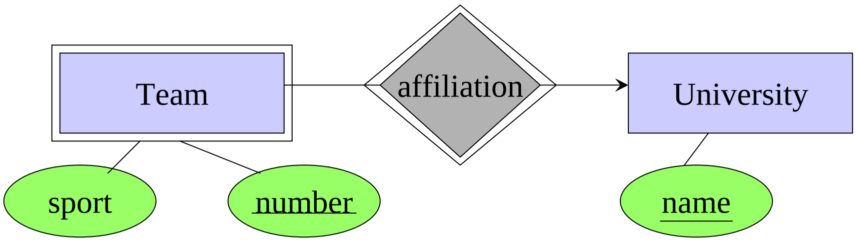
Other Constraints



What does this mean ?

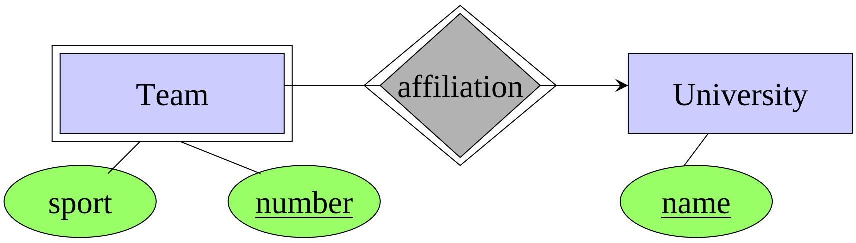
Weak Entity Sets

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 (last lecture)

Handling Weak Entity Sets



Convert to a relational schema (in class)