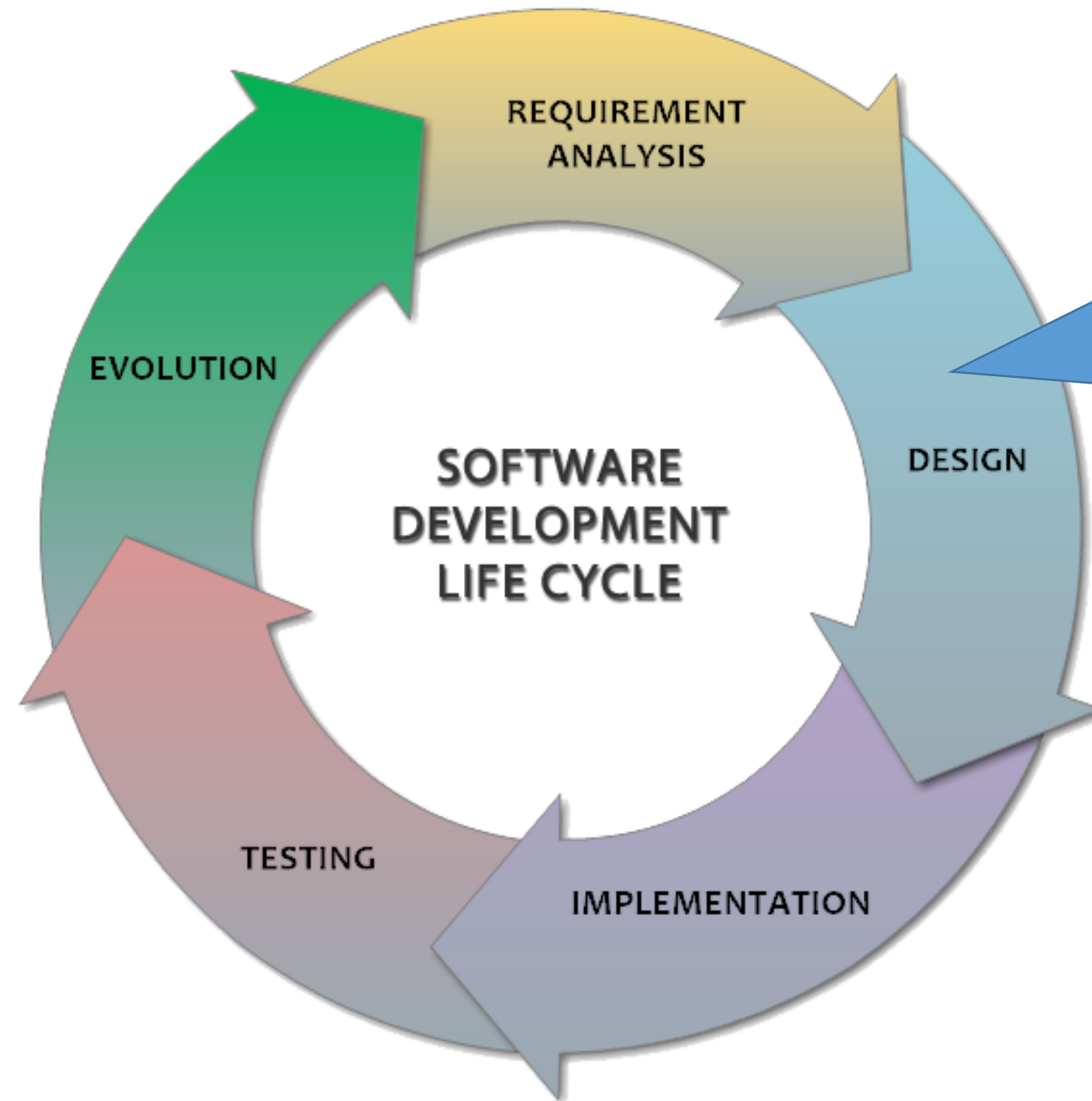


COMP 430

Intro. to Database Systems

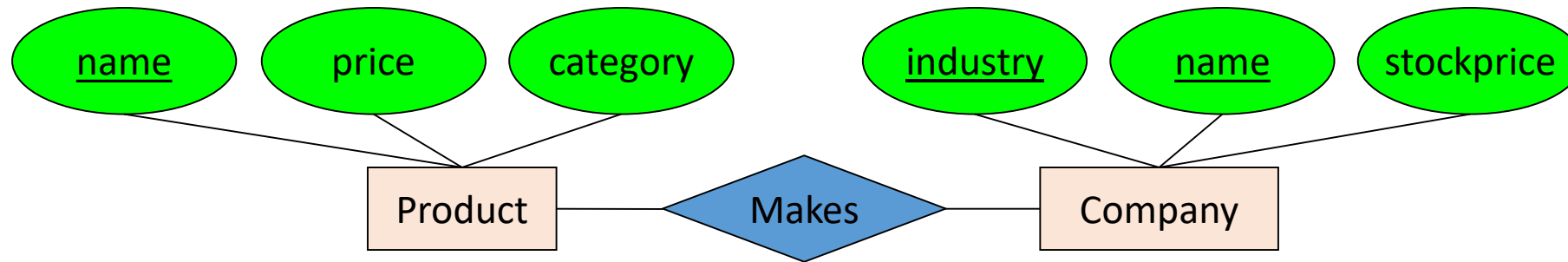
Entity-Relationship Diagrams



Goal: Agree on DB structure to implement.

- What entities to model
- How entities related
- What constraints exist in domain
- How to achieve good design

Entity-Relationship Diagrams



*“The Entity-Relationship model
– toward a unified view of data”*
Peter Chen, 1976



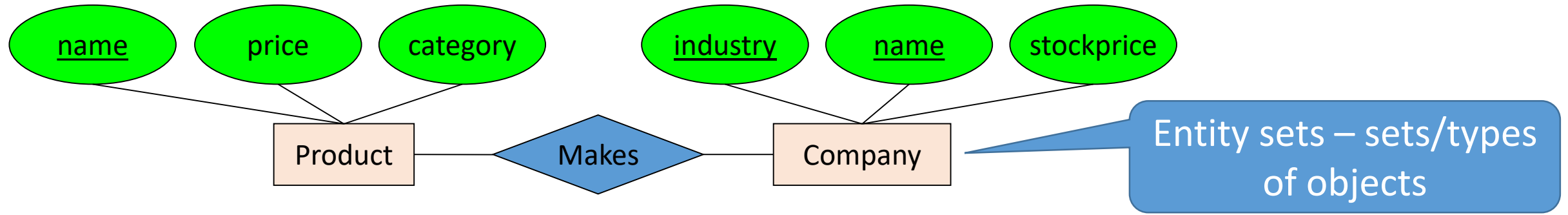
Precise enough for technical decisions

Abstracted enough to omit some implementation details

Abstracted enough for non-technical people

Many variations

For the course, use
the given notation.

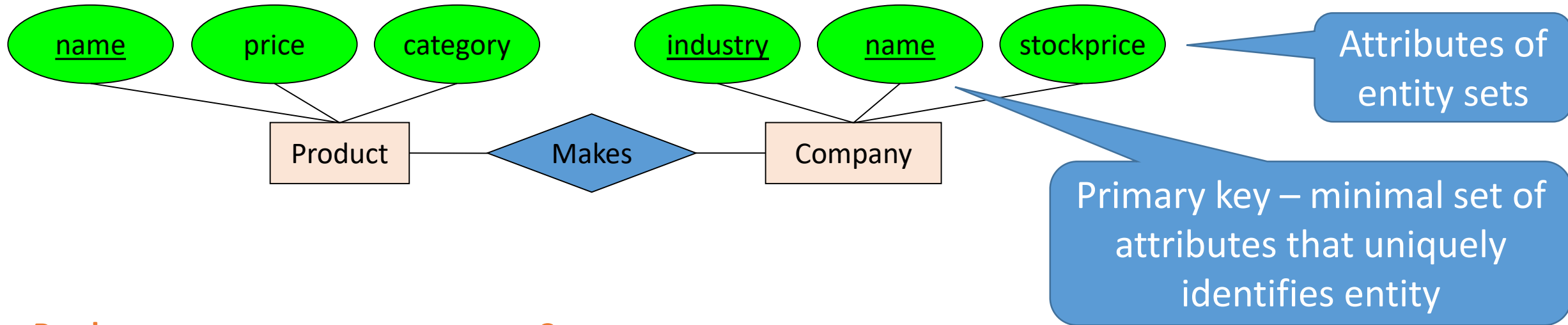


Product

--

Company

--



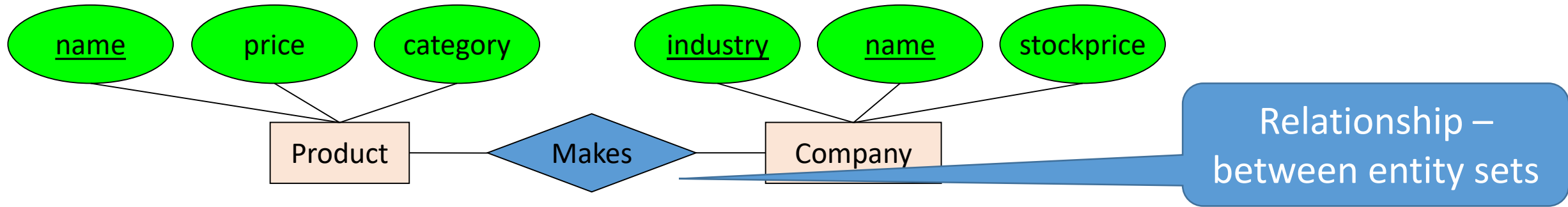
Product

<u>name</u>	price	category
iPad	\$200	Tablet
Galaxy Tab	\$200	Tablet
Galaxy Note	\$500	Smartphone
iPhone	\$600	Smartphone
Let It Be	\$10	CD

Company

<u>industry</u>	<u>name</u>	stockprice
Music	Apple	
Technology	Apple	\$100
Technology	Samsung	\$45

Convenient to draw in tabular form.
Implemented as tables.



Sets A, B:

$A = \{1, 2, 3\}$, $B = \{a, b, c, d\}$

Cross-product $A \times B$:

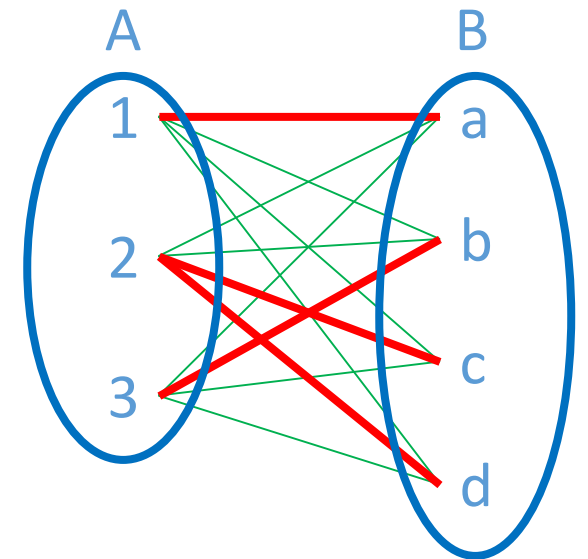
Set of all $(a \in A, b \in B)$ pairs

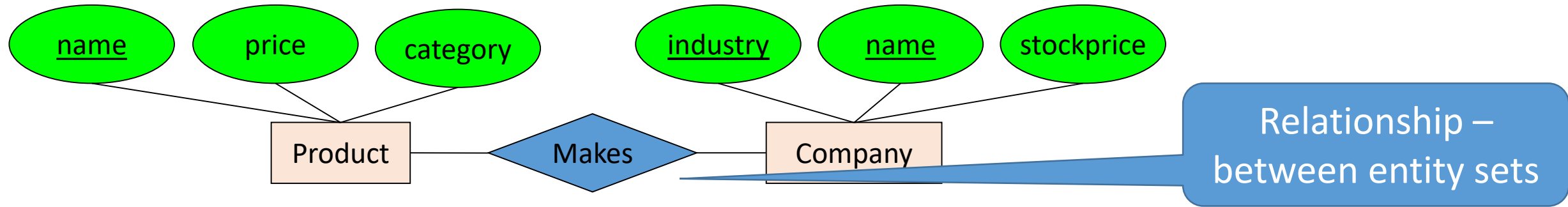
$A \times B = \{(1, a), (1, b), (1, c), (1, d), (2, a), (2, b), (2, c), (2, d), (3, a), (3, b), (3, c), (3, d)\}$

(Binary) Relationship R:

Some subset of $A \times B$

$R = \{(1, a), (2, c), (2, d), (3, b)\}$





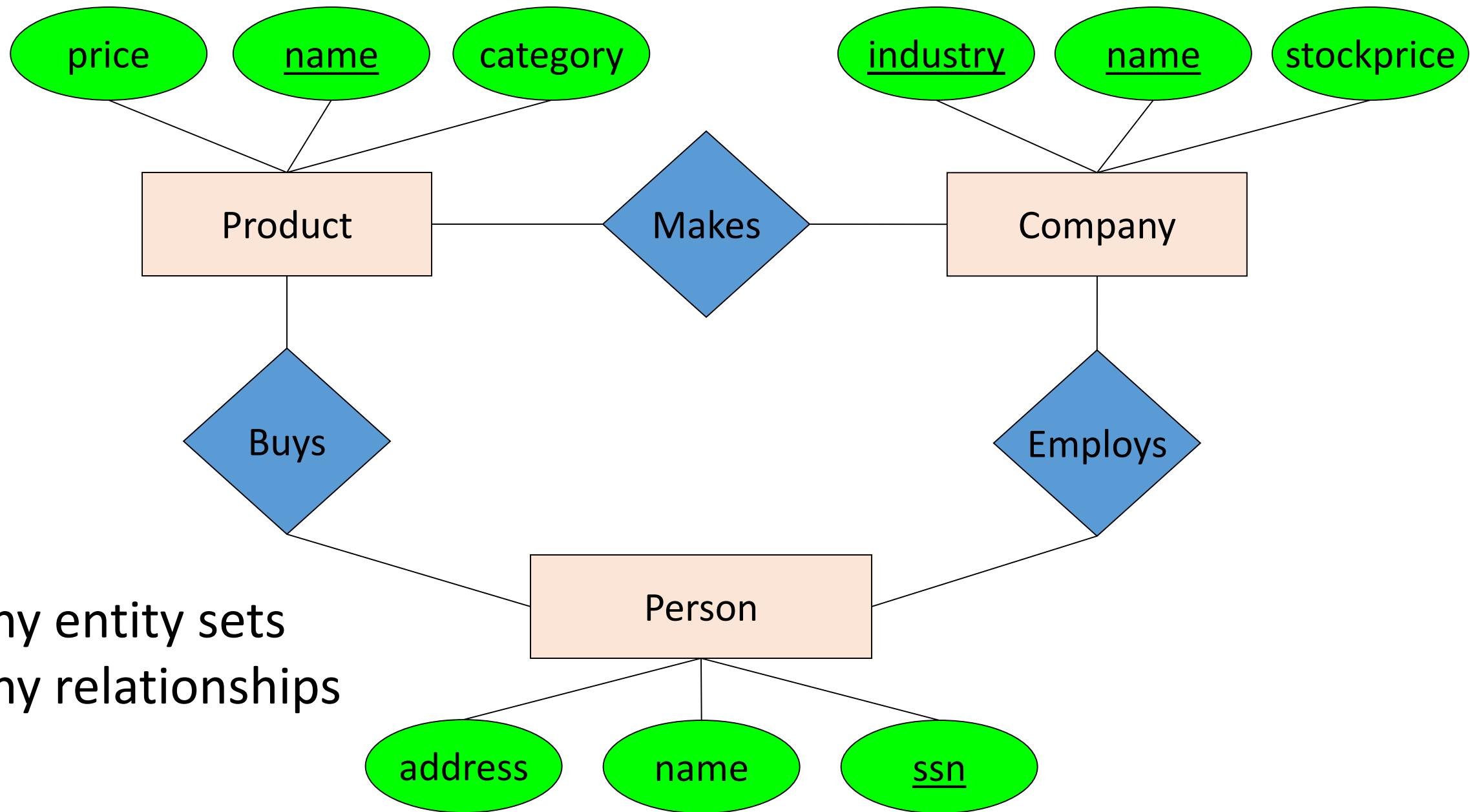
Company $c \times$ Product p

<u>c.industry</u>	<u>c.name</u>	<u>p.name</u>	...
Music	Apple	iPad	...
Music	Apple	Galaxy Tab	...
Music	Apple	Galaxy Note	...
Music	Apple	iPhone	...
Music	Apple	Let It Be	...
Technology	Apple	iPad	...
Technology	Apple	Galaxy Tab	...
...
Technology	Samsung	iPhone	...
Technology	Samsung	Let It Be	...

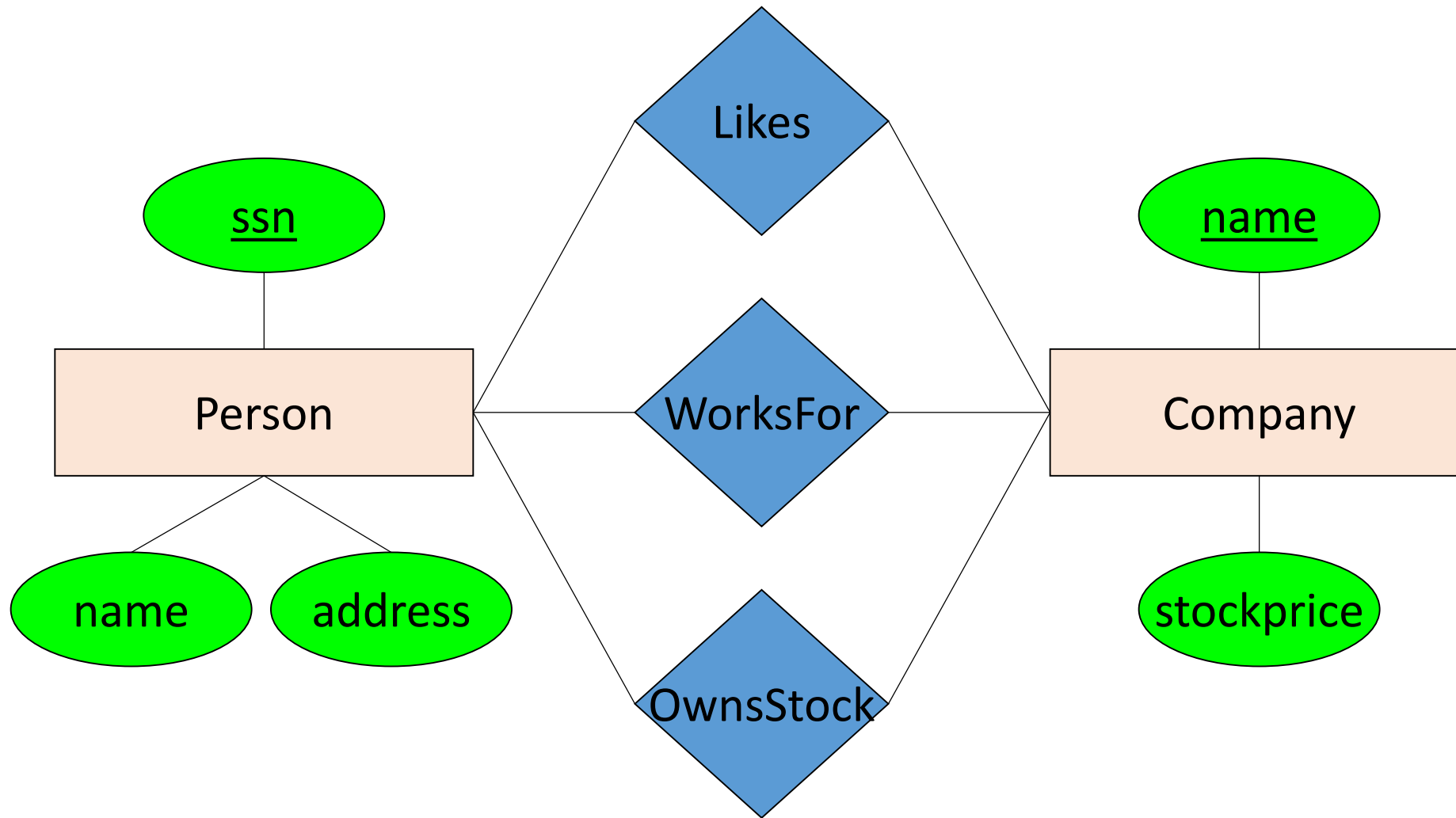
Makes

<u>c.industry</u>	<u>c.name</u>	<u>p.name</u>	...
Music	Apple	Let It Be	...
Technology	Apple	iPad	...
Technology	Apple	iPhone	...
Technology	Samsung	Galaxy Tab	...
Technology	Samsung	Galaxy Note	...

Convenient to draw in tabular form.
Implementation as tables discussed later.

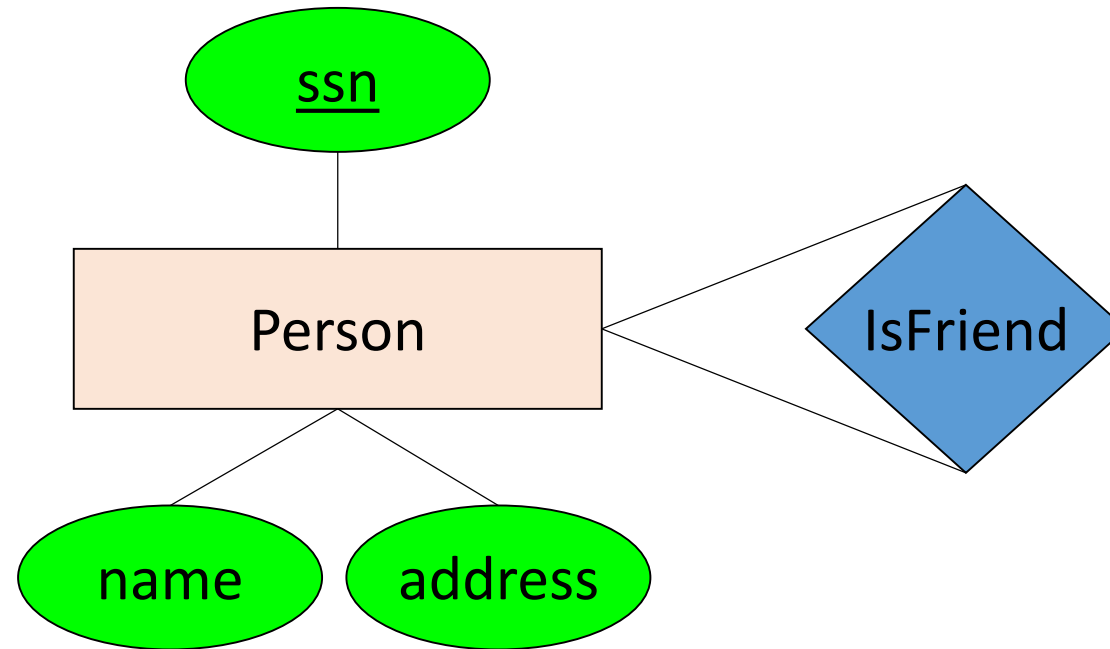


Many entity sets
Many relationships



Can have multiple relationships between same entity sets.

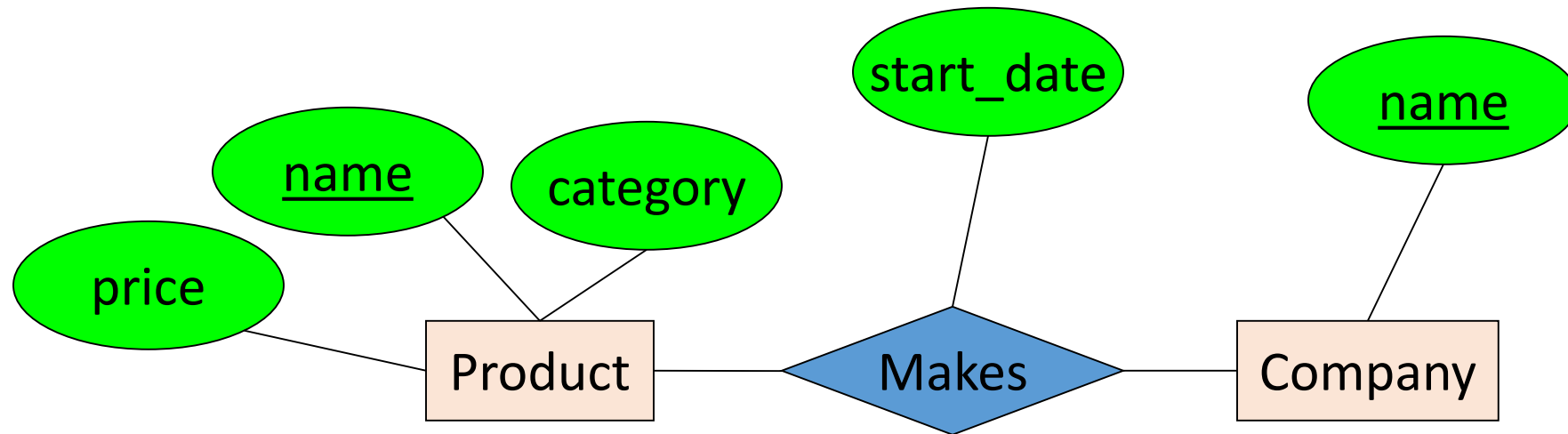
Each is a subset of **Person** × **Company** with primary key (ssn, name).



Can have relationship between single entity set.

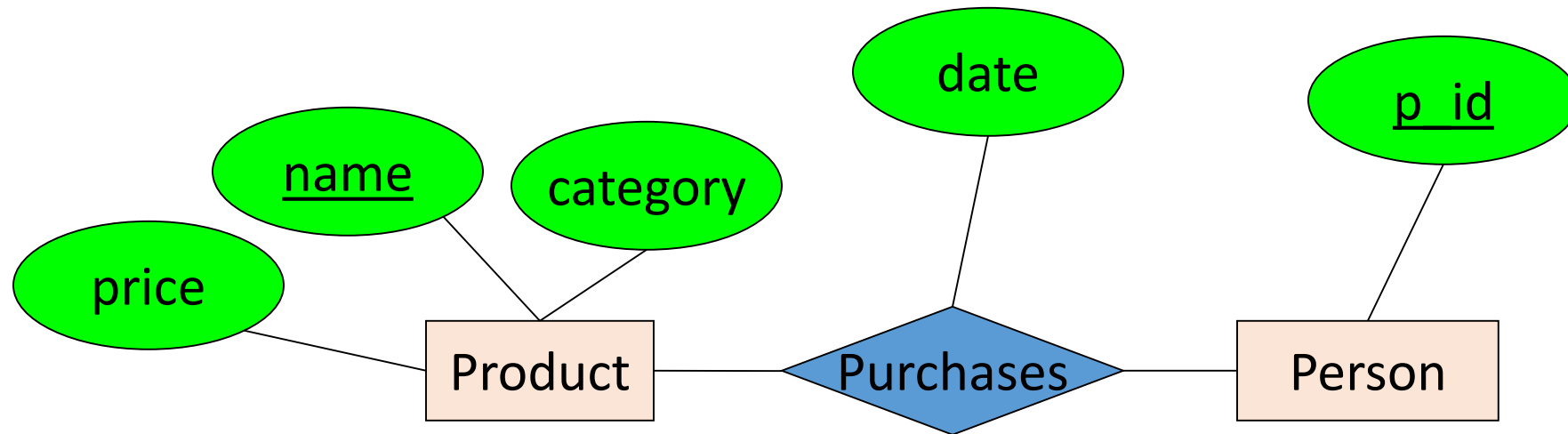
A subset of **Person** × **Person** with primary key (ssn, ssn).

Relationships can have attributes



Relationship attributes are implicitly unique per (p.name, c.name).

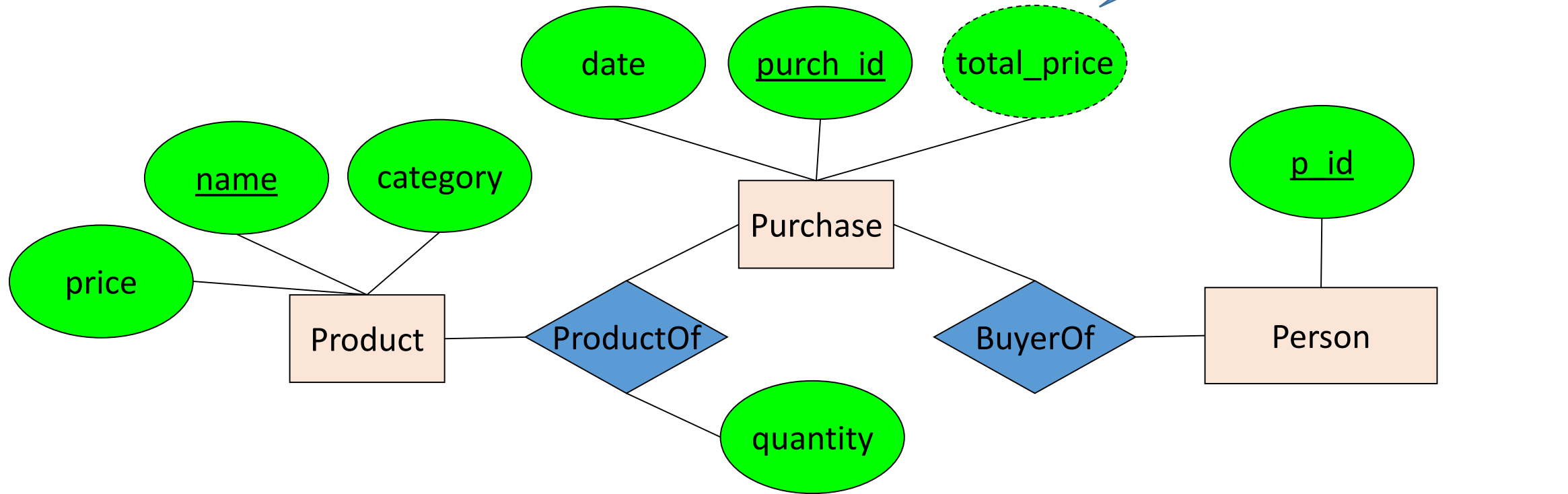
Relationship vs. entity



Relationship attributes are implicitly unique per (name, p_id).

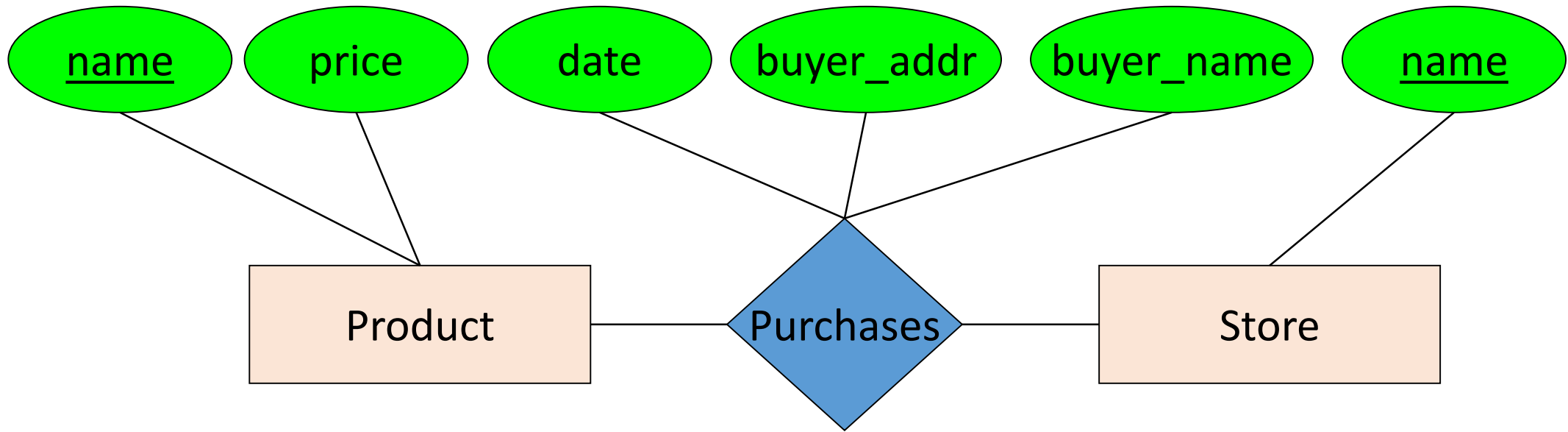
What if we don't want uniqueness?

Relationship vs. entity



Representing as an entity allows multiple **Purchases** for each **Product-Person** combination.

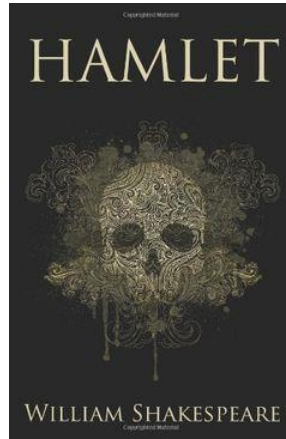
What's wrong?



Activity – Draw ER diagram



Authors have IDs and names. They write books.



Books have ISBNs and titles. The library keeps track of how many copies it has of the book. Each book is written by authors and published by a publisher. We want to know every time it is checked out by a borrower.

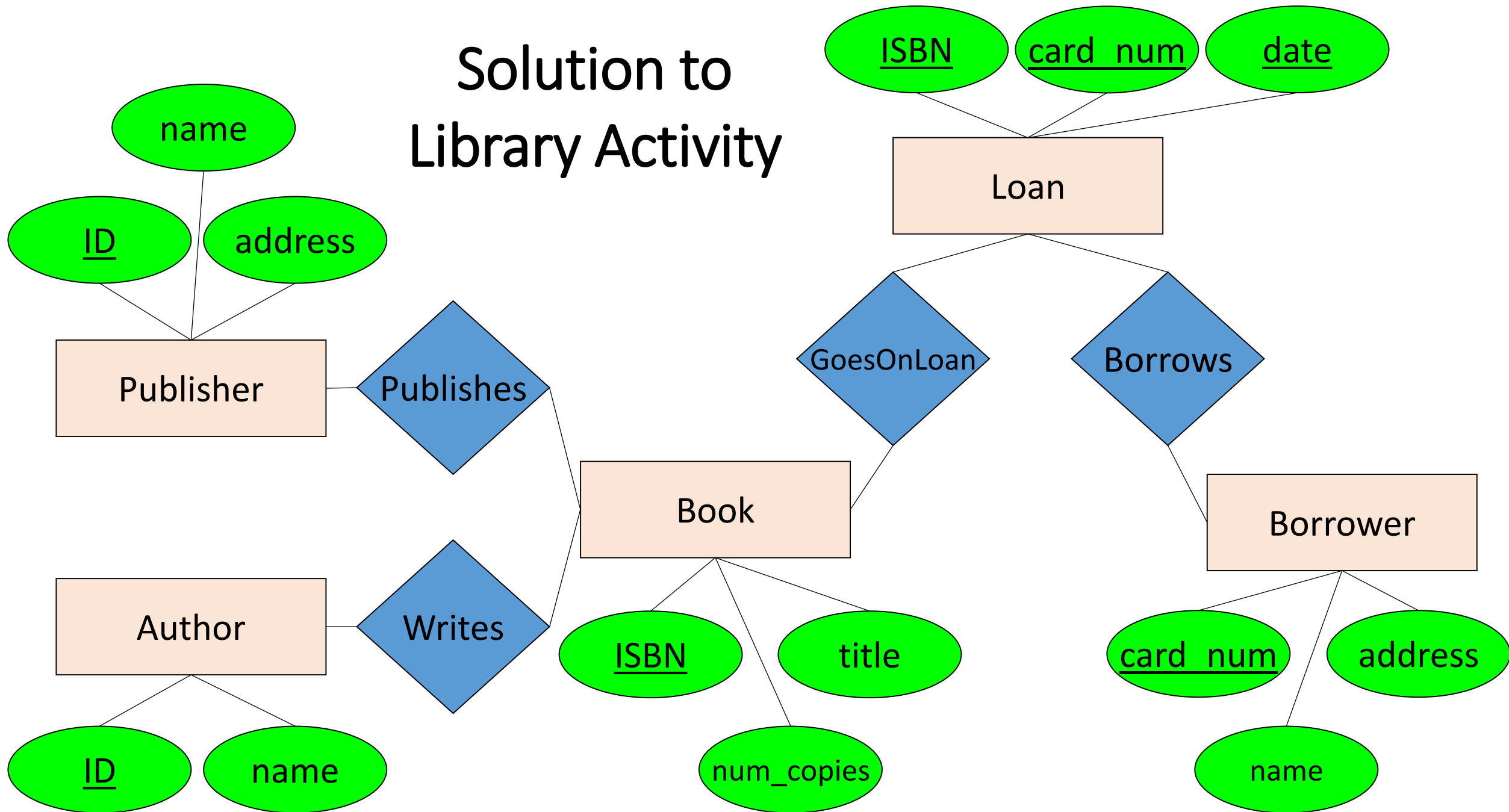


Borrowers have a library card number, name, and address. They can check out a book on a particular date.



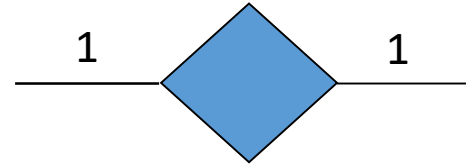
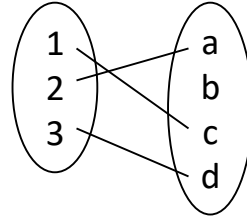
Publishers have an ID, name and address. They publish books.

Solution to Library Activity

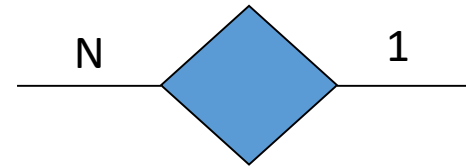
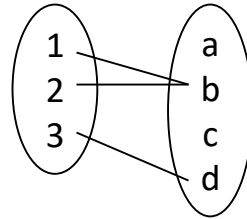


Maximum cardinality

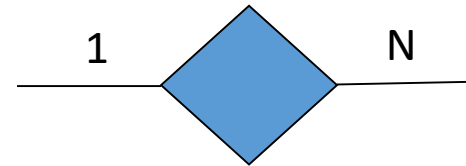
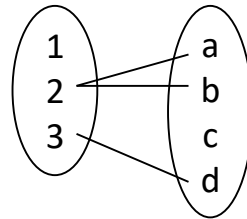
One-to-one:



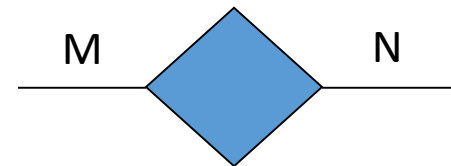
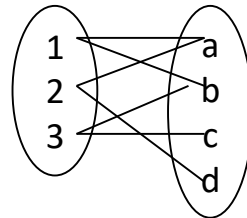
Many-to-one:

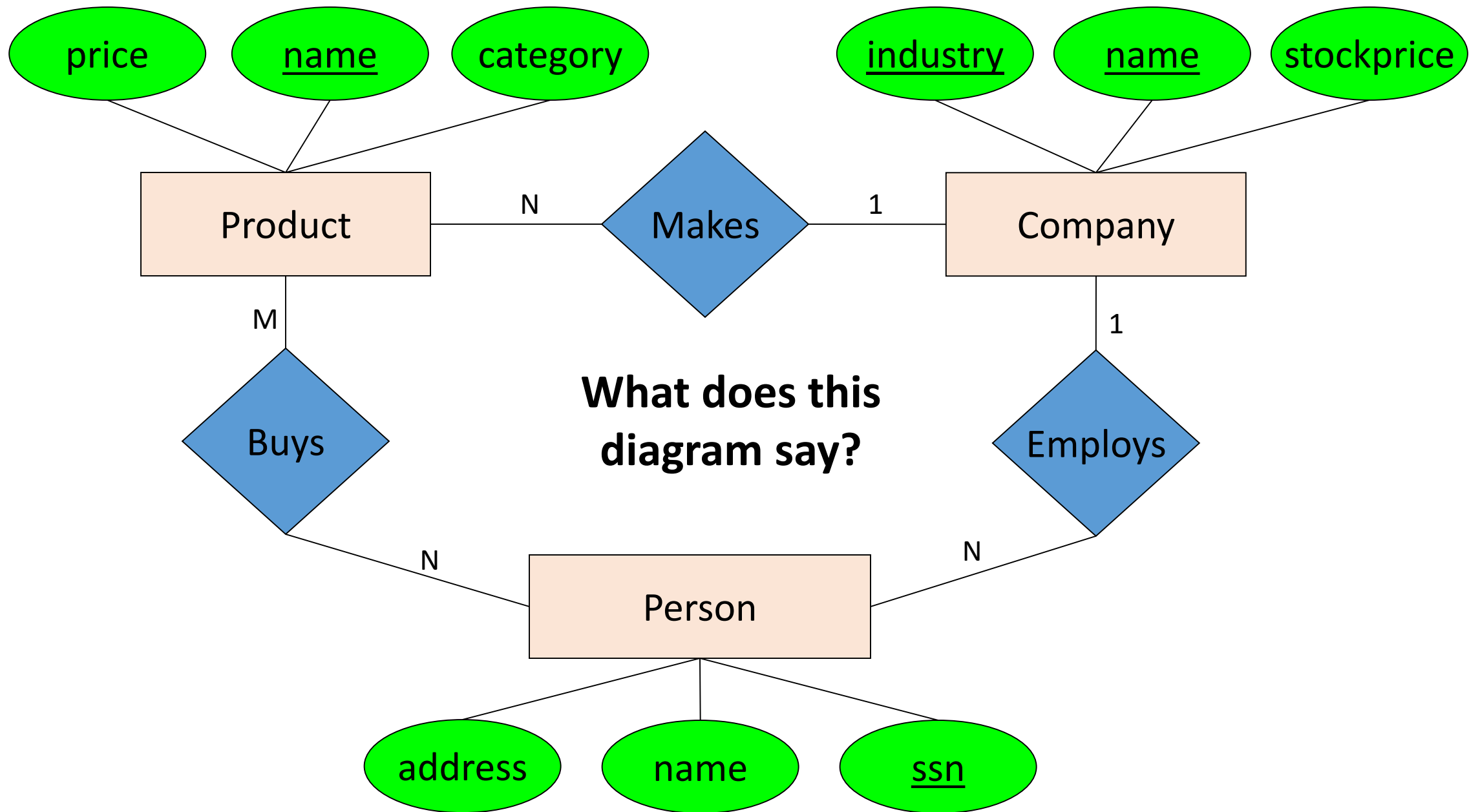


One-to-many:

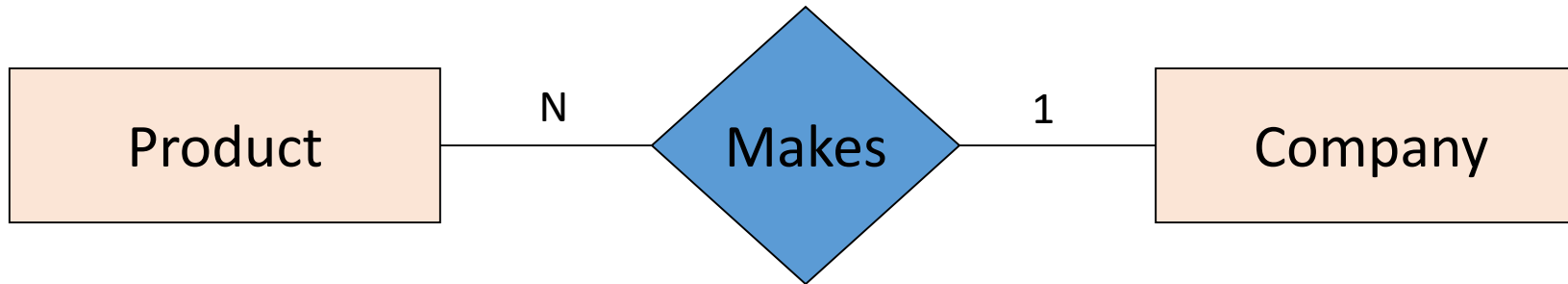


Many-to-many:



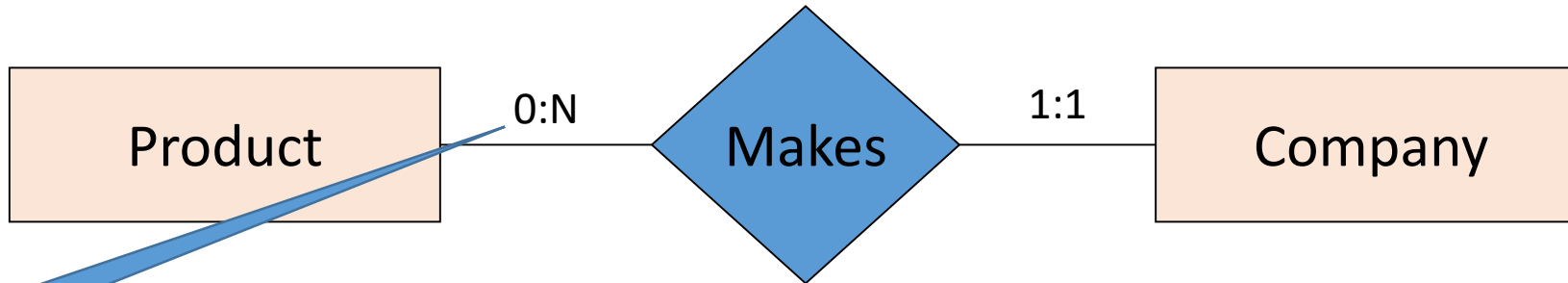


Minimum cardinality



Are there products made by no company?

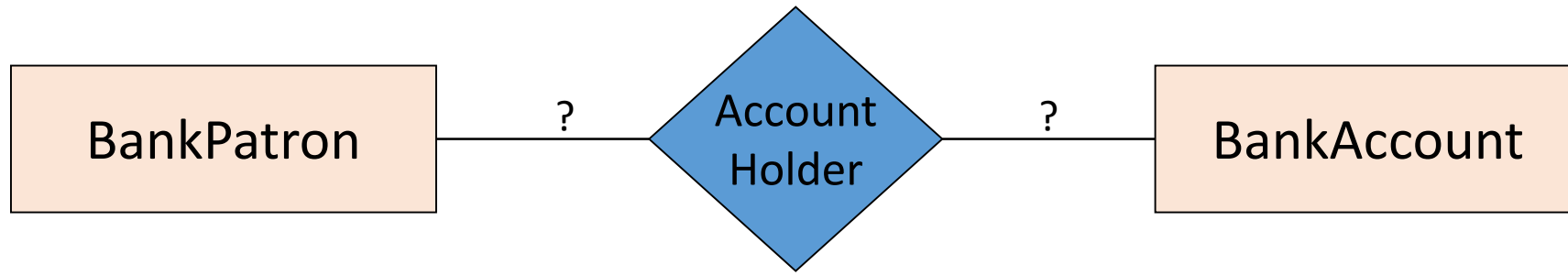
Does every company make a product?



Or, simply N.

Each product maps to $1 \geq c \geq 1$ company.

Each company maps to $0 \geq p$ products.



Assume typical real-world context.

A. 1, 1

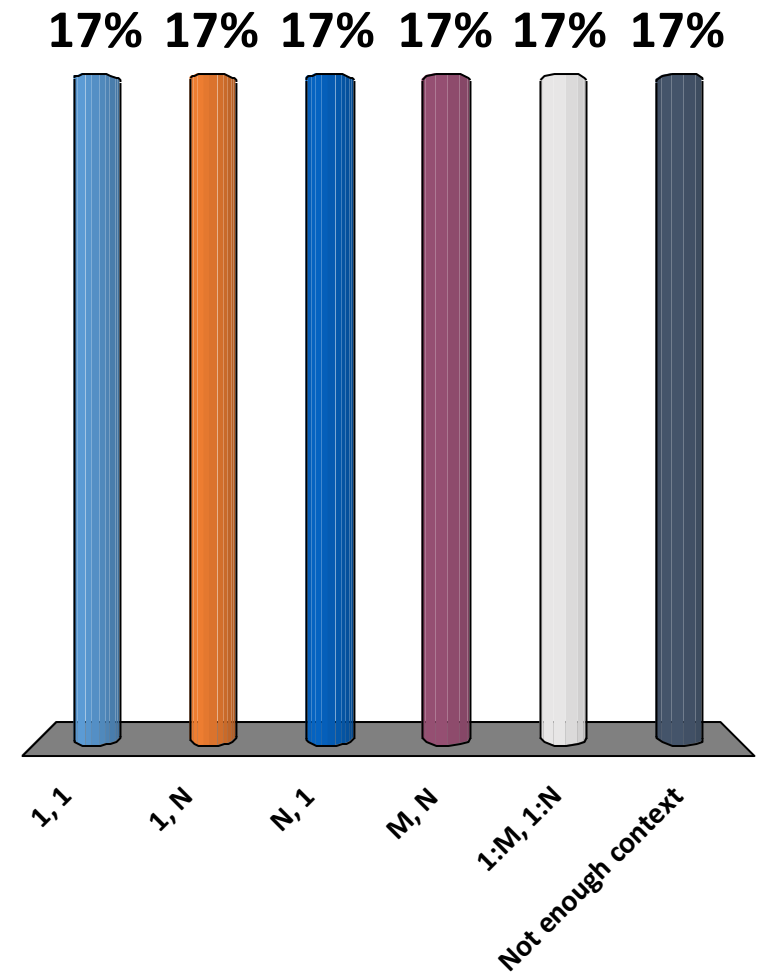
B. 1, N

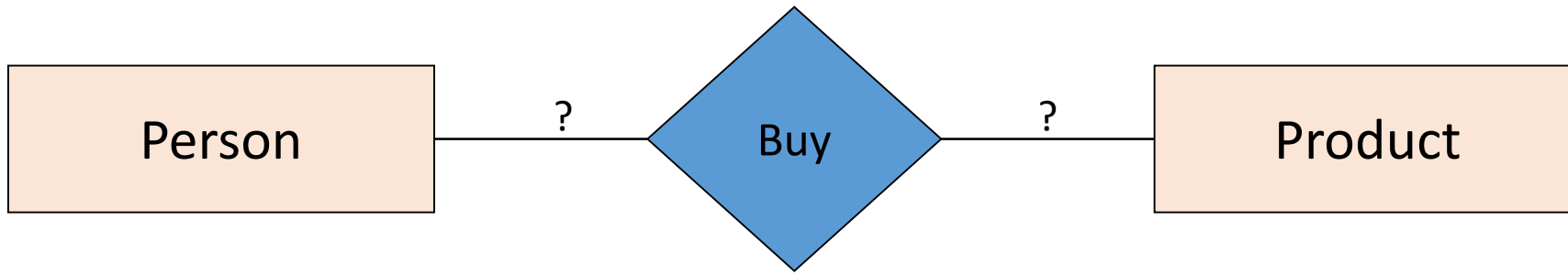
C. N, 1

D. M, N

✓ E. 1:M, 1:N

F. Not enough context





Assume typical real-world context.

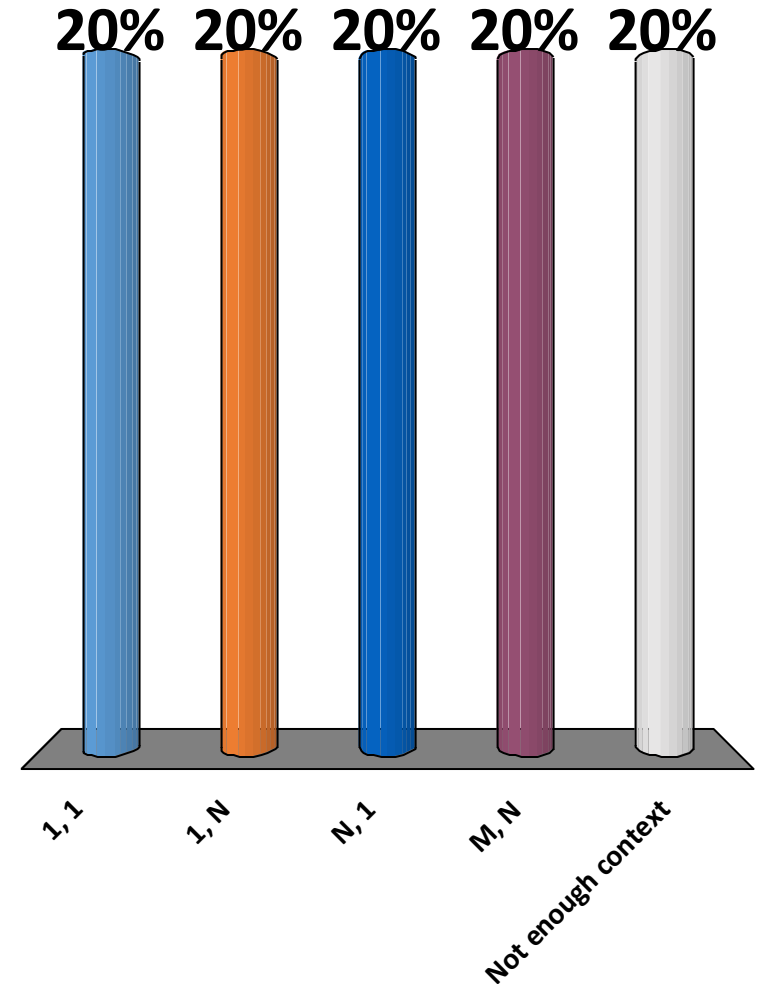
A. 1, 1

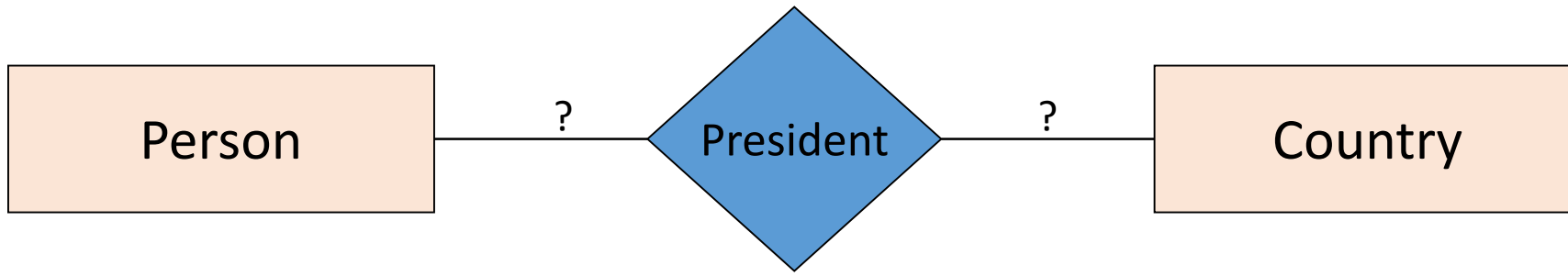
B. 1, N

C. N, 1

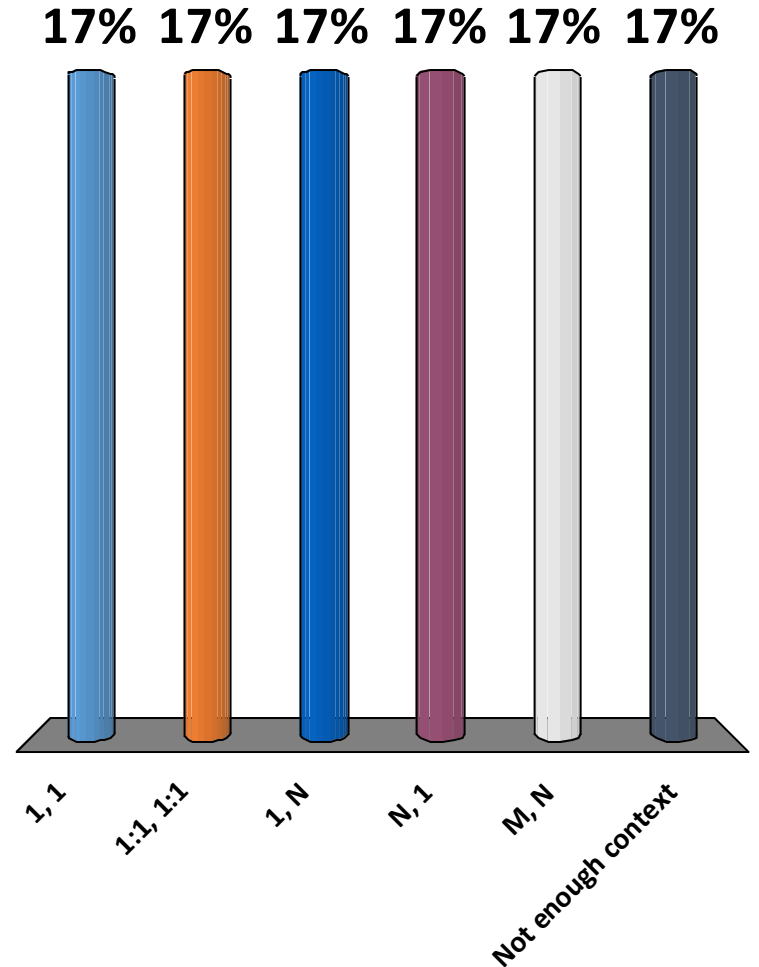
D. M, N

✓ E. Not enough context

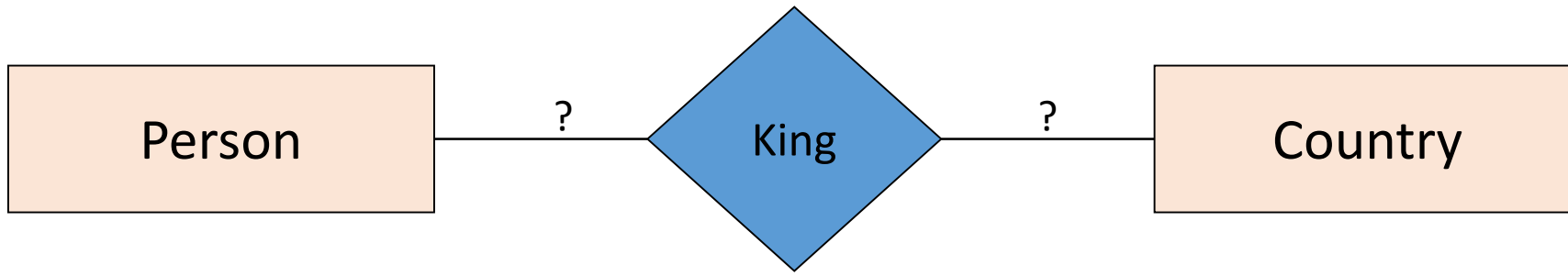




Assume typical real-world context.



- ✓ A. 1, 1
- B. 1:1, 1:1
- C. 1, N
- D. N, 1
- E. M, N
- F. Not enough context



Assume typical real-world context.

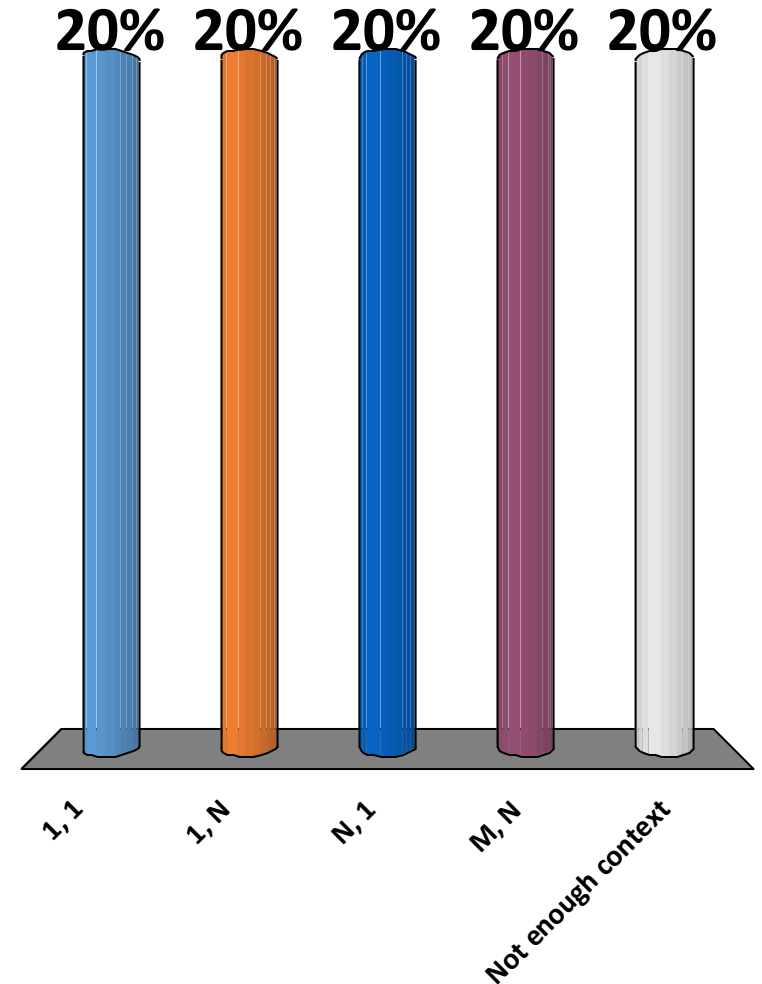
A. 1, 1

✓ B. 1, N

C. N, 1

D. M, N

E. Not enough context



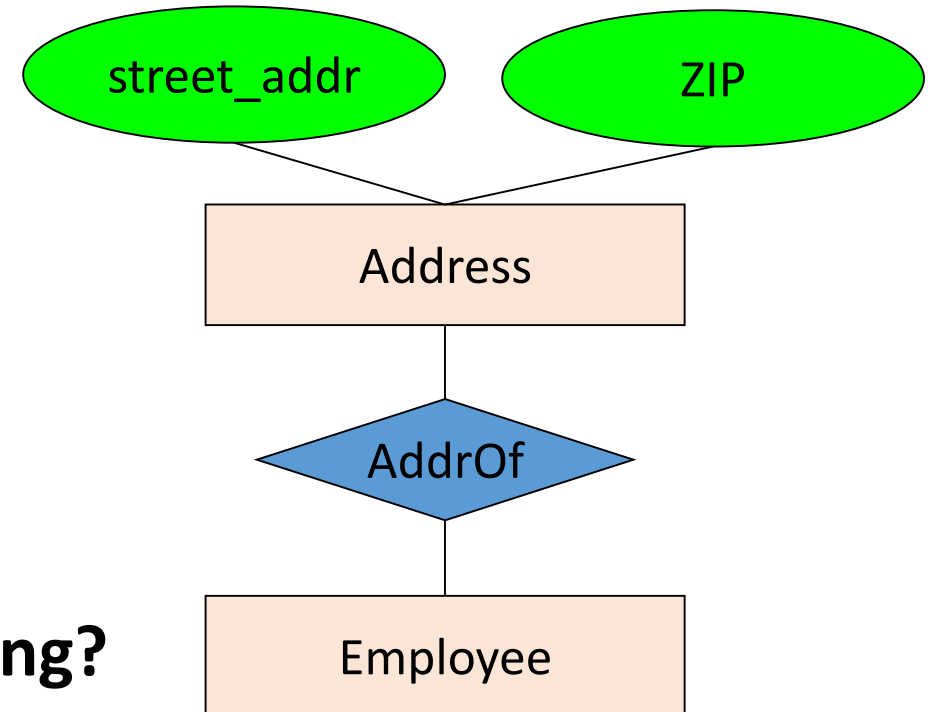
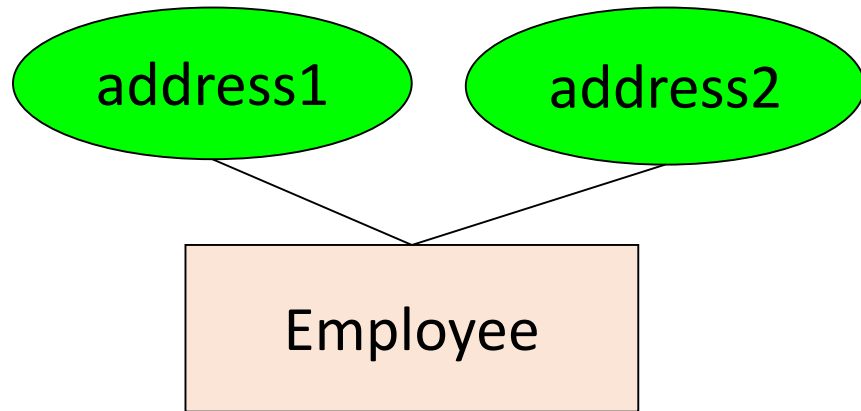
Discussion activity

Make ERD to represent people and their biological parents.

Pros/cons of different approaches?

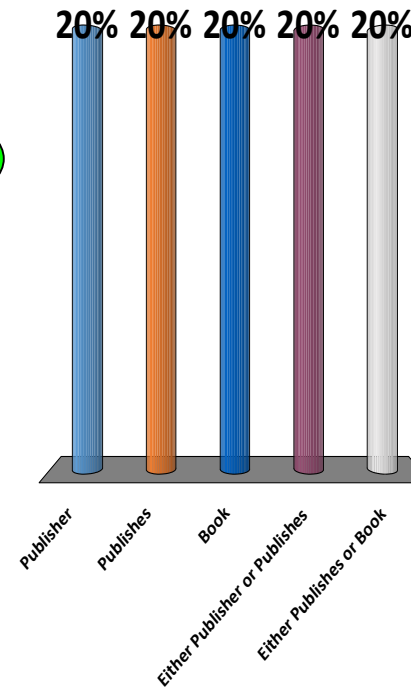
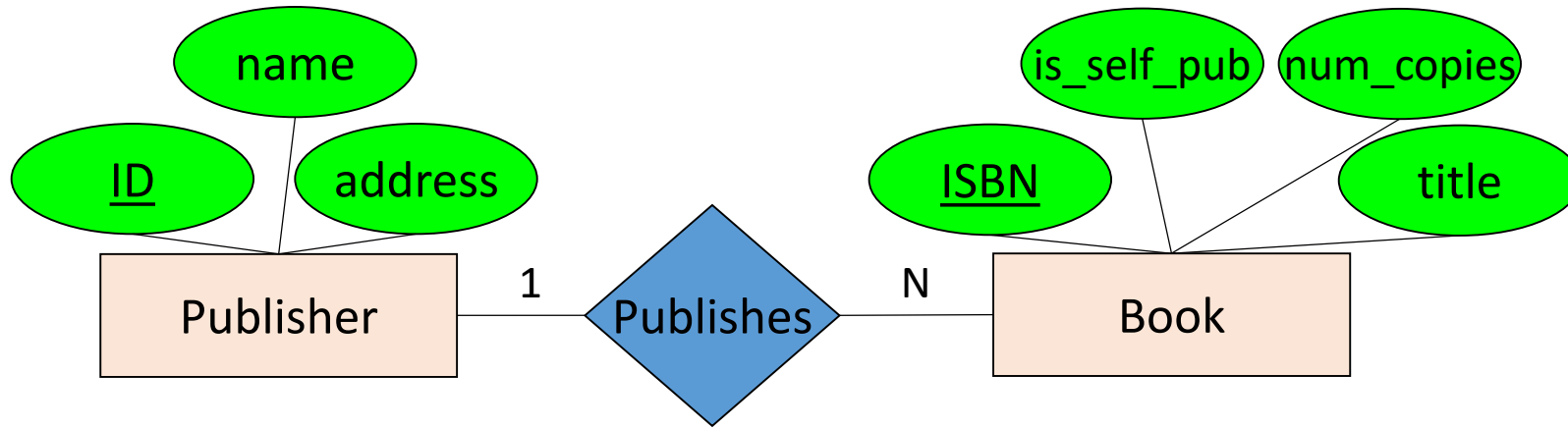


Similar ex.: attribute vs. related entity set?



Difference in meaning?
Advantages of each?
Cardinality?

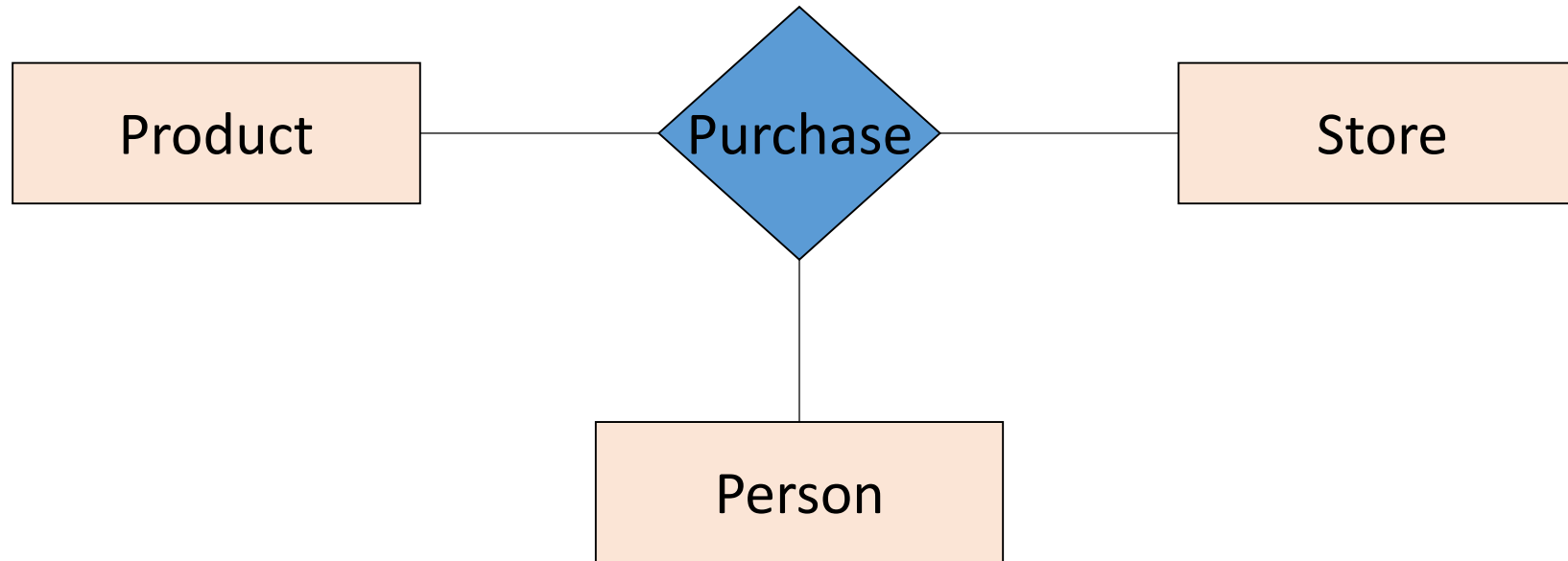
Where to add publication date attribute?



- A. Publisher
- B. Publishes
- C. Book
- D. Either Publisher or Publishes
- ✓ E. Either Publishes or Book

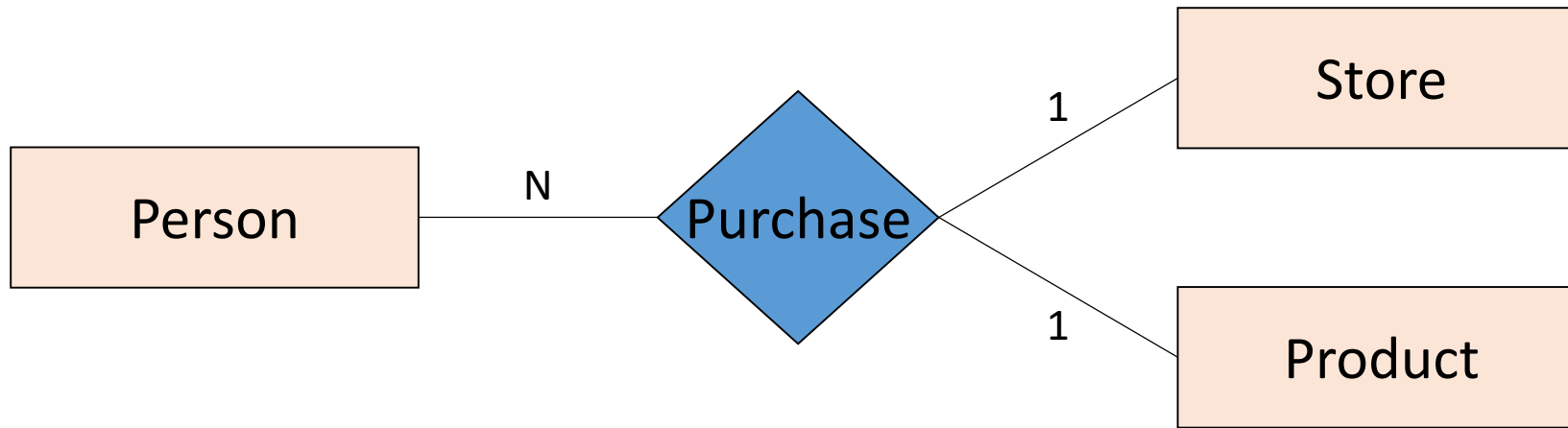
Attributes omitted
for brevity

N-ary relationships



Purchase is a subset of **Person** × **Product** × **Store**.

Cardinality in n-ary relationships



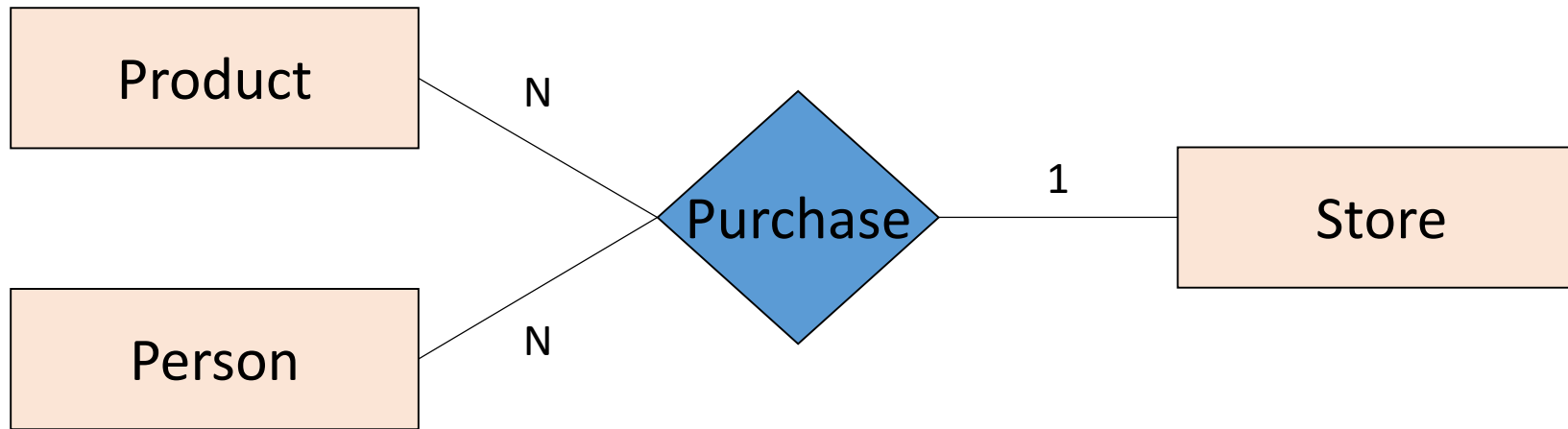
Purchase

person	store	product
Alice	Target	Jeans
Bob	Target	Shirt
Charles	Macys	Jeans
Dana	Amazon	Books

Given **Person**, then **Store** & **Product** are determined.

Each person can make one purchase – and thus of one product at one store.

Cardinality in n-ary relationships



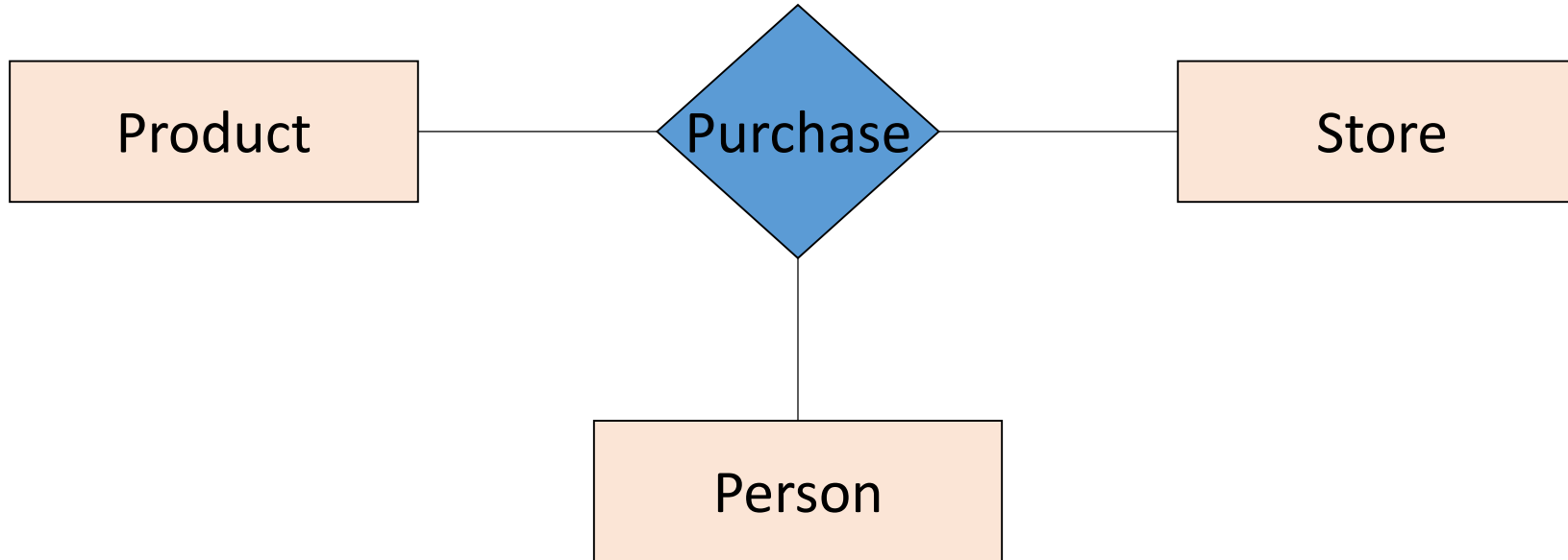
Purchase

person	store	product
Alice	Target	Jeans
Alice	Powells	Books
Bob	Target	Shirt
Charles	Macys	Jeans
Charles	Target	Shirt
Dana	Amazon	Books

Given **Product** & **Person**, then **Store** is determined.

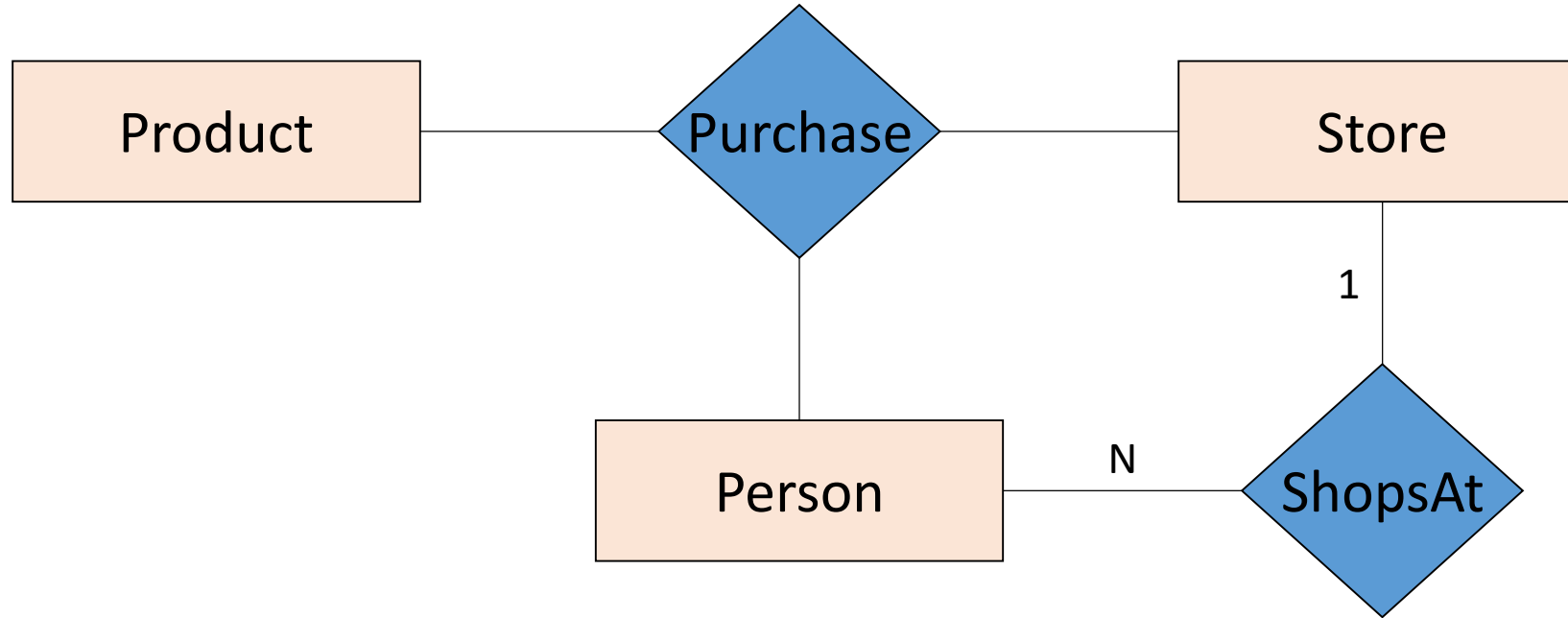
Any person can buy any given product at most once – and thus at one store.

Cardinality in n-ary relationships



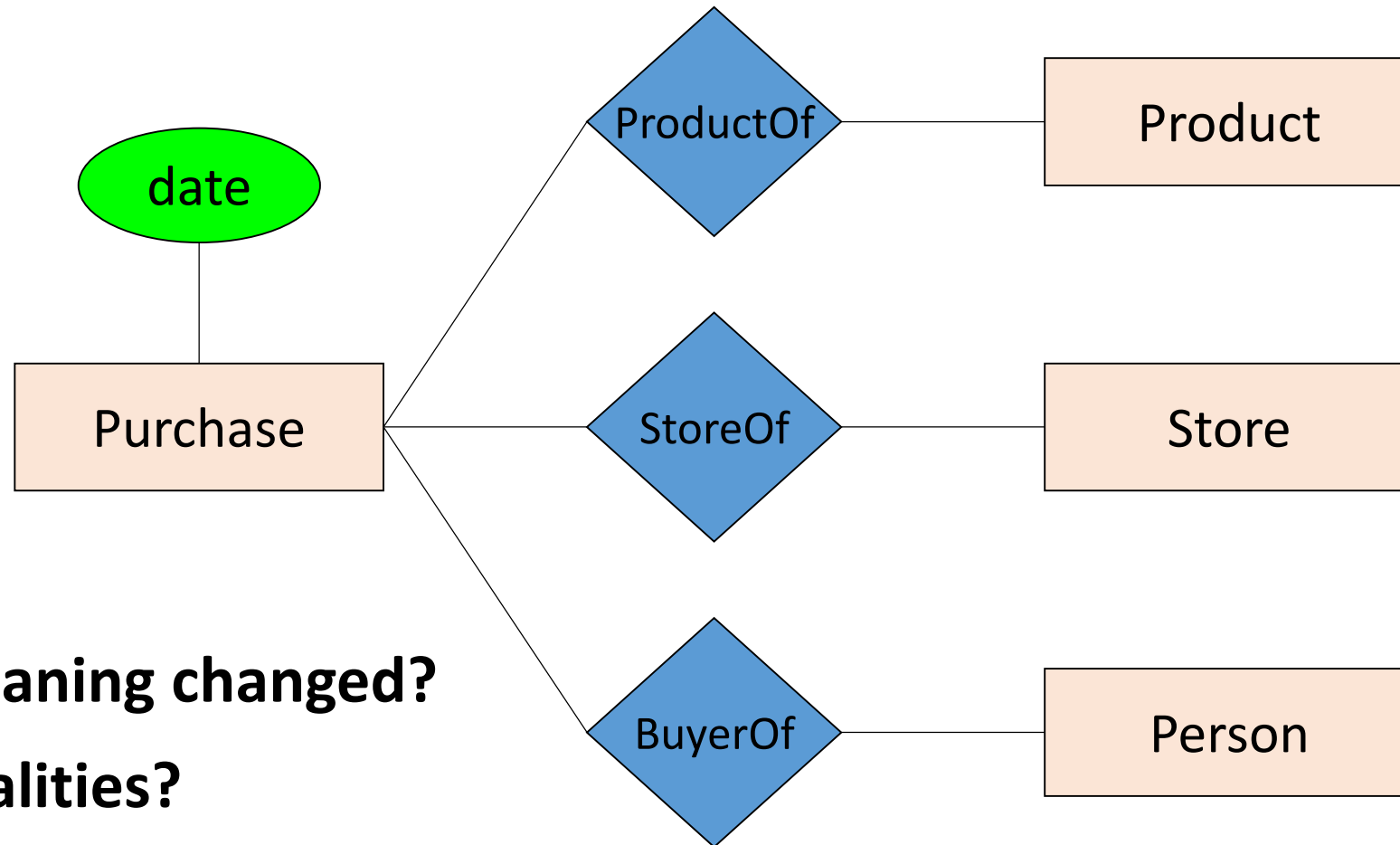
How to say: “Each person shops in at most one store.”?

Some constraints require extra relationships



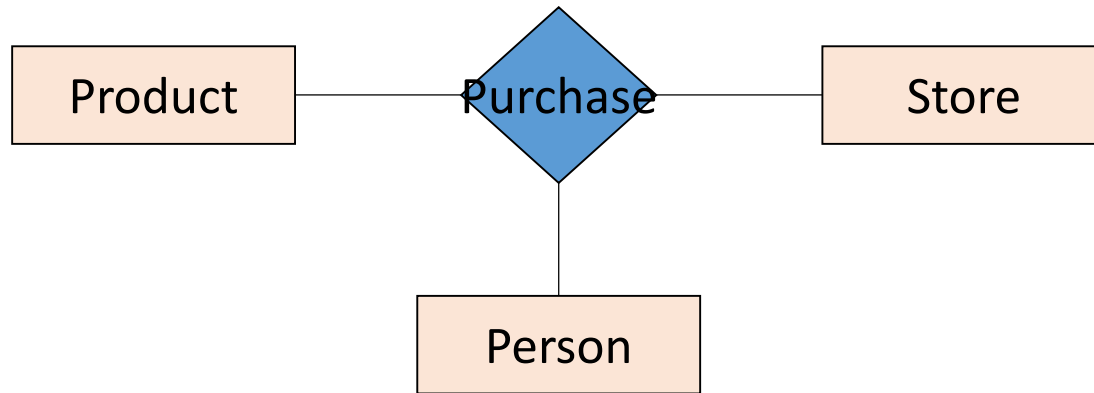
How to say: “Each person shops in at most one store.”.

Can convert n-ary to binary

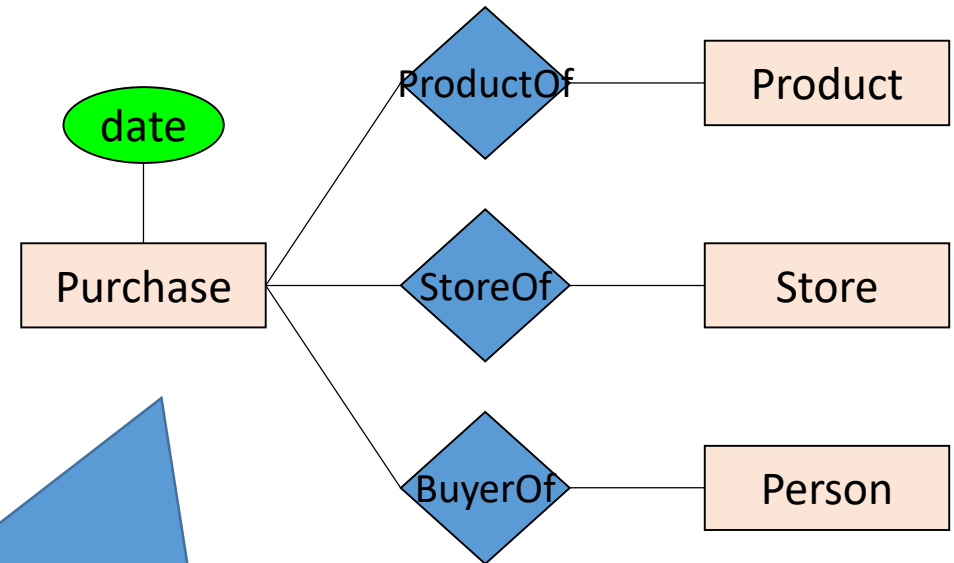


How has the meaning changed?
Cardinalities?

Decision: n-ary or binary?



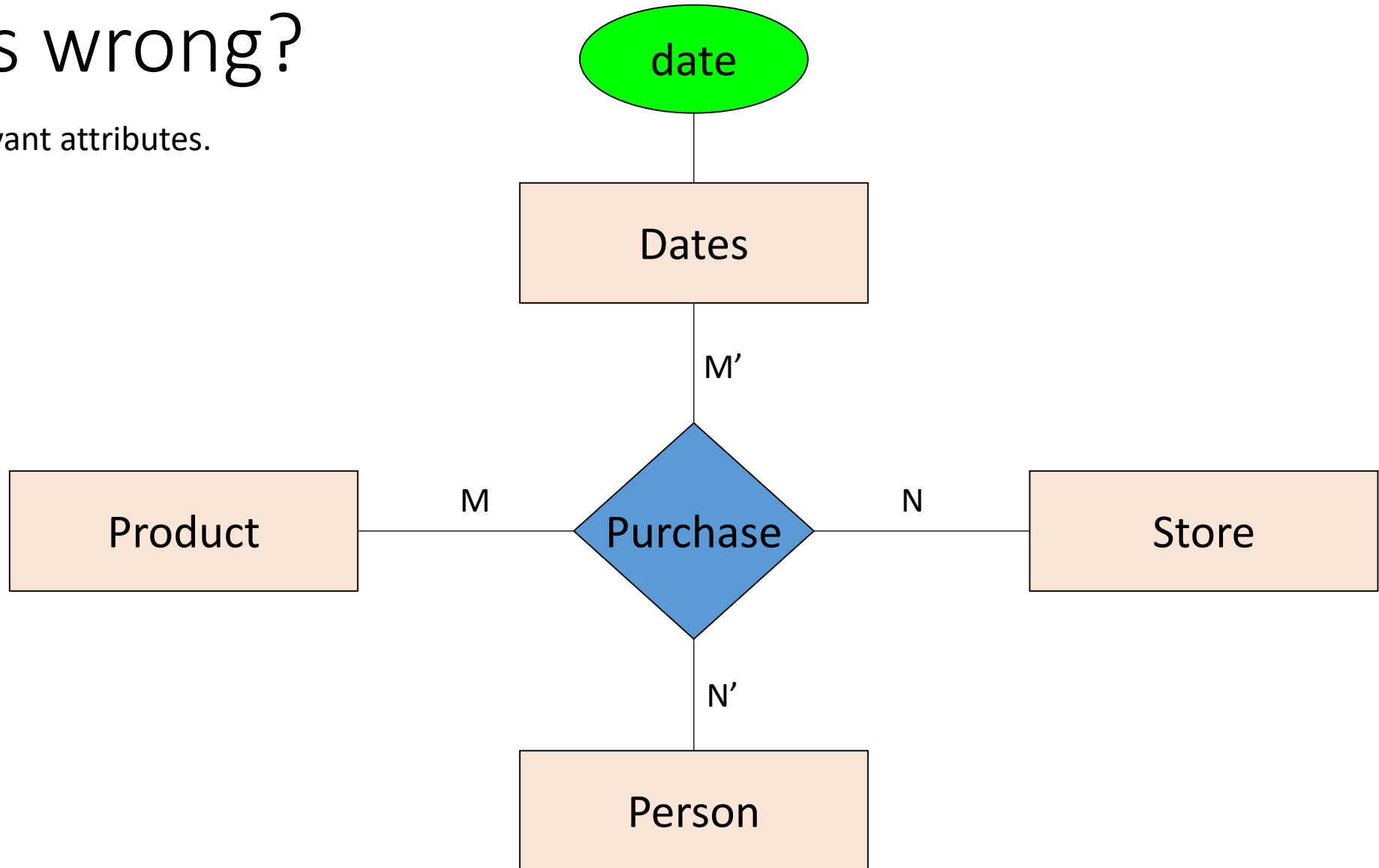
Best when relationship really is between multiple entities.



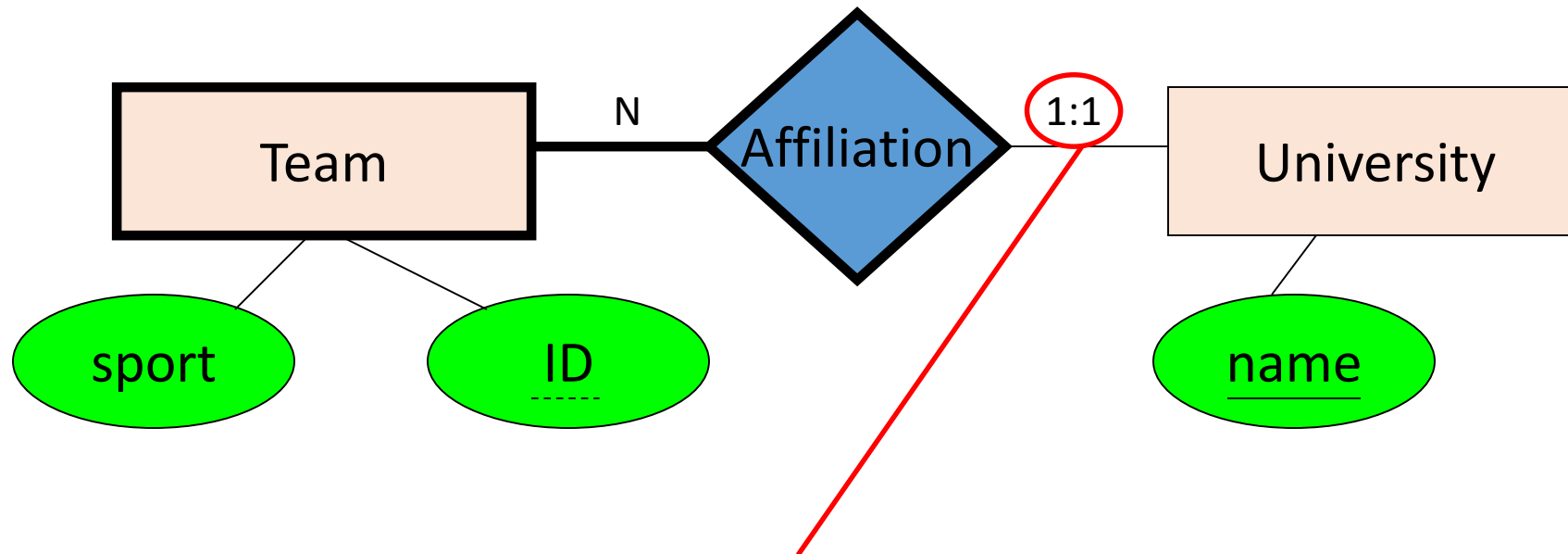
- Allows multiple purchases per Product-Store-Person combination.
- Allows attributes/constraints on Purchase.
 - “A person who shops in only one store.”
 - “How long a person has been shopping at a store.”

What's wrong?

Omitting irrelevant attributes.

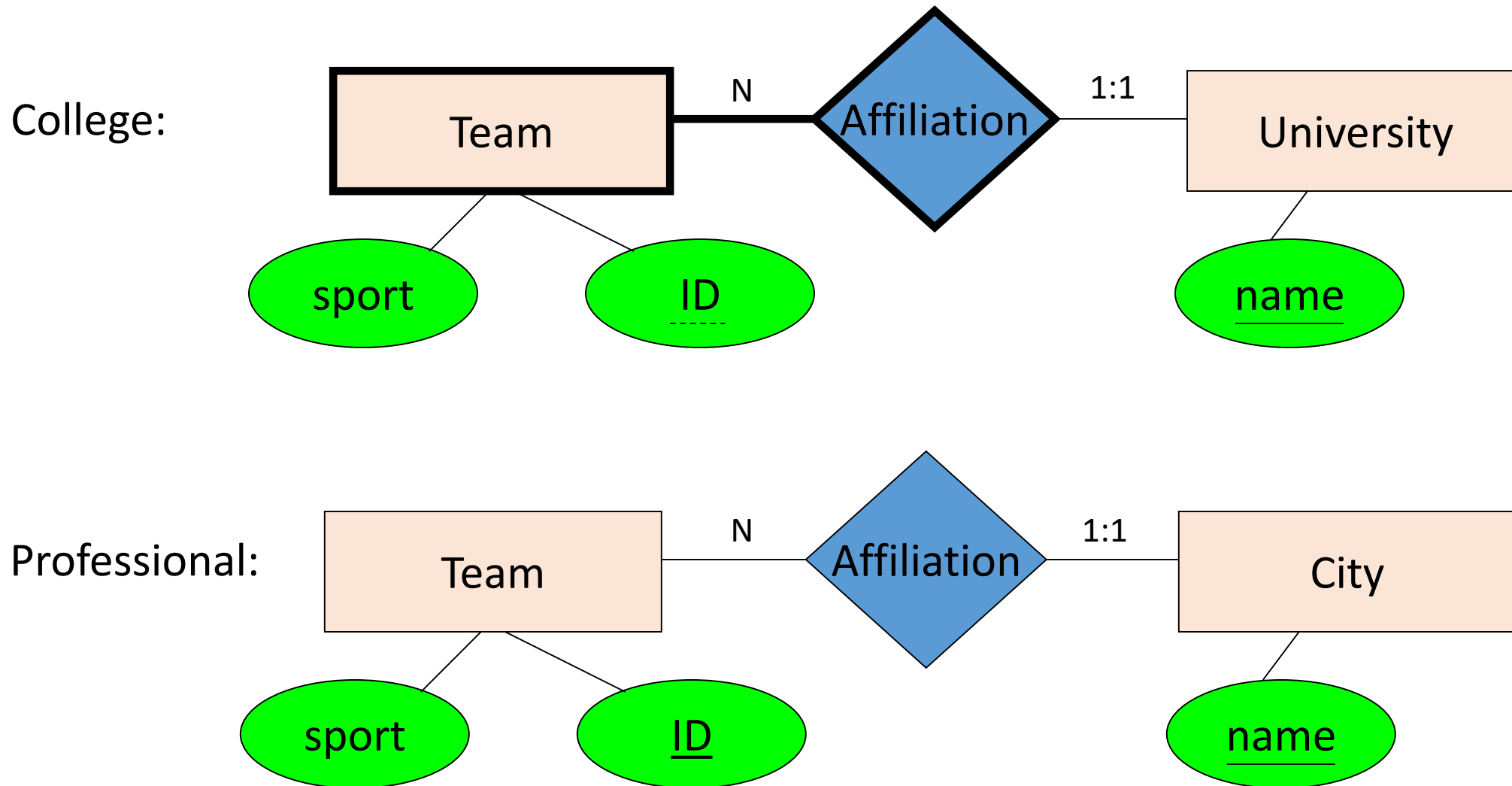


Weak entity set

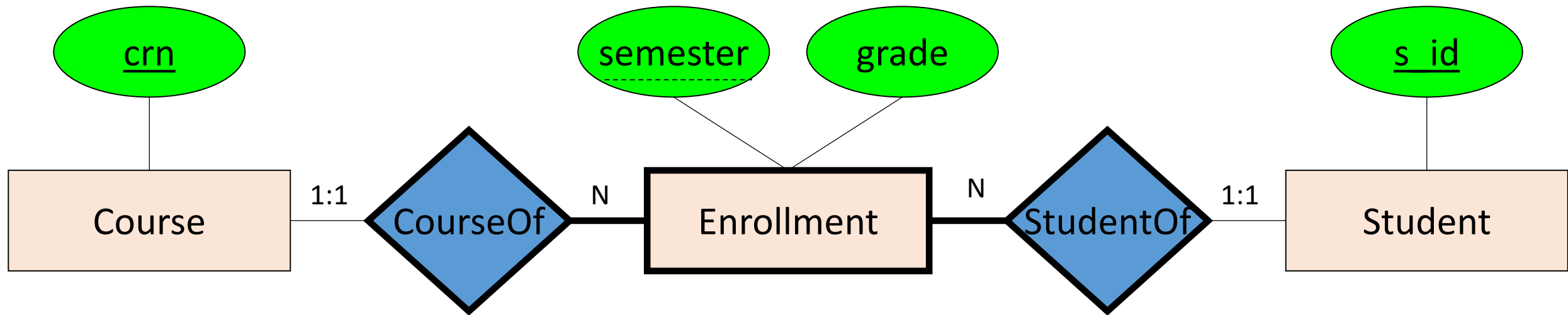


- Existence/meaning is **dependent** on another entity set(s).
- Part of its key comes from that other entity set(s)

Weak entity – a subtle semantic distinction



Many-to-many junctions often weak

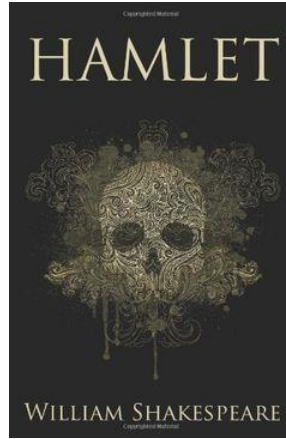


Enrollment isn't interesting/useful away from its connections to **Course** & **Student**.

Activity – Add multiplicity to ER diagram



Authors have IDs and names. They write books.



Books have ISBNs and titles. The library keeps track of how many copies it has of the book. Each book is written by authors and published by a publisher. We want to know every time it is checked out by a borrower.

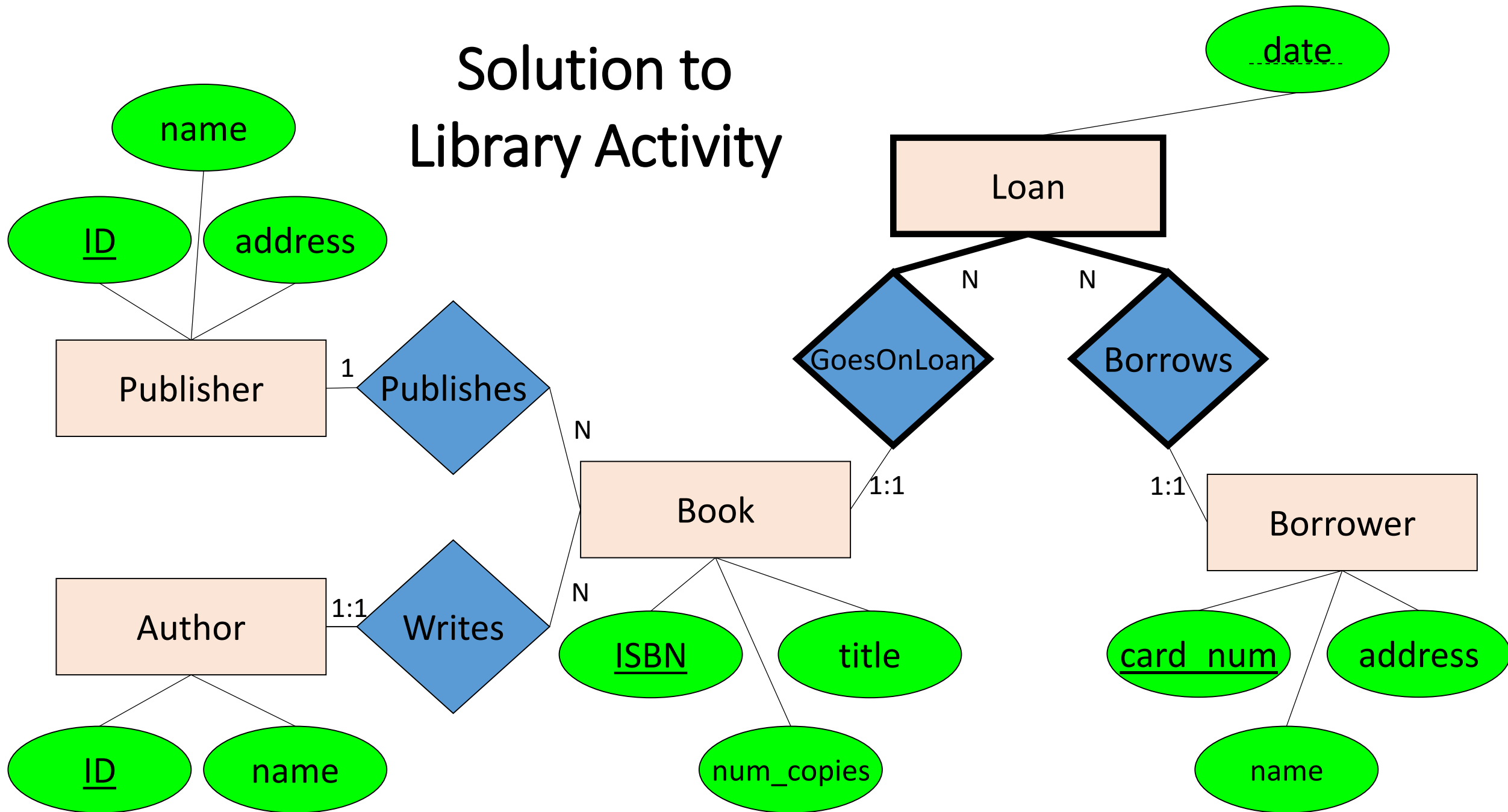


Borrowers have a library card number, name, and address. They can check out a book on a particular date.

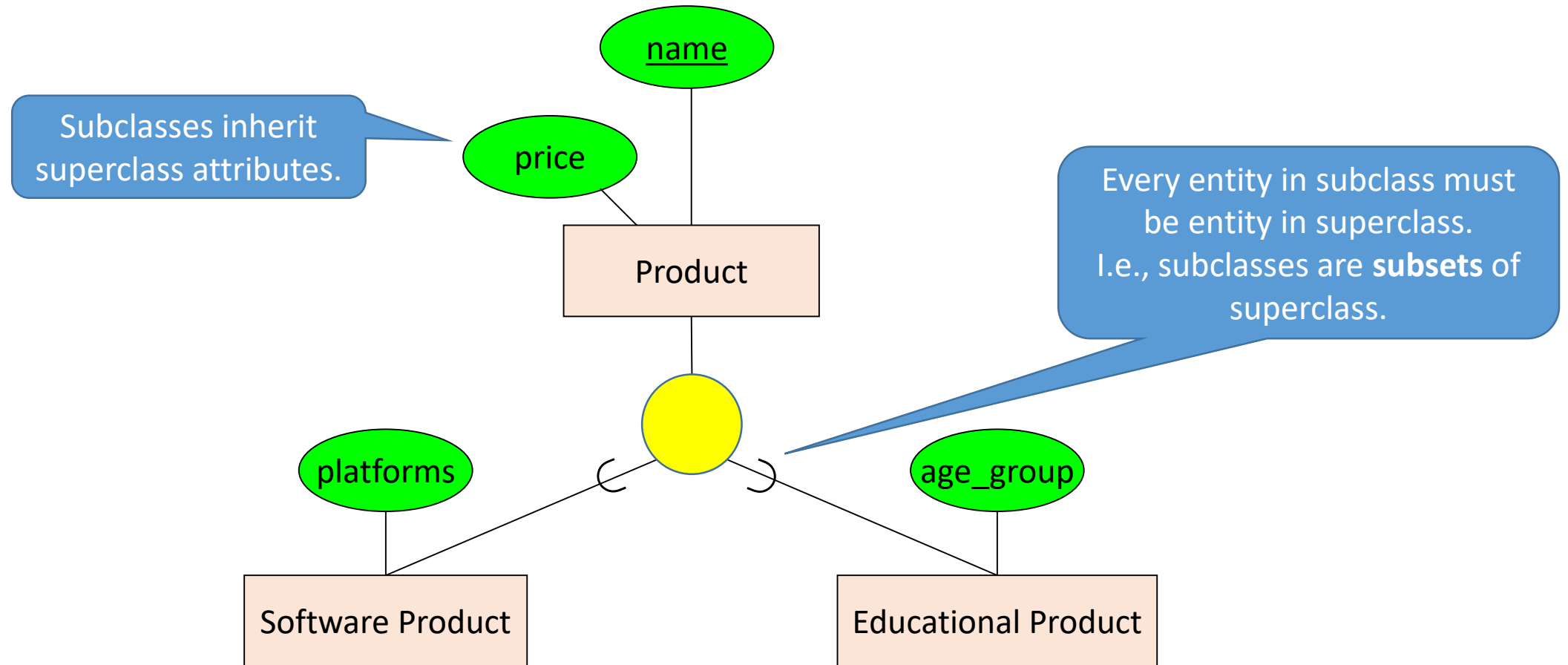


Publishers have an ID, name and address. They publish books.

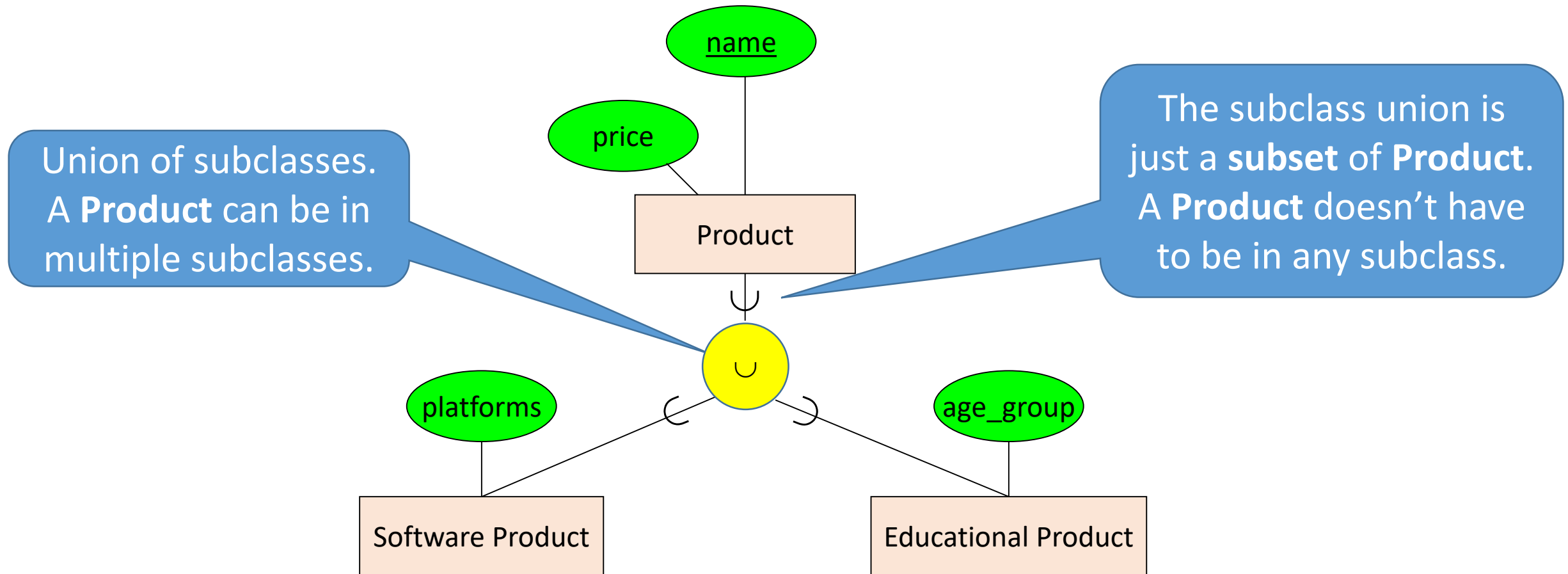
Solution to Library Activity



Subclasses & inheritance

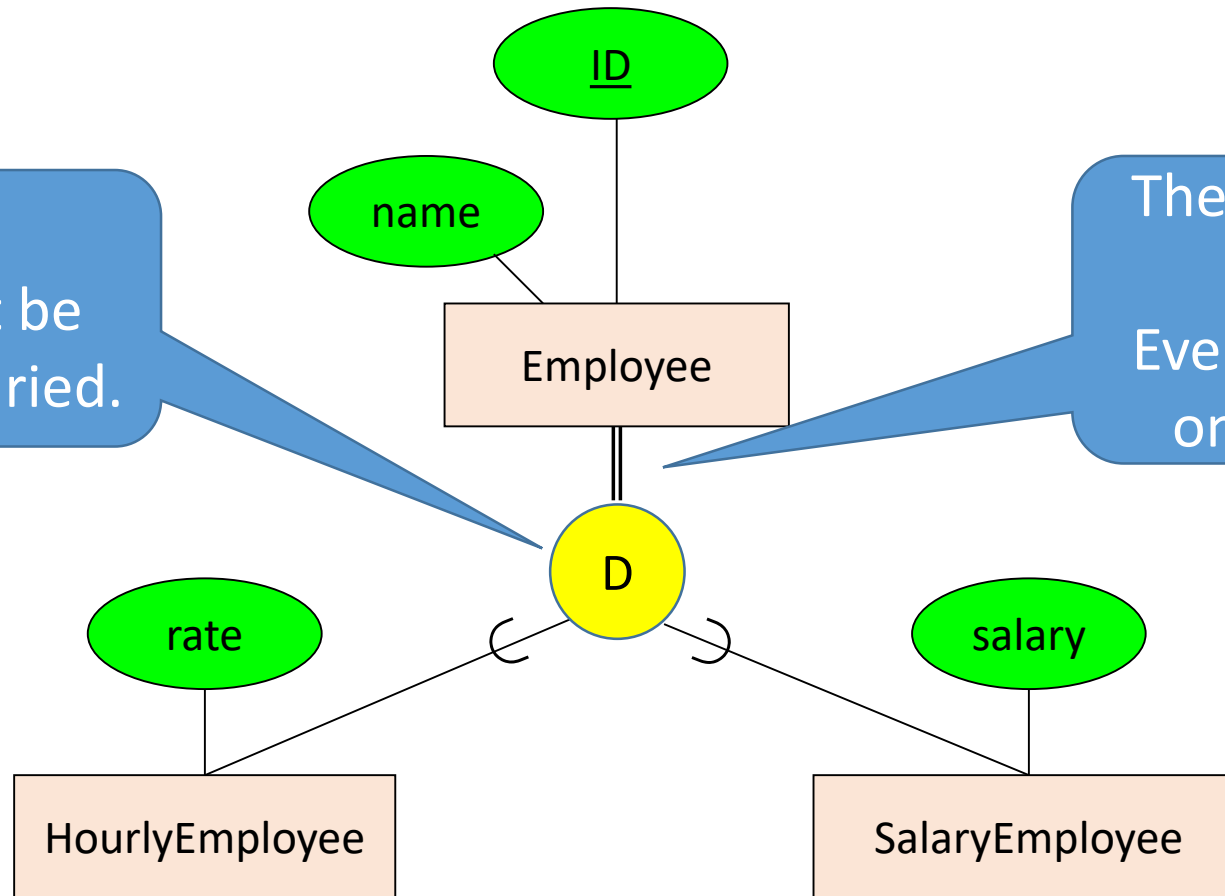


ER subclasses: unions



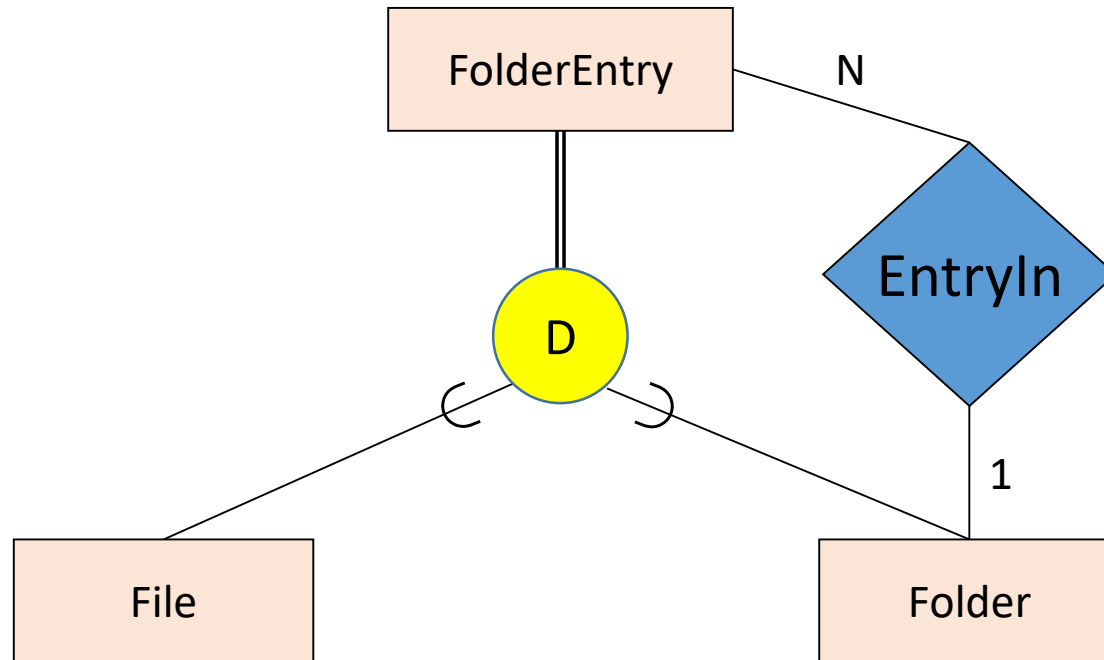
ER subclass: unions, equality, disjoint unions

Disjoint union.
An **Employee** can't be both hourly and salaried.

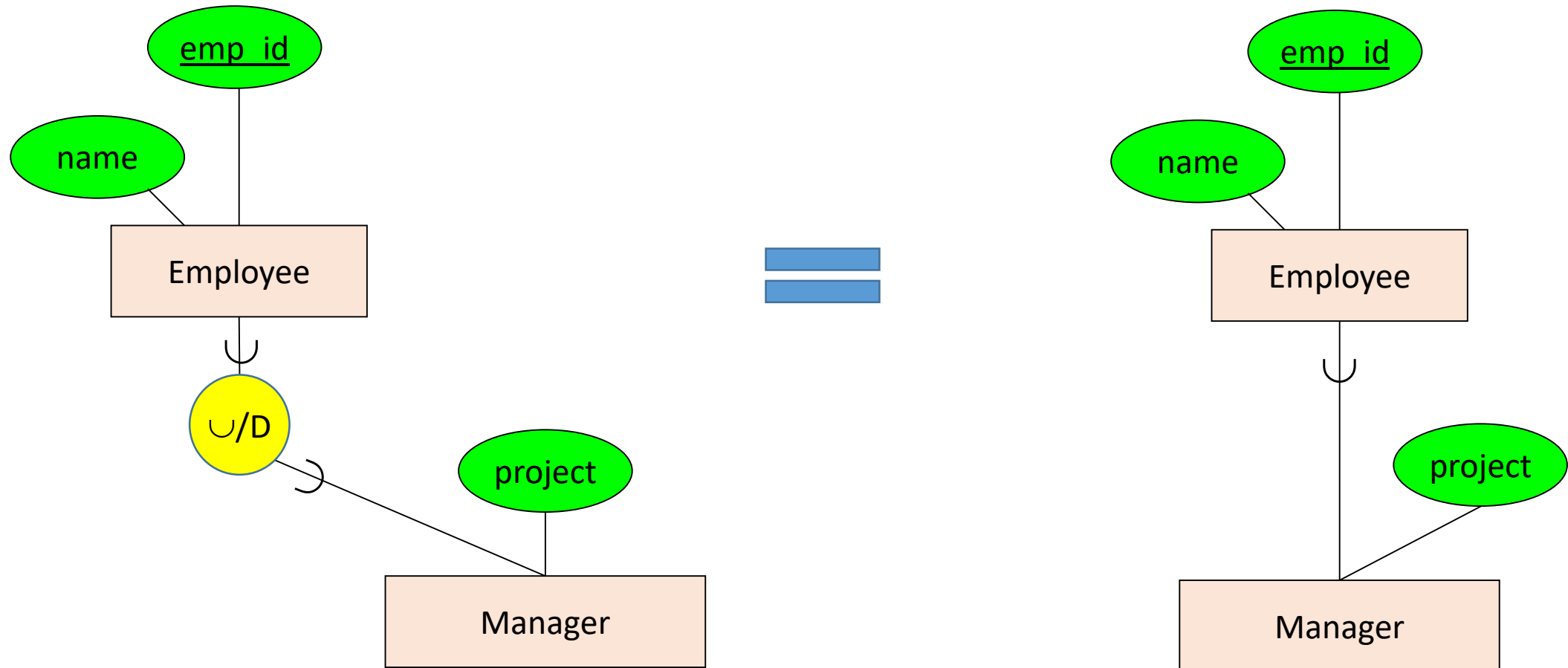


The subclass union is **equal** to **Employee**.
Every **Employee** must be in one or more subclasses.

Composite pattern example



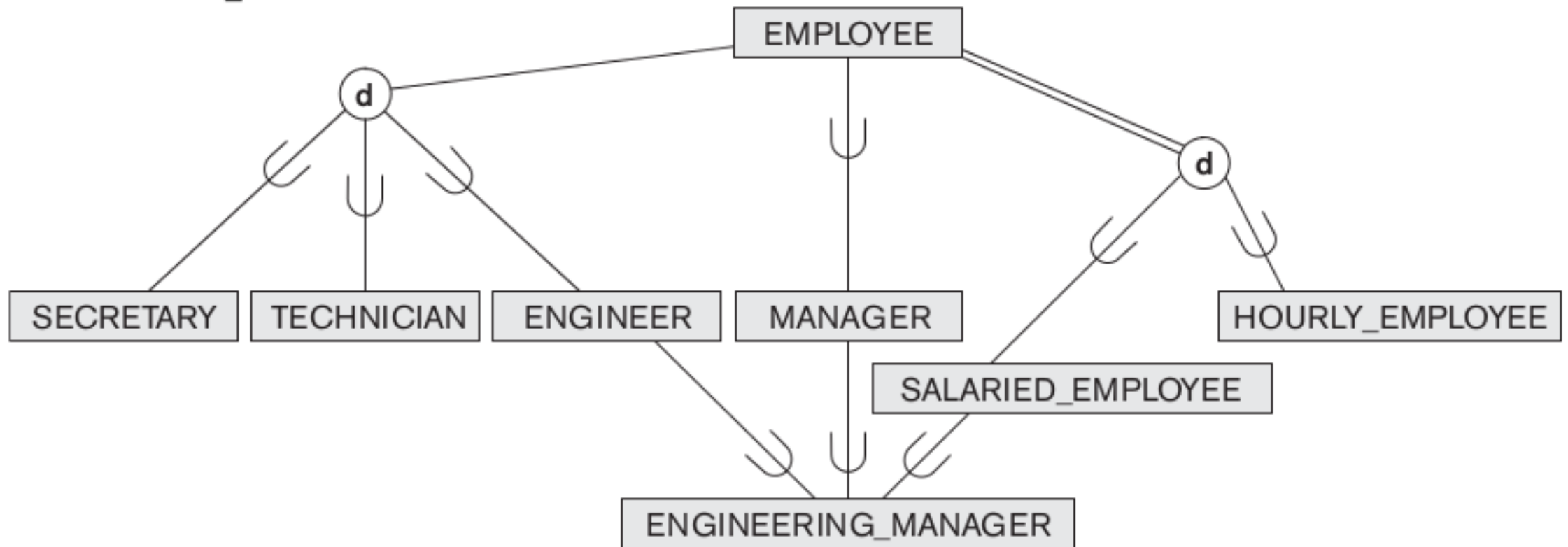
Shorthand for singleton subclass



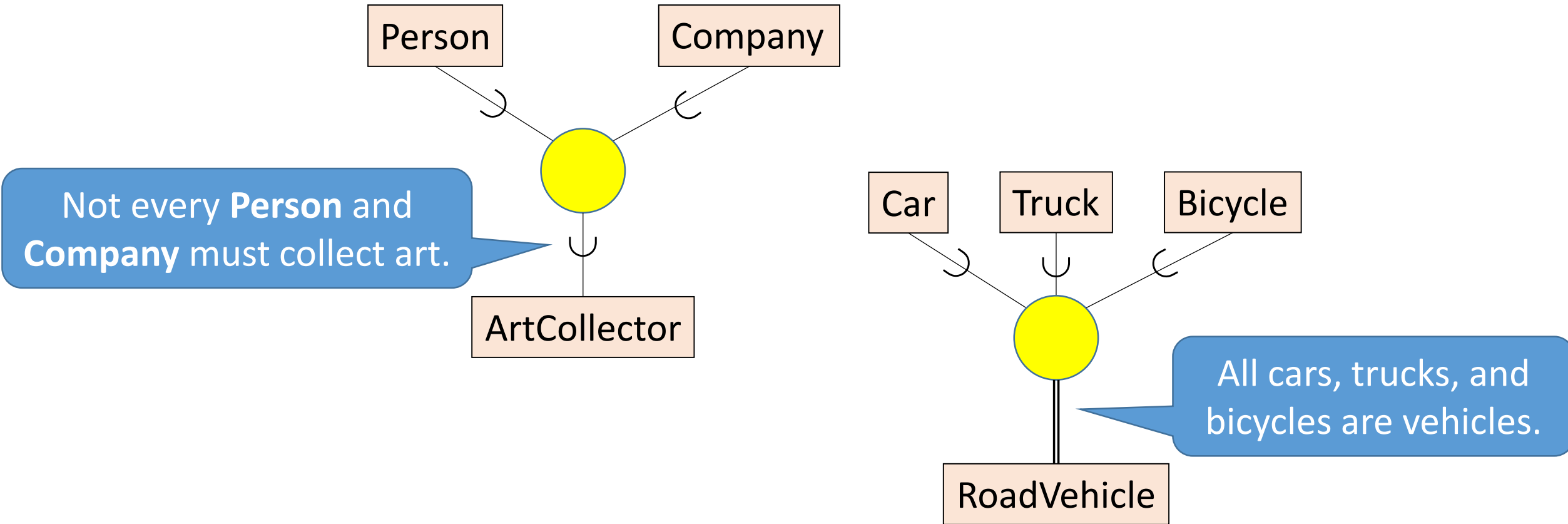
Subclasses can form hierarchy

Figure 8.6

A specialization lattice with shared subclass ENGINEERING_MANAGER.

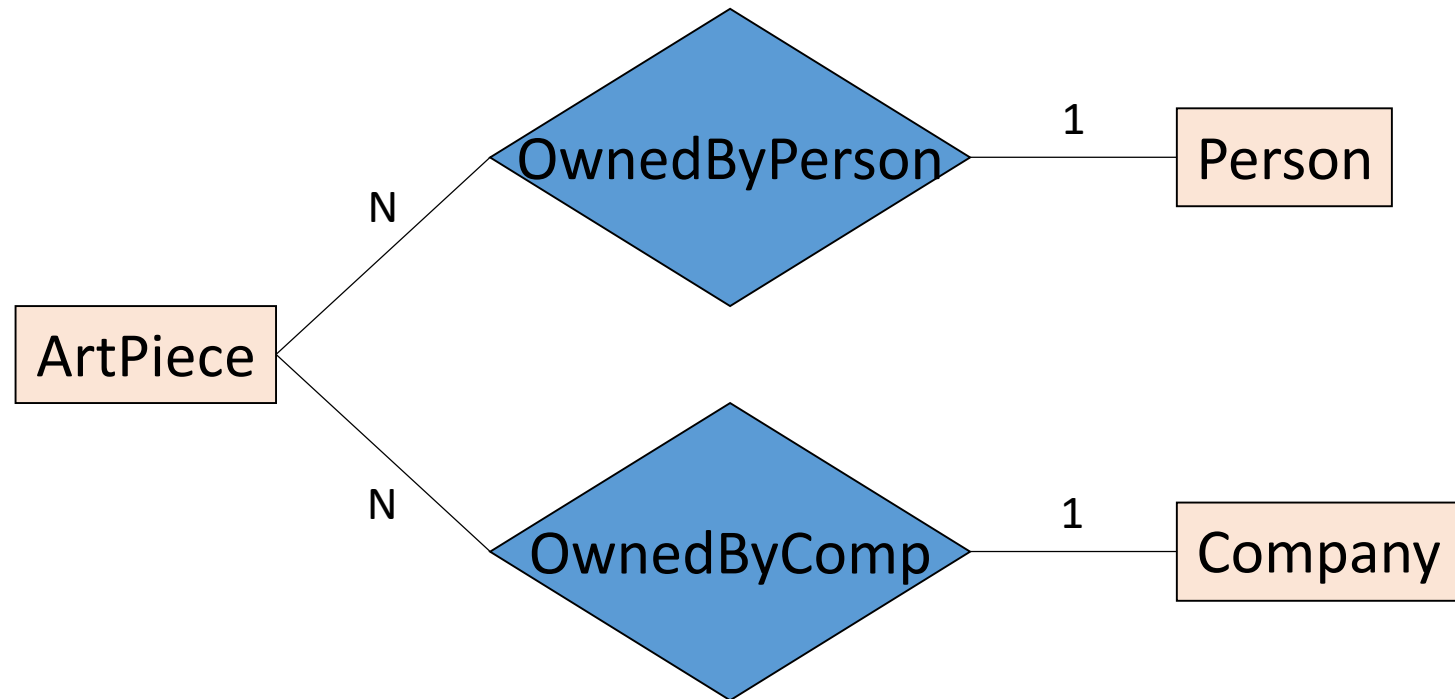


ER subclasses: unions, equality – “categories”



The need for categories/unions

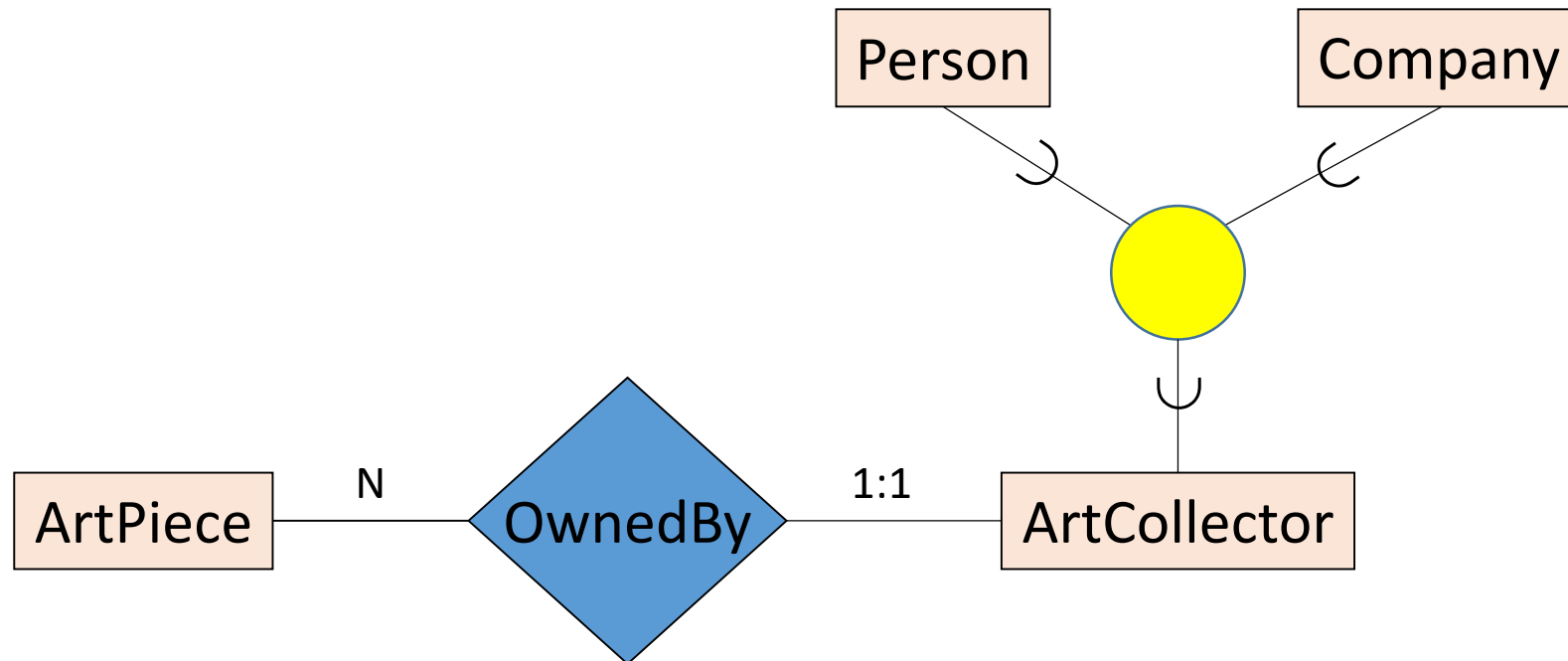
Goal: “Every art piece is owned by a person or company.”



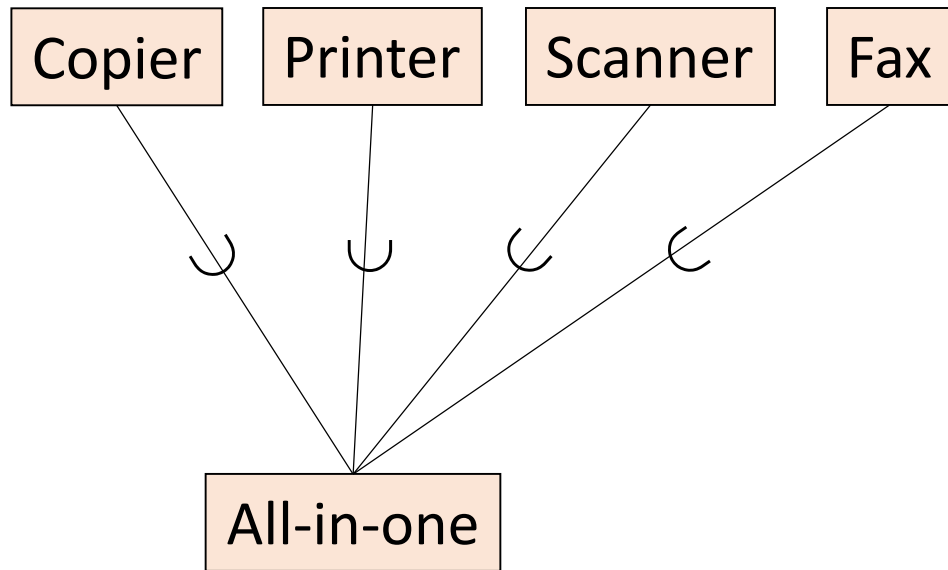
What is the problem?

Solution with categories

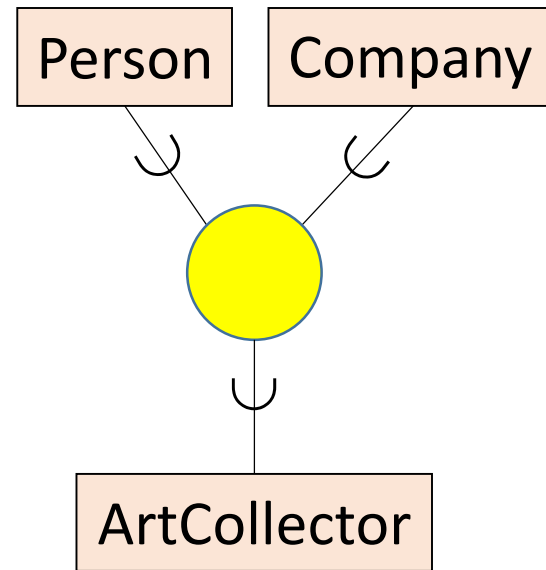
Goal: “Every art piece is owned by a person or company.”



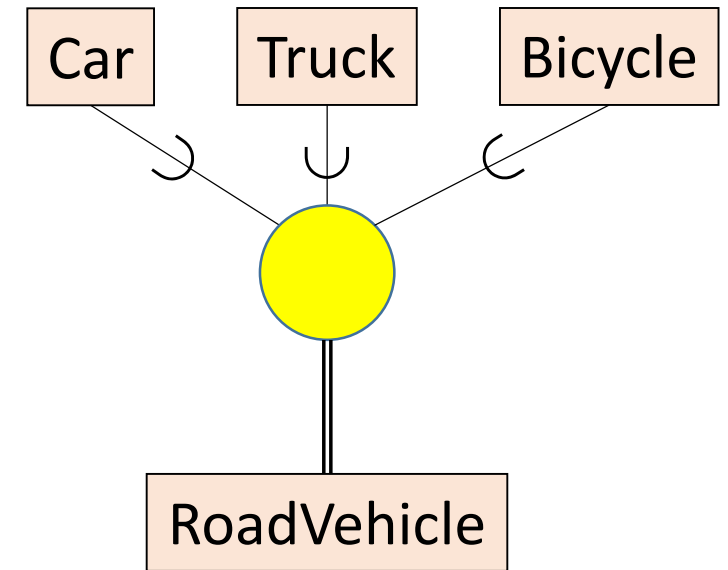
Different options for multiple superclasses



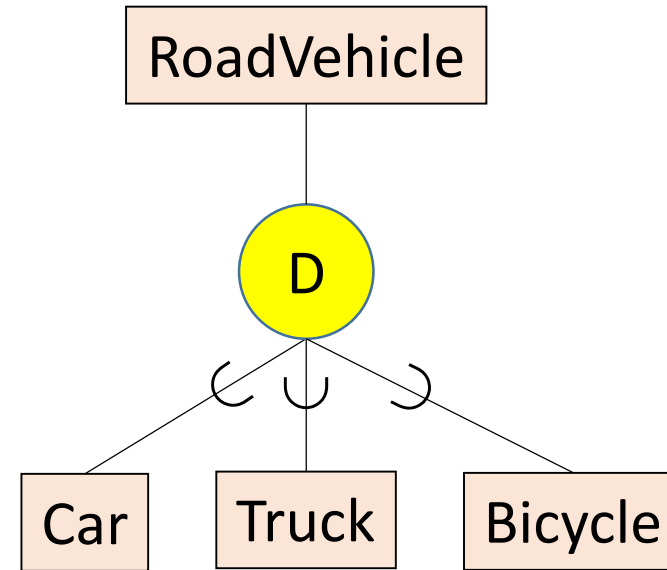
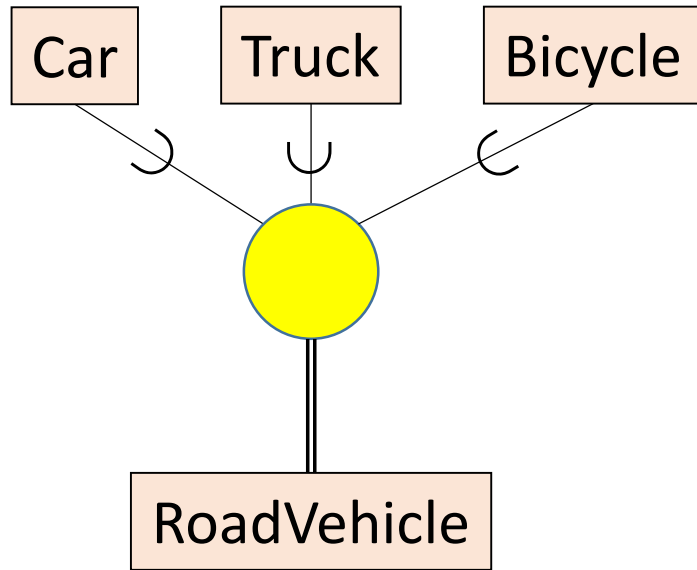
Each subclass entity belongs to & inherits from **all** superclasses.



Each subclass entity belongs to & inherits from **the appropriate one** superclass.



What's the difference?



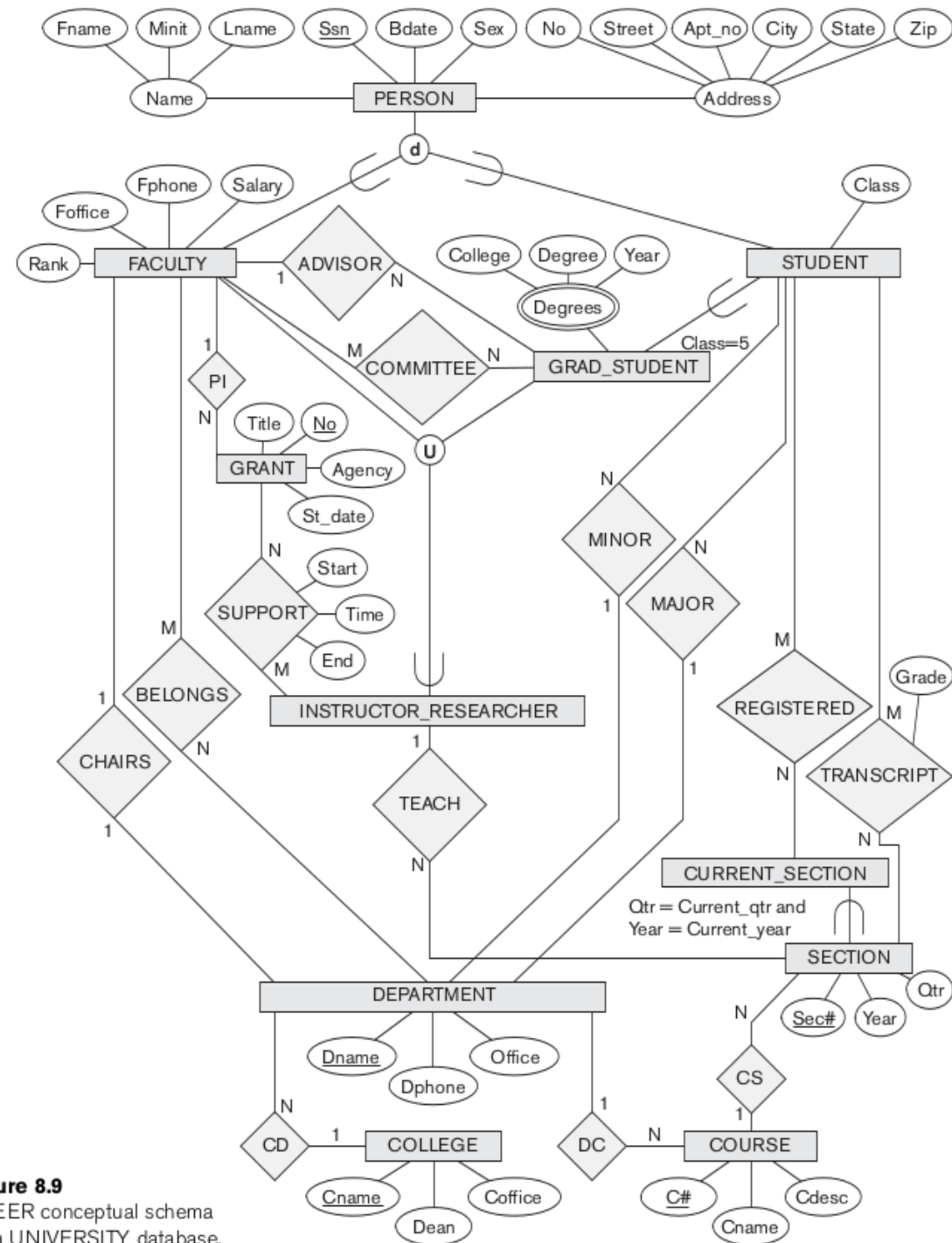


Figure 8.9
An EER conceptual schema
for a UNIVERSITY database.

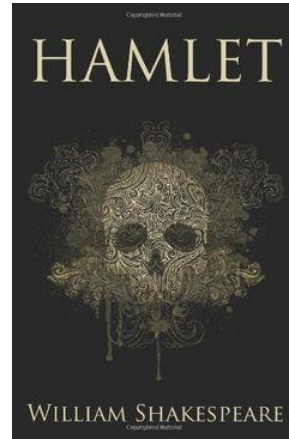
ER design summary

Semi-formal design technique based upon informal semantics

Goal: Schemas that accurately represent and formalize semantics

1. Design ER diagram
 - a. Identify entity sets, their attributes, and sub/superclasses
 - b. Identify relationships between entity sets, and their attributes
 - c. Identify max. & min. cardinality of relationships
 - d. Identify weak entity sets
2. Convert to schemas – next topic
3. Normalize schemas – coming soon

Activity – Add participation, sub/superclasses



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A Solution to Library Activity

