The Entity-Relationship Model
ER Model - Part 2: Conversion to SQL

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Based on slides for CS145 Introduction to Databases (Stanford)

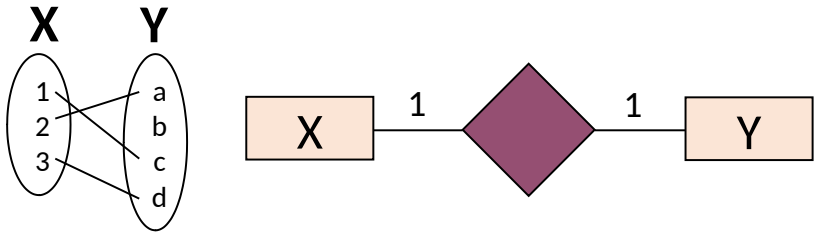
What you will learn about in this section

1. Relationships: multiplicity, multi-way
2. Design considerations
3. Conversion to SQL

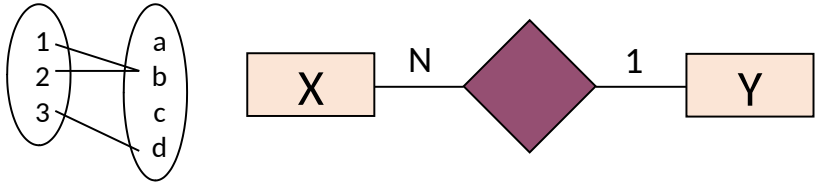
Multiplicity of ER Relationships

Using Chen's Notation

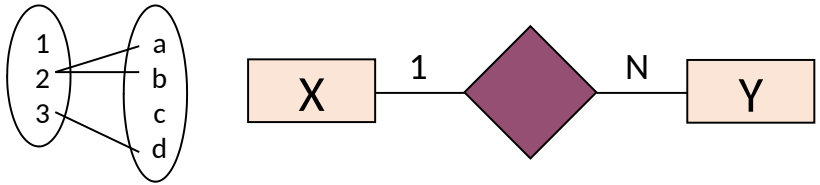
One-to-one:



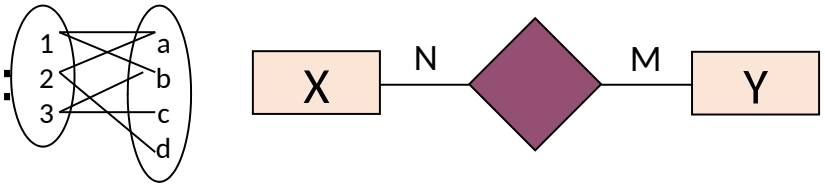
Many-to-one:



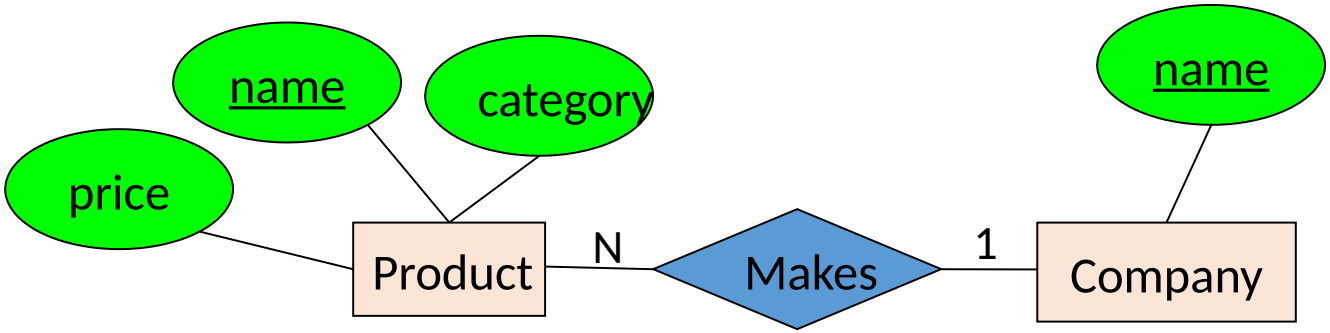
One-to-many:



Many-to-many:

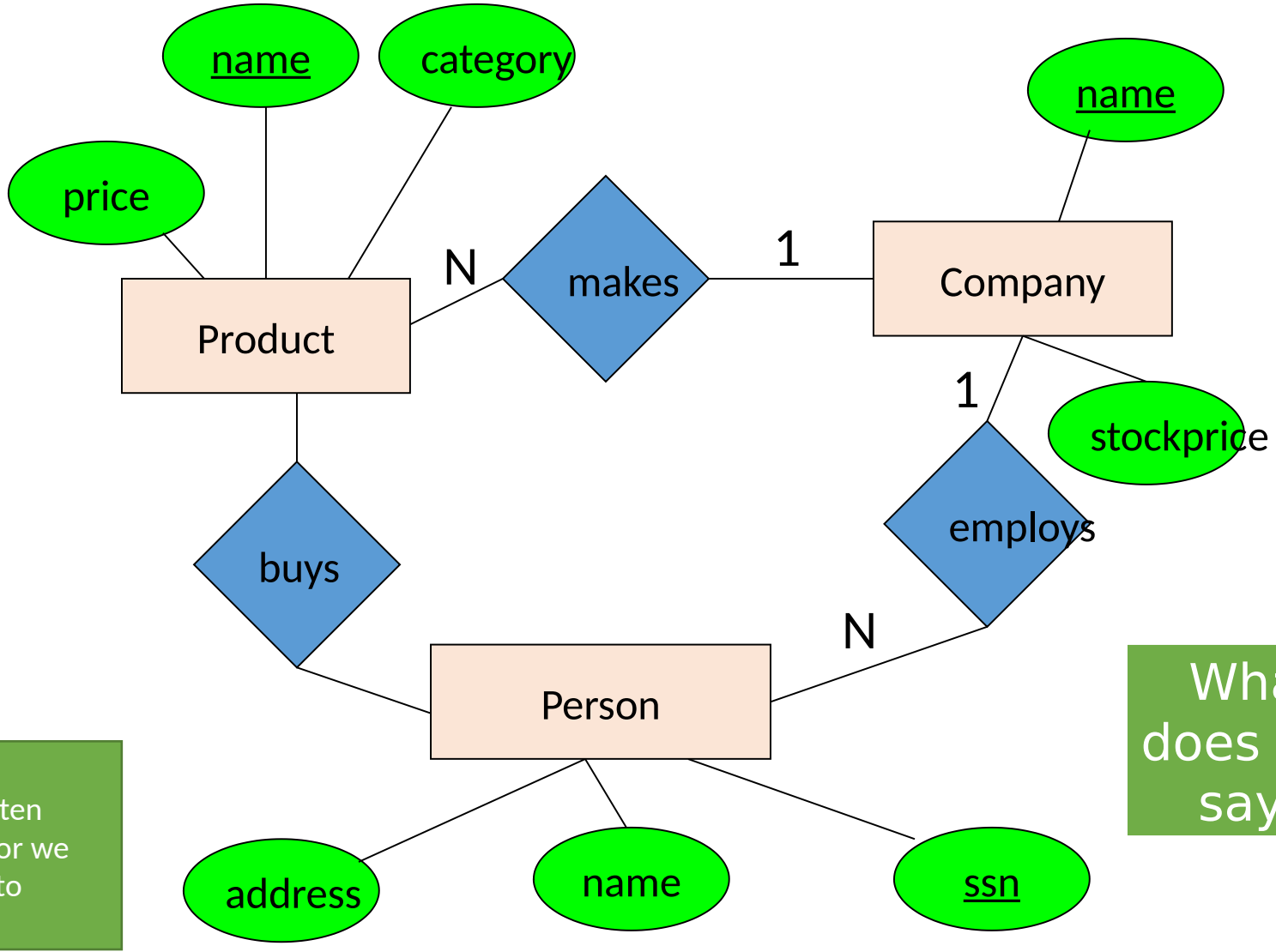


Multiplicity of ER Relationships



How to read a relationship in both directions:

1. A product is made by a **one** company
2. A company makes **many** product

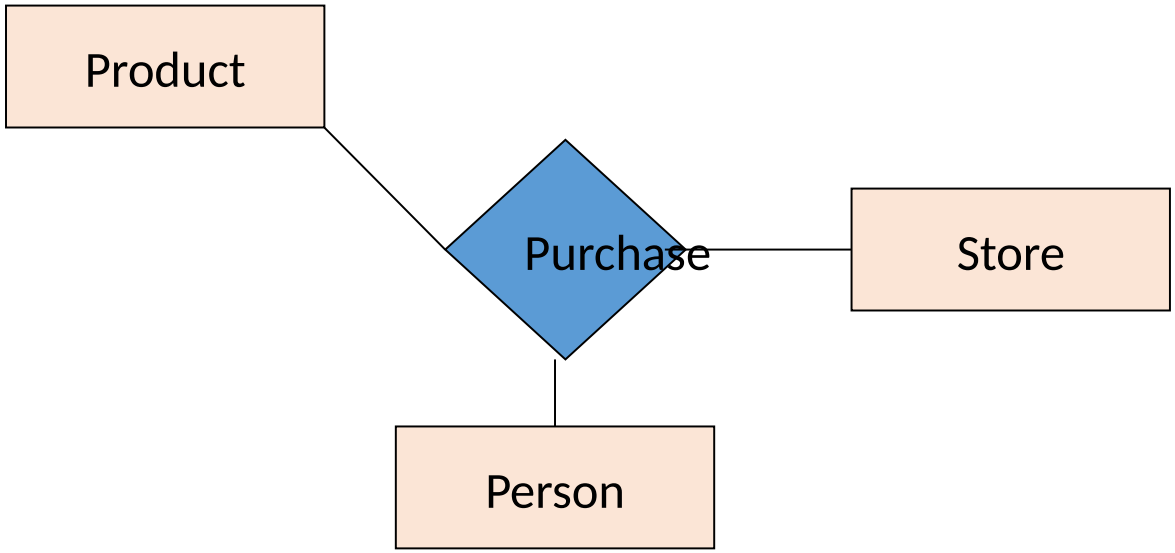


No specified cardinality often means N:M, or we do not want to decide, yet.

What does this say?

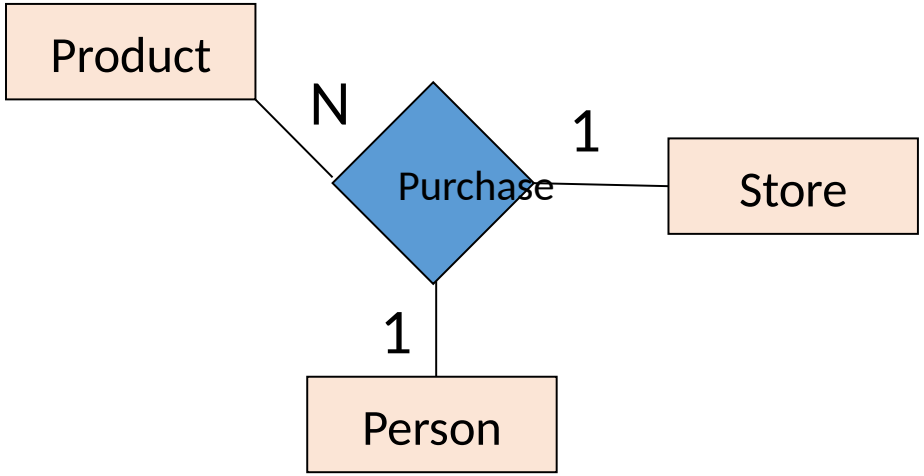
Multi-way Relationships

How do we model *"A person buys a product in a store?"*



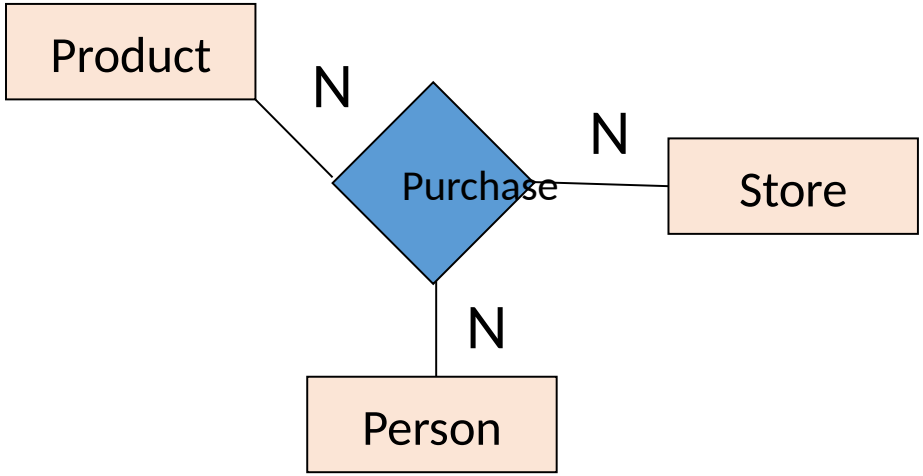
Multiplicity in Multiway Relationships

Q: What do the 1s and the N mean?



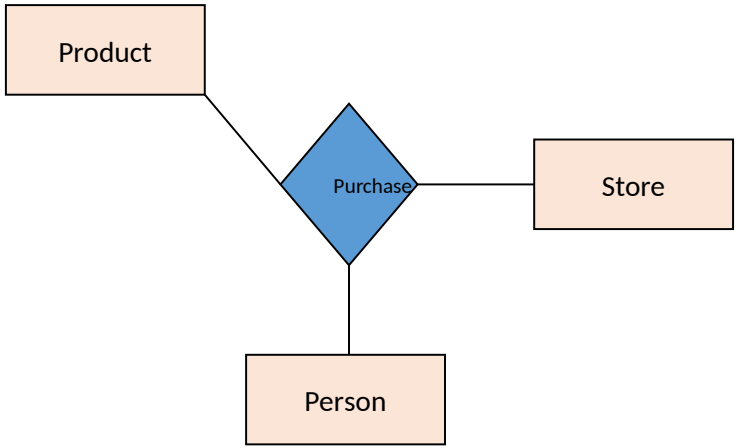
Multiplicity in Multiway Relationships

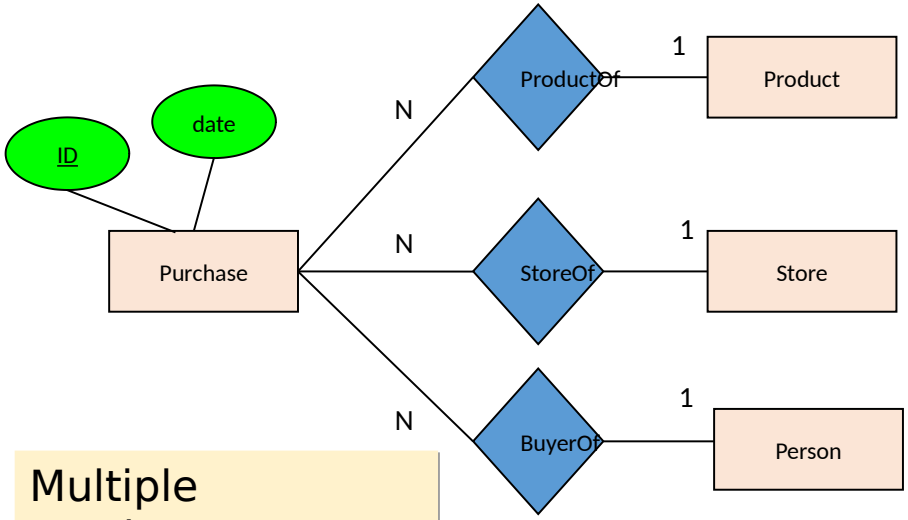
Better: many to many to many relationship



Conversion of Multi-way Relationship to New Entity + Binary Relationships?

Multi-way Relationship → Entity + Binary

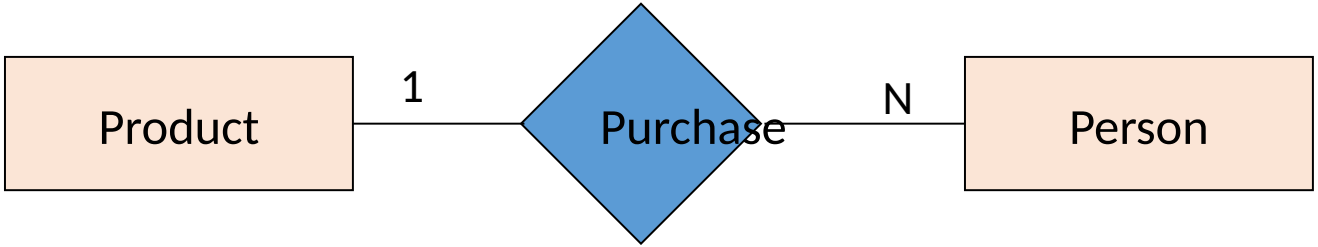


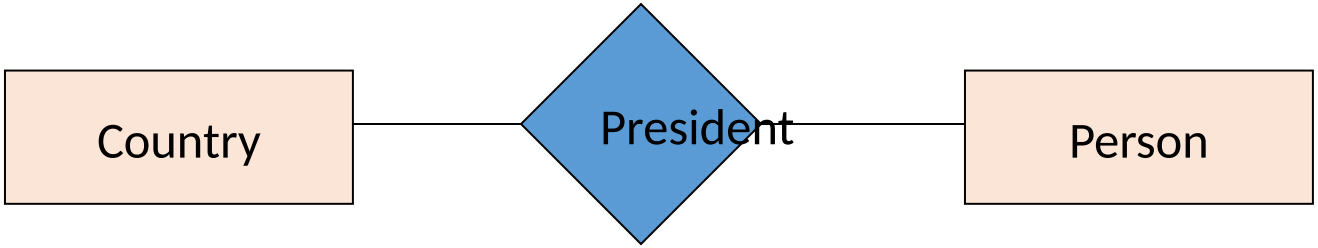


Multiple purchases per (product, store, person) possible here!

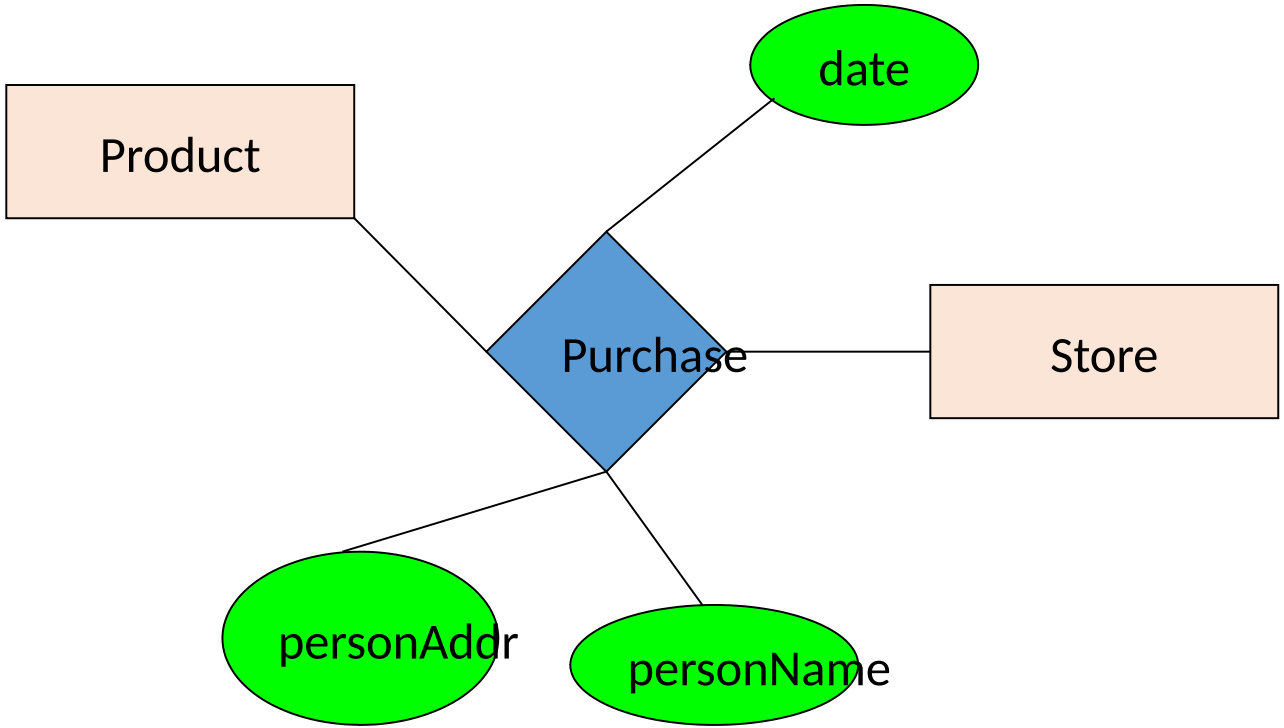
3. Design Principles

What’s wrong with these examples?

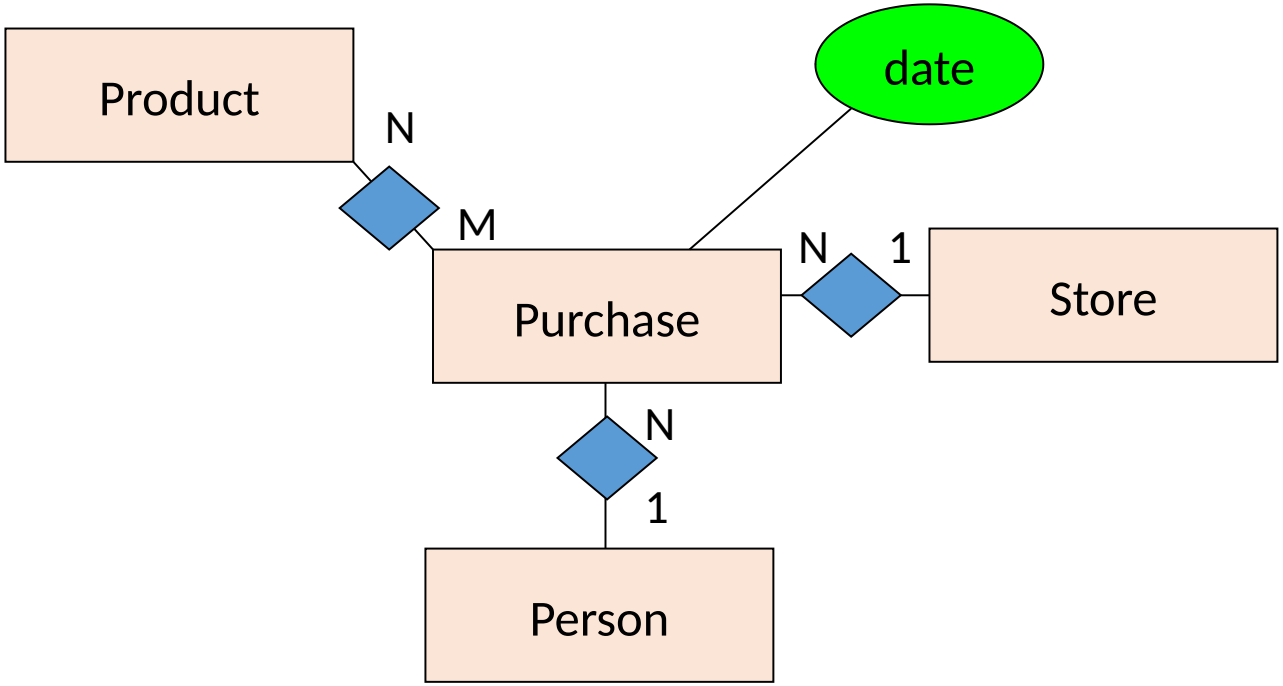




Design Principles: What's Wrong?

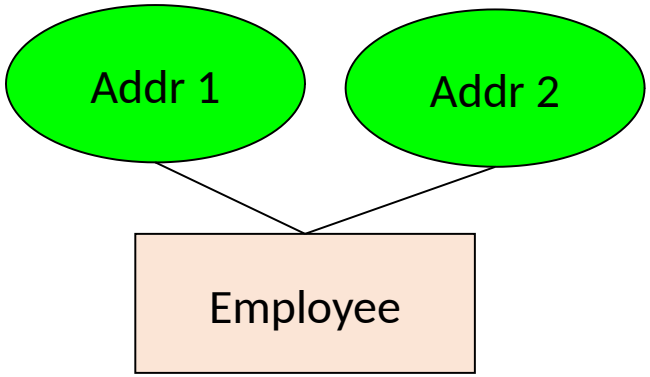


Design Principles: What’s Wrong? - Fixed

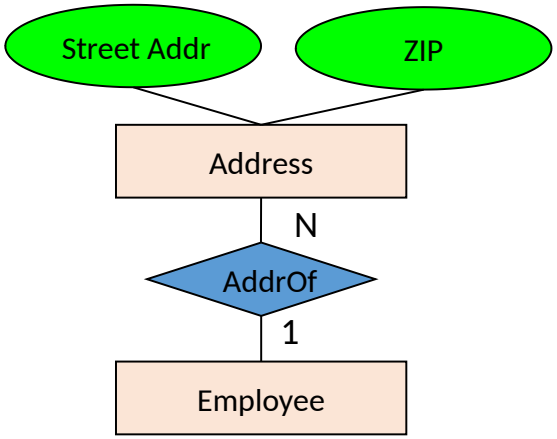


Examples: Entity vs. Attribute

Should address be an attribute?

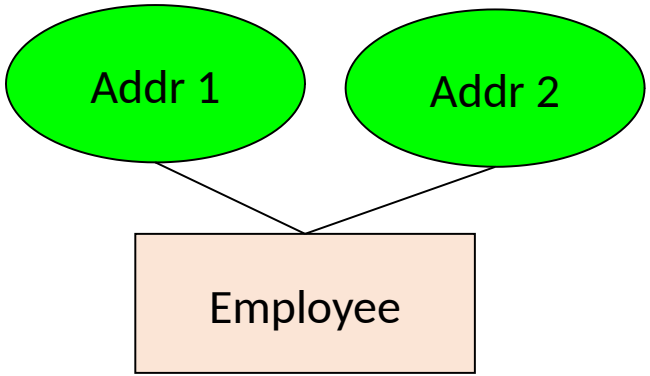


Or an entity?



Examples: Entity vs. Attribute

Should address be an attribute?

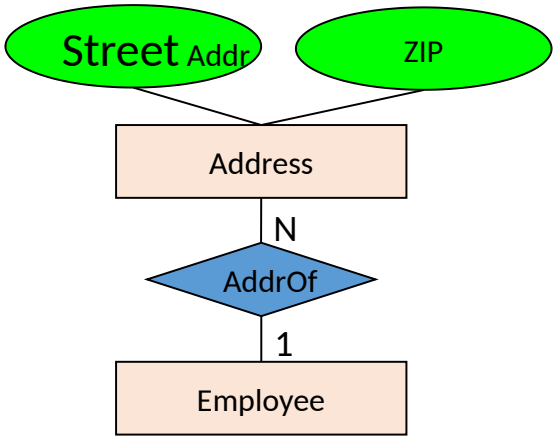


- How do we handle employees with more than **two addresses**?

- How do we handle addresses where internal structure of the address (e.g. zip code, state) is useful?

Examples: Entity vs. Attribute

Use an entity



In general, when we want to record several values, we choose a separate entity.

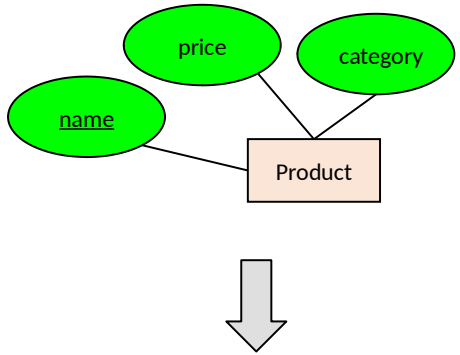
From ER Diagrams to Relational Schema

Key concept:

Both ***Entity sets*** and ***Relationships*** become relations (tables in RDBMS)

From ER Diagrams to Relational Schema

- An entity set becomes a relation (multiset of tuples / table)
  - Each tuple is one entity
  - Each tuple is composed of the entity's attributes, and has the same primary key

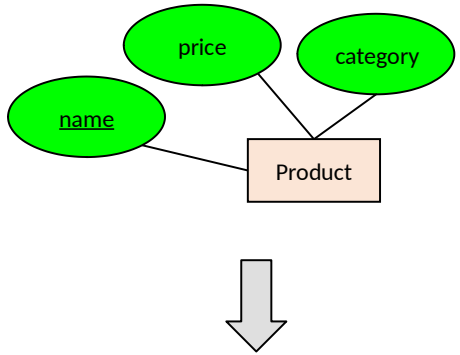


Product

name	price	category
Gizmo1	99.99	Camera
Gizmo2	19.99	Edible

From ER Diagrams to Relational Schema

```
CREATE TABLE Product(
  name     CHAR(50) PRIMARY KEY,
  price    DOUBLE,
  category VARCHAR(30)
)
```

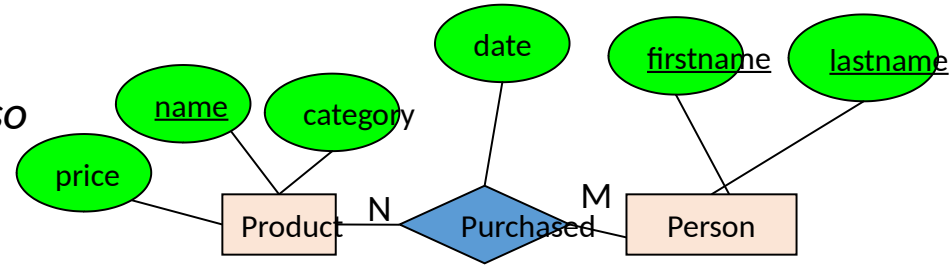


Product

name	price	category
Gizmo1	99.99	Camera
Gizmo2	19.99	Edible

From ER Diagrams to Relational Schema (N:M)

- A relation <u>between entity sets $A_1, \ldots, A_N$</u> *also* becomes a multiset of tuples / a table
  - Each row/tuple is one relation, i.e. one unique combination of entities $(a_1,\ldots,a_N)$
  - Each row/tuple is
    - composed of the **union of the entity sets' attributes**
    - has the entities' primary keys as foreign keys
    - has the union of the entity sets' keys as primary key

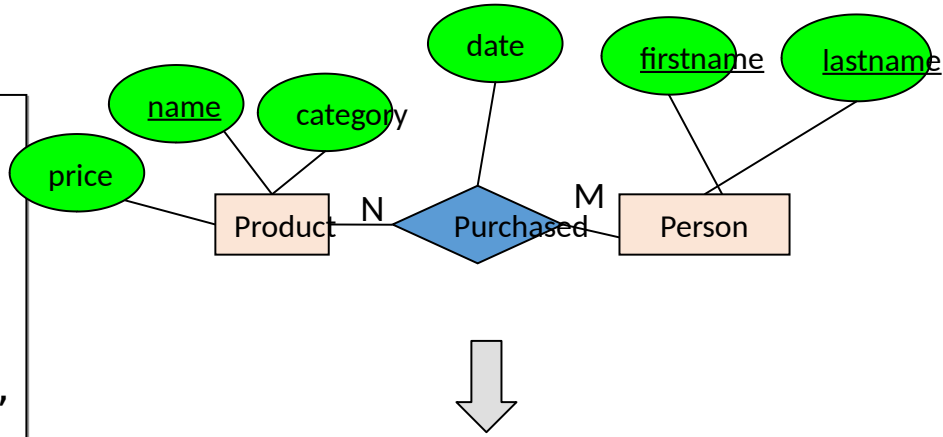


Purchased

name	firstname	lastname	date
Gizmo1	Bob	Joe	01/01/15
Gizmo2	Joe	Bob	01/03/15
Gizmo1	JoeBob	Smith	01/05/15

From ER Diagrams to Relational Schema (N:M)

```
CREATE TABLE Purchased(
  name      CHAR(50),
  firstname CHAR(50),
  lastname  CHAR(50),
  date      DATE,
  PRIMARY KEY (name, firstname, lastname),
  FOREIGN KEY (name)
      REFERENCES Product,
  FOREIGN KEY (firstname, lastname)
      REFERENCES Person
)
```



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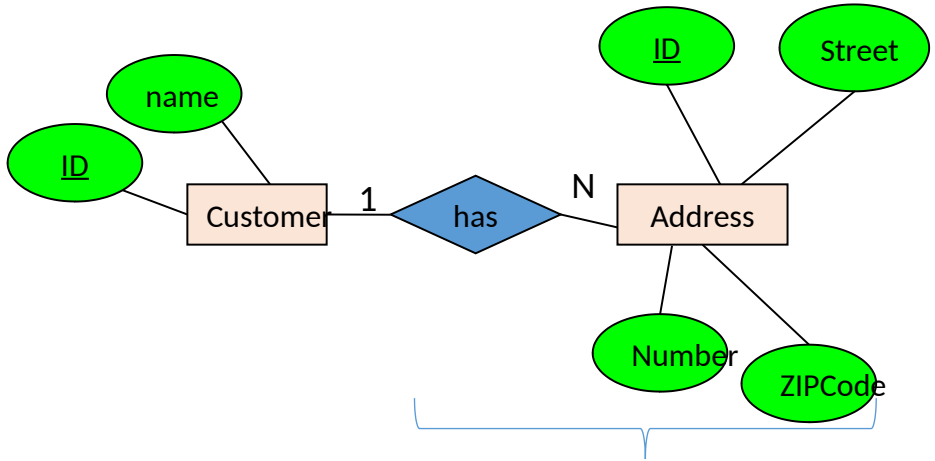
Gizmo1	JoeBob	Smith	01/05/15

From ER Diagrams to Relational Schema (1:N)

- A 1:N relationship can be implemented without an extra table.
- Add the primary key of the “1 side” to the table for the “N side” entity.

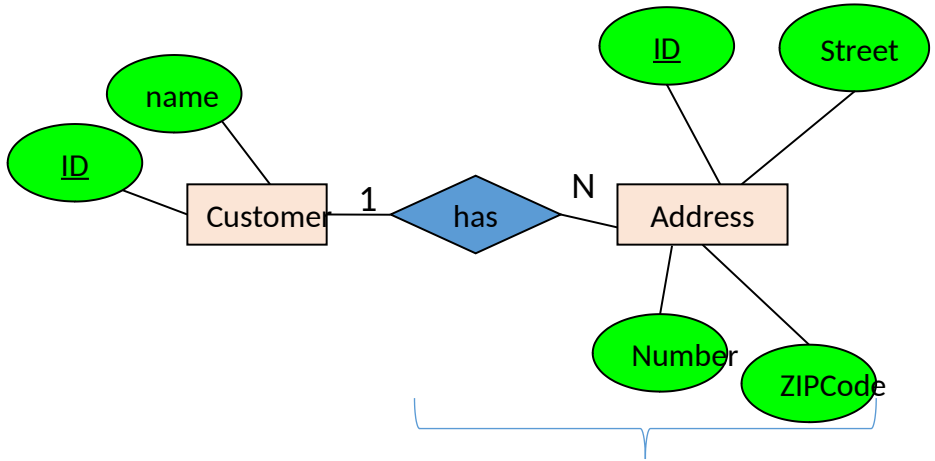


Address

ID	Number	Street	ZIPCode	CustID
1	123	Main St	75000	1
2	6660	Willow Dr	86123	1
3	1	Nowhere Pl	99999-1234	2

From ER Diagrams to Relational Schema (1:N)

```
CREATE TABLE Address(
  ID          CHAR(50),
  Number      CHAR(50),
  Street      CHAR(50),
  ZIPCode     CHAR(10),
  PRIMARY KEY (ID),
  FOREIGN KEY (CustID)
      REFERENCES Customer,
)
```



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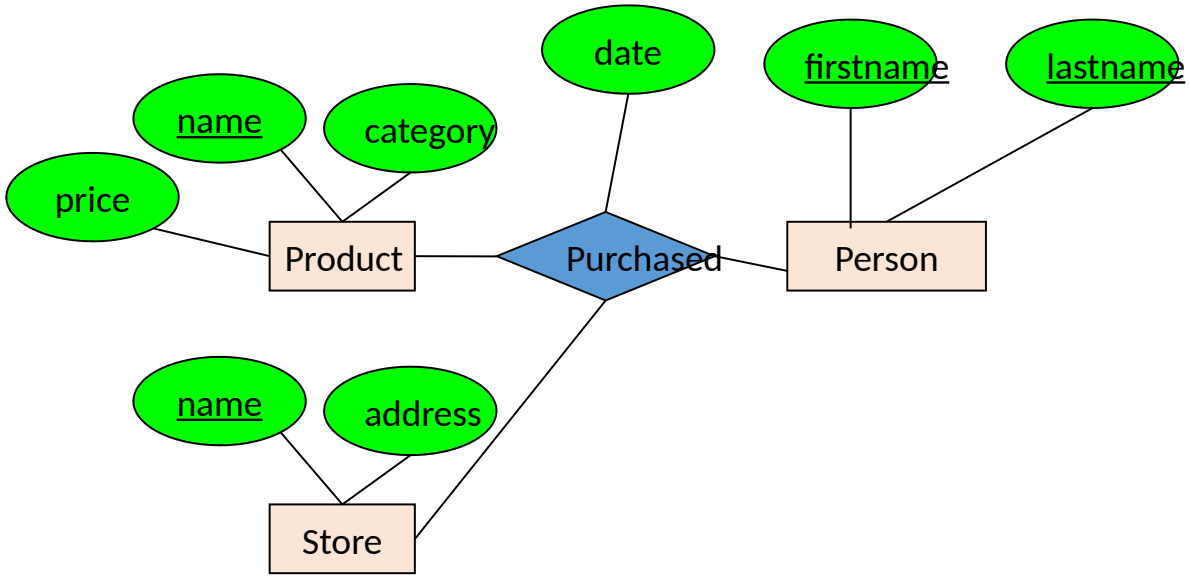
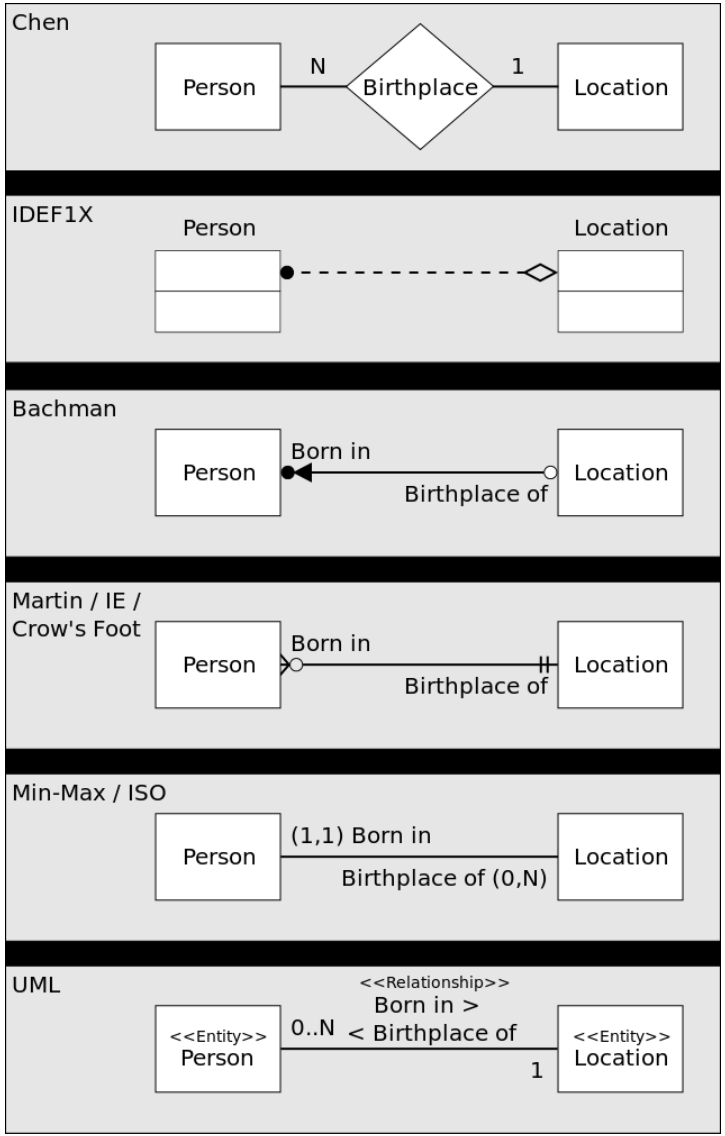
1	123	Main St	75000	1
2	6660	Willow Dr	86123	1
3	1	Nowhere Pl	99999-1234	2

From ER Diagram to Relational Schema

How do we represent this as
a relational schema?



Alternative Notations



Exercise: Add Multiplicity to your ER diagram

Also make sure to add **(new concepts underlined):**

A player can only belong to one team, a play can only be in one game, a pass/run..?

Multiple players **Tackle** a single person in a play

Players can achieve a **Personal Record** linked to a specific Game and Play

Players have a **weight** which changes in on vs. off-season