

Introduction to Database Systems CSE 414

Lecture 19: E/R Diagrams

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Class Overview

- Unit 1: Intro
- Unit 2: Relational Data Models and Query Languages
- Unit 3: Non-relational data
- Unit 4: RDBMS internals and query optimization
- Unit 5: Parallel query processing
- Unit 6: DBMS usability, conceptual design
 - E/R diagrams
 - Schema normalization
- Unit 7: Transactions

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Database Design

What it is:

- Starting from scratch, design the database schema: relation, attributes, keys, foreign keys, constraints etc

Why it's hard

- The database will be in operation for a very long time (years). Updating the schema while in production is very expensive (why?)

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Database Design

- Consider issues such as:
 - What entities to model
 - How entities are related
 - What constraints exist in the domain
- Several formalisms exist
 - We discuss E/R diagrams
 - UML, model-driven architecture
- Reading: Sec. 4.1-4.6



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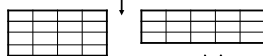
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Database Design Process

Conceptual Model:



Relational Model:
Tables + constraints
And also functional dep.



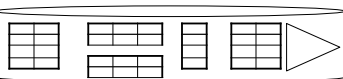
Normalization:
Eliminates anomalies



Conceptual Schema

Physical storage details

Physical Schema



Entity / Relationship Diagrams

- Entity set = a class
 - An entity = an object
- Attribute
- Relationship

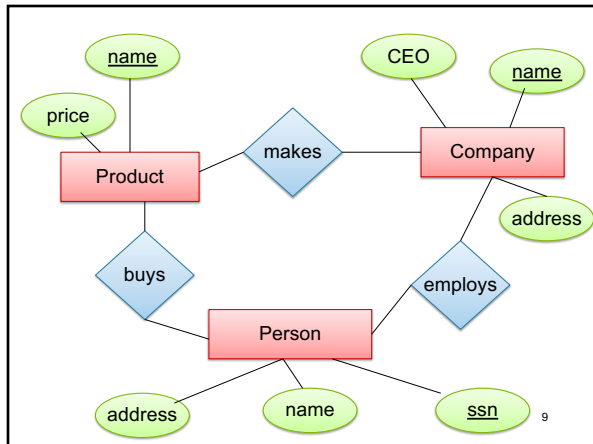
Product

city

makes

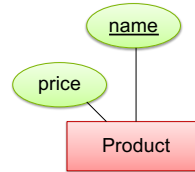
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Keys in E/R Diagrams

- Every entity set must have a key

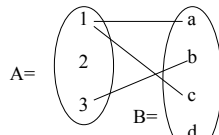


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What is a Relation ?

- A mathematical definition:
 - if A, B are sets, then a relation R is a subset of $A \times B$
- $A = \{1, 2, 3\}$, $B = \{a, b, c, d\}$
 $A \times B = \{(1, a), (1, b), \dots, (3, d)\}$
 $R = \{(1, a), (1, c), (3, b)\}$



- **makes** is a subset of **Product** \times **Company**:



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Multiplicity of E/R Relations

- one-one:



- many-one

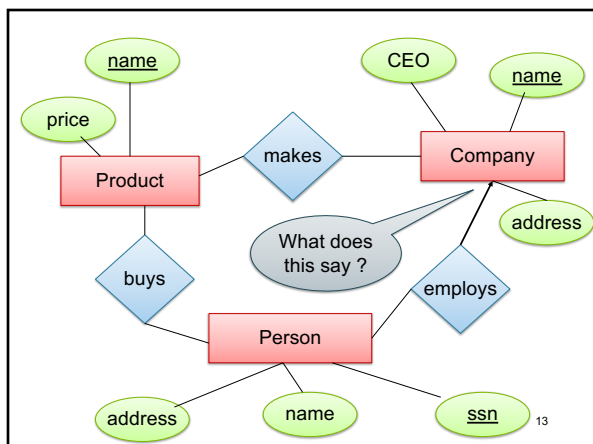


- many-many

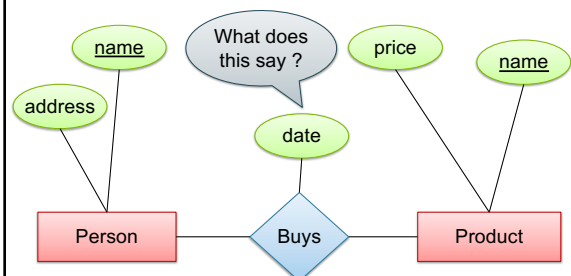


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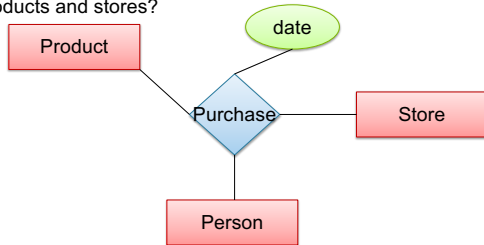
Attributes on Relationships



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Multi-way Relationships

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



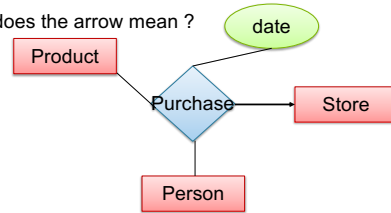
Can still model as a mathematical set (How?)

As a set of triples $\subseteq \text{Person} \times \text{Product} \times \text{Store}$

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Arrows in Multiway Relationships

Q: What does the arrow mean?



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

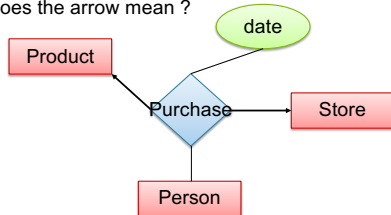
[Fine print: Arrow pointing to E means that if we select one entity from each of the other entity sets in the relationship, those entities are related to at most one entity in E]

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Arrows in Multiway Relationships

Q: What does the arrow mean?

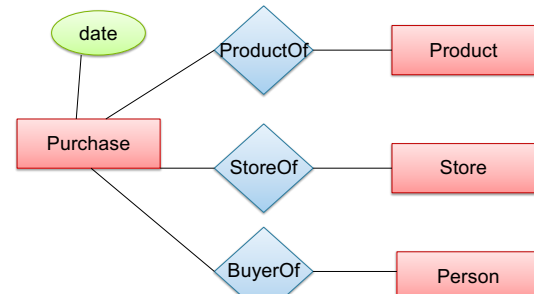


A: Any person buys a given product from at most one store AND every store sells to every person at most one product

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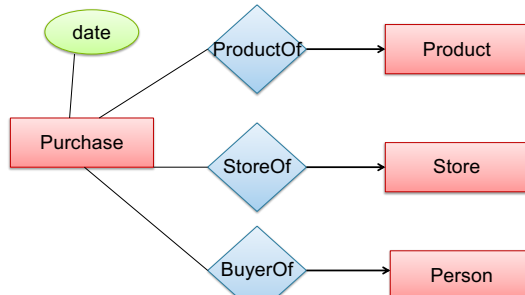
Converting Multi-way Relationships to Binary



Arrows go in which direction?

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Converting Multi-way Relationships to Binary

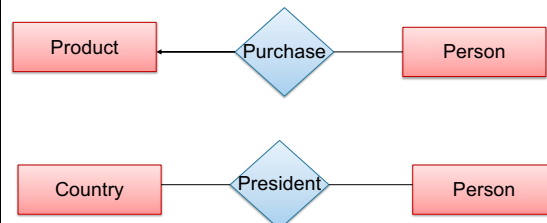


Make sure you understand why!

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3. Design Principles

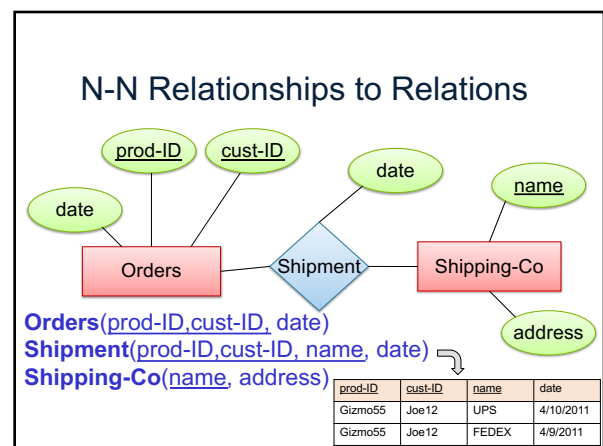
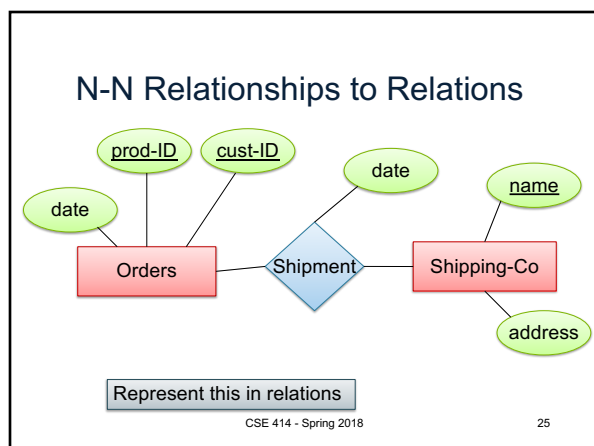
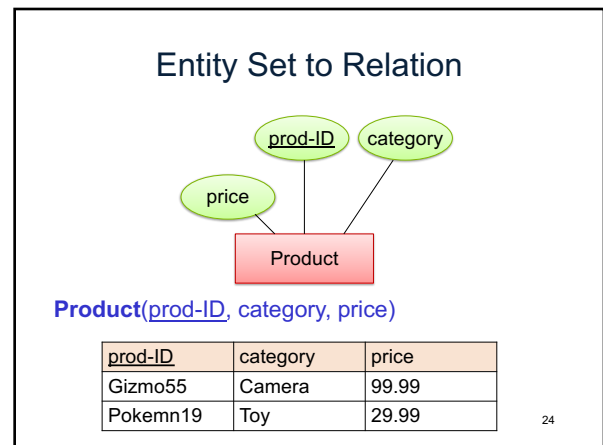
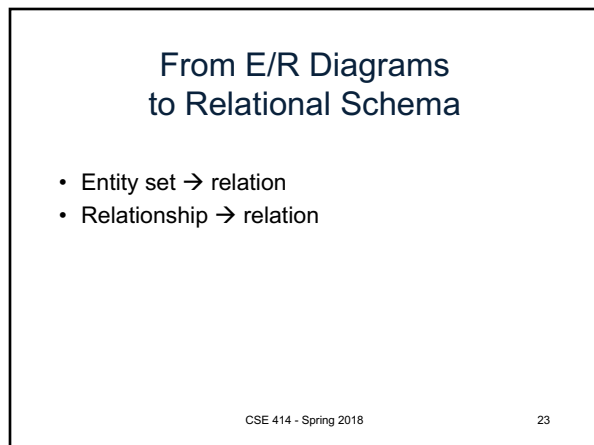
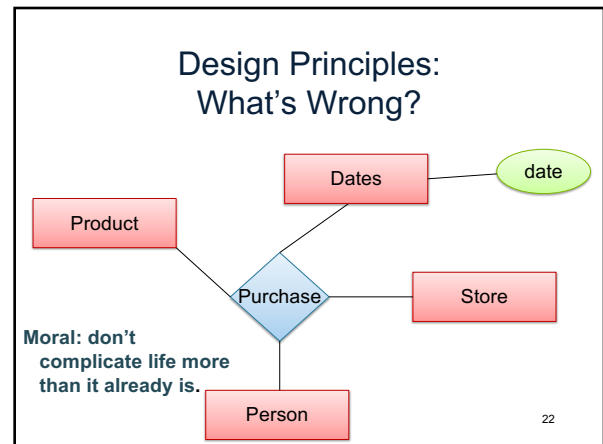
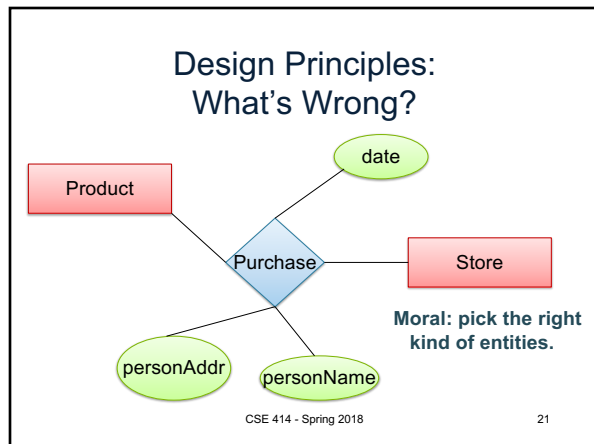
What's wrong?



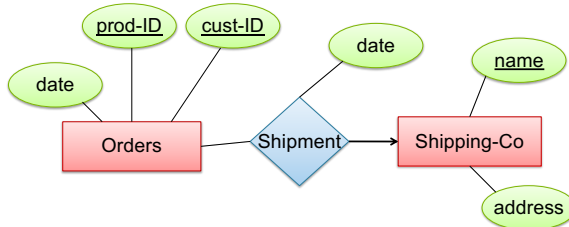
Moral: Be faithful to the specifications of the application!

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N-1 Relationships to Relations

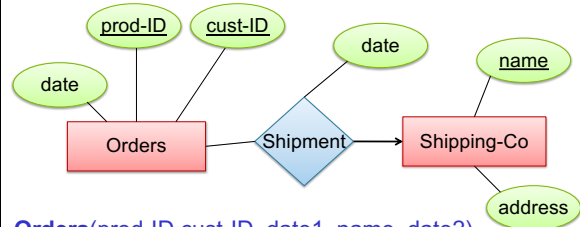


Represent this in relations

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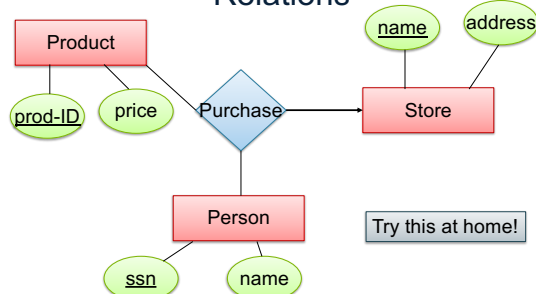
N-1 Relationships to Relations



Orders(prod-ID, cust-ID, date1, name, date2)
Shipping-Co(name, address)

Remember: no separate relations for many-one relationship

Multi-way Relationships to Relations



Try this at home!

Purchase(prod-ID, ssn, name)

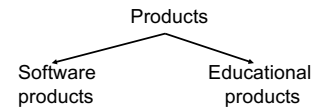
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Modeling Subclasses

Some objects in a class may be special

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

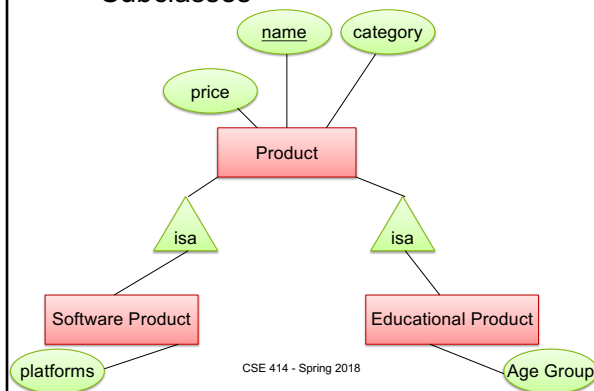


So --- we define subclasses in E/R

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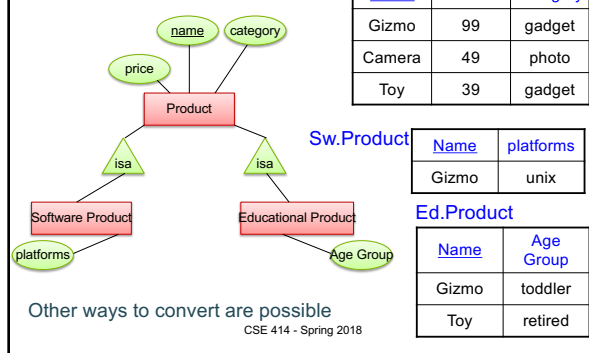
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Subclasses



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Subclasses to Relations



Product

<u>Name</u>	<u>Price</u>	<u>Category</u>
Gizmo	99	gadget
Camera	49	photo
Toy	39	gadget

Sw.Product

<u>Name</u>	<u>platforms</u>
Gizmo	unix

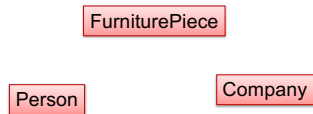
Ed.Product

<u>Name</u>	<u>Age Group</u>
Gizmo	toddler
Toy	retired

Other ways to convert are possible

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Modeling Union Types with Subclasses



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

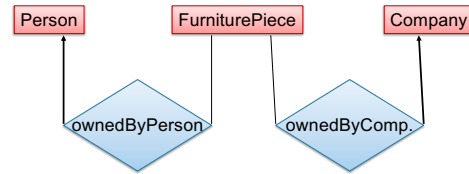
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Modeling Union Types with Subclasses

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

Solution 1. Acceptable but imperfect (What's wrong ?)

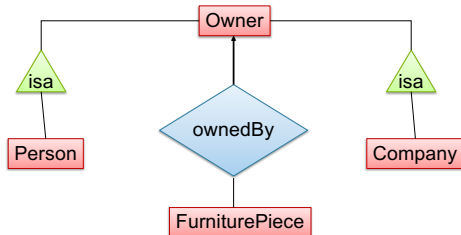


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Modeling Union Types with Subclasses

Solution 2: better, more laborious

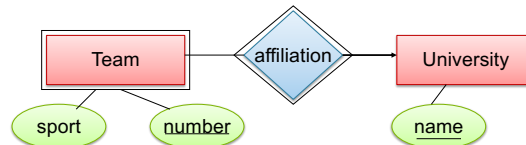


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Weak Entity Sets

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



Team(sport, number, universityName)
University(name)

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