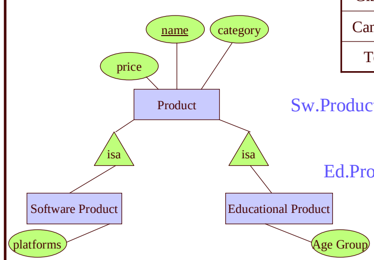
Lecture 08:

Wednesday, October 16, 2002

Outline

- Finish E/R diagrams (Chapter 2)
  - And E/R diagrams to relations (3.2, 3.3)
- The relational data model: 3.1
- Functional dependencies: 3.4

Subclasses to Relations



Product

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

Sw.Product

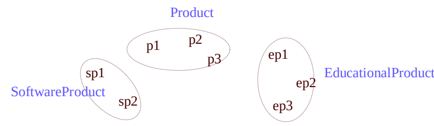
Name	platforms
Gizmo	unix

Ed.Product

Name	Age Group
Gizmo	toddler
Toy	retired

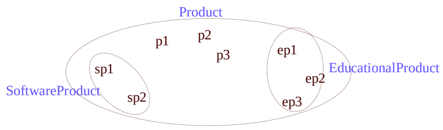
Difference between ODL and E/R inheritance

- ODL: classes are disjoint

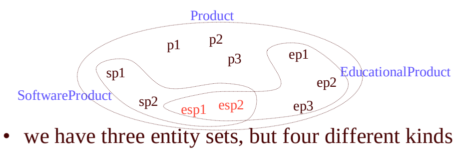


Difference between ODL and E/R inheritance

- E/R: entity sets overlap

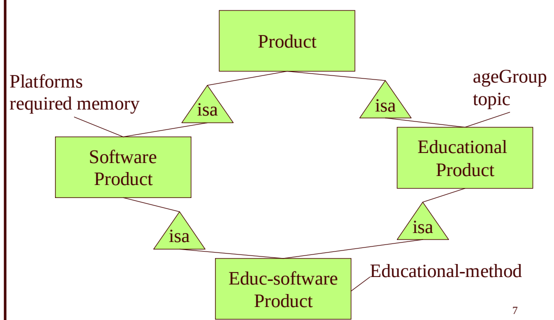


- No need for multiple inheritance in E/R



- we have three entity sets, but four different kinds of objects
- Still needed if we want extra attributes

Modeling Subclass Structure



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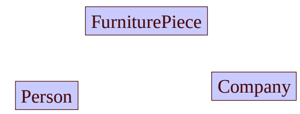
Modeling UnionTypes With Subclasses



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

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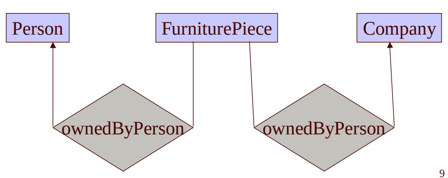
Modeling Union Types with Subclasses

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

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



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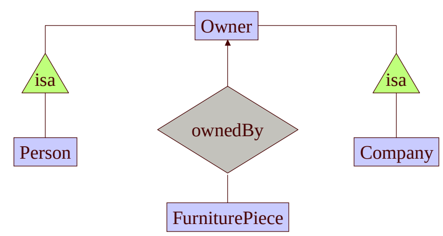
Modeling Union Types with Subclasses

Solution 2: better, more laborious



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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.

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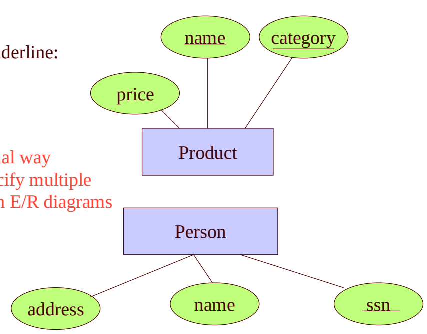
Keys in E/R Diagrams

Underline:



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

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Single Value Constraints

v. s.

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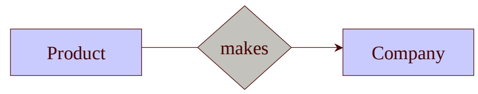
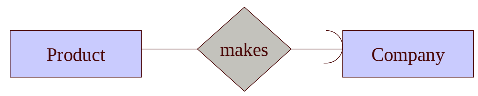
Referential Integrity Constraints





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Other Constraints

What does this mean ?

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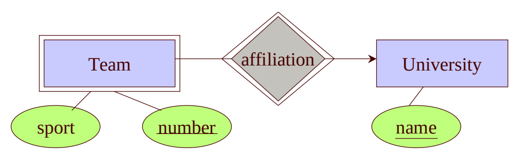
Weak Entity Sets

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



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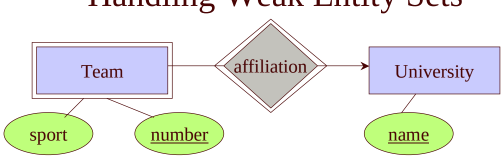
Handling Weak Entity Sets



Convert to a relational schema (in class)

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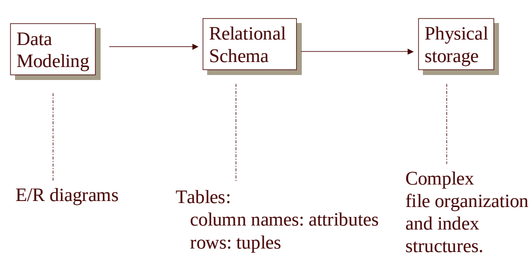
The Relational Data Model



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Terminology

Table name or relation name

Attribute names

Products:

Name	Price	Category	Manufacturer
gizmo	$19.99	gadgets	GizmoWorks
Power gizmo	$29.99	gadgets	GizmoWorks
SingleTouch	$149.99	photography	Canon
MultiTouch	$203.99	household	Hitachi

Tuples or rows or records

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Schemas

Relational Schema:

- Relation name plus attribute names
- E.g. Product(Name, Price, Category, Manufacturer)
- In practice we add the domain for each attribute

Database Schema

- Set of relational schemas
- E.g. Product(Name, Price, Category, Manufacturer), Company(Name, Address, Phone), ...

This is all mathematics, not to be confused with SQL tables !

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Instances

- **Relational schema** = $R(A_1,\ldots,A_k)$:
  Instance = relation with k attributes (of "type" R)
  - values of corresponding domains
- **Database schema** = $R_1(\ldots), R_2(\ldots), \ldots, R_n(\ldots)$
  Instance = n relations, of types $R_1, R_2, \ldots, R_n$

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Example

Relational schema: Product(Name, Price, Category, Manufacturer)
Instance:

Name	Price	Category	Manufacturer
gizmo	$19.99	gadgets	GizmoWorks
Power gizmo	$29.99	gadgets	GizmoWorks
SingleTouch	$149.99	photography	Canon
MultiTouch	$203.99	household	Hitachi

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First Normal Form (1NF)

- A database schema is in First Normal Form if all tables are flat

Student

Name	GPA	Courses
Alice	3.8	Math, DB, OS
Bob	3.7	DB, OS
Carol	3.9	Math, OS

→

Student

Name	GPA
Alice	3.8
Bob	3.7
Carol	3.9

Takes

Student	Course
Alice	Math
Carol	Math
Alice	DB
Bob	DB
Alice	OS
Carol	OS

Course

Course
Math
DB
OS

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Functional Dependencies

- A form of constraint
  - hence, part of the schema
- Finding them is part of the database design
- Also used in normalizing the relations

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Functional Dependencies

Definition:

If two tuples agree on the attributes

$A_1, A_2, \ldots A_n$

then they must also agree on the attributes

$B_1, B_2, \ldots B_m$

Formally: $A_1, A_2, \ldots A_n \rightarrow B_1, B_2, \ldots B_m$

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Examples

EmpID	Name	Phone	Position
E0045	Smith	1234	Clerk
E1847	John	9876	Salesrep
E1111	Smith	9876	Salesrep
E9999	Mary	1234	Lawyer

- EmpID $\rightarrow$ Name, Phone, Position
- Position $\rightarrow$ Phone
- but Phone $\not\rightarrow$ Position

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In General

- To check A → B, erase all other columns

…	A	…	B	
	X1		Y1	
	X2		Y2	
	…		…	

- check if the remaining relation is many-one (called ***functional*** in mathematics)

Note: this *is* the mathematical definition of a function. Book is wrong.

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Example

EmpID	Name	Phone	Position
E0045	Smith	1234	Clerk
E1847	John	9876	Salesrep
E1111	Smith	9876	Salesrep
E9999	Mary	1234	Lawyer

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Typical Examples of FDs

Product: name → price, manufacturer

Person: ssn → name, age

Company: name → stockprice, president

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In Class: Find All FDs

Student	Dept	Course	Room
Alice	CSE	C++	020
Bob	CSE	C++	020
Alice	EE	HW	040
Carol	CSE	DB	045
Dan	CSE	Java	050
Elsa	CSE	DB	045
Frank	EE	Circuits	020

Do all FDs make sense in practice ?

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Formal definition of a key

- A **key** is a set of attributes $A_1, \ldots, A_n$ s.t. for any other attribute B, $A_1, \ldots, A_n \rightarrow B$
- A **minimal key** is a set of attributes which is a key and for which no subset is a key
- Note: book calls them **superkey** and **key**

Examples of Keys

- Product(name, price, category, color)

  name, category → price
  category → color

  Keys are: {name, category} and all supersets

- Enrollment(student, address, course, room, time)

  student → address
  room, time → course
  student, course → room, time

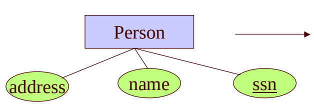
  Keys are: [in class]

Finding the Keys of a Relation

Given a relation constructed from an E/R diagram, what is its key?

Rules:

1. If the relation comes from an entity set, the key of the relation is the set of attributes which is the key of the entity set.

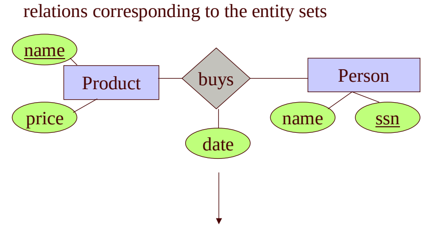


Person(address, name, <u>ssn</u>**)**

Finding the Keys

Rules:

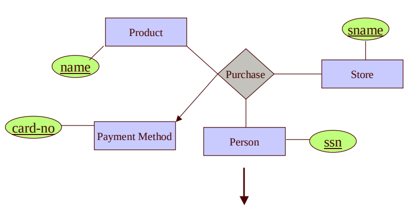
2. If the relation comes from a many-many relationship, the key of the relation is the set of all attribute keys in the relations corresponding to the entity sets



buys(<u>name, ssn</u>, date)

Finding the Keys

Except: if there is an arrow from the relationship to E, then we don't need the key of E as part of the relation key.



Purchase(<u>name , sname, ssn</u>, card-no)

Finding the Keys

More rules:

- Many-one, one-many, one-one relationships
- Multi-way relationships
- Weak entity sets

(Try to find them yourself, or check book)