



Week4_Course_part1

ER Model-Basic stuff



ER Model

- Gives us a language to specify
 - what information the db must hold
 - what are the relationships among components of that information
- Proposed by Peter Chen in 1976
- What we will cover
 - – Basic stuff
 - Relationships
 - Constraints
 - Design principles



Entity Sets

- ***Entity*** = “thing” or object.
- ***Entity set*** = collection of similar entities.
 - Similar to a class in object-oriented languages.
- ***Attribute*** = property of an entity set.
 - Generally, all entities in a set have the same properties.
 - Attributes are simple values, e.g. integers or character strings.

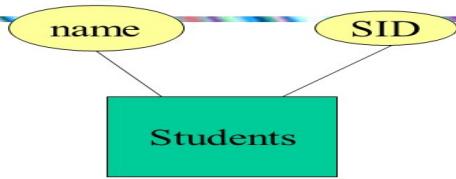


E/R Diagrams

- In an entity-relationship diagram, each entity set is represented by a rectangle.
- Each attribute of an entity set is represented by an oval, with a line to the rectangle representing its entity set.



Example



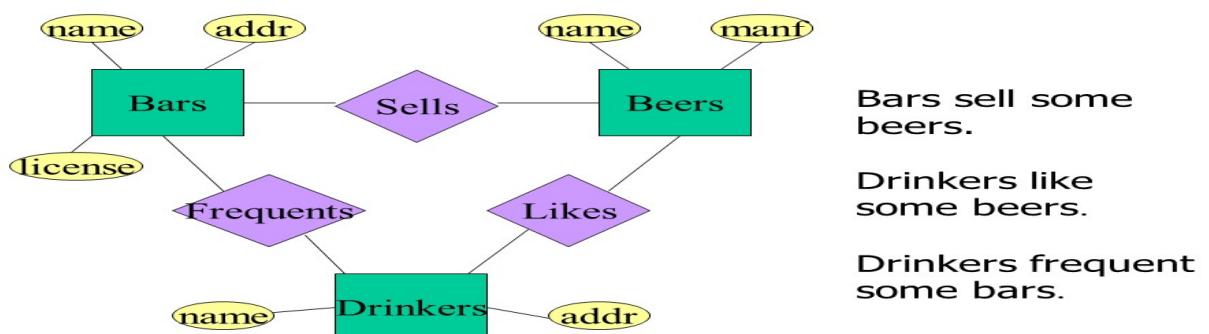
- Entity set **Students** has two attributes, **name** and **SID** (student ID).
- Each Student entity has values for these two attributes, e.g. (张三, 20191234)



Relationships

- A relationship connects two or more entity sets.
- It is represented by a diamond, with lines to each of the entity sets involved.

Example





Relationship Set

- The current “value” of an entity set is the set of entities that belong to it.
 - Example: the set of all bars in our database.
- The “value” of a relationship is a set of lists of currently related entities, one from each of the related entity sets.



Example

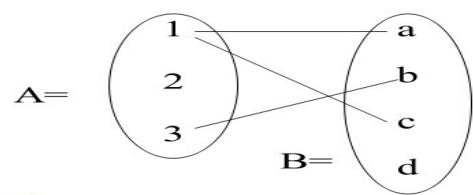
- For the relationship *Sells*, we might have a relationship set like:

Bar	Beer
Joe's Bar	Bud
Joe's Bar	Miller
Sue's Bar	Bud
Sue's Bar	Pete's Ale
Sue's Bar	Bud Lite



Relations

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



sells is a subset of Bar \times Beer:





Basic stuff: Summary

- Entity, entity set, attribute
- Relation
- Value of an entity set
- Value of a relationship
- Mathematical definition

题 1分



互动交流一

ER模型的作用是（）？

- A 概念设计
- B 逻辑模式设计
- C 物理模式设计

题 1分
題

互动交流二

以下哪个是实体集合?

- A 数据库课程
- B 电影
- C 选课
- D 南开大学

题 1分



互动交流三

以下不可以作为属性的取值类型的是？

- A 字符串
- B 整数数组
- C 浮点数
- D 整数

互动交流四

两个实体集合之间可以有多种不同关系吗？

- A 可以
- B 不可以

题 1分



互动交流五

从数学定义上来看，关系可以看作是关系所关联的实体集合的 [填空1]



Database System



Entity–Relationship Model



Why do database systems need modeling tools ?



What is the core technique of conceptual model?



How to design conceptual model of DBs ?



Why do database systems need modeling tools ?



机器世界
DBMS 支持的数据模型



数据准确表达现实信息?

Database System



What is the core technique of conceptual model?

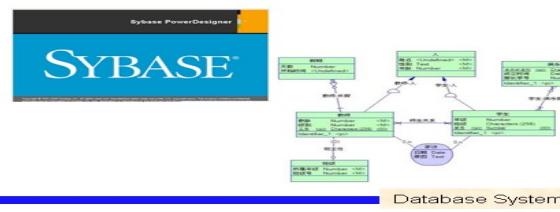
概念数据模型是现实世界到信息世界的第
一层抽象，它面向用户、面向现实世界，
与DBMS无关

概念数据模型应具有的特点：1) 较强的
语义表达能力；2) 简单、清晰、易于用
户理解；3) 可以方便地映射到DBMS的
逻辑模型（例如：ER Model）

到了90年代，Sybase收购PowerSoft，把它的
旗舰产品PowerBuilder纳入麾下，1995年，
Sybase又通过收购获得了PowerDesigner



至此三件神器：设计（PowerDesigner），开发
(PowerBuilder)，数据库（Sybase）集齐了。





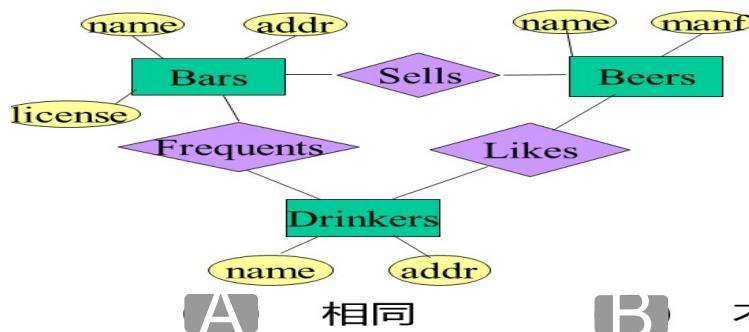
How to design ER model of DBs ?

- Basic stuff 预习视频
 - Relationships
 - Constraints
 - Design principles
- 
- 本周课程

最多可选1项

思考题一

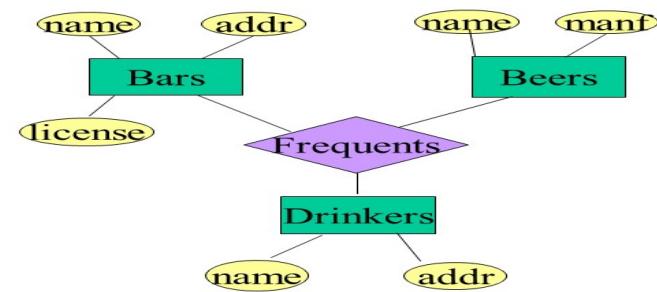
以下两个ER模型是否是相同的?



相同



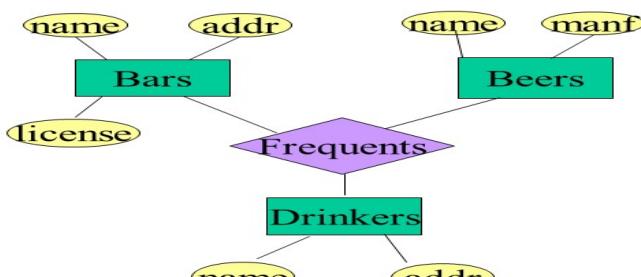
不相同



最多可选1项

思考题二

以下两个ER模型是否是相同的?



相同



不相同





Week4_Course_part2

ER Model-Relationships

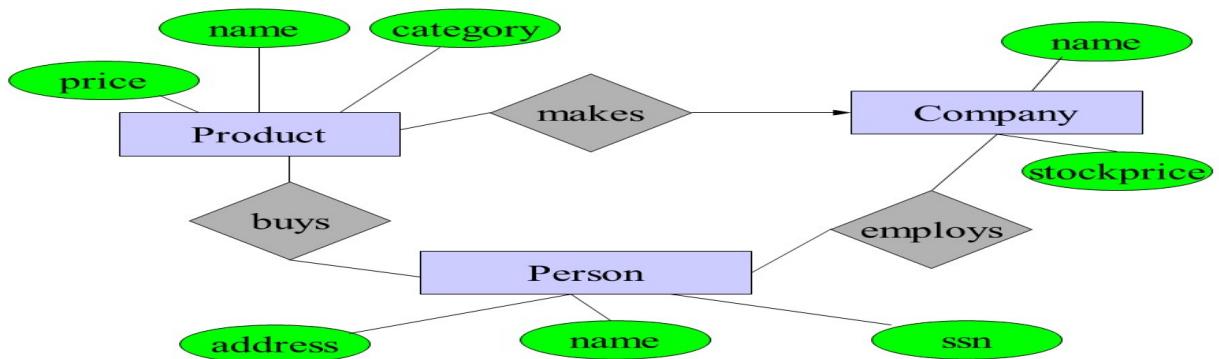


ER Model

- Basic stuff
- ➡ • Relationships
- Constraints
- Design principles



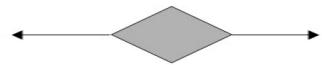
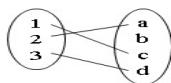
ER Diagram



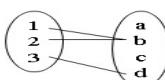


Multiplicity of E/R Relations

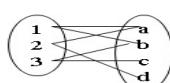
- one-one:



- many-one



- many-many





Representing “Multiplicity”

- Show a many-one relationship by an arrow entering the “one” side.
- Show a one-one relationship by arrows entering both entity sets.
- In some situations, we can also assert “exactly one,” i.e., each entity of one set must be related to exactly one entity of the other set. To do so, we use a rounded arrow.



Example

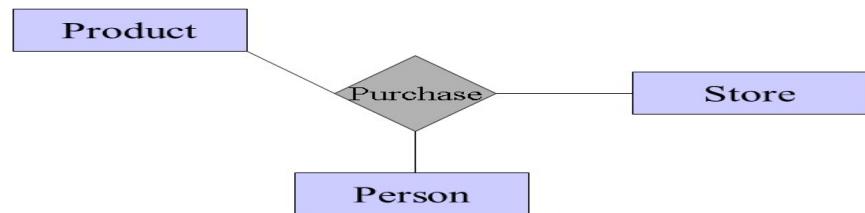
- Consider *Best-seller* between *Manfs* and *Beers*.
- Some beers are not the best-seller of any manufacturer, so a rounded arrow to *Manfs* would be inappropriate.
- But a manufacturer has to have a best-seller (we assume they are beer manufacturers).





Multiway Relationships

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



Can still model as a mathematical set: (Joe, Macy's, iPhone8)



Arrows in Multiway Relationships

Q: what does the arrow mean ?

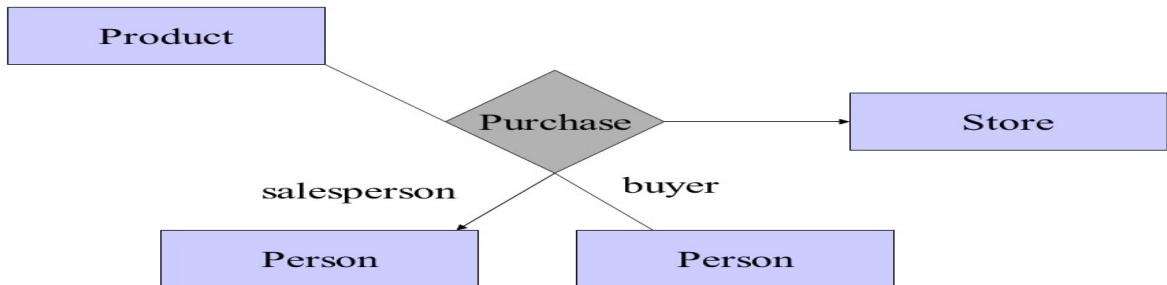


A: if I know the movie and star, I know the studio too



Roles in Relationships

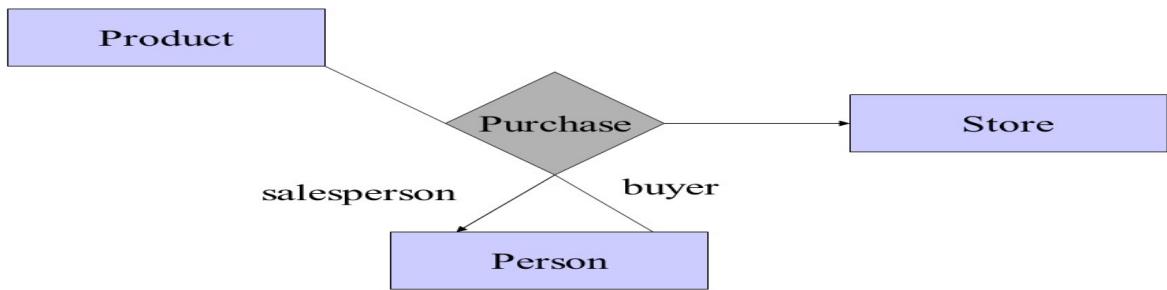
What if we need an entity set twice in one relationship?





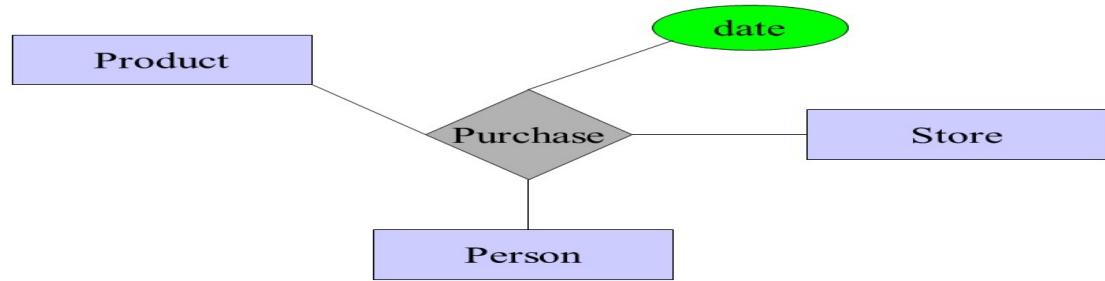
Roles in Relationships

What if we need an entity set twice in one relationship?



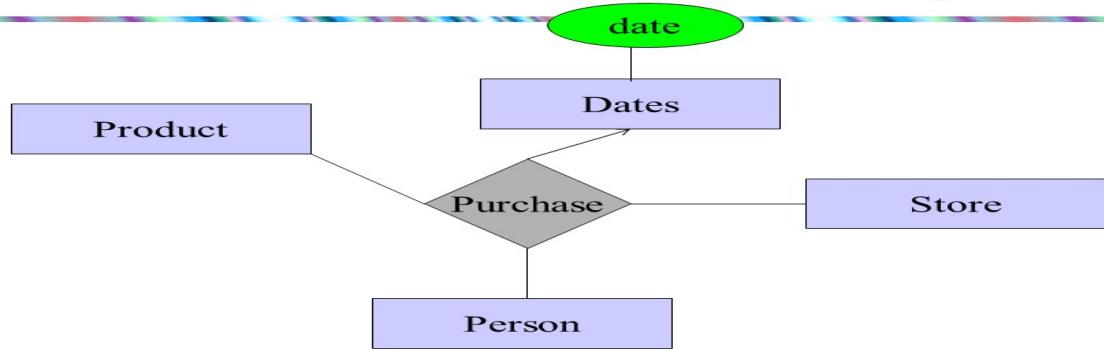


Attributes on Relationships

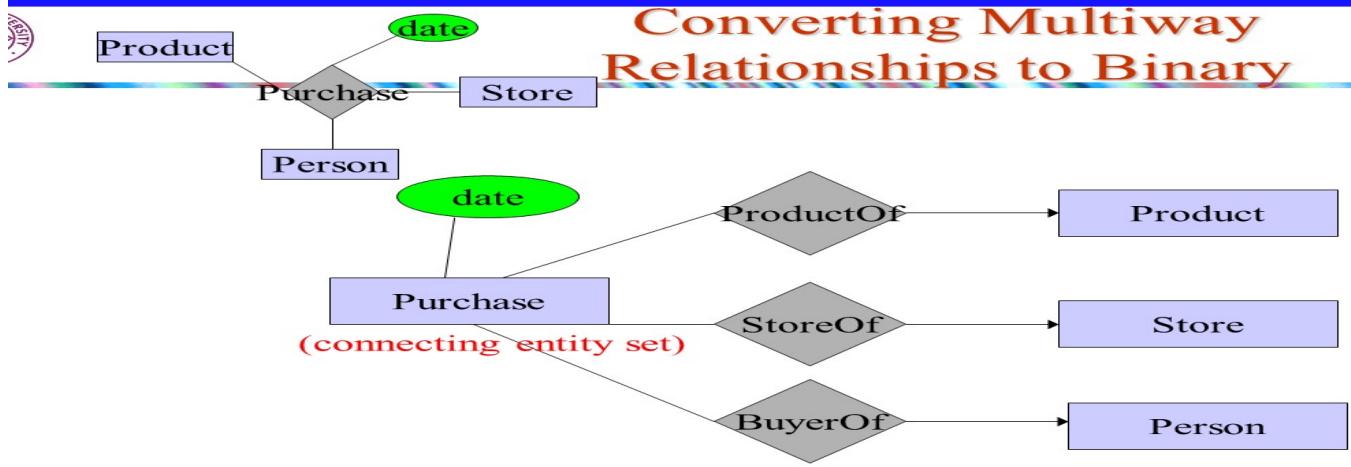




Attributes on Relationships



Converting Multiway Relationships to Binary





Subclasses in ER Diagrams

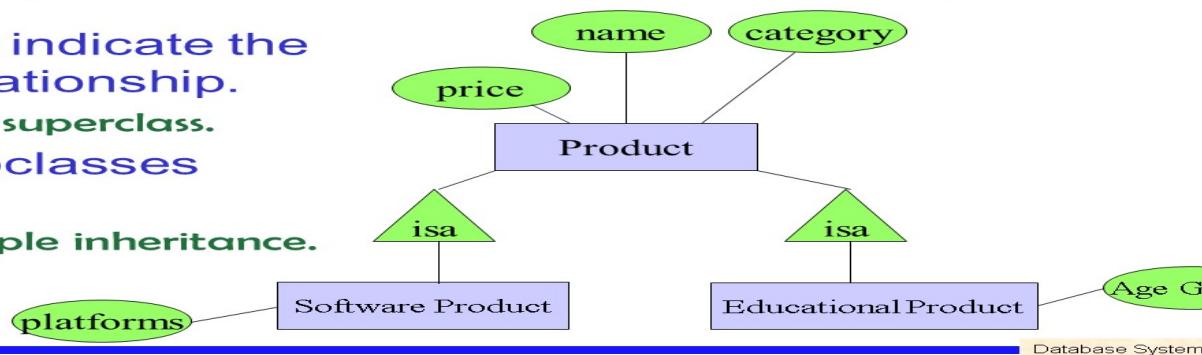
Subclass = special case = fewer entities = more properties

sa triangles indicate the subclass relationship.

- Point to the superclass.

Assume subclasses form a tree.

- I.e., no multiple inheritance.





E/R Vs. Object-Oriented Subclasses

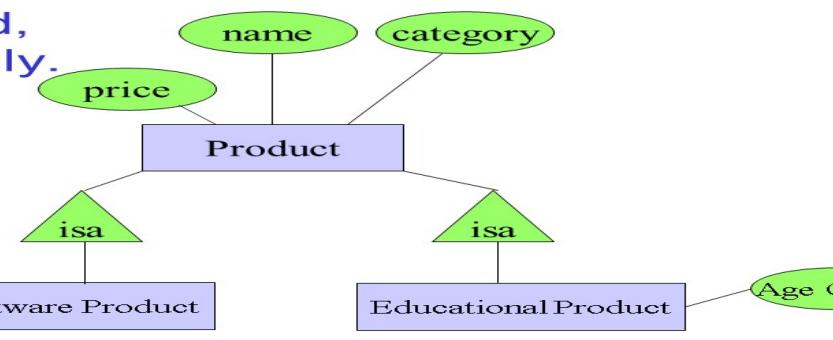
In the object-oriented world, objects are in one class only.

- Subclasses inherit properties from superclasses.

In contrast, E/R entities have components in all subclasses to which they belong.

- E.g., 雨课堂

platforms

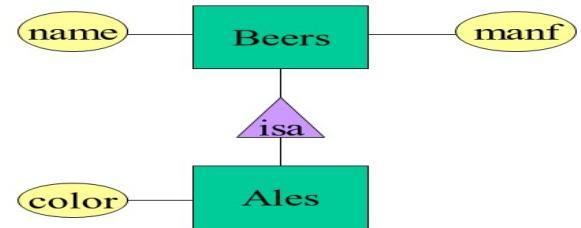




Example

Example: Ales are a kind of beer.

- Not every beer is an ale, but some are.
- Let us suppose that in addition to all the attributes of beers, ales also have the attribute *color*.



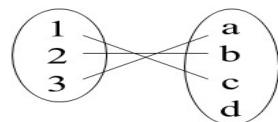


Relationships: Summary

- Relation Multiplicity
 - many-one, one-one, many-many
- Multiway Relationships
 - Converting a multiway one into many binary ones
- Roles in Relationships
- Attributes on Relationships
- Subclasses

题 1分
互动交流一

以下是ER模型中的哪种关系?



many-one



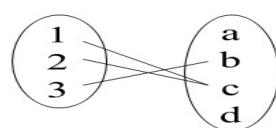
one-one



many-many

题 1分
互动交流二

以下是ER模型中的哪种关系？



many-one



one-one



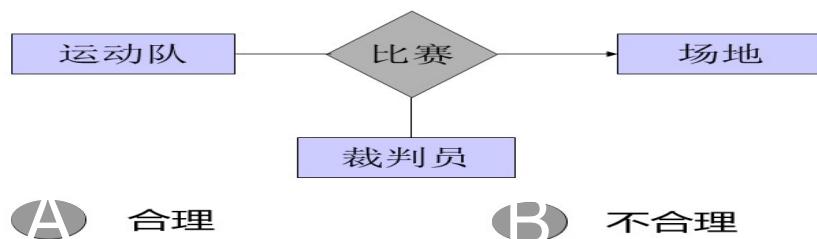
many-many

题 1分

3

互动交流三

以下多路联系中的箭头是否合理?



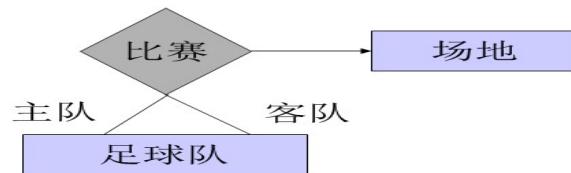
A 合理

B 不合理

题 1分

互动交流四

以下ER图的背景是中国足球超级联赛，该多路联系中的箭头是否合理？



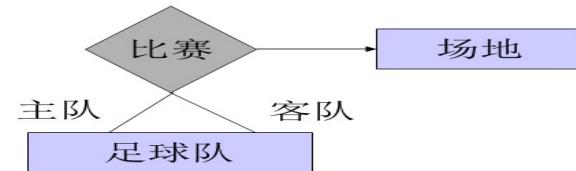
A 合理

B 不合理

题 1分

互动交流五

以下ER图的背景是中国足球超级联赛，如果想表达比赛时间，通常做法应该怎么做修改ER图？ [填空1]



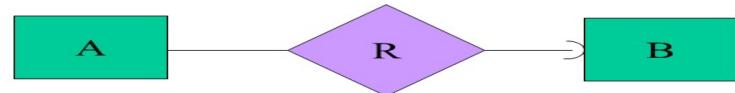
题 1分

习

互动交流六

如果实体集合A中当前拥有100个实体，那么实体集合B所拥有的实体数量是多少？

- I. 1
- II. 100
- III. 200



I or II



II or III



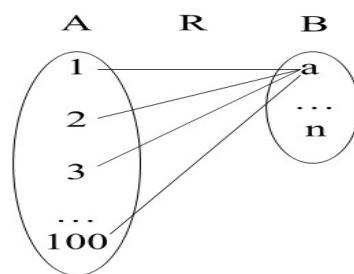
II only



I, II or III



讲解





我们需要为学校设计一个学生信息管理系统，在设计该系统时，本科生、研究生是否需要作为两个不同的实体集合？为什么？
(请用弹幕回答)

怎么设计ER模型才能体现他们很相似（具有很多共同属性，如学号、姓名、性别、出生日期、身份证号等），但又不完全相同（他们拥有各自属性，如本科生具有班导师，研究生具有研究方向、导师）的特性？
(请用弹幕回答)



Week4_Course_part3

ER Model-Constraints



ER Model

- Basic stuff
- Relationships
- Constraints
- Design principles



Modeling Constraints

Finding constraints is part of the modeling process.
Commonly used constraints:

Keys: social security number uniquely identifies a person.

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

Domain constraints: peoples' ages are between 0 and 200.

General constraints: all others (at most 50 students enroll in a class)



Keys

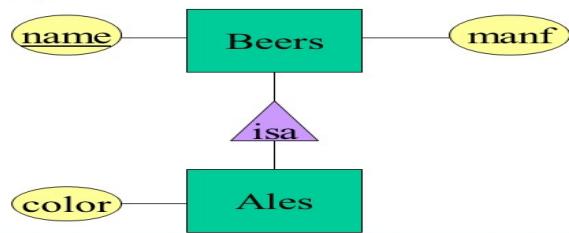
- We must designate a key for every entity set.
- A *key* is a set of attributes for one entity set such that no two entities in this set agree on all the attributes of the key.
 - It is allowed for two entities to agree on some, but not all, of the key attributes.



Keys in E/R Diagrams

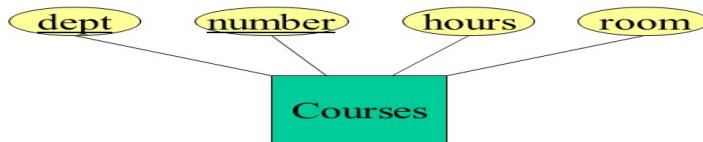
- Underline the key attribute(s).
- In an Isa hierarchy, only the root entity set has a key, and it must serve as the key for all entities in the hierarchy.

Example:
name is Key
for *Beers*





Example: a Multi-attribute Key



- Note that *hours* and *room* could also serve as a key, but we must select only one key.



More about Keys

- Every entity set must have a key
- A key can consist of more than one attribute
- There can be more than one key for an entity set
 - one key will be designated as primary key
- Requirement for key in an isa hierarchy
 - only the root entity set has a key

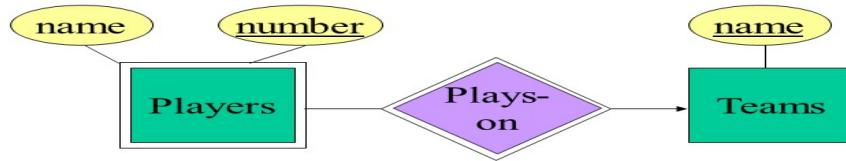


Weak Entity Sets

- Occasionally, entities of an entity set need “help” to identify them uniquely.
- Entity set E is said to be **weak** if in order to identify entities of E uniquely, we need to follow one or more many-one relationships from E and include the key of the related entities from the connected entity sets.



In E/R Diagrams



name is almost a key for players, but there might be two with the same name.
number is certainly not a key, since players on two teams could have the same number.

But *number*, together with the *Team* related to the player by *Plays-on* should be unique.

Double diamond for many-one supporting relationship.

Double rectangle for the weak entity set.

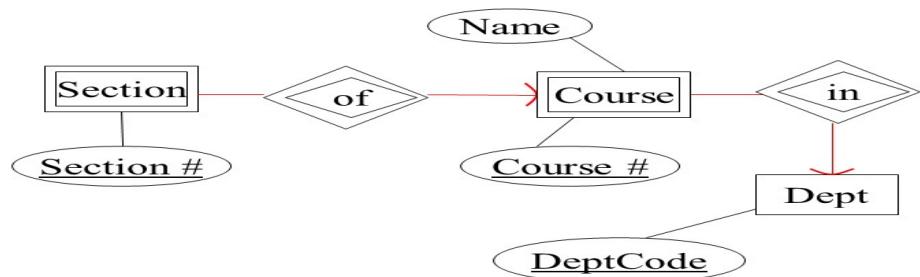


Weak Entity Set Rules

- A weak entity set has one or more many-one relationships to other (supporting) entity sets.
 - Not every many-one relationship from a weak entity set need be supporting.
- The key for a weak entity set is its own underlined attributes and the keys for the supporting entity sets.
 - E.g., *player-number* and *team-name* is a key for *Players* in the previous example.



Chain of Weakness



Dept's Key: (DeptCode)

Course's Key: (Course #, DeptCode)

Section's key: (Section #, Course #, DeptCode)



Constraints: Summary

- Key
- Weak entity set

题 1分

2

互动交流一

关于键约束的描述，错误的是：

- (A) 一个实体集合可以有多个键
- (B) 一个键只能由一个属性构成
- (C) 同一实体集合中的实体在键属性上可以部分相同
- (D) 在isa层次结构中，只需为根节点的实体集合设置键

题 1分

2

互动交流二

关于弱实体集合的描述，错误的是：

- (A) 支持联系可以是多对多的联系
- (B) 从弱实体集合出发的联系可能是支持联系，也可能不是支持联系
- (C) 支持联系用双边菱形表示
- (D) 弱实体集合的键由自己的键属性加上它所有支持实体集合的键属性构成

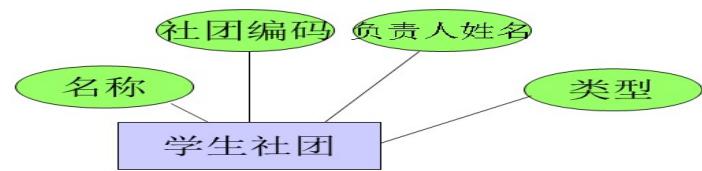
题 1分

3

互动交流三

以下ER模型的背景是南开大学需要一个社团管理系统，指出该实体集合的键可以是哪些情况？

- [A] 名称
- [B] 社团编码
- [C] 负责人姓名
- [D] 负责人姓名，类型



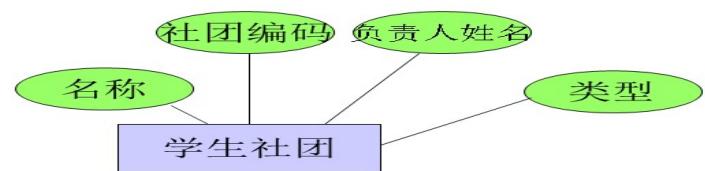
题 1分



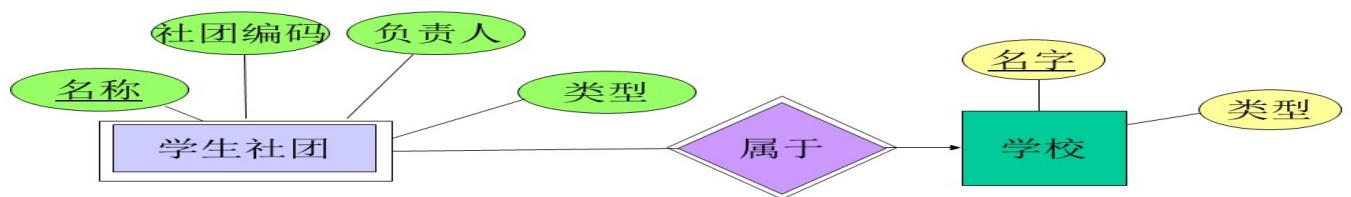
互动交流四

以下ER模型的背景变为教育部需要一个高校社团管理系统，指出该实体集合的键可以是哪些情况？

- A 名称
- B 社团编码
- C 负责人姓名
- D 弱实体集合



讲解





Week4_Course_part4

ER Model-Design principles



ER Model

- Basic stuff
- Relationships
- Constraints
- Design principles



Design Techniques

1. Be Faithful

- Design should reflect your (possibly vague) ideas of the data.

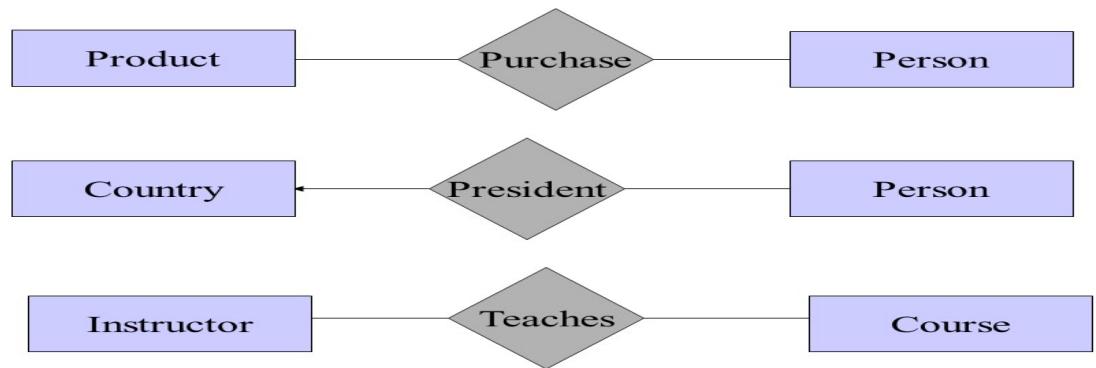
2. Avoid redundancy

3. Don't use an entity set when an attribute will do

4. Limit the use of weak entity sets



Design Principles 1: Be Faithful



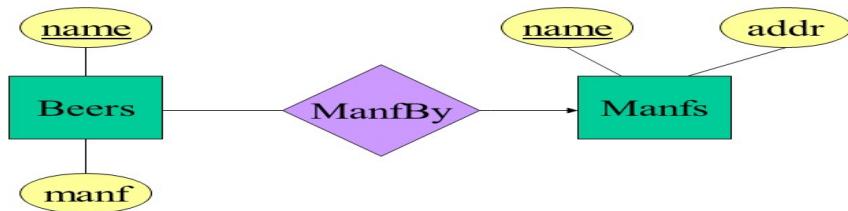


Avoiding Redundancy

- Redundancy occurs when we say the same thing in two different ways.
- Redundancy wastes space and (more importantly) encourages inconsistency.
 - The two instances of the same fact may become inconsistent if we change one and forget to change the other, related version.



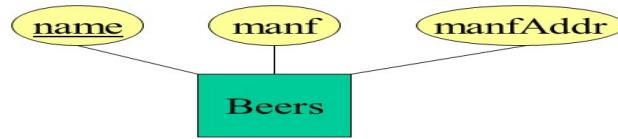
Example: Bad



This design states the manufacturer of a beer twice: as an attribute and as a related entity.



Example: Bad

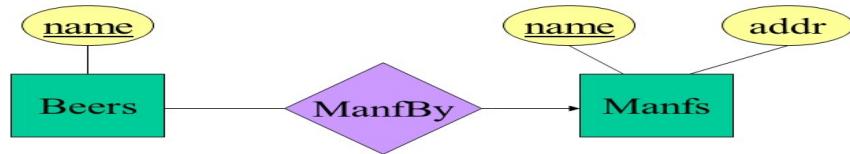


name	manf	manfAddr
1	A	A-Address
2	A	A-Address
3	A	A-Address
4	B	B-Address

This design repeats the manufacturer's address once for each beer; loses the address if there are temporarily no beers for a manufacturer.



Example: Good



This design stores the information of each manufacturer exactly once.

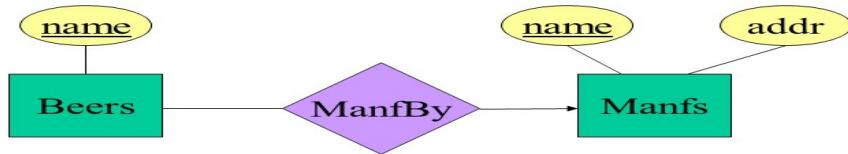


Entity Sets Versus Attributes

- An entity set should satisfy at least one of the following conditions:
 - It is more than the name of something; it has at least one nonkey attribute.
or
 - It is the “many” in a many-one or many-many relationship.



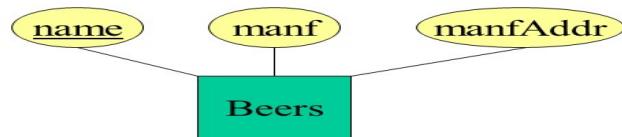
Example: Good



- *Manfs* deserves to be an entity set because of the nonkey attribute *addr*.
- *Beers* deserves to be an entity set because it is the “many” of the many-one relationship *ManfBy*.

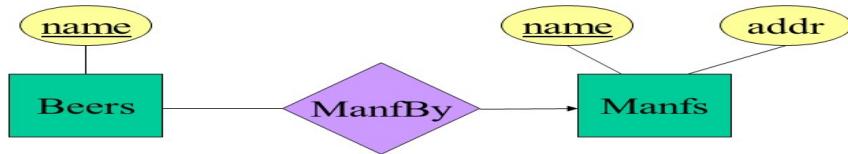


Example: Bad





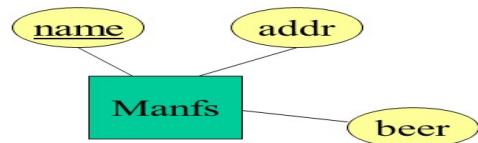
Example: Good



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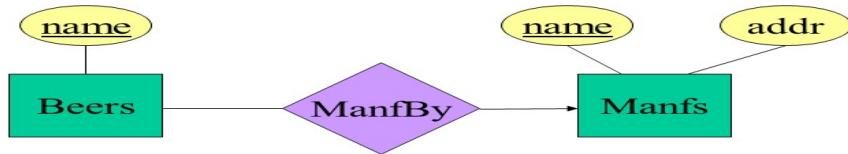


Example: Bad





Example: Good



- *Manfs* deserves to be an entity set because of the nonkey attribute *addr*.
- *Beers* deserves to be an entity set because it is the “many” of the many-one relationship *ManfBy*.



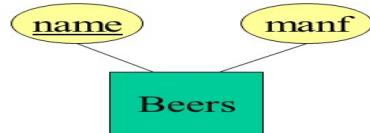
Example: Bad



Since the manufacturer is nothing but a name,
and is not at the “many” end of any relationship,
it should not be an entity set.



Example: Good



There is no need to make the manufacturer an entity set, because we record nothing about manufacturers besides their name.



Don't Overuse Weak Entity Sets

- Beginning database designers often doubt that anything could be a key by itself.
 - They make all entity sets weak, supported by all other entity sets to which they are linked.
- In reality, we usually create unique ID's for entity sets.
 - Examples include social-security numbers, automobile VIN's etc.



When Do We Need Weak Entity Sets?

- The usual reason is that there is no global authority capable of creating unique ID's.
- Example: it is unlikely that there could be an agreement to assign unique player numbers across all football teams in the world.

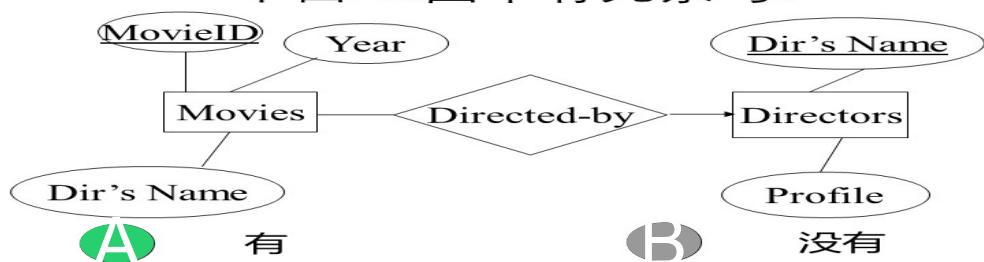


Design principles: Summary

- Be faithful
- Avoid redundancy
- Don't use an entity set when an attribute will do
- Limit the use of weak entity sets

题 1分
互动交流一

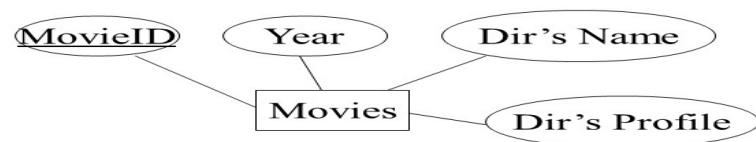
下面ER图中有冗余吗?



题 1分
互动交流二

互动交流二

下面ER图中有冗余吗？

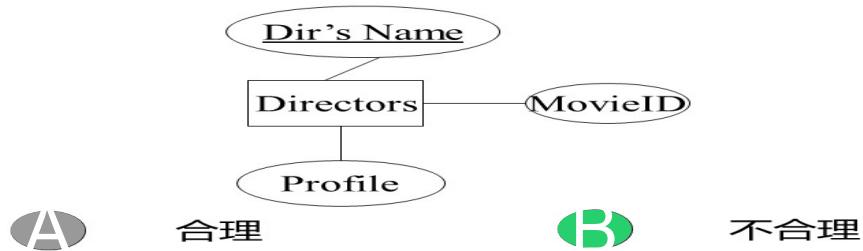


A 有

B 没有

题 1分
互动交流三

下面ER图合理吗？



题 1分

互动交流四

下面ER图合理吗？



题 1分
互动交流五

互动交流五

下面ER图合理吗？



A

合理

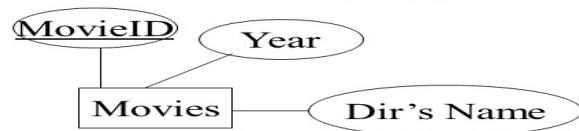
B

不合理

题 1分
互动交流六

互动交流六

下面ER图合理吗？



A

合理

B

不合理

