Databases

Database Design Using Entity-Relationship Model

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Outline

- Weak Entity Sets
- Attributes of Relationship Sets
- *n-ary* Relationship Sets
- Extended E-R features
  - Specialization
  - Attribute Inheritance
  - Completeness Constraints
- Common Design Issues

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These slides use the following book as reference: Abraham Silberschatz, Henry F. Korth and S. Sudarshan, "Database System Concepts", McGraw-Hill Education, Seventh Edition, 2019.

This class focuses mostly on **Chapter 6**

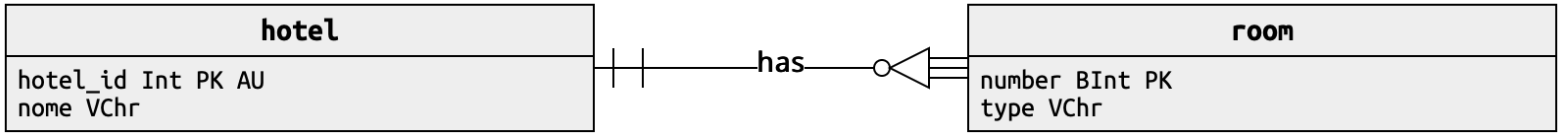
Weak Entity Sets

- A weak entity set is one whose existence is dependent on another entity set, called its identifying entity set
- An entity set that is not a weak entity set is termed a strong entity set
- Every weak entity must be associated with an identifying entity
  - i.e., the weak entity set existence depends on the identifying entity set
  - The identifying entity set is said to own the weak entity set that it identifies

Weak Entity Sets

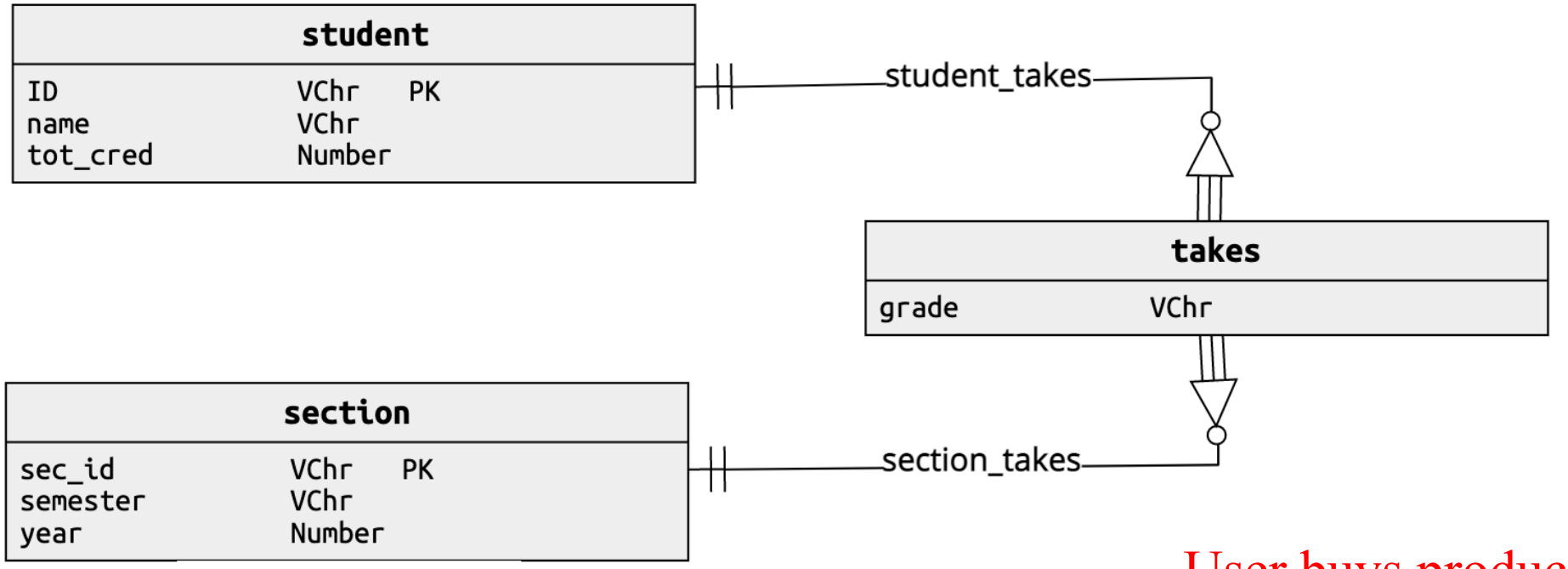
- The relationship associating the weak entity set with the identifying entity set is called the identifying relationship
- The primary key of a weak entity is the primary key of the identifying entity, along with extra attributes
  - Together, discriminator attributes and the primary key of the identifying entity uniquely identify a weak entity

Weak Entity Sets → Relations



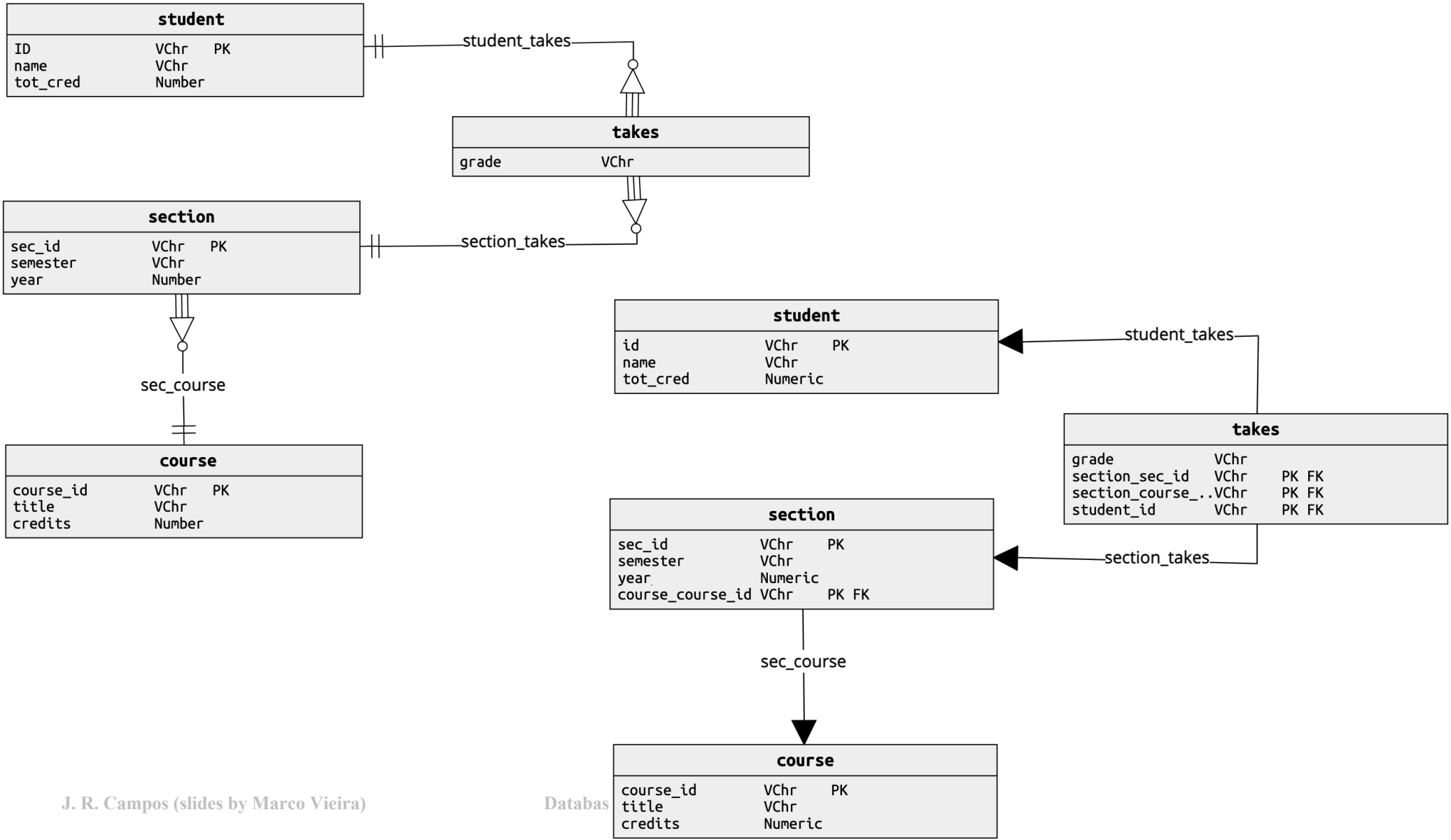
Attributes of Relationship Sets

- A relationship may also have attributes, called descriptive attributes
- Such attributes may be represented in the form of weak entity sets
  - Different notations follow different approaches!



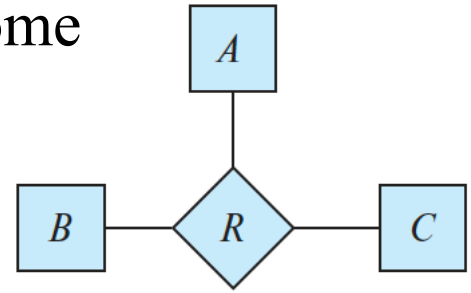
User buys product?

Weak Entity Sets → Relations

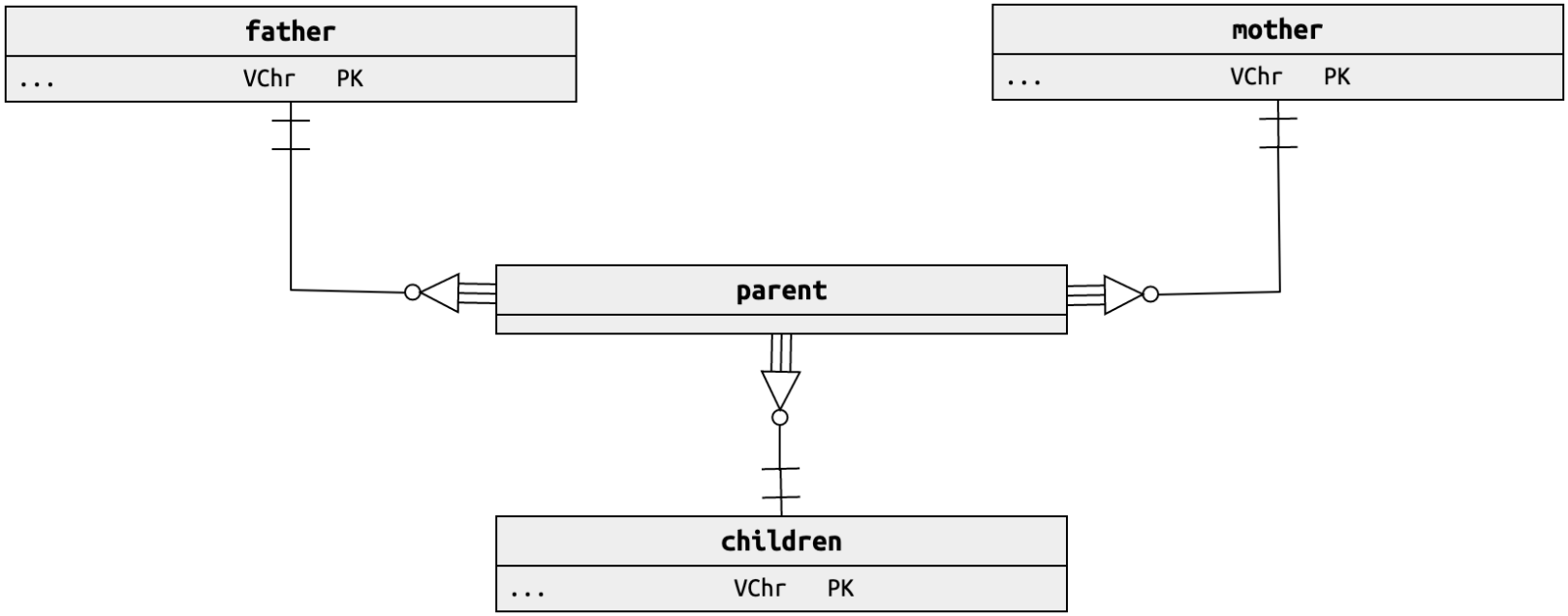


n-ary Relationships Sets

- Relationships in databases are mostly binary, but in some relationships appear to be nonbinary (*n-ary*)

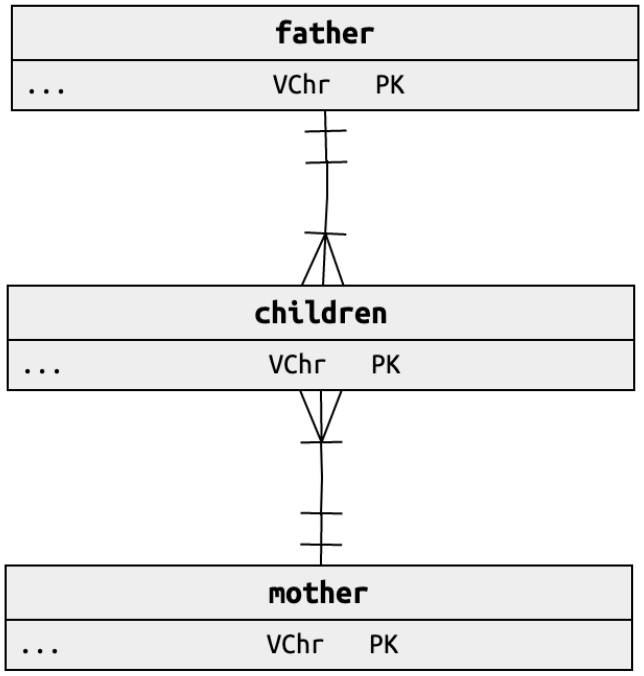


- For example, one could create a ternary relationship parent, relating a child to his/her mother and father



n-ary Relationships Sets

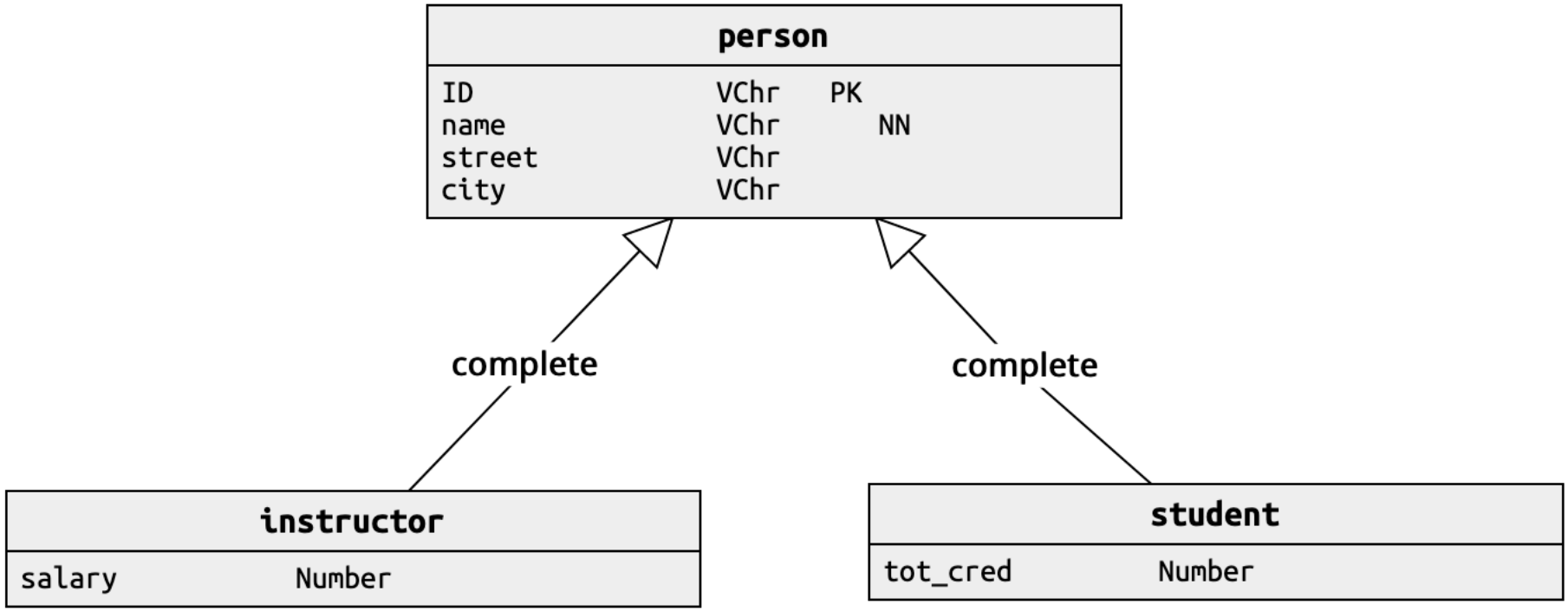
- Relationships that appear to be nonbinary can actually be better represented by several binary relationships
- The ternary relationship mother/father could also be represented by two binary relationships, mother and father
- It is always possible to replace a nonbinary (n-ary, for n > 2) relationship set by a number of distinct binary relationship sets
  - but it might not always be the best choice



Specialization

- An entity set may include subgroupings of entities that are distinct in some way from other entities in the set
  - i.e., a subset of entities within an entity set may have attributes that are not shared by all the entities in the entity set
  - e.g., the entity set person may be further classified as *employee* or *student*
- The process of designating subgroupings within an entity set is called specialization
- The specialization of *person* allows distinguishing among person entities according to whether they are *employees* or *students*
  - In general, a person could be an employee, a student, both, or neither

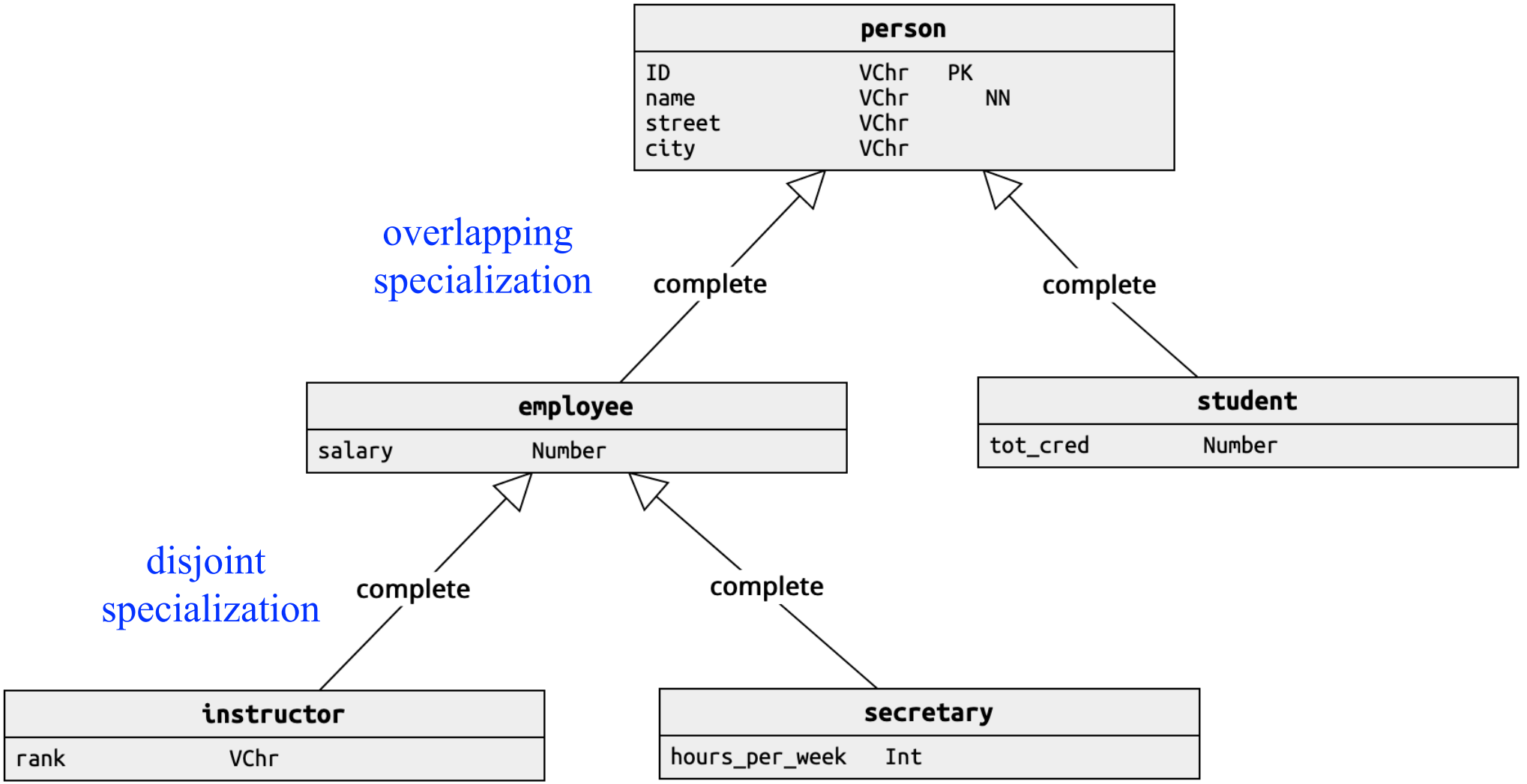
Person Specialization



Overlapping and Disjoint Specialization

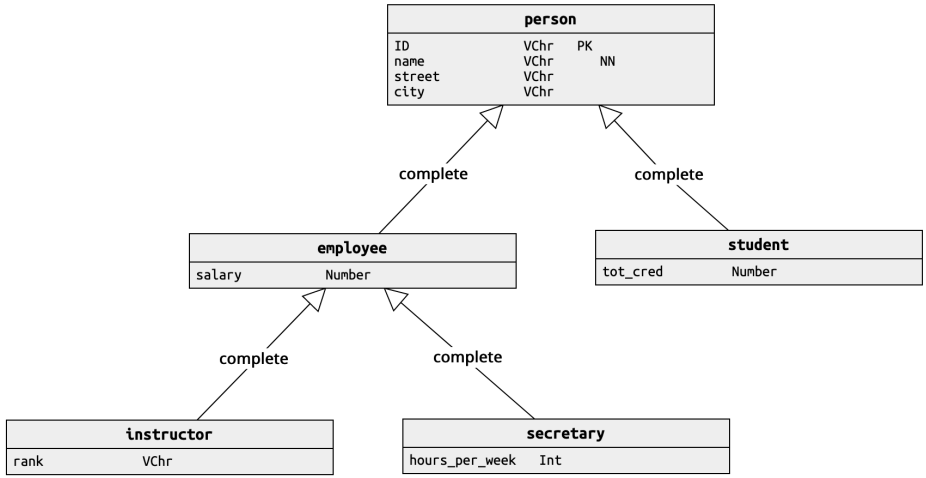
- An entity may belong to multiple specialized entity sets *OR* it may belong to at most one specialized entity set
  - Overlapping specialization: multiple sets permitted
  - Disjoint specialization: at most one permitted
- The specialization relationship may also be referred to as a superclass-subclass relationship
- Not always identifiable in the diagram

Person Specialization



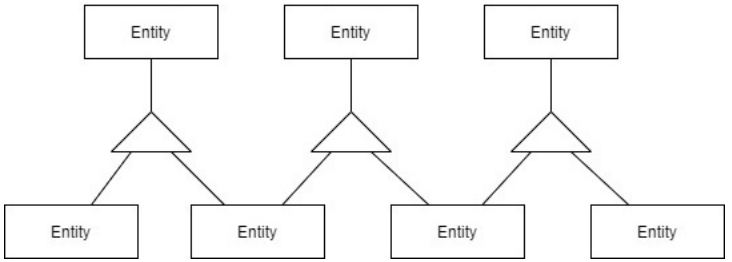
Completeness Constraints

- Whether or not an entity in the higher-level entity set must belong to at least one of the lower-level entity sets
- Total specialization: each higher-level entity must belong to a lower-level entity set
  - e.g., all persons in the university database are either and *employee* and/or a *student*
- Partial specialization: some higher-level entities may not belong to any lower-level entity set
  - e.g., there are persons that are neither employees nor students, but they are in the database anyway



Attribute Inheritance

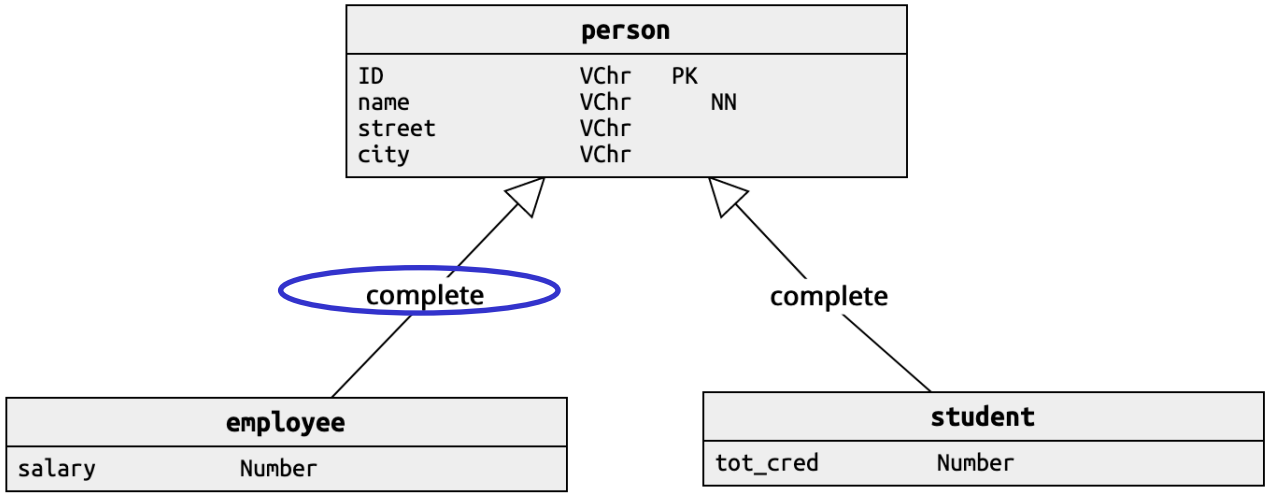
- A crucial property of specialization and generalization is attribute inheritance
  - Attributes of the higher-level entity sets are inherited by the lower-level ones
  - e.g., *student* and *employee* inherit the attributes of *person*
- A given entity set may be involved as a lower-level entity set in only one relationship, i.e., entity sets have only single inheritance
- If an entity set is a lower-level entity set in more than one relationship, then the entity set has multiple inheritance

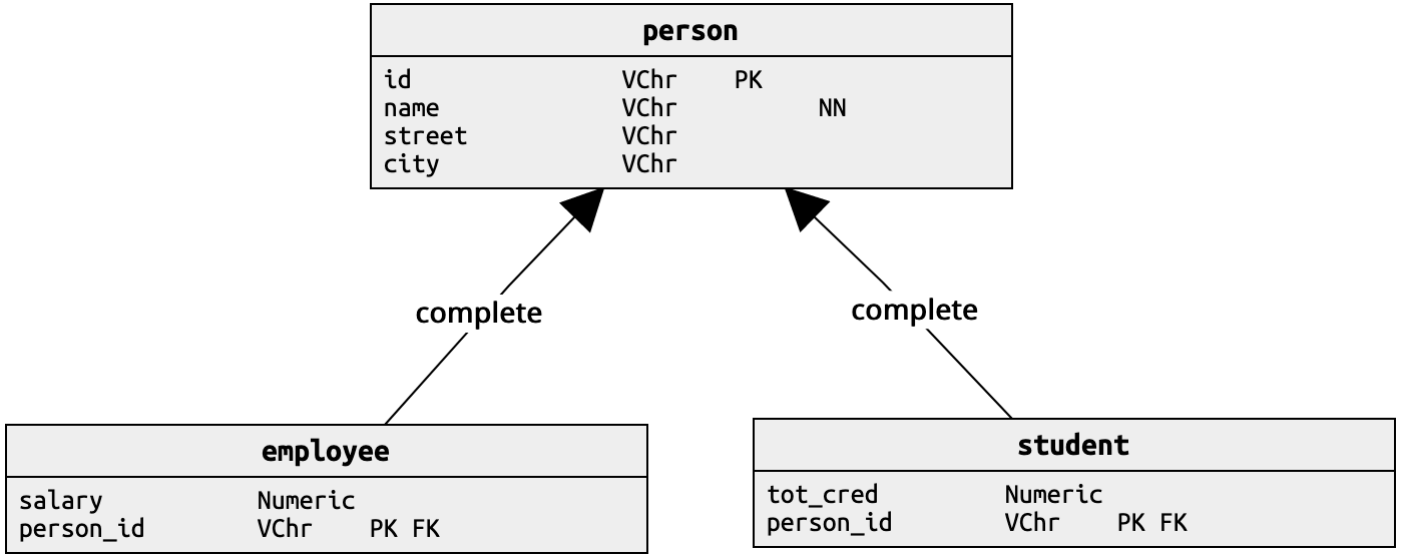


Specialization → Relations

- Two main approaches for designing relation schemas for an E-R diagram that includes specialization
- Alternative #1:
  - Create a schema for the higher-level entity set
  - For each lower-level entity set:
    - Create a schema that includes an attribute for each of the attributes of that entity set
    - One attribute for each attribute of the primary key of the higher-level entity set

Specialization → Relations

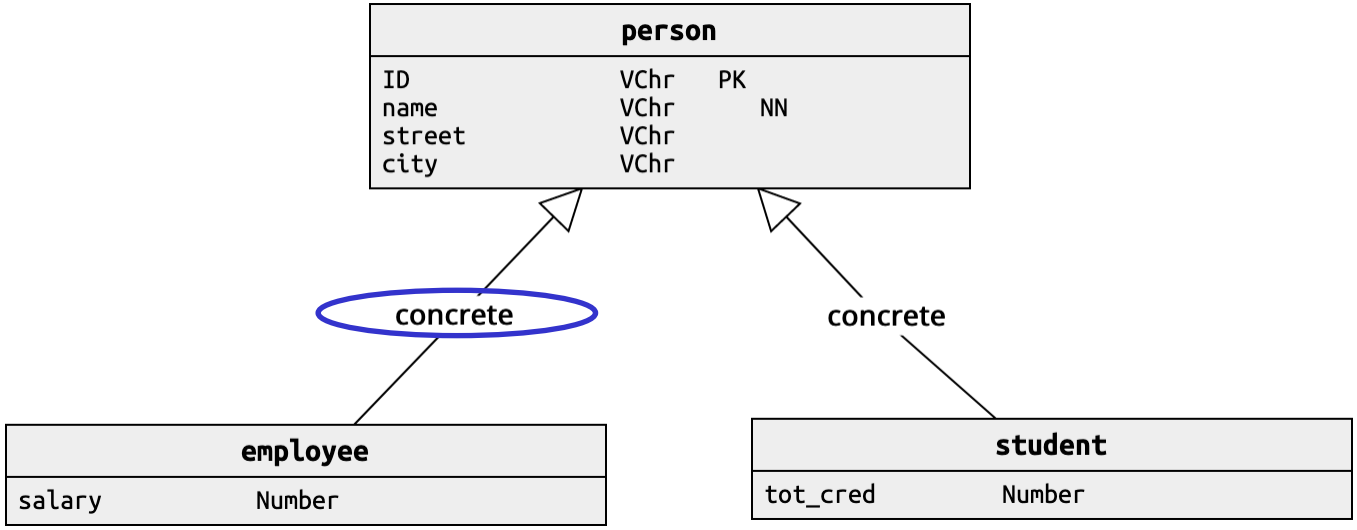




Specialization → Relations

- Alternative #2
  - Do not create a schema for the higher-level entity set
  - For each lower-level entity set, create a schema that includes:
    - An attribute for each of the attributes of that entity set
    - One for each attribute of the higher-level entity set
  - Applies only if the generalization is disjoint and complete
    - If no entity is a member of two lower-level entity sets directly below a higher-level entity set
    - If every entity in the higher-level entity set is also a member of one of the lower-level entity sets

Specialization → Relations



employee

salary	Numeric	
person_id	VChr	PK
person_name	VChr	NN
person_street	VChr	
person_city	VChr	

student

tot_cred	Numeric	
person_id	VChr	PK
person_name	VChr	NN
person_street	VChr	
person_city	VChr	

Common Design Issues

- Use of the primary key of an entity set as an attribute of another entity set, instead of using a relationship
  - **No "foreign keys" in E-R diagrams!**

- Entity Sets *vs* Attributes
- Entity Sets *vs* Relationship Sets
- Binary *vs n-ary* Relationship Sets

Take-Away(s)

- Binary and *n-ary* relationships sets
- Weak entity sets and strong entity sets
- Attributes in relationship sets
- Specialization: overlapping, disjoint
- Attribute Inheritance: single inheritance, multiple inheritance
- Completeness Constraints: total specialization, partial specialization
- Design choices
- Specialization to relational schemas: two main approaches

Next Lesson(s)

- Functional Dependencies
- Normal Forms
- Decomposition using Functional Dependencies

Q&A

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