Conceptual Data Modeling and the Entity-Relationship Model

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Data Models

- A means of describing the structure of the data
- A set of operations that manipulate the data (only in data models that are implemented)
- Types of data models
  - Conceptual data model
  - Logical data models - relational, network, hierarchical, inverted list, or object-oriented

Conceptual Data Model

- Shows the structure of the data including the relationships
- Communication tool
- Independent of commercial DBMSs
- Easy to learn and use
- Provides semantics
- Graphical representation of the data
- Entity-Relationship Model is most common one used in world

Logical Data Models

- Relational -
  - data stored in tables with no repeating groups allowed
  - based upon a mathematical model
  - first presented by E. F. Codd in early 1970s
  - Commercial relational data models
    - DB2, Oracle, Ingress, and Microsoft Access

Logical Data Models

- Network -
  - data stored in records and associations called sets
  - very complex model
  - based upon the CODASYL model
  - created by a committee in 1970’s
  - commercial DBMSs
    - IDMS and TOTAL

Logical Data Models

- Hierarchical -
  - data stored in tree structure with parent / child relationships
  - first commercial DBMS created by IBM in late 1960s
  - commercial DBMSs
    - IMS and System 2000
  - XML

Logical Data Models

- Inverted List -
  - tabular representation of the data using indicies to access the tables
  - first touted themselves as relational in early 1970’s when no real relational available
  - NOT relational because repeating groups are allowed
  - commercial DBMSs
    - ADABAS (out of Germany)

Logical Data Models

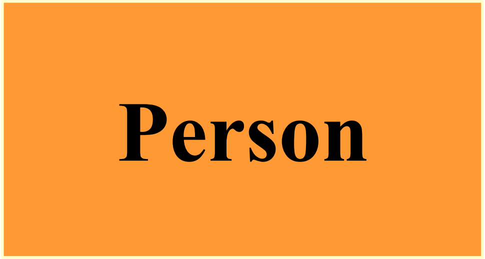
- Object-Oriented –
  - Data stored as objects which contain
    - Identifier
    - Name
    - Lifetime
    - Structure
  - Commercial object-oriented DBMSs
    - O2 (now called Ardent) and ObjectStore

Entity-Relationship Model

- First introduced in 1976 by Peter P. Chen
- Simple
- Readable
- Understood easily by both database designer and unsophisticated user

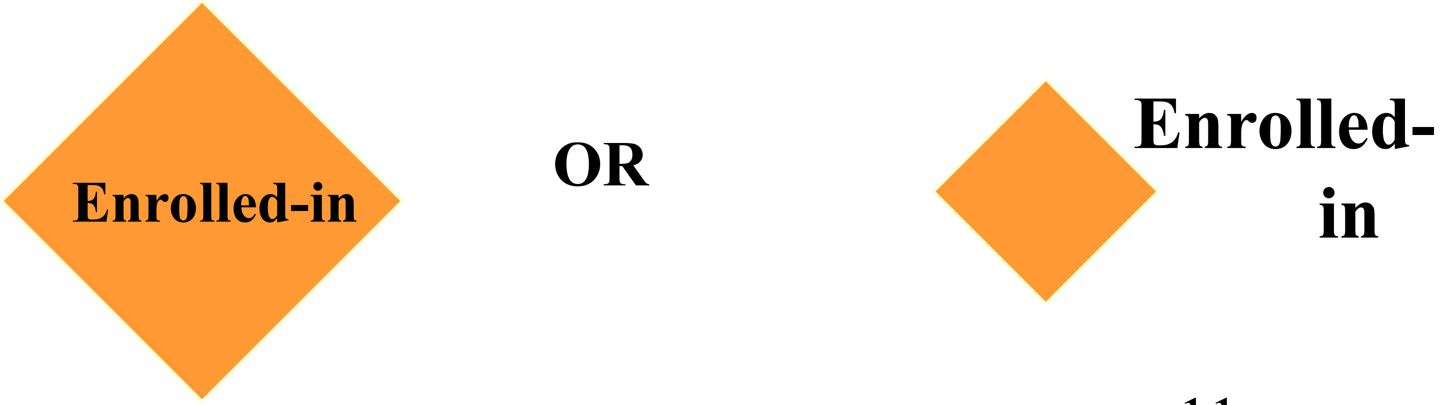
Basic ER Concepts

- Entities
  - principal objects about which information is kept
  - denote a noun such as person, place, thing, or event
  - shown as a rectangle with the name (singular) inside



Basic ER Concepts

- Relationships
  - associations among one or more entities
  - cannot exist without associated entities
  - represented as a diamond with name inside or just next to it



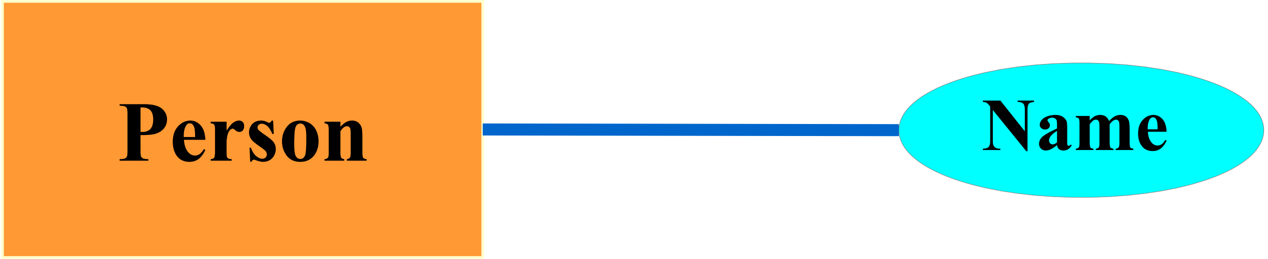
Enrolled-in

OR

Enrolled-in

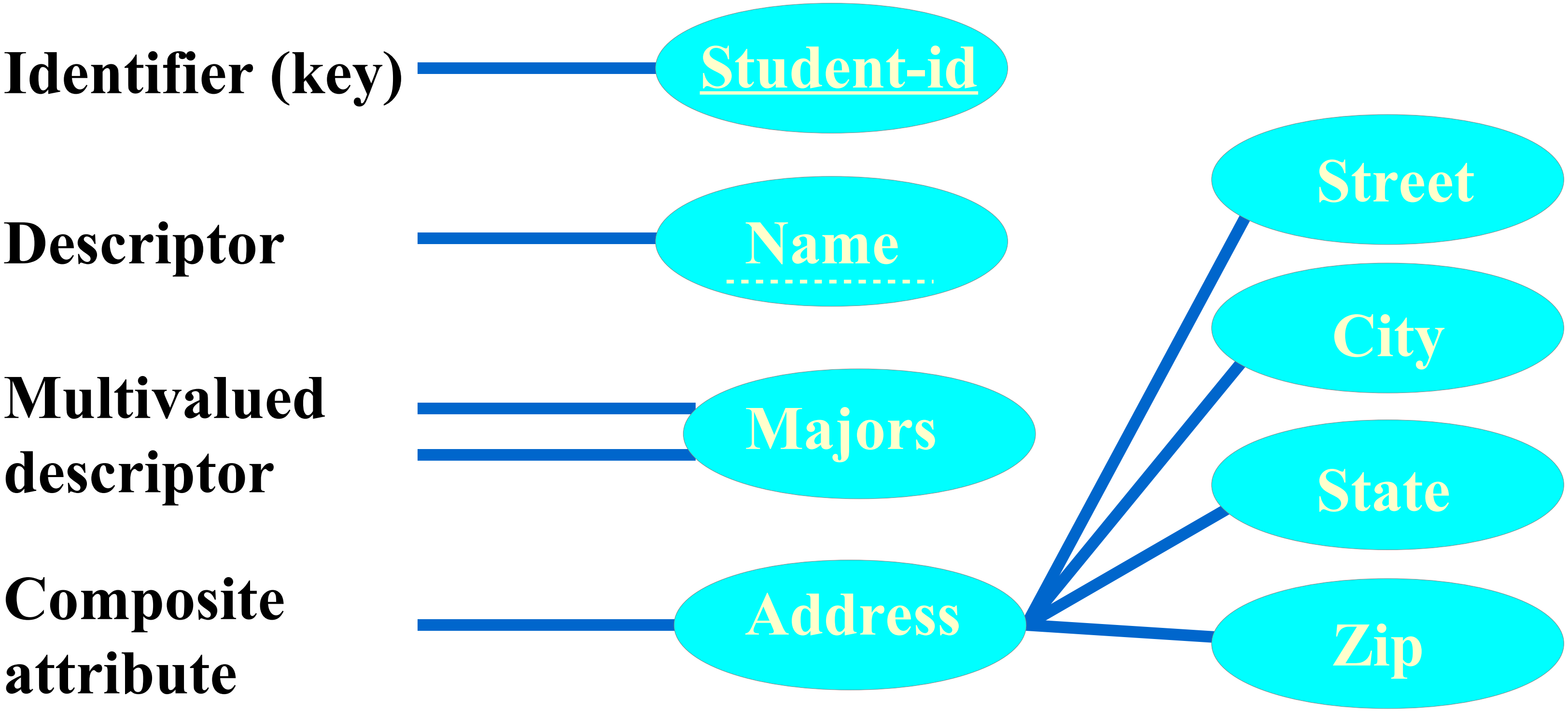
Basic ER Concepts

- Attributes
  - characteristics of entities or relationships
  - fields in a file
  - shown using oval attached to entity



Basic ER Concepts

- Attributes



Identifier (key)

Student-id

Descriptor

Name

Multivalued descriptor

Majors

Composite attribute

Address

Street

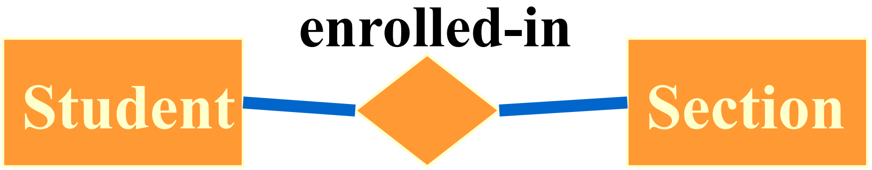
City

State

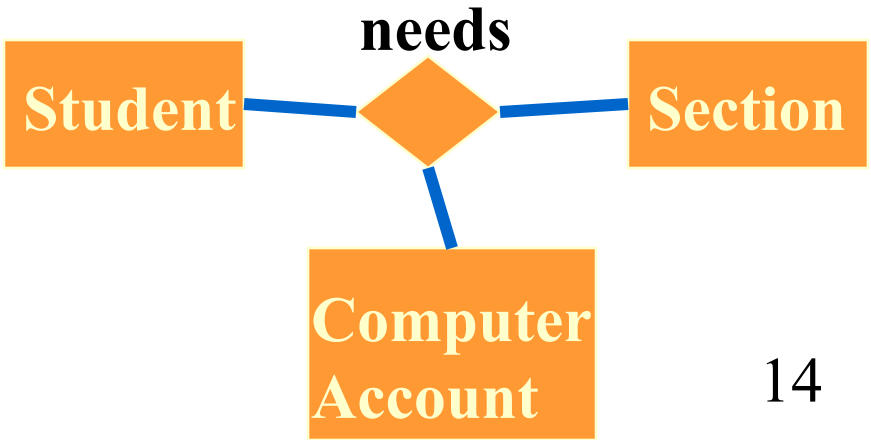
Zip

Basic ER Concepts

- Degree of a Relationship
  - the number of entities associated with a relationship
    - binary

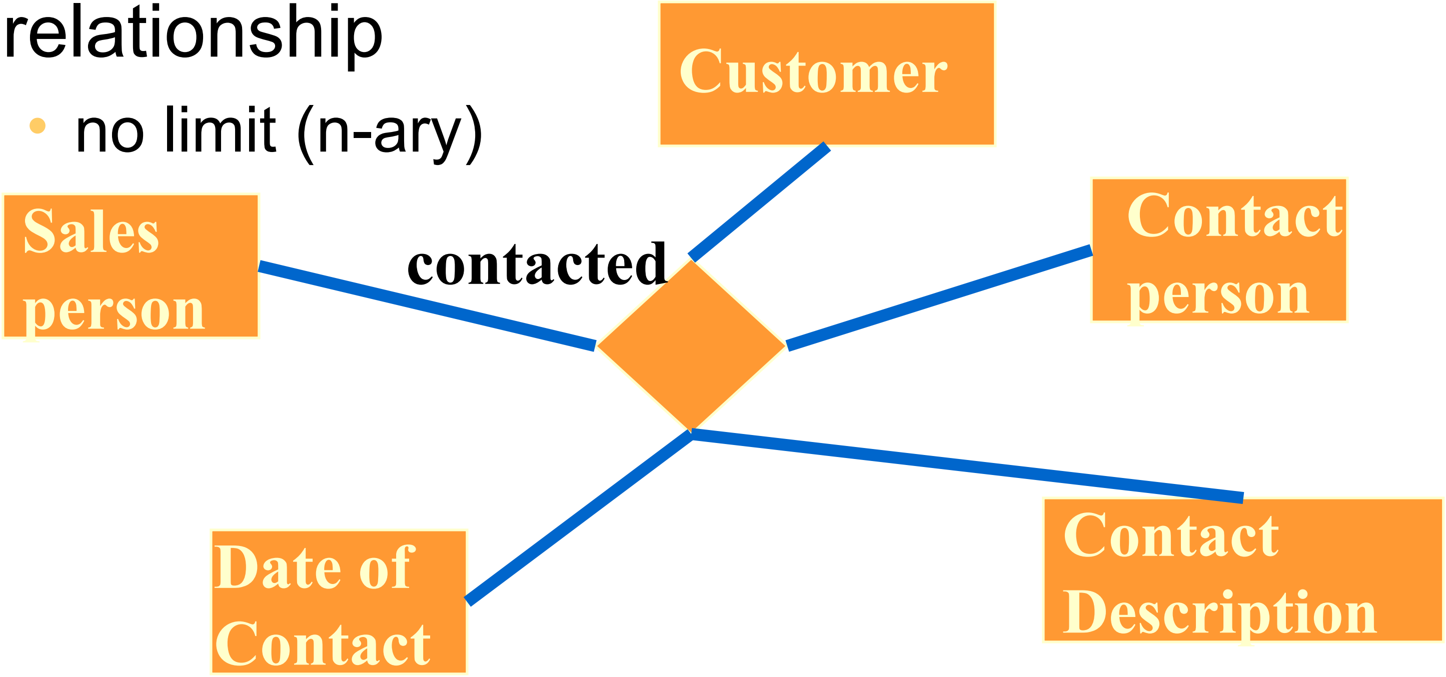


    - ternary



Basic ER Concepts

- Degree of a Relationship
  - the number of entities associated with a relationship
    - no limit (n-ary)



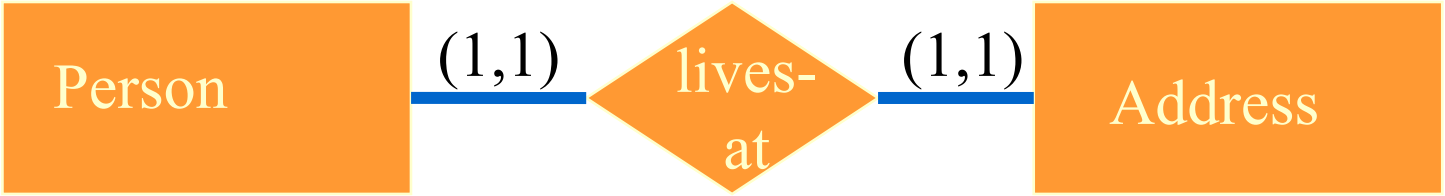
Basic ER Concepts

- Connectivity of a Relationship
  - constraint on the mapping of associated entities
  - written as (min,max)
  - minimum - zero or one (usually)
  - maximum - one or many (usually)
  - actual number is called CARDINALITY

Basic ER Concepts

- Connectivity of a Relationship

One-to-one



Person

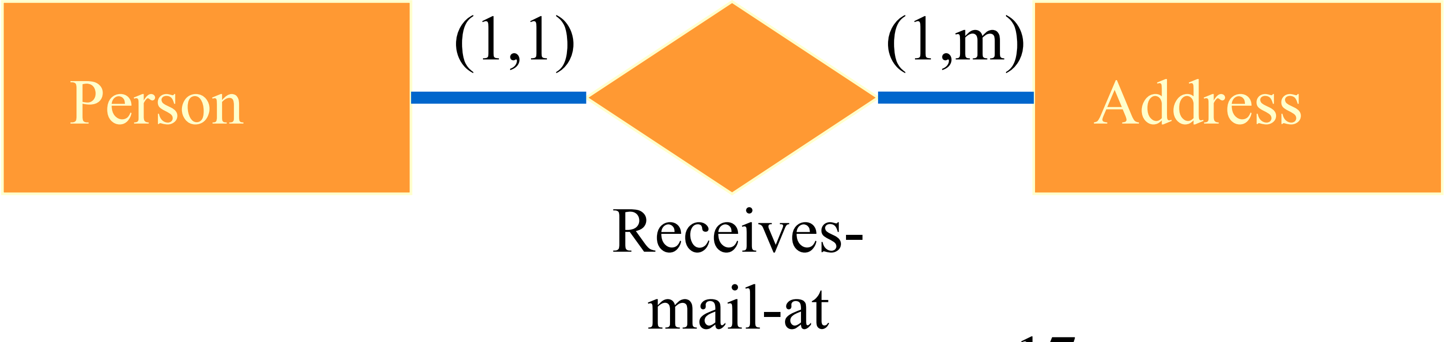
(1,1)

lives-at

(1,1)

Address

One-to-many



Person

(1,1)

(1,m)

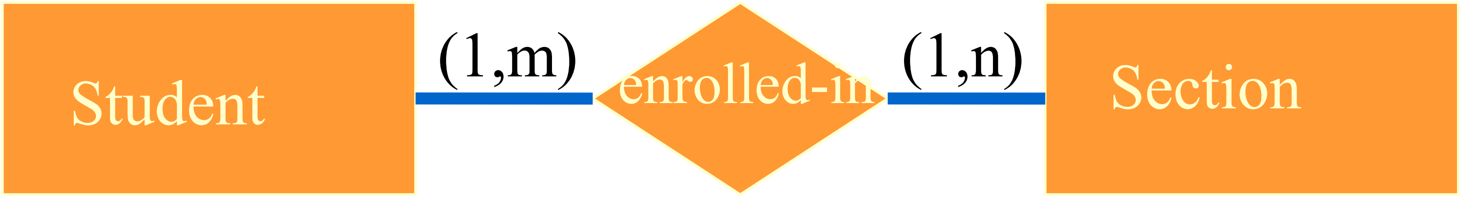
Address

Receives-mail-at

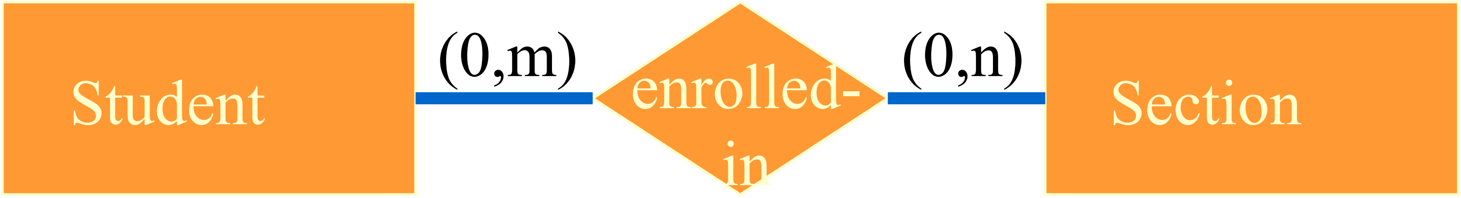
Basic ER Concepts

- Connectivity of a Relationship

mandatory many-to-many

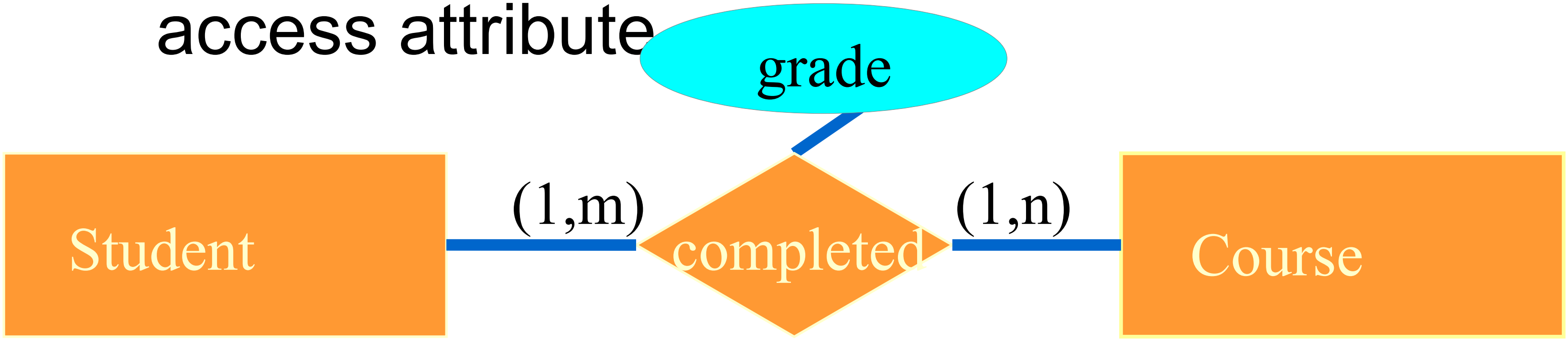


optional many-to-many



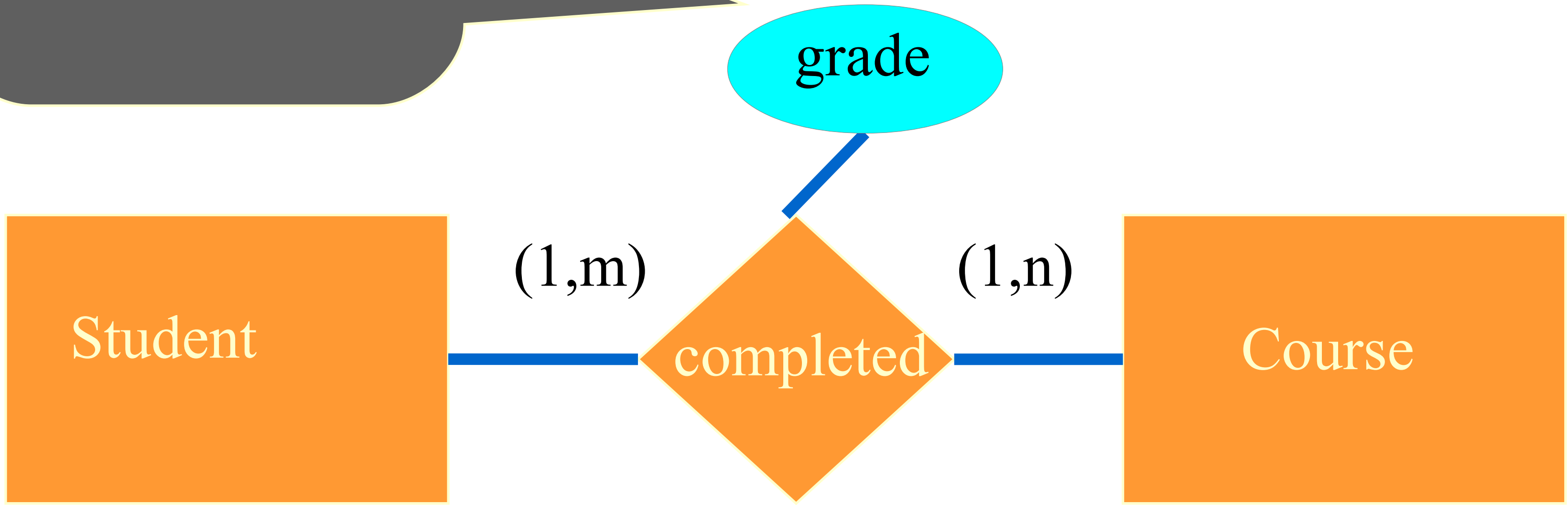
Basic ER Concepts

- Attributes of a Relationship
  - must be on a many-to-many relationship (NOT on a 1-m or 1-1 relationship)
  - intersection data
  - needs to know ALL associated entities to access attribute



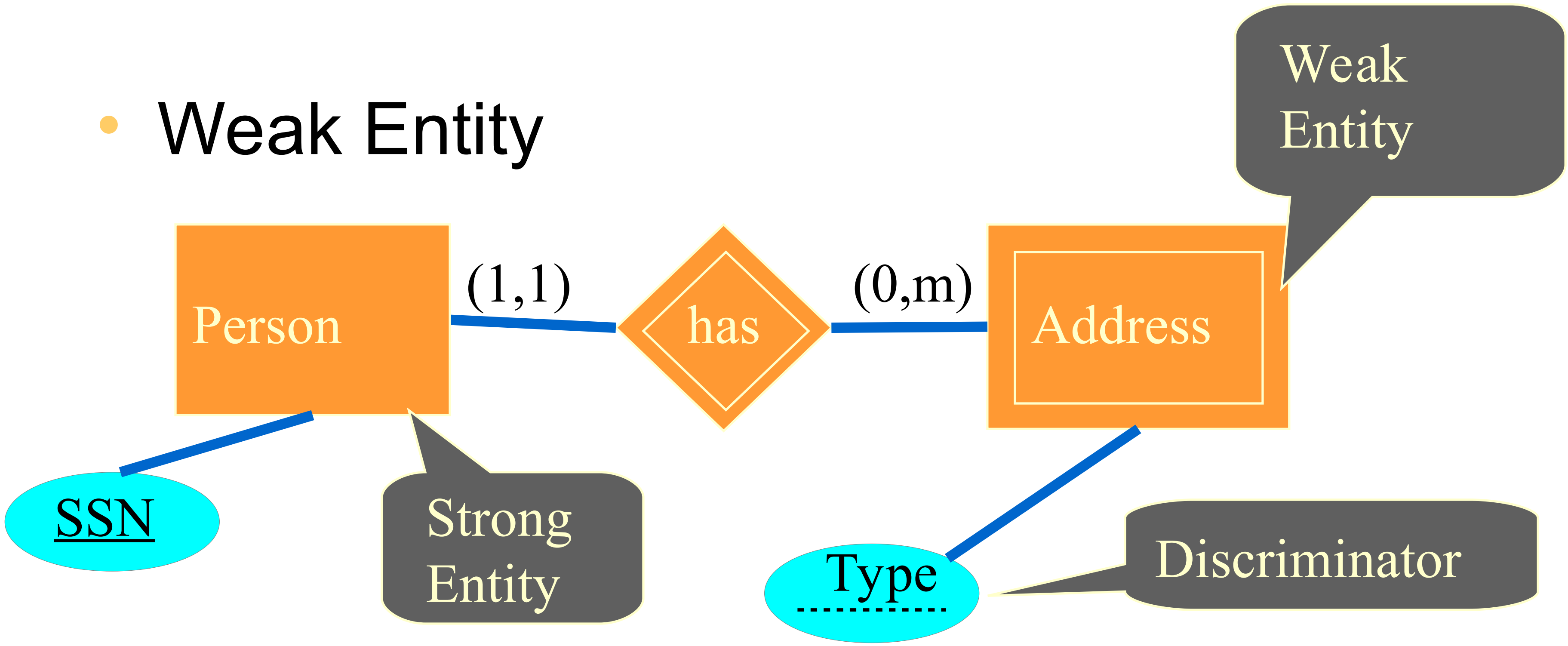
Basic ER Concepts

Need to know BOTH Student AND Course to get to grade.



Basic ER Concepts

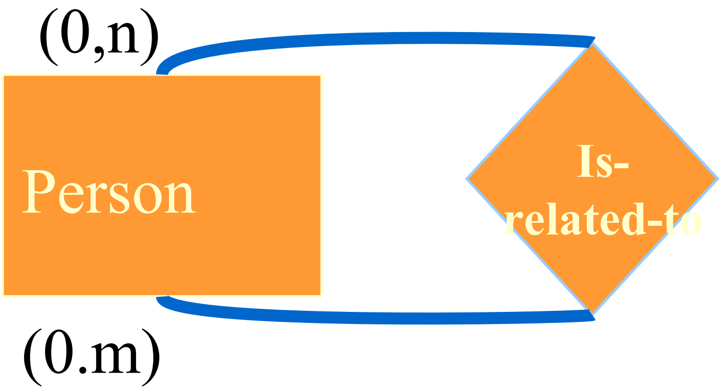
- Weak Entity

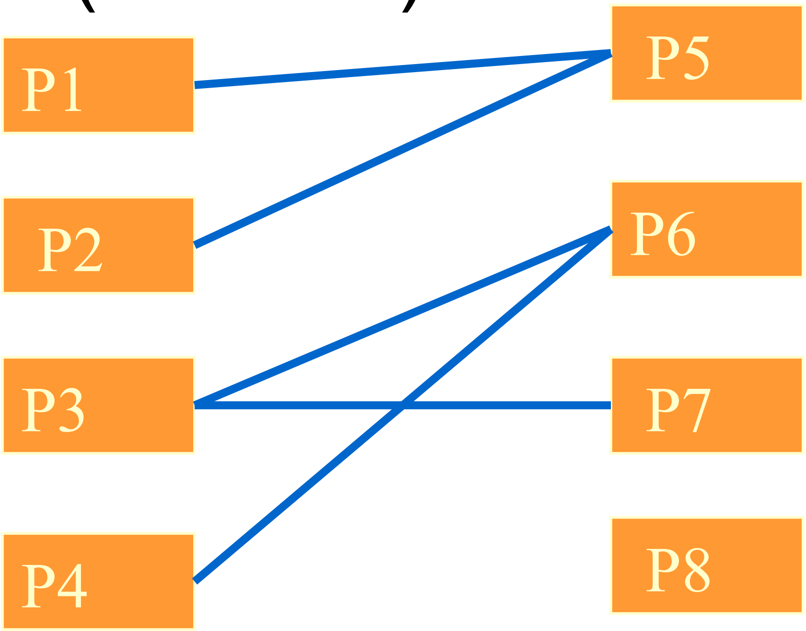


- Identifier of Address = SSN and Type

Basic ER Concepts

- Recursive Relationship: many-to-many (network)

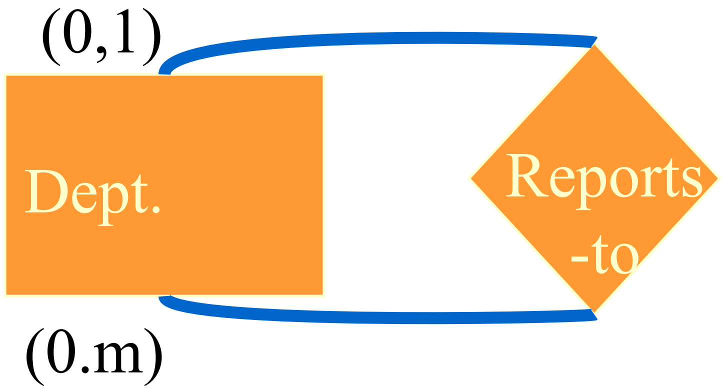


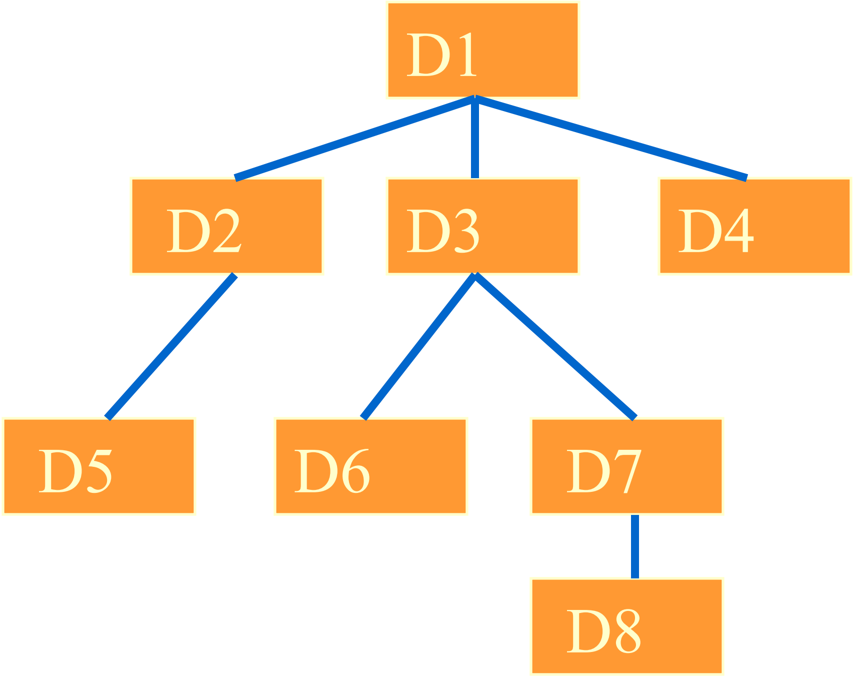


A Person has many relatives.
AND A Person is related to many other Persons.

Basic ER Concepts

- Recursive Relationship: 1 - many (tree)

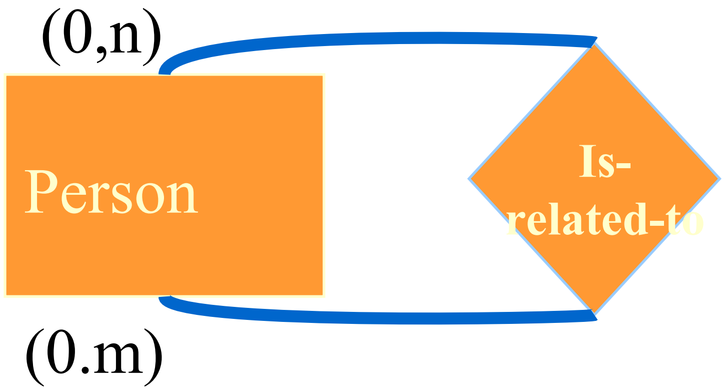


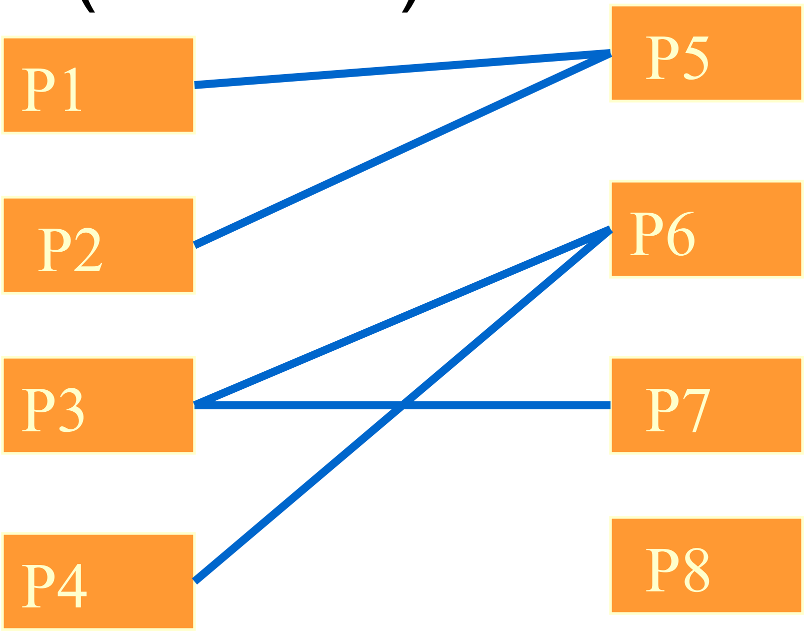


A Department reports to One and only one Department. AND A Department may have 0, 1, or more reporting to it.

Basic ER Concepts

- Recursive Relationship: many-to-many (network)





A Person has many relatives. AND A Person is related to many other Persons.

Advanced ER Constructs

- Supertype / Subtype (isa relationship)
  - generalization
  - specialization
  - overlapping subtypes
  - disjoint subtypes

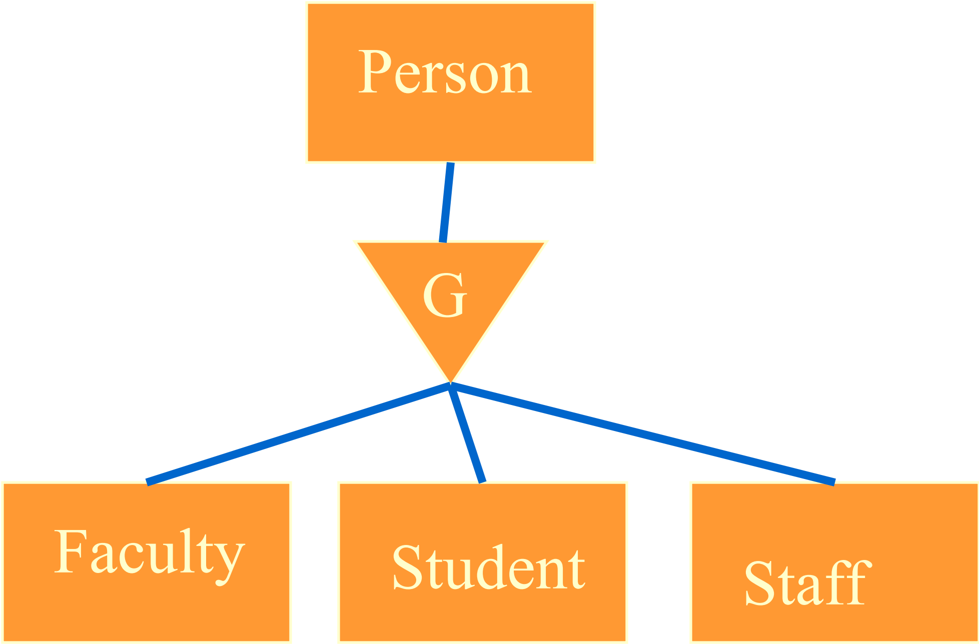
Advanced ER Constructs

- Inheritance
  - the attributes describing the supertype entity are inherited by the entities of the subtypes
- The identifier of the subtypes is the same as the supertype.

- NOTE: the notation used here is different than the book.

Advanced ER Constructs

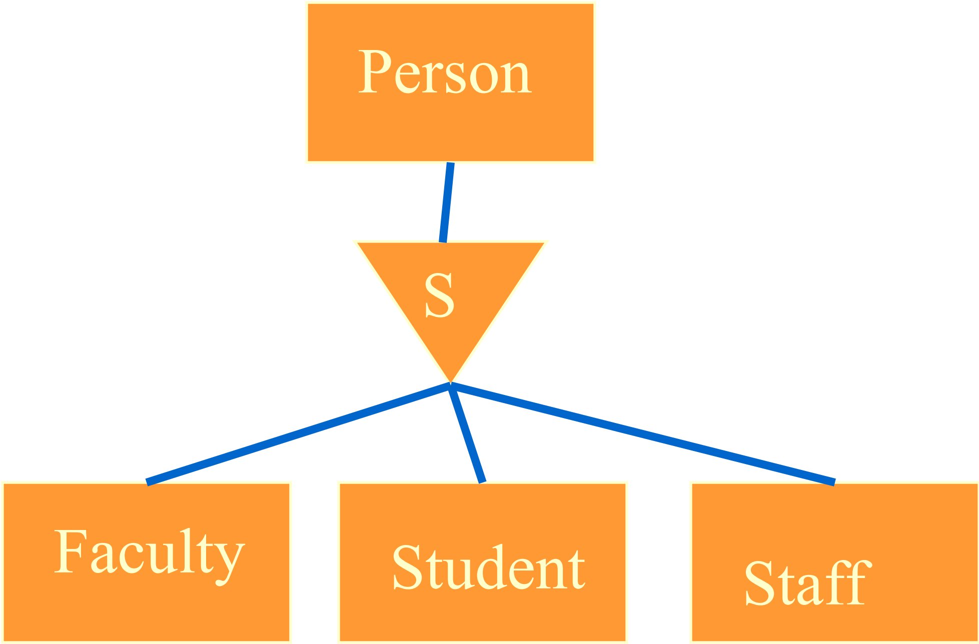
- Generalization
  - Supertype is the UNION of all the subtypes.
  - An instance of the supertype CANNOT exist without being related to at least one instance of a subtype.



A Person MUST be either a Faculty, Student, or Staff.

Advanced ER Constructs

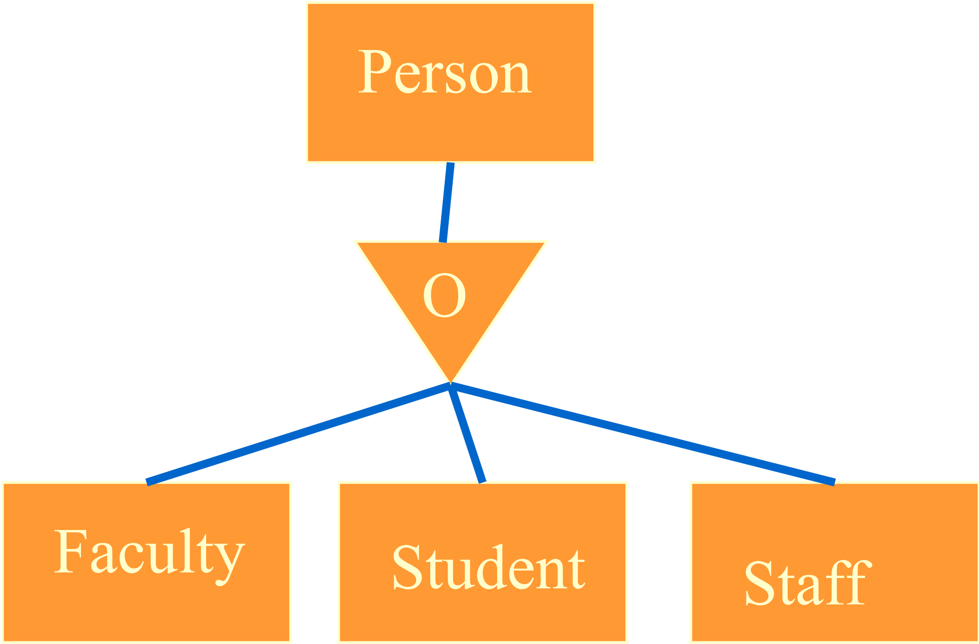
- Specialization
  - The subtype entities specialize the supertype.
  - An instance of the supertype CAN exist without being related to any subtype.



A Person CAN be either a Faculty, Student, or Staff but DOES NOT have to be any of them.

Advanced ER Constructs

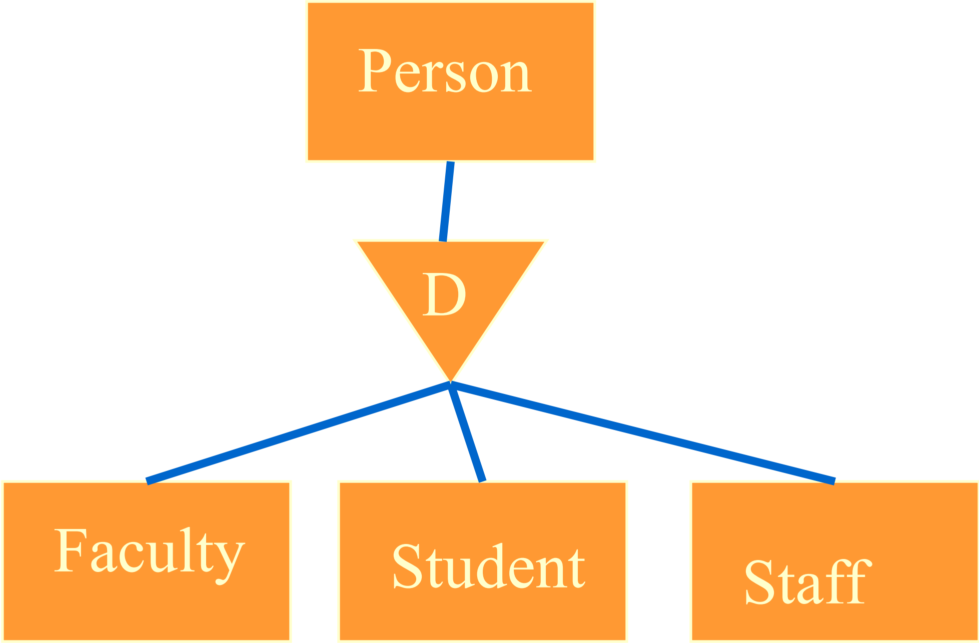
- Overlapping Subtype Entities
  - An instance of the supertype can be related to one or more of the subtypes.



A Person CAN be either a Faculty, Student, or Staff OR can be BOTH a Faculty and Student OR BOTH a Faculty and Staff OR BOTH a Student and Staff OR can be all three.

Advanced ER Constructs

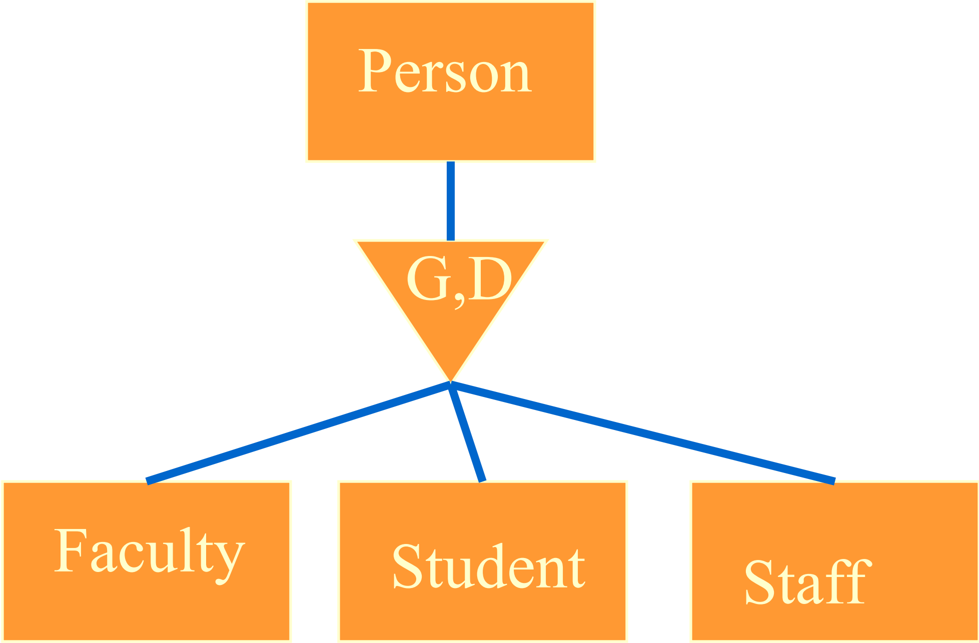
- Disjoint Subtype Entities
  - the subtype entities are mutually exclusive



A Person CAN be ONLY ONE of either Faculty, Student, or Staff.

Advanced ER Constructs

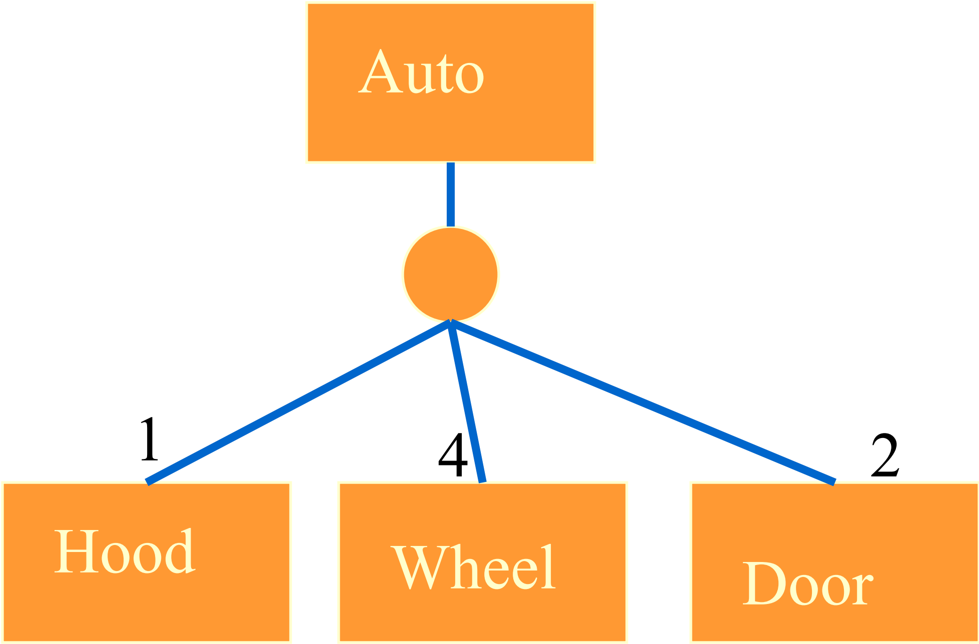
- Use combinations:
  - G / O: generalization with overlapping subtypes
  - G / D: generalization with disjoint subtypes
  - S / O: specialization with overlapping subtypes
  - S / D: specialization with disjoint subtypes



A Person MUST be ONE and ONLY ONE of either Faculty, Student, or Staff.

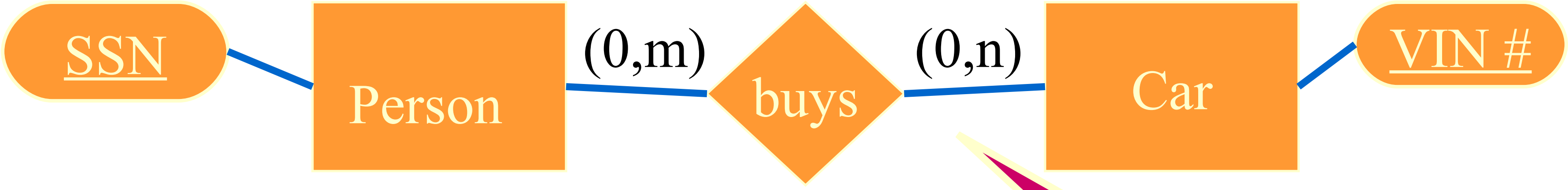
Advanced ER Constructs

- Aggregation (ispo relationship)
  - Is-part-of
  - Is-made-up-of



An Auto is-made-up-of one Hood, four Wheels, and two doors.

Interesting Construct

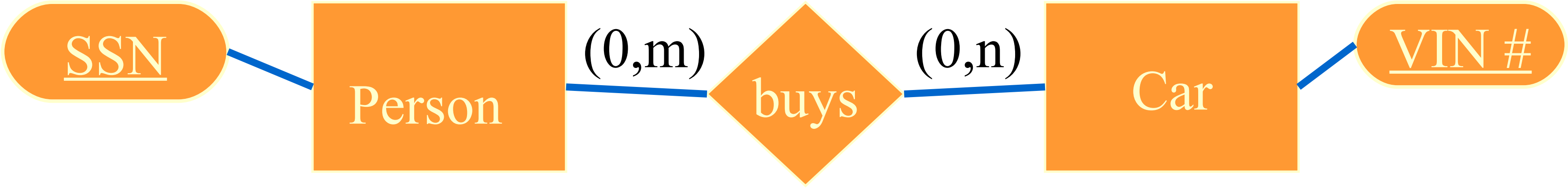


Relationship is represented by a table whose Primary Key is the concatenation of the IDs of the related entities.

SSN	VIN #
222	1111
333	5555
444	8888

Question? What happens if a Person buys the SAME Car more than one time?

Interesting Construct



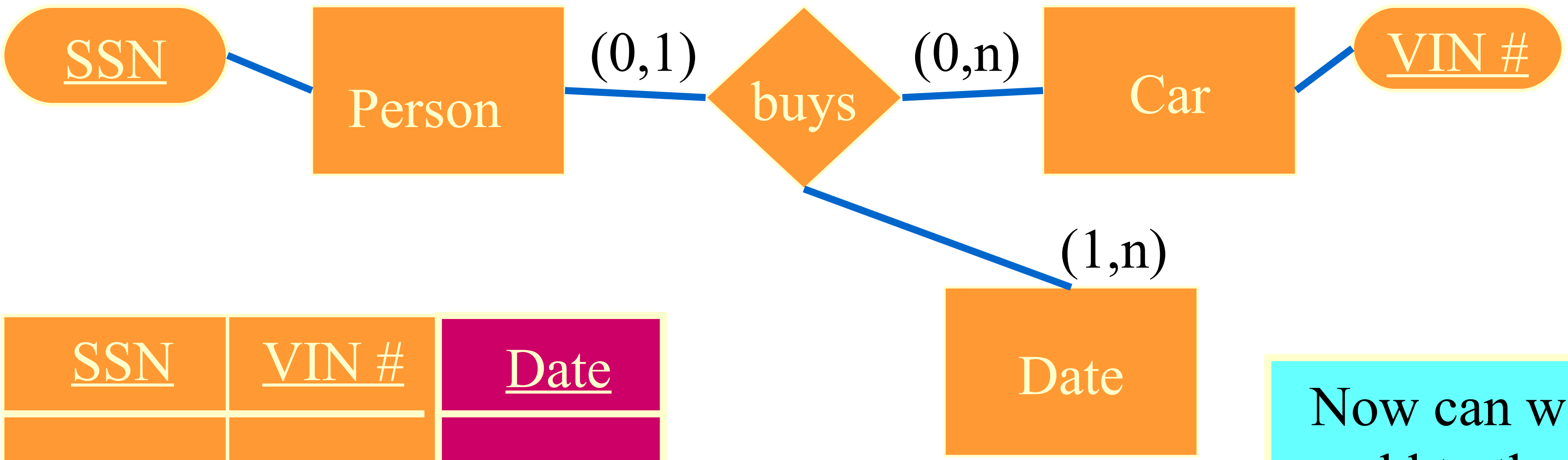
SSN	VIN #
222	1111
333	5555
444	8888

NO, because the insert would cause a duplicate instance. A duplicate instance is NOT allowed.

222	1111

Can we insert?

Interesting Construct

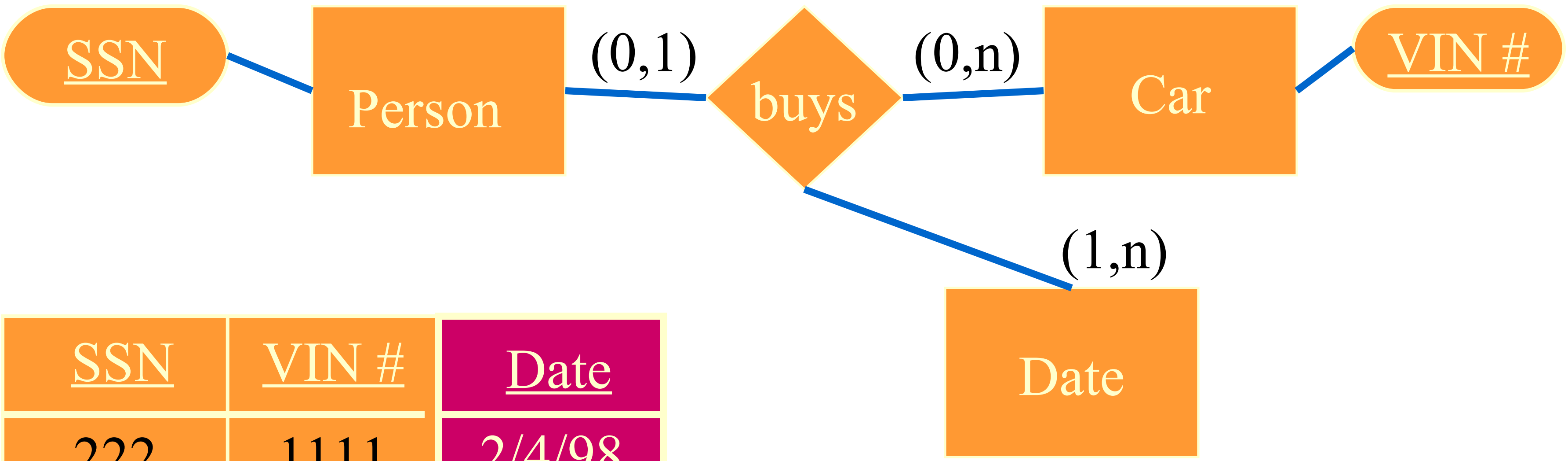


SSN	VIN #	Date
222	1111	2/4/98
333	5555	5/8/00
444	8888	11/3/77

Now can we add to the table?

222	1111	10/02/99

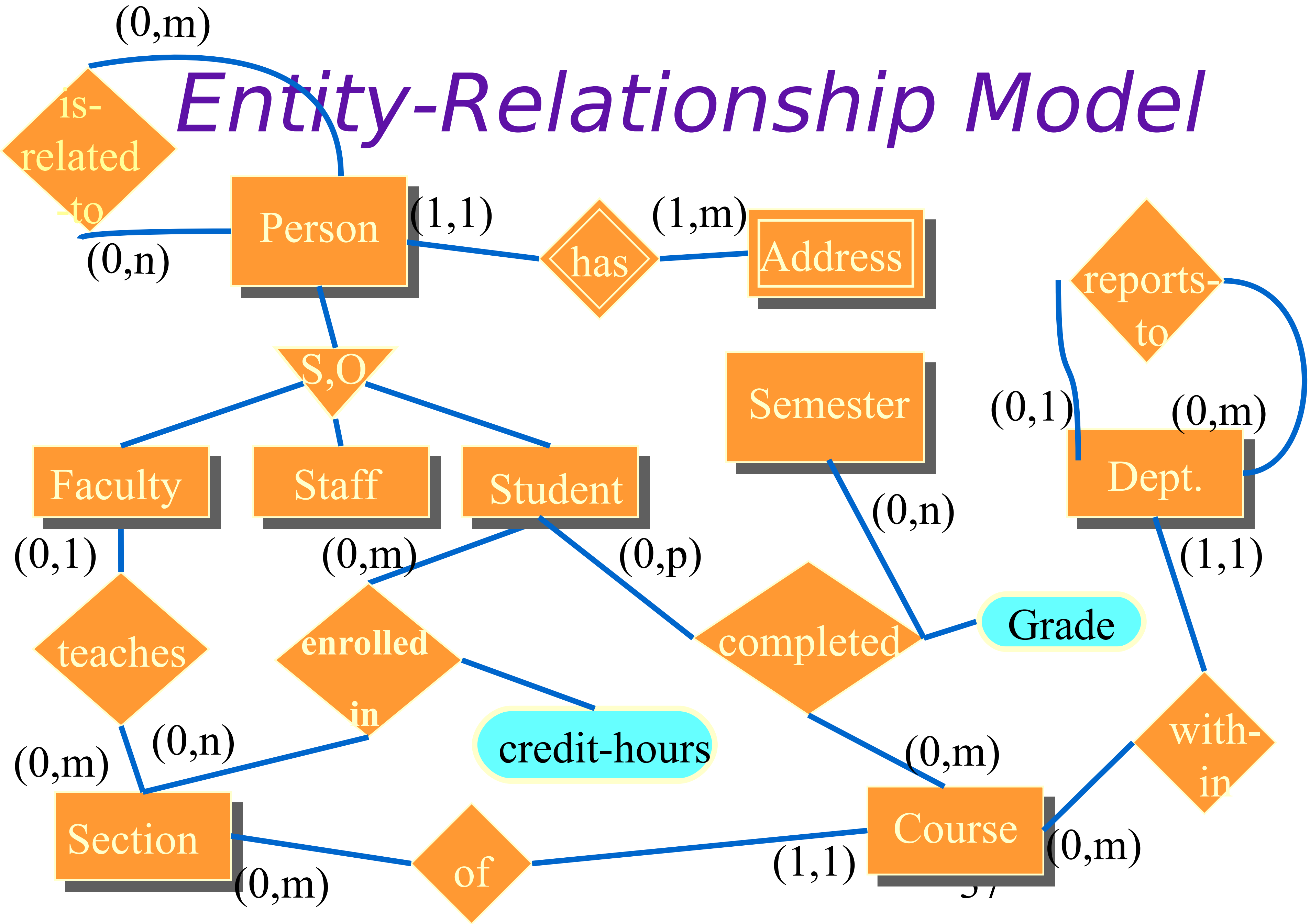
Interesting Construct



SSN	VIN #	Date
222	1111	2/4/98
333	5555	5/8/00
444	8888	11/3/77
222	1111	10/02/99

YES, because the Date attribute is part of the key.

Entity-Relationship Model



ENTITIES

Entity-Relationship Model

- Person
  - SSN (Identifier)
  - Name
  - Birth-Date
  - Beginning Date
- Address
  - Type (discriminator)
  - Street
  - City
  - State
  - Zip
- Faculty
  - SSN (Identifier)
  - Contact hours
  - Tenure status
- Staff
  - SSN (Identifier)
  - Position
- Student
  - SSN (Identifier)
  - Overall GPA
  - Major

ENTITIES

Entity-Relationship Model

- Dept.
  - Dept-Code (ID)
  - Dept-Name
  - Dept-Address
  - Dept-Chair
- Course
  - Crse-Code (ID)
  - Crse-Title
  - Crse-Max-Credit-Hours
  - Crse-Var-Hours-Code
  - Crse-Fee
- Section
  - Sect-Code (ID)
  - Sect-Credit-Hours
  - Sect-Meet-Time
  - Sect-Meet-Day
- Semester
  - Sem-Yr (ID)
  - Sem-Session (ID)

Entity-Relationship Model

RELATIONSHIPS with attributes

- Student enrolled-in Section
  - Credit-hours
    - In a variable credit section this attribute would be used to hold the credit hours for which a specific student is enrolled.
- Completed
  - Grade
    - A student is allowed to take a course more than once.