CS 325 Week 4-2

intro to entity-relationship modeling part I (DB Reading Packet 4)

ENTITY-RELATIONSHIP MODELING!

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- NOTE: if you do additional reading on this, that's great! The more you practice the better. BUT you are expected to use the CS 325 class style standards for E-R models that I have to look at... 8-)

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- data modeling is the process of creating a representation of the users' view of the data (in some setting or scenario)

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- data modeling is the process of creating a representation of the users' view of the data (in some setting or scenario)
    - can have a LARGE effect on the usability of an eventual database!

ENTITY-RELATIONSHIP MODELING!

- IMPORTANT PHILOSOPHY HERE:
    - you will have a much better chance of building a robust, usable database for a scenario if you MODEL it BEFORE deciding on its relations/tables!!!!!!!!!!!!!!!

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  - you will have a much better chance of building a robust, usable database for a scenario if you MODEL it BEFORE deciding on its relations/tables!!!!!!!!!!!!!!!
- so that's the idea here:
  - FIRST you model the scenario,
  - THEN you convert that model into appropriate corresponding relations/tables

ENTITY-RELATIONSHIP MODELING!

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- while an entity (class) will EVENTUALLY be converted to ONE or MORE tables in an eventual database DESIGN, IN THE MODELING PHASE, YOU SHOULD NOT BE THINKING IN TERMS OF TABLES YET!!
- if you are E-R modeling, you should be trying very hard to think in terms of ENTITY (classes)!

ENTITY-RELATIONSHIP MODELING!

- a quick definition: AFTER the modeling, THEN we will convert the E-R model we come up with into a Database DESIGN/database schema:
  - database design? database schema?
  - Its the STRUCTURE of the relations in a database and their relationships;

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  - here's a slightly more pragmatic definition than the very mathematical one from last week:
    - [from Kroenke's Database Design text]
    - it include relations/tables,
    - its relationships,   <-- we'll define those via foreign keys
    - domains,   <-- of its attributes
    - business rules   <-- are day-to-day "rules"-of-thumb within the scenario

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  - business rules <-- are day-to-day "rules"-of-thumb within the scenario
- (you can think of business rules as being one way to state some of the so-called constraints on allowable data values...)
- depending on how you express this, it CAN be pretty DBMS-software independent;

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- E-R models!
- These were introduced by Peter Chen in a 1976 paper;
- a model created via E-R modeling is often called an E-R model, and is often depicted using an E-R diagram!
- The "base" objects in an E-R model are:
  - entities (or entity classes)
  - attributes
  - identifiers
  - relationships

ENTITY-RELATIONSHIP MODELING!

- ENTITIES and entity classes!
  - entity: is a thing that exists and is distinguishable from other things
  - ...it needs to be something that can be identified within a scenario or a setting; that the users within may want to track

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        - an entity can be concrete or abstract
            - A particular student at a University
            - A particular course at that University
        - an entity CLASS is a SET of entities of the same type
            - the SET of students at a University
            - the SET of courses at that University

ENTITY-RELATIONSHIP MODELING!

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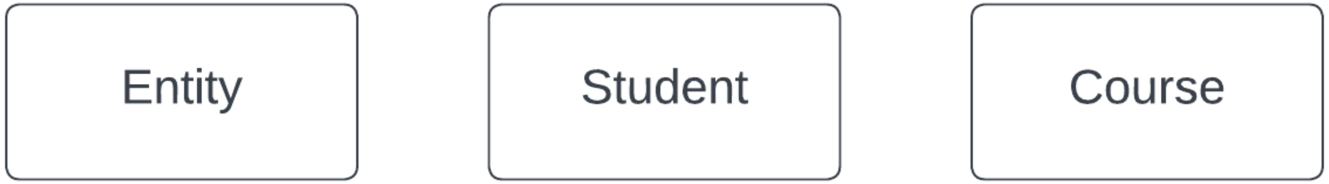
  - entity: is a thing that exists and is distinguishable from other things
  - ...it needs to be something that can be identified within a scenario or a setting; that the users within may want to track
    - an entity can be concrete or abstract
    - an entity CLASS is a SET of entities of the same type
    - in an E-R model:
      - we want to determine the entity classes that are significant in a scenario;
      - entity classes CAN be disjoint, but they don't have to be;

ENTITY-RELATIONSHIP MODELING!

- ENTITIES and entity classes!
  - In an E-R diagram (depicting an E-R model), an entity class is typically depicted as a labeled rectangle (this part IS common!)



Question

Consider an independent, mom-and-pop art-supply store that has been in its same historic location since 1977. Which of the following are most likely to be entity classes in that scenario?

1) CleanLine extra-fine brush, Vivid brand tempera paint
2) Brush, Paint
3) Brush_width, Paint_color
4) art-supply store

ENTITY-RELATIONSHIP MODELING!

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    - really, in an E-R model, an entity instance is represented by a set of attributes;
      - Think about what may be the attributes for a department or customer?

ENTITY-RELATIONSHIP MODELING!

- ATTRIBUTES
  - attributes or properties describe entity class CHARACTERISTICS that are important or significant to the users in a scenario
    - really, in an E-R model, an entity instance is represented by a set of attributes;
    - You need to consider:
      - what are significant or important characteristics of an instance of this entity class to those in the scenario?
      - what is ethical or legal to keep track of?
      - what is practical to keep track of?

ENTITY-RELATIONSHIP MODELING!

- ATTRIBUTES
  - attributes or properties describe entity class CHARACTERISTICS that are important or significant to the users in a scenario
    - how are these depicted in an E-R model, in an E-R diagram

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  - attributes or properties describe entity class CHARACTERISTICS that are important or significant to the users in a scenario
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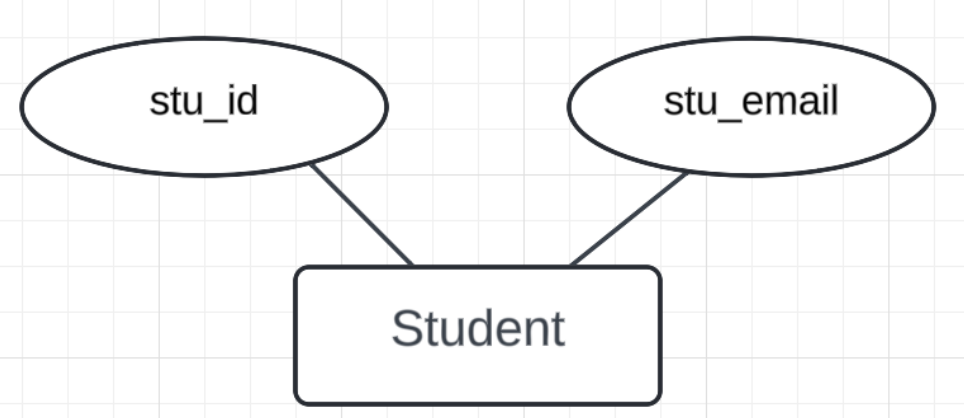
      - you'll see them depicted in ovals attached to the entity class rectangle -- but that's clunky unless you have special software to deal with that;



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            - BUT, for simplicity and easy-depicting, I will make a list of such attributes labeled by the entity class name, placed "nearby“

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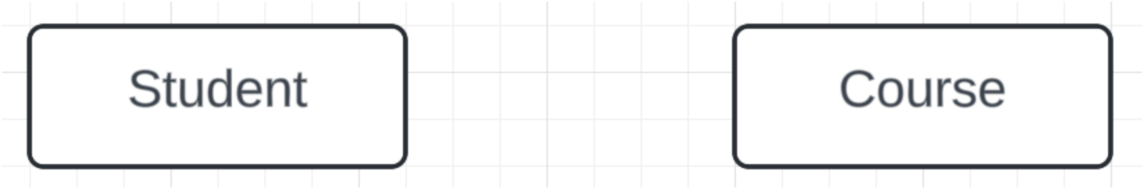
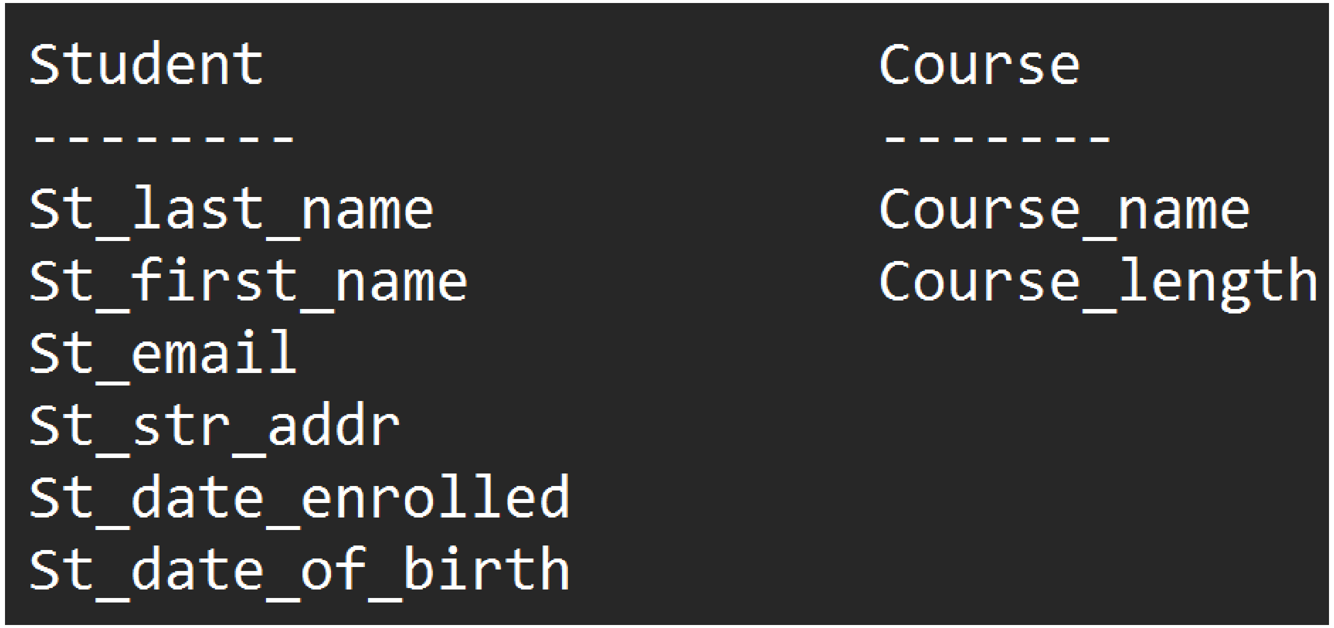
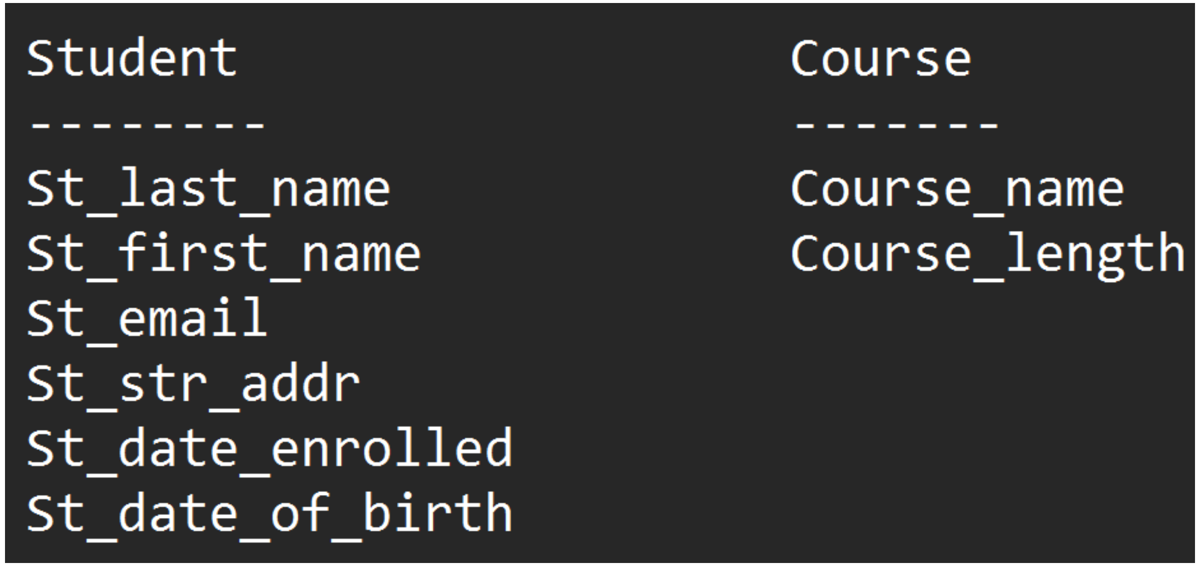




```
Student                  Course
--------                 -------
St_last_name             Course_name
St_first_name            Course_length
St_email
St_str_addr
St_date_enrolled
St_date_of_birth
```

ENTITY-RELATIONSHIP MODELING!

- ATTRIBUTES
  - and notice that each of these attributes has a DOMAIN, a set of possible values....



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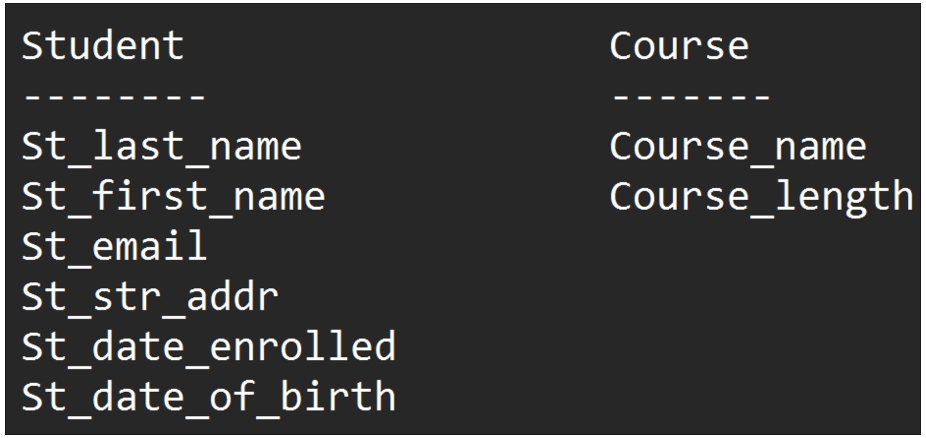
  - and notice that each of these attributes has a DOMAIN, a set of possible values....
  - some approaches have you create and document a data dictionary giving the domains for each attribute;
  - We WILL, note when attributes are MULTI-VALUED -- when ONE entity instance might REASONABLY have multiple values for that attribute;



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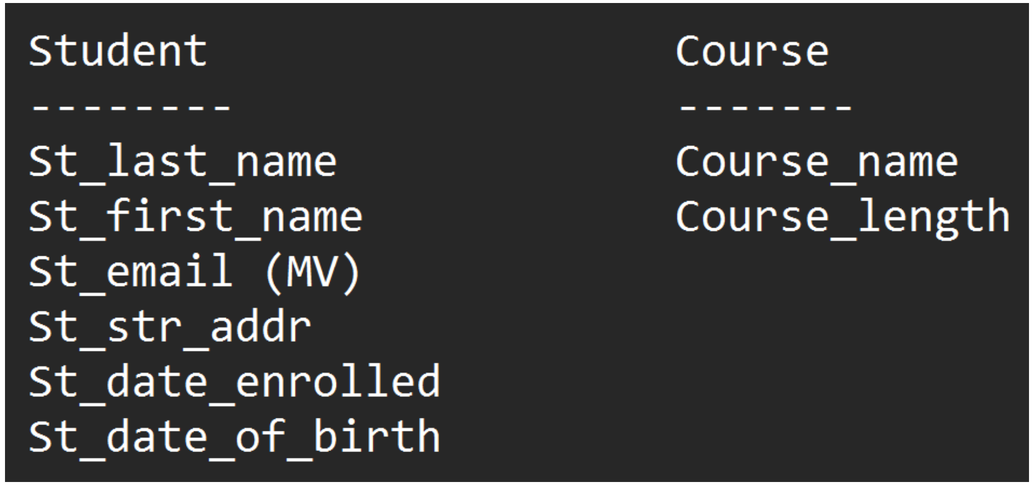
  - some approaches have you create and document a data dictionary giving the domains for each attribute;
  - We WILL, note when attributes are MULTI-VALUED -- when ONE entity instance might REASONABLY have multiple values for that attribute;
    - we'll (our approach) mark multi-valued attributes with (MV) after the attribute's name



```
Student                  Course
--------                 -------
St_last_name             Course_name
St_first_name            Course_length
St_email (MV)
St_str_addr
St_date_enrolled
St_date_of_birth
```

Question

Which of the following are most likely to be attributes in the model for our independent, mom-and-pop art-supply store scenario?

1. CleanLine extra-fine brush, Vivid brand tempera paint
2. Brush, Paint
3. Brush_brand, Paint_grade
4. '3/4 inch', 'Lovely Lavendar'

CONTINUING our INTRO to E-R modeling!

- IDENTIFIERS
    - how do people in a scenario tell instances of an entity class apart?

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    - how do people in a scenario tell instances of an entity class apart?
    - ...at the modeling level, the attributes they use for that are called identifiers
        - SOME ENTITY CLASSES DO NOT HAVE IDENTIFIER ATTRIBUTES. (we'll talk about why this can be useful later!)
        - Identifiers NOT necessarily primary keys! Because at the early model stage, entity classes ARE NOT RELATIONS
        - (each entity class will EVENTUALLY be turned into ONE OR MORE relations IN a database design LATER!!!!!!!)

CONTINUING our INTRO to E-R modeling!

- IDENTIFIERS
  - BUT we do like to indicate these identifying attributes (when they exist) in our models, and our CLASS STANDARD (for now) will be to write these identifying attribute names in ALL-UPPERCASE

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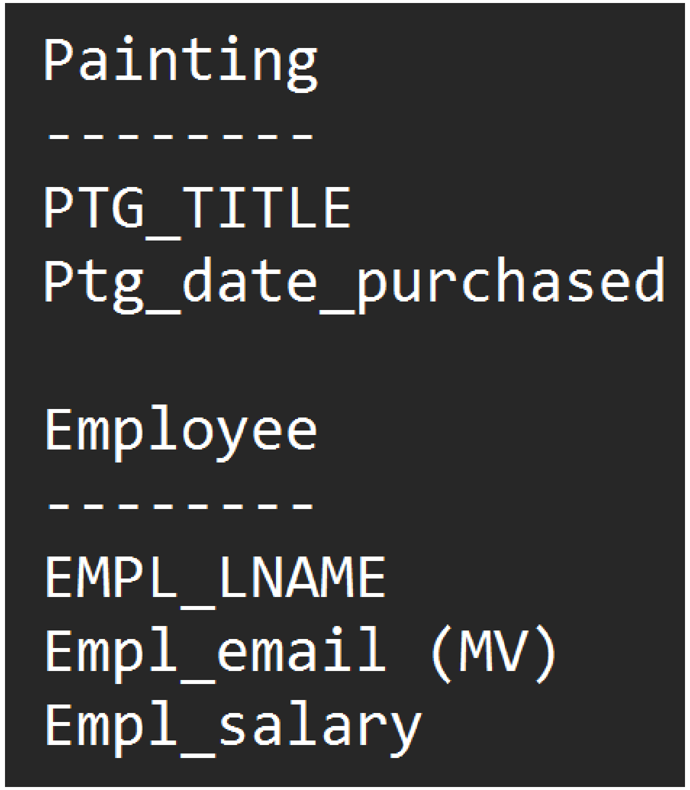

```
Painting
--------
PTG_TITLE
Ptg_date_purchased

Employee
--------
EMPL_LNAME
Empl_email (MV)
Empl_salary
```

CONTINUING our INTRO to E-R modeling!

- RELATIONSHIPS
  - the R in the E-R model!!!!!
  - a relationship class is an association that can be between entity classes (and is significant in the users' scenario)

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- RELATIONSHIPS
  - the R in the E-R model!!!!!
  - a relationship class is an association that can be between entity classes (and is significant in the users' scenario)
  - a relationship instance is an association that can be between entity instances
    - a Customer might be able to have an Account;
    - Customer Harris has Account 23657

CONTINUING our INTRO to E-R modeling!

- RELATIONSHIPS
  - in the E-R model, we want to give a name describing each relationship;
    - might be "verb"-y, describing the nature of the relationship;
    - might be a combo of the names of the entity classes involved;
    - might be a combo of the above...!

CONTINUING our INTRO to E-R modeling!

- RELATIONSHIPS
  - How can you indicate a relationship in an E-R diagram depicting an E-R model?
    - it is pretty typical to draw a LINE between entity class rectangles to indicate a relationship within an E-R model;
    - Our Class Standard:
      - to draw a line with a DIAMOND between the two related entity classes, and we'll LABEL that diamond (on or near that diamond, either is fine) with its descriptive name

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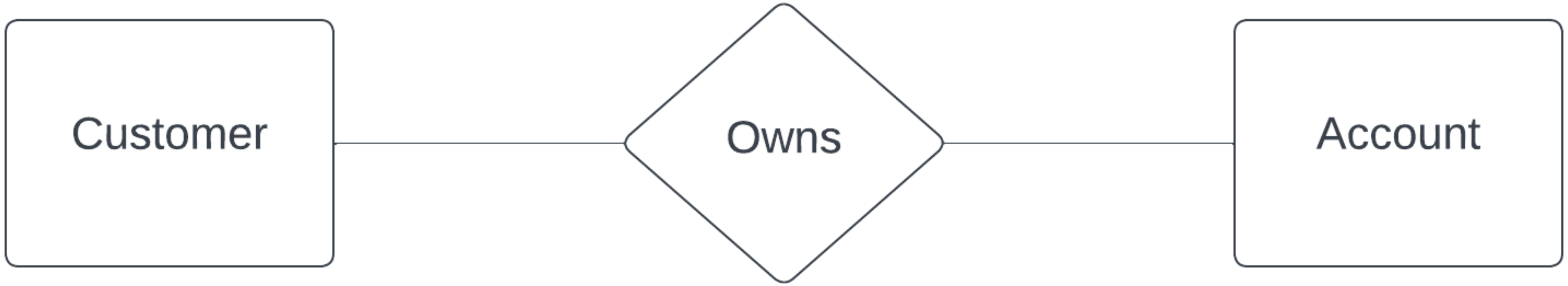

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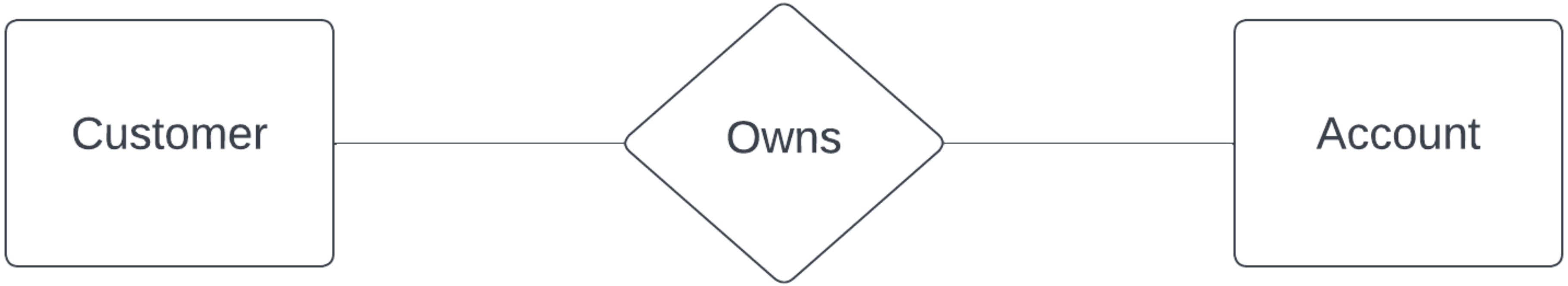
    - it is NOT required that the name be reasonably-readable in BOTH directions!



Question

Consider the following entity classes within an art-supply store ER-model: Paint, Brush, Sale_item, Customer, Supplier, Order, Sale

Which of the following is an example of a relationship within this model?

1. available-from, between Sale_item and Supplier
2. 'Lovely Lavendar', between color and paint
3. Paint, between Sale and Customer
4. a Customer may use at most one coupon for a Sale

CONTINUING our INTRO to E-R modeling!

- DEGREE of a relationship
  - Is the number of entities involved in that relationship
  - a relationship of degree 2, or a binary relationship, is between TWO entities;

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- DEGREE of a relationship
  - Is the number of entities involved in that relationship
  - a relationship of degree 2, or a binary relationship, is between TWO entities;
    - if a relationship being modeled is of degree more than two, we will "break" that into 2 or more binary relationships;
    - (possibly adding small entity classes to make this work and to possibly be where characteristics of such a relationship would be placed;)

CONTINUING our INTRO to E-R modeling!

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CONTINUING our INTRO to E-R modeling!

- MODELING can be ... an INTERESTING process!
  - it CAN be tricky sometimes to distinguish between attributes and entity classes!
  - it CAN be tricky to distinguish between attributes and relationships between entity classes!

Question

Assume that, in an art supply store E-R model, there is a Sale entity class, and a Paint entity class.

Which of the following is a reasonable attribute to include in the Sale entity class's attribute list?

1. attribute Paint_sold
2. attribute Paint
3. attribute Sale_Date
4. attribute Paint_color

CONTINUING our INTRO to E-R modeling!

- MODELING can be ... an INTERESTING process!
  - it CAN be tricky sometimes to distinguish between attributes and entity classes!
  - it CAN be tricky to distinguish between attributes and relationships between entity classes!
    - remember: the attributes in an E-R MODEL should be characteristics of ONE instance of that entity class – be careful that you don't treat a relationship as an attribute
      - avoid "burying" a relationship in your attributes...
      - LINES are used to indicate relationships between entity classes at the modeling stage!!!!!!!!!!!!!

CONTINUING our INTRO to E-R modeling!

- CARDINALITIES of relationships

CONTINUING our INTRO to E-R modeling!

- CARDINALITIES of relationships
  - maximum cardinalities
  - minimum cardinalities

CONTINUING our INTRO to E-R modeling!

- maximum cardinalities:
  - for a given relationship, for an entity instance in one of the entity classes involved, HOW MANY instances of the OTHER class CAN this entity instance be related to (in this relationship)?
  - the numbers we really care about:
    - One or Many!
    - 1 or (N or M)

CONTINUING our INTRO to E-R modeling!

- maximum cardinalities:
    - for a given relationship, for an entity instance in one of the entity classes involved, HOW MANY instances of the OTHER class CAN this entity instance be related to (in this relationship)?
    - the numbers we really care about:
        - One or Many!
        - 1 or (N or M)
    - the 4 possible maximum cardinality possibilities we care about in the modeling phrase:
        - 1:1 - one-to-one
        - 1:N (some people also include N:1) - one-to-many (sometimes also many-to-one)
        - N:M - many-to-many

CONTINUING our INTRO to E-R modeling!

- maximum cardinalities:
  - 1:1 - in a relationship R between entity class A and entity class B, R has a maximum cardinality of 1:1 if
    - an entity instance in A can be related to AT MOST one entity instance in B, AND
    - an entity instance in B can be related to AT MOST one entity instance in A
    - not all that common, actually!

CONTINUING our INTRO to E-R modeling!

- maximum cardinalities:
  - 1:N - in a relationship R between entity class A and entity class B, R has a maximum cardinality of 1:N if
    - an entity instance in A can be related to MORE THAN ONE entity instance in B, BUT
    - an entity instance in B can be related to AT MOST one entity instance in A
    - REALLY common! (arguably the MOST common) in most scenarios;

Question

Which of the following is most likely to be a 1:N relationship in a model?

1. available-from, a relationship between Sale_item and Supplier
2. sells-to, a relationship between Sale and Customer
3. enrolled-in, a relationship between Student and Course

CONTINUING our INTRO to E-R modeling!

- maximum cardinalities:
  - N:M - in a relationship R between entity class A and entity class B, R has a maximum cardinality of N:M if
    - an entity instance in A can be related to MORE THAN ONE entity instance in B, AND
    - an entity instance in B can be related to MORE THAN ONE entity instance in A
    - more common than 1:1, less common (usually) than 1:N

Question

Maximum cardinalities are typically one of what two values?

1. one or many
2. N or M
3. one or zero
4. minimum or maximum

CONTINUING our INTRO to E-R modeling!

- maximum cardinalities:
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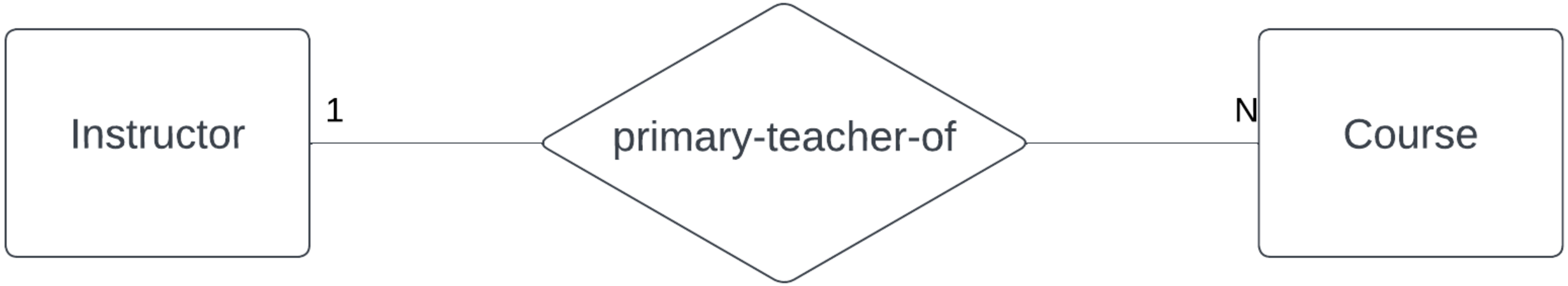
    - 1:1 - one-to-one
    - 1:N (some people also include N:1) - one-to-many (sometimes also many-to-one)
    - N:M - many-to-many
  - THIS IS IMPORTANT to NOTE in an E-R MODEL! (REALLY affects the tables in the eventual design!)
    - SO many different ways to SHOW this!
    - Our Class Standard:

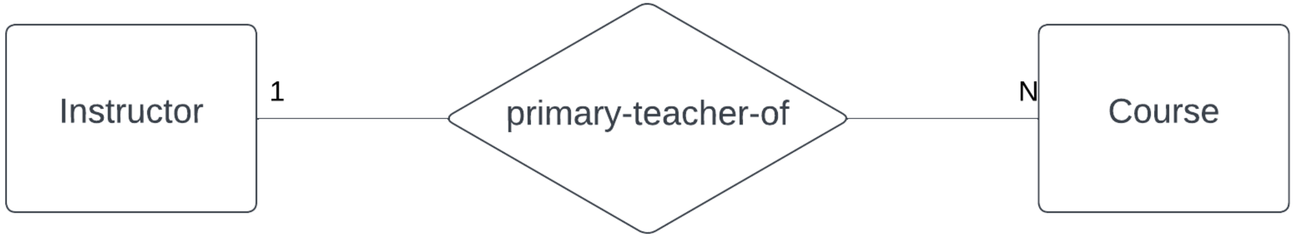
CONTINUING our INTRO to E-R modeling!

- maximum cardinalities:
  - Our Class Standard:
    - put a 1 or M or N NEAR the relationship line NEAR the entity class rectangle involved;
    - but you read these "across" the relationship line;



CONTINUING our INTRO to E-R modeling!

- maximum cardinalities (this is what these instances CAN have):
  - Our Class Standard:
    - put a 1 or M or N NEAR the relationship line NEAR the entity class rectangle involved;
    - but you read these "across" the relationship line;
    - this means an instructor instance can be the primary-teacher-of MORE than one course,
    - BUT a course instance can only have ONE instructor instance who is its primary-teacher;



Question

Which of the following is most likely to be an N:M relationship in a model?

1. has-record, a relationship between Student and Grade-record
2. makes-up, a relationship between Sale_line_item and Sale
3. works-on, a relationship between Volunteer and Project
4. main-contact-for, a relationship between Volunteer and Project

CONTINUING our INTRO to E-R modeling!

- MINIMUM CARDINALITIES
  - minimum cardinalities
  - for a given relationship, for an entity instance in one of the entity classes involved, HOW MANY instances of the OTHER class MUST this entity instance be related to (in this relationship)?

CONTINUING our INTRO to E-R modeling!

- MINIMUM CARDINALITIES
  - minimum cardinalities
  - for a given relationship, for an entity instance in one of the entity classes involved, HOW MANY instances of the OTHER class MUST this entity instance be related to (in this relationship)?
  - the numbers we really care about:
    - One or Zero!
    - MUST the relationship exist for an entity instance, or may it NOT exist?

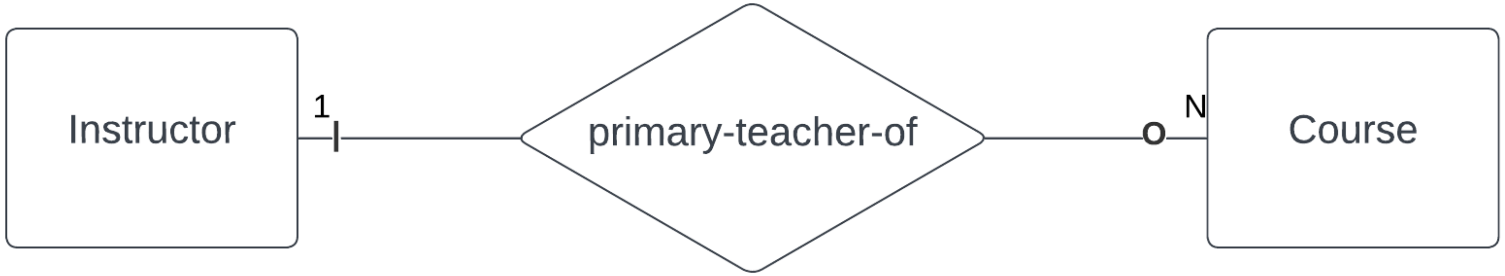
Question

Minimum cardinalities are typically one of what two values?

1. one or many
2. N or M
3. one or zero
4. minimum or maximum

CONTINUING our INTRO to E-R modeling!

- MINIMUM CARDINALITIES
  - Our class style standard:
    - put an OVAL or a LINE NEAR the relationship line NEAR the entity class rectangle involved;
    - this means an instructor instance does not have to be the primary-teacher-of any course
    - BUT a course instance MUST have an instructor instance who is its primary-teacher;
    - this is what these instances MUST have; (or may not be required to have)



Question

Consider the relationship works-on, a relationship between Volunteer and Project. It turns out that a project has to have at least one volunteer working on it, but a volunteer doesn't have to necessarily work on any projects. Which of the following is correct for indicating the minimum cardinality of this relationship?

1. put an N on the relationship line near Volunteer, and an M on the relationship line near Project
2. put a hash on the relationship line near Volunteer, and an oval on the relationship line near Project <-- correct
3. put an N on the relationship line near Volunteer, and an oval on the relationship line near Project
4. put an oval on the relationship line near Volunteer, and a hash on the relationship line near Project