50.043 Database and Big Data Systems

Entity Relationship Model

Roy Ka-Wei Lee
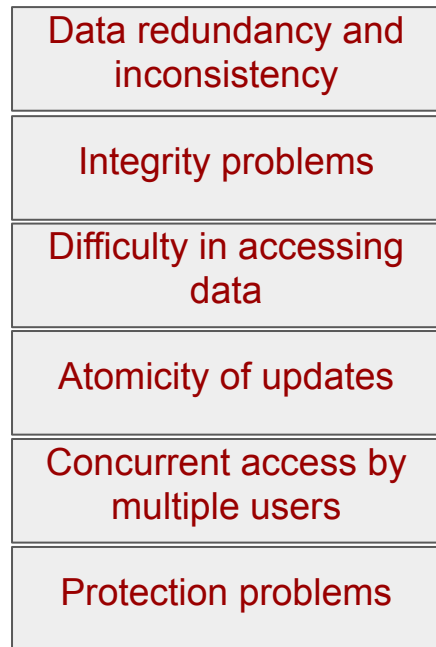Assistant Professor, ISTD, SUTD

Learning Outcome

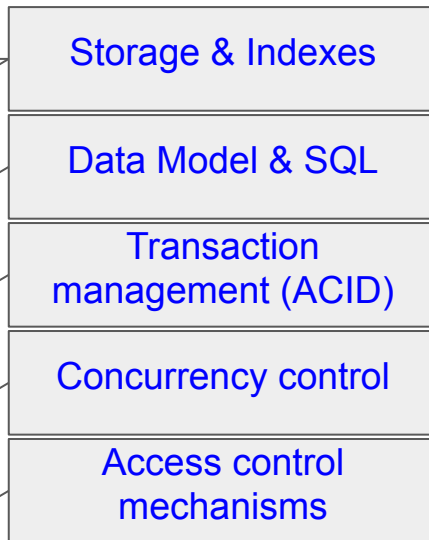By the end of this lesson, you should be able to

- Identify components of an Entity Relationship Diagram

- Interpret Entity Relation Model
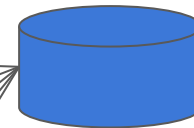
- Design and Draw ER diagrams

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Recap - Where We Left Off…

File System DB Issues	DB Techniques	DBMS

File System DB Issues
- Data redundancy and inconsistency
- Integrity problems
- Difficulty in accessing data
- Atomicity of updates
- Concurrent access by multiple users
- Protection problems

DB Techniques
- Storage & Indexes
- Data Model & SQL
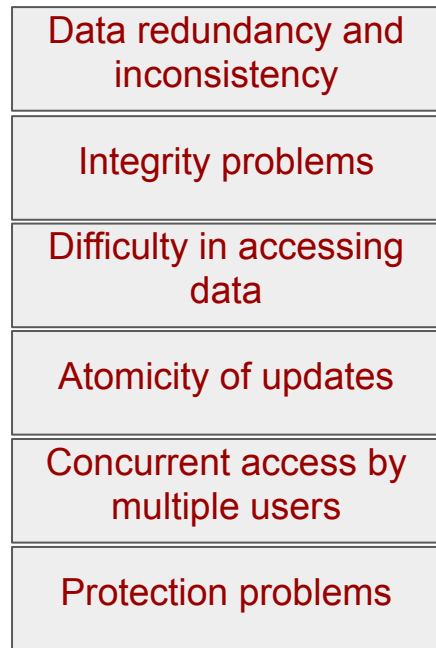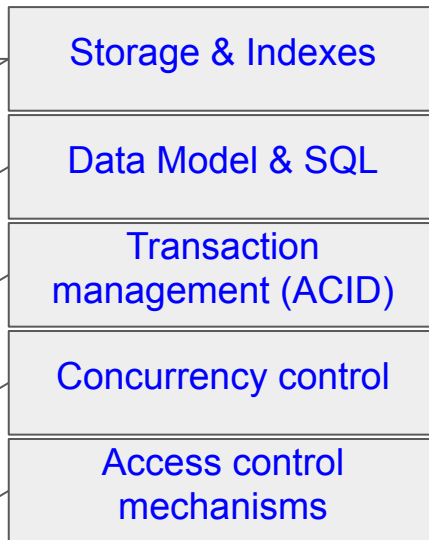- Transaction management (ACID)
- Concurrency control
- Access control mechanisms

DBMS

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File System DB Issues

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DB Techniques

- Storage & Indexes
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DBMS

But how do we design and build the database…

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Recall This Diagram….

Real world application → Conceptual Modeling → Logical Modeling | Physical Modeling → Database implementation

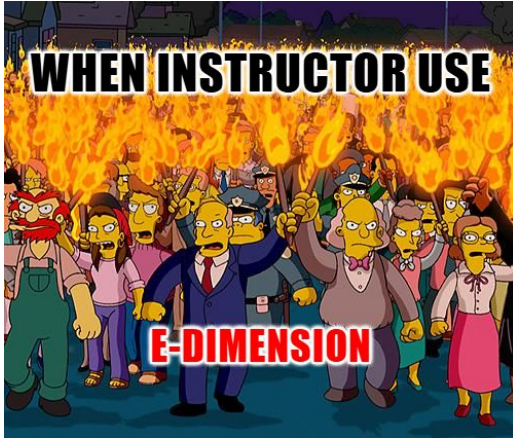We focus on this today!

A Typical Scenario

- eDimension sucks!

- I can write a better one!

- What database should I use?

Conceptual Modeling

- How do you **describe** the **application** to **other users**?
    - Easy (for others) to understand
    - Without ambiguity (bad example: *"it stores student profiles"*)
- A good way to do this: **Entity-Relationship (ER) Model**
    - Describe **what data** the application has

It all begins with a concept!

Purpose of E/R Model

- The E/R model allows us to sketch the design of a database informally.

- Designs are pictures called *entity-relationship diagrams*.

- Fairly mechanical ways to convert E/R diagrams to real implementations like relational databases exist.

ER Model

- A graphical diagram
- Building blocks:
  - Entity set: a collection of similar objects
    - Object = entity
    - Represented by a **rectangle**
  - Attribute: property of an entity
    - Entities in the same entity set have the same set of attributes
    - Represented by an **oval**
  - Relationship: connection between entity sets
 - Represented by a **diamond**

Entity

Attribute

Relationship

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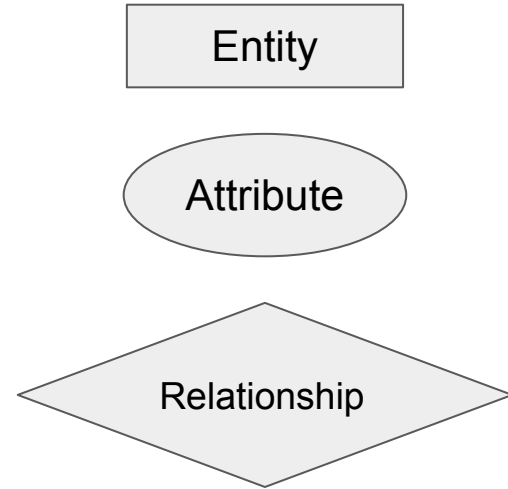
Entity Set

- *Entity* = "thing" or object.
- *Entity set* = collection of similar entities.
  - Similar to a class in object-oriented languages.
  - It's a **set** (pls remember!) - Every entity is unique!
- 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.
- Primary Key:
  - *minimal set of attributes* that uniquely identifies an entity in the set
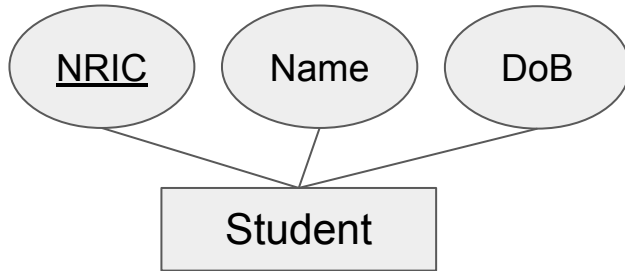- Example: Passport vs (Passport, Mobile, DoB, Name)?
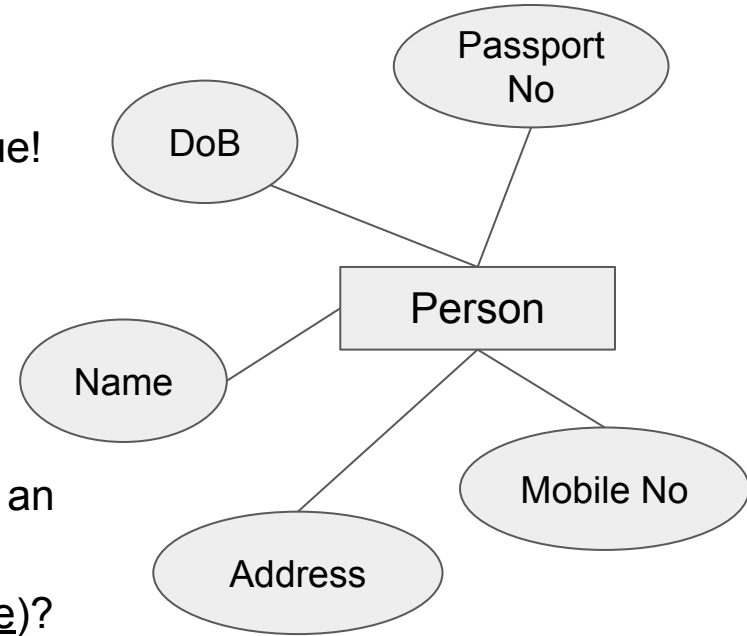
Relationship

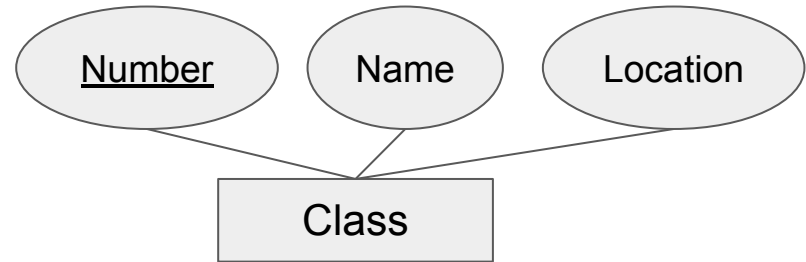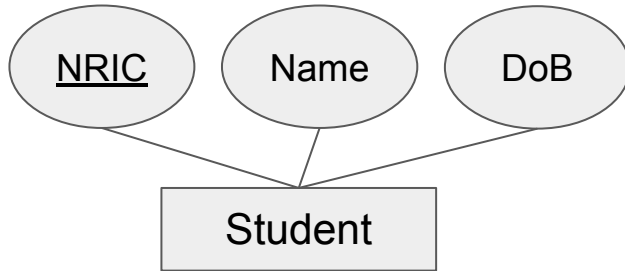- A relationship connects two or more entity sets.
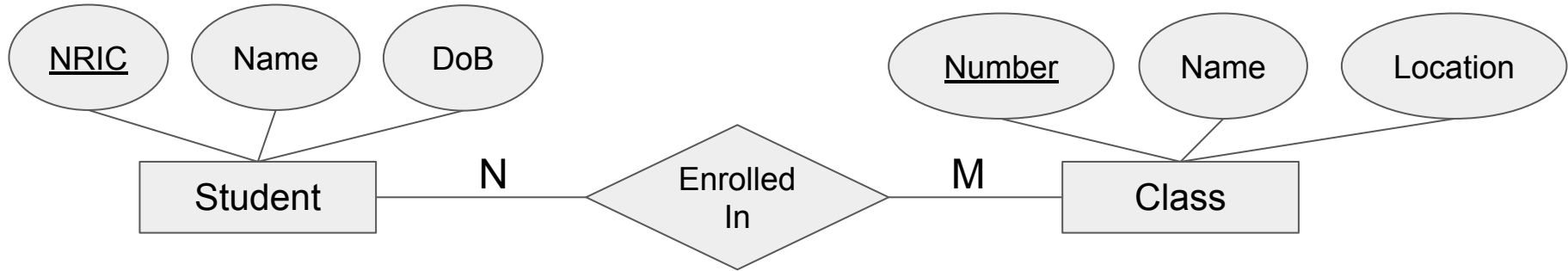
Relationship - Step by Step Example

- A student (entity) as the following attributes:
  - Class Number (which uniquely identify the class)
  - Name
  - Location

```
  (NRIC)    (Name)    (DoB)
      \        |        /
       [    Student    ]
```
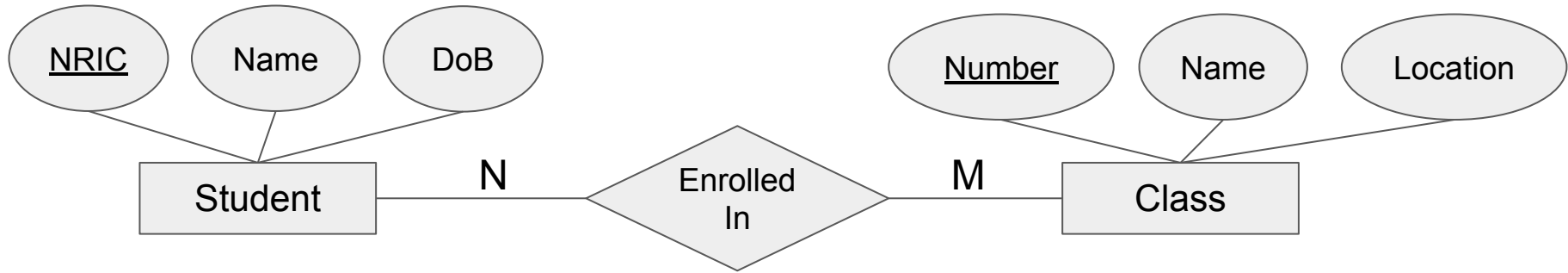
Relationship - Step by Step Example

- A class (entity) as the following attributes:
  - NRIC (which uniquely identify the student)
  - Name
  - Date of Birth

```
  ( NRIC )   ( Name )   ( DoB )
       \        |        /
        [    Student    ]


  ( Number )  ( Name )  ( Location )
       \        |        /
        [     Class     ]
```
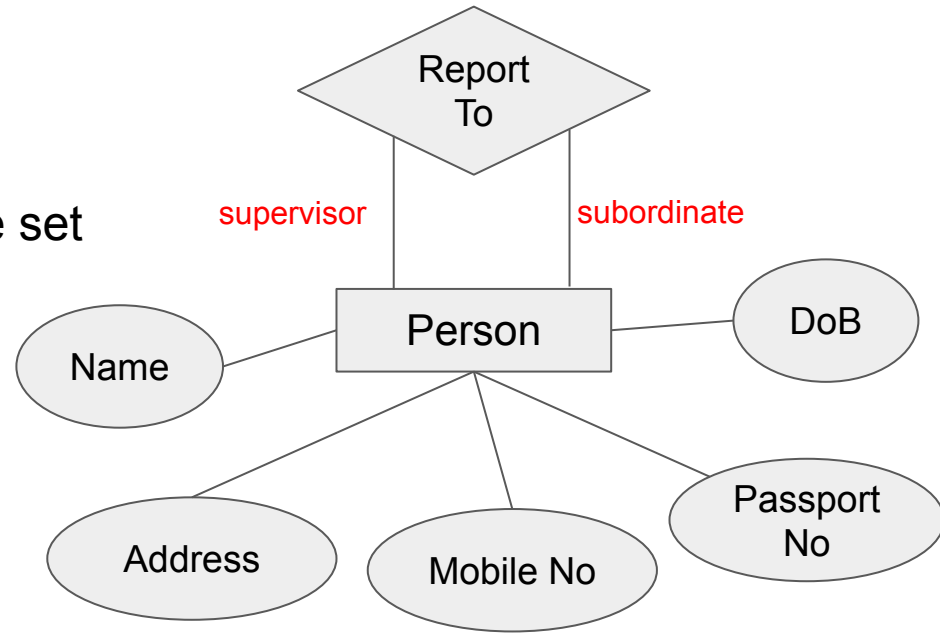
Relationship - Step by Step Example

- Each student can enroll in M class
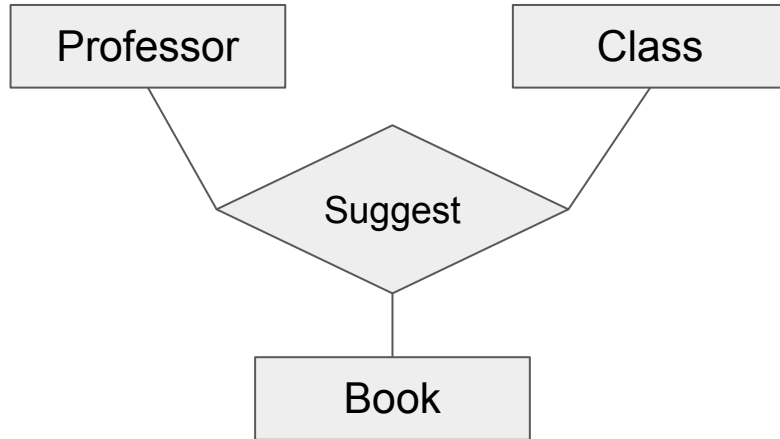- Each class can be enrolled by N students

Relationship - Entities of Same Set

- How about relationship between entities of the same set
    - *Prof / Student*
    - *Supervisor / Subordinate*
    - *Husband / Wife*
- <u>Role</u>: model relationship in the same set
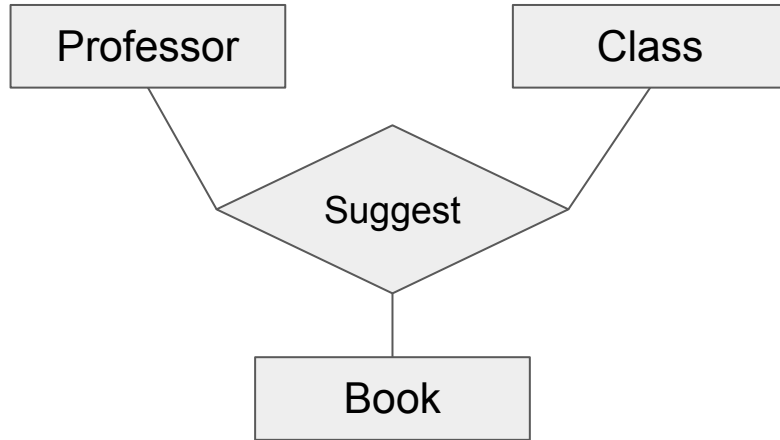
Multi-Way Relationship

- More than 2 entity sets
  - Example: *A professor can suggest books used in a class*

Multi-Way Relationship

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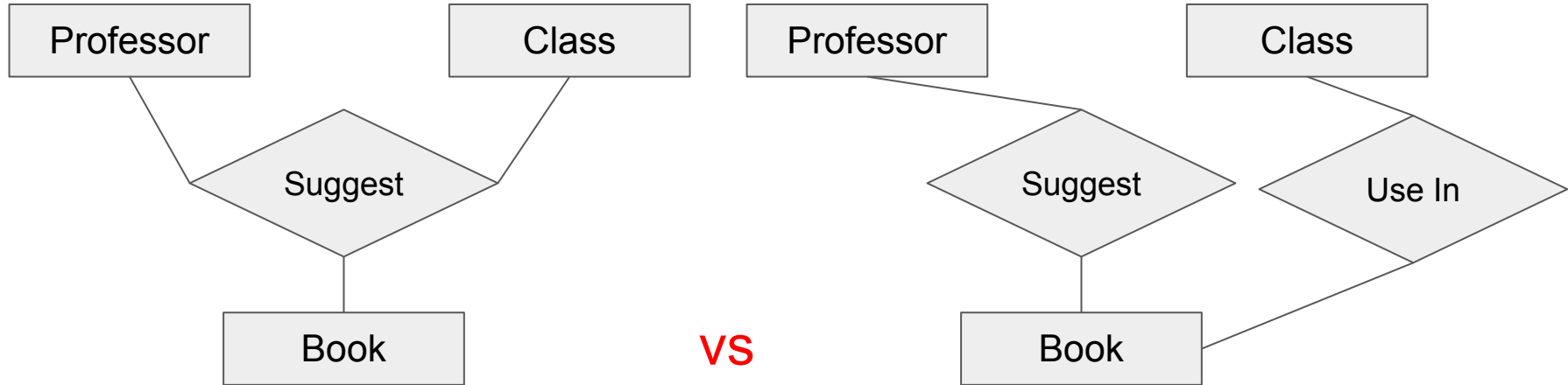   - Example: *A professor can suggest books used in a class*

Professor

Class

Suggest

Book

OMG What is this Situationship?! Can simplify?

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Multi-Way Relationship

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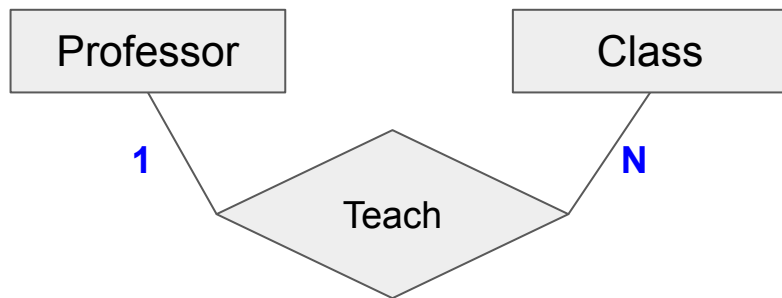 - Example: *A professor can suggest books used in a class*

VS

Cardinality Constraints

- Cardinality constraints
 - Entity in set A related to *how many* entities in set B

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    - *Each professor teaches **many** classes, each class has at most **1** professor*
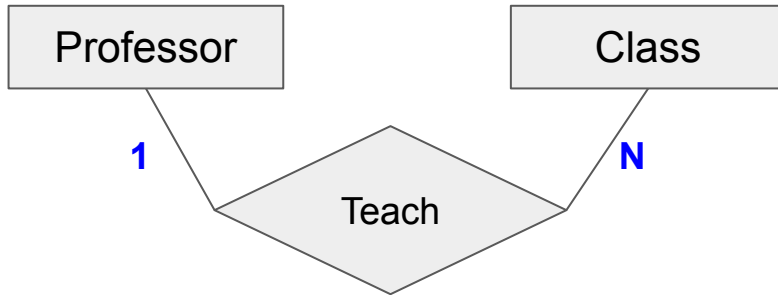
Cardinality Constraints

- Cardinality constraints
  - Entity in set A related to *how many* entities in set B
- Example:
  - *Each professor teaches **many** classes, each class has at most **1** professor*
  - *Each professor teaches at most **1** class, each class can be taught by **multiple** professors*
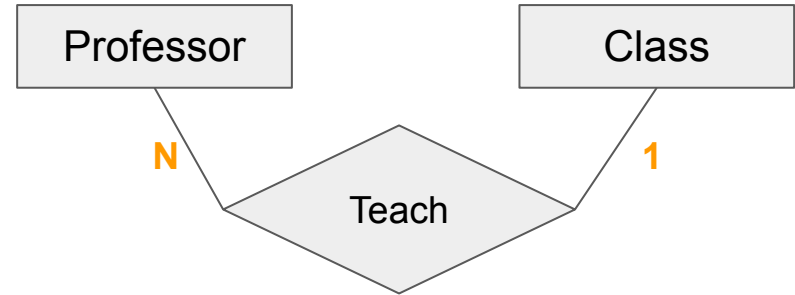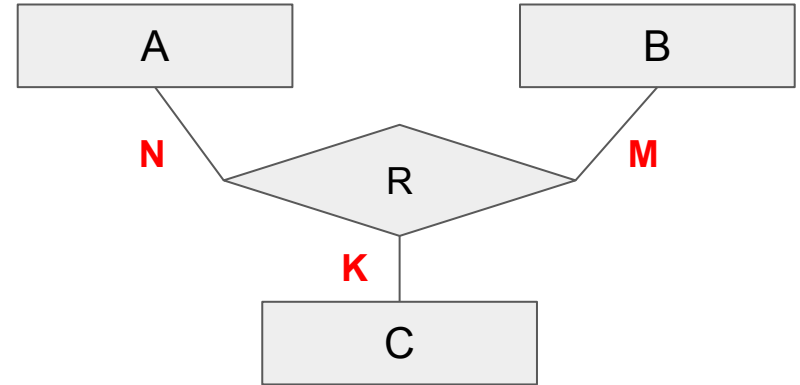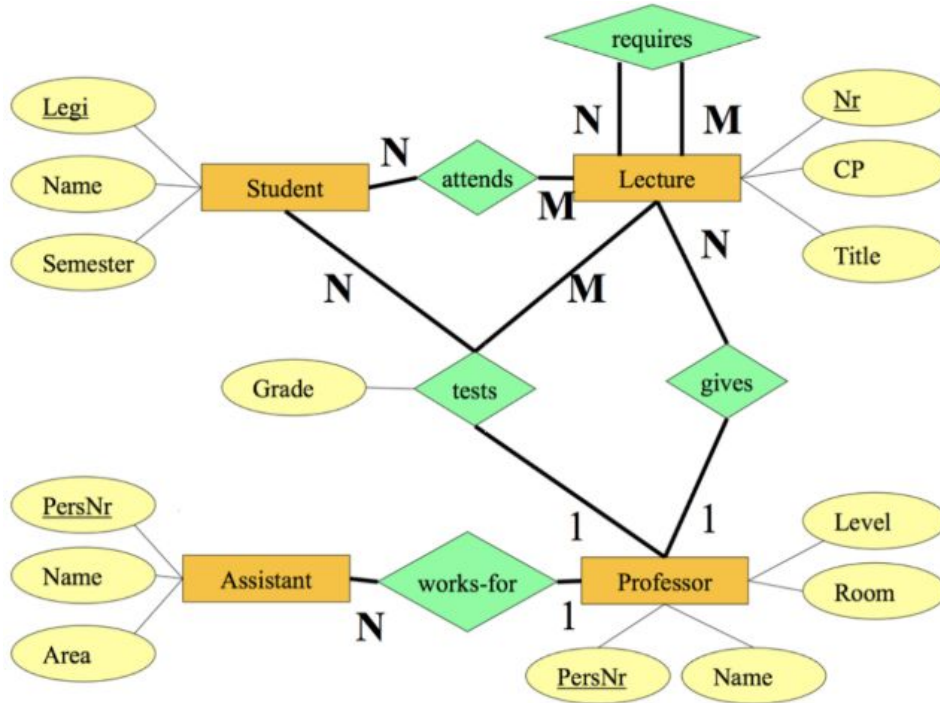
Cardinality Constraints - More Examples

1 entity in A has relation R to **M** entities in B
1 entity in B has relation R to **N** entities in A
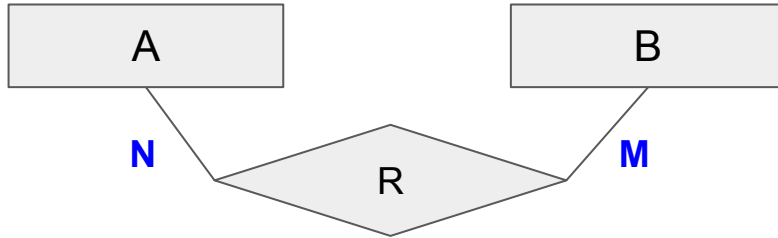
1 *pair* of entity in (A,B) has relation R to **K** entities in C
1 *pair* of entity in (A,C) has relation R to **M** entities in B
1 *pair* of entity in (B,C) has relation R to **N** entities in A

Quiz Time!

Explain this ER Diagram!

What you should know?

- What are the components of an Entity Relationship Diagram?

- How to interpret Entity Relationship Model?

- How to design and draw ER diagrams?

Reading Resources:
- https://www.geeksforgeeks.org/introduction-of-er-model/
- https://sutd50043.github.io/notes/l1_er/

Please work on Cohort 1!

Acknowledgement

- *The following material have been referenced or partially used:*
  - *MIT Database Systems (6.830)*
  - *University of Washington: Introduction to Data Management (CSE344)*
  - *CMU Database Systems (15-445/645)*
  - *ETH's Data Modeling and Databases (252-0063-00L)*
  - *ETH's Big Data For Engineers*
  - *Yale's Database System Concepts Seventh Edition (https://codex.cs.yale.edu/avi/courses/CS-437/slides/index.html)*
  - *Stanford CS145 http://infolab.stanford.edu/~ullman/dscb/gslides.html*