Tutorial 1

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How to Best Make Use of Tutorials

Treat material presented in these slides as a supplement to Prof. Zarnett's lecture slides, given from a slightly different perspective.

If you notice that this perspective could be wrong, don't hesitate to speak up!

We will also walk through some exercises in tutorial to serve as practice.

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The Entity-Relationship Model

In short, this model lets us represent:

- tables in a database with **mathematical sets**, and
- queries on the database with a language called the **relational algebra**.

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Nouns of the Relational Model (1/2)

A **relation** *R* is equivalent to a table.

An **attribute** *A* is equivalent to a column of a table.

We describe the combination of relation and attributes with a **relation schema** of the form $R(A_1, A_2, ..., A_n)$.

Student(student_number, name, address) tells us:

- there is a table called Student, and
- it has attributes name and address.

name is an attribute of the relation Student.

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Nouns of the Relational Model (2/2)

The **contents** of a relation R are denoted r(R).

r(R) is an (unordered) set of (ordered) **n-tuples**.

Each **n-tuple** of r(R) is equivalent to a row in the relation/table R.

The elements of each n-tuple correspond with the attributes $A_1, A_2, ..., A_n$ of R.

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Nouns of the Entity-Relationship Model (1/5)

An **entity** [table] is equivalent to a relation, which is equivalent to a table.

■ Student can be an entity in an E-R model.

However, we also use the term **entity** to describe an object in the real world, indistinguishable from other objects.

■ A student with student number 20000000 and name Matt is an entity of type Student.

In this way, an entity [object] is equivalent to a row of an entity [table].

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Nouns of the Entity-Relationship Model (2/5)

An **entity set** is a set of entities (in the object sense), and is equivalent to the contents of an entity table.

■ The set of all students studying at the University of Waterloo might comprise the entity set Student.

For instance, Student = {(20000000, Matt), (20000001, Josh)}

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Nouns of the Entity-Relationship Model (3/5)

Suppose we have another entity called Course, with attributes course_id and title.

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Then the following are two possible entity sets:
Student = {(20000000, Matt), (20000001, Josh)}
Course = {(CS101, Intro to CS), (CS999, Super Hard CS)}
```

A **relationship** describes some connection between entities, in both the table sense and the object sense.

- In our E-R model, we can say Student takes Course.
- An individual student like Matt can take a course like Intro to CS.

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Nouns of the Entity-Relationship Model (4/5)

A **relationship instance** describes how two entity instances are related. The following are each relationship instances:

- Matt takes Intro to CS: *takes*₁ = ((20000000, Matt), (CS101, Intro to CS))
- Josh also takes Intro to CS: takes₂ = ((20000001, Josh), (CS101, Intro to CS))
- Intro to CS is taught by Prof. X: taughtby₁ = ((CS101, Intro to CS), (1, Prof. X))

A **relationship set** is a set of relationship instances.

- In an E-R model, a relationship set represents how entities (in the table sense) are related.
 - Students take Courses: Takes = {takes₁, takes₂}
 - Courses are taught by Instructors: TaughtBy = {taughtby₁}

In an E-R model, we can use a table to represent a relationship set. Such a table will have columns to identify which entities are related.

- The StudentTakesCourse table might have columns for student_id and course_id.
- This represents a relationship of **degree** 2, since it relates 2 entities.

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Nouns of the Entity-Relationship Model (5/5)

An attribute is data used to describe an entity.

Attributes have a set of legal values called a **domain**, determined by the data type we ascribe to them in our relational schema.

Simple attributes contain a single value, e.g. INT, VARCHAR(20), ENUM.

Composite attributes encapsulate other simple or composite attributes. Think someething similar to C structs.

- A composite attribute like an Address can be composed of the following attributes:
 - lot number,
 - street,
 - nullable apartment/unit number,
 - city,
 - province/state,
 - country, and
 - postal code.

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A Note About NULL

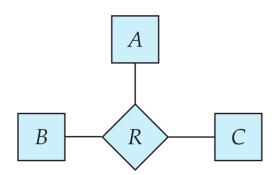
Use <column> IS NULL or <column> IS NOT NULL to perform null checks.

It typically does not make sense to have any other operators on NULL values.

Treat NULL as "not having a value", as opposed to an "empty value" like 0 or "".

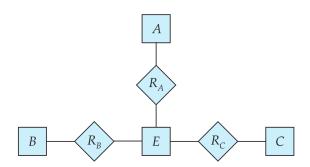
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Translate the following E-R diagram into a set of database tables by writing relational schemas:



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Translate the following E-R diagram into a set of database tables by writing relational schemas:



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Draw an E-R diagram to represent the following database specification for a simple Quest-like system:

- Students are identified by student numbers, and have names.
- Courses have course codes and titles.
- Courses are offered in a given term (W, S, F) in a given year.
- Courses are offered in one or more sections.
- Students enroll in sections of a course.
- Students get grades for the sections they are enrolled in at the end of a term.

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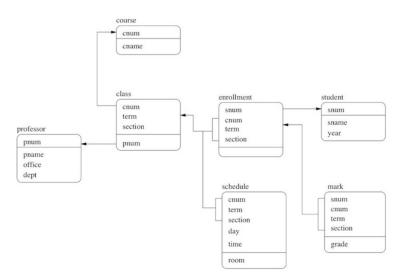
Sketch out the tables that would implement your E-R diagram for the following specification:

- Students are identified by student numbers, and have names.
- Courses have course codes and titles.
- Courses are offered in a given term (W, S, F) in a given year.
- Courses are offered in one or more sections.
- Students enroll in sections of a course.
- Students get grades for the sections they are enrolled in at the end of a term.

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Let's get some exercise! - Relational Queries

Let's say we're given the following schema for a university database:

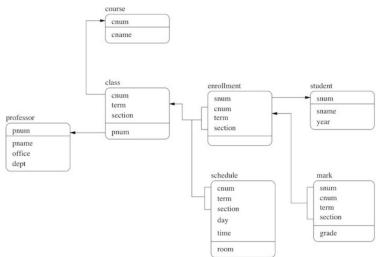


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Let's get some exercise! - Relational Queries

Find the names of all of the students that have not yet been given a grade in a class they have enrolled in.

Try writing the query in SQL, then in relational algebra.

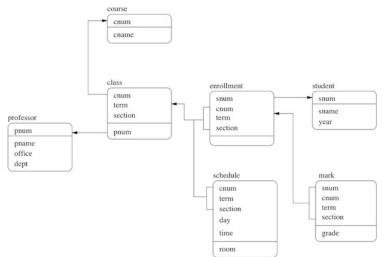


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Let's get some exercise! - Relational Queries

Find all of the course codes along with the names of a student with the top grades in each course.

Try writing the query in SQL, then in relational algebra.



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