CSIT115 Data Management and Security

Database Design

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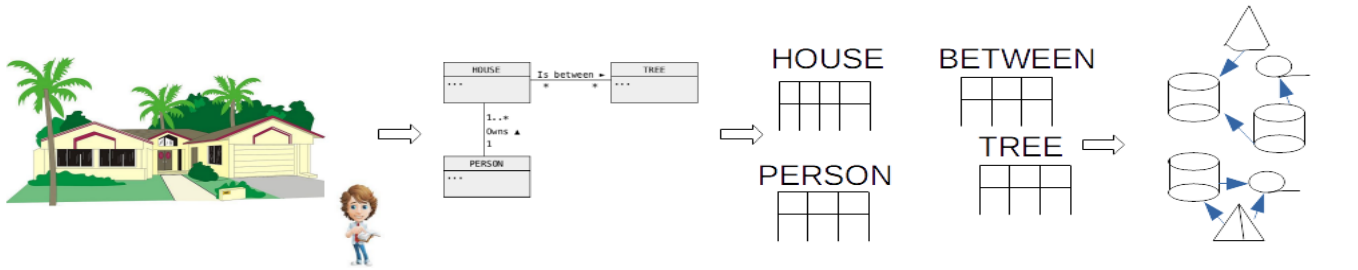
Database Design

Outline

Database Design Process

A simplified process of database design consists of the following stages:

- Conceptual modeling
- Conceptual modeling transforms a specification of database domain into a conceptual schema
- Logical design
- Logical design transforms a conceptual schema into a logical schema e.g. headers of relational tables
- Physical design
- Physical design determines the implementation details and adds to a logical schema persistent storage structures that improve perfromance, e.g. indexes, clusters, partitions, materialized views, etc



Database Design

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Database Domain

A database domain is a selected fragment of the real world to be described by the contents of a database

For example, a typical simple business domain can be described as a sequence of statements:

- A company would like to store and to maintain information about its suppliers and the parts shipped by the suppliers
- A supplier is described by a supplier name, date of birth, salary, and city he/she lives in
- A part is described by part number, part name, colour and price
- A shipment is described by a supplier number, part name and quantity
- A supplier is identified by supplier number and part is identified by part number

Database Design

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Database Schema

A database schema is a description of stored data expressed in the terms of a particular data abstraction level

- For example, a conceptual schema is a description of stored data expressed in the terms of classes objects, properties of objects, identifiers of classes of objects, associations between the classes of objects, etc
- For example, a logical schema is a description of stored data expressed in the terms of attributes, values of attributes, rows, columns, headers, tables
- For example, a physical schema is a description of stored data expressed in the terms of files, indexes, clusters, data blocks, etc

Database Design

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Object Modeling

An object modeling is a special kind of conceptual modeling where a specification of database domain is transformed into a simplified class diagram (conceptual schema)

Principles of object modeling:

- Contents of a database is quantised into discrete objects
- Objects are described by attributes (properties) and operations (methods)
- Good news: we ignore operations !
- Objects are identified by the values of selected attributes
- A class of objects is a group of homogeneous objects with common properties, common semantics, and common identifiers

Object Modeling

Examples:

- A student is an object, a lecturer is an object, a lecture hall is an object, a shipment is an object, an accident is an object, etc
- A student is described by the attributes student number, first name, last name, date of birth, etc
- A student is identified by a student number, a lecture hall is identified by building number and room number, a shipment is identified by a supplier name, date, and time, etc
- A group of students forms a class `STUDENT`, a group of lecturers forms a class `LECTURER`, a group of shipments forms a class `SHIPMENT`, etc

Object Modeling

More object modeling principles:

- A link a conceptual connection between two or more objects
- An association represents a group of homogeneous links with a common structure, common attributes, common semantics, and common identifiers

Examples of links:

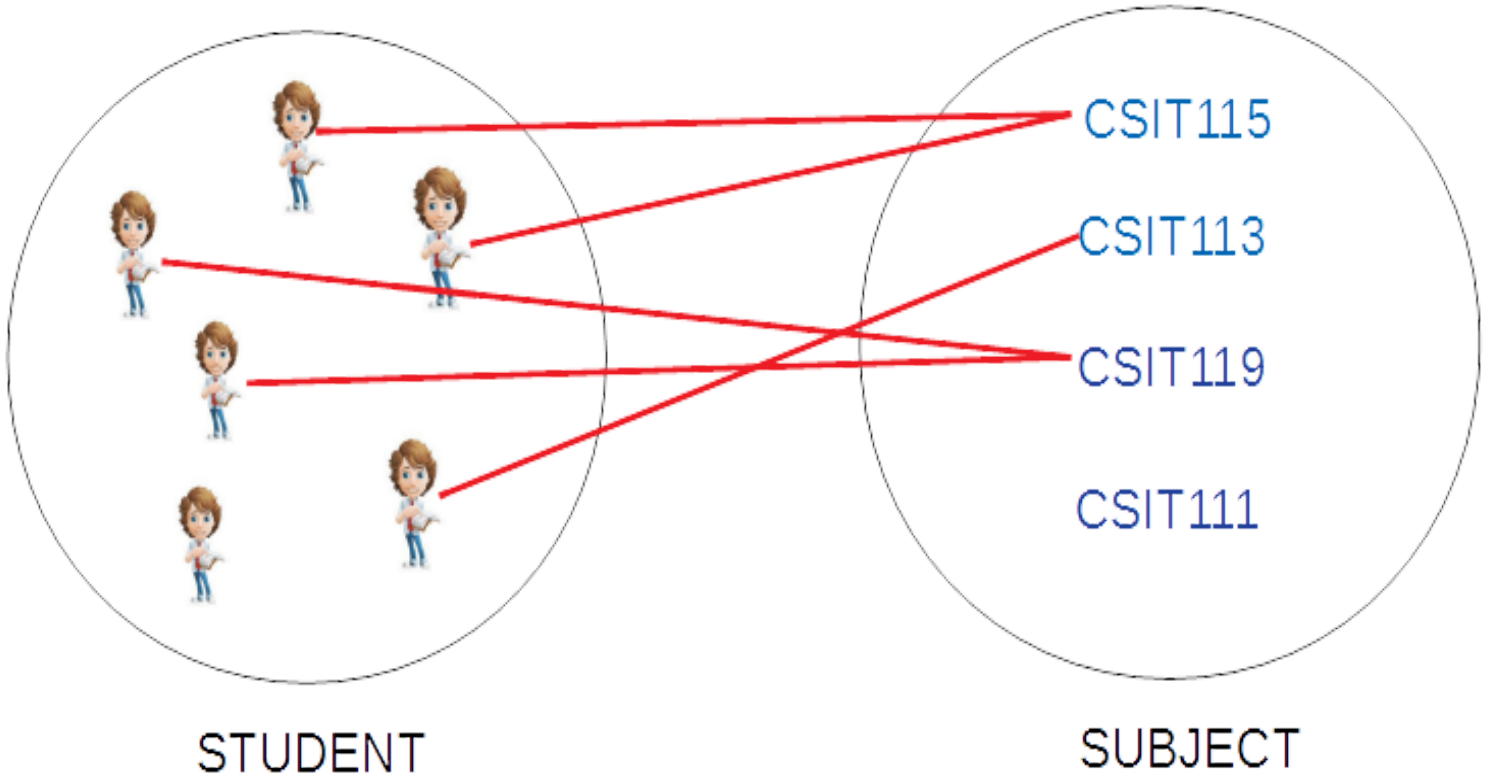
- James talks to Janusz
- Lecture 1 in CSIT115 is in building 3 room 2
- Peter supplies bolts to James

Examples of associations:

- `STUDENT Talks-to LECTURER`
- `LECTURE Is-in BUILDING`
- `SUPPLIER Supplies PART To MANUFACTURER`

Object Modeling

Visualizations of objects, links, classes, and associations



Object Modeling

More object modeling principles:

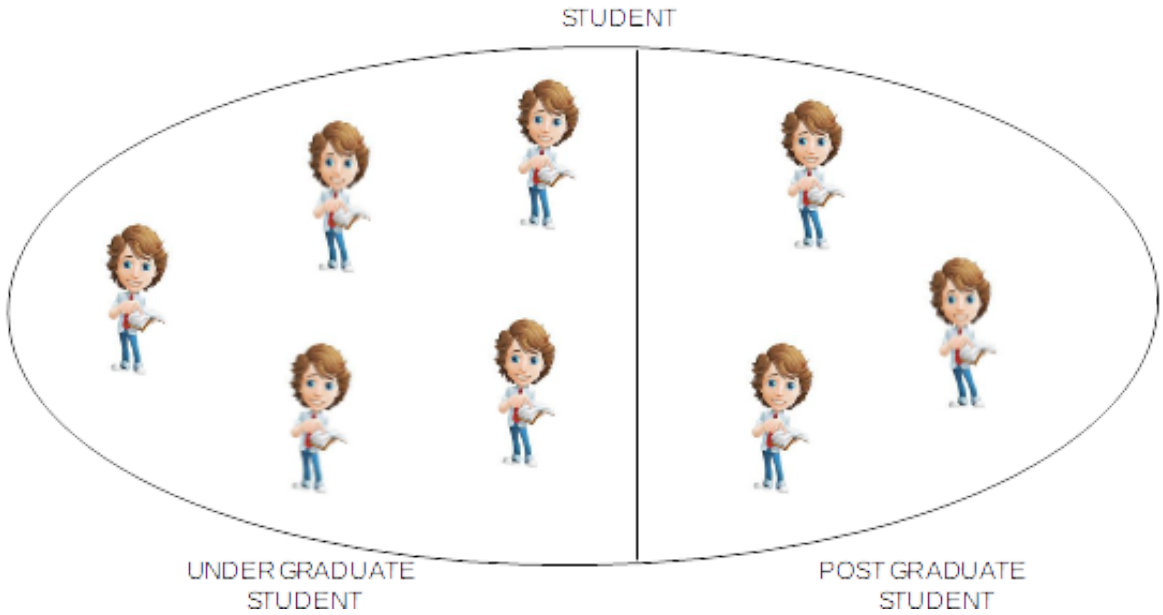
- A generalization hierarchy represents Is-a-subset relation between the classes of objects
- If a set of all objects in a class X is a subset of a set of all a objects in a class Y then class Y is a generalization of class X
- In the other words, if a class Y is a generalization of class X then a set of all objects in Y includes a set of all objects in X

Example of generalization:

- A class `STUDENT` is a generalization of classes `UNDERGRADUATE STUDENT` and `POSTGRADUATE STUDENT`
- It is so because a set of all undergraduate students is a subset of a set of all students and a set of all postgraduate students is a subset of a set of all students
- In the other words, a set of all students includes a set of all postgraduate students and it also includes a set of all undergraduate students

Object Modeling

Visualizations of generalizations `UNDERGRADUATE STUDENT ISa STUDENT` and `POSTGRADUATE STUDENT ISA STUDENT`



Object Modeling

Another example of generalization:

- A class `HUMAN` is a generalization of classes `STUDENT` and `LECTURER`
- It is so because a set of all students is a subset of a set of all humans and a set of all lecturers is a subset of a set of all humans
- In the other words, a set of all humans includes a set of all students and it also includes a set of all lecturers

Yet another (and my favorite) example of generalization:

- A class `BAT` is a generalization of classes `GREY-BAT`, `VAMPIRE-BAT`, and `BATMAN`
- It is so because a set of all grey bats is a subset of a set of all bats and a set of all vampire bats is a subset of a set of all bats and a set of all batmen is a subset of a set of all bats

References

T. Connoly, C. Begg, Database Systems, A Practical Approach to Design, Implementation, and Management, Chapter 10 Database System Development Cycle, Pearson Education Ltd, 2015