SQL Data Definition

Database Systems Lecture 6

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In This Lecture

- SQL
  - The SQL language
  - SQL, the relational model, and E/R diagrams
  - CREATE TABLE
    - Columns
    - Primary Keys
    - Foreign Keys
- For more information
  - Connolly and Begg chapter 6
  - Ullman and Widom 3.2, 6.6.

SQL

- Originally ‘Sequel’ - Structured English query Language, part of an IBM project in the 70’s
- Sequel was already taken, so it became SQL - Structured Query Language
- ANSI Standards
  - SQL-89
  - SQL-92 (SQL2)
  - SQL-99 (SQL3)
- Most modern DBMS use a variety of SQL
  - Most based on SQL2, increasingly SQL3
  - Few (if any) are true to the standard

SQL

- SQL provides
  - A data definition language (DDL)
  - A data manipulation language (DML)
  - A data control language (DCL)
- In addition SQL
  - Can be used from other languages
  - Is often extended to provide common programming constructs (such as if-then tests, loops, variables, etc.)

Notes

- SQL is (usually) not case-sensitive, but we'll write SQL keywords in upper case for emphasis
- SQL statements will be written in **BOLD COURIER FONT**

- Strings in SQL are surrounded by single quotes:
  `'I AM A STRING'`
- Single quotes within a string are doubled:
  `'I''M A STRING'`
- The empty string:`''`

Non-Procedural Programming

- SQL is a declarative (non-procedural) language
  - Procedural - say exactly what the computer has to do
  - Non-procedural – describe the required result (not the way to compute it)
- Example: Given a database with tables
  - Student with attributes ID, Name, Address
  - Module with attributes Code, Title
  - Enrolment with attributes ID, Code
- Get a list of students who take the module ‘Database Systems’

Procedural Programming

```
Set M to be the first Module Record              /* Find module code for    */
Code = ''                                        /* 'Database Systems'      */
While (M is not null) and (Code = '')
   If (M.Title = 'Database Systems') Then
      Code = M.Code
   Set M to be the next Module Record
Set NAMES to be empty                            /* A list of student names */
Set S to be the first Student Record
While S is not null                              /* For each student...     */
   Set E to be the first Enrolment Record
    While E is not null                          /* For each enrolment...   */
      If (E.ID = S.ID) And                       /* If this student is      */
         (E.Code = Code) Then                    /* enrolled in DB Systems  */
         NAMES = NAMES + S.NAME                  /* add them to the list    */
      Set E to be the next Enrolment Record
   Set S to be the next Student Record
Return NAMES
```

Non-Procedural (SQL)

```
SELECT Name FROM Student, Enrolment
   WHERE
   (Student.ID = Enrolment.ID)
   AND
   (Enrolment.Code =
      (SELECT Code FROM Module WHERE
         Title = 'Database Systems'))
```

SQL, the Relational Model, and E/R Design

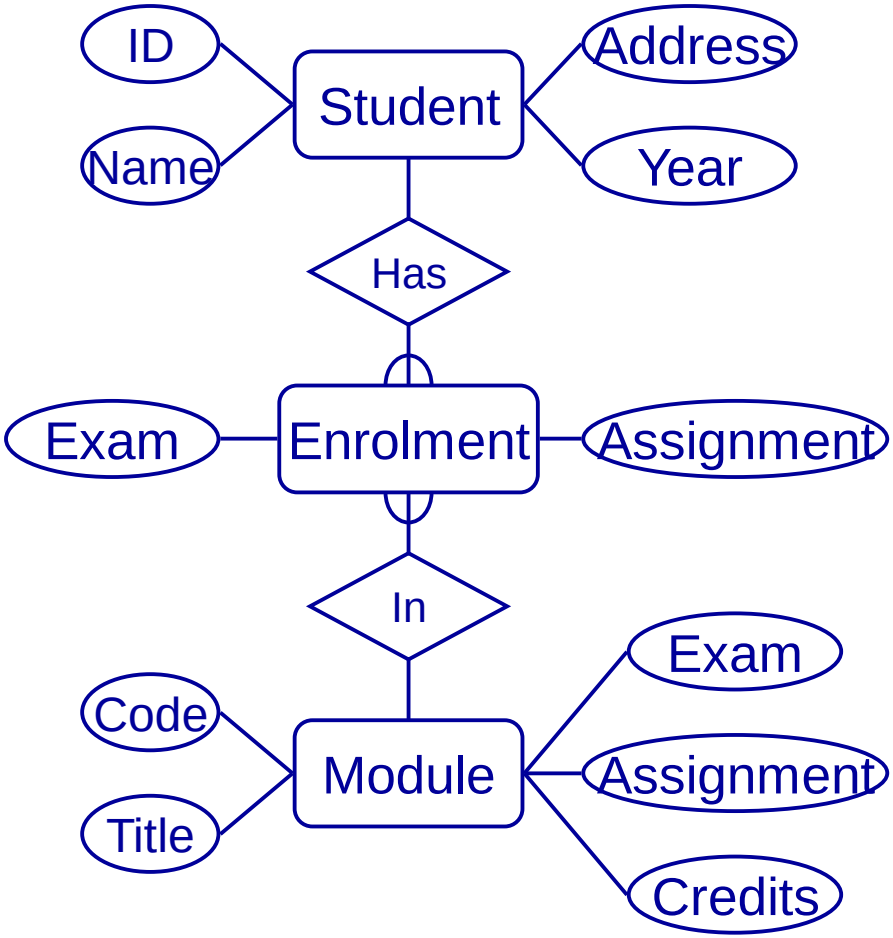
- SQL is based on the relational model
  - It has many of the same ideas
  - Databases that support SQL are often described as relational databases
  - It is not always true to the model
- E/R designs can be implemented in SQL
  - Entities, attributes, and relationships can all be expressed in terms of SQL
  - Many-to-many relationships are a problem, so should be removed

Relations, Entities, Tables

Relational model	E/R Diagram	SQL
Relation	Entity	Table
Tuple	Instance	Row
Attribute	Attribute	Column or Field
Foreign Key	M:1 Relationship	Foreign Key
Primary Key		Primary Key

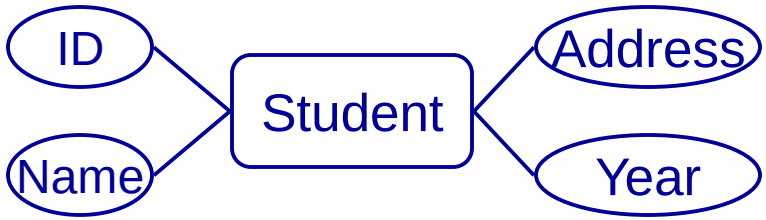
Implementing E/R Designs

- Given an E/R design
  - The entities become SQL tables
  - Attributes of an entity become columns in the corresponding table
  - Relationships may be represented by foreign keys



Entities and Attributes

- Each entity becomes a table in the database
  - The name of the table is often the name of the entity
  - The attributes become columns of the table with the same name



- A table called Student
- With columns for ID, Name, Address, and Year

CREATE TABLE

```
CREATE TABLE
<name> (
  <col-def-1>,
  <col-def-2>,
        :
  <col-def-n>,
  <constraint-1>,
        :
  <constraint-k>)
```

- You supply
  - A name for the table
  - A list of column definitions
  - A list of constraints (such as keys)

Column Definitions

```
<col-name> <type>
  [NULL|NOT NULL]
  [DEFAULT <val>]
  [constraint-1 [,
   constraint-2[,
    ...]]]
```

- Each column has a name and a type
- Common types
  - **INT**
  - **REAL**
  - **CHAR(n)**
  - **VARCHAR(n)**
  - **DATE**

Column Definitions

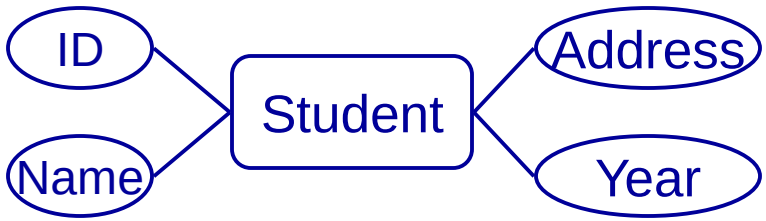
- Columns can be specified as **`NULL`** or **`NOT NULL`**
- **`NOT NULL`** columns cannot have missing values
- If neither is given then columns are assumed **`NULL`**

- Columns can be given a default value
- You just use the keyword DEFAULT followed by the value, eg:

```
num INT DEFAULT 0
```

Example

```
CREATE TABLE Student (
   stuID INT NOT NULL,
   stuName VARCHAR(50) NOT NULL,
   stuAddress VARCHAR(50),
   stuYear INT DEFAULT 1)
```



Constraints

CONSTRAINT

<name>

<type>

<details>

- Common **<type>**s
  - **PRIMARY KEY**
  - **UNIQUE**
  - **FOREIGN KEY**
  - **INDEX**

- Each constraint is given a name - Access requires a name, but some others don't
- Constraints which refer to single columns can be included in their definition

Primary Keys

- Primary Keys are defined through constraints
- A **`PRIMARY KEY`** constraint also includes a **`UNIQUE`** constraint and makes the columns involved **`NOT NULL`**

- The **`<details>`** for a primary key is a list of columns which make up the key

```
CONSTRAINT <name>
   PRIMARY KEY
   (col1, col2, …)
```

Unique Constraints

- As well as a single primary key, any set of columns can be specified as **UNIQUE**
- This has the effect of making candidate keys in the table

- The **<details>** for a unique constraint are a list of columns which make up the candidate key

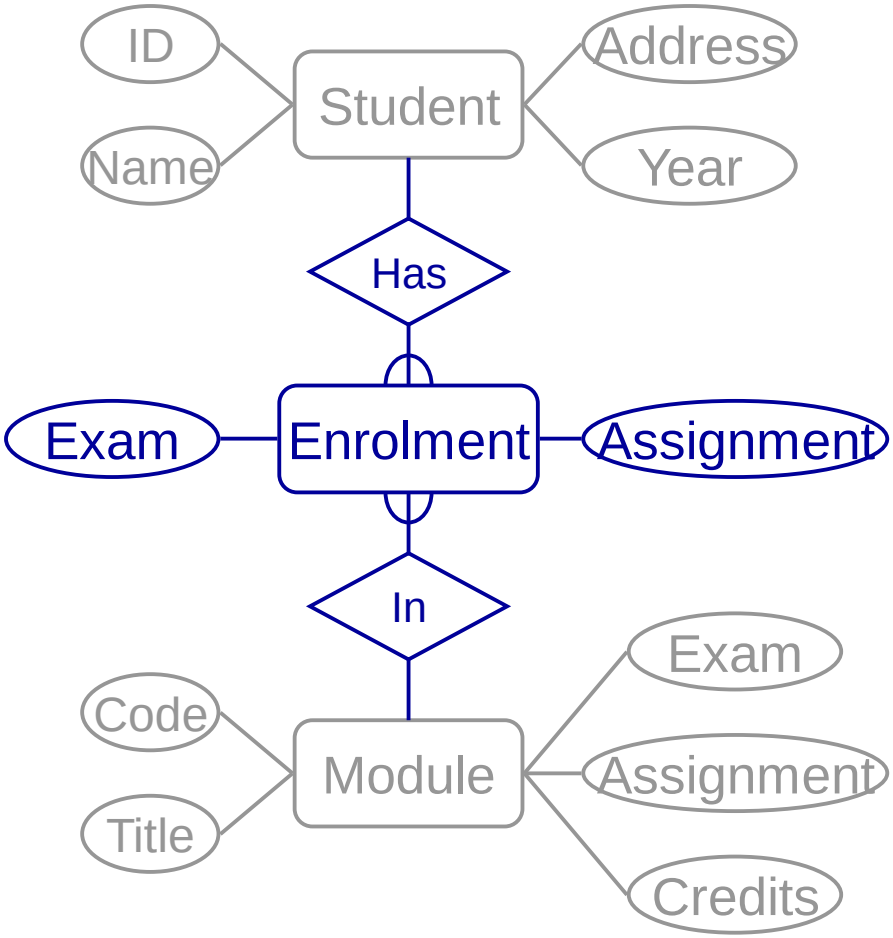
```
CONSTRAINT <name>
   UNIQUE
   (col1, col2, …)
```

Example

```
CREATE TABLE Student (
   stuID INT NOT NULL,
   stuName VARCHAR(50) NOT NULL,
   stuAddress VARCHAR(50),
   stuYear INT DEFAULT 1,
   CONSTRAINT pkStudent
     PRIMARY KEY (stuID))
```

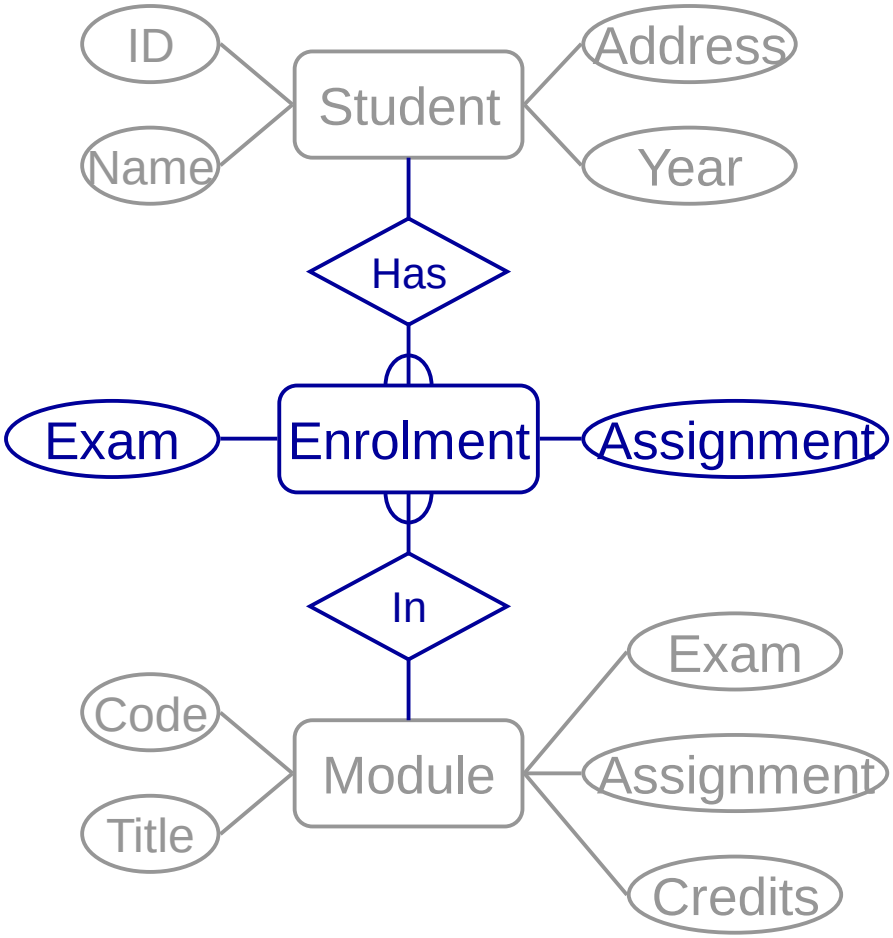
Relationships

- Depends on the type
  - 1:1 are usually not used, or can be treated as a special case of M:1
  - M:1 are represented as a foreign key from the M-side to the 1
  - M:M are split into two M:1 relationships



Representing Relationships

- The Enrolment table
  - Will have columns for the Exam and Assignment attributes
  - Will have a foreign key to Student for the 'has' relationship
  - Will have a foreign key to Module for the 'in' relationship



Foreign Keys

- Foreign Keys are also defined as constraints
- You need to give
  - The columns which make up the FK
  - The referenced table
  - The columns which are referenced by the FK

```
CONSTRAINT <name>
  FOREIGN KEY
  (col1,col2,…)
  REFERENCES
  <table>
  [(ref1,ref2,…)]
```

- If the FK references the PK of **<table>** you don't need to list the columns

Example

```
CREATE TABLE Enrolment (
  stuID INT NOT NULL,
  modCode CHAR(6) NOT NULL,
  enrAssignment INT,
  enrExam INT,
  CONSTRAINT enrPK
    PRIMARY KEY (stuID, modCode),
  CONSTRAINT enrStu FOREIGN KEY (stuID)
    REFERENCES Student (stuID),
  CONSTRAINT enrMod FOREIGN KEY (modCode)
    REFERENCES Module (modCode))
```

Next Lecture

- More SQL
  - DROP TABLE
  - ALTER TABLE
  - INSERT, UPDATE, and DELETE
  - Data dictionary
  - Sequences
- For more information
  - Connolly and Begg chapters 5 and 6
  - Ullman and Widom 6.5