Jargon

2-Tier

Client -> Server

3-Tier

Client -> Server -> Database
Sometimes database means a program for managing data

    Oracle Corporation is a database company.
    MS Access is database.

Sometimes database means a collection of data

    I keep a database of my CD collection on 3 by 5 cards

Sometimes database means a set of tables, indexes, and views

    My program needs to connect to the Airline Reservation database, which uses Oracle
Some Reasons for Using a Database

Persistence of data

Sharing of data between programs

Handle concurrent requests for data access

Transactions that can be rolled back

Report generation
Types of Databases

Relational

Data is stored in tables

Object-Oriented

Tables can be subclassed

Programmer can define methods on tables

Object

Objects are stored in the database
Relational, Object-Oriented Databases and SQL

Database consists of a number of tables

Table is a collection of records

Each Column of data has a type

<table>
<thead>
<tr>
<th>firstname</th>
<th>lastname</th>
<th>phone</th>
<th>code</th>
</tr>
</thead>
<tbody>
<tr>
<td>John</td>
<td>Smith</td>
<td>555-9876</td>
<td>2000</td>
</tr>
<tr>
<td>Ben</td>
<td>Oker</td>
<td>555-1212</td>
<td>9500</td>
</tr>
<tr>
<td>Mary</td>
<td>Jones</td>
<td>555-3412</td>
<td>9900</td>
</tr>
</tbody>
</table>

Use Structured query language (SQL) to access data
Some Available Databases

Oracle
DB2
SQL Server
Access
Informix
Ingres
InterBase
Sybase
FileMaker Pro
FoxPro
Paradox
dBase

Open Source Databases
MySQL
PostgresSQL
SQL History

Dr. E. F. Codd develops relational database model
Early 1970's

IBM System R relational database
  Mid 1970's
  Contained the original SQL language

First commercial database - Oracle 1979

SQL was aimed at:
  Accountants
  Business people

SQL92
  First commonly followed standard
  ANSI X3.135-1992
  SQL2

ISO/IEC 9075-1 through 5
  New SQL standard
MySQL & PostgreSQL

Open source databases

http://www.mysql.com/

http://www.postgresql.org/

Above site have free downloads and documentation
MySQL – Connecting to the Database

Can be done with:
- Mysql command line tool - mysql
- GUI clients
- Program

GUI Clients

If done well are very useful

There are many of these

I use DbVisualizer, & CocoaMySQL

DbVisualizer if Java based so runs on may platforms

http://www.dbvis.com/products/dbvis/
SQL Syntax

Names

Databases, tables columns & indexes have names

Legal Characters

Alphanumeric characters

- 

'$'

Names can start with:

- Letter
- Underscore
- Letter with diacritical marks and some non-latin letters

Name length

63 characters – default in PostgreSQL
64 characters - MySQL

Names are not case sensitive
Data Types

Numeric Values
Integer - decimal or hex
Floating-point - scientific & 12.1234

String Values

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>'</td>
<td>Single quote</td>
</tr>
<tr>
<td>\b</td>
<td>Backspace</td>
</tr>
<tr>
<td>\n</td>
<td>Newline</td>
</tr>
<tr>
<td>\r</td>
<td>Tab</td>
</tr>
<tr>
<td>\</td>
<td>Backslash</td>
</tr>
<tr>
<td>\xxxx</td>
<td>Character were xxxx is the octal of ASCII code (PostgreSQL)</td>
</tr>
</tbody>
</table>

Including a quote character in a string
Double quote the character
'Don"t do it'

Escape the quote character with a backslash
'Don\'t do it'
Comments

-- this is a comment in MySQL and PostgreSQL

/* this is also a comment in MySQL and PostgreSQL */

# this is a comment in MySQL
## Numeric Data Types

<table>
<thead>
<tr>
<th>Type name</th>
<th>Description</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>smallint</td>
<td>Fixed-precision</td>
<td>-32768 to +32767</td>
</tr>
<tr>
<td>integer</td>
<td>Usual choice for fixed-precision</td>
<td>-2147483648 to +2147483647</td>
</tr>
<tr>
<td>bigint</td>
<td>Very large range fixed-precision</td>
<td>-9223372036854775808 to 9223372036854775807</td>
</tr>
<tr>
<td>decimal</td>
<td>user-specified precision, exact</td>
<td>no limit</td>
</tr>
<tr>
<td>numeric</td>
<td>user-specified precision, exact</td>
<td>no limit</td>
</tr>
<tr>
<td>real</td>
<td>variable-precision, inexact</td>
<td>6 decimal digits precision</td>
</tr>
<tr>
<td>double precision</td>
<td>variable-precision, inexact</td>
<td>15 decimal digits precision</td>
</tr>
<tr>
<td>serial</td>
<td>autoincrementing integer</td>
<td>1 to 2147483647</td>
</tr>
</tbody>
</table>

Numeric(10, 2) defines a number with maximum of 10 digits with 2 of the 10 to the right of the decimal point

12345678.91

decimal and numeric are different names for the same type
### String Types

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>char(n)</code></td>
<td>Fixed-length blank padded</td>
</tr>
<tr>
<td><code>varchar(n)</code></td>
<td>Variable-length with limit</td>
</tr>
<tr>
<td><code>text</code></td>
<td>Variable unlimited length</td>
</tr>
<tr>
<td><code>bytea (PostgreSQL)</code></td>
<td>Variable (not specifically limited) length binary string</td>
</tr>
<tr>
<td><code>blob (MySQL)</code></td>
<td>Variable (not specifically limited) length binary string</td>
</tr>
</tbody>
</table>

CHAR & VARCHAR are the most common string types

CHAR is fixed-width
   Shorter strings are padded

TEXT can be any size

PostgreSQL limits a string to 1GB in storage space

MySQL limits CHAR and VARCHAR to 255 characters
# Date & Time Types - PostgreSQL

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>timestamp [(p)] without time zone</td>
<td>both date and time</td>
</tr>
<tr>
<td>timestamp [ (p) ] [ with time zone ]</td>
<td>both date and time</td>
</tr>
<tr>
<td>interval [ (p) ]</td>
<td>for time intervals</td>
</tr>
<tr>
<td>date</td>
<td>dates only</td>
</tr>
<tr>
<td>time [ (p) ] [ without time zone ]</td>
<td>times of day only</td>
</tr>
<tr>
<td>time [ (p) ] with time zone</td>
<td>times of day only</td>
</tr>
</tbody>
</table>

(p) indicates optional number of fractional digits retained in the seconds field
## Date Formats - PostgreSQL

<table>
<thead>
<tr>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 8, 1999</td>
<td>Unambiguous</td>
</tr>
<tr>
<td>1999-01-08</td>
<td>ISO-8601 format, preferred</td>
</tr>
<tr>
<td>1/8/1999</td>
<td>U.S.; read as August 1 in European mode</td>
</tr>
<tr>
<td>8/1/1999</td>
<td>European; read as August 1 in U.S. mode</td>
</tr>
<tr>
<td>1/18/1999</td>
<td>U.S.; read as January 18 in any mode</td>
</tr>
<tr>
<td>19990108</td>
<td>ISO-8601 year, month, day</td>
</tr>
<tr>
<td>990108</td>
<td>ISO-8601 year, month, day</td>
</tr>
<tr>
<td>1999.008</td>
<td>Year and day of year</td>
</tr>
<tr>
<td>99008</td>
<td>Year and day of year</td>
</tr>
<tr>
<td>J2451187</td>
<td>Julian day</td>
</tr>
<tr>
<td>January 8, 99 BC</td>
<td>Year 99 before the Common Era</td>
</tr>
</tbody>
</table>
Setting Date Formats - PostgreSQL

SET DateStyle TO 'US'
SET DateStyle TO 'NonEuropean'

Sets date format to month day year

SET DateStyle TO 'European'

Sets date format to day month year

Default is ISO style
DATETIME – ‘YYYY-MM-DD HH:MM:SS’ format

DATE – ‘YYYY-MM-DD’ format

TIMESTAMP
   Changed in MySQL 4.1
   Basically now is same as DATETIME
## Common SQL Statements

<table>
<thead>
<tr>
<th>Statement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SELECT</td>
<td>Retrieves data from table(s)</td>
</tr>
<tr>
<td>INSERT</td>
<td>Adds row(s) to a table</td>
</tr>
<tr>
<td>UPDATE</td>
<td>Changes field(s) in record(s)</td>
</tr>
<tr>
<td>DELETE</td>
<td>Removes row(s) from a table</td>
</tr>
<tr>
<td>CREATE TABLE</td>
<td>Define a table and its columns(fields)</td>
</tr>
<tr>
<td>DROP TABLE</td>
<td>Deletes a table</td>
</tr>
<tr>
<td>ALTER TABLE</td>
<td>Adds a new column, add/drop primary key</td>
</tr>
<tr>
<td>CREATE INDEX</td>
<td>Create an index</td>
</tr>
<tr>
<td>DROP INDEX</td>
<td>Deletes an index</td>
</tr>
<tr>
<td>CREATE VIEW</td>
<td>Define a logical table from other table(s)/view(s)</td>
</tr>
<tr>
<td>DROP VIEW</td>
<td>Deletes a view</td>
</tr>
</tbody>
</table>

SQL is not case sensitive
Examples That Follow

Will use mysql command line tool

Used the command

    mysql -h host -u user -p

to connect to the database, where host and user are given the correct value

On rohan the full name of command is:

    /opt/local/mysql/bin/mysql

Some examples will also show postgresQL text client
CREATE DATABASE

General Form
CREATE DATABASE [IF NOT EXISTS] db_name
    [create_specification [, create_specification] ...]

create_specification:
    [DEFAULT] CHARACTER SET charset_name
    | [DEFAULT] COLLATE collation_name

Example
mysql> create database lectureExamples;
Query OK, 1 row affected (0.00 sec)
Al 15->psql -h bismarck.sdsu.edu cs580whitney cs580whitney
Password:
Welcome to psql 7.4, the PostgreSQL interactive terminal.

Type: \copyright for distribution terms
    \h for help with SQL commands
    \? for help on internal slash commands
    \g or terminate with semicolon to execute query
    \q to quit

cs580whitney=> create database lectureExamples;
ERROR:  permission denied to create database
cs580whitney=>

Student accounts do not have authority to create new databases
USE

Sets a default database for subsequent queries

General Form

USE db_name

Example

mysql> use lectureExamples;
Database changed
CREATE table

General Form

CREATE TABLE table_name (  
    col_name    col_type [ NOT NULL | PRIMARY KEY]  
    [, col_name col_type [ NOT NULL | PRIMARY KEY]]*  
)

Example

mysql> CREATE TABLE students  
    (  
        firstname  CHAR(20) NOT NULL,  
        lastname   CHAR(20),  
        phone      CHAR(10),  
        code       INTEGER  
    );

mysql> CREATE TABLE codes  
    (  
        code       INTEGER,  
        name       CHAR(20)  
    );
PostgreSQL Example

cs580whitney=> CREATE TABLE students
    (firstname  CHAR(20) NOT NULL,
     lastname   CHAR(20),
     phone      CHAR(10),
     code       INTEGER);
CREATE TABLE

cs580whitney=> select * from students;
    firstname | lastname | phone | code
--------------+----------+-------+------
(0 rows)
Select

Gets data from one or more tables

General Form

```
SELECT [STRAIGHT_JOIN]
  [SQL_SMALL_RESULT] [SQL_BIG_RESULT]
  [SQL_BUFFER_RESULT] [SQL_CACHE | SQL_NO_CACHE]
  [SQL_CALC_FOUND_ROWS] [HIGH_PRIORITY]
  [DISTINCT | DISTINCTROW | ALL]
  select_expression,...
  [INTO {OUTFILE | DUMPFILE} 'file_name' export_options]
  [FROM table_references
   [WHERE where_definition]
   [GROUP BY {unsigned_integer | col_name | formula} [ASC | DESC],...]
   [WITH ROLLUP]]
  [HAVING where_definition]
  [ORDER BY {unsigned_integer | col_name | formula} [ASC | DESC],...]
  [LIMIT [offset,] row_count | row_count OFFSET offset]
  [PROCEDURE procedure_name(argument_list)]
  [FOR UPDATE | LOCK IN SHARE MODE]]
```

Example

```
mysql> SELECT * FROM students;
Empty set (0.00 sec)
```
Insert

Add data to a table

**General Form**

```
INSERT [LOW_PRIORITY | DELAYED] [IGNORE]
[INTO] tbl_name [(col_name,...)]
VALUES ((expression | DEFAULT),...),(...),...
[ ON DUPLICATE KEY UPDATE col_name=expression, ... ]
```

**Examples**

```
mysql> INSERT
    INTO students (firstname, lastname, phone, code)
    VALUES ('Roger', 'Whitney', '594-3535', 2000);

mysql> INSERT
    INTO codes (code, name)
    VALUES (2000, 'marginal');

mysql> SELECT * FROM students;
+-----------+----------+----------+------+
| firstname | lastname | phone    | code |
+-----------+----------+----------+------+
| Roger     | Whitney  | 594-3535 | 2000 |
+-----------+----------+----------+------+
1 row in set (0.01 sec)
```
More Select Examples

mysql> SELECT firstname , phone FROM students;
+-----------+----------+
| firstname | phone    |
+-----------+----------+
| Roger     | 594-3535 |
+-----------+----------+
1 row in set (0.00 sec)

mysql> SELECT lastname, name
    FROM students, codes
    WHERE students.code = codes.code;

+----------+----------+
| lastname | name     |
+----------+----------+
| Whitney  | marginal |
+----------+----------+
1 row in set (0.00 sec)
More Select Examples

mysql> SELECT students.lastname, codes.name
    ->     FROM students, codes
    ->     WHERE students.code = codes.code;

+----------+----------+
| lastname | name     |
+----------+----------+
| Whitney  | marginal |
+----------+----------+
1 row in set (0.00 sec)
Update

Modify existing data in a database

General Form

UPDATE [LOW_PRIORITY] [IGNORE] tbl_name [, tbl_name ...]
    SET col_name1=expr1 [, col_name2=expr2 ...]
    [WHERE where_definition]

Example

mysql> UPDATE students
    SET firstname='Sam'
    WHERE lastname='Whitney';

Query OK, 1 row affected (0.00 sec)
Rows matched: 1  Changed: 1  Warnings: 0