Ders # 7

Introduction to SQL Programming Techniques

From Elmasri/Navathe textbook Ch9,26

Sciore textbook, Ch 9-10

Outline:

- Database Programming Approaches
- Embedded SQL
- JDBC
- Stored Procedures, SQL/PSM
- PHP
- Summary

Objective:

Various techniques for accessing and manipulating a database via programs in general-purpose languages s.a. Java,C, etc.

❑Modern application programming architectures and techniques s.a. JAVA EE..

Database Programming

- Objective:
  - To access a database from an application program (as opposed to interactive interfaces)
- Why?
  - An interactive interface is convenient but not sufficient
    - A majority of database operations are made thru application programs (increasingly thru web applications)

Database Programming Approaches

1. **Embedded commands:**
   - Database commands are embedded in a general-purpose programming language
2. **Library of database functions:**
   - Available to the host language for database calls; known as an *API*
     - *API* standards for Application Program Interface
3. **A brand new, full-fledged language**
   - Minimizes impedance mismatch
   - **impedance mismatch**: Incompatibilities between a host programming language and the database model, e.g.,
   - type mismatch and incompatibilities; requires a new binding for each language
   - set vs. record-at-a-time processing
     - need special iterators to loop over query results and manipulate individual values

Basic Steps in Database Programming

I. Client program *opens a connection* to the database server

II. Client program *submits queries to and/or updates* the database

III. When database access is no longer needed, client program *closes (terminates) the connection*

1-) Embedded SQL

- Most SQL statements can be embedded in a general-purpose *host* programming language such as ADA,COBOL, C, Java
- An embedded SQL statement is distinguished from the host language statements by enclosing it between **EXEC SQL** or **EXEC SQL BEGIN** and a matching **END-EXEC** or **EXEC SQL END** (or semicolon)
  - Syntax may vary with language
  - *Shared variables* (used in both languages) usually prefixed with a colon (:) in SQL; used without (:) in the host program.

Variable Declaration:

- Variables inside **DECLARE** are shared and can appear (while prefixed by a colon) in SQL statements
- **SQLCODE** is used to communicate errors/exceptions between the database and the program

```
int loop;
EXEC SQL BEGIN DECLARE SECTION;
        varchar dname[16], fname[16], lname[16], …;
        char ssn[10], bdate[11], …;
        float salary, raise;
        int dno, dnumber, SQLCODE, …;
EXEC SQL END DECLARE SECTION;
```

Connecting to a Database:

- Connection (multiple connections are possible but only one is active)

```
CONNECT TO server-name AS connection-name
AUTHORIZATION user-account-info;
```

- Change from an active connection to another one

```
SET CONNECTION connection-name;
```

- Disconnection

```
DISCONNECT connection-name;
```

Example1*: retrieving single tuple*

```
loop = 1;
while (loop) {
    prompt (“Enter SSN: “, ssn);
    EXEC SQL
            select FNAME, LNAME, ADDRESS, SALARY
            into :fname, :lname, :address, :salary
            from EMPLOYEE where SSN == :ssn;
            if (SQLCODE == 0) printf(fname, …);
            else printf(“SSN does not exist: “, ssn);
            prompt(“More SSN? (1=yes, 0=no): “, loop);
    END-EXEC
}
```

Example2: Retrieving multiple tuples

- A **cursor** (iterator) is needed to process multiple tuples
- **FETCH** commands move the cursor to the *next* tuple
- **CLOSE CURSOR** indicates that the processing of query results has been completed

```
//Program Segment E2:
prompt("Enter the Department Name: " dname)
EXEC SQL
select DNUMBER into :dnumber
from DEPARTMENT where DNAME = :dname ;
EXEC SQL DECLARE EMP CURSOR FOR
select SSN, FNAME, MINIT, LNAME, SALARY
from EMPLOYEE where DNO = :dnumber
FOR UPDATE OF SALARY ;
EXEC SQL OPEN EMP ;
EXEC SQL FETCH from EMP into :ssn, :fname, :minit, :lname, :salary
while (SQLCODE == 0) {
    printf("Employee name is:", fname, minit, lname)
    prompt("Enter the rai se amount: rai se)
    EXEC SQL
    update EMPLOYEE
    set SALARY = SALARY + :raise
    where CURRENT OF EMP ;
    EXEC SQL FETCH from EMP into :ssn, :fname, :minit, :lname, :salary
}
EXEC SQL CLOSE EMP ;
```

Dynamic SQL

- Objective:
  - Composing and executing new (not previously compiled) SQL statements at run-time
    - a program accepts SQL statements from the keyboard at run-time
    - a point-and-click operation translates to certain SQL query
- Dynamic update is relatively simple; dynamic query can be complex
  - because the type and number of retrieved attributes are unknown at compile time
- Example:

```
EXEC SQL BEGIN DECLARE SECTION;
varchar sqlupdatestring[256];
EXEC SQL END DECLARE SECTION;
…
prompt (“Enter update command:“, sqlupdatestring);
EXEC SQL PREPARE sqlcommand FROM :sqlupdatestring;
EXEC SQL EXECUTE sqlcommand;
```

- No syntax check or other types of checks are possible at copile time..
- Unable to know the type or number of attributes to be retrievedby the SQL query at the compile time.
- PREPARE is useful in case the dynamic SQL is to be executed in the code repeatedly.

Embedded SQL in Java: SQLJ

- SQLJ: a **standard** for embedding SQL in Java
- An SQLJ translator converts SQL statements into Java
  - These are executed thru the *JDBC* interface
- Certain classes have to be imported. e.g., **java.sql**
- Example: *Establising a connection*

```
1) import java.sql.* ;
2) import java.io.* ;
3) import sqlj.runtime.*
4) import sqlj.runtime.ref.*
5) import oracle.sqlj.runtime.*
6) DefaultContext cntxt =
7) oracle.getConnection("<url name>", "<user name>", "<password>", true)
8) DefaultContext.setDefaultContext(cntxt);
```

Example1: *retrieving single tuple*

```
string dname, ssn , fname, fn, lname, ln, bdate, address
char minit, mi ;
double salary, sal ;
integer dna, dnumber ;
ssn = readEntry (" Enter a Socia1 Securi ty Numbe r : ")
try {
#sql{select FNAME, MINIT, LNAME, ADDRESS, SALARY
into :fname , :minit, :lname, :address, :salary
from EMPLOYEE where SSN = :ssn} ;
} catch (SQLException se) {
System.out.println("Social Security Number does not exist: " + ssn)
Return ;
}
System.out.println(fname + " " + minit + " " + lname + " " + address + " " +salary)
```

Example2: *retrieving multiple tuples w/ named iterator*

- SQLJ supports two types of iterators:
  - *named iterator*: associated with a query result
  - *positional iterator*: lists only attribute types in a query result
- A **`FETCH`** operation retrieves the next tuple in a query result:

  `fetch iterator-variable into program-variable`

```
dname = readEntry("Enter the Department Name: ")
try {
#sql{select DNUMBER into :dnumber
    from DEPARTMENT where DNAME = :dname}
} catch CSQLException se) {
System.out.println("Department does not exist: " + dname)
Return ;
}
System.out.printline("Employee information for Department: " + dname) ;
#sql iterator Emp(String ssn, String fname, String minit, String lname ,double salary) ;
Emp e = null ;
#sql e = {select ssn, fname, mInIt, lname, salary
        from EMPLOYEE where DNO :dnumber}
while (e.next()) {
     System.out.printline(e.ssn + " " + e.fname + " " + e.minit + " " + e.lname + " " + e.salary)
} ;
e.close() ;
```

Example3: *retrieving multiple tuples w/ positional iterator*

```
dname = readEntry("Enter the Department Name: ")
 try {
       #sql{select DNUMBER into :dnumber
               from DEPARTMENT where DNAME = :dname}
 } catch (SQLException se) {
       System.out.println("Department does not exist: " + dname)
       return ;
 }
 System.out.printline("Employee information for Department: " + dname)
 #sql iterator Emppos(String, String, String, String, double)
 Emppos e = null ;
 #sql e ={select ssn, fname, minit, lname, salary
               from EMPLOYEE where DNO = : dnumber} ;

 #sql {fetch :e into :ssn, :fn, :mi, :ln, :sal}
 while (!e.endFetch()) {
       System.out.printline(ssn + " " + fn + " " + mi + " " + ln + " " + sal)
       #sql {fetch :e into :ssn, :fn, :mi, :ln, :sal}
 };
 e.close() ;
```

2-) Database Programming with Functional Calls

- Embedded SQL provides static database programming
- **API**: Dynamic database programming with a library of functions
  - Advantage:
    - No preprocessor needed (thus more flexible)
  - Disadvantage:
    - SQL syntax checks to be done at run-time
    - requires more complex programming to access query results because the types and numbers of attributes in a query result may not be known in advance.
- Example:
  - SQL/CLI
    - A part of the SQL standard
    - Provides easy access to several databases within the same program
    - Certain libraries (e.g., **sqlcli.h** for C) have to be installed and available
    - SQL statements are dynamically created and passed as string parameters in the calls
  - **JDBC**
    - **SQL connection function calls for Java programming**
    - **A Java program with JDBC functions can access any relational DBMS that has a JDBC driver** ***(JDBC driver: a specific implementation functions of JDBC API)***
    - **JDBC allows a program to connect to several databases (known as data sources)**

Steps in JDBC Database Access:

Driver → Connection → Statement → ResultSet

1. Import JDBC library **(java.sql.*) and** Load JDBC driver:
   - **Class.forname("oracle.jdbc.driver.OracleDriver")**
   - **in the command line:**

     -Djdbc.drivers = oracle.jdbc.driver
2. Define appropriate variables and Create a connect object (via **getConnection**)
3. Create a statement object from the **Statement** class:
   - PreparedStatment
     - Identify statement parameters (designated by question marks)
     - Bound parameters to program variables
     - Execute SQL statement (referenced by an object) via JDBC's **executeQuery**
   - CallableStatement

6. Process query results (returned in an object of type ResultSet)
   - **ResultSet** is a 2-dimentional table

Example1 (*retrieving single tuple)*

```
import java.io.*
import java.sql.*
class getEmpInfo {
 public static void main (String args []) throws SQLException, IOException {
      try { Class.forName("oracle.jdbc.driver.OracleDriver")
      } catch (ClassNotFoundException x) {
      System.out.println ("Driver could not be loaded") ;}

   String dbacct, passwrd, ssn, lname;
   Double salary ;
   dbacct = readentry("Enter database account:");
    passwrd = readentry("Enter pasword:") ;
   Connection conn = DriverManager.getConnection) ("jdbc:oracle:oci8:" + dbacct + "/" + passwrd)
   String stmtl = "select LNAME, SALARY from EMPLOYEE where SSN = ?"
   PreparedStatement p = conn.prepareStatement(stmt1) ;
   ssn = readentry("Enter a Social Security Number: ") ;
   p.clearParameters() ;
   p.setString(1, ssn) ; //bounding
   ResultSet r = p.executeQuery()
   while (r.next()) {
      lname = r.getString(l) ;
      salary = r.getDouble(2) ;
      system.out.printline(lname + salary);}
} }
```

Example2 (*retrieving multiple tuples*)

```
import java. io.* ;
import java. sql .*,
class printDepartmentEmps {
      public static void main (String args [J) throws SQLException, IOException {
            try { Class. forName("oracl e. jdbc ,driver .Oracl eDriver")
            } catch (ClassNotFoundException x) { ,
              System.out.println ("Driver could not be loaded“);}
      String dbacct, passwrd, 1name ;
      Double salary;
      Integer dno ;
      dbacct = readentry("Enter database account: ")
      passwrd = readentry("Enter pasword: ") ;
      Connection conn = DriverManager.getConnection ("jdbc:oracle:oci8:" + dbacct + "/" + passwrd)
      dno = readentry("Enter a Department Number: ") ;
      String q = "sel ect LNAME, SALARY from EMPLOYEE where DNO “+dno.tostringO ;
      Statement s = conn. c reateStatement0
      ResultSet r = s. executeQuery(q)
      while (r.next()) {
            name = r. getStri ng(l) ;
            salary = r.getDouble(2) ;
             system.out.printline(lname + salary)
      }
   }
 }
```

3-)Database Stored Procedures

- Persistent procedures/functions (modules) are stored locally and executed by the database server
  - As opposed to execution by clients
- Advantages:
  - **If the procedure is needed by many applications, it can be invoked by any of them (thus reduce duplications)**
  - **Execution by the server reduces communication costs**
  - **Enhance the modeling power of views**
- Disadvantages:
  - Every DBMS has its own syntax and this can make the system less portable

Stored Procedure Constructs

- SQL/PSM:
  - Part of the SQL standard for writing persistent stored modules
- SQL + stored procedures/functions + additional programming constructs
  - E.g., branching and looping statements
  - Enhance the power of SQL
- A stored procedure

  CREATE PROCEDURE procedure-name (params)

  local-declarations

  procedure-body;
- A stored function

  CREATE FUNCTION fun-name (params) RETURNS return-type

  local-declarations

  function-body;
- Calling a procedure or function

  CALL procedure-name/fun-name (arguments);

SQL/PSM: Example#1

```
CREATE FUNCTION DEPT_SIZE (IN deptno INTEGER)
RETURNS VARCHAR[7]
DECLARE TOT_EMPS INTEGER;

SELECT COUNT (*) INTO TOT_EMPS
    FROM SELECT EMPLOYEE WHERE DNO = deptno;
IF TOT_EMPS > 100 THEN RETURN “HUGE”
    ELSEIF TOT_EMPS > 50 THEN RETURN “LARGE”
    ELSEIF TOT_EMPS > 30 THEN RETURN “MEDIUM”
    ELSE RETURN “SMALL”
ENDIF;
```

EXAMPLE#2: Stock management

- Here is the part of stock tracking db for this example:

```
create table item
(
   item_id              serial,
   description           varchar(64) not null,
   cost_price           numeric(7,2),
   sell_price          numeric(7,2),
   CONSTRAINT           item_pk PRIMARY KEY(item_id)
);
create table stock
(
   item_id               integer not null,
   quantity              integer  not null,
   CONSTRAINT            stock_pk PRIMARY KEY(item_id),
   CONSTRAINT stock_item_id_fk FOREIGN KEY(item_id)
            REFERENCES item(item_id)
);
```

Check stock condition w/ a function

```
create table reorders
(
  item_id integer,
  message text
);

-- reorders
-- scan the stock table to raise re orders of item low on stock

create function reorders(min_stock int4) returns integer as $$
declare
   reorder_item integer;
   reorder_count integer;
   stock_row stock%rowtype;
   msg text;
begin
   select count(*) into reorder_count from stock
        where quantity <= min_stock;
   for stock_row in select * from stock
               where quantity <= min_stock
   loop
      declare
         item_row item%rowtype;
      begin
         select * into item_row from item
         where item_id = stock_row.item_id;
            msg = 'order more ' ||
                 item_row.description || 's at ' ||
                 to_char(item_row.cost_price,'99.99');
         insert into reorders
            values (stock_row.item_id, msg);
      end;
   end loop;
   return reorder_count;
end;
$$ language plpgsql;
```

Check stock condition w/ a trigger

```
create function reorder_trigger() returns trigger AS $$
declare
    mq integer;
    item_record record;
begin
    mq := tg_argv[0];
    raise notice 'in trigger, mq is %', mq;
    if new.quantity <= mq
    then
        select * into item_record from item
        where item_id = new.item_id;
        insert into reorders
          values (new.item_id, item_record.description);
    end if;
    return NULL;
end;
$$ language plpgsql;

create trigger trig_reorder
after insert or update ON stock
for each row execute procedure reorder_trigger(3);
```

....additional tables are

```
create table orderinfo
(
   orderinfo_id                  serial,
   customer_id                   integer not null,
   date_placed                   date not null,
   date_shipped                  date,
   shipping                      numeric(7,2) ,
   CONSTRAINT                    orderinfo_pk PRIMARY KEY(orderinfo_id),
   CONSTRAINT orderinfo_customer_id_fk FOREIGN KEY(customer_id) REFERENCES customer(customer_id)
);

create table orderline
(
   orderinfo_id                  integer not null,
   item_id                       integer not null,
   quantity                      integer not null,
   CONSTRAINT                    orderline_pk PRIMARY KEY(orderinfo_id, item_id),
   CONSTRAINT orderline_orderinfo_id_fk FOREIGN KEY(orderinfo_id) REFERENCES orderinfo(orderinfo_id),
   CONSTRAINT orderline_item_id_fk FOREIGN KEY(item_id) REFERENCES item(item_id)
);
```

Example: (state what the following trigger does..)

```
create function customer_trigger() returns trigger AS $$
declare
   order_record record;
begin
select * into order_record from orderinfo
   where customer_id = old.customer_id
        and date_shipped is NULL;
   if not found
   then
      raise notice 'deletion allowed: no outstanding orders';
      raise notice 'old.customer_id is %', old.customer_id;
      return NULL;

     for order_record in select * from orderinfo
                                where customer_id = old.customer_id
      loop
         delete from orderline
                   where orderinfo_id = order_record.orderinfo_id;
      end loop;

      delete from orderinfo
                 where customer_id = old.customer_id;

      return old;
   else
      raise notice 'deletion aborted: outstanding orders present';
      return NULL;
   end if;
end;
$$ language plpgsql;
```

create trigger trig_customer before delete on customer
for each row execute procedure customer_trigger();

Web Programming w/ PHP

- Overview
- Structured, semi-structured, and unstructured data
- PHP
- Example of PHP
- Basic features of PHP
- Overview of PHP Database programming

Overview

- Hypertext documents
  - Common method of specifying contents
  - Various languages
    - HTML (HyperText Markup Language)
      - Used for generating static web pages
    - XML (eXtensible Markup Language)
      - Standard for exchanging data over the web
    - PHP (PHP Hypertext Preprocessor {recursive acronym})
      - Dynamic web pages

Structured, semi-structured, and unstructured data

- Structured data
  - Strict format (predefined schema)
  - Disadv: In real world, not all data collected is structured
  - **Ex: Information stored in DB**
- Semi-structured data
  - Data may have certain structure but not all information collected has identical structure
  - No exact pre-defined schema but
    - Semi-structured data *(names of attributes, relationships, and classes)* is mixed in with its schema (self-describing data)
    - Can be displayed as a graph
  - Some attributes may exist in some of the entities of a particular type but not in others
  - **Ex: XML**
- Unstructured data
  - Very limited indication of data type
  - No schema information
    - E.g., a simple text document
    - **HTML**

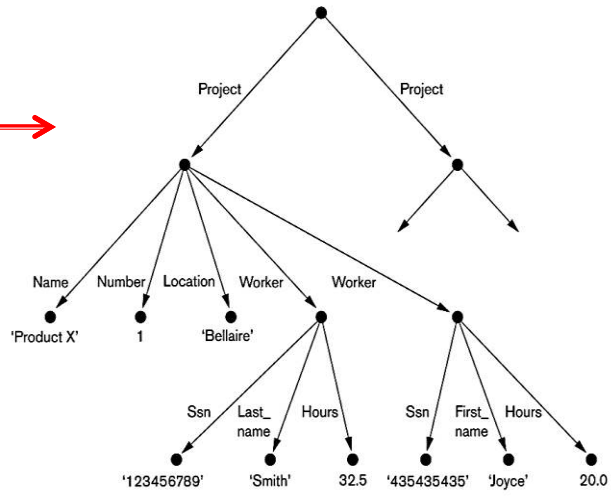
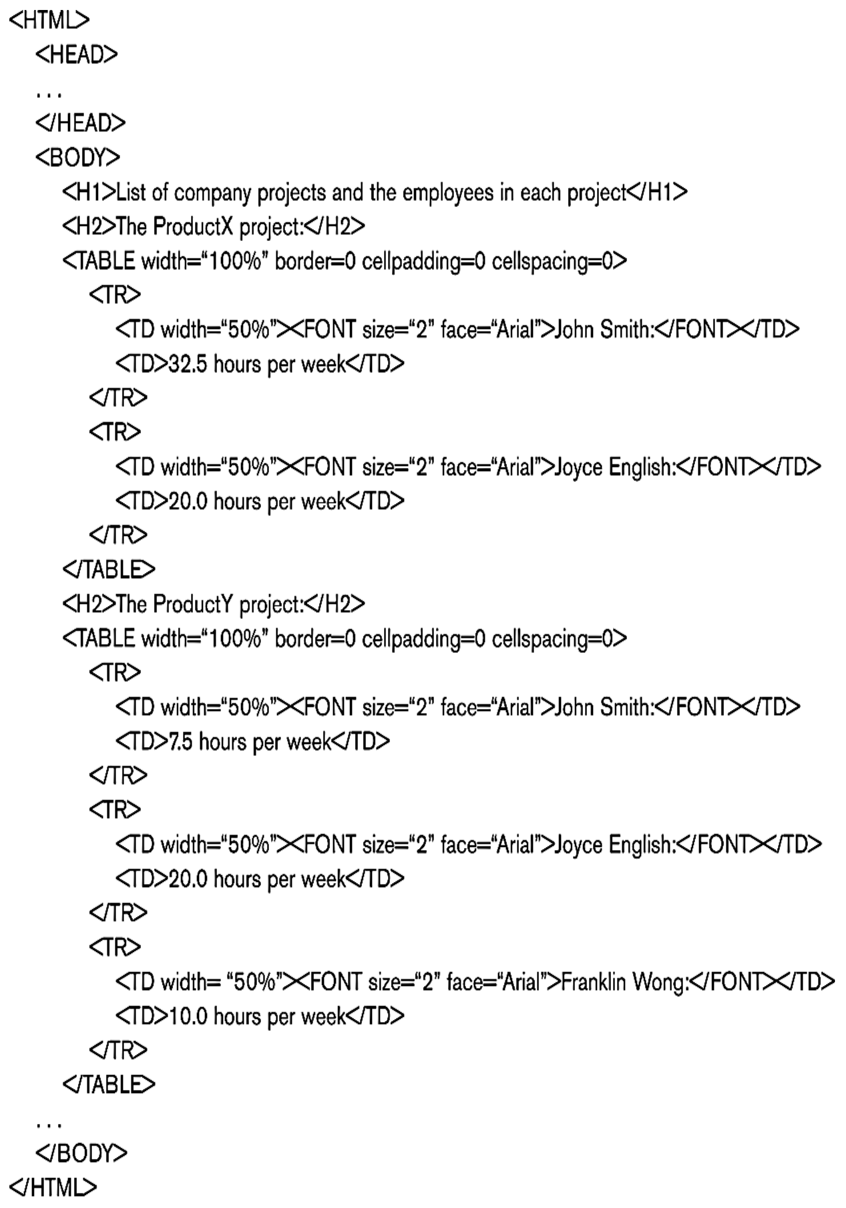


Figure 26.1
Representing semistructured data as a graph

Unstructured data:

- Limited indication of data types
  - E.g., web pages in html contain some unstructured data
  - Figure shows part of HTML document representing unstructured data
- Diffucult to interpret by computer programs BECAUSE no schema (type of data) information is known.
  - XML, conversely, provides easier interpretation and exchange Web documents b/w computers.



```
<HTML>
 <HEAD>
 . . .
 </HEAD>
 <BODY>
  <H1>List of company projects and the employees in each project</H1>
  <H2>The ProductX project:</H2>
  <TABLE width=“100%” border=0 cellpadding=0 cellspacing=0>
   <TR>
    <TD width=“50%”><FONT size=“2” face=“Arial”>John Smith:</FONT></TD>
    <TD>32.5 hours per week</TD>
   </TR>
   <TR>
    <TD width=“50%”><FONT size=“2” face=“Arial”>Joyce English:</FONT></TD>
    <TD>20.0 hours per week</TD>
   </TR>
  </TABLE>
  <H2>The ProductY project:</H2>
  <TABLE width=“100%” border=0 cellpadding=0 cellspacing=0>
   <TR>
    <TD width=“50%”><FONT size=“2” face=“Arial”>John Smith:</FONT></TD>
    <TD>7.5 hours per week</TD>
   </TR>
   <TR>
    <TD width=“50%”><FONT size=“2” face=“Arial”>Joyce English:</FONT></TD>
    <TD>20.0 hours per week</TD>
   </TR>
   <TR>
    <TD width= “50%”><FONT size=“2” face=“Arial”>Franklin Wong:</FONT></TD>
    <TD>10.0 hours per week</TD>
   </TR>
  </TABLE>
 . . .
 </BODY>
</HTML>
```

Figure 26.2
Part of an HTML document representing unstructured data.

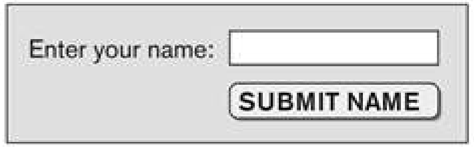
PHP

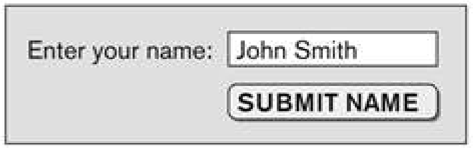
- Open source
- General purpose scripting language
- Interpreter engine in C
  - Can be used on nearly all computer types
- Particularly suited for manipulation of text pages
- Manipulates (**dynamic html**) at the Web *server*
  - Conversely, JavaScript is downloaded and executed on the client
- **dynamic html:** Webs pages, where part of the info is extracted from databases are called dynamic web pages..
- Has libraries of functions for accessing databases

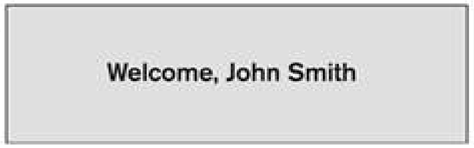
A simple PHP Example

- Suppose the file containing program segment P1 is stored at www.myserver.com/example/greeting.php

```
//Program Segment P1:
<?php
// Printing a welcome message if the user submitted their name
// through the HTML form
if ($_POST['user_name']) {
  print("Welcome,  ") ;
  print($_POST['user_name']);
}
else {
  // Printing the form to enter the user name since no name has
  // been entered yet
  print <<<_HTML_
  <FORM method="post" action="$_SERVER['PHP_SELF']">
  Enter your name: <input type="text" name="user_name">
  <BR/>
  <INPUT type="submit" value="SUBMIT NAME">
  </FORM>
  _HTML_;
}
?>
```

(b)


(c)


(d)


Welcome, John Smith

Figure 26.3
(a) PHP program segment for entering a greeting,
(b) Initial form displayed by PHP program segment,
(c) User enters name *John Smith*, (d) Form prints
welcome message for *John Smith*.

Overview of basic features of PHP

- PHP variables, data types, and programming constructs
  - Variable names start with $ and can include characters, letters, numbers, and _.
    - No other special characters are permitted
    - Are case sensitive
    - Can’t start with a number
  - Variables are not types
    - Values assigned to variables determine their type
    - Assignments can change the type
  - Variable assignments are made by =

Overview of basic features of PHP

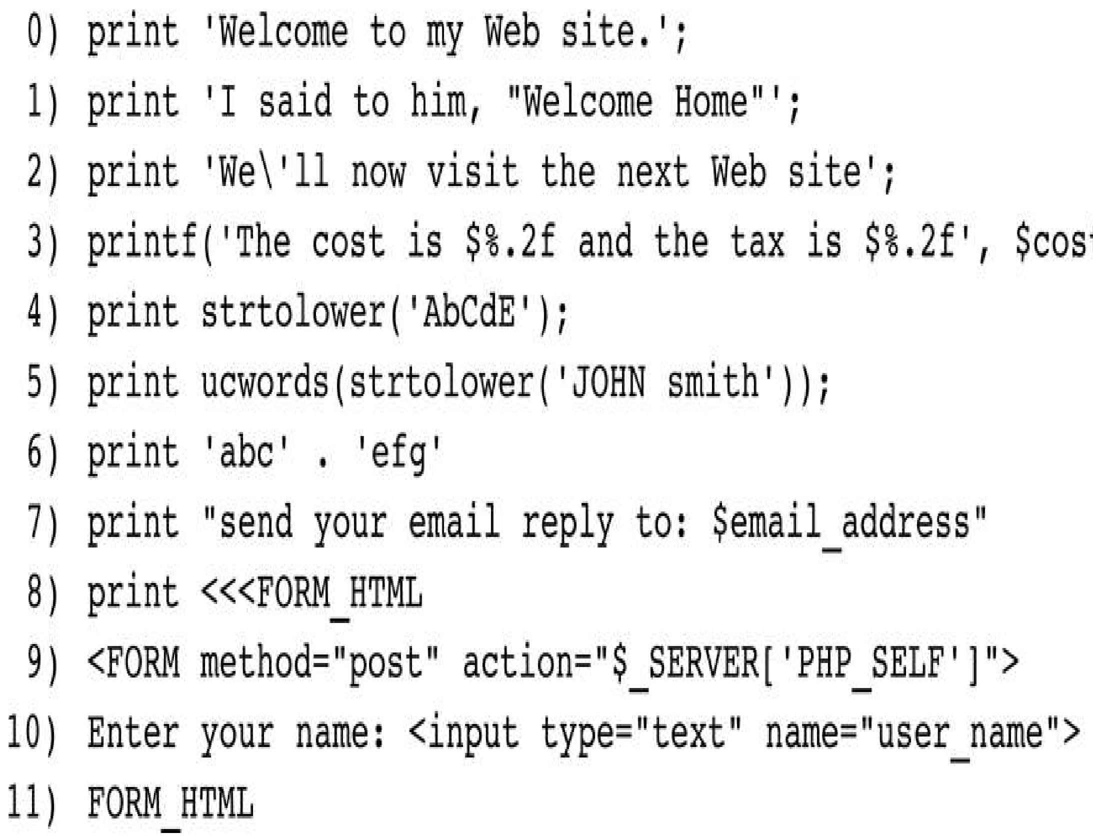
- PHP variables, data types, and programming constructs (contd.)
  - Main ways to express strings
    - Single-quoted strings (lines 0, 1, 2)
      - \' represents a quote in a string
    - Double-quoted strings (line 7)
      - Variable names can be interpolated
    - Here documents (line 8-11)
      - Enclose a part of a document between <<<DONMANE and end it with a single line containing the document name DONAME
    - Single and double quotes
      - The quotes should be straight quotes (') not (‘) or (’)

```
 0) print 'Welcome to my Web site.';
 1) print 'I said to him, "Welcome Home"';
 2) print 'We\'ll now visit the next Web site';
 3) printf('The cost is $%.2f and the tax is $%.2f', $cost, $tax) ;
 4) print strtolower('AbCdE');
 5) print ucwords(strtolower('JOHN smith'));
 6) print 'abc' . 'efg'
 7) print "send your email reply to: $email_address"
 8) print <<<FORM_HTML
 9) <FORM method="post" action="$_SERVER['PHP_SELF']">
10) Enter your name: <input type="text" name="user_name">
11) FORM_HTML
```

Figure 26.4
Illustrating basic PHP string and text values.

Overview of basic features of PHP

- PHP variables, data types, and programming constructs (contd.)
  - String operations
    - (.) Is concatenate as in Line 6
    - (strtolower()) converts string into lower case
    - Others as needed
  - Numeric data types follows C rules



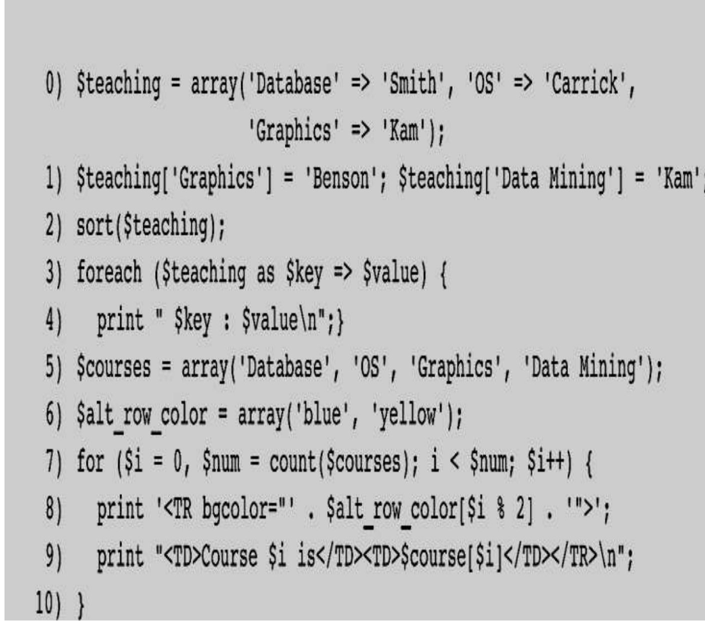
```
 0) print 'Welcome to my Web site.';
 1) print 'I said to him, "Welcome Home"';
 2) print 'We\'ll now visit the next Web site';
 3) printf('The cost is $%.2f and the tax is $%.2f', $cost, $tax) ;
 4) print strtolower('AbCdE');
 5) print ucwords(strtolower('JOHN smith'));
 6) print 'abc' . 'efg'
 7) print "send your email reply to: $email_address"
 8) print <<<FORM_HTML
 9) <FORM method="post" action="$_SERVER['PHP_SELF']">
10) Enter your name: <input type="text" name="user_name">
11) FORM_HTML
```

Figure 26.4
Illustrating basic PHP string and text values.

Overview of basic features of PHP

- PHP variables, data types, and programming constructs (contd.)
  - Other programming constructs similar to C language constructs
    - for-loops
    - while-loops
    - if-statements
  - Boolean logic
    - True/false is equivalent no non-zero/zero
    - Comparison operators
      - ==, !=, >, >=, <, <=
- PHP Arrays
  - Allow a list of elements
  - Can be 1-dimensional or multi-dimensional
  - Can be **numeric** or **associative**
    - Numeric array is based on a numeric index
    - Associative array is based on a key => value relationship
  - Line 0: $teaching is a associative array
    - Line 1 shows how the array can be updated/accessed
  - Line 5: $courses is a numeric array
    - No key is provided => numeric array
  - There are several ways of looping through arrays
    - Line 3 and 4 show "**for each**" construct for looping through each and every element in the array
    - Line 7 and 10 show a traditional "**for loop**" construct for iterating through an array

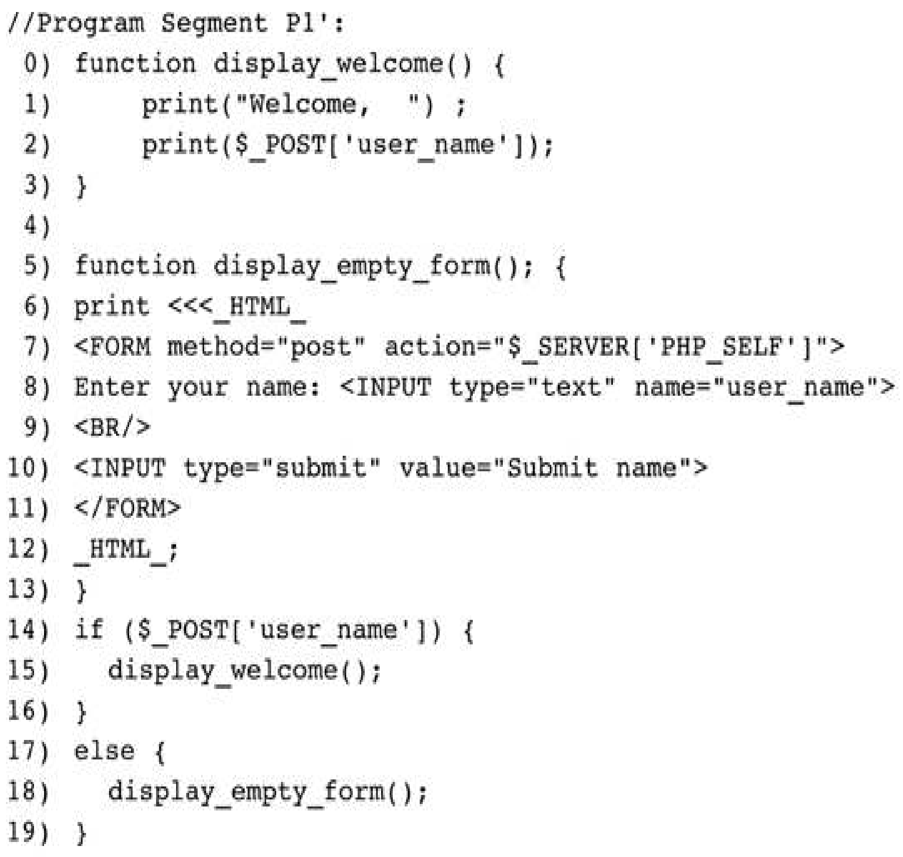
Figure 26.5
Illustrating basic PHP array processing.



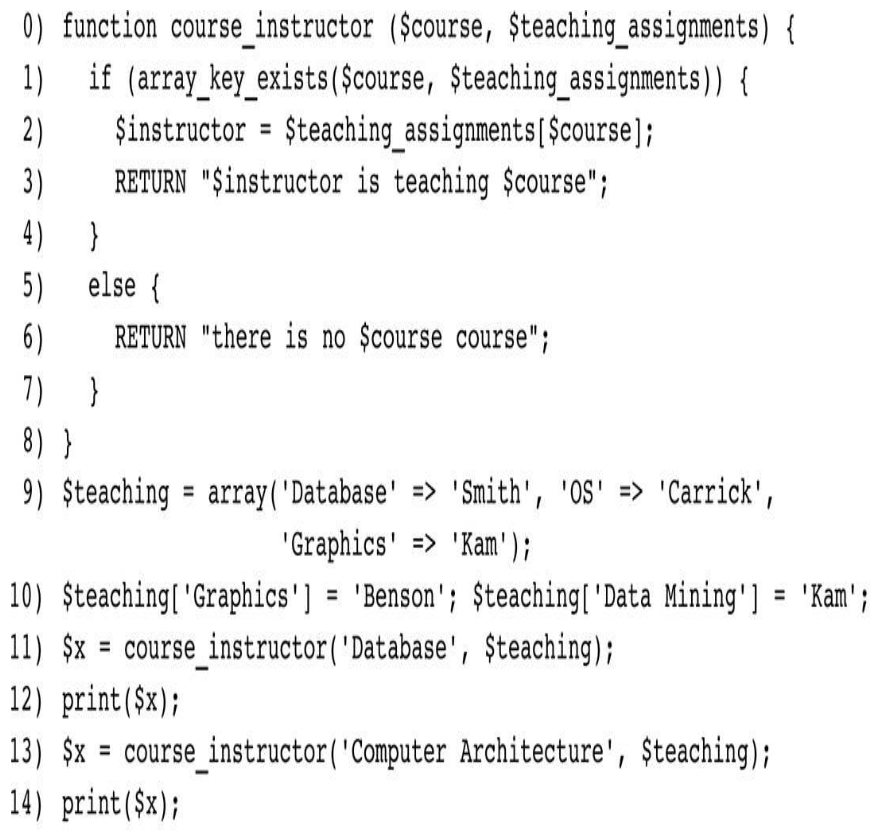
```
 0) $teaching = array('Database' => 'Smith', 'OS' => 'Carrick',
                      'Graphics' => 'Kam');
 1) $teaching['Graphics'] = 'Benson'; $teaching['Data Mining'] = 'Kam'
 2) sort($teaching);
 3) foreach ($teaching as $key => $value) {
 4)   print " $key : $value\n";}
 5) $courses = array('Database', 'OS', 'Graphics', 'Data Mining');
 6) $alt_row_color = array('blue', 'yellow');
 7) for ($i = 0, $num = count($courses); i < $num; $i++) {
 8)   print '<TR bgcolor="' . $alt_row_color[$i % 2] . '">';
 9)   print "<TD>Course $i is</TD><TD>$course[$i]</TD></TR>\n";
10) }
```

Overview of basic features of PHP

- PHP Functions
  - Code segment P1' in Figure 26.6 has two functions
    - display_welcome()
    - display_empty_form()
  - Line 14-19 show how these functions can be called



```
//Program Segment P1':
 0) function display_welcome() {
 1)     print("Welcome,  ") ;
 2)     print($_POST['user_name']);
 3) }
 4)
 5) function display_empty_form(); {
 6) print <<<_HTML_
 7) <FORM method="post" action="$_SERVER['PHP_SELF']">
 8) Enter your name: <INPUT type="text" name="user_name">
 9) <BR/>
10) <INPUT type="submit" value="Submit name">
11) </FORM>
12) _HTML_;
13) }
14) if ($_POST['user_name']) {
15)   display_welcome();
16) }
17) else {
18)   display_empty_form();
19) }
```



```
function course_instructor ($course, $teaching_assignments) {
  if (array_key_exists($course, $teaching_assignments)) {
    $instructor = $teaching_assignments[$course];
    RETURN "$instructor is teaching $course";
  }
  else {
    RETURN "there is no $course course";
  }
}
$teaching = array('Database' => 'Smith', 'OS' => 'Carrick',
                  'Graphics' => 'Kam');
$teaching['Graphics'] = 'Benson'; $teaching['Data Mining'] = 'Kam';
$x = course_instructor('Database', $teaching);
print($x);
$x = course_instructor('Computer Architecture', $teaching);
print($x);
```

Figure 26.7
Illustrating a function with arguments and return value.

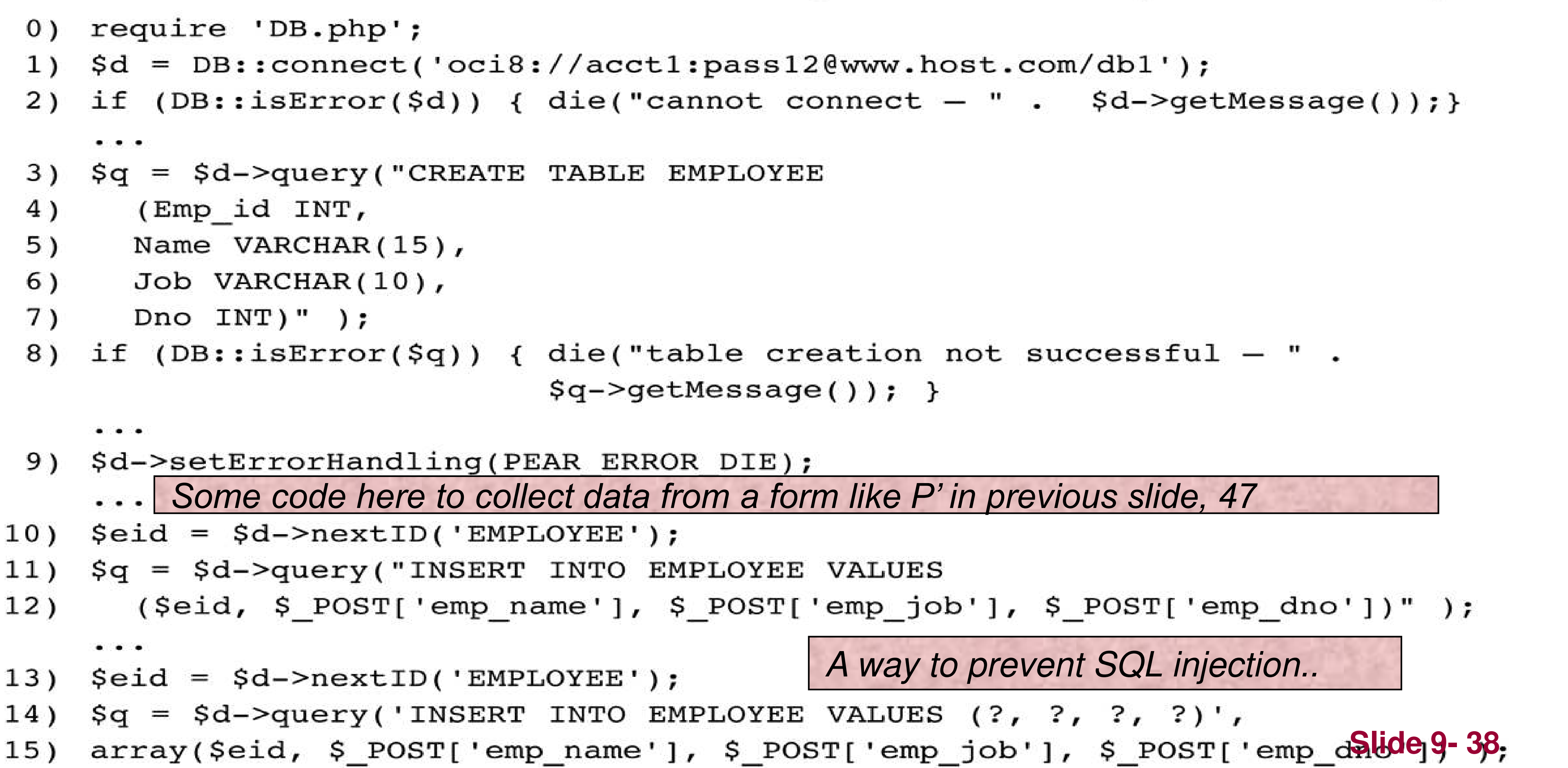
Overview of basic features of PHP

- PHP Server Variables and Forms
  - There a number of built-in entries in PHP function. Some examples are:
    - $_SERVER['SERVER_NAME‘]
      - This provides the Website name of the server computer where PHP interpreter is running
    - $_SERVER['REMOTE_ADDRESS']
      - IP address of client user computer that is accessing the server
    - $_SERVER['REMOTE_HOST']
      - Website name of the client user computer
    - $_SERVER['PATH_INFO']
      - The part of the URL address that comes after backslash (/) at the end of the URL
    - $_SERVER['QUERY_STRING']
      - The string that holds the parameters in the IRL after ?.
    - $_SERVER['DOCUMENT_ROOT']
      - The root directory that holds the files on the Web server

Overview of PHP Database Programming

- Connecting to the database
  - Must load PEAR DB library module DB.php
  - DB library functions are called using DB::<function_name>
  - The format for the connect string is:
    - <DBMS>://<userid>:<password>@<DBserver>
    - For example:
      - $d=DB::connect('oci8://ac1:pass12@www.abc.com/db1')
  - Line 10-12 shows how information collected via forms can be stored in the database

Figure 26.
Connecting to a database, creating a table, and inserting a record



```
 0) require 'DB.php';
 1) $d = DB::connect('oci8://acct1:pass12@www.host.com/db1');
 2) if (DB::isError($d)) { die("cannot connect — " .  $d->getMessage());}
    ...
 3) $q = $d->query("CREATE TABLE EMPLOYEE
 4)   (Emp_id INT,
 5)    Name VARCHAR(15),
 6)    Job VARCHAR(10),
 7)    Dno INT)" );
 8) if (DB::isError($q)) { die("table creation not successful — " .
                             $q->getMessage()); }
    ...
 9) $d->setErrorHandling(PEAR_ERROR_DIE);
    ...
10) $eid = $d->nextID('EMPLOYEE');
11) $q = $d->query("INSERT INTO EMPLOYEE VALUES
12)   ($eid, $_POST['emp_name'], $_POST['emp_job'], $_POST['emp_dno'])" );
    ...
13) $eid = $d->nextID('EMPLOYEE');
14) $q = $d->query('INSERT INTO EMPLOYEE VALUES (?, ?, ?, ?)',
15) array($eid, $_POST['emp_name'], $_POST['emp_job'], $_POST['emp_dno']) );
```

Some code here to collect data from a form like P' in previous slide, 47

A way to prevent SQL injection..

Overview of PHP Database Programming

- Retrieval queries and Database tables
  - Lines 4-7 retrieves name and department number of all employee records
  - Lines 8-13 is a dynamic query (conditions based on user selection)
    - Values for these are entered through forms
  - Lines 14-17 is an alternative way of specifying a query and looping over its records
    - Function $d->getAll holds all the records in $allresult

```
 0) require 'DB.php';
 1) $d = DB::connect('oci8://acct1:pass12@www.host.com/dbname');
 2) if (DB::isError($d)) { die("cannot connect - " .  $d->getMessage()); }
 3) $d->setErrorHandling(PEAR_ERROR_DIE);
    ...
 4) $q = $d->query('SELECT Name, Dno FROM EMPLOYEE');
 5) while ($r = $q->fetchRow()) {
 6)   print "employee $r[0] works for department $r[1] \n" ;
 7) }
    ...
 8) $q = $d->query('SELECT Name FROM EMPLOYEE WHERE Job = ? AND Dno = ?',
 9)   array($_POST['emp_job'], $_POST['emp_dno']) );
10) print "employees in dept $_POST['emp_dno'] whose job is
      $_POST['emp_job']: \n"
11) while ($r = $q->fetchRow()) {
12)   print "employee $r[0] \n" ;
13) }
    ...
14) $allresult = $d->getAll('SELECT Name, Job, Dno FROM EMPLOYEE');
15) foreach ($allresult as $r) {
16)   print "employee $r[0] has job $r[1] and works for department $r[2] \n" ;
17) }
    ...
```

Figure 26.9
Illustrating database retrieval queries.

Summary

- Assertions provide a means to specify additional constraints
- Triggers are assertions that define actions to be automatically taken when certain conditions occur
- A database may be accessed in an interactive mode; Most often, however, data in a database is manipulate via application programs
- Several methods of database programming:
  - Embedded SQL
  - Dynamic SQL
  - JDBC
  - Stored procedure and functions
  - Web Programming with PHP