Database Management System

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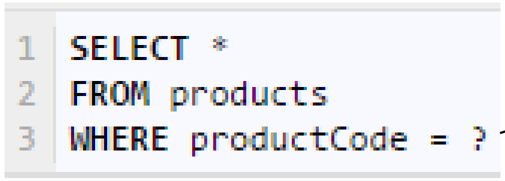
Objectives

- Advance SQL (Part IV)
  - Prepared Statement
  - General Purpose Stored Procedure
  - Cursors
  - Resources

Prepared Statement

- Prepared statement or parameterized statement is a feature used to execute the same or similar database statements repeatedly with high efficiency

- Example: 

```
SELECT *
FROM products
WHERE productCode = ?
```

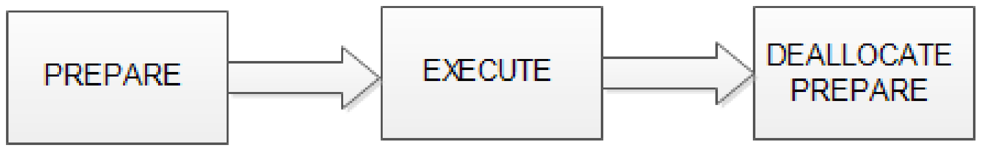
This question mark is used as a placeholder.

- When MySQL executes example query with different product code values, it does not have to parse the query fully. As a result, this helps MySQL execute the query faster, especially when MySQL executes the query multiple times. Because the prepared statement uses placeholders (?), this helps avoid many variants of SQL injection hence make your application more secure.

Prepared Statement (Cont.)

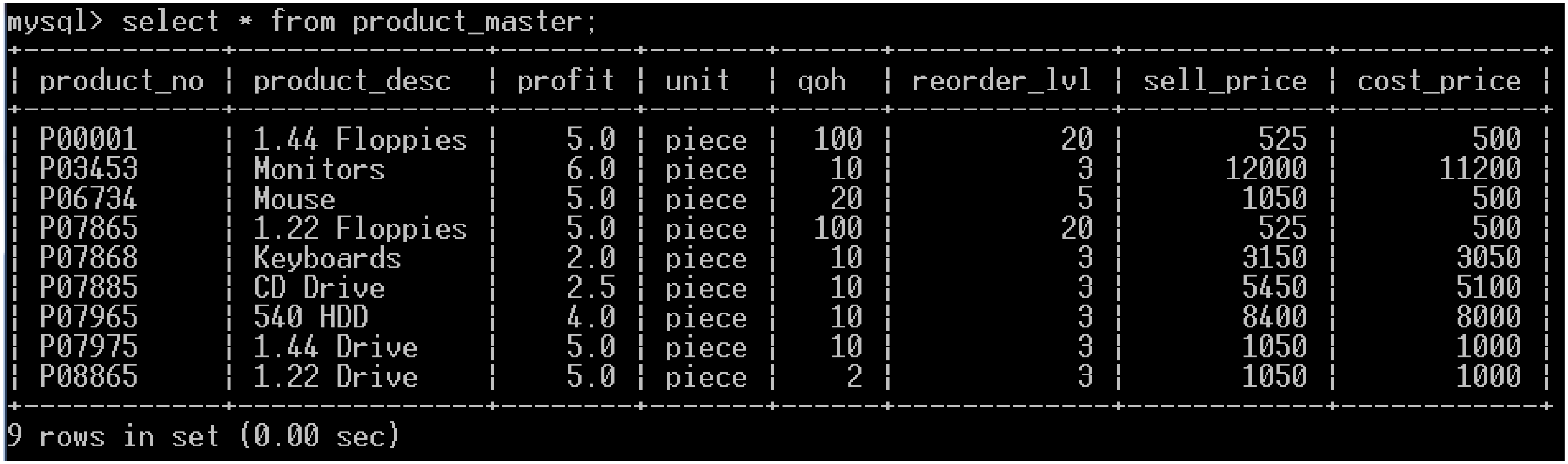
- Consists of three steps:
    1. PREPARE – Prepares statement for execution
    2. EXECUTE – Executes a prepared statement preparing by a PREPARE statement
    3. DEALLOCATE PREPARE – Releases a prepared statement

The following diagram illustrates how to use the prepared statement:



Example

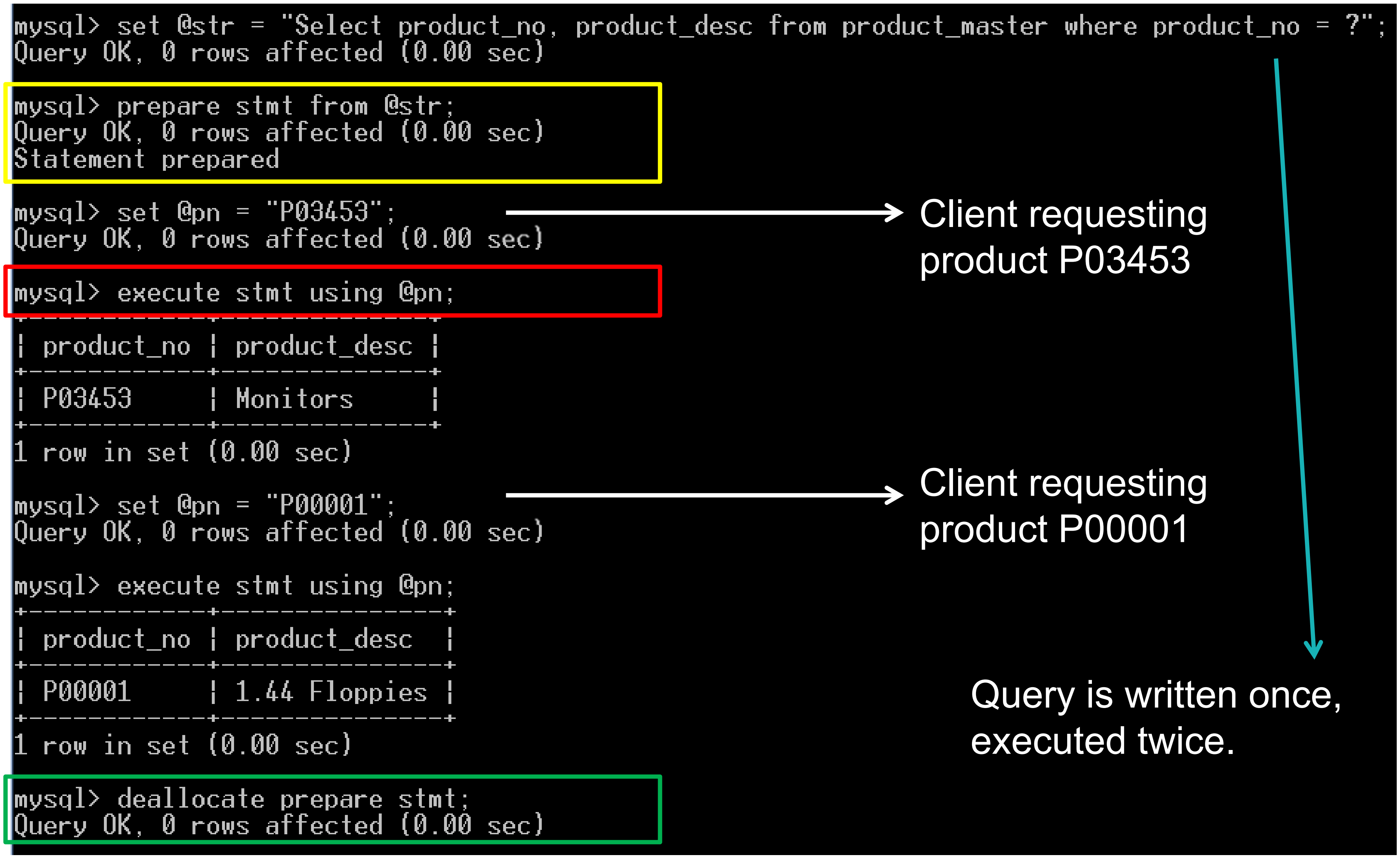
- Consider the product_master table as given in sam_data2:



```
mysql> select * from product_master;
+------------+---------------+--------+-------+------+-------------+------------+------------+
| product_no | product_desc  | profit | unit  | qoh  | reorder_lvl | sell_price | cost_price |
+------------+---------------+--------+-------+------+-------------+------------+------------+
| P00001     | 1.44 Floppies |    5.0 | piece |  100 |          20 |        525 |        500 |
| P03453     | Monitors      |    6.0 | piece |   10 |           3 |      12000 |      11200 |
| P06734     | Mouse         |    5.0 | piece |   20 |           5 |       1050 |        500 |
| P07865     | 1.22 Floppies |    5.0 | piece |  100 |          20 |        525 |        500 |
| P07868     | Keyboards     |    2.0 | piece |   10 |           3 |       3150 |       3050 |
| P07885     | CD Drive      |    2.5 | piece |   10 |           3 |       5450 |       5100 |
| P07965     | 540 HDD       |    4.0 | piece |   10 |           3 |       8400 |       8000 |
| P07975     | 1.44 Drive    |    5.0 | piece |   10 |           3 |       1050 |       1000 |
| P08865     | 1.22 Drive    |    5.0 | piece |    2 |           3 |       1050 |       1000 |
+------------+---------------+--------+-------+------+-------------+------------+------------+
9 rows in set (0.00 sec)
```

We'll use this table to retrieve various products on demand from clients.

Example (Cont.)



```
mysql> set @str = "Select product_no, product_desc from product_master where product_no = ?";
Query OK, 0 rows affected (0.00 sec)

mysql> prepare stmt from @str;
Query OK, 0 rows affected (0.00 sec)
Statement prepared

mysql> set @pn = "P03453";
Query OK, 0 rows affected (0.00 sec)

mysql> execute stmt using @pn;
+------------+--------------+
| product_no | product_desc |
+------------+--------------+
| P03453     | Monitors     |
+------------+--------------+
1 row in set (0.00 sec)

mysql> set @pn = "P00001";
Query OK, 0 rows affected (0.00 sec)

mysql> execute stmt using @pn;
+------------+--------------+
| product_no | product_desc |
+------------+--------------+
| P00001     | 1.44 Floppies |
+------------+--------------+
1 row in set (0.00 sec)

mysql> deallocate prepare stmt;
Query OK, 0 rows affected (0.00 sec)
```

Client requesting product P03453
Client requesting product P00001
Query is written once, executed twice.

Example (Cont.)

- First we used the PREPARE statement to prepare a statement for execution. We used the SELECT statement to query product data from the products table based on a specified product code. We used a question mark (?) as a placeholder for the product code.
- Next, we declared a product code variable @pn and set its value to “P03453".
- Then, we used the EXECUTE statement to execute the prepared statement with the product code variable @pn.
- Next, we declared again product code variable @pn and set its value to “P00001".
- Finally, we used the DEALLOCATE PREPARE to release the prepared statement.

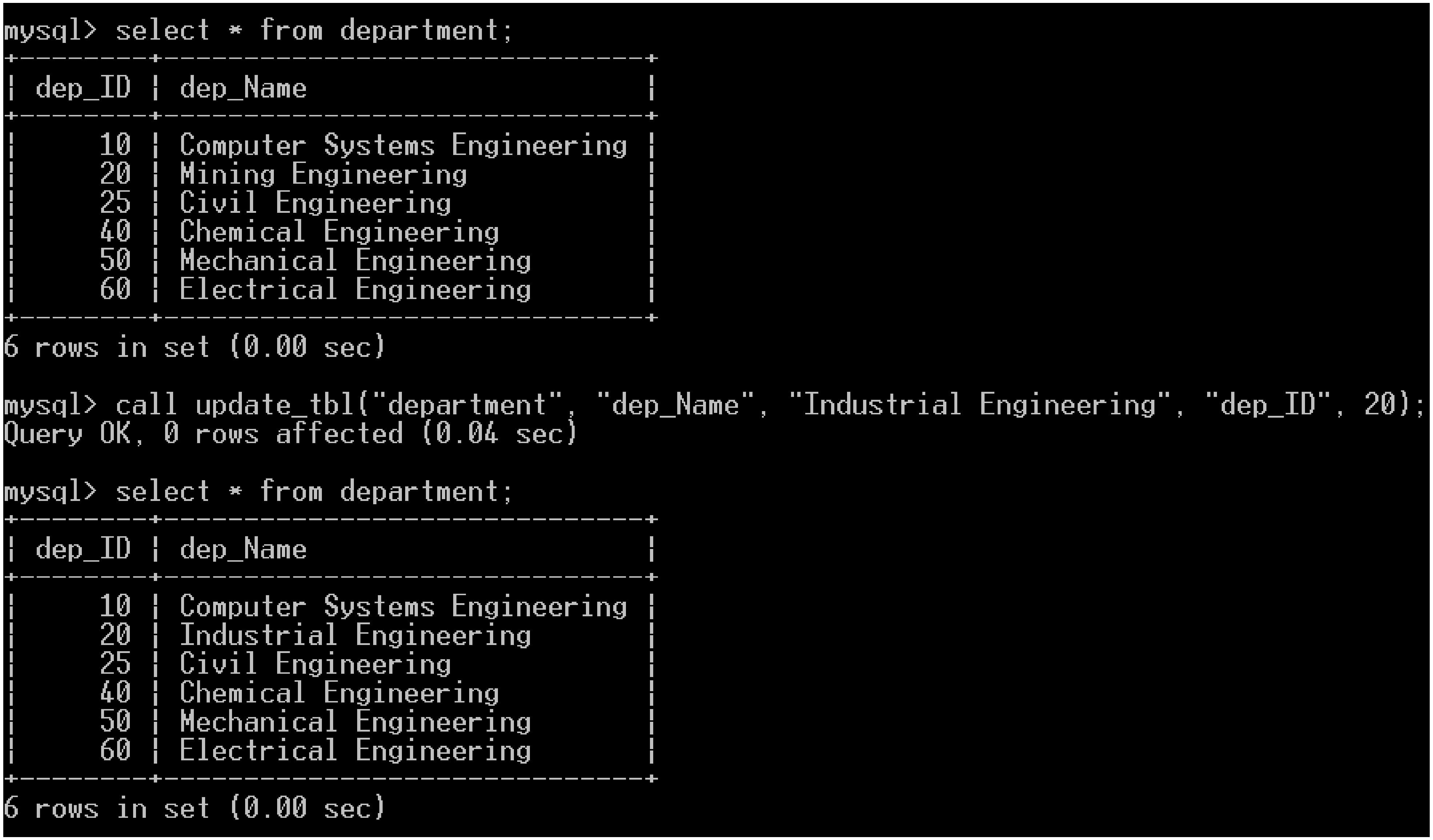
General Purpose Stored Procedure

```
DELIMITER $$

CREATE PROCEDURE update_tbl(tbl_name varchar(30), tbl_col varchar(30), tbl_val varchar(50),
tbl_id varchar(30), tbl_id_valie varchar(50))
begin
        -- STEPT 1: Set variables to store arguments
        set @tn = tbl_name;
        set @tc = tbl_col;
        set @tv = tbl_val;
        set @ti = tbl_id;
        set @tid = tbl_id_valie;

        -- STEPT 2: Write query using set variables
        set @q = concat('update ', @tn, ' set ', @tc, ' = ''', @tv, ''' where ', @ti, ' = ''', @tid, '''');

        -- STEPT 3: Prepare statement (As query is dynamically generated, so its need to be prepared)
        prepare stmt from @q;

        -- STEPT 4: Execute statement prepared in Step 3
        execute stmt;

        -- STEPT 5: Free space by deallocating  prepare statement
        deallocate prepare stmt;
end
```

- Optional Step.
- Used for clarity.
- Variable tbl_col etc. can be used directly.

General Purpose SP uses Prepared Statement for generalization.

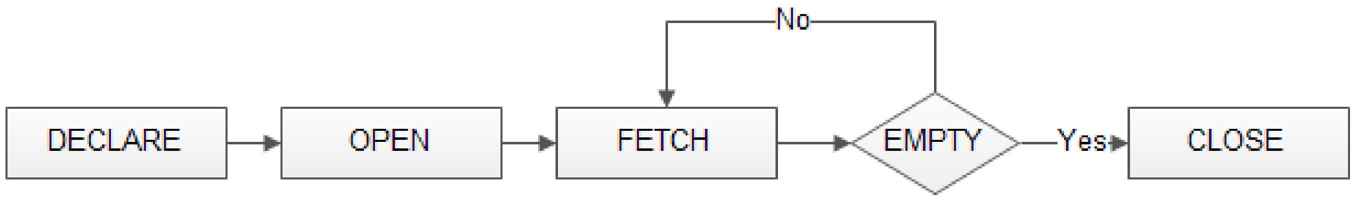
Output



```
mysql> select * from department;
+--------+-----------------------------+
| dep_ID | dep_Name                    |
+--------+-----------------------------+
|     10 | Computer Systems Engineering |
|     20 | Mining Engineering          |
|     25 | Civil Engineering           |
|     40 | Chemical Engineering        |
|     50 | Mechanical Engineering      |
|     60 | Electrical Engineering      |
+--------+-----------------------------+
6 rows in set (0.00 sec)

mysql> call update_tbl("department", "dep_Name", "Industrial Engineering", "dep_ID", 20);
Query OK, 0 rows affected (0.04 sec)

mysql> select * from department;
+--------+-----------------------------+
| dep_ID | dep_Name                    |
+--------+-----------------------------+
|     10 | Computer Systems Engineering |
|     20 | Industrial Engineering      |
|     25 | Civil Engineering           |
|     40 | Chemical Engineering        |
|     50 | Mechanical Engineering      |
|     60 | Electrical Engineering      |
+--------+-----------------------------+
6 rows in set (0.00 sec)
```

Cursor

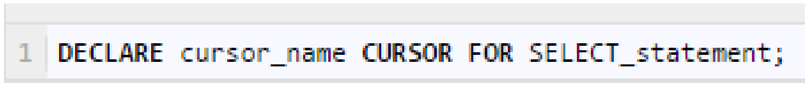
- To handle a result set inside a stored procedure, cursor is used. A cursor allows you to iterate a set of rows returned by a query and process each row accordingly.
- It can be used in any stored program.
- There are following steps involved in cursor creation:



- Each of discussed next.

Using Cursor

1) Declare Cursor:



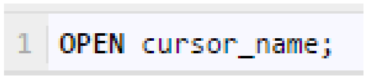
```
DECLARE cursor_name CURSOR FOR SELECT_statement;
```

– The cursor declaration must be after any variable declaration.

– If you declare a cursor before variables declaration, MySQL will issue an error.

– A cursor must always be associated with a SELECT statement.

2) Open Cursor:

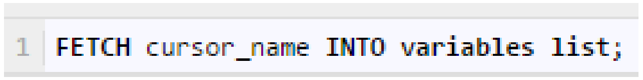


```
OPEN cursor_name;
```

– Next, you open the cursor by using the OPEN statement.

– The OPEN statement initializes the result set for the cursor, therefore, you must call the OPEN statement before fetching rows from the result set.

3) Fetch Cursor:

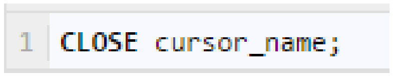


```
FETCH cursor_name INTO variables list;
```

– Then, use the FETCH statement to retrieve the next row pointed by the cursor and move the cursor to the next row in the result set.

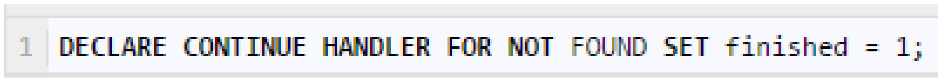
Using Cursor (Cont.)

4) Check Cursor:
   - Check if there is any row available before fetching it.

5) Close Cursor: 

```sql
CLOSE cursor_name;
```

   - Use CLOSE statement to deactivate the cursor and release the memory associated with it.

6) Declare Continue Handler: 

```sql
DECLARE CONTINUE HANDLER FOR NOT FOUND SET finished = 1;
```

   - Cursors need to declare a NOT FOUND handler to handle the situation when it could not find any row.
   - As each time FETCH statement is called, cursor attempts to read the next row in the result set.
   - When the cursor reaches the end of the result set, it will not be able to get the data, and a condition is raised.
   - This handler is used to handle that condition.

Cursor Example 1 – Build Email List of Employees

```sql
DELIMITER $$

CREATE DEFINER=`root`@`localhost` PROCEDURE `build_email_list`(INOUT email_list varchar(4000))
BEGIN

DECLARE v_finished INTEGER DEFAULT 0;
DECLARE v_email varchar(100) DEFAULT "";

 -- declare cursor for employee email
 DECLARE email_cursor CURSOR FOR
 SELECT email FROM client_master;
```

1. Declare Cursor

```sql
 -- declare NOT FOUND handler
 DECLARE CONTINUE HANDLER
        FOR NOT FOUND SET v_finished = 1;
```

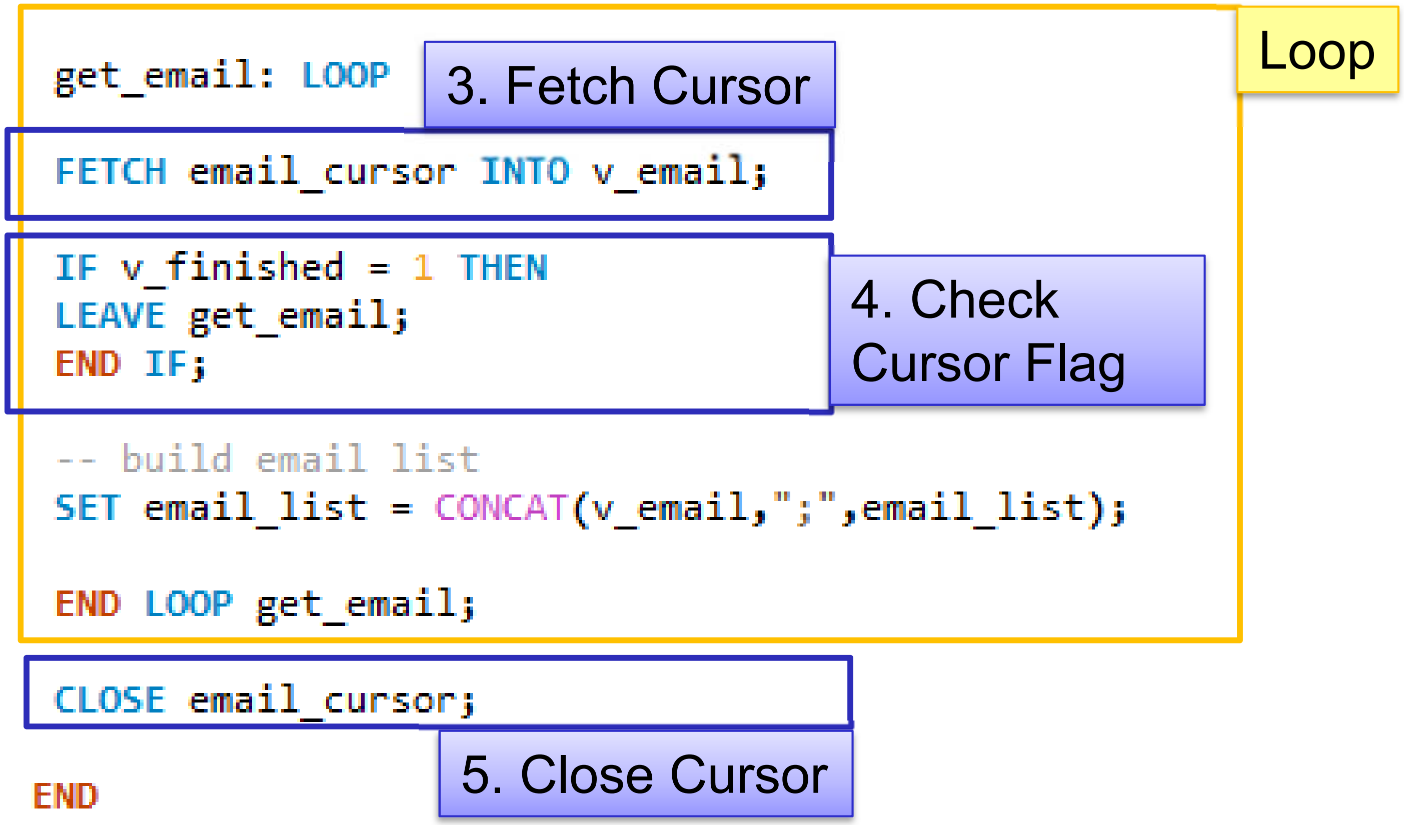
6. Declare Continue Handler

```sql
 OPEN email_cursor;
```

2. Open Cursor

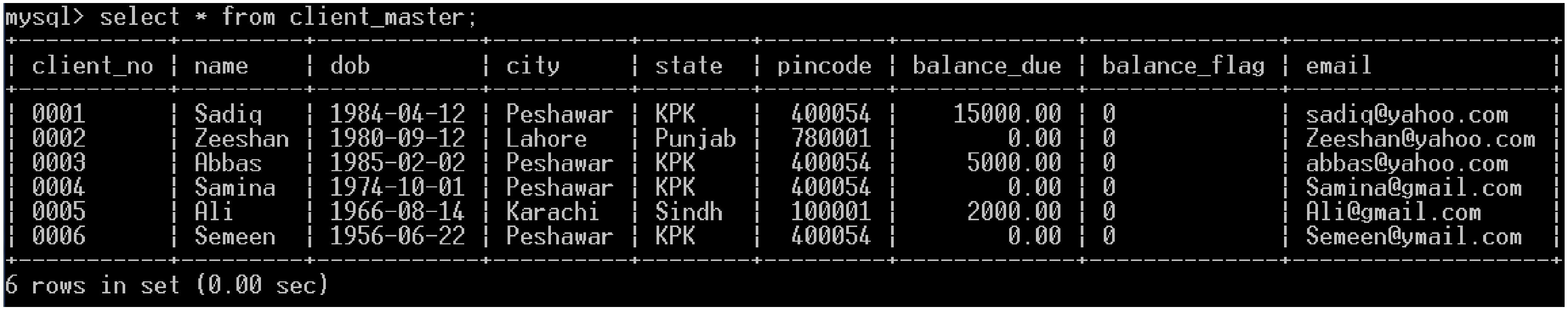
```sql
 get_email: LOOP
```

Cursor Example 1 – Build Email List of Employees (Cont.)

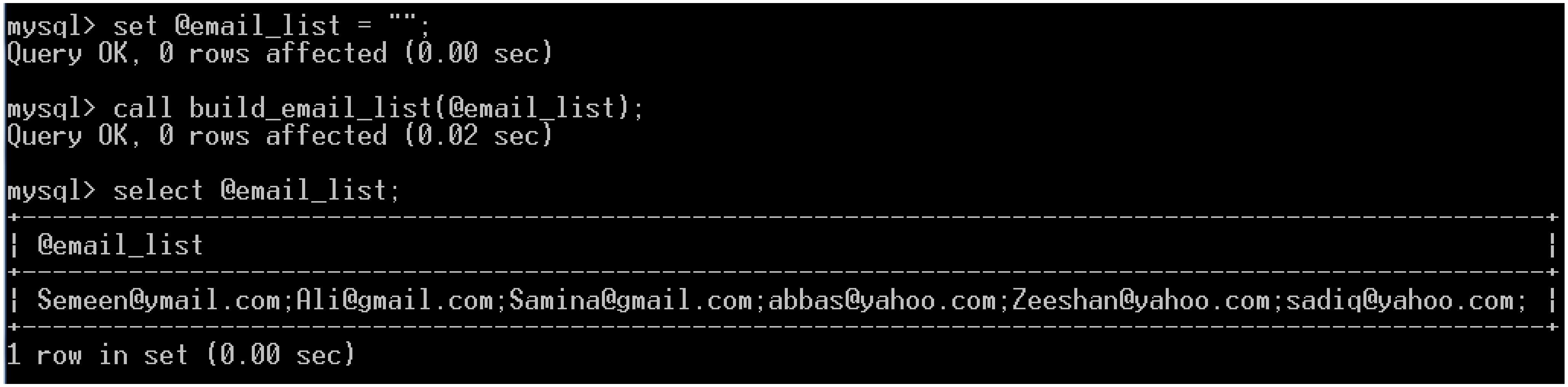


```
get_email: LOOP

FETCH email_cursor INTO v_email;

IF v_finished = 1 THEN
LEAVE get_email;
END IF;

-- build email list
SET email_list = CONCAT(v_email,";",email_list);

END LOOP get_email;

CLOSE email_cursor;

END
```

Output



```
mysql> select * from client_master;
+-----------+---------+------------+----------+--------+---------+-------------+--------------+--------------------+
| client_no | name    | dob        | city     | state  | pincode | balance_due | balance_flag | email              |
+-----------+---------+------------+----------+--------+---------+-------------+--------------+--------------------+
| 0001      | Sadiq   | 1984-04-12 | Peshawar | KPK    |  400054 |    15000.00 | 0            | sadiq@yahoo.com    |
| 0002      | Zeeshan | 1980-09-12 | Lahore   | Punjab |  780001 |        0.00 | 0            | Zeeshan@yahoo.com  |
| 0003      | Abbas   | 1985-02-02 | Peshawar | KPK    |  400054 |     5000.00 | 0            | abbas@yahoo.com    |
| 0004      | Samina  | 1974-10-01 | Peshawar | KPK    |  400054 |        0.00 | 0            | Samina@gmail.com   |
| 0005      | Ali     | 1966-08-14 | Karachi  | Sindh  |  100001 |     2000.00 | 0            | Ali@gmail.com      |
| 0006      | Semeen  | 1956-06-22 | Peshawar | KPK    |  400054 |        0.00 | 0            | Semeen@ymail.com   |
+-----------+---------+------------+----------+--------+---------+-------------+--------------+--------------------+
6 rows in set (0.00 sec)
```



```
mysql> set @email_list = "";
Query OK, 0 rows affected (0.00 sec)

mysql> call build_email_list(@email_list);
Query OK, 0 rows affected (0.02 sec)

mysql> select @email_list;
+--------------------------------------------------------------------------------------------+
| @email_list                                                                                |
+--------------------------------------------------------------------------------------------+
| Semeen@ymail.com;Ali@gmail.com;Samina@gmail.com;abbas@yahoo.com;Zeeshan@yahoo.com;sadiq@yahoo.com; |
+--------------------------------------------------------------------------------------------+
1 row in set (0.00 sec)
```

Cursor Example 2 – Fetch Table Attributes into Variable

```
DELIMITER $$
CREATE PROCEDURE  cursor_proc()
BEGIN
        declare id int(5);
        declare n varchar(50);

        -- STEPT 1: As cursor will reach end of table, this flag will set to be true
        declare exit_loop boolean;

        -- STEP 2: Declare cursor
        declare department_cursor cursor for select dep_ID, dep_Name from department;

        -- STEP 3: Set exit_loop flag to true if there are no more rows
        declare continue handler for not found set exit_loop = true;

        -- STEP 4: Open cursor
        open department_cursor;
```

Cursor Example 2 – Fetch Table Attributes into Variable (Cont.)

```
        -- start loop
        department_loop: loop

                -- STEP 5: Read data into variables
                fetch department_cursor into id, n;

                -- check if the exit_loop flag has been set by mysql,
                -- STEP 6: Close the cursor and exit the loop if it has.
                if exit_loop then
                        close department_cursor;
                        leave department_loop;
                end if;

                select id, n;

        end loop department_loop;
END
```

Advantages of Using Cursors

- No need to write business logic after fetching data from your code logic.
- Gives better flexibility for operating even on the single column of the row. Manipulation become always easy.
- Saves from the simplex join structure.
- Easy to maintain the business logic of your application at one place.

Disadvantages of Using Cursors

- Slows down stored procedure or function performance in cause of large record set in cursor.
- Debugging of your business logic become tough.
- Hard to manage.
- Need extra care in cause of the implementation of replication using binary log.
- Need to consider locking of the database.

Summary

- Discussed and implemented prepared statement
- Discussed and implemented general purpose store procedure based on prepared statement
- Discussed and implemented cursor in database

Resources

- Books
  1) MySQL Stored Procedure Programming, by Guy Harrison with Steven Feuerstein
  2) MySQL in a Nutshell, by Russell Dyer
  3) Web Database Applications with PHP and MySQL, by Hugh Williams and David Lane
  4) MySQL, by Paul DuBois
  5) High Performance MySQL, by Jeremy Zawodny and Derek Balling
  6) MySQL Cookbook, by Paul DuBois
  7) Pro MySQL, by Michael Krukenberg and Jay Pipes
  8) MySQL Design and Tuning, by Robert D. Schneider
  9) SQL in a Nutshell, by Kevin Kline, et al.
  10) Learning SQL, by Alan Beaulieu

Resources (Cont.)

- Internet Resources
  1) MySQL - Start at http://www.mysql.com
  2) MySQL Developer Zone - http://dev.mysql.com/
  3) MySQL Online Documentation - http://dev.mysql.com/doc/
  4) MySQL Forums - http://www.planetmysql.org/
  5) MySQL Stored Routines Library - http://savannah.nongnu.org/projects/mysql-sr-lib/