10

Managing Tables Using DML Statements

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Objectives

After completing this lesson, you should be able to do the following:

- Describe each data manipulation language (DML) statement
- Control transactions

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In this lesson, you learn how to use the data manipulation language (DML) statements to insert rows into a table, update existing rows in a table, and delete existing rows from a table. You also learn how to control transactions with the COMMIT, SAVEPOINT, and ROLLBACK statements.

Lesson Agenda

- Adding new rows in a table
  - INSERT statement
- Changing data in a table
  - UPDATE statement
- Removing rows from a table:
  - DELETE statement
  - TRUNCATE statement
- Database transactions control using COMMIT, ROLLBACK, and SAVEPOINT
- Read consistency
- FOR UPDATE clause in a SELECT statement

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Data Manipulation Language

- A DML statement is executed when you:
  - Add new rows to a table
  - Modify existing rows in a table
  - Remove existing rows from a table
- A *transaction* consists of a collection of DML statements that form a logical unit of work.

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Data manipulation language (DML) is a core part of SQL. When you want to add, update, or delete data in the database, you execute a DML statement. A collection of DML statements that form a logical unit of work is called a *transaction*.

Consider a banking database. When a bank customer transfers money from a savings account to a checking account, the transaction might consist of three separate operations: decreasing the savings account, increasing the checking account, and recording the transaction in the transaction journal. The Oracle server must guarantee that all the three SQL statements are performed to maintain the accounts in proper balance. When something prevents one of the statements in the transaction from executing, the other statements of the transaction must be undone.

Note

- Most of the DML statements in this lesson assume that no constraints on the table are violated. Constraints are discussed later in this course.
- In SQL Developer, click the Run Script icon or press [F5] to run the DML statements. The feedback messages will be shown on the Script Output tabbed page.

Adding a New Row to a Table

DEPARTMENTS

	70 Public Relations	100	1700

New row

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
1	10	Administration	200	1700
2	20	Marketing	201	1800
3	50	Shipping	124	1500
4	60	IT	103	1400
5	80	Sales	149	2500
6	90	Executive	100	1700
7	110	Accounting	205	1700
8	190	Contracting	(null)	1700

Insert new row into the DEPARTMENTS table.

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
1	70	Public Relations	100	1700
2	10	Administration	200	1700
3	20	Marketing	201	1800
4	50	Shipping	124	1500
5	60	IT	103	1400
6	80	Sales	149	2500
7	90	Executive	100	1700
8	110	Accounting	205	1700
9	190	Contracting	(null)	1700

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The graphic in the slide illustrates the addition of a new department to the DEPARTMENTS table.

INSERT Statement Syntax

- Add new rows to a table by using the INSERT statement:

```
INSERT INTO    table [(column [, column...])]
VALUES         (value [, value...]);
```

- With this syntax, only one row is inserted at a time.

You can add new rows to a table by issuing the INSERT statement.

In the syntax:

table	Is the name of the table
column	Is the name of the column in the table to populate
value	Is the corresponding value for the column

Note: This statement with the VALUES clause adds only one row at a time to a table.

Inserting New Rows

- Insert a new row containing values for each column.
- List values in the default order of the columns in the table.
- Optionally, list the columns in the `INSERT` clause.

```
INSERT INTO departments(department_id,
        department_name, manager_id, location_id)
VALUES (70, 'Public Relations', 100, 1700);
```
`1 rows inserted`

- Enclose character and date values within single quotation marks.

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Because you can insert a new row that contains values for each column, the column list is not required in the `INSERT` clause. However, if you do not use the column list, the values must be listed according to the default order of the columns in the table, and a value must be provided for each column.

```
DESCRIBE departments
```

```
DESCRIBE departments
Name               Null       Type
----------------   --------   ------------
DEPARTMENT_ID      NOT NULL   NUMBER(4)
DEPARTMENT_NAME    NOT NULL   VARCHAR2(30)
MANAGER_ID                    NUMBER(6)
LOCATION_ID                   NUMBER(4)
```

For clarity, use the column list in the `INSERT` clause.
Enclose character and date values within single quotation marks; however, it is not recommended that you enclose numeric values within single quotation marks.

Inserting Rows with Null Values

- Implicit method: Omit the column from the column list.

```
INSERT INTO   departments (department_id,
                           department_name)
VALUES        (30, 'Purchasing');
1 rows inserted
```

- Explicit method: Specify the NULL keyword in the VALUES clause.

```
INSERT INTO   departments
VALUES        (100, 'Finance', NULL, NULL);
1 rows inserted
```

Method	Description
Implicit	Omit the column from the column list.
Explicit	Specify the NULL keyword in the VALUES list; specify the empty string (' ') in the VALUES list for character strings and dates.

Be sure that you can use null values in the targeted column by verifying the Null status with the DESCRIBE command.

The Oracle server automatically enforces all data types, data ranges, and data integrity constraints. Any column that is not listed explicitly obtains a null value in the new row unless we have default values for the missing columns that are used.

Common errors that can occur during user input are checked in the following order:
- Mandatory value missing for a NOT NULL column
- Duplicate value violating any unique or primary key constraint
- Any value violating a CHECK constraint
- Referential integrity maintained for foreign key constraint
- Data type mismatches or values too wide to fit in column

Note: Use of the column list is recommended because it makes the INSERT statement more readable and reliable, or less prone to mistakes.

Inserting Special Values

The SYSDATE function records the current date and time.

```
INSERT INTO employees (employee_id,
                first_name, last_name,
                email, phone_number,
                hire_date, job_id, salary,
                commission_pct, manager_id,
                department_id)
VALUES          (113,
                'Louis', 'Popp',
                'LPOPP', '515.124.4567',
                SYSDATE, 'AC_ACCOUNT', 6900,
                NULL, 205, 110);
1 rows inserted
```

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You can use functions to enter special values in your table.

The slide example records information for employee Popp in the EMPLOYEES table. It supplies the current date and time in the HIRE_DATE column. It uses the SYSDATE function that returns the current date and time of the database server. You may also use the CURRENT_DATE function to get the current date in the session time zone. You can also use the USER function when inserting rows in a table. The USER function records the current username.

Confirming Additions to the Table

```
SELECT employee_id, last_name, job_id, hire_date, commission_pct
FROM   employees
WHERE  employee_id = 113;
```

	EMPLOYEE_ID	LAST_NAME	JOB_ID	HIRE_DATE	COMMISSION_PCT
1	113	Popp	AC_ACCOUNT	24-AUG-12	(null)

Note: The hire date may vary from the screenshot and it will fetch data as per the data insert date.

Inserting Specific Date and Time Values

- Add a new employee.

```
INSERT INTO employees
VALUES       (114,
              'Den', 'Raphealy',
              'DRAPHEAL', '515.127.4561',
              TO_DATE('FEB 3, 2003', 'MON DD, YYYY'),
              'SA_REP', 11000, 0.2, 100, 60);
1 rows inserted
```

- Verify your addition.

EMPLOYEE_ID	FIRST_NAME	LAST_NAME	EMAIL	PHONE_NUMBER	HIRE_DATE	JOB_ID	SALARY	COMMISSION_PCT	MANAGER_ID
1	114 Den	Raphealy	DRAPHEAL	515.127.4561	03-FEB-03	SA_REP	11000	0.2	10C

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The DD-MON-RR format is generally used to insert a date value. With the RR format, the system provides the correct century automatically.

You may also supply the date value in the DD-MON-YYYY format. This is recommended because it clearly specifies the century and does not depend on the internal RR format logic of specifying the correct century.
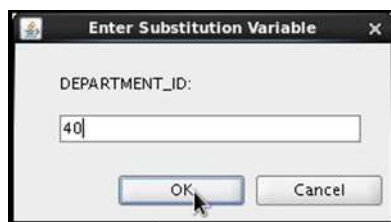
If a date must be entered in a format other than the default format (for example, with another century or a specific time), you must use the TO_DATE function.

The example in the slide records information for employee Raphealy in the EMPLOYEES table. It sets the HIRE_DATE column to be February 3, 2003.

Creating a Script

- Use the & substitution in a SQL statement to prompt for values.
- & is a placeholder for the variable value.

```
INSERT INTO departments
            (department_id, department_name, location_id)
VALUES      (&department_id, '&department_name',&location);
```
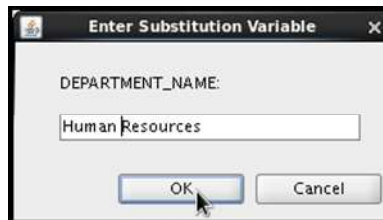
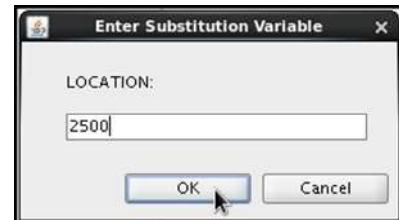Enter Substitution Variable

DEPARTMENT_ID:

40

OK   Cancel

Enter Substitution Variable

DEPARTMENT_NAME:

Human Resources

OK   Cancel

Enter Substitution Variable

LOCATION:

2500

OK   Cancel

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You can save commands with substitution variables to a file and execute the commands in the file. The example in the slide records information for a department in the DEPARTMENTS table.

Run the script file and you are prompted for input for each of the ampersand (&) substitution variables. After entering a value for the substitution variable, click the OK button. The values that you input are then substituted into the statement. This enables you to run the same script file over and over, but supply a different set of values each time you run it.

Copying Rows
from Another Table

- Write your `INSERT` statement with a subquery:

```
INSERT INTO sales_reps(id, name, salary, commission_pct)
  SELECT employee_id, last_name, salary, commission_pct
  FROM   employees
  WHERE  job_id LIKE '%REP%';
```

5 rows inserted.

- Do not use the `VALUES` clause.

- Match the number of columns in the `INSERT` clause to those in the subquery.

- Inserts all the rows returned by the subquery in the table, `sales_reps`.

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You can use the `INSERT` statement to add rows to a table where the values are derived from existing tables. In the example in the slide, for the `INSERT INTO` statement to work, you must have already created the `sales_reps` table using the `CREATE TABLE` statement. `CREATE TABLE` is discussed in the lesson titled " Introduction to "Introduction to Data Definition Language."

In place of the `VALUES` clause, you use a subquery.

Syntax

```
INSERT INTO table [ column (, column) ] subquery;
```

In the syntax:

table	Is the name of the table
column	Is the name of the column in the table to populate
subquery	Is the subquery that returns rows to the table

The number of columns and their data types in the column list of the `INSERT` clause must match the number of values and their data types in the subquery. Zero or more rows are added depending on the number of rows returned by the subquery. To create a copy of the rows of a table, use `SELECT` * in the subquery:

```
INSERT INTO copy_emp
  SELECT *
  FROM   employees;
```

Lesson Agenda

- Adding new rows in a table
  - `INSERT` statement
- Changing data in a table
  - `UPDATE` statement
- Removing rows from a table:
  - `DELETE` statement
  - `TRUNCATE` statement
- Database transactions control using `COMMIT`, `ROLLBACK`, and `SAVEPOINT`
- Read consistency
- `FOR UPDATE` clause in a `SELECT` statement

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Changing Data in a Table

EMPLOYEES

EMPLOYEE_ID	FIRST_NAME	LAST_NAME	SALARY	MANAGER_ID	COMMISSION_PCT	DEPARTMENT_ID
100	Steven	King	24000	(null)	(null)	90
101	Neena	Kochhar	17000	100	(null)	90
102	Lex	De Haan	17000	100	(null)	90
103	Alexander	Hunold	9000	102	(null)	60
104	Bruce	Ernst	6000	103	(null)	60
107	Diana	Lorentz	4200	103	(null)	60
124	Kevin	Mourgos	5800	100	(null)	50

Update rows in the EMPLOYEES table:

EMPLOYEE_ID	FIRST_NAME	LAST_NAME	SALARY	MANAGER_ID	COMMISSION_PCT	DEPARTMENT_ID
100	Steven	King	24000	(null)	(null)	90
101	Neena	Kochhar	17000	100	(null)	90
102	Lex	De Haan	17000	100	(null)	90
103	Alexander	Hunold	9000	102	(null)	80
104	Bruce	Ernst	6000	103	(null)	80
107	Diana	Lorentz	4200	103	(null)	80
124	Kevin	Mourgos	5800	100	(null)	50

The slide illustrates changing the department number for employees in department 60 to department 80.

`UPDATE` Statement Syntax

- Modify existing values in a table with the `UPDATE` statement:

```
UPDATE          table
SET             column = value [, column = value, ...]
[WHERE          condition];
```

- Update more than one row at a time (if required).

You can modify the existing values in a table by using the `UPDATE` statement.

In the syntax:

`table`	Is the name of the table
`column`	Is the name of the column in the table to populate
`value`	Is the corresponding value or subquery for the column
`condition`	Identifies the rows to be updated and is composed of column names, expressions, constants, subqueries, and comparison operators

Confirm the update operation by querying the table to display the updated rows.

For more information, see the section on "`UPDATE`" in *Oracle Database SQL Language Reference* for 12*c* database.

Note: In general, use the primary key column in the `WHERE` clause to identify a single row for update. Using other columns can unexpectedly cause several rows to be updated. For example, identifying a single row in the `EMPLOYEES` table by name is dangerous, because more than one employee may have the same name.

Updating Rows in a Table

- Values for a specific row or rows are modified if you specify the WHERE clause:

```
UPDATE  employees
SET     department_id = 50
WHERE   employee_id = 113;
1 rows updated
```

- Values for all the rows in the table are modified if you omit the WHERE clause:

```
UPDATE    copy_emp
SET       department_id = 110;
22 rows updated
```

- Specify SET *column_name*= NULL to update a column value to NULL.

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The UPDATE statement modifies the values of a specific row or rows if the WHERE clause is specified. The example in the slide shows the transfer of employee 113(Popp) to department 50.

If you omit the WHERE clause, values for all the rows in the table are modified. Examine the updated rows in the COPY_EMP table.

```
SELECT last_name, department_id
FROM    copy_emp;
```

	LAST_NAME	DEPARTMENT_ID
1	King	110
2	Kochhar	110
3	De Haan	110

. . .

For example, an employee who was an SA_REP has now changed his job to an IT_PROG. Therefore, his JOB_ID needs to be updated and the commission field needs to be set to NULL.

```
UPDATE employees
SET job_id = 'IT_PROG', commission_pct = NULL
WHERE employee_id = 114;
```

Note: The COPY_EMP table has the same data as the EMPLOYEES table.

Updating Two Columns with a Subquery

Update employee 113's job and salary to match those of
employee 205.

```
UPDATE     employees
SET        (job_id,salary)  = (SELECT   job_id,salary
                        FROM    employees
                        WHERE   employee_id = 205)
           WHERE    employee_id    =  103;

1 rows updated
```

You can update multiple columns in the SET clause of an UPDATE statement by writing
multiple subqueries. The syntax is as follows:

```
UPDATE table
SET     column =
                    (SELECT  column
                     FROM table
                     WHERE condition)
        [ ,
         column  =
                    (SELECT   column
                     FROM table
                     WHERE condition)]
     [WHERE   condition ]    ;
```

Updating Rows Based on Another Table

Use the subqueries in the `UPDATE` statements to update row values in a table based on values from another table:

```
UPDATE   copy_emp
SET      department_id  =   (SELECT department_id
                             FROM employees
                             WHERE employee id = 100)
WHERE    job_id         =   (SELECT job_id
                             FROM employees
                             WHERE employee_id = 200);
1 rows updated
```

You can use the subqueries in the `UPDATE` statements to update values in a table. The example in the slide updates the `COPY_EMP` table based on the values from the `EMPLOYEES` table. It changes the department number of all employees with employee 200's job `ID` to employee 100's current department number.

Lesson Agenda

- Adding new rows in a table
  - `INSERT` statement
- Changing data in a table
  - `UPDATE` statement
- **Removing rows from a table:**
  - `DELETE` statement
  - `TRUNCATE` statement
- Database transactions control using `COMMIT`, `ROLLBACK`, and `SAVEPOINT`
- Read consistency
- `FOR UPDATE` clause in a `SELECT` statement

Removing a Row from a Table

DEPARTMENTS

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
1	10 Administration	200	1700
2	20 Marketing	201	1800
3	50 Shipping	124	1500
4	60 IT	103	1400
5	80 Sales	149	2500
6	90 Executive	100	1700
7	110 Accounting	205	1700
8	190 Contracting	(null)	1700

Delete a row from the DEPARTMENTS table:

	DEPARTMENT_ID	DEPARTMENT_NAME	MANAGER_ID	LOCATION_ID
1	10 Administration	200	1700
2	20 Marketing	201	1800
3	50 Shipping	124	1500
4	60 IT	103	1400
5	80 Sales	149	2500
6	90 Executive	100	1700
7	110 Accounting	205	1700

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The Contracting department has been removed from the DEPARTMENTS table (assuming no constraints on the DEPARTMENTS table are violated), as shown by the graphic in the slide.

DELETE **Statement**

You can remove existing rows from a table by using the
DELETE statement:

```
DELETE  [FROM]    table
 [WHERE            condition];
```

You can remove existing rows from a table by using the DELETE statement.

In the syntax:

table	Is the name of the table
condition	Identifies the rows to be deleted, and is composed of column names, expressions, constants, subqueries, and comparison operators

Note: If no rows are deleted, the message "0 rows deleted" is returned (on the Script Output tab in SQL Developer).

For more information, see the section on "DELETE" in *Oracle Database SQL Language Reference* for 12*c* database.

Deleting Rows from a Table

- Specific rows are deleted if you specify the WHERE clause:

```
DELETE FROM departments
WHERE   department_name = 'Finance';
```
1 rows deleted

- All rows in the table are deleted if you omit the WHERE clause:

```
DELETE FROM   copy_emp;
```
22 rows deleted

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You can delete specific rows by specifying the WHERE clause in the DELETE statement. The first example in the slide deletes the Accounting department from the DEPARTMENTS table. You can confirm the delete operation by displaying the deleted rows using the SELECT statement.

```
SELECT  *
FROM    departments
WHERE   department_name = 'Finance';
```
no rows selected

However, if you omit the WHERE clause, all rows in the table are deleted. The second example in the slide deletes all rows from the COPY_EMP table, because no WHERE clause was specified.

Example

Remove rows identified in the WHERE clause.

```
DELETE FROM   employees WHERE employee_id = 114;
```
1 rows deleted

```
DELETE FROM   departments WHERE department_id IN (30, 40);
```
2 rows deleted

Deleting Rows Based on Another Table

Use the subqueries in the `DELETE` statements to remove rows from a table based on values from another table:

```
DELETE FROM employees
WHERE   department_id IN
                (SELECT department_id
                 FROM   departments
                 WHERE  department_name
                        LIKE '%Public%');
1 rows deleted
```

You can use the subqueries to delete rows from a table based on values from another table. The example in the slide deletes all the employees in a department, where the department name contains the string `Public`.

The subquery searches the `DEPARTMENTS` table to find the department number based on the department name containing the string `Public`. The subquery then feeds the department number to the main query, which deletes rows of data from the `EMPLOYEES` table based on this department number.

TRUNCATE Statement

- Removes all rows from a table, leaving the table empty and the table structure intact
- Is a data definition language (DDL) statement rather than a DML statement; cannot easily be undone
- Syntax:

```
TRUNCATE TABLE table_name;
```

- Example:

```
TRUNCATE TABLE copy_emp;
```

A more efficient method of emptying a table is by using the TRUNCATE statement.
You can use the TRUNCATE statement to quickly remove all rows from a table or cluster.
Removing rows with the TRUNCATE statement is faster than removing them with the DELETE statement for the following reasons:

- The TRUNCATE statement is a data definition language (DDL) statement and generates no rollback information. Rollback information is covered later in this lesson.
- Truncating a table does not fire the delete triggers of the table.

If the table is the parent of a referential integrity constraint, you cannot truncate the table. You need to disable the constraint before issuing the TRUNCATE statement. Disabling constraints is covered in the lesson titled "Introduction to DDL Statements."

Lesson Agenda

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- Read consistency
- `FOR UPDATE` clause in a `SELECT` statement

Database Transactions

A database transaction consists of one of the following:

- DML statements that constitute one consistent change to the data
- One DDL statement
- One data control language (DCL) statement

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The Oracle server ensures data consistency based on transactions. Transactions give you more flexibility and control when changing data, and they ensure data consistency in the event of user process failure or system failure.

Transactions consist of DML statements that constitute one consistent change to the data. For example, a transfer of funds between two accounts should include the debit in one account and the credit to another account of the same amount. Both actions should either fail or succeed together; the credit should not be committed without the debit.

Transaction Types

Type	Description
Data manipulation language (DML)	Consists of any number of DML statements that the Oracle server treats as a single entity or a logical unit of work
Data definition language (DDL)	Consists of only one DDL statement
Data control language (DCL)	Consists of only one DCL statement

Database Transactions: Start and End

- Begin when the first DML SQL statement is executed.
- End with one of the following events:
  - A `COMMIT` or `ROLLBACK` statement is issued.
  - A DDL or DCL statement executes (automatic commit).
  - The user exits SQL Developer or SQL*Plus.
  - The system crashes.

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When does a database transaction start and end?

A transaction begins when the first DML statement is encountered and ends when one of the following occurs:

- A `COMMIT` or `ROLLBACK` statement is issued.
- A DDL statement, such as `CREATE`, is issued.
- A DCL statement is issued.
- The user exits SQL Developer or SQL*Plus.
- A machine fails or the system crashes.

After one transaction ends, the next executable SQL statement automatically starts the next transaction.

A DDL statement or a DCL statement is automatically committed and, therefore, implicitly ends a transaction.

Advantages of `COMMIT` and `ROLLBACK` Statements
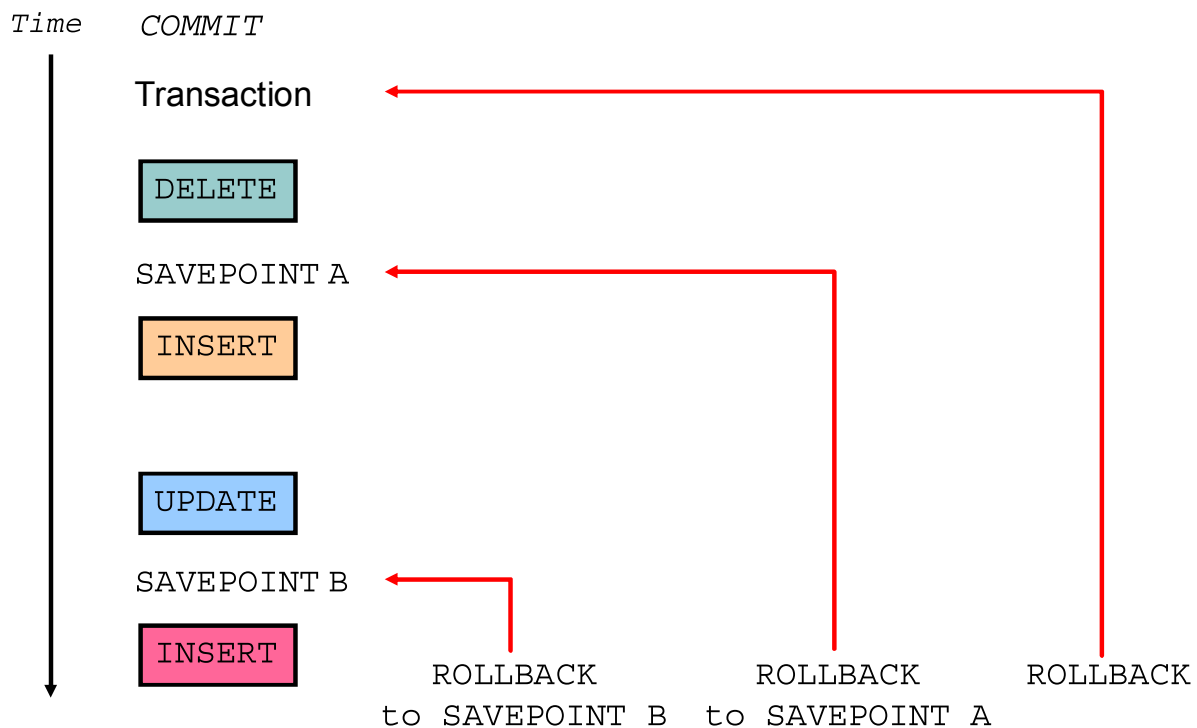
With `COMMIT` and `ROLLBACK` statements, you can:

- Ensure data consistency
- Preview data changes before making changes permanent
- Group logically related operations

With the `COMMIT` and `ROLLBACK` statements, you have control over making changes to the data permanent.

Explicit Transaction Control Statements

Time   `COMMIT`

Transaction

| DELETE |

SAVEPOINT A

| INSERT |

| UPDATE |

SAVEPOINT B

| INSERT |

```
        ROLLBACK        ROLLBACK        ROLLBACK
    to SAVEPOINT B   to SAVEPOINT A
```

You can control the logic of transactions by using the `COMMIT`, `SAVEPOINT`, and `ROLLBACK` statements.

Statement	Description
`COMMIT`	`COMMIT` ends the current transaction by making all pending data changes permanent.
`SAVEPOINT` *name*	`SAVEPOINT` *name* marks a savepoint within the current transaction.
`ROLLBACK`	`ROLLBACK` ends the current transaction by discarding all pending data changes.
`ROLLBACK TO` `SAVEPOINT` *name*	`ROLLBACK TO SAVEPOINT` rolls back the current transaction to the specified savepoint, thereby discarding any changes and/or savepoints that were created after the savepoint to which you are rolling back. If you omit the `TO SAVEPOINT` clause, the `ROLLBACK` statement rolls back the entire transaction. Because savepoints are logical, there is no way to list the savepoints that you have created.

Note: You cannot `COMMIT` to a `SAVEPOINT`. `SAVEPOINT` is not ANSI-standard SQL.

Rolling Back Changes to a Marker

- Create a marker in the current transaction by using the `SAVEPOINT` statement.
- Roll back to that marker by using the `ROLLBACK TO SAVEPOINT` statement.

```
UPDATE...
SAVEPOINT update_done;
SAVEPOINT update_done succeeded.
INSERT...
ROLLBACK TO update_done;
ROLLBACK TO succeeded.
```

You can create a marker in the current transaction by using the `SAVEPOINT` statement, which divides the transaction into smaller sections. You can then discard pending changes up to that marker by using the `ROLLBACK TO SAVEPOINT` statement.

Note that if you create a second savepoint with the same name as an earlier savepoint, the earlier savepoint is deleted.

Implicit Transaction Processing

- An automatic commit occurs in the following circumstances:
  - A DDL statement issued
  - A DCL statement issued
  - Normal exit from SQL Developer or SQL*Plus, without explicitly issuing COMMIT or ROLLBACK statements
- An automatic rollback occurs when there is an abnormal termination of SQL Developer or SQL*Plus or a system failure.

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Status	Circumstances
Automatic commit	DDL statement or DCL statement issued SQL Developer or SQL*Plus exited normally, without explicitly issuing COMMIT or ROLLBACK commands
Automatic rollback	Abnormal termination of SQL Developer or SQL*Plus or system failure

Note: In SQL*Plus, the AUTOCOMMIT command can be toggled ON or OFF. If set to ON, each individual DML statement is committed as soon as it is executed. You cannot roll back the changes. If set to OFF, the COMMIT statement can still be issued explicitly. Also, the COMMIT statement is issued when a DDL statement is issued or when you exit SQL*Plus. The SET AUTOCOMMIT ON/OFF command is skipped in SQL Developer. DML is committed on a normal exit from SQL Developer only if you have the Autocommit preference enabled. To enable Autocommit, perform the following:

- In the Tools menu, select Preferences. In the Preferences dialog box, expand Database and select Worksheet Parameters.
- In the right pane, select the "Autocommit in SQL Worksheet" option. Click OK.

System Failures

When a transaction is interrupted by a system failure, the entire transaction is automatically rolled back. This prevents the error from causing unwanted changes to the data and returns the tables to the state at the time of the last commit. In this way, the Oracle server protects the integrity of the tables.

In SQL Developer, a normal exit from the session is accomplished by selecting Exit from the File menu. In SQL*Plus, a normal exit is accomplished by entering the EXIT command at the prompt. Closing the window is interpreted as an abnormal exit.

State of the Data Before `COMMIT` or `ROLLBACK`

- The previous state of the data can be recovered.
- The current session can review the results of the DML operations by using the `SELECT` statement.
- Other sessions *cannot* view the results of the DML statements issued by the current session.
- The affected rows are *locked*; other session cannot change the data in the affected rows.

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Every data change made during the transaction is temporary until the transaction is committed.

The state of the data before `COMMIT` or `ROLLBACK` statements are issued can be described as follows:

- Data manipulation operations primarily affect the database buffer; therefore, the previous state of the data can be recovered.
- The current session can review the results of the data manipulation operations by querying the tables.
- Other sessions cannot view the results of the data manipulation operations made by the current session. The Oracle server institutes read consistency to ensure that each session sees data as it existed at the last commit.
- The affected rows are locked; other session cannot change the data in the affected rows.

State of the Data After `COMMIT`

- Data changes are saved in the database.
- The previous state of the data is overwritten.
- All sessions can view the results.
- Locks on the affected rows are released; those rows are available for other sessions to manipulate.
- All savepoints are erased.

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Make all pending changes permanent by using the `COMMIT` statement. Here is what happens after a `COMMIT` statement:

- Data changes are written to the database.
- The previous state of the data is no longer available with normal SQL queries.
- All sessions can view the results of the transaction.
- The locks on the affected rows are released; the rows are now available for other sessions to perform new data changes.
- All savepoints are erased.

Committing Data

- Make the changes:

```
DELETE FROM EMPLOYEES
WHERE employee_id=113;
1 rows deleted
INSERT INTO departments
VALUES (290, 'Corporate Tax', NULL, 1700);
1 rows inserted
```

- Commit the changes:

```
COMMIT;
commited.
```

In the example in the slide, a row is deleted from the EMPLOYEES table and a new row is inserted into the DEPARTMENTS table. The changes are saved by issuing the COMMIT statement.

Example

Remove departments 290 and 300 in the DEPARTMENTS table and update a row in the EMPLOYEES table. Save the data change.

```
    DELETE FROM departments
    WHERE   department_id IN (290, 300);

    UPDATE   employees
       SET    department_id = 80
       WHERE employee_id = 206;

    COMMIT;
```

State of the Data After ROLLBACK

Discard all pending changes by using the ROLLBACK statement:

- Data changes are undone.
- Previous state of the data is restored.
- Locks on the affected rows are released.

```
DELETE FROM copy_emp;
ROLLBACK ;
```

Discard all pending changes by using the ROLLBACK statement, which results in the following:
- Data changes are undone.
- The previous state of the data is restored.
- Locks on the affected rows are released.

State of the Data After `ROLLBACK`: Example

```
DELETE FROM test;
4 rows deleted.

ROLLBACK;
Rollback complete.

DELETE FROM test WHERE  id = 100;
1 row deleted.

SELECT * FROM   test WHERE  id = 100;
No rows selected.

COMMIT;
Commit complete.
```

While attempting to remove a record from the `TEST` table, you may accidentally empty the table. However, you can correct the mistake, reissue a proper statement, and make the data change permanent.

Statement-Level Rollback

- If a single DML statement fails during execution, only that statement is rolled back.
- The Oracle server implements an implicit savepoint.
- All other changes are retained.
- The user should terminate transactions explicitly by executing a COMMIT or ROLLBACK statement.

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A part of a transaction can be discarded through an implicit rollback if a statement execution error is detected. If a single DML statement fails during execution of a transaction, its effect is undone by a statement-level rollback, but the changes made by the previous DML statements in the transaction are not discarded. They can be committed or rolled back explicitly by the user.

The Oracle server issues an implicit commit before and after any DDL statement. So, even if your DDL statement does not execute successfully, you cannot roll back the previous statement because the server issued a commit.

Terminate your transactions explicitly by executing a COMMIT or ROLLBACK statement.

Lesson Agenda

- Adding new rows in a table
  - `INSERT` statement
- Changing data in a table
  - `UPDATE` statement
- Removing rows from a table:
  - `DELETE` statement
  - `TRUNCATE` statement
- Database transactions control using `COMMIT`, `ROLLBACK`, and `SAVEPOINT`
- **Read consistency**
- `FOR UPDATE` clause in a `SELECT` statement

Read Consistency

- Read consistency guarantees a consistent view of the data at all times.
- Changes made by one user do not conflict with the changes made by another user.
- Read consistency ensures that, on the same data:
    - Readers do not wait for writers
    - Writers do not wait for readers
    - Writers wait for writers

Database users access the database in two ways:

- Read operations (`SELECT` statement)
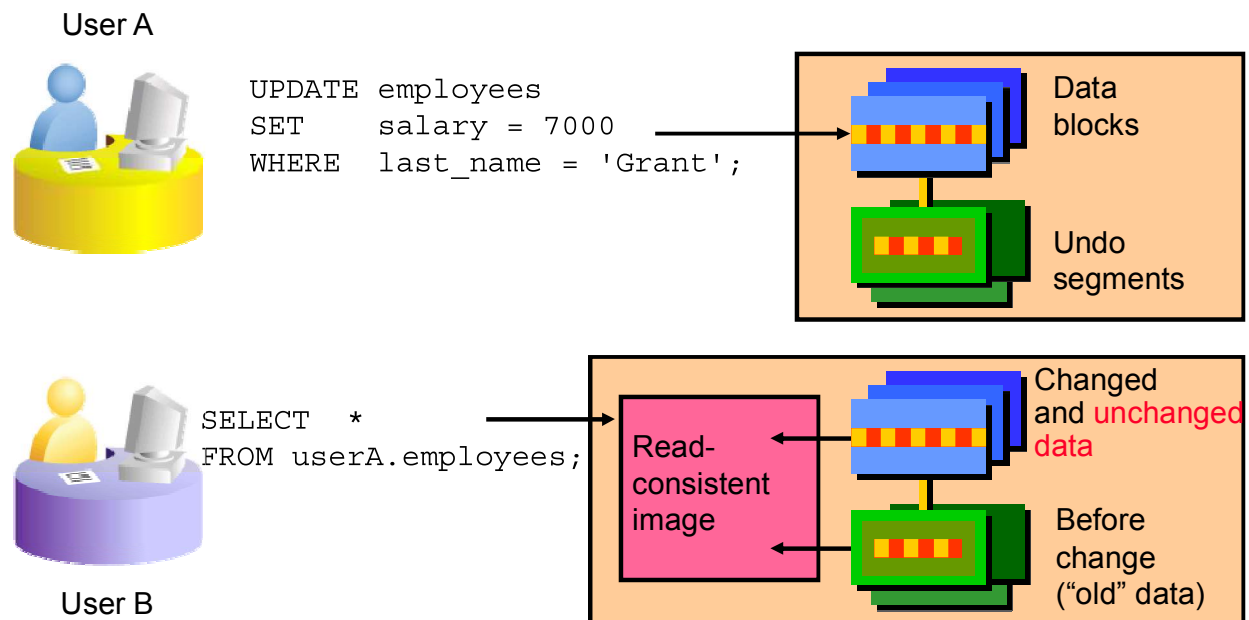- Write operations (`INSERT`, `UPDATE`, `DELETE` statements)

You need read consistency so that the following occur:

- The database reader and writer are ensured a consistent view of the data.
- Readers do not view data that is in the process of being changed.
- Writers are ensured that the changes to the database are done in a consistent manner.
- Changes made by one writer do not disrupt or conflict with the changes being made by another writer.

The purpose of read consistency is to ensure that each user sees data as it existed at the last commit, before a DML operation started.

Note: The same user can log in to different sessions. Each session maintains read consistency in the manner described above, even if they are the same users.

Implementing Read Consistency

User A

```
UPDATE employees
SET    salary = 7000
WHERE  last_name = 'Grant';
```

Data blocks

Undo segments

```
SELECT  *
FROM userA.employees;
```

Read-consistent image

Changed and unchanged data

Before change ("old" data)

User B

Read consistency is an automatic implementation. It keeps a partial copy of the database in the undo segments. The read-consistent image is constructed from the committed data in the table and the old data that is being changed and is not yet committed from the undo segment.

When an insert, update, or delete operation is made on the database, the Oracle server takes a copy of the data before it is changed and writes it to an *undo segment*.

All readers, except the one who issued the change, see the database as it existed before the changes started; they view the undo segment's "snapshot" of the data.

Before the changes are committed to the database, only the user who is modifying the data sees the database with the alterations. Everyone else sees the snapshot in the undo segment. This guarantees that readers of the data read consistent data that is not currently undergoing change.

When a DML statement is committed, the change made to the database becomes visible to anyone issuing a `SELECT` statement *after* the commit is done. The space occupied by the *old* data in the undo segment file is freed for reuse.

If the transaction is rolled back, the changes are undone:

- The original, older version of the data in the undo segment is written back to the table.
- All users see the database as it existed before the transaction began.

Lesson Agenda

- Adding new rows in a table
  - `INSERT` statement
- Changing data in a table
  - `UPDATE` statement
- Removing rows from a table:
  - `DELETE` statement
  - `TRUNCATE` statement
- Database transactions control using `COMMIT`, `ROLLBACK`, and `SAVEPOINT`
- Read consistency
- `FOR UPDATE` clause in a `SELECT` statement

FOR UPDATE Clause in a SELECT Statement

- Locks the rows in the `EMPLOYEES` table where `job_id` is `SA_REP`.

```
SELECT employee_id, salary, commission_pct, job_id
FROM employees
WHERE job_id = 'SA_REP'
FOR UPDATE
ORDER BY employee_id;
```

- Lock is released only when you issue a `ROLLBACK` or a `COMMIT`.

- If the `SELECT` statement attempts to lock a row that is locked by another user, the database waits until the row is available, and then returns the results of the `SELECT` statement.

When you issue a `SELECT` statement against the database to query some records, no locks are placed on the selected rows. In general, this is required because the number of records locked at any given time is (by default) kept to the absolute minimum: only those records that have been changed but not yet committed are locked. Even then, others will be able to read those records as they appeared before the change (the "before image" of the data). There are times, however, when you may want to lock a set of records even before you change them in your program. Oracle offers the `FOR UPDATE` clause of the `SELECT` statement to perform this locking.

When you issue a `SELECT...FOR UPDATE` statement, the relational database management system (RDBMS) automatically obtains exclusive row-level locks on all the rows identified by the `SELECT` statement, thereby holding the records "for your changes only." No one else will be able to change any of these records until you perform a `ROLLBACK` or a `COMMIT`.

You can append the optional keyword `NOWAIT` to the `FOR UPDATE` clause to tell the Oracle server not to wait if the table has been locked by another user. In this case, control will be returned immediately to your program or to your SQL Developer environment so that you can perform other work, or simply wait for a period of time before trying again. Without the `NOWAIT` clause, your process will block until the table is available, when the locks are released by the other user through the issue of a `COMMIT` or a `ROLLBACK` command.

FOR UPDATE Clause: Examples

- You can use the `FOR UPDATE` clause in a `SELECT` statement against multiple tables.

```
SELECT e.employee_id, e.salary, e.commission_pct
FROM employees e JOIN departments d
USING (department_id)
WHERE job_id = 'ST_CLERK'
AND location_id = 1500
FOR UPDATE
ORDER BY e.employee_id;
```

- Rows from both the `EMPLOYEES` and `DEPARTMENTS` tables are locked.
- Use `FOR UPDATE OF column_name` to qualify the column you intend to change, then only the rows from that specific table are locked.

In the example in the slide, the statement locks rows in the `EMPLOYEES` table with `JOB_ID` set to `ST_CLERK` and `LOCATION_ID` set to 1500, and locks rows in the `DEPARTMENTS` table with departments in `LOCATION_ID` set as 1500.

You can use the `FOR UPDATE OF` *column_name* to qualify the column that you intend to change. The `OF` list of the `FOR UPDATE` clause does not restrict you to changing only those columns of the selected rows. Locks are still placed on all rows; if you simply state `FOR UPDATE` in the query and do not include one or more columns after the `OF` keyword, the database will lock all identified rows across all the tables listed in the `FROM` clause.

The following statement locks only those rows in the `EMPLOYEES` table with `ST_CLERK` located in `LOCATION_ID` 1500. No rows are locked in the `DEPARTMENTS` table:

```
SELECT e.employee_id, e.salary, e.commission_pct

FROM employees e JOIN departments d

USING (department_id)

WHERE job_id = 'ST_CLERK' AND location_id = 1500

FOR UPDATE OF e.salary

ORDER BY e.employee_id;
```

In the following example, the database is instructed to wait for five seconds for the row to become available, and then return control to you.

```
SELECT employee_id, salary, commission_pct, job_id
FROM employees
WHERE job_id = 'SA_REP'
FOR UPDATE WAIT 5
ORDER BY employee_id;
```

Quiz

The following statements produce the same results:

```
DELETE FROM copy_emp;
```

```
TRUNCATE TABLE copy_emp;
```

a. True
b. False

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Answer: b

Summary

In this lesson, you should have learned how to use the following statements:

Function	Description
INSERT	Adds a new row to the table
UPDATE	Modifies existing rows in the table
DELETE	Removes existing rows from the table
TRUNCATE	Removes all rows from a table
COMMIT	Makes all pending changes permanent
SAVEPOINT	Is used to roll back to the savepoint marker
ROLLBACK	Discards all pending data changes
FOR UPDATE clause in SELECT	Locks rows identified by the SELECT query

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In this lesson, you should have learned how to manipulate data in the Oracle database by using the INSERT, UPDATE, DELETE, and TRUNCATE statements, as well as how to control data changes by using the COMMIT, SAVEPOINT, and ROLLBACK statements. You also learned how to use the FOR UPDATE clause of the SELECT statement to lock rows for your changes only.

Remember that the Oracle server guarantees a consistent view of data at all times.

Practice 10: Overview

This practice covers the following topics:
- Inserting rows into the tables
- Updating and deleting rows in the table
- Controlling transactions

In this practice, you add rows to the MY_EMPLOYEE table, update and delete data from the table, and control your transactions. You run a script to create the MY_EMPLOYEE table.