SQL & ADVANCED SQL

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AGENDA

- Goal of this tutorial:
  - ✓ Present the overview of basic SQL capabilities
  - ✓ Explain several selected advanced SQL features

- Outline
  - ✓ Introduction
  - ✓ SQL basics
  - ✓ Joins & Complex queries
  - ✓ Analytical functions & Set operators
  - ✓ Other DB objects (Sequences, Synonyms, DBlinks, Views & Mviews)
  - ✓ Indexes & IOTs
  - ✓ Partitioning
  - ✓ Undo & Flashback technologies

SQL LANGUAGE

- Objective: be able to perform the basic operation of the RDBMS data model
  - ✓ create, modify the layout of a table
  - ✓ remove a table from the user schema
  - ✓ insert data into the table
  - ✓ retrieve and manipulate data from one or more tables
  - ✓ update/ delete data in a table
  - ✓ +
    - Some more advanced modifications

SQL LANGUAGE (2)

- Structured Query Language
  - ✓ Programing language
  - ✓ Designed to mange data in relational databases

- DDL Data Definition Language
  - ✓ Creating, replacing, altering, and dropping objects
  - ✓ Example: `DROP TABLE [TABLE];`
- DML Data Modification Language
  - ✓ Inserting, updating, and deleting rows in a table
  - ✓ Example: `DELETE FROM [TABLE];`
- DCL Data Control Language
  - ✓ Controlling access to the database and its objects
  - ✓ Example: `GRANT SELECT ON [TABLE] TO [USER];`

SQL LANGUAGE(3)

STATEMENT	DESCRIPTION
SELECT	Data Retrieval
INSERT UPDATE DELETE	Data Manipulation Language (DML)
CREATE ALTER DROP RENAME TRUNCATE	Data Definition Language (DDL)
GRANT REVOKE	Data Control Language (DCL)
COMMIT ROLLBACK	Transaction Control

TRANSACTION & UNDO

- A transaction is a sequence of SQL Statements that Oracle treats as a single unit of work
- A transaction must be commited or rolled back:

  COMMIT; - makes permanent the database changes you made during the transaction.

  ROLLBACK; - ends the current transaction and undoes any changes made since the transaction began.
- Check COMMIT settings in your Client Tool (eg AUTOCOMMIT, EXITCOMMIT in SQL*Plus)
- UNDO tablespace:
  - ✓ circular buffer
  - ✓ records all actions of transactions
  - ✓ used when rolling back a transaction

SQL LANGUAGE(3)

STATEMENT	DESCRIPTION
SELECT	Data Retrieval
INSERT UPDATE DELETE	Data Manipulation Language (DML)
CREATE ALTER DROP RENAME TRUNCATE	Data Definition Language (DDL) Commit;
GRANT REVOKE	Data Control Language (DCL)
COMMIT ROLLBACK	Transaction Control

DATABASE SCHEMA (USER)

- Collection of logical structures of data
  - ✓ called schema objects
  - ✓ tables, views, indexes, synonyms, sequences, packages, triggers, links, …
- Owned by a database user
  - ✓ same name of the user
- Schema objects can be created and manipulated with SQL

SELECT * FROM USER_OBJECTS | USER_TABLES (…)

SELECT user DROM dual;

SHOW USER; (in SQL*Plus)

CREATE A TABLE

- Define the table layout:
  - ✓ table identifier
  - ✓ column identifiers and data types
  - ✓ column constraints,
  - ✓ default values
  - ✓ integrity constraints
  - ✓ relational constraints

```
CREATE TABLE employees (
 employee_id NUMBER(6) NOT NULL,
 first_name VARCHAR2(20),
 last_name VARCHAR2(25),
 hire_date DATE DEFAULT SYSDATE,
 department_id NUMBER(4),
 salary NUMBER(8,2) CHECK (salary > 0));
```

```
SQL> describe employees
Name            Null?    Type
 ---------------- -------- ------------
 EMPLOYEE_ID      NOT NULL NUMBER(6)
 FIRST_NAME                VARCHAR2(20)
 LAST_NAME                 VARCHAR2(25)
 HIRE_DATE                 DATE
 DEPARTMENT_ID             NUMBER(4)
 SALARY                    NUMBER(8,2)
```

DATATYPES

- Each value has a datatype
  - ✓ defines the domain of values that each column can contain
  - ✓ when you create a table, you must specify a datatype for each of its columns
- ANSI defines a common set
  - ✓ Oracle has its set of built-in types
  - ✓ User-defined types

ANSI data type	Oracle
integer	NUMBER(38)
smallint	NUMBER(38)
numeric(p,s)	NUMBER(p,s)
varchar(n)	VARCHAR2(n)
char(n)	CHAR(n)
float	NUMBER
real	NUMBER

SELECT STATEMENT

```
SELECT [ALL | DISTINCT] column1[,column2]
FROM table1[,table2]
[WHERE "conditions"]
[GROUP BY "column-list"]
[HAVING "conditions]
[ORDER BY "column-list" [ASC | DESC] ]
```

```
SELECT d.department_name,
      sum(e.salary)as DEPT_AL
FROM departments d, employees e
WHERE d.department_id = e.department_id
GROUP BY d.department_name
HAVING SUM(e.salary) > 10000
ORDER BY department_name;
```

```
DEPARTMENT_NAME       DEPT_SAL
-------------------- ----------
Accounting                20300
Executive                 58000
Finance                   51600
IT                        28800
Marketing                 19000
Purchasing                24900
Sales                    304500
Shipping                 156400
```

INSERT, UPDATE, DELETE (DML)

- Insert some data

```
INSERT INTO table1 values(value-list) ;

INSERT INTO table1(column-list) values(value-list);

INSERT INTO table1(column-list)
                SELECT values(value-list);

COMMIT;
```

- Update

```
UPDATE table1 SET column = value;

COMMIT;
```

- Delete

```
DELETE FROM table1;

COMMIT;
```

ALTER TABLE (DDL)

- Modify the name:

```
ALTER TABLE employees RENAME TO newemployees;
```

- Modify the layout:

```
ALTER TABLE employees ADD (salary NUMBER(7));
ALTER TABLE employees RENAME COLUMN id TO emp_id;
ALTER TABLE employees DROP(hiredate);
```

- But also:
  - ✓ Add/modify/drop constraints
  - ✓ Enable/Disable constraints
  - ✓ Modify more advanced properties…

CONSTRAINTS (DDL)

- NOT NULL / CHECK

  ALTER TABLE employees MODIFY last_name NOT NULL;

  ALTER TABLE employees MODIFY salary CHECK (salary > 1000);

- PRIMARY KEY

  ALTER TABLE employees ADD PRIMARY KEY(emp_id);

- FOREIGN KEY

  ALTER TABLE employees ADD FOREIGN KEY(dept_id) REFERENCES departments(department_id);

- Constraints errors:

  - ✓ **ORA-02290: check constraint (owner.constraintname) violated – DURING INSERT**
  - ✓ **ORA-02291: integrity constraint (owner.constraintname) violated - parent key not found – DURING INSERT**
  - ✓ **ORA-02292:violated integrity constraint (owner.constraintname)- child record found – DURING DELETE**

NULL VALUE

- special value that means
  - ✓ unavailable
  - ✓ unassigned
  - ✓ unknown
  - ✓ inapplicable
- not equivalent to
  - ✓ zero
  - ✓ blank space

```
SELECT * FROM [TABLE] where id = 0;
SELECT * FROM [TABLE] where id IS NULL;
```

- Often used as default

DUAL TABLE

- special one-row table present by default in all Oracle database installations
  - ✓ Accessible to all users
  - ✓ Examples of use:

```
SQL> describe dual;

Name            Null?    Type
--------------- -------- ------------
DUMMY                    VARCHAR2(1)
```

```
SELECT SYSDATE FROM DUAL;
SELECT USER FROM DUAL;
-- equal to SHOW USER in SQL*Plus
```

- Create really big table in one command - use dual;

```
CREATE TABLE BIG_TABLE
AS SELECT trunc(dbms_random.value(0,20)) RANDOM_INT
FROM DUAL
CONNECT BY LEVEL <= 100000;
```

DELETE ALL ROWS FROM A TABLE

- ?
- What is the difference between:

  DELETE FROM employees;

  vs

  TRUNCATE TABLE employees;

  - ✓ DML vs DDL commands?
    - Is COMMIT essential? In which case?
  - ✓ Generate UNDO segments?
    - Which is more efficient?

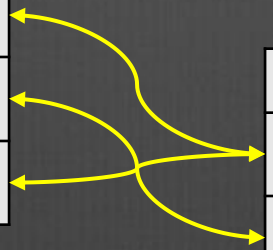
TYPES OF JOINS

EQUIJOIN	Values in the two corresponding columns of the different tables must be equal
NON-EQUIJOIN	The relationship between the columns of the different tables must be other than equal
OUTERJOIN (LEFT, RIGHT, FULL)	It returns also the rows that do not satisfy the join condition
SELFJOIN	Joining data in a table to itself

EQUIJOIN

```
SQL> SELECT e.emp_name, e.emp_deptno, d.dept_name
            FROM emp e, dept d
            WHERE e.emp_deptno = d.deptno
            ORDER BY emp_name;
```

EMP_NAME	EMP_DEPTNO
KING	10
BLAKE	30
CLARK	10



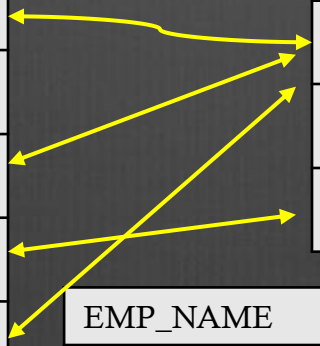
DEPT_NO	DEPT_NAME
10	ACCOUNTING
30	SALES
20	OPERATIONS

EMP_NAME	EMP_DEPTNO	DEPT_NAME
KING	10	ACCOUNTING
BLAKE	30	SALES
CLARK	10	ACCOUNTING

OUTERJOIN

```
SQL> SELECT e.emp_name, e.emp_deptno, d.dept_name
        FROM emp e, dept d
        WHERE e.emp_deptno = d.deptno(+)
        ORDER BY emp_name;
```

EMP_NAME	EMP_DEPTNO
KING	10
BLAKE	NULL
CLARK	10
MARTIN	20
TURNER	10
JONES	NULL



DEPT_NO	DEPT_NAME
10	ACCOUNTING
30	SALES
20	OPERATIONS

EMP_NAME	EMP_DEPTNO	DEPT_NAME
KING	10	ACCOUNTING
BLAKE	NULL	NULL
CLARK	10	ACCOUNTING
MARTIN	20	OPERATIONS
TURNER	10	ACCOUNTING
JONES	NULL	NULL

JOINS SYNTAX ANSI VS ORACLE

- Equijoins:
  - ✓ ANSI syntax

```
SELECT e.name, d.name FROM employees e
INNER JOIN departments d ON e.dept_id=d.dept_id;
```

  - ✓ Oracle

```
SELECT e.name, d.name FROM employees e, departments d
WHERE e.dept_id=d.dept_id;
```

- Outerjoins
  - ✓ ANSI syntax (LEFT, RIGHT, FULL)

```
SELECT e.name, d.name FROM employees e
RIGHT OUTER JOIN departments d ON e.dept_id=d.dept_id;
```

  - ✓ Oracle

```
SELECT e.name, d.name FROM employees e, departments d
WHERE e.dept_id(+)=d.dept_id;
```

ADVANCED SQL QUERIES

Types	Question
SUBQUERIES	Who works in the same department as Clark?
Correlated SUBQUERIES	Who are the employees that receive more than the average salary of their department?
Inline Views	What are the employees salary and the minimum salary in their department?
Top-N QUERIES	What are the 5 most well paid employees?
Hierarchical QUERIES	What is the hierarchy of management in my enterprise?

SUBQUERIES (1/5)

- A subquery is a query within a query and it is used to answer multiple-part questions.
- Oracle fully supports them in the sense that:
  - ✓ You can create subqueries within your SQL statements
  - ✓ A subquery can reside in the WHERE clause, the FROM clause or the SELECT clause.

SUBQUERIES (2/5)

Types
- A) Single-row (and single-column)
- B) Multiple-row (and single-column)
- C) Multiple-column

- who works in the same department as Clark?

```
SELECT … WHERE dep = (SELECT dep FROM … WHERE name = 'CLARK');
```

- who works in the same department as Clark OR Blake?

```
SELECT … WHERE dep IN (SELECT dep
                       FROM …
                       WHERE name ='CLARK' or name = 'BLAKE');
```

- who works in the same department(s) AND under the same boss as Clark?

```
SELECT … WHERE (dep, mgr) = (SELECT dep, mgr
                             FROM …
                             WHERE name = 'CLARK')
```

CORRELATED SUBQUERIES

- A correlated subquery is a subquery that is evaluated FOR EACH ROW produced by the parent query.
- Which employees receive more than the average salary of their department?

```
SELECT e.emp_id, e.dept_id,
       e.last_name, e.salary
FROM employees e
WHERE e.salary > (SELECT avg(i.salary)
                  FROM employees i
                  WHERE e.dept_id = i.dept_id)
```

EMP_ID	DEPT_ID	LAST_NAME	SALARY
201	20	Hartstein	13000
114	30	Raphaely	11000
123	50	Vollman	6500
122	50	Kaufling	7900
120	50	Weiss	8000
121	50	Fripp	8200
103	60	Hunold	9000
147	80	Errazuriz	12000
146	80	Partners	13500
145	80	Russell	14000
100	90	King	24000
108	100	Greenberg	12000

- In this case, the correlated subquery specifically computes, for each employee, the average salary for the employee's department

INLINE VIEWS

- An In-line view is a subquery in the FROM clause of a SQL statement just as if it was a table. It acts as a data source!

- *What are the employees salary and the MINIMAL salary in their department?*

```
SELECT e.emp_id a.dept_id, e.last_name,
       e.salary, a.min_sal,
FROM employees e,
    (SELECT MIN(salary)min_sal, dept_id
     FROM employees
     GROUP BY dept_id) a
WHERE e.dept_id = a.dept_id
ORDER BY e.dept_id, e.salary DESC;
```

EMP_ID	DEPT_ID	LAST_NAME	SALARY	MIN_SAL
200	10	Whalen	4400	4400
201	20	Hartstein	13000	6000
202	20	Fay	6000	6000
114	30	Raphaely	11000	2500
115	30	Khoo	3100	2500
116	30	Baida	2900	2500
117	30	Tobias	2800	2500
118	30	Himuro	2600	2500
119	30	Colmenares	2500	2500
203	40	Mavris	6500	6500
121	50	Fripp	8200	2100
120	50	Weiss	8000	2100
122	50	Kaufling	7900	2100
123	50	Vollman	6500	2100
124	50	Mourgos	5800	2100
184	50	Sarchand	4200	2100
185	50	Bull	4100	2100
192	50	Bell	4000	2100

TOP-N QUERIES

- We need to use "in-line view" together with the ROWNUM pseudocolumn

- *What are the top 5 most well paid employees?*

```
SELECT * FROM
        (SELECT emp_id, last_name, salary
         FROM employees
         ORDER BY salary desc)
WHERE rownum < 6
```

EMP_ID	LAST_NAME	SALARY
100	King	24000
101	Kochhar	17000
102	De Haan	17000
145	Russell	14000
146	Partners	13500

- *What are the next 5 most well paid employees?*

```
SELECT emp_id, last_name, salary FROM (
        SELECT emp_id,last_name, salary,
        rownum as rnum
        FROM employees
        ORDER BY salary desc)
WHERE rnum between 6 and 10;
```

EMP_ID	LAST_NAME	SALARY
108	Greenberg	12000
109	Faviet	9000
106	Pataballa	4800
105	Austin	4800
107	Lorentz	4200

HIERARCHICAL QUERIES

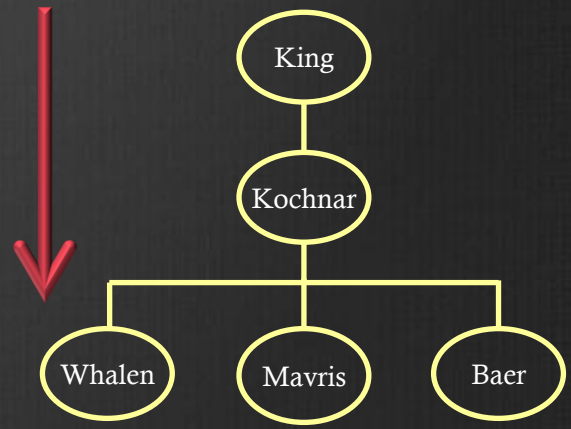
- If a table contains hierarchical data, then you can select rows in a hierarchical order using the *hierarchical query clause*
- Syntax:

```
SELECT … FROM … WHERE …
    START WITH  <condition>
Specifies the starting point of the hierarchy (tree)
    CONNECT BY PRIOR child_row = parent_row (TOP-DOWN)
                     parent_row = child_row (BOTTOM-UP)
relationship between parent row and child rows of the hierarchy
```

- Pseudo-column LEVEL is the hierarchy level

```
SELECT empid, last_name, mgrid, LEVEL
FROM employees
WHERE LEVEL <= 3
START WITH employee_id = 100
CONNECT BY PRIOR
employee_id = manager_id;
```

EMPID	LAST_NAME	MGRID	LEVEL
100	King		1
101	Kochhar	100	2
200	Whalen	101	3
203	Mavris	101	3
204	Baer	101	3



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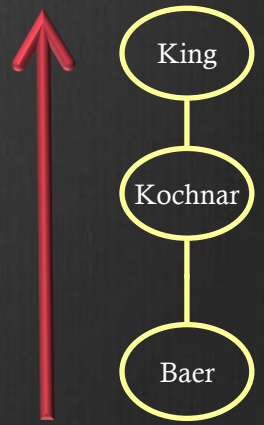
relationship between parent row and child rows of the hierarchy
```

- Pseudo-column LEVEL is the hierarchy level

```
SELECT empid, last_name, mgrid, LEVEL
FROM employees
START WITH employee_id = 204
CONNECT BY PRIOR
manager_id = employee_id;
```

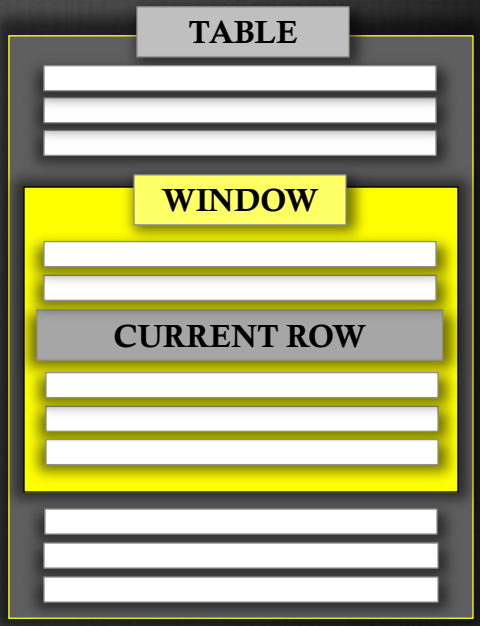
EMPID	LAST_NAM	MGR_ID	LEVEL
204	Baer	101	1
101	Kochhar	100	2
100	King		3



ANALYTICAL FUNCTIONS

- General syntax of analytical function:

```
SELECT analytical-function(col-expr)
OVER (window-spec) [AS col-alias]
FROM [TABLE];
```



- Window specification syntax

```
[PARTITION BY [expr list]]
ORDER BY [sort spec] [range spec]
```

- Example for range specification (for more check oracle docs)

```
ROWS UNBOUNDED PRECEDING AND CURRENT ROW (default)
ROWS BETWEEN CURRENT ROW AND UNBOUNDED FOLLOWING
RANGE BETWEEN 2 PRECEDING AND 2 FOLLOWING
```

ORDERRED ANALYTICAL WINDOW

- Analytical functions applied to all window rows
- Remember about ordering inside the window

```
SQL>  select employee_id, last_name, manager_id, salary
      sum(salary) over (order by  employee_id, last_name, salary)
      as cumulative from employees;

EMPLOYEE_ID LAST_NAME  MANAGER_ID SALARY CUMULATIVE
----------- ---------- ---------- ------ ----------
        100 King                  24000      24000
        101 Kochhar          100  17000      41000
        102 De Haan          100  17000      58000 = 24000+17000+17000
        103 Hunold           102   9000      67000
        104 Ernst            103   6000      73000
        105 Austin           103   4800      77800
        106 Pataballa        103   4800      82600
        107 Lorentz          103   4200      86800
        108 Greenberg        101  12000      98800
        109 Faviet           108   9000     107800
        110 Chen             108   8200     116000
```

RANGE SPECIFICATION (1/2)

- RANGE BETWEEN 2 PRECEDING AND 2 FOLLOWING

```
SQL> select manager_id, last_name, salary, sum(salary) over (order by
last_name, salary rows between 2 preceding and 1 following) as
cumulative from employees;

MANAGER_ID LAST_NAME  SALARY CUMULATIVE
---------- --------- ------ ----------
       103 Austin      4800      10800
       103 Ernst       6000      22800
       101 Greenberg  12000      31800
       102 Hunold      9000      51000 = 6000 + 12000 + 9000 + 24000
           King       24000      62000
       100 Kochhar    17000      54200
       103 Lorentz     4200      45200
```

RANGE SPECIFICATION (2/2)

- ROWS BETWEEN CURRENT ROW AND UNBOUNDED FOLLOWING

```
SQL> select manager_id, last_name, salary, sum(salary) over (order by
last_name, salary rows between current row and unbounded following)
as cumulative from emp_part;

MANAGER_ID LAST_NAME  SALARY CUMULATIVE
---------- --------- ------ ----------
       103 Austin      4800      77000
       103 Ernst       6000      72200
       101 Greenberg  12000      66200
       102 Hunold      9000      54200 = 9000 + 24000 + 17000 + 4200
           King       24000      45200
       100 Kochhar    17000      21200
       103 Lorentz     4200       4200
```

PARTITIONED ANALYTICAL WINDOW

- Analytical functions start again for each partition

```
SQL> break on manager_id
SQL> SELECT manager_id, last_name, employee_id, salary,
     sum(salary) over (PARTITION BY manager_id order by employee_id)
     as cumulative
     FROM employees order by manager_id, employee_id, last_name;

MANAGER_ID LAST_NAME       EMPLOYEE_ID SALARY CUMULATIVE
---------- --------------- ----------- ------ ----------
       100 Kochhar                 101  17000      17000
           De Haan                 102  17000      34000
           Raphaely                114  11000      45000
           Weiss                   120   8000      53000
       101 Greenberg               108  12000      12000
           Whalen                  200   4400      16400
           Mavris                  203   6500      22900
           Baer                    204  10000      32900
       102 Hunold                  103   9000       9000
       103 Ernst                   104   6000       6000
           Austin                  105   4800      10800
           Pataballa               106   4800      15600
```

ANALYTIC FUNCTIONS

- For analytic functions, you can use all of the regular group functions
  - ✓ SUM
  - ✓ MAX
  - ✓ MIN
  - ✓ AVG
  - ✓ COUNT
- Plus list of additional analytical functions that can be used only for window queries.
  - ✓ LAG
  - ✓ LEAD
  - ✓ FIRST
  - ✓ LAST
  - ✓ FIRST VALUE
  - ✓ LAST VALUE
  - ✓ ROW_NUMBER
  - ✓ DENSE_RANK

ANALYTICAL FUNCTION EXAMPLE

➢ LAG function example

```
SQL> select * from currency order by 1;

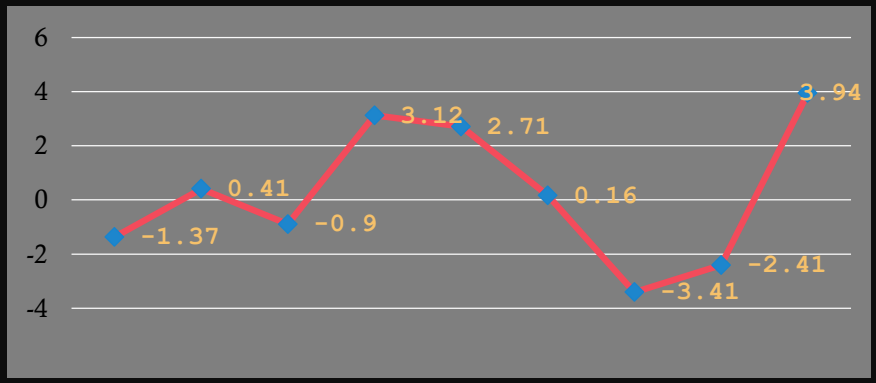
DAY                   EURCHF
-------------------- ------
01-JUN-2012 00:00:00  1.240
02-JUN-2012 00:00:00  1.223
03-JUN-2012 00:00:00  1.228
04-JUN-2012 00:00:00  1.217
05-JUN-2012 00:00:00  1.255
06-JUN-2012 00:00:00  1.289
07-JUN-2012 00:00:00  1.291
08-JUN-2012 00:00:00  1.247
09-JUN-2012 00:00:00  1.217
10-JUN-2012 00:00:00  1.265
```

```
SQL> select day, EURCHF,
lag(EURCHF,1) over (order by day)
as prev_eurchf from currency;

DAY                   EURCHF    PREV_EURCHF
-------------------- ------ --------------
01-JUN-2012 00:00:00  1.240
02-JUN-2012 00:00:00  1.223          1.240
03-JUN-2012 00:00:00  1.228          1.223
04-JUN-2012 00:00:00  1.217          1.228
05-JUN-2012 00:00:00  1.255          1.217
06-JUN-2012 00:00:00  1.289          1.255
07-JUN-2012 00:00:00  1.291          1.289
08-JUN-2012 00:00:00  1.247          1.291
09-JUN-2012 00:00:00  1.217          1.247
10-JUN-2012 00:00:00  1.265          1.217
```

```
SQL> select day, EURCHF, ((EURCHF - prev_eurchf) / prev_eurchf )*100 as pct_change from (
     select day, EURCHF, LAG(EURCHF,1) over (order by day) as prev_eurchf from currency);

DAY                   EURCHF PCT_CHANGE
-------------------- ------ ----------
01-JUN-2012 00:00:00  1.240
02-JUN-2012 00:00:00  1.223      -1.37
03-JUN-2012 00:00:00  1.228       0.41
04-JUN-2012 00:00:00  1.217      -0.90
05-JUN-2012 00:00:00  1.255       3.12
06-JUN-2012 00:00:00  1.289       2.71
07-JUN-2012 00:00:00  1.291       0.16
08-JUN-2012 00:00:00  1.247      -3.41
09-JUN-2012 00:00:00  1.217      -2.41
10-JUN-2012 00:00:00  1.265       3.94
```



SET OPERATORS

- Combine multiple queries
- Union without duplicates

```
SELECT name, email FROM employees
UNION
SELECT name, email FROM visitors;
```

- Union with the duplicates

```
SELECT cit_id FROM employees
UNION ALL
SELECT cit_id FROM visitors;
```

- Intersect

```
SELECT  name FROM employees
INTERSECT
SELECT  name FROM visitors;
```

- Minus

```
SELECT  name FROM employees
MINUS
SELECT  name FROM visitors;
```

SEQUENCES

- A database object that generates (in/de)creasing unique integer numbers
  - ✓ Very efficient thanks to caching
  - ✓ Transaction safe
- It is typically used to generate Primary Key values
- No guarantee that ID will be continuous
  - ✓ rollback, use in >1 tables, concurrent sessions
  - ✓ Gaps less likely if caching switched off
- The use of application-side generation of numbers is not recommended. Highly prone to locks, errors.

```
SQL> CREATE SEQUENCE seq_dept
INCREMENT BY 10
MAXVALUE 1000
NOCACHE;
```

```
SELECT seq_dept.NEXTVAL FROM DUAL;
SELECT seq_dept.CURRVAL FROM DUAL;

INSERT INTO dept VALUES
(seq_dept.NEXTVAL,'HR',4);
```

DATABASE LINKS & SYNONYMS

- object in the local database that allows you to access objects on a remote database

```
CREATE DATABASE LINK devdb
CONNECT TO scott IDENTIFIED BY tiger USING 'devdb';
```

  - ✓ How to access to tables over a database link?

```
SELECT * FROM emp@devdb;
```

- Solution: Use synonyms to hide the fact that a table is remote:

```
CREATE SYNONYM emp_syn for emp@devdb;
SELECT * FROM emp_syn;
```

TEMPORARY TABLES

- Special type of table for storing temporary data
  - ✓ Volatile – no statistics are gathered
  - ✓ Session or transaction
    - ON COMMIT PRESERVE | DELETE ROWS
  - ✓ indexes, views can be created on temporary tables

```
SQL> CREATE GLOBAL TEMPORARY TABLE temp_table_session (id number) ON COMMIT
PRESERVE ROWS;
SQL> CREATE GLOBAL TEMPORARY TABLE temp_table_transaction (id number) ON COMMIT
DELETE ROWS;
SQL> INSERT INTO temp_table_session values(2);
SQL> INSERT INTO temp_table_transaction values(2);
SQL> COMMIT;
SQL> SELECT * FROM temp_table_session;

            ID
--------------
             2

SQL> SELECT * FROM temp_table_transaction;

no rows selected
```

VIEWS

- It's a stored SQL statement that defines a virtual table. It takes the output of a query and makes it appear as a virtual table
- Advantages:
  - ✓ To hide the complexity of a query
    - Provide different representations of same data
    - To ensure that exactly the same SQL is used throughout your application
  - ✓ To improve security by restricting access to data
    - Restrict the columns/rows which can be queried
    - Restrict the rows and columns that may be modified
  - ✓ To isolate and application from any future change to the base table definition
    - Users formulate their queries on the views (virtual tables)
- Views are updatable! Use WITH READ ONLY to make view nonupdatable

DATA DICTIONARY VIEWS

- Data dictionary? Read-only set of tables that provides information about the database
- These predefined views provided by oracle are a source of valuable information for developers and dbusers

user_ts_quotas	user quotas per tablespace
user_objects, user_tables, user_views, user_mviews user_indexes user_constraints	objects created in the user's schema
user_sys_privs, user_role_privs, user_tab_privs	system privileges roles granted to the user privileges granted on the user's objects
user_segments, user_extents	storage of the user's objects
session_privs	all privileges available for current session

MATERIALIZED VIEWS (1/2)

- A database object that stores the result of a query
  - ✓ A hybrid of view and table
- Advantages
  - ✓ Useful for summarizing, pre-computing, replicating and distributing data
  - ✓ Faster access for expensive and complex joins
  - ✓ Transparent to end-users
  - ✓ Especially useful for heavy queries and big tables
- Disadvantages
  - ✓ Storage costs of maintaining the views
  - ✓ configuration for refresh

MATERIALIZED VIEWS (2/2)

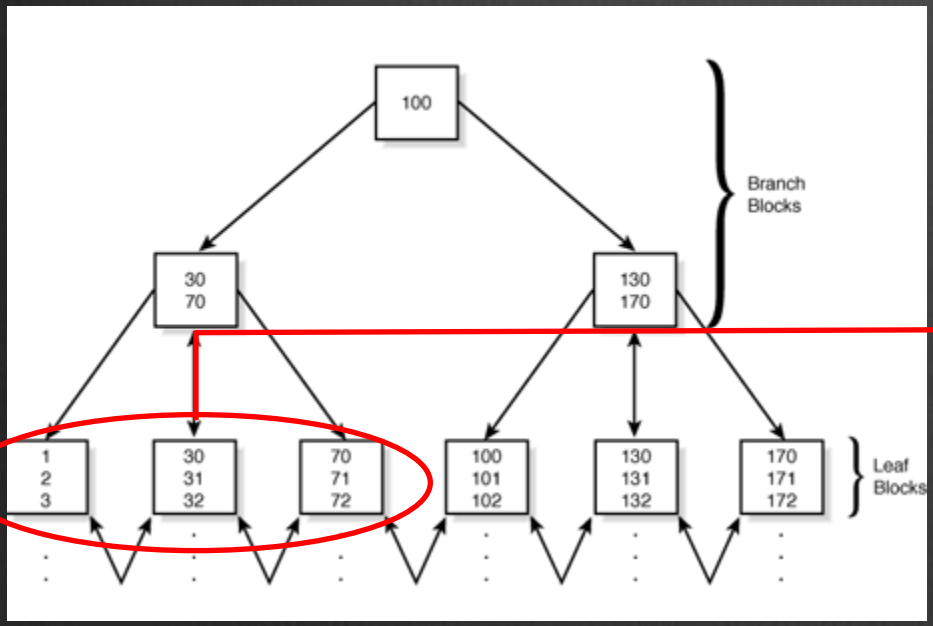
- Syntax of materialized views:

```
CREATE MATERIALIZED VIEW mv
BUILD IMMEDIATE | DEFFERED | ON PREBUILT TABLE
REFRESH COMPLETE | FAST | FORCE
        ON COMMIT | ON DEMAND | START WITH
ENABLE QUERY REWRITE
AS (SELECT… FROM table);
```

- The "*query rewrite*" feature – the ability of database engine to silently rewrites the query and executes it against MV.
- Controlled by following Oracle parameters:
  - **QUERY_REWRITE_ENABLED**
  - **QUERY_REWRITE_INTEGRITY**

B-TREE INDEX

- Index with a balanced tree
- When to use?
  1. OLTP systems
  2. High cardinality columns (primary key columns)
  3. Size: B-tree index will be signifficantly smaller than Bitmap index for high cardinality column.



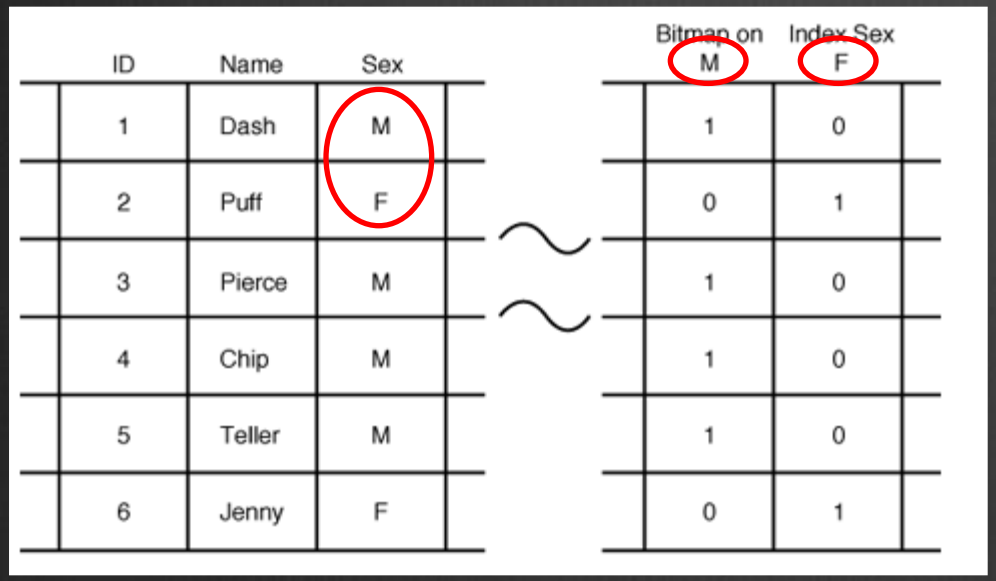

```
CREATE INDEX
i_employee_id ON
employee (empid);
```

```
SELECT *
FROM employee
WHERE empid < 73
```

BITMAP INDEX

- Index with a bitmap of the column values
- When to use?

1. DSS systems (bitmap indexes can cause a serious locking problem in systems where data is frequently updated by many concurrent systems)
2. Low cardinality columns (columns with few discrete values)
3. Size: Bitmap index will be signifficantly smaller than B-tree index on low cardinality column




```
CREATE BITMAP INDEX
i_employee_sex ON
employee (sex);

SELECT * FROM employee
WHERE sex='F';
```

COMPOSITE & FUNCTION BASED IND

- Composite index: Index over multiple columns in a table
- When to use?
  - ✓ When WHERE clause uses more than one column
  - ✓ To increase selectivity joining columns of low selectivity

```
CREATE INDEX mgr_deptno_idx ON emp(mgr, deptno);
```

- Function-based index: Is an index created on a function that involves columns in the table being indexed (b-tree or bitmap)
  - ✓ They speed up queries that evaluate those functions to select data because they pre-compute the result and stores it in an index

```
CREATE INDEX emp_name_idx ON employee (UPPER(ename));
```

INDEX ORGANIZED TABLES

- IOT stores all of the table's data in the B-tree index structure

```
CREATE TABLE orders (
order_id NUMBER(10),
      …, …, …
CONSTRAINT pk_orders PRIMARY KEY
  (order_id)
 )
ORGANIZATION INDEX;
```

- Efficient when:
  - ✓ table is usually accessed by the primary key
- Inefficient when:
  - ✓ there's a heavy DML activity especially not primary key based
  - ✓ access to table's data not via primary key is slower comparing to a cheap table

ORACLE PARTITIONING

- Tables and indexes can be divided into smaller and more manageable physical pieces called partitions which are treated as a single logical unit
- Advantages:
  - ✓ Manageability: data management operations at the partition level (data load, index creation, backup/recovery, etc)
  - ✓ Performance: Improves query performance, possibility of concurrent maintenance operations on different partitions of the same table/index.
  - ✓ Partitioning can be implemented without requiring any modifications to your applications.

PARTITIONING TYPES

- There are different criteria to split the data:
  - ✓ List: partition by lists of predefined discrete values
  - ✓ Range: partition by predefined ranges of continuous values
  - ✓ Hash: partition according to hashing algorithm applied by Oracle
  - ✓ Composite: e.g. range-partition by key1, hash-subpartition by key2

```
CREATE TABLE SALES_2010
(
salesman_id  NUMBER(5),
salesman_name VARCHAR2(30),
region VARCHAR2(1),
sales_amount NUMBER(10),
sale_date   DATE
)
PARTITION BY RANGE(sale_date) (
PARTITION p_jan2010 VALUES LESS THAN(TO_DATE('01/01/2010','DD/MM/YYYY')),
PARTITION p_feb2010 VALUES LESS THAN(TO_DATE('02/01/2010','DD/MM/YYYY')),
PARTITION p_mar2010 VALUES LESS THAN(TO_DATE('03/01/2010','DD/MM/YYYY')),
PARTITION p_apr2010 VALUES LESS THAN(TO_DATE('04/01/2010','DD/MM/YYYY')),
(…)
PARTITION p_aug2010 VALUES LESS THAN(TO_DATE('08/01/2010','DD/MM/YYYY')),
PARTITION p_sep2010 VALUES LESS THAN(TO_DATE('09/01/2010','DD/MM/YYYY')),
PARTITION p_oct2010 VALUES LESS THAN(TO_DATE('10/01/2010','DD/MM/YYYY')),
PARTITION p_nov2010 VALUES LESS THAN(TO_DATE('11/01/2010','DD/MM/YYYY')),
PARTITION p_dec2010 VALUES LESS THAN(TO_DATE('12/01/2010','DD/MM/YYYY')),
PARTITION p_others VALUES LESS THAN (MAXVALUE));
```

PARTITIONING TYPES

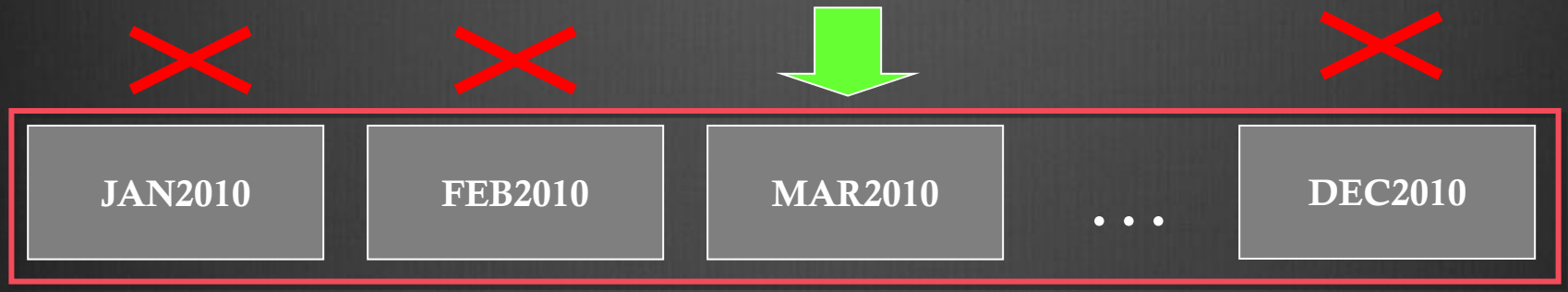
- There are different criteria to split the data:
  - ✓ List: partition by lists of predefined discrete values
  - ✓ Range: partition by predefined ranges of continuous values
  - ✓ Hash: partition according to hashing algorithm applied by Oracle
  - ✓ Composite: e.g. range-partition by key1, hash-subpartition by key2

```
CREATE TABLE SALES_REGIONS_2010
(
salesman_id  NUMBER(5),
salesman_name VARCHAR2(30),
region VARCHAR2(1),
sales_amount NUMBER(10),
sale_date   DATE
)
PARTITION BY RANGE(sale_date)
SUBPARTITION BY LIST(region)
SUBPARTITION TEMPLATE (
SUBPARTITION p_emea VALUES ('E'),
SUBPARTITION p_asia VALUES ('A'),
SUBPARTITION p_nala VALUES ('N')) (
PARTITION p_jan2010 VALUES LESS THAN(TO_DATE('01/01/2010','DD/MM/YYYY')),
PARTITION p_feb2010 VALUES LESS THAN(TO_DATE('02/01/2010','DD/MM/YYYY')),
PARTITION p_mar2010 VALUES LESS THAN(TO_DATE('03/01/2010','DD/MM/YYYY')),
(…)
PARTITION p_nov2010 VALUES LESS THAN(TO_DATE('11/01/2010','DD/MM/YYYY')),
PARTITION p_dec2010 VALUES LESS THAN(TO_DATE('12/01/2010','DD/MM/YYYY')),
PARTITION p_others VALUES LESS THAN (MAXVALUE));
```

PARTITION PRUNNING

- Table partitioned by date

```
INSERT INTO table … VALUES('MAR 2010');
```

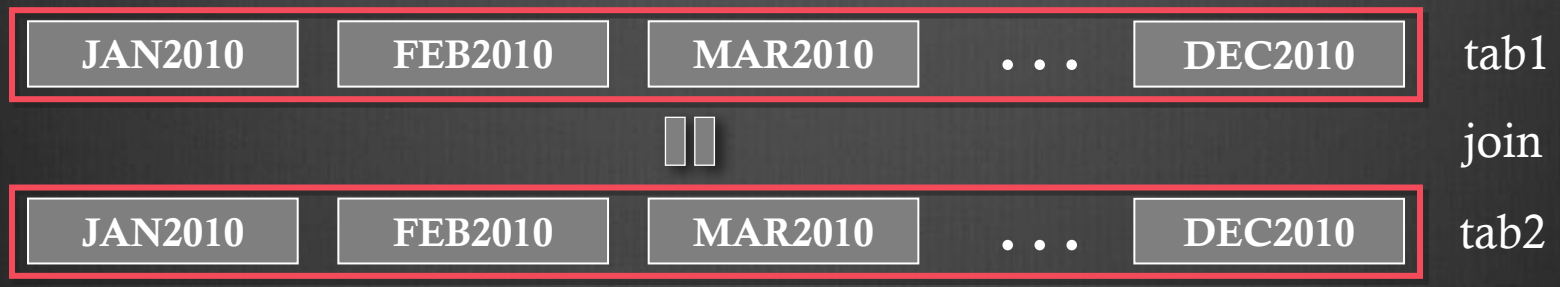



```
SELECT * FROM table WHERE key = ('DEC 2010');
```

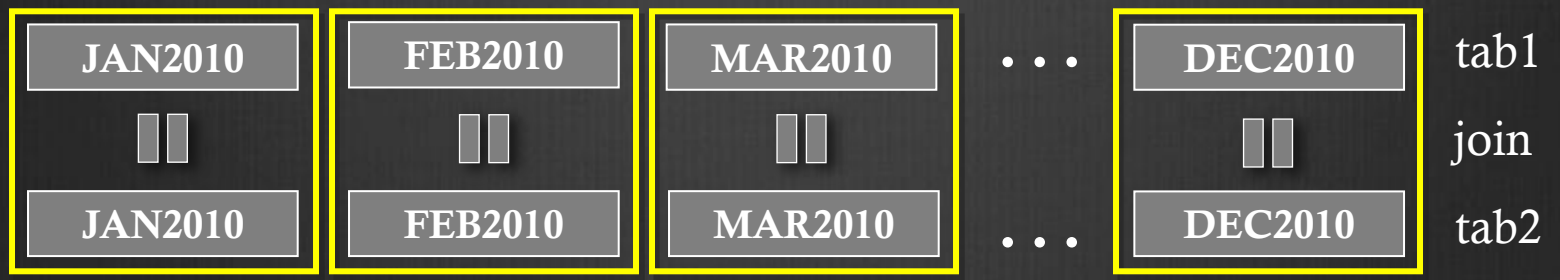
PARTITION WISE JOINS

```
SELECT … FROM tab1, tab2 WHERE tab1.key = tab2.key
```

- Without partitioning: global join (query time ~ N x N)



- With partitioning: local joins (query time ~ N)



PARTITIONED INDEXES

- Local index: partitioned on the same key as table

```
CREATE INDEX day_idx ON table (day) LOCAL;
```

- Global index: not partitioned on the same key as table

```
CREATE INDEX day_idx ON table (day) GLOBAL;
```

- Combine the advantages of partitioning and indexing:
  - ✓ Partitioning improves query performance by pruning
  - ✓ Local index improves performance on full scan of partition
- Bitmap indexes on partitioned tables are always local
  - ✓ The concept of global index only applies to B*-tree indexes

FLASHBACK TECHNOLOGIES

- For COMMITED data
- Flashback technologies support recovery at all levels:
  - ✓ Row
  - ✓ Table
  - ✓ Transaction (this is not in the scope of this tutorial)
  - ✓ Entire Database (this is not in the scope of this tutorial)
- We DO NOT GUARANTEE that past data will be always accessible (UNDO is a circular buffer)
- SCN System Change Number - is an ever-increasing value that uniquely identifies a committed version of the database. In simple words: "*it's an Oracle's clock - every time we commit, the clock increments.*" – Tom Kyte

FLASHBACK TECHS (2)

- For error analysis
  - ✓ **Flashback Query**
  - ✓ **Flashback Version query**
  - ✓ Flashback Transaction query (not part of this tutorial)
- For error recovery
  - ✓ Flashback Transaction Backout (not part of this tutorial) new 11g!
  - ✓ **Flashback Table**
  - ✓ **Flashback Drop**
  - ✓ Flashback Database (not part of this tutorial)

FLASHBACK QUERY

- For analysis
- To perform queries as of a certain time

```
SELECT *
FROM <TABLE>
AS OF TIMESTAMP | SCN;
```

```
SQL> select
DBMS_FLASHBACK.GET_SYSTEM_CHANGE_NUMBER from dual;

GET_SYSTEM_CHANGE_NUMBER
------------------------
        6268302650456

SQL> delete from test;

3 rows deleted.

SQL> commit;

Commit complete.
```

```
SQL> SELECT * FROM test;

no rows selected

SQL> SELECT * FROM test
    AS OF SCN 6268302650456;

        ID STR_VAL
---------- ----------
         1 one
         2 two
         3 three
```

FLASHBACK VERSION QUERY

- For analysis
- To retrieve all the versions of the rows that exist between two points in time or two SCNs
- Pseudocolumns:
  - VERSIONS_STARTTIME (start timestamp of version)
  - VERSIONS_ENDTIME (end timestamp of version)
  - VERSIONS_STARTSCN (start SCN of version)
  - VERSIONS_ENDSCN (end SCN of version)
  - VERSIONS_XID (transaction ID of version)
  - VERSIONS_OPERATION (DML operation of version)
- The VERSIONS clause cannot span DDL commands

```
SELECT versions_xid, versions_operation, salary
FROM employees
VERSIONS BEETWEN TIMESTAMP | SCN <t1> and <t2>;
```

FLASHBACK TABLE

- For error correction
- Flashback Table provides a way for users to easily and quickly recover from accidental modifications without a database administrator's involvement☺

FLASHBACK TABLE employees
TO TIMESTAMP | SCN <t1>;

```
SQL> SELECT * FROM test;

no rows selected

SQL> ALTER TABLE test ENABLE ROW MOVEMENT;

Table altered.

SQL> FLASHBACK ATBLE test TO SCN 6268302650456;

Flashback complete.
```

```
SQL> SELECT * FROM test

        ID STR_VAL
---------- ----------
         1 one
         2 two
         3 three
```

FLASHBACK DROP

- For error correction
- The RECYCLEBIN initialization parameter is used to control whether the Flashback Drop capability is turned ON or OFF.
- It's RECYCLEBIN is set to ON for CERN Physics databases

FLASHBACK TABLE employees TO BEFORE DROP;

```
SQL> DROP TABLE test;

Table dropped.

SQL> FLASHBACK TABLE test TO BEFORE DROP;

Flashback complete.
```

FLASHBACK

```
select versions_xid, versions_operation, versions_startscn,       versions_endscn, id, str_val
from test versions between       timestamp minvalue and maxvalue order by
VERSIONS_STARTSCN;

VERSIONS_XID     V VERSIONS_STARTSCN VERSIONS_ENDSCN  ID STR_VAL
---------------- - ---------------- -------------- --- ----------
21001D00F8B50F00 I    6268303135869                  1 one
21001D00F8B50F00 I    6268303135869   6268303136686  3 three
21001D00F8B50F00 I    6268303135869   6268303136686  2 two
23000600BAFB0D00 U     6268303136686                 9 nine
23000600BAFB0D00 D     6268303136686                 3 three
23000400B9FC0D00 I    6268303136698                 11 eleven
23000400B9FC0D00 I    6268303136698                 10 ten
```

```
select * from test:
(as of scn 6268303136698)

 ID STR_VAL
--- ----------
  1 one
  9 nine
 10 ten
 11 eleven
```

FLASHBACK

```
select versions_xid, versions_operation, versions_startscn,       versions_endscn, id, str_val
from test versions between        timestamp minvalue and maxvalue order by
VERSIONS_STARTSCN;

VERSIONS_XID     V VERSIONS_STARTSCN VERSIONS_ENDSCN  ID STR_VAL
---------------- - ---------------- -------------- --- ----------
21001D00F8B50F00 I    6268303135869                  1 one
21001D00F8B50F00 I    6268303135869   6268303136686  3 three
21001D00F8B50F00 I    6268303135869   6268303136686  2 two
23000600BAFB0D00 U     6268303136686                 9 nine
23000600BAFB0D00 D     6268303136686                 3 three
23000400B9FC0D00 I    6268303136698                 11 eleven
23000400B9FC0D00 I    6268303136698                 10 ten
```

```
select * from test:
(as of scn 6268303136698)

 ID STR_VAL
--- ----------
  1 one
  9 nine
 10 ten
 11 eleven
```

```
select * from test as of scn
6268303136686;

 ID STR_VAL
--- ----------
  1 one
  9 nine
```

FLASHBACK

```
select versions_xid, versions_operation, versions_startscn,       versions_endscn, id, str_val
from test versions between       timestamp minvalue and maxvalue order by
VERSIONS_STARTSCN;

VERSIONS_XID     V VERSIONS_STARTSCN VERSIONS_ENDSCN  ID STR_VAL
---------------- - ---------------- -------------- --- ----------
21001D00F8B50F00 I    6268303135869                  1 one
21001D00F8B50F00 I    6268303135869   6268303136686  3 three
21001D00F8B50F00 I    6268303135869   6268303136686  2 two
23000600BAFB0D00 U     6268303136686                 9 nine
23000600BAFB0D00 D     6268303136686                 3 three
23000400B9FC0D00 I    6268303136698                 11 eleven
23000400B9FC0D00 I    6268303136698                 10 ten
```

```
select * from test:
(as of scn 6268303136698)

 ID STR_VAL
--- ----------
  1 one
  9 nine
 10 ten
 11 eleven
```

```
select * from test as of scn
6268303136686;

 ID STR_VAL
--- ----------
  1 one
  9 nine
```

```
select * from test
as of scn 6268303135869;

 ID STR_VAL
--- ----------
  1 one
  2 two
  3 three
```

FLASHBACK

```
select versions_xid, versions_operation, versions_startscn,       versions_endscn, id, str_val
from test versions between       timestamp minvalue and maxvalue order by
VERSIONS_STARTSCN;

VERSIONS_XID     V VERSIONS_STARTSCN VERSIONS_ENDSCN  ID STR_VAL
---------------- - ---------------- -------------- --- ----------
21001D00F8B50F00 I    6268303135869                  1 one
21001D00F8B50F00 I    6268303135869   626830313[illegible]6686   3 three
21001D00F8B50F00 I    6268303135869   6268303136686   2 two
23000600BAFB0D00 U     6268303136686                  9 nine
23000600BAFB0D00 D     6268303136686                  3 three
23000400B9FC0D00 I    6268303136698                 11 eleven
23000400B9FC0D00 I    6268303136698                 10 ten
```

```
create table test
(id number(5), str_val varchar2(10));

insert into test values(1, 'one');
insert into test values(2, 'two');
insert into test values(3, 'three');
commit;
```

```
select * from test
as of scn 6268303135869;

 ID STR_VAL
--- ----------
  1 one
  2 two
  3 three
```

FLASHBACK

```
select versions_xid, versions_operation, versions_startscn,       versions_endscn, id, str_val
from test versions between       timestamp minvalue and maxvalue order by
VERSIONS_STARTSCN;

VERSIONS_XID     V VERSIONS_STARTSCN VERSIONS_ENDSCN  ID STR_VAL
---------------- - ---------------- -------------- --- ----------
21001D00F8B50F00 I    6268303135869                  1 one
21001D00F8B50F00 I    6268303135869   6268303136686  3 three
21001D00F8B50F00 I    6268303135869   6268303136686  2 two
23000600BAFB0D00 U    6268303136686                  9 nine
23000600BAFB0D00 D    6268303136686                  3 three
23000400B9FC0D00 I    6268303136698                 11 eleven
23000400B9FC0D00 I    6268303136698                 10 ten
```

```
update test set id = 9, str_val = 'nine'
where id =2;
delete from test where id = 3;
commit;
```

```
select * from test as of scn
6268303136686;

 ID STR_VAL
--- ----------
  1 one
  9 nine
```

FLASHBACK

```
select versions_xid, versions_operation, versions_startscn,       versions_endscn, id, str_val
from test versions between       timestamp minvalue and maxvalue order by
VERSIONS_STARTSCN;

VERSIONS_XID     V VERSIONS_STARTSCN VERSIONS_ENDSCN  ID STR_VAL
---------------- - ---------------- -------------- --- ----------
21001D00F8B50F00 I    6268303135869                  1 one
21001D00F8B50F00 I    6268303135869   6268303136686  3 three
21001D00F8B50F00 I    6268303135869   6268303136686  2 two
23000600BAFB0D00 U     6268303136686                 9 nine
23000600BAFB0D00 D     6268303136686                 3 three
23000400B9FC0D00 I     6268303136698                11 eleven
23000400B9FC0D00 I     6268303136698                10 ten
```

```
insert into test values(10, 'ten');
insert into test values(11, 'eleven');
commit;
```

```
select * from test:
(as of scn 6268303136698)

 ID STR_VAL
--- ----------
  1 one
  9 nine
 10 ten
 11 eleven
```

REFERENCES

- *Oracle Documentation*
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- *SQL language reference*
  - ✓ http://docs.oracle.com/cd/E11882_01/server.112/e26088/toc.htm
- *Mastering Oracle SQL and SQL*Plus*, Lex De Haan
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- *Mastering Oracle SQL*, Mishra Sanjay
- *Expert One on One Oracle*, Thomas Kyte (more advanced topics than SQL)

Questions?

THANK YOU!

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