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Database Programming with SQL

16-1
Working With Sequences

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Objectives

This lesson covers the following objectives:

- List at least three useful characteristics of a sequence
- Write and execute a SQL statement that creates a sequence
- Query the data dictionary using USER_SEQUENCES to confirm a sequence definition
- Apply the rules for using NEXTVAL to generate sequential unique numbers in a table
- List the advantages and disadvantages of caching sequence values
- Name three reasons why gaps can occur in a sequence

Purpose

- Can you image how tedious it would be to have to enter the names of the 30,000 people who enter the London Marathon into a database, while making sure that no one was given the same identification number?
- What if you went to lunch and when you returned, someone else had entered some of the runners' applications?
- How would you know where to start again?

Purpose

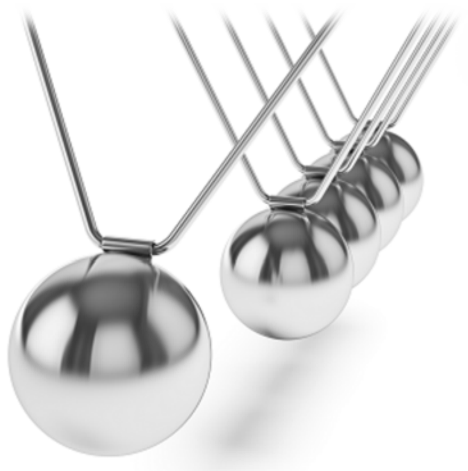
- Fortunately, SQL has a process for automatically generating unique numbers that eliminates the worry about the details of duplicate numbers.
- The numbering process is handled through a database object called a SEQUENCE.

The Sequence Object

- You already know how to create two kinds of database objects, the TABLE and the VIEW.
- A third database object is the SEQUENCE.
- A SEQUENCE is a shareable object used to automatically generate unique numbers.
- Because it is a shareable object, multiple users can access it.
- Typically, sequences are used to create a primary-key value.

The Sequence Object

- As you'll recall, primary keys must be unique for each row. The sequence is generated and incremented (or decremented) by an internal Oracle routine.
- This object is a time-saver for you because it reduces the amount of code you need to write.



The Sequence Object

- Sequence numbers are stored and generated independently of tables.
- Therefore, the same sequence can be used for multiple tables.
- To create a SEQUENCE:

```
CREATE SEQUENCE sequence
       [INCREMENT BY n]
       [START WITH n]
       [{MAXVALUE n | NOMAXVALUE}]
       [{MINVALUE n | NOMINVALUE}]
       [{CYCLE | NOCYCLE}]
       [{CACHE n | NOCACHE}];
```

Sequence Syntax

```
CREATE SEQUENCE sequence
       [INCREMENT BY n]
       [START WITH n]
       [{MAXVALUE n | NOMAXVALUE}]
       [{MINVALUE n | NOMINVALUE}]
       [{CYCLE | NOCYCLE}]
       [{CACHE n | NOCACHE}];
```

sequence	is the name of the sequence generator (object)
INCREMENT BY n	specifies the interval between sequence numbers where n is an integer (If this clause is omitted, the sequence increments by 1.)
START WITH n	specifies the first sequence number to be generated (If this clause is omitted, the sequence starts with 1.)

Sequence Syntax

```
CREATE SEQUENCE sequence
       [INCREMENT BY n]
       [START WITH n]
       [{MAXVALUE n | NOMAXVALUE}]
       [{MINVALUE n | NOMINVALUE}]
       [{CYCLE | NOCYCLE}]
       [{CACHE n | NOCACHE}];
```

MAXVALUE n	specifies the maximum value the sequence can generate
NOMAXVALUE	specifies a maximum value of 10^27 for an ascending sequence and -1 for a descending sequence (default)
MINVALUE n	specifies the minimum sequence value

Sequence Syntax

```
CREATE SEQUENCE sequence
       [INCREMENT BY n]
       [START WITH n]
       [{MAXVALUE n | NOMAXVALUE}]
       [{MINVALUE n | NOMINVALUE}]
       [{CYCLE | NOCYCLE}]
       [{CACHE n | NOCACHE}];
```

NOMINVALUE	specifies a minimum value of 1 for an ascending sequence and –(10^26) for a descending sequence (default)
CYCLE | NOCYCLE	specifies whether the sequence continues to generate values after reaching its maximum or minimum value (NOCYCLE is the default option.)

Sequence Syntax

```
CREATE SEQUENCE sequence
       [INCREMENT BY n]
       [START WITH n]
       [{MAXVALUE n | NOMAXVALUE}]
       [{MINVALUE n | NOMINVALUE}]
       [{CYCLE | NOCYCLE}]
       [{CACHE n | NOCACHE}];
```

CACHE n | NOCACHE	specifies how many values the Oracle server pre-allocates and keeps in memory. (By default, the Oracle server caches 20 values.) If the system crashes, the values are lost.

Creating a Sequence

- In the SEQUENCE created for the London Marathon runners, the numbers will increment by 1, starting with the number 1.
- In this case, beginning the sequence with 1 is probably the best starting point.

```
CREATE SEQUENCE runner_id_seq
  INCREMENT BY 1
  START WITH 1
  MAXVALUE 50000
  NOCACHE
  NOCYCLE;
```

Creating a Sequence

- It is a tradition that the best runner in the elite group wears number 1.
- For other situations, such as department IDs and employee IDs, the starting number may be assigned differently.
- Because there will be at least 30,000 runners, the sequence's maximum value was set well above the expected number of runners.

```
CREATE SEQUENCE runner_id_seq
  INCREMENT BY 1
  START WITH 1
  MAXVALUE 50000
  NOCACHE
  NOCYCLE;
```

Creating a Sequence

- The NOCACHE option prevents values in the SEQUENCE from being cached in memory, which in the event of system failure prevents numbers pre-allocated and held in memory from being lost.

```
CREATE SEQUENCE runner_id_seq
  INCREMENT BY 1
  START WITH 1
  MAXVALUE 50000
  NOCACHE
  NOCYCLE;
```

Creating a Sequence

- The NOCYCLE option prevents the numbering from starting over at 1 if the value 50,000 is exceeded.
- Don't use the CYCLE option if the sequence is used to generate primary-key values unless there is a reliable mechanism that deletes old rows faster than new ones are added.

```
CREATE SEQUENCE runner_id_seq
  INCREMENT BY 1
  START WITH 1
  MAXVALUE 50000
  NOCACHE
  NOCYCLE;
```

Confirming Sequences

- To verify that a sequence was created, query the USER_OBJECTS data dictionary.
- To see all of the SEQUENCE settings, query the USER_SEQUENCES data dictionary as shown below.
- List the value names in the SELECT statement as shown below.

```
SELECT sequence_name, min_value, max_value, increment_by, last_number
FROM user_sequences;
```

Confirming Sequences

- If NOCACHE is specified, the last_number column in the query displays the next available sequence number.
- If CACHE is specified, the last_number column displays the next available number in the sequence which has not been cached into memory.

```
SELECT sequence_name, min_value, max_value, increment_by, last_number
FROM user_sequences;
```

NEXTVAL and CURRVAL Pseudocolumns

- The NEXTVAL pseudocolumn is used to extract successive sequence numbers from a specified sequence.
- You must qualify NEXTVAL with the sequence name.
- When you reference sequence.NEXTVAL, a new sequence number is generated and the current sequence number is placed in CURRVAL.

NEXTVAL and CURRVAL Pseudocolumns

- The example below inserts a new department in the DEPARTMENTS table.
- It uses the DEPARTMENTS_SEQ sequence for generating a new department number as follows:

```
INSERT INTO departments
        (department_id, department_name, location_id)
VALUES  (departments_seq.NEXTVAL, 'Support', 2500);
```

NEXTVAL and CURRVAL Pseudocolumns

- Suppose now you want to hire employees to staff the new department.
- The INSERT statement to be executed for all new employees can include the following code:

```
INSERT INTO employees
       (employee_id, department_id, ...)
VALUES (employees_seq.NEXTVAL, dept_deptid_seq .CURRVAL, ...);
```

- Note: The preceding example assumes that a sequence called EMPLOYEES_SEQ has already been created for generating new employee numbers.

NEXTVAL and CURRVAL Pseudocolumns

- The CURRVAL pseudocolumn in the example below is used to refer to a sequence number that the current user has just generated.
- NEXTVAL must be used to generate a sequence number in the current user's session before CURRVAL can be referenced.
- You must qualify CURRVAL with the sequence name.

NEXTVAL and CURRVAL Pseudocolumns

- When sequence.CURRVAL is referenced, the last value generated by that user's process is returned.

```
INSERT INTO employees
       (employee_id, department_id, ...)
VALUES (employees_seq.NEXTVAL, dept_deptid_seq.CURRVAL, ...);
```

Using a Sequence

- After you create a sequence, it generates sequential numbers for use in your tables. Reference the sequence values by using the NEXTVAL and CURRVAL pseudocolumns.
- You can use NEXTVAL and CURRVAL in the following contexts:
  - The SELECT list of a SELECT statement that is not part of a subquery
  - The SELECT list of a subquery in an INSERT statement
  - The VALUES clause of an INSERT statement
  - The SET clause of an UPDATE statement

Using a Sequence

- You cannot use NEXTVAL and CURRVAL in the following contexts:
  - The SELECT list of a view
  - A SELECT statement with the DISTINCT keyword
  - A SELECT statement with GROUP BY, HAVING, or ORDER BY clauses
  - A subquery in a SELECT, DELETE, or UPDATE statement
  - The DEFAULT expression in a CREATE TABLE or ALTER TABLE statement

Using a Sequence

- To continue our London Marathon example, a table was created for the runners:

```
CREATE TABLE runners
(runner_id NUMBER(6,0) CONSTRAINT runners_id_pk PRIMARY KEY,
 first_name VARCHAR2(30),
 last_name VARCHAR2(30));
```

Using a Sequence

- We then create the sequence that will generate values for the runner_id primary key column.

```
CREATE SEQUENCE runner_id_seq
   INCREMENT BY 1
   START WITH 1
   MAXVALUE 50000
   NOCACHE
   NOCYCLE;
```

Using a Sequence

- Using the following syntax would allow new participants to be inserted into the runners table.
- The runner's identification number would be generated by retrieving the NEXTVAL from the sequence.

```
INSERT INTO runners
        (runner_id, first_name, last_name)
VALUES  (runner_id_seq.NEXTVAL, 'Joanne', 'Everely');
```

```
INSERT INTO runners
        (runner_id, first_name, last_name)
VALUES  (runner_id_seq.NEXTVAL, 'Adam', 'Curtis');
```

Using a Sequence

- To confirm the sequence worked correctly, we query the table:

```
SELECT runner_id, first_name, last_name
FROM runners;
```

RUNNER_ID	FIRST_NAME	LAST_NAME
1	Joanne	Everely
2	Adam	Curtis

Using a Sequence

- To view the current value for the runners_id_seq, CURRVAL is used.
- Note the use of the DUAL table in this example.
- Oracle Application Express will not execute this query, but you should understand how this works.

```
SELECT runner_id_seq.CURRVAL
FROM dual;
```

Using a Sequence

- Cache sequences in memory provide faster access to sequence values.
- The cache is populated the first time you refer to the sequence.
- Each request for the next sequence value is retrieved from the cached sequence.
- After the last sequence value is used, the next request for the sequence pulls another cache of sequences into memory.
- 20 is the default number of sequence numbers cached.

Nonsequential Numbers

- Although sequence generators issue sequential numbers without gaps, this action occurs independently of a database commit or rollback.
- Gaps (nonsequential numbers) can be generated by:
  - Rolling back a statement containing a sequence, the number is lost.
  - A system crash. If the sequence caches values into the memory and the system crashes, those values are lost.
  - The same sequence being used for multiple tables. If you do so, each table can contain gaps in the sequential numbers.

Viewing the Next Value

- If the sequence was created with NOCACHE, it is possible to view the next available sequence value without incrementing it by querying the USER_SEQUENCES table.

```
SELECT sequence_name, min_value, max_value, last_number AS "Next number"
FROM USER_SEQUENCES
WHERE sequence_name = 'RUNNER_ID_SEQ';
```

SEQUENCE_NAME	MIN_VALUE	MAX_VALUE	Next number
RUNNER_ID_SEQ	1	50000	3

Modifying a Sequence

- As with the other database objects you've created, a SEQUENCE can also be changed using the ALTER SEQUENCE statement.
- What if the London Marathon exceeded the 50,000 runner registrations and you needed to add more numbers?
- The sequence could be changed to increase the MAXVALUE without changing the existing number order.

```
ALTER SEQUENCE runner_id_seq
               INCREMENT BY 1
               MAXVALUE 999999
               NOCACHE
               NOCYCLE;
```

Modifying a Sequence

- Some validation is performed when you alter a sequence.
- For example, a new MAXVALUE that is less than the current sequence number cannot be executed.

```
ALTER SEQUENCE runner_id_seq
               INCREMENT BY 1
               MAXVALUE 90
               NOCACHE
               NOCYCLE;
```

```
ERROR at line 1:
ORA-04009: MAXVALUE cannot be made to be less than the current value
```

ALTER SEQUENCE Guidelines

- A few guidelines apply when executing an ALTER SEQUENCE statement.
- They are:
  – You must be the owner or have the ALTER privilege for the sequence in order to modify it.
  – Only future sequence numbers are affected by the ALTER SEQUENCE statement.
  – The START WITH option cannot be changed using ALTER SEQUENCE. The sequence must be dropped and re-created in order to restart the sequence at a different number.

Removing a Sequence

- To remove a sequence from the data dictionary, use the DROP SEQUENCE statement.
- You must be the owner of the sequence or have DROP ANY SEQUENCE privileges to remove it.
- Once removed, the sequence can no longer be referenced.

```
DROP SEQUENCE runner_id_seq;
```

Terminology

Key terms used in this lesson included:

- CACHE/ NOCACHE
- CREATE SEQUENCE
- CURRVAL
- CYCLE/ NOCYCLE
- INCREMENT BY
- MAXVALUE
- MINVALUE

Terminology

Key terms used in this lesson included:

- NEXTVAL
- NOMAXVALUE
- NOMINVALUE
- Sequences
- START WITH

Summary

In this lesson, you should have learned how to:

- List at least three useful characteristics of a sequence
- Write and execute a SQL statement that creates a sequence
- Query the data dictionary using USER_SEQUENCES to confirm a sequence definition
- Apply the rules for using NEXTVAL to generate sequential unique numbers in a table
- List the advantages and disadvantages of caching sequence values
- Name three reasons why gaps can occur in a sequence

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