CMSC 508
Database Theory

Advanced SQL (III)

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Chapter 4 from Database System Concepts, 6th Ed. by Silberschatz, Korth, Sudarshan, 2011
Chapter 5 from Database Management Systems, 3rd Ed. by Ramakrishnan, Gehrke, 2003

- Sequences
  - Database objects from which users may generate unique integers. Use sequences to automatically generate primary key values.
  - The sequence of numbers can be generated in either ascending or descending order.
  - Optional arguments: MAXVALUE, MINVALUE, CYCLE, CACHE, ORDER ...

```
CREATE SEQUENCE name_of_my_seq
 START WITH     1000
 MAXVALUE       5000
 INCREMENT BY   1
 NOCYCLE;
```

  - Call the next value anytime as:

```
name_of_my_seq.nextval
```

- Functions and procedures
  - Users can define new methods (functions and procedures) to be called in a SQL statement, trigger, etc.
  - Functions are typically coded to perform a small calculation.
  - Procedures are typically coded to perform larger operations implying database changes.
  - **Difference**: procedures can be called with SQL statements, while functions are called as **part of** an expression. Functions return values to the caller environment.

- User-defined functions
  - Can accept input parameters (optional) and return a data type
  - In functions, a RETURN statement **must** contain an expression
  - Functions **CANNOT modify** data in any table

```
CREATE [OR REPLACE] FUNCTION <function_name> (
            <parameter1_name> <data type>,
            <parameter2_name> <data type>, ...)
RETURN <function return value data type> {AS|IS}
   <Variable declarations>
BEGIN
   Executable Commands
   RETURN (return_value);
   . . .
[EXCEPTION
   Exception handlers]
END;
```

- User-defined functions
- Functions with no parameters

```
CREATE OR REPLACE FUNCTION RetrieveSalary
    RETURN NUMBER
IS
    v_Salary NUMBER(10,2);
BEGIN
    SELECT salary INTO v_Salary
    FROM employees
    WHERE employee_id = '100';
    RETURN v_Salary;
END RetrieveSalary;
/
```

- Functions with parameters

```
CREATE OR REPLACE FUNCTION RetrieveSalary
( p_employee_id in
  employees.employee_id%TYPE )
    RETURN NUMBER
IS
    v_Salary employees.salary%TYPE;
BEGIN
    SELECT salary INTO v_Salary
    FROM employees
    WHERE employee_id = p_employee_id;
    RETURN v_Salary;
END RetrieveSalary;
/
```

- Procedures
  - In procedures, a RETURN statement **cannot** contain an expression.

```
CREATE [OR REPLACE] PROCEDURE <procedure_name> (
<parameter1_name> <data type>,
<parameter2_name> <mode> <data type>, ...)
{AS|IS}
   <Variable declarations>
BEGIN
   Executable statements
[EXCEPTION
   Exception handlers]
END <optional procedure name>;
```

```
CREATE OR REPLACE PROCEDURE
IncreaseSalary (
  p_employee_id in
employees.employee_id%TYPE )
IS
BEGIN
    UPDATE employees set salary = salary * 1.05
    where employee_id = p_employee_id;
END IncreaseSalary;
/
```

- Cursors (iterators)

```
create or replace PROCEDURE get_emp_names (dept_num IN NUMBER)
IS
    emp_name  VARCHAR2(10);
    CURSOR    c1 (dept_num NUMBER) IS
              SELECT LAST_NAME FROM EMPLOYEES
              WHERE DEPARTMENT_ID = dept_num;
BEGIN
  OPEN c1(dept_num);
  LOOP
    FETCH c1 INTO emp_name;
    EXIT WHEN C1%NOTFOUND;
    DBMS_OUTPUT.PUT_LINE(emp_name);
  END LOOP;
  CLOSE c1;
END;
/
```

- Advanced table creation: Integrity constraints
  - Integrity constraints guard against accidental damage to the database, by ensuring that authorized changes to the database do not result in a loss of data consistency
  - Constraints in a single relation:
    - **primary key**
    - **not null**
    - **unique**
    - **check** (P), where P is a predicate

- Integrity constraints
  - **not null**

```
create table students (
        last_name varchar2(20) not null
);
```

  - **unique**

```
create table students (
        last_name varchar2(20) not null,
        email varchar2(20) not null unique
);
```

- Integrity constraints
  - **primary key**

```
create table students (
        id number(6,0) primary key,
        last_name varchar2(20) not null,
        email varchar2(20) not null unique
);

create table students (
        first_name varchar2(20) not null,
        last_name varchar2(20) not null,
        email varchar2(20) not null unique,
        primary key (first_name, last_name)
);
```

- Integrity constraints
  - **check** (P), where P is a predicate

```
create table students (
        first_name varchar2(20) not null,
        last_name varchar2(20) not null,
        email varchar2(20) not null unique,
        semester varchar2(20),
        primary key (first_name, last_name),
        check (semester in ('Fall', 'Winter', 'Spring', 'Summer'))
);
```

However, we **cannot** include a subquery in a check predicate:

```
check (email not in (select email from spam_addresses))
```

Therefore, use triggers to control such “dynamic” behavior!

- Referential integrity
  - Foreign keys

```
create table employee (
        department_id number(4,0)
                references departments
                on update cascade on delete cascade
);
```

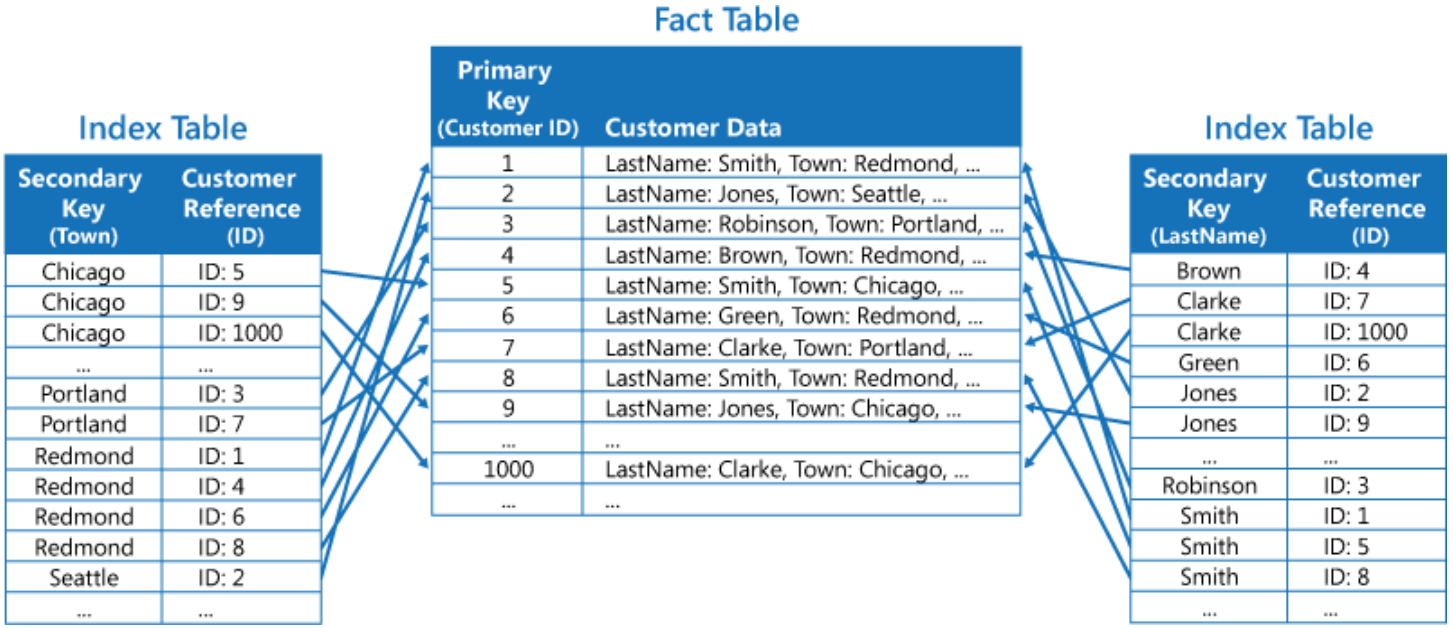
  - **CASCADE**: Delete or update the row from the parent table, and **automatically** delete or update the matching rows in the child table
  - **Referential actions**: cascade, set null, set default, no action

- Data types
  - **create type** construct in SQL creates user-defined type

```
CREATE OR REPLACE TYPE car AS OBJECT
(
        price number(8,0),
        model varchar2(20)
);
```

  - DB designer decision, data representation: relation vs object.
  - Most useful in object-oriented DBMS.

- Indices
  - An **index** is a schema object that contains an entry for each value that appears in the indexed column(s) of the and provides direct, fast access to rows



Syntax: **create index** *myindexfooname* **on** *table*(column);
Example: **create index** *jobID_index* **on** *employees*(job_id);

- Exercises

The following exercises, together with the ones from triggers are expected to be uploaded into blackboard:

- Create a sequence to control the PK generation of the employees.
- Create a function to return the full name for an employee whose id is provided as parameter.
- Create a procedure to increase 10% the salary of the manager whose subordinate id is provided as parameter.
- Create a table for projects (manager, duration (days), cost), and check that the cost must be < 500 per day nor bigger than the sum of the salaries of the department employees the manager works for
- Create a mechanism to check and prevent employees salary bigger than his manager (or King if they have no manager).

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