Advanced Databases - LAB Week 10

Indexes and Query Optimization

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In this lab we will experiment with query optimization.

Create the following tables:

1. Persons
2. Jobs
3. Jobs-persons

A list of persons is connected many-to-many to a list of jobs (the table jobs-person is the relation table).

```
drop table persons;
create table persons(
person_id integer,
person_name varchar(20),
person_surname varchar(20),
person_age integer not null,
person_wealth integer,
person_weight float
);

drop table jobs_person;
create table jobs_person(
jobs_id integer,
person_id integer,
start_date date,
end_date date);

drop table jobs;
create table jobs(
jobs_id integer,
job_description varchar(200),
salary integer
);
```

Execute the following sql 3 commands block **ONE BY ONE** to fill the tables with random data. The commands are also in the *populate.sql* (but execute them one by one!!)

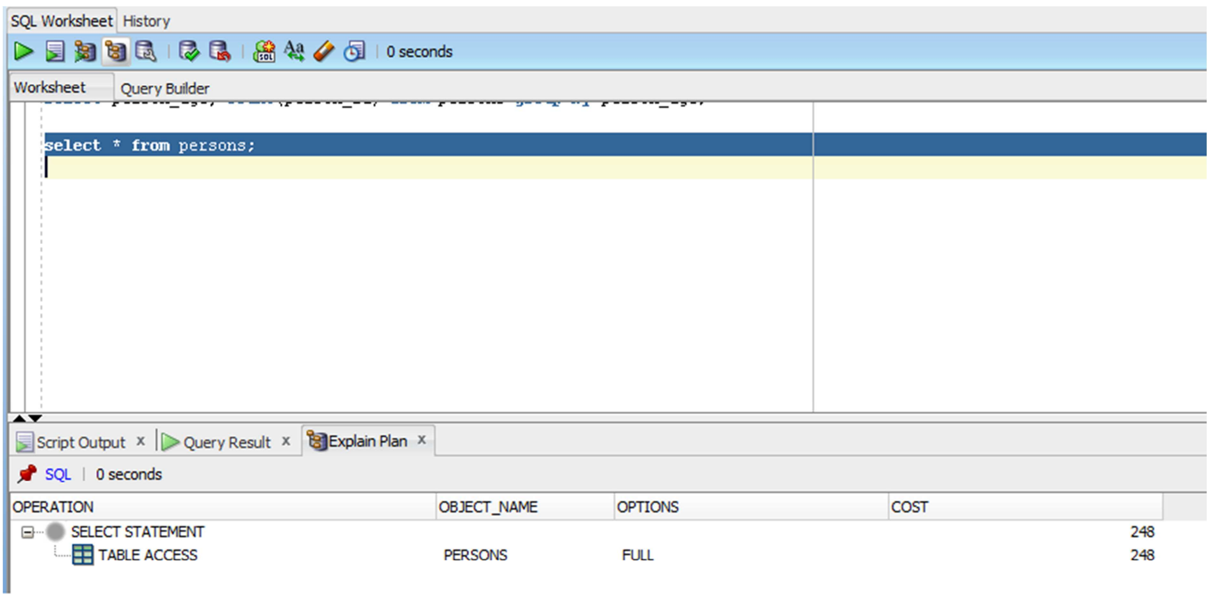
```
/* 1. populate table persons */
declare v_p_id number;
 v_p_name varchar2(20);
 v_p_surname varchar2(20);
 v_p_age integer;
 p_wealth float;
 p_weight float;
BEGIN
  FOR i IN 1..10000 LOOP
   select DBMS_RANDOM.STRING('a', 20) into v_p_name from dual;
   select DBMS_RANDOM.STRING('a', 20) into v_p_surname from dual;
   SELECT TRUNC(DBMS_RANDOM.VALUE(18, 100)) into v_p_age FROM DUAL;
   SELECT TRUNC(DBMS_RANDOM.VALUE(0,10000000)) into p_wealth FROM
DUAL;
   SELECT trunc(DBMS_RANDOM.VALUE(40, 120),2) into p_weight FROM
DUAL;
   insert into persons
values(i,v_p_name,v_p_surname,v_p_age,p_wealth,p_weight);
  END LOOP;
end;

/* 2. populate table jobs */
declare j_id number;
 j_description varchar2(100);
 j_salary float;
BEGIN
  FOR i IN 1..10000 LOOP
   select DBMS_RANDOM.STRING('a', 100) into j_description from dual;
   SELECT TRUNC(DBMS_RANDOM.VALUE(0,100000)) into j_salary FROM
DUAL;
   insert into jobs values(i,j_description,j_salary);
  END LOOP;
end;
```

```
/* 3. populate table jobs-persons */
declare j_id number;
 p_id integer;
 start_date date;
 end_date date;
 st integer;
 en integer;
BEGIN
  FOR i IN 1..10000 LOOP
   FOR j in 1..15 LOOP
   SELECT TRUNC(DBMS_RANDOM.VALUE(0,1000000)) into p_id FROM DUAL;
   SELECT TRUNC(DBMS_RANDOM.VALUE(0, 1000)) into st FROM DUAL;
   SELECT TRUNC(DBMS_RANDOM.VALUE(0, 2000)) into en FROM DUAL;
   SELECT TO_DATE(TRUNC(DBMS_RANDOM.VALUE(2452641,2452641+st)),'J')
into start_date FROM DUAL;
   SELECT
TO_DATE(TRUNC(DBMS_RANDOM.VALUE(2452641+st,2452641+st+en)),'J') into
end_date FROM DUAL;
   insert into jobs_person values(i,p_id,start_date,end_date);
    END LOOP;
  END LOOP;
end;
```

There are no keys or indexes defined. The person_id and the jobs_id are unique.

Using the oracle function Explain Plain (in SQL developer is the fourth icon from the left in the sql script window or press F10), we3 will analyse how ORACLE executes queries and the cost of each query - a number expressing how much resources and time your query takes.



Execute the following steps to analyse Oracle Index behaviour

1. Check that data are in the three tables. Have a look at the data
   There are no indexes or keys defined at this stage.
2. Execute the following query
   Query1.
   *select * from persons*
   And select the explain plain function.
   How much is the cost? ____
   Was it a full or index scan of the table? ______________________________
   Why? ____
   ____
3. Execute
   Query2 .
   *select * from persons where person_id>1000 and person_id<3000*
   Total cost? ____
   Full or index scan? Why? ____
   Any difference with the previous query? _________________________________

4. Define a primary key over *person_id* (using an ALTER TABLE … ADD CONSTRAINTS statement)
   Remember that this creates an index on *person_id* as well. Perform **Query1**

   Cost? ____
   Full or Index? ____
   Comment the results.
   ____
   ____
   ____

   Perform **Query2**

   Cost? ____
   Full or Index? ____
   Comment the results.
   ____
   ____
   ____

   Query1 requires a full scan since it gives back the full unfiltered table
   Query2 requires uses the index scan on the primary index *person_id* to filter the data. Note that range scan refers to accessing an interval of value (range) using an index (therefore oracle finds the starting point using the index and then the scan is sequential over an ordered list. It is therefore faster than full scan)

5. Perform the following

   Query3

   *select * from persons where person_id+5>1000 and person_id<3000*

   Check cost and type of scan

   Cost: ____

   Type of Scan ____

   Query4

   *select * from persons where person_id+5>1000 and person_id*2<3000*

   Check cost and type of scan

   Cost: ____

   Type of Scan ____

   Comment the behaviour of Query3 and Query4

   ____

   ____

   ____

   In **Query3** the index person_id is contained in the expression (person_id+5) so it cannot be used. However, the index can be used in the other where clause (person_id<20000), so Oracle performs an index access of the table to get the persons with person_id<20000 and at the same time it filters the condition (person_id+5>20000)

   In **Query4**, none of the index can be used so a full scan is performed

   Remember: if an index is used in an expression that affects the ordering of the data , it won't be used!

6. Execute

   Query5.

   select person_age, count(person_id) from persons group by person_age;

   Cost? ____

   Full or Index? ______________________________________

   Comment the results.

   ____

   ____

   ____

   The index on *person_id* does not help since we are grouping by person_age, so a full scan is required. Note the extra cost of grouping, executed by Oracle in a quick way by hashing the persons by age during the full scan

7. Define an index on person_age by executing:

   create index p_age on persons(person_age);

   Execute again **Query5**

   Cost? ____
   Full or Index? ____

   Even if an index is defined on person_age, the index is not used, why?
   The reason is the following (IMPORTANT!): if a column contains NULL values or it has been defined (with CREATE TABLE) without NOT NULL the index will be ineffective!

   1. Drop the table persons.

   2. Modify the create table statement adding "*not null*" to the field *person_age (*and add primary key to the *person_id* field so you do not need to alter the table afterwards).

   3. Populate the table with the sql command used before (page 2, block 1)
   4. Execute query5

   Cost? ____

   Full or Index? ____

   You should see an index-like access (hash, i.e. the type of index create on person_age – default) and the cost is now reduced

8. Joining two tables
   Perform the following query:

   select jobs.jobs_id,jobs.job_description, jobs.salary, jobs_person.person_id
   from jobs inner join jobs_person
   on jobs.jobs_id = jobs_person.jobs_id
   where jobs_person.jobs_id=34;

   Cost? ____
   Full or Index? ____
   Comment the results.
   ____
   ____
   ____

   Note how the query is divided into steps: first the full scans and the hash table used to speed-up the join.

Add indexes on jobs_id.jobs_id and jobs_person.jobs_id (note that one could be aprimary key and the other a foreign key).
Check again the results.
Did they improve or not? Why?
(you should see a reduction in cost due to the usage of indexes).

9. Reduce the cost of this query as much as you can:

   /* select person name, max salary and job description between 2003 and 2004 */
   select p.person_name, j.salary, j.job_description
   from persons p inner join jobs_person jp on p.person_id = jp.person_id
   inner join jobs j on jp.jobs_id=j.jobs_id
   where jp.start_date> '01-JAN-2003' and jp.end_date < '31-DEC-03';

   Use indexes, temporary tables, change the SQL code, split the join – but be sure the result is still equivalent!