

Assignment #8: Integrity Constraint, Transaction and Indexing

Release: Apr. 3, 2018

Due: 8:00 PM, Tuesday, Apr. 17, 2018

Goal

Gain familiarity with basic specification of integrity constraint, transaction and index structures. You will continue with the US forest database using SQL in the Oracle server.

Part I. Integrity Constraint and Transaction

Assume the following relational database schema that records information related to US forests.

- FOREST = (Forest_No, Name, Area, Acid_Level, MBR_XMin, MBR_XMax, MBR_YMin, MBR_YMax)
- STATE = (Name, Abbreviation, Area, Population)
- COVERAGE = (Forest_No, State, Percentage, Area)
- ROAD = (Road_No, Name, Length)
- INTERSECTION = (Forest_No, Road_No)
- SENSOR = (Sensor_Id, X, Y, Last_Charged, Energy, Maintainer)
- REPORT = (Sensor_Id, Temperature, Report_Time)
- WORKER = (SSN, Name, Age, Rank)

Answer the following questions [for a total of 50 points]:

1. [12 points total] Modify the `hw8-db.sql` to define evaluation modes of the syntactic integrity constraints. **Do not change table names or attribute names.**
 - Make all primary keys DEFERRABLE
 - Make all foreign key constraints INITIALLY DEFERRED DEFERRABLE
 - Make all unique constraints INITIALLY IMMEDIATE DEFERRABLE
2. [20 points total] Further modify the `hw8-db.sql` using ALTER TABLE statements to incorporate the following information/constraints in the US Forest Database. All the added constraints are INITIALLY IMMEDIATE NOT DEFERRABLE. **Do not change table names or attribute names.**
 - (a) In table SENSOR, the Energy should be not less than 0 and not greater than 10.
 - (b) In table FOREST, the Acid_Level should be not less than 0 and not greater than 1.
 - (c) In table FOREST, the MBR_XMin should be less than MBR_XMax and MBR_YMin should be less than MBR_YMax.
 - (d) In table COVERAGE, the Percentage should be not less than 0 and not greater than 1.

Use the modified `hw8-db.sql` to create and populate the tables.

3. [18 points total] Make necessary updates to the database to reflect each of the following changes. You need to use transaction appropriately when necessary to guarantee the atomicity of the updates.

- (a) PennDOT built a new road which crosses Allegheny National Forest. The road is named “century road”, which has `road_no` 5 and length 200.
- (b) The administration office has switched Mike and Jason’s duties. They are now maintaining sensors that have been maintained by the other in the past. You can assume that the worker’s name is unique.
- (c) The administration office have hired a new worker, Paula, who is age 22 and rank 1. Paula’s SSN is “5555555555”. She is assigned to maintain sensor 1 from now on (and John will not maintain sensor 1 any more).

Part II. Indexing

Answer the following questions [for a total of 50 points]:

4. [25 points total] Using the *class method* (not the textbook method), construct a B⁺-tree for the following set of key values:

2, 4, 5, 8, 11, 15, 18, 21, 30, 35, 10.

Assume that the tree is initially empty and values are added in the above order. Assume that the order of the tree is 4, that is, the number of pointers that will fit in one node is four.

5. [20 points total] Answer the following questions:
- (a) Show how the B⁺-tree you created in Question 4 changes when you delete key 5.
 - (b) Now show how the B⁺-tree you created after deleting key 5 changes when you delete key 30.
6. [15 points total] Consider a table $R(A, B)$ with 7525 rows, where B is an alternative key, i.e., a unique key but not the primary key. Suppose that each B⁺-tree index block can hold up to 9 keys and 10 pointers. What is the minimum number of levels required for a B⁺-tree index on attribute B ? Explain how you got your answer. The root counts as a level.

What to submit

You are required to submit four files under your “pitt_user_name” (e.g., pit101):

- `hw8-pitt_user_name-db.sql`: In this file, please submit the answers to question 1 and 2.
- `hw8-pitt_user_name-query.sql`: In this file, please submit the answers to question 3.
- `hw8-pitt_user_name-output.txt`: In this file, please submit the query results of the queries in the above two files. You could use the command “SPOOL log file name” in SQLPLUS to record your query results.
- `hw8-pitt_user_name.pdf`: In this file, please submit the answers to question 4, 5 and 6.

In addition to providing the answers, you are expected to:

- **include your name and pitt user name at the top of each file**, and
- identify the question number before each answer

All SQL files should be composed of **valid SQL statements** entirely.

How to submit your assignment

1. Submit your assignment (the 4 files described above) through the Web-base submission interface you have used to submit the previous assignments. **It is your responsibility to make sure the assignment was properly submitted..**
2. Submit your assignment by the due date (8:00 PM, Tuesday, Apr. 17, 2018). There is no late submission.

Academic Honesty

The work in this assignment is to be done *independently*. Discussions with other students on the assignment should be limited to understanding the statement of the problem. Cheating in any way, including giving your work to someone else will result in an F for the course and a report to the appropriate University authority.