B561 Assignment 4: Introduction to SQL
Due Date: Wednesday, November 7, 2001

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This assignment has two parts. Part I should be submitted as per the usual assignment instructions, via e-mail or hardcopy. Part II must be two working Oracle PL/SQL scripts (one for questions 4 and 5 and a separate one for question 6). Submit only one e-mail for Part II, with 2 separate files attached appropriately. B561 students should send this e-mail to Sufeng (szhu@cs.indiana.edu).

All questions for this assignment concern two relational tables: ZONES and ROADS. The SQL CREATE TABLE statements for these tables follow.

\[
\text{CREATE TABLE ZONES(ZONEID NUMBER, TYPE CHAR(1), PRIMARY KEY (ZONEID))}
\]

\[
\text{CREATE TABLE ROADS(ROADID NUMBER, SRCZONE NUMBER, ENDZONE NUMBER, DIST NUMBER, PRIMARY KEY (ROADID))}
\]

The table ZONES lists the zones associated with a particular city by their ID number (a positive integer) and their type (R = residential, C = commercial, I = industrial).

The table ROADS lists the roads connecting various zones and the distance (in miles) between the zones along that road. All roads are one-way, meaning that if there is a road from zone \(i\) to zone \(j\) (i.e. \(x, i, j, y \in \text{ROADS}\)), this says nothing about the existence of any roads from zone \(j\) to zone \(i\) (or lack thereof). Make no assumptions about the connectivity of zones other than the tuples provided in the ROADS relation.

Your solutions to parts I and II (below) must work on any database instance with tables ROADS and ZONES of the appropriate schemas.

To illustrate the queries below, consider the example database in figure 1.

Part I

1. Formulate each of the following queries in the safe domain relational calculus (sDRC). If your solution involves a complicated formula, break it up into sub-formulas and briefly describe (in English) what each signifies and how they are composed to obtain the final expression.

   (a) Find all zones of type I or R. On the sample database, this query yields the zones \(\{1, 2, 6, 7, 8, 9, 10\}\).
(b) Find those roads that go from a zone of type I to a zone of type R, or vice-versa. On the sample database, this query yields the roads \( \{3, 7, 9\} \).

(c) Find all zones that have no roads leaving them. On the sample database, this query yields the zones \( \{3, 4, 9\} \).

(d) Find all roads that do not connect zones of differing type. Thus, for example, a road \( x \) would qualify if it connects a residential zone to another residential zone. On the sample database, this query yields the roads \( \{1, 4, 5, 11, 12, 14, 15\} \).

(e) Find all zones from which a road goes to at least one of each type of zone. Thus, for example, a residential zone, \( z_r \) would qualify if there is at least one road going from it to another zone of type R, at least one road going from it to a zone of type I, and at least one road going from it to a zone of type C. On the sample database, this query yields the zones \( \{1, 7\} \).

2. The proof that the sDRC is equivalent to the RA was begun in class. Complete this proof.

3. Formulate the queries 1(a), 1(c), and 1(e) in the relational algebra (RA), using the translation method developed in the proof for question 2 to translate your DRC answers to question 1. Make sure you annotate your answers clearly in English, so that your grader can follow every step easily.
Part II

For each of the following questions your answer should not use looping of any kind or cursors. For question 4, your answer should not use aggregation. For questions 4 and 5, your answer should not use triggers.

Your answers to questions 4 and 5 should be contained in a single script file named “userid4a.sql” (e.g. “crood4a.sql”). This script file should run without errors when called from the Oracle SQL command line. Your queries must run on tables of the proper schema. Your script must not create, drop or modify the tables ZONES or ROADS. You may create temporary tables or views, but these tables and views must be dropped before the script terminates.

The output from your script should be easily readable. In particular, it should clearly delineate the output from each query. Your script should not display any unnecessary output. To prevent such output, place “set feed off;” as the first line of your script and “set feed on;” as the last line (once you have completed your final debugging).

You will not receive credit for a solution script that does not run. You will lose points for not following the above instructions correctly. If you have questions, make sure to ask Dirk, Cathy or Sufeng before submitting your final assignment.

4. Formulate the queries 1(a) through 1(e) in Oracle SQL. None of your answers should contain duplicates.

5. Formulate the following queries in Oracle SQL using aggregation.

   (a) Find the shortest roads connecting residential zones to commercial zones. On the sample database, this would yield roads \{6, 8, 10\} (each with a distance of 2).

   (b) Find all zones that have exactly three roads originating from them. On this sample database, this would yield zone \{1\}.

6. Write an Oracle PL/SQL trigger for maintaining the following integrity constraints upon insertions to the ROADS table:

   - Every zone can have at most three roads originating from it.
   - Duplicate ROADID values are not allowed in the ROADS table.

   Upon insertion of a tuple \(\langle\text{ROADID} : i, \text{SRCZONE} : s, \text{ENDZONE} : e, \text{DIST} : d\rangle\) in the ROADS table, your trigger should fire if the insertion of this tuple would cause a violation of either integrity constraint. Your trigger should output an error message and not allow the insertion to be carried out. Your trigger should fire once for each row of ROADS that is affected by the triggering statement.

Submit your trigger in a separate file named “userid4b.sql” (e.g. “crood4b.sql”). Your script should not create any temporary tables, views or procedures, only the trigger itself. Name the trigger RoadConstrain. Do not drop the trigger in your script.

You will not receive credit for a solution script that does not run. You will lose points for not following the above instructions correctly. If you have questions, make sure to ask Dirk, Cathy or Sufeng before you submit your final assignment.