Fall 2022 B561 Assignment 1

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1 Formulating queries in the safe Tuple Relational Calculus

20.a (Problem 2)

Find each pair (d,m) where d is the name of a department and m is a major of a student who is employed by that department and who earns a salary of at least 20000.

$\{(e.deptname, sm.major) \mid employedBy(e) \wedge studentmajor(m) \wedge e.sid = m.sid \wedge e.salary >= 20000\}$

20.b (Problem 3)

Find each pair (s1 , s2) of sids of different students who have the same (set of) friends who work for the CS department.

$\{(s_1.sid, s_2.sid) \mid student(s_1) \wedge student(s_2) \wedge s_1.sid \neq s_2.sid \wedge \forall s_3 \in student(hasFriend(s1_sid, s_3.sid) \rightarrow hasFriend(s2_sid, s_3.sid) \wedge employedBy(e_1) \wedge e_1.sid = s_3.sid \wedge e_1.deptname = \texttt{CS}) \wedge \forall s_4 \in student(hasFriend(s2_sid, s_4.sid) \rightarrow hasFriend(s1_sid, s_4.sid) \wedge employedBy(e_2) \wedge e_2.sid = s_4.sid \wedge e_2.deptname = \texttt{CS})\}$

20.c (Problem 4)

Find each major for which there exists a student with that major and who does not only have friends who also have that major.

$\{(sm_1.major \mid studentmajor(sm_1) \wedge \exists s \in student(sm_1.sid = s.sid \wedge \exists f \in hasFriend \exists sm_2 \in studentmajor(f.sid_1 = s.sid \wedge f.sid2 = sm_2.sid \wedge sm_1.major \neq sm_2.major)))\}$

2 Formulating constraints in the safe Tuple Relational Calculus and as boolean SQL and Python queries

22.a

Some major has fewer than 2 students with that major.

Explanation: For major fewer than two student we can consider majors with zero students or majors with exactly one students enrolled.

$\exists m(major(m) \wedge \nexists s_1(student(s_1) \wedge studentmajor(sm_1) \wedge sm_1.sid = s_1.sid \wedge sm_1.major = m.major \vee (\exists s_2(student(s_2) \wedge studentmajor(sm_2) \wedge sm_2.sid = s_2.sid \wedge sm_2.major = m.major \wedge \nexists s_3(student(s_3) \wedge studentmajor(sm_3) \wedge s_3.sid \neq s_2.sid \wedge sm_3.sid = s_3.sid \wedge sm_3.major = m.major)))))$

23.a

Each student who works for a department has a friend who also works for that department and who earns the same salary.

$\forall s(student(s) \wedge employedBy(e) \wedge (s.sid = e.sid \rightarrow$
$\exists s_1(student(s_1) \wedge employedBy(e_1) \wedge hasFriend(s.sid, s_1.sid) \wedge s1.sid \neq s.sid \wedge e1.salary = e.salary \wedge e1.deptname = e.deptname)))$

24.a

All students working in a same department share a major and earn the same salary

$\forall s_1(student(s_1) \wedge employedBy(e_1) \wedge studentmajor(sm_1) \wedge s_1.sid = e_1.sid \wedge s_1.sid = sm_1.sid \wedge \forall s_2((student(s_2) \wedge employedBy(e_2) \wedge studentmajor(sm_2) \wedge (s_1.sid \neq s_2.sid \wedge s_1.sid = e_1.sid \wedge s_1.sid = sm_2.sid \rightarrow sm_1.major = sm_2.major \wedge e_1.salary = e_2.salary))$