Definition. ***Relational algebra exercises***

1. *11 sIDs and surnames of all pairs of students who've taken a course (offering) together*

   $Pairs(sID1, sID2) := \Pi_{T1.sID,T2.sID}(\sigma_{T1.oID<T2.oID \wedge T1.sID!=T2.sID}(\rho_{T1}(Took) \times \rho_{T2}(Took)))$

   Note $T1.oID < T2.oID$ *instead of* $T1.oID = T2.oID$ *to remove pseudo-duplicates, i.e. same* sID *but different combination*

   $$\sigma_{Student.sID=Pairs.sID1}(Student \times Pairs)$$

2. *12 sID of students with the highest grade in csc343, in term 2009*

   $$Takers(sID, grade) := \Pi_{sID,grade}\sigma_{term=2009 \wedge dept=csc \wedge cNum=343}(Offering \bowtie Took)$$

   $$NotMax(sID) := \Pi_{T1.sID}\sigma_{T1.grade>T2.grade}(\rho_{T1}Takers \times \rho_{T2}Takers)$$

   Note, however, selecting by $T1.grade < T2.grade$ *does not imply we get maximum, instead we get the set of* $sIDs$ *that have some (¿=1) grade higher than itself*

   $$Max(sID) := \Pi_{sID}Takers - NotMax$$

   Idea is there are things that cant be done directly, like finding the maximum. So have to find the result indirectly. Also cartesian product of the same table (after renaming) conceptually achieves pairwise comparison.

3. *14 sID of students who have a grade of 100 at least twice*

   $AtLeastTwice := \Pi_{T1.sID}(\sigma_{T1.sID=T2.sID \wedge T2.oID!=T2.oID \wedge T1.grade=T2.grade=100}(\rho_{T1}(Took) \times \rho_{T2}(Took)$

4. *15 sID of students who have a grade of 100 exactly twice.*

   $$AtLeastThrice(sID) := \Pi_{sID}(\sigma_{C_1}(\rho_{T1}(Took) \times \rho_{T2}(Took) \times \rho_{T3}(Took)))$$

   where

   $C_1 = T1.sID = T2.sID = T3.sID \wedge T1.oID < T2.oID < T3.oID \wedge T1.grade = T2.grade = T3.grade$

   $$ExactlyTwice(sID) := AtLeastTwice - AtLeastThrice$$

5. *15 sID of students who have a grade of 100 at most twice.*

   $$AtMostTwice(sID) := \Pi_{sID}(Took) - AtLeastThrice$$

6. *16 Department and cNum of all courses that have been taught in every term when csc488 is taught*

   $$Requirement(dept, cNum, term) := (\Pi_{dept,cNum}CourseTerm) \times 488Terms$$

   $$Missing(dept, cNum, term) := Requirement - CourseTerm$$

   $$Answer(dept, cNum) := (\Pi_{dept,cNum}CourseTerm) - (\Pi_{dept,cNum}Missing)$$

   Division R/S. *The result consists of the restrictions of tuples in* R *to the attribute names unique to* R