Assignment 1: Sample Solutions

Note that there are multiple correct answers to all of these questions.

1. Report the user name of every student who has never worked with anyone, but has indeed submitted at least one file for at least one assignment.

Answer:

```
had\_groupmates(username) := \Pi_{M1.username}(\sigma_{M1.gID=M2.gID \land M1.username \neq M2.username}(\rho_{M1}Membership \times \rho_{M2}Membership))
no\_groupmates(username) := \Pi_{username}User - had\_groupmates
submitted\_some\_files(username) := \Pi_{username}Submission
Answer(username) := no\_groupmates \cap submitted\_some\_files
```

2. Find the graders who have marked every assignment. We will say that a grader has marked an assignment if they have given a grade on that assignment to at least one group, whether or not that grade has been released. Report the grader's userName.

Answer:

```
marker\_marked\_assignment(grader, aID) := \Pi_{username,aID}(Group \bowtie Grader \bowtie Result)
all\_grader\_assignment(grader, aID) := \Pi_{userName}Grader \times \Pi_{aID}Assignment
have\_not\_graded\_some\_assignment(grader) := \Pi_{grader}(all\_grader\_assignment - marker\_marked\_assignment)
\mathbf{Answer}(\mathbf{grader}) := \Pi_{userName}Grader - have\_not\_graded\_some\_assignment
```

3. Find all groups for A2 (*i.e.*, the assignment whose description is "A2") whose last submission was after the due date, but who submitted at least two different files (*i.e.*, files with two different names) before the due date. Report the group ID, the name of the first file they submitted, and when they submitted it. If there are ties for a group's first submit, report them all.

Answer:

```
a2\_submission(gID, when, due, fileName) := \\ \Pi_{gID, when, due, fileName} \sigma_{description = ``A2''}(Submission \bowtie Group \bowtie Assignment) \\ two\_different\_files(gID, due, when1, when2) := \Pi_{gID, S1.due, S1.when, S2.when} \\ (\sigma_{S1.gID = S2.gID \land S1.filename \neq S2.filename}(\rho_{S1}a2\_submission \times \rho_{S2}a2\_submission)) \\ two\_different\_files\_before\_deadline\_A2(gID) := \Pi_{qID}\sigma_{when1 < due \land when2 < due} two\_different\_files
```

```
a2\_not\_last\_submission(gID, when) := \Pi_{S2.qID,S2.when}
   (\sigma_{S1.gID=S2.gID \land S1.when} > S2.when(\rho_{S1}a2\_submission \times \rho_{S2}a2\_submission))
   a2\_last\_submission(gID, when) := \Pi_{aID, when}a2\_submission - a2\_not\_last\_submission
   a2\_last\_submission\_after\_due(gID) := \Pi_{aID}
   (\sigma_{A1.when>due}(\rho_{A1}a2\_last\_submission \bowtie A2\_submission))
   partial\_answer(qID) :=
          a2\_last\_submission\_a fter\_due \bowtie two\_different\_files\_before\_deadline\_a2
   a2\_not\_first\_submission(gID, when) := \Pi A2.gID, A2.when
   (\sigma_{A1.qID=A2.qID \land A1.when \lt A2.when}(\rho_{A1}a2\_Submission \times \rho_{A2}a2\_Submission))
   A2\_first\_submission(gID, when) := \Pi_{gID.when}a2\_submission - a2\_not\_first\_submission
   \mathbf{Answer} := \Pi_{S3.gID,S2.when,S1.filename}(\sigma_{S1.gID=S2.gID \land S3.gID=S2.gID}(\rho_{S3}partial\_answer)
   \bowtie \rho_{S1} Submission \bowtie \rho_{S2} a2\_first\_Submission))
4. Find pairs of students who worked in a group together, and without any other students, on each
   assignment in the database that allowed groups of size two or more. Report their user names, last
   names, and firstnames.
   Answer:
   WorkedTogether(u1, u2, qID) :=
         \Pi_{M1.userName,M2.userName,M1.gID}\sigma_{M1.userName \neq M2.userName \land M1.gID = M2.gID}
```

```
(\rho_{M1}Membership \times \rho_{M2}Membership)
WorkedTogetherWithAnother(u1, u2, gID) :=
      \Pi_{u1,u2,gID}\sigma_{userName\neq u1\land userName\neq u2}(WorkedTogether\bowtie Membership)
WorkedTogetherAlone(u1, u2, gID) :=
      WorkedTogether - WorkedTogetherWithAnother
WorkedTogetherAloneOn(u1, u2, aID) :=
      \Pi_{u1.u2.aID}WorkedTogetherAlone \bowtie Group
AllowedTwoPlus(aID) :=
      \Pi_{aID}\sigma_{groupMax>2} Assignment
ShouldHave(u1, u2, aID) :=
      (\Pi_{u1,u2}WorkedTogetherAloneOn) \times AllowedTwoPlus
MissedSome(u1, u2, aID) :=
      Should Have-Worked Together Alone On\\
MissedNone(u1, u2) :=
      (\Pi_{u1.u2} \dot{W}orkedTogetherAloneOn) - (\Pi_{u1.u2} MissedSome)
Answer(u1, last1, first1, u2, last2, first2) :=
      \prod_{u1,last1,first1,u2,last2,first2}
            (MissedNone \bowtie \rho_{S1(u1,last1,first1,type1)}User \bowtie \rho_{S1(u2,last2,first2,type2)}User)
```

5. Find any assignments where the highest mark given by one grader is less than the lowest mark given by another grader. In your result, include a row for each grader on each of these assignments. Report the assignment ID, the grader's userName, and their minimum and maximum grade.

Answer:

```
graders\_info(gID, aID, mark, marker) := \Pi_{qID, aID, mark, username}(Grader \bowtie Result \bowtie Total (Grader))
graders\_not\_highest\_mark(aID, marker, mark) :=
      \Pi_{G1.aID,G1.marker,G1.mark}
      (\sigma_{G1.marker=G2.marker \land G1.aID=G2.aID \land G1.mark < G2.mark}(\rho_{G1}Graders\_info \times \rho_{G2}Graders\_info))
qraders\_highest\_mark(aID, hmarker, hmark) :=
      \Pi_{aID.marker.mark} graders\_info - graders\_not\_highest\_mark
graders\_not\_lowest\_mark(aID, lmarker, lmark) :=
      \Pi_{G1.aID,G1.marker,G1.mark}
      (\sigma_{G1.marker=G2.marker \land G1.aID=G2.aID \land G1.mark \gt G2.mark}(\rho_{G1}Graders\_info \times \rho_{G2}Graders\_info))
graders\_lowest\_mark(aID, marker, mark) :=
      \Pi_{aID,marker,mark} graders\_info - graders\_not\_lowest\_mark
assignment\_marker\_lowest\_mark\_higher\_than\_highest\_mark(aID) :=
      \prod_{G1.aID}(\sigma_{G1.aID=G2.aID} \land G1.marker \neq G2.marker \land G1.mark > G2.mark)
      (\rho_{G1}graders\_lowest\_mark \times \rho_{G2}graders\_highest\_mark))
Answer(aID, marker, min_mark, max_mark) :=
      \Pi_{L1.aID,L2.hmarker,L3.lmark,L2.hmark}
      \sigma_{L2.hmarker=L3.lmarker}
      (\rho_{L1}assignment\_marker\_lowest\_mark\_higher\_than\_highest\_mark \bowtie
      \rho_{L2} graders\_highest\_mark \bowtie \rho_{L3} graders\_lowest\_mark)
```

6. Find all students who have worked in a group with at least one other person, but have never worked with the same person twice. Report their userName.

Answer:

```
partners(gID, member1, member2) := \\ \Pi_{M1.gID,M1.username,M2.username} \\ (\sigma_{M1.gID=M2.gID \land M1.username \neq M2.username}(\rho_{M1}Membership \times \rho_{M2}Membership)) \\ HadAPartner(username) := \Pi_{member1}partners \\ RepeatedAPartner(username) := \\ \Pi_{P1.member1} \\ \sigma_{P1.member1=P2.member1 \land P1.member2=P2.member2 \land P1.gID \neq P2.gID}(\rho_{P1}partners \bowtie \rho_{P2}partners) \\ \mathbf{Answer(username)} := HadAPartner - RepeatedAPartner
```

7. Find all students who meet these two requirements: (a) their groups (whether they were working alone or with others) handed in every required file, and did so on time, for all assignments, and (b) their grades never went down from one assignment to another with a later due date. Report their userName. Note: If an assignment has no required files, it is true of any group that they handed in every required file.

Answer:

```
all\_required\_files(gID, aID, filename) := \prod_{gID,aID,filename}(Required\bowtie Group)
not\_submitted\_all(gID, aID) := \prod_{gID,aID} (all\_required\_files - \prod_{gID,aID,filename}(\sigma_{due})_{when}(Submission\bowtie Group\bowtie Assignment)))
submitted\_all(gID, aID) := \prod_{gID,aID}Group - not\_submitted\_all
group\_assignment\_mark(gID, aID, mark, due) := \prod_{gID,aID,mark,due}(submitted\_all\bowtie Result\bowtie Assignment)
user\_assignment\_mark(username, aID, mark, due) := \prod_{username,aID,mark,due}(group\_assignment\_mark\bowtie Membership)
decreasing\_mark(username) := \prod_{username}(\sigma_{U1.mark} > U2.mark \land U1.due < U2.due \land U1.username = U2.username}(\rho_{U1}user\_assignment\_mark \lor \rho_{U2}user\_assignment\_mark))
Answer(username) := \prod_{username}User - decreasing\_mark
```

8. Find all assignments that have one or more groups with no grade or with a grade that has not been released. Report the assignment ID and description.

Answer:

```
unmarked\_groups(gID) := \Pi_{gID}Group - \Pi_{gID}Result groups\_with\_unreleased\_marks(gID) := \Pi_{gID}\sigma_{\neg released}Result unmarked\_or\_unreleased(gID) := unmarked\_groups \cup groups\_with\_unreleased\_marks \mathbf{Answer}(\mathbf{aID}, \mathbf{description}) := \Pi_{aID,description}(unmarked\_or\_unreleased \bowtie Group \bowtie Assignment)
```

9. Assignments may have required files, but students can also hand in other files that are not required. Find all groups that never handed in a file that was not required. Report the group ID.

Answer:

$$required_files(gID, aID, filename) := \Pi_{aID,aID,filename}(Required \bowtie Group)$$

```
submitted\_files(gID, aID, filename) := \Pi_{gID,aID,filename}(Group \bowtie Submission)
submitted\_not\_required\_files := \Pi_{gID,aID,filename}(submitted\_files - required\_files)
\mathbf{Answer}(\mathbf{gID}, \mathbf{aID}) := \Pi_{gID,aID}(submitted\_files - submitted\_not\_required\_files)
```

Part 2: Additional Integrity Constraints

Express the following integrity constraints with the notation $R = \emptyset$, where R is an expression of relational algebra. You are welcome to define intermediate results with assignment and then use them in an integrity constraint.

1. No grades can be released for an assignment unless every group has been given a grade on that assignment (whether or not it has been released).

Answer:

```
SomeGradeReleasedOn(aID) := \\ \Pi_{aID}(\sigma_{released="true"}(Result \bowtie Group))
GroupUngradedOn(gID, aID) := \\ \Pi_{gID,aID}Group - \Pi_{gID,aID}(Group \bowtie Result)
GroupUngradedOn \bowtie SomeGradeReleasedOn = \emptyset
```

2. A TA can't give a grade to any groups on an assignment unless they have completed marking (*i.e.*, they have given a grade, whether or not it has been released) for every group they were assigned to grade on every assignment with an earlier due date.

Answer:

```
released\_marks\_marker(marker, gID, aID, due, released) := \\ \Pi_{userName,gID,aID,due,released}(Grader \bowtie Result \bowtie Group \bowtie Assignment) \\ \sigma_{R1.marker=R2.marker \land R1.due < R2.due \land R1.released="false" \land R2.released="true"} \\ (\rho_{R1}released\_marks\_marker \times \rho_{R2}released\_marks\_marker) = \emptyset
```

3. A TA can't be assigned to grade a group of size two or more unless he or she has already given a grade (that has been released) to at least 3 students (each working in a group of size 1) on an assignment with an earlier due date.

Answer:

We will supply this solution later.