CS 348 - Homework 3

Relational Algebra

Spring 2024

Write your answers for questions 1 to 9 in this latex file. Use a latex editor, such as overleaf to edit and compile your latex to a PDF file. Submit your latex file to Brightspace. Submit your PDF file to Gradescope. Question 1 includes all relational algebra operators and symbols that you can use in your answers.

1. **Answer:**
   $\sigma_{trip.id<=7450}(trip)$

2. **Answer:**
   $\sigma_{trip.id<=7450}(trip)$

3. **Answer:**
   $\pi_{origin\_station,start\_d,duration,destination\_station}(trips \bowtie (\rho_{name \to origin\_station}(\rho_{id \to start\_station\_id}(station))) \bowtie$

$(\rho_{name \to destination\_station}(\rho_{id \to end\_station\_id}(station))))$

4. **Answer:**
$\pi_{bike_id}((\sigma_{station.name="MountainViewCaltrainStation"}(trip \bowtie_{trip.id=station.end\_station\_id} station)) \cap (\sigma_{station.name="EvelynParkandRide"}(trip \bowtie_{trip.id=station.end\_station\_id} station)))$

5. **Answer:**
$\pi_{station.id,station.name,trip.id,trip.duration}(station \rtimes\!\bowtie_{station.id=trip.end_station_id} trip)$

6. **Answer:**
$\pi_{station.id,station.name}(station) - \pi_{station.id,station.name}(station \bowtie_{station.id=trip.start\_station\_id} trip)$

7. **Answer:**
$\pi_{s1.name,s1.id,s2.name,s2.id}(\rho_{s1}(station) \times \rho_{s2}(station)) - \pi_{s1.name,s1.id,s2.name,s2.id}((\rho_{s1}(station) \times \rho_{s2}(station)) \bowtie_{s1.id=start\_station\_id \text{ and } s2.id=end\_station\_id} trip)$

8. **Answer:**
$\pi_{station\_status.station\_id,station.name,station\_status.time}(\sigma_{station\_status.docks\_available=station.dock\_count}(station\_status \bowtie$
$station))$

9. **Answer:**
$trips - \pi_{t1}(\rho_{t1}(trips) \bowtie_{t2.duration>t1.duration} \rho_{t2}(trips)))$

10. **Answer:**
b. The resulting number of tuples will always be n. Since the union operator does not

include duplicates, and $\pi_A S$ is a subset of $\pi_A R$, there will always be exactly n tuples.

c. Minimum: 0. The minimum case occurs when n = m and B = C. Set differences cannot be calculated on sets that have different attributes, so B must be the same attributes as C and must be associated with the same keys.
Maximum: n. If there exists no element in S where the attribute associated with the key in S is the same as the attribute associated with the key in R, then nothing will be removed from R.

d. Minimum: 0. The minimum case occurs when there is one element in S and one element in R, both with the same key. Since there is no S.A strictly greater than any given R.A, nothing will be joined.
Maximum: n * $\sum_{i=0}^{m-1} i$. The maximum case occurs when every key in R appears in S. As such, for each key in A, we will join every key in S greater than the key in A, resulting in the given sum.

e. Minimum: 1. The minimum case occurs when R and S have one element, and so only one combination of keys exists.
Maximum: m^2. The maximum case occurs when n = m.