

MIDTERM EXAM - 601.415/615 - Databases

Name:

Date: Thursday, November 5, 2020, 3-4:30 PM

The total number of points in this exam is 76 for 601.415/615 students. If you work at approximately 1 minute per point, you should finish on time. All of the programming problems are no worth 6 points (for 6 minutes on average), with 14+ minutes to spare at the end for review and extra time.

Relational Algebra Shortcuts:

\bowtie -> JOIN	Π -> PI
\ltimes -> RIGHT JOIN	ρ -> RHO
\Join -> LEFT JOIN	σ -> SIGMA
\cap -> INTERSECT	\cup -> UNION
$-$ -> MINUS or just -	\wedge -> AND or just ^

Relational Calculus Shortcuts:

\exists -> EXISTS	\nexists -> NEXISTS
\neg -> NOT	\in -> IN

QBE Shortcut: \neg -> NOT

Questions 1-3 - Relational Algebra (18 points)

1. (6 points) List the name, age and EID of employees who are certified to fly *all* aircraft (AID) in the database that have a cruising range greater than 3000 miles.
Answer in RELATIONAL ALGEBRA.

Relational Algebra Shortcuts:

- i. \bowtie -> JOIN, \ltimes -> RIGHT JOIN, \ltimes -> LEFT JOIN, \cap -> INTERSECT,
- -> MINUS, π -> PI, ρ -> RHO, σ -> SIGMA, \cup -> UNION

Answer:

$\pi_{(EName, Age, EID)} (EMPLOYEES \text{ JOIN } (CERTIFIED_TO_FLY) \text{ DIV } (\pi_{(AID)} \text{ SIGMA}_{(Cruising_Range > 300)} (AIRCRAFT)))$

2. (6 points) List the names and age of all pilots who have *never* had a maintenance issue on a flight where they were the pilot. Answer in RELATIONAL ALGEBRA.

Relational Algebra Shortcuts:

- i. \bowtie -> JOIN, \bowtie -> RIGHT JOIN, \bowtie -> LEFT JOIN, \cap -> INTERSECT,
- -> MINUS, π -> PI, ρ -> RHO, σ -> SIGMA, \cup -> UNION

Answer:

(2)PI_(ENAME, AGE) ((SIGMA_EID(CERTIFIED_TO_FLY) - SIGMA_EID(CERTIFIED_TO_FLY JOIN
MAINTANCE_ISSUE)) JOIN EMPLOYEES)

3. (6 points) For all employees, list pairs of the Employee Name and the aircraft (Aircraft name and AID) that they are *not* certified to fly. If John Smith is not certified to fly 93 aircraft in the database then there should be 93 rows for John Smith in the answer (with the employee name and aircraft name and AID listed for each row). Every employee should be included, even if they are not certified to fly any aircraft, but your table will omit employees who are certified to fly all aircraft. You don't need to use an outer join. Answer in RELATIONAL ALGEBRA.

Relational Algebra Shortcuts:

- i. \bowtie -> JOIN, \bowtie_{right} -> RIGHT JOIN, \bowtie_{left} -> LEFT JOIN, \cap -> INTERSECT,
- -> MINUS, π -> PI, ρ -> RHO, σ -> SIGMA, \cup -> UNION

Answer:

(3) $\pi_{\text{ENAME, AID, ANAME}}(((\pi_{\text{EID, AID}}(\text{EMPLOYEES} \times \text{AIRCRAFT}) - \text{CERTIFIED_TO_FLY}) \text{ JOIN EMPLOYEES JOIN AIRCRAFT})$

Question 4 - Tuple Relational Calculus (6 points)

4. (6 points) list all directed city pairs (e.g. BWI,DEN) and their distance where there is a direct flight between those cities listed in the database under 2000 miles and there is at least 1 flight listed that on that route that has flown using a Boeing 787.

Answer in the TUPLE RELATIONAL CALCULUS.

Relational Calculus Shortcuts:

- i. \exists -> EXISTS, \nexists -> NEXISTS, \neg -> NOT, \in -> IN, \wedge -> AND or \wedge , \vee -> OR or \vee

Answer:

```
(4){T |  
  EXISTS F IN FLIGHTS{  
    EXISTS FD IN FLIGHTDETAILS{  
      EXISTS A IN AIRCRAFT
```

```
    F.Distance < 2000 AND  
    F.FLNO = FD.FNO AND  
    FD.PlaneAID = A.AID AND  
    A.AName = "Boeing 787" AND
```

```
    T.CITY1 = F.FromCode  
    T.CITY2 = F.ToCode  
    T.DISTANCE = F.Distance}}}
```

Question 5 - SQL (24 points)

5a. (6 points) How many total miles has Jason Eisner flown as a pilot of an Embraer 135 flight in the database? Answer in SQL.

Answer:

```
SELECT SUM(F.Distance)
```

```
FROM EMPLOYEES AS E, FLIGHTDETAILS AS FD, AIRCRAFT AS A, FLIGHT AS F
```

```
WHERE E.ENAME = "Jason Eisner" AND E.EID = FD.PilotEID AND FD.PlaneAID = A.AID AND
```

```
A.AName = "Embraer 125" AND F.FLNO = FD.FNO;
```

5b. (6 points) Which type of aircraft has had the most total unresolved maintenance issues in the entire database (e.g. Embraer 135, where Resolved=False)?
ANSWER IN SQL.

Answer:

```
SELECT M.AID, M.AName
FROM
(SELECT COUNT(MI.AID) AS CNT, A.AID, A.AName
FROM MAINTENANCE_ISSUE AS MI, AIRCRAFT AS A
WHERE MI.PlaneAID = A.AID AND MI.Resolved = "False"
GROUP BY A.AID) AS M
HAVING M.CNT =
(SELECT MAX(M.CNT)
FROM
(SELECT COUNT(MI.AID) AS CNT
FROM MAINTENANCE_ISSUE AS MI, AIRCRAFT AS A
WHERE MI.PlaneAID = A.AID AND MI.Resolved = "False"
GROUP BY A.AID) AS M)
```

5c. (6 points) Which pilot has flown the most total miles on a flight that has either started or ended in Maryland? List their name, age and total miles.

ANSWER IN SQL.

Answer:

```
SELECT E.ENAME, E.AGE, M.TotalDist
(SELECT SUM(F.Distance) AS TotalDist, FD.PilotEID
FROM FLIGHTS AS F, CODE_NAMES AS CN, FLIGHTDETAILS AS FD
WHERE ((F.FromCode = CN.Code AND CN.StateName = "Maryland") OR (F.ToCode =
CN.Code and CN.StateName = "Maryland"))) AND FD.FNO = F.FLNO
GROUP BY FD.PilotEID) AS M,
EMPLOYEES AS E
WHERE E.EID = M.PilotEID
HAVING M.TotalDist =
(SELECT MAX(M.TotalDist)
FROM
(SELECT SUM(F.Distance) AS TotalDist
FROM FLIGHTS AS F, CODE_NAMES AS CN, FLIGHTDETAILS AS FD
WHERE ((F.FromCode = CN.Code AND CN.StateName = "Maryland") OR (F.ToCode =
CN.Code and CN.StateName = "Maryland"))) AND FD.FNO = F.FLNO
GROUP BY FD.PilotEID) AS M)
```


5d. (6 points) For all city pairs in a given direction (e.g. from BWI to DEN) and more than 5000 miles, list the lowest direct price listed in the database for that route (you don't need to include connections). Answer in SQL

Answer:

```
SELECT DISTINCT CP.Code1, CP. Code2, MIN(F.Price)
FROM (CODE_NAMES AS CN1 INNER JOIN CODE_NAMES AS CN2) AS CP JOIN FLIGHTS AS F
WHERE F.Distance > 5000
GROUP BY (CP.Code1, CP.Code2)
```

Question 6 - QBE (18 points)

Express the following queries in QBE. To simplify your work, table shells have been provided. Just fill in the appropriate cells with variables/values.

6a. (6 points) Find all 2-flight connections between BWI and SFO that have a total combined flight distance under 3200 miles. List the first flight number, 2nd flight number, name of connecting city and total distance in your answer.

QBE Shortcut: \neg -> NOT

FLIGHTS	<u>FLNO</u>	FromCode	ToCode	DepTime	ArrTime	Price	Distance
	P._x P._y	BWI _a	_a SFO				_b _c

CODE_NAMES	Code	CityName	StateName
	_a	P._z	

EMPLOYEES	EID	ENAME	Age	Salary

AIRCRAFT	AID	ANAME	CruisingRange

CERTIFIED_TO_FLY	EID	AID

RESULT	FirstFlightNumber	SecondFlightNumber	Name of connect city	Total distance	
	_x	_y	_z	P.(_b+_c)	

Conditions
_b+_c < 3200

6b. (6 points) A customer wants to fly from BWI to SFO on 2 or 3 connecting flights (e.g. a flight from BWI to ORD, another from ORD to DEN and another flight from DEN to SFO). List all 2 or 3-flight options from BWI to SFO including their departure time from BWI, their arrival time in SFO and both the airport codes and name of the first city where the flight connects. ANSWER IN QBE

QBE Shortcut: \neg -> NOT

FLIGHTS	<u>FLNO</u>	FromCode	ToCode	DepTime	ArrTime	Price	Distance
		BWI _a BWI _b _c	P._a SFO P._b _c SFO	P._x1 P._x2	P._y1 P._y2		

CODE_NAMES	Code	CityName	StateName
	_a	P._z1	
	_b	P._z2	

EMPLOYEES	EID	EName	Age	Salary

AIRCRAFT	AID	AName	CruisingRange

CERTIFIED_TO_FLY	EID	AID

RESULT					

Conditions

6c. (6 points) List the flight number of all nonstop flights from a city in Maryland to a city in California which could possibly be piloted by an certified employee who is less than 23 years old or makes less than 20,000 a year.

QBE Shortcut: \neg -> NOT

FLIGHTS	<u>FLNO</u>	FromCode	ToCode	DepTime	ArrTime	Price	Distance
	P._c	_a	_b				

CODE_NAMES	Code	CityName	StateName
	_a		Maryland
	_b		California

EMPLOYEES	EID	EName	Age	Salary
	_d		<23	< 20000 / 52

AIRCRAFT	AID	AName	CruisingRange

CERTIFIED_TO_FLY	EID	AID

FLIGHTDETAILS	FNO	M	D	Y	PilotEID	PlaneAID
	_c				_d	

RESULT					

Conditions

Question 7 - Functional Dependencies (10 points)

(5 points) Consider the relation $r(A,B,C,D,E)$ with given functional dependencies:

$AB \rightarrow C$

$B \rightarrow D$

$CD \rightarrow E$

$D \rightarrow C$

	Derivable from FD's above (type YES/NO) You don't need to give a justification or derivation.
$B \rightarrow C ?$	YES
$A \rightarrow C ?$	NO
$AB \rightarrow A ?$	YES
$ABD \rightarrow E ?$	YES
$ABC \rightarrow D ?$	YES
$AB \rightarrow E ?$	YES
$AC \rightarrow E ?$	NO
$A \rightarrow E ?$	NO
$B \rightarrow E ?$	YES
$C \rightarrow E ?$	NO

7b (5 points) List at least one candidate key for r (informally show your work):

AB is candidate key

$AB \rightarrow A$

$AB \rightarrow B$

$AB \rightarrow C : B \rightarrow D, D \rightarrow C$

$AB \rightarrow D : B \rightarrow D$

$AB \rightarrow E : AB \rightarrow C, AB \rightarrow D, CD \rightarrow E$

So AB is a superkey

A^+ is not a closure, A cannot get B

B^+ is not a closure, B cannot get A

Therefore, AB is candidate key