

Exercise 1

(3+4=7 Marks)

- a) Given the following definition of a relation. What are its possible superkeys:

```
CREATE TABLE Foo (
  X INT,
  Y INT,
  Z INT not null,
  primary key (X, Y),
  unique (Z)
);
```

- b) Given the following ERDs where the departure and arrival times are once represented as attributes of the relationships ‘from’ and ‘to’, and once represented as attributes of the Flight.

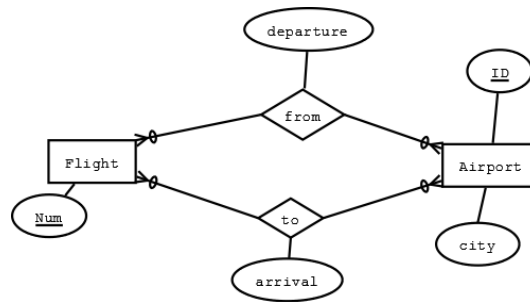


Figure 1: Option 1.

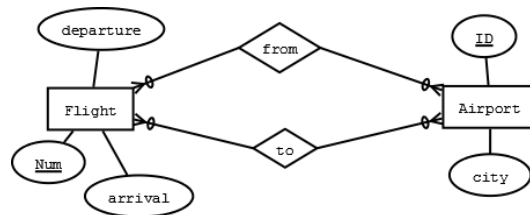


Figure 2: Option 2.

Are the 2 ERDs equivalent? Justify your answer.

1. What is the corresponding set of functional dependencies.

2. Normalize the previous relations up to BCNF. Show your workout.

Given the following schema for employees, departments and projects in different companies. Use it for Exercises 3, 4 and 5

```
Company(name, specilization)
Department(deptName, location, company, budget)
-----
Department.company REFERENCES company
Employee(empId, name, assigneddepartment, manager, gender, baselocation, salary)
-----
Employee.assigneddepartment REFERENCES Department
Employee.manager REFERENCES Employee
Project(projectname, company, baselocation)
-----
Project.company REFERENCES Company
WorksIn(employee, project, location, percentage)
-----
WorksIn.employee REFERENCES Employee
WorksIn.dept REFERENCES Project
```


- d) Consider the following SQL queries Q1, Q2, and Q3. Indicate which queries are equivalent. Justify your answer.

Q1:

```
Select assigneddepartment
from Employee
where gender = 'F'
group by assigneddepartment
having count(*) < 5
```

Q2:

```
Select distinct x.assigneddepartment
from Employee x
where (select count(*)
from Employee y
where x.assigneddepartment = y.assigneddepartment AND y.gender='F') < 5
```

Q3:

```
Select distinct x.assigneddepartment
from Employee x
where x.gender = 'F' AND
(select count(*)
from Employee y
where x.assigneddepartment = y.assigneddepartment AND y.gender= 'F') < 5
```

- e) Write a stored procedure called **Merge** that merges two departments of one company into one department. This procedure should have two input parameters: dept1, dept2. All employees from the first department should be re-allocated to the second department. The head of the merged department depends on which department was larger before merging. If the first department was larger then the head of that department becomes the head of the merged department, otherwise the head of the second department becomes the head of the merged department.

Exercise 6

(3+3+3+3=12 Marks)

Suppose we have relation $R(A, B, C, D, E, F, G)$ with functional dependencies

$$A \rightarrow E, AB \rightarrow D, ABC \rightarrow F, ABC \rightarrow G, CD \rightarrow G, E \rightarrow F, G \rightarrow B$$

a) What are the candidate keys of R ? Show your workout.

b) Is the relation in second normal form? If not, normalize it to the second normal form.

c) Is the resulting relation in third normal form? If not, normalize it to the third normal form.

d) Is the resulting relation in BCNF? If not, normalize it to the BCNF.

Exercise 7

(6 Marks)

Suppose we have relation $R(A, B, C, D, E, F, G)$ and functional dependencies

$$AB \rightarrow C, B \rightarrow D, CD \rightarrow E, CE \rightarrow GH$$

. Prove or disprove the following functional dependency:

$$AB \rightarrow G$$

If you decide to prove the functional dependency use the following Armstrong inference rules:

Reflexivity : if $Y \subseteq X$ then $X \rightarrow Y$

Augmentation : if $X \rightarrow Y$ then $XZ \rightarrow YZ$

Transitivity : if $X \rightarrow Y$ and $Y \rightarrow Z$ then $X \rightarrow Z$

If you decide to disprove give a counter example.

Exercise 8

(4+4=8 Marks)

A set X of attributes is closed if $X^+ = X$.

- a) Consider a relation $R(A, B, C, D)$. Give a set of functional dependencies that satisfies the following conditions: the closed sets are AB , CD , and the candidate keys are AD and BC .

- b) For each of the statements below, indicate if they are true or false. X and Y denote sets of attributes. Justify your answers.

1. If X , Y are closed then $X \cup Y$ is closed.
2. If X , Y are closed then $X \cap Y$ is closed

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