Exercise 1: Consider the following schema: the schema describes a database containing information about parts supplied by suppliers. The underlined attributes denote the primary keys of the relations. Domain of each field is listed after the field name. The Catalog relation lists the prices charged for parts by Suppliers.

Suppliers(sid: integer, sname: string, address: string)
Parts(pid: integer, pname: string, color: string)
Catalog(sid: integer, pid: integer, cost: real)

Write the following queries in SQL.

Q1. Find the names of suppliers who supply some red part.

A1.
```
SELECT S.sname
FROM Suppliers S, Parts P, Catalog C
WHERE P.color='red' AND C.pid=P.pid AND C.sid=S.sid
```

Q2. Find the sids of suppliers who supply some red or green part.

A2.
```
SELECT C.sid
FROM Catalog C, Parts P
WHERE (P.color = 'red' OR P.color = 'green') AND P.pid = C.pid
```

Q3. Find the sids of suppliers who supply some red part or are at 221 Packer Street.

A3.
```
SELECT S.sid
FROM Suppliers S
WHERE S.address = '221 Packer street'
        OR S.sid IN (   SELECT C.sid
                        FROM Parts P, Catalog C
                        WHERE P.color='red' AND P.pid = C.pid )
```

Q4. Find the sids of suppliers who supply some red part and some green part.

A4.
```
SELECT C.sid
FROM Parts P, Catalog C
WHERE P.color = 'red' AND P.pid = C.pid
        AND EXISTS ( SELECT P2.pid
                        FROM Parts P2, Catalog C2
                        WHERE P2.color = 'green' AND C2.sid = C.sid
                                AND P2.pid = C2.pid )
```

Q5. Find the sids of suppliers who supply every part.

A5.
```
SELECT C.sid
FROM Catalog C
WHERE NOT EXISTS (    SELECT P.pid
                      FROM Parts P
                      WHERE NOT EXISTS (    SELECT C1.sid
                                            FROM Catalog C1
                                            WHERE C1.sid = C.sid
                                            AND C1.pid = P.pid))
```

Q6. Find the sids of suppliers who supply every red part.

A6.
```
SELECT C.sid
FROM Catalog C
WHERE NOT EXISTS (    SELECT P.pid
                      FROM Parts P
                      WHERE P.color = 'red'
                      AND (NOT EXISTS (  SELECT C1.sid
                                         FROM Catalog C1
                                         WHERE C1.sid = C.sid
                                         AND C1.pid = P.pid)))
```

Q7. Find the sids of suppliers who supply every red or green part.

A7.
```
SELECT C.sid
FROM Catalog C
WHERE NOT EXISTS (    SELECT P.pid
                      FROM Parts P
                      WHERE (P.color = 'red' OR P.color = 'green')
                      AND (NOT EXISTS (  SELECT C1.sid
                                         FROM Catalog C1
                                         WHERE C1.sid = C.sid
                                         AND C1.pid = P.pid)))
```

Q8. Find pairs of sids such that the supplier with the first sid charges more for some part than the supplier with the second sid.

A8.
```
SELECT C1.sid, C2.sid
FROM Catalog C1, Catalog C2
WHERE C1.pid = C2.pid
        AND C1.cost > C2.cost
```

Q9. Find the pids of parts supplied by at least two different suppliers.

A9.
```
SELECT C.pid
FROM Catalog C
WHERE EXISTS (  SELECT C1.sid
                FROM Catalog C1
                WHERE C1.pid = C.pid AND C1.sid != C.sid )
```

Exercise 2: The following relations keep track of airline flight information:

Flights(flno: integer, from: string, to: string, distance: integer, departs: time, arrives: time, price: real)

Aircraft(aid: integer, aname: string, cruisingrange: integer)

Certified(eid: integer, aid: integer)

Employees(eid: integer, ename: string, salary: integer)

Note that the Employees relation describes pilots and other kinds of employees as well; every pilot is certified for some aircraft, and only pilots are certified to fly. Write each of the following queries in SQL.

Q1. Find the names of aircraft such that all pilots certified to operate them have salaries more than $80,000.

A1.
```
SELECT DISTINCT A.aname
FROM Aircraft A
WHERE A.Aid IN (SELECT C.aid
                FROM Certified C, Employees E
                WHERE C.eid = E.eid AND
                NOT EXISTS ( SELECT *
                             FROM Employees E1
                             WHERE E1.eid = E.eid AND E1.salary < 80000 ))
```

Q2. For each pilot who is certified for more than three aircraft, find the eid and the maximum *cruisingrange* of the aircraft for which she or he is certified.

A2.
```
SELECT C.eid, MAX (A.cruisingrange)
FROM Certified C, Aircraft A
WHERE C.aid = A.aid
GROUP BY C.eid
```

```
HAVING COUNT (*) > 3
```

Q3. Find the names of pilots whose salary is less than the price of the cheapest route from Los Angeles to Honolulu.

A3.

```
SELECT DISTINCT E.ename
FROM Employees E
WHERE E.salary < ( SELECT MIN (F.price)
                   FROM Flights F
                   WHERE F.from = 'Los Angeles' AND F.to = 'Honolulu' )
```

Q4. For all aircraft with *cruisingrange* over 1000 miles, find the name of the aircraft and the average salary of all pilots certified for this aircraft.

A4.

Observe that aid is the key for Aircraft, but the question asks for aircraft names; we deal with this complication by using an intermediate relation Temp:

```
SELECT Temp.name, Temp.AvgSalary
FROM ( SELECT A.aid, A.aname AS name, AVG (E.salary) AS AvgSalary
       FROM Aircraft A, Certified C, Employees E
       WHERE A.aid = C.aid AND C.eid = E.eid AND A.cruisingrange > 1000
       GROUP BY A.aid, A.aname ) AS Temp
```

Q5. Find the names of pilots certified for some Boeing aircraft.

A5.

```
SELECT DISTINCT E.ename
FROM Employees E, Certified C, Aircraft A
WHERE E.eid = C.eid AND C.aid = A.aid AND A.aname LIKE 'Boeing%'
```

Q6. Find the aids of all aircraft that can be used on routes from Los Angeles to Chicago.

A6.

```
SELECT A.aid
FROM Aircraft A
WHERE A.cruisingrange > ( SELECT MIN (F.distance)
                         FROM Flights F
                         WHERE F.from = 'Los Angeles' AND F.to = 'Chicago' )
```

Q7. Identify the routes that can be piloted by every pilot who makes more than $100,000.

A7.

```
SELECT DISTINCT F.from, F.to
FROM Flights F
WHERE NOT EXISTS ( SELECT *
                   FROM Employees E
                   WHERE E.salary > 100000 AND
                   NOT EXISTS (SELECT *
                               FROM Aircraft A, Certified C
                               WHERE A.cruisingrange > F.distance
                               AND E.eid = C.eid AND A.aid = C.aid) )
```

Q8. Print the enames of pilots who can operate planes with *cruisingrange* greater than 3000 miles but are not certified on any Boeing aircraft.

A8.

```
SELECT DISTINCT E.ename
FROM Employees E
WHERE E.eid IN ( ( SELECT C.eid
                   FROM Certified C
                   WHERE EXISTS ( SELECT A.aid
                                  FROM Aircraft A
                                  WHERE A.aid = C.aid
                                  AND A.cruisingrange > 3000 )
                                  AND NOT EXISTS ( SELECT A1.aid
                                  FROM Aircraft A1
                                  WHERE A1.aid = C.aid
                                  AND A1.aname LIKE 'Boeing%' ))
```

Q9. A customer wants to travel from Madison to New York with no more than two changes of flight. List the choice of departure times from Madison if the customer wants to arrive in New York by 6 p.m.

A9.

```
SELECT F.departs
FROM Flights F
```

```
WHERE F.flno IN ( ( SELECT F0.flno
                    FROM Flights F0
                    WHERE F0.from = 'Madison'
                    AND F0.to = 'New York' AND F0.arrives < '18:00' )
                    UNION ( SELECT F0.flno
                                FROM Flights F0, Flights F1
                                WHERE F0.from = 'Madison'
                                AND F0.to <> 'New York'
                                AND F0.to = F1.from
                                AND F1.to = 'New York'
                                AND F1.departs > F0.arrives
                                AND F1.arrives < '18:00' )
                                UNION ( SELECT F0.flno
                                        FROM Flights F0, Flights F1, Flights F2
                                        WHERE F0.from = 'Madison'
                                        AND F0.to = F1.from
                                        AND F1.to = F2.from
                                        AND F2.to = 'New York'
                                        AND F0.to <> 'New York'
                                        AND F1.to <> 'New York'
                                        AND F1.departs > F0.arrives
                                        AND F2.departs > F1.arrives
                                        AND F2.arrives < '18:00' ))
```

Q10. Compute the difference between the average salary of a pilot and the average salary of all employees (including pilots).

A10.

```
SELECT Temp1.avg - Temp2.avg
FROM (SELECT AVG (E.salary) AS avg
        FROM Employees E
        WHERE E.eid IN (SELECT DISTINCT C.eid
                            FROM Certified C )) AS Temp1,
        (SELECT AVG (E1.salary) AS avg
        FROM Employees E1 ) AS Temp2
```

Q11. Print the name and salary of every nonpilot whose salary is more than the average salary for pilots.

A11.

```
SELECT E.ename, E.salary
FROM Employees E
WHERE E.eid NOT IN ( SELECT DISTINCT C.eid FROM Certified C )
AND E.salary > ( SELECT AVG (E1.salary)
                 FROM Employees E1
                 WHERE E1.eid IN ( SELECT DISTINCT C1.eid FROM Certified C1 ) )
```

Q12. Print the names of employees who are certified only on aircrafts with cruising range longer than 1000 miles.

A12.

```
SELECT E.ename
FROM Employees E, Certified C, Aircraft A
WHERE C.aid = A.aid AND E.eid = C.eid
GROUP BY E.eid, E.ename
HAVING EVERY (A.cruisingrange > 1000)
```

Q13. Print the names of employees who are certified only on aircrafts with cruising range longer than 1000 miles, but on at least two such aircrafts.

A13.

```
SELECT E.ename
FROM Employees E, Certified C, Aircraft A
WHERE C.aid = A.aid AND E.eid = C.eid
GROUP BY E.eid, E.ename
HAVING EVERY (A.cruisingrange > 1000) AND COUNT (*) > 1
```

Q14. Print the names of employees who are certified only on aircrafts with cruising range longer than 1000 miles and who are certified on some Boeing aircraft.

A14.

```
SELECT E.ename
FROM Employees E, Certified C, Aircraft A
WHERE C.aid = A.aid AND E.eid = C.eid
GROUP BY E.eid, E.ename
HAVING EVERY (A.cruisingrange > 1000) AND ANY (A.aname = 'Boeing')
```