Sample relational algebra problems and solutions.

All are based on the following airline database schema:

Flights(flno, from, to, distance, departs)
Aircraft(aid, aname, range)
Certified(eid, aid)
Employees(eid, ename, salary)

By definition, pilots are those employees who are certified on at least one aircraft. An aircraft can be used for any flight provided it has sufficient range. Pilots can pilot any flight provided they are certified on an aircraft with sufficient range.

Problems

1. Find eid's of pilots who are certified on some Boeing.
2. Find names of pilots who are certified on some Boeing.
3. Find aid's of aircraft that can fly non-stop from LA to NY. Assume you don't already know the distance.
4. Find flno of flights that can be piloted by every pilot whose salary is over $100,000.
5. Solve problem 4 without using the division operator.
6. Find names of pilots who can operate planes with a range greater than 3,000 miles, but are not certified on any Boeing.
7. Find eid of employee(s) with the highest salary.
8. Find eid of employee(s) with the second highest salary.
9. Find eid of employee(s) certified on the most aircraft.
10. Find eid's of employees certified on exactly three aircraft.

Solutions

1. $\Pi_{eid}(\sigma_{aname = \text{'Boeing'}}(Aircraft \bowtie Certified))$

2. $\Pi_{ename}(\sigma_{aname = \text{'Boeing'}}(Aircraft \bowtie Certified \bowtie Employees))$

3. $\Pi_{aid}(\sigma_{range \geq distance}(Aircraft \times \sigma_{from = \text{'LA'} \wedge to = \text{'NY'}}(Flignts)))$

4. $\Pi_{flno,eid}(\sigma_{range \geq distance}(Aircraft \times Flights) \bowtie Certified) \div \Pi_{eid}(\sigma_{salary > 100000}(Employees \bowtie Certified))$

5. $\Pi_{flno}(Flights) - \Pi_{flno}((\Pi_{flno}(Flights) \times \Pi_{eid}(\sigma_{salary > 100000}(Employees \bowtie Certified))) - \Pi_{flno,eid}(\sigma_{range \geq distance}(Aircraft \times Flights) \bowtie Certified))$

6 $\Pi_{ename}(Employees \bowtie (\Pi_{eid}(\sigma_{range > 3000}(Aircraft \bowtie Certified)) - \Pi_{eid}(\sigma_{name = \text{'Boeing'}}(Aircraft \bowtie Certified))))$

7. $\Pi_{eid}(Employees) - \Pi_{e2.eid}(\sigma_{e1.salary > e2.salary}(\rho_{e1}(Employees) \times \rho_{e2}(Employees)))$

8 $temp \leftarrow \Pi_{e2.eid,\ e2.salary}(\sigma_{e1.salary > e2.salary}(\rho_{e1}(Employees) \times \rho_{e2}(Employees))$
$result \leftarrow \Pi_{eid}(temp) - \Pi_{e2.eid}(\sigma_{e1.salary > e2.salary}(\rho_{e1}(temp) \times \rho_{e2}(temp)))$

9 There is no solution to this problem using relational algebra.

10 $\Pi_{eid}(\sigma_{r1.aid \neq r2.aid \wedge r1.aid \neq r3.aid \wedge r2.aid \neq r3.aid \wedge r1.eid = r2.eid = r3.eid}(\rho_{r1}(Certified) \times \rho_{r2}(Certified) \times \rho_{r3}(Certified))) - \Pi_{eid}(\sigma_{r1.aid \neq r2.aid \wedge r1.aid \neq r3.aid \wedge r1.aid \neq r4.aid \wedge r2.aid \neq r3 \wedge r2.aid \neq r4.aid \wedge r3.aid \neq r4.aid \wedge r1.eid = r2.eid = r3.eid = r4.eid}(\rho_{r1}(Certified) \times \rho_{r2}(Certified) \times \rho_{r3}(Certified) \times \rho_{r4}(Certified)))$