CPS 116 Fall 2004
Supplemental Problem Set #1
(Not due; for use as optional additional exercises)

Problem 1.

An airline database contains the following tables:

- *Flight* (*flno*, *from_city*, *to_city*, *distance*, *departs*, *arrives*, *price*)
- *Aircraft* (*aid*, *aname*, *cruising_range*)
- *Employee* (*eid*, *ename*, *salary*)
- *Certified* (*eid*, *aid*)

The *Employee* table describes pilots as well as other types of employees. Employees who are certified to operate on some aircraft are considered pilots. Run `/home/dbcourse/examples/db-flights/setup.sh` to setup a database with some sample data. For the SQL database schema, please refer to the file `create.sql` in the same directory. Write SQL statements to answer the following queries.

(a) Find the names of aircraft such that all pilots certified to operate them earn more than $80,000.
(b) Find the names of pilots whose salary is less than the price of the cheapest direct flight from Los Angeles to Honolulu.
(c) Find the names of pilots certified for some Boeing aircraft.
(d) Find the aid's of all aircraft that can be used to fly from Los Angeles to Chicago.
(e) A customer wants to travel from Madison to New York with no more than two changes of flight. List the choice of departures from Madison if the customer wants to arrive at New York by 6pm.
(f) Print the name and salary of every non-pilot whose salary is more than the average salary for pilots.
(g) Print the names of employees who are certified only for aircrafts with cruising range longer than 1000 miles.

Problem 2.

Which queries in Problem 2 *cannot* be formulated in basic relational algebra? For relational algebra, assume that selection and join conditions may use built-in SQL predicates on strings, times, etc., but no SQL aggregation functions are allowed.

Problem 3.

Consider a relation R (A, B, C, D) with FD's $AB \rightarrow C$, $C \rightarrow D$, and $D \rightarrow A$.

(a) Show that $\{A, B\}$ is a key of R (remember a key has to be minimal).
(b) What are the other keys of R? (Hint: B must be in every key of R; why?)
(c) $D \rightarrow A$ is a BNCF violation. Using this violation, we decompose R into R_1 (A, D) and R_2 (B, C, D). What are the keys of R_1?

(d) What are the FD's that hold in R_1? Do not list them all; instead, give a set of FD's from which all other FD's in R_1 follow. This set of FD's is called a *basis*. When checking for BCNF violations, it suffices to check just the basis.
(e) Is R_1 in BCNF? Briefly explain why.
(f) What are the keys of R_2? (Hint: There is more than one.)
(g) What are the FD's that hold in R_2? Again, do not list them all; instead, give a basis.
(h) Is R_2 in BCNF? If yes, briefly explain why. Otherwise, decompose further until all decomposed relations are in BCNF, and then show your final results.

Problem 4.

Using the chase procedure to prove or disprove the following claims.

(a) In a relation $R(A, B, C, D)$, if $A \twoheadrightarrow BC$, then $A \twoheadrightarrow B$.
(b) In a relation $R(A, B, C, D)$, if $A \twoheadrightarrow B$ and $A \rightarrow C$, then $A \twoheadrightarrow D$.