Assignment No. 7: The Theory of Database Design

Solutions due 27 July. Type your solution and upload it to Blackboard as a single pdf file.

Problem 1.

1. Does the following relation instance satisfy the functional dependency $AB \to C$?

   means if A,B is identical do I have to same C?

A	B	C
1	1	2
1	1	3
1	2	3

2. List *all* the functional dependencies (involving the attributes A, B, C) that are satisfied by the following relation instance: *(list all 49 tuples) (But they are trivial.*

   $? \to ?$

   $A, B, C -$

   E.g: $ABC \to ABC$ or $ABC \to AB$

A	B	C
1	1	2
1	2	3
1	4	3

✓ **Problem 2.** Assume a schema $R = (A, B, C)$ and the functional dependencies $F = \{A \to B, B \to C\}$. Prove that the functional dependency $AB \to CB$ is entailed by the set F. (Hint: Try to derive this functional dependency from the functional dependencies in F using Armstrong's Axioms.)

✓ **Problem 3.** The decomposition rule states that if $X \to YZ$ then $X \to Y$ and $X \to Z$. Prove that the decomposition rule is sound. (Hint: Try to derive these two functional dependencies from Armstrong's Axioms.) *→ means works/correct.*

✓ **Problem 4.** Show that the following "rule" for functional dependencies is *not sound*: If $X \to Y$ and $Z \to Y$ then $X \to Z$. (Hint: find a relation instance r that refutes the "rule".)

Problem 5. Consider the schema $R = (A, B, C)$ and the set of functional dependencies $F = \{A \to B, BC \to A\}$.

1. Use Armstrong's Axioms to generate F^+; i.e., the set of *all* functional dependencies that are entailed by F. Indicate on the list the functional dependencies that are *trivial*.

2. By examining F^+, find all the *superkeys* and then the *candidate keys* of R. (Hint: Recall that K is a superkey of R iff $K \to R$.) *= keys*

Problem 6. Consider the relation schema $R = (A, B, C, D, E)$ and the set of functional dependencies $F = \{A \rightarrow BC, CD \rightarrow E, B \rightarrow D, E \rightarrow A\}$.
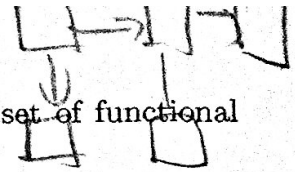
→ Show the

1. Show that (A, B, C) and (A, D, E) is a lossless-join decomposition of R (under F).

2. Show that (A, B, C) and (C, D, E) is not a lossless-join decomposition of R (under F).

3. Using the normalization algorithm, find a lossless-join decomposition of R (under F) into BCNF relation schemas.

↳ Find the Key

Problem 7. Consider this relation schema with 7 attributes

$$Visit = (Date, P\#, Pname, E\#, Ename, Diagnosis, Cost)$$

and this set of 4 functional dependencies

$$F = \{P\# \rightarrow Pname, E\# \rightarrow Ename, Diagnosis \rightarrow Cost, (Date, P\#) \rightarrow (E\#, Diagnosis)\}$$

1. Find a key of V by discovering a set of attributes whose attribute closure is all the attributes of V.

2. Is V in BCNF (under F)? Why?

3. Is $V_1 = (Date, P\#, Pname)$ in BCNF? Why?

4. Is $V_2 = (Date, E\#, Ename, Diagnosis, Cost)$ in BCNF? Why?

5. Is V_1 and V_2 a lossless-join decomposition (under F)? Why?

6. Using the normalization algorithm, find a lossless-join decomposition of V into BCNF relation schemas (under F).

Problem 8. Consider a database for surgery appointments. The patient is given an appointment at a specific time and date and at a particular surgery location. On each date for which there are appointments, one surgeon is assigned to a specific surgery location for that entire day. Initially, the following relation schema is proposed: $R = (SurgId, SurgName, PatId, PatName, AppDate, AppTime, SurgLoc)$, where SurgId is surgeon identification number, SurgName is surgeon name, PatId is patient identification number, PatNameia is patient name, AppDate is appointment date, AppTime is appointment time, and SurgLoc is surgery location.

1. List the functional dependencies that denote the information given above.

2. Describe the negative aspects of the initial relation.

3. Using the normalization algorithm, find a lossless-join decomposition of R into BCNF relations schemas (under the set of functional dependencies listed earlier).