Directions: Examine the following relations.

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1. Using Table 1, determine if $A \to B$, $B \to C$, and $AB \to D$. In words, is B dependent on A? is C dependent on B? and is D dependent on AB?

   Solution: Yes, no, yes.

Table 1: Relation in Problem 1.

R =

A	B	C	D
a_1	b_1	c_1	d_1
a_1	b_1	c_3	d_1
a_2	b_1	c_3	d_4
a_2	b_1	c_3	d_4
a_3	b_6	c_3	d_1

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2. Determine if there are any transitive dependencies in Table 2. If so, specify.

   Solution: $A \to B \to D$

Table 2: Relation in Problem 2.

R =

A	B	C	D
a_1	b_1	c_1	d_1
a_1	b_1	c_3	d_1
a_2	b_2	c_3	d_4
a_2	b_2	c_3	d_4
a_3	b_6	c_3	d_2

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3. Determine all (nontrivial) dependencies in Table 3. Identify symmetric and transitive dependencies. Note: A functional dependency $A \to B$ is **trivial** if $B \subseteq A$. *Hint*: there are five.

Table 3: Relation in Problem 3.

R =

A	B	C	D	E
a_1	b_2	c_7	d_9	e_4
a_5	b_2	c_8	d_9	e_5
a_1	b_4	c_7	d_9	e_6
a_5	b_4	c_8	d_9	e_4
a_1	b_6	c_7	d_2	e_6
a_5	b_6	c_8	d_2	e_6

Solution: $A \rightarrow C$, $C \rightarrow A$, $B \rightarrow D$, $AB \rightarrow E$, and $BC \rightarrow E$. From here, we can use Armstrong's rules to obtain all other dependencies such as $AB \rightarrow CD$, $AB \rightarrow CDE$, etc.

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4. Use functional dependencies in the relation R (see Table 3) to determine a primary key for the relation. Note: functional dependencies are used to identify candidate keys (any of which can be used for the primary key). Candidate keys are determined by finding set(s) of attributes for which all other attributes are functionally dependent.

   Solution: AB is a primary key since $AB \rightarrow C, D, E$. In fact, $A \rightarrow C$, $B \rightarrow D$, and $AB \rightarrow E$. In addition, trivially, $A \rightarrow A$ and $B \rightarrow B$. Therefore, $AB \rightarrow ABCDE$.

   Note: since $A \leftrightarrow C$, then BC is also a key.

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5. List three anomalies and give an example of one of them.

   Solution: Insertion, modification (or update), and deletion. As an example, consider the Flights database. If we need to update the destination LAX, we must update it in many places. Such an activity is prone to inconsistency errors and would vitiate the database.
