Exercise Sheet 7

Question 19: Working with functional dependencies

Consider a schema \( T(A, B, C, D, E) \) with the following functional dependencies: \( A \rightarrow B \), \( BC \rightarrow E \), \( ED \rightarrow A \).

a. Find all the candidate keys for the schema \( T \).
   (Hint: Note that the collection of all attributes \( ABCDE \) forms a candidate key. You can progressively remove from this collection one attribute at a time, and determine whether it still remains a candidate key. A minimal candidate key is one from which you cannot remove any further attributes. You should attempt to find at least one minimal candidate key during the lab session, and hunt for the remaining ones at home.)

b. Is the table in Boyce-Codd normal form (BCNF)?

c. If it is not, decompose it into BCNF using the normalisation procedure of Section 11.

Question 20: Normalisation example

Consider the following schema for a table that arose with performing tests on airplanes in Class Test 2.

\[
\text{test(IATAno, name, date, airplane, technician, duration, score, maxscore)}
\]

The attributes satisfy the following functional dependencies:

- \( \text{IATAno} \rightarrow \text{name} \)
- \( \text{IATAno} \rightarrow \text{maxscore} \)
- \( \text{IATAno, airplane, date} \rightarrow \text{technician} \)
- \( \text{IATAno, airplane, date} \rightarrow \text{duration} \)
- \( \text{IATAno, airplane, date} \rightarrow \text{score} \)

a. Use the normalisation procedure to decompose the table into BCNF.

b. Briefly describe how each of the anomalies mentioned in Section 11 might arise with the original table, but are avoided in the decomposed tables.

Question 21: Judging decompositions

a. Assume that the functional dependencies \( AB \rightarrow C \), \( AB \rightarrow D \) and \( BC \rightarrow D \), hold for the schema \((A, B, C, D)\). Which set(s) of attributes form a candidate key?

Consider each of the following decompositions and determine whether it is lossless. If so, say whether it is redundancy reducing and dependency preserving. If all three properties hold determine whether the resulting tables are in Boyce-Codd Normal Form.

i. \((A, B) \& (B, C, D)\)

ii. \((A, B, C) \& (B, C, D)\)

iii. \((A, B, D) \& (B, C, D)\)

iv. \((A, B, C, D) \& (B, C, D)\)

b. Like the previous item: Assume \( A \rightarrow B, A \rightarrow C, A \rightarrow D, A \rightarrow E, B \rightarrow C, \) and \( CD \rightarrow E \) hold in schema \((A, B, C, D, E)\), and consider the decompositions

i. \((A, B) \& (B, C) \& (C, D, E)\)

ii. \((A, B, D) \& (B, C) \& (B, D, E)\)

iii. \((A, B, C, D) \& (B, C) \& (C, D, E)\)
**Question 22: Evaluating functional dependencies**

Each of the following relational schemata contains a (non-trivial) functional dependency. Discuss how harmful it is likely to be with regards to “RAUDI” (redundancy and the anomalies of aggregation, update, deletion and insertion). You should attempt to discuss at least one of them. If you have a study partner, it would be fun to discuss the issues between you.

a. Consider a schema for a table describing airline bookings. It would have attributes describing the customer (name, address, etc), attributes describing the flight (airline, flight number, etc), date, and details of the credit card that was used to pay for the flight. Discuss in this context the functional dependency

\[
\text{credit\_card\_number} \rightarrow \text{customer\_details}
\]

b. Consider a schema for a table that describes the machines available from a computer store. There would be attributes for model name, price, amount of RAM memory, etc. Discuss the functional dependency

\[
\text{processor} \rightarrow \text{clock\_speed}
\]

c. Consider a schema for a table describing students, with the obvious attributes. Discuss the functional dependency

\[
\text{home\_or\_overseas\_status}, \text{degree\_programme} \rightarrow \text{tuition\_fee}
\]

d. Consider a schema for a table containing scientific articles published in academic journals. We would have attributes such as author, title, start page, end page, submission date, etc. There is also the year of publication and the “journal volume”. (Journals publish between one and 10 volumes per year.) Discuss the functional dependency

\[
\text{journal\_name}, \text{volume\_number} \rightarrow \text{year}
\]