BSCCS2001: Mock Quiz 2 with Solutions
Weeks 4 to 6

1 Objective Questions

1. Kiran was born on 19 Janurary, 1980. His date of birth was registered in the municipal corporation database on 21 January, 1980.
Considering that the municipal corporation database is a temporal database, which among the following statements is true.

[ARUP:MCQ:2points]

- √ 19 Janurary, 1980 is a valid time which provides historical information, whereas 21 January, 1980 is a transaction time which provides rollback information.
- ◯ 19 Janurary, 1980 is a valid time which provides rollback information, whereas 21 January, 1980 is a transaction time which provides historical information.
- ◯ 19 Janurary, 1980 is a transaction time which provides rollback information, whereas 21 January, 1980 is a valid time which provides historical information.
- ◯ 19 Janurary, 1980 is a transaction time which provides historical information, whereas 21 January, 1980 is a valid time which provides rollback information.

Solution:

- 19 Janurary, 1980 is time when actual event took place. Thus, it is the valid time and provides historical information.
- 21 January, 1980 is the time when event information is entered into the temporal database. Thus, it is transaction time and provides rollback information.

2. Consider the relation **student_course**(*student, course, instructor, textbook*) with the following multivalued functional dependencies:
$student \rightarrow\rightarrow course$
$course \rightarrow\rightarrow textbook$
No functional dependencies are defined for the relation. Identify the appropriate 4NF decompositions for the relation.

[ARUP:MSQ:2points]

- ◯ (*student, course, instructor*), (*instructor, textbook*)
- √ (*student, course*), (*student, instructor*), (*textbook, course*)

√ (*student, instructor*), (*student, textbook*), (*student, course*)

◯ (*student, instructor, textbook*), (*student, course*)

Solution:
Since there is no functional dependency defined for the relation **student_course**, the only possible superkey is the combination of all the attributes,
Let us consider MVD: *student* $\rightarrow\rightarrow$ *course* first which is violating 4NF since *student* is not a superkey and the MVD is not trivial. We can create a relation **R1**(*student, course*), which is in 4NF (since *student* $\rightarrow\rightarrow$ *course* trivial in **R1**). Another relation would be **R2**(*student, instructor, textbook*). Nevertheless, **R2** is not in 4NF, since for MVD: *student* $\rightarrow\rightarrow$ *textbook* (implied by the transitivity on the given MVDs), *student* is neither a superkey nor the MVD is trivial. Thus, we can further create another relation **R21**(*student, textbook*). **R21** is in 4NF, since MVD: *student* $\rightarrow\rightarrow$ *textbook* becomes trivial. Another relation **R22**(*student, instructor*) is already in 4NF as no FD or MVD is defined for it. Finally, the decomposed relations are: (*student, course*), (*student, textbook*), (*student, instructor*), which is option-3
If we start with MVD: *course* $\rightarrow\rightarrow$ *textbook* which violates 4NF, since neither *course* is a superkey nor is it trivial in the given relation. Thus, we can decompose it as **R1**(*course, textbook*) and **R2**(*student, course, instructor*). Relation **R1** is in 4NF, since MVD: *course* $\rightarrow\rightarrow$ *textbook* becomes trivial. However, **R2** is not in 4NF, since for MVD: *student* $\rightarrow\rightarrow$ *course*, neigther *student* nor the MVD is trivial. Thus, we can decompose the **R2** as: **R21**(*student, course*) and **R22**(*student, instructor*), where bot satifes 4NF conditions. Finally, the decomposed relations are: (*course, textbook*), (*student, course*), (*student, instructor*), which is option-2
In option-1, (*student, course, instructor*) is not in 4NF, since for MVD: *student* $\rightarrow\rightarrow$ *course* neither *student* is a superkey nor it is trivial in the relation.
In option-4, (*student, instructor, textbook*) is not in 4NF, since for MVD: *student* $\rightarrow\rightarrow$ *textbook* (implied by the given MVDs) neither *student* is a superkey nor it is trivial in the relation.

3. Consider the relational schema **R**(A, B, C, D), where the domains of A, B, C and D include only atomic values. Identify the sets of functional dependencies satisfied by **R** such that **R** is in BCNF.

[ARUP:MSQ:2points]

√ FD: $\{ABC \rightarrow D, AD \rightarrow BC\}$

◯ FD: $\{AB \rightarrow CD, CD \rightarrow B, D \rightarrow A\}$

√ FD: $\{A \rightarrow B, B \rightarrow C, C \rightarrow D, D \rightarrow A\}$

◯ FD: $\{AB \rightarrow D, D \rightarrow B, D \rightarrow C, C \rightarrow A\}$

Solution:
For FD: $\{ABC \rightarrow D, AD \rightarrow BC\}$, since $(ABC)^+ = ABCD$ and $(AD)^+ = ABCD$, ABC and AD are superkeys. Thus, it is in BCNF.
For FD: $\{AB \rightarrow CD, CD \rightarrow B, D \rightarrow A\}$, since $(D)^+ = AD$, D is not superkey in FD $D \rightarrow A$. Thus, it is not BCNF.
For FD: $\{A \rightarrow B, B \rightarrow C, C \rightarrow D, D \rightarrow A\}$, since $(A)^+ = ABCD$, $(B)^+ = ABCD$, $(C)^+ = ABCD$, $(D)^+ = ABCD$, A, B, C, D all are superkeys . Thus, it is in BCNF.
For FD: $\{AB \rightarrow D, D \rightarrow B, D \rightarrow C, C \rightarrow A\}$, since $(C)^+ = CA$, C is not superkey in FD $C \rightarrow A$. Thus, it is not BCNF.

4. Which among the following methods of `psycopg2` is/are used to execute SQL statements?

[ARUP:MSQ:2points]

- √ `cursor.execute()`
- √ `cursor.executemany()`
- ◯ `cursor.fetchall()`
- ◯ `cursor.fetchmany()`

Solution:
The methods `cursor.execute()` and `cursor.executemany()` are used to execute an SQL statement.
Whereas, `cursor.fetchall()` fetches all the rows and `cursor.fetchmany()` fetches next n (required to pass as an argument in the method) rows from a query result.

5. With reference to the E-R diagram as shown in Figure 1, which of the statements is/are correct?

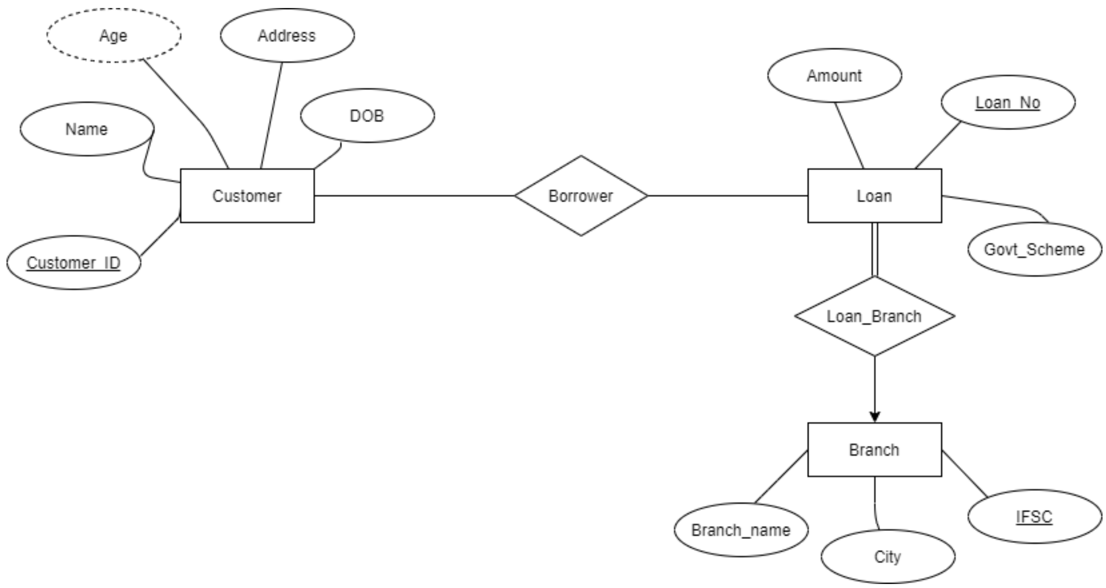

Figure 1: E-R diagram

[Piyush: MSQ: 2 points]

- ○ **Age** is the multivalued attribute, and there is total participation between the **Loan** and **Loan_Branch**.
- ○ Minimum 5 tables are required to represent E-R diagram in relational model.
- √ In the relational schema, the **Loan** table will have 4 attributes i.e., (Loan_No, Amount, Govt_Scheme, IFSC)
- √ In the relational schema, the **Borrower** table will have two attributes i.e., (Customer_ID, Loan_no).

Solution:

- **Age** is the derived attribute here.
- There is total participation between the **Loan** and **Loan_Branch**.
- Minimum 4 tables are required to represent E-R diagram in relational schema.
  i.e., **Customer(Customer_ID, Name, Address, Age, DOB)**
  Borrower(Customer_ID, Loan_No)
  Loan(Loan_No, Amount, Govt_Scheme, IFSC)
  Branch(IFSC, Branch_name, City)

6. Consider a relation $\mathbf{R}(A,\ B,\ C,\ D,\ E,\ F,\ G,\ H,\ I,\ J)$ having functional dependencies as follows $\mathcal{F} = \{AB \to C, B \to F,\ D \to IJ,\ A \to DE,\ F \to GH\}$.
Then, which among the following is a lossless decomposition of **R**? [Piyush:MCQ:4 Points]

 ◯ R1 (A, B, C, I, J), R2 (D, E, F) and R3 (G, H, I)
 ◯ R1 (A, B, C), R2 (D, E, F), R3 (G, H) and R4 (D, I, J)
 √ R1 (A, B, C), R2 (A, D, E), R3(B, F), R4 (F, G, H) and R5 (D, I, J)
 ◯ R1 (A, B, C, D), R2 (D, E), R3 (B, F), R4 (F, G, H) and R5 (D, I, J)

Solution:
Option 1: R1(A, B, C, I, J), R2(D, E, F) and R3(G, H, I) is a lossy decomposition.

- R1 ∪ R2 ∪ R3 = R
- Here, R1 ∩ R2 = ϕ, R2 ∪ R3 = ϕ, and also R1 ∪ R3 = ϕ

Option 2: R1(A, B, C), R2(D, E, F), R3(G, H) and R4(D, I, J) is a lossy decomposition.

- R1 ∪ R2 ∪ R3 ∪ R4 = R
- R2 ∩ R4 = D, by using D → IJ, we can determine R4.
- But, R1 ∩ R3 = ϕ

Option 3: R1(A, B, C), R2(A, D, E), R3(B, F), R4(F, G, H) and R5(D, I, J)

- R1 ∪ R2 ∪ R3 ∪ R4 ∪ R5 = R
- R1 ∩ R3 = B, by using B → F, we can determine R3. Let R13 = R1 ∪ R3 = (A, B, C, F)
- R2 ∩ R5 = D, by using D → IJ, we can determine R5. Let R25 = R2 ∪ R5 = (A, D, E, I, J)
- Now, R13 ∩ R4 = F, by using F → GH, we can determine R4. Let R134 = R13 ∪ R4 = (A, B, C, F, G, H)
- Now, R134 ∩ R25 = A, by using A → DE and D → IJ, we can determine R25. So, given decomposition is lossless and thus option 3 is correct.

Option 4: R1 (A, B, C, D), R2 (D, E), R3 (B, F), R4 (F, G, H) and R5 (D, I, J)

- R1 ∪ R2 ∪ R3 ∪ R4 ∪ R5 = R

- $R1 \cap R3 = B$, by using $B \rightarrow F$, we can determine R3. Let $R13 = R1 \cup R3 =$ (A, B, C, D, F)
- $R2 \cap R5 = D$, by using $D \rightarrow IJ$, we can determine R5. Let $R25 = R2 \cup R5 =$ (D, E, I, J)
- Now, $R13 \cap R4 = F$, by using $F \rightarrow GH$, we can determine R4. Let $R134 = R13 \cup R4 =$ (A, B, C, D, F, G, H)
- Now, $R134 \cap R25 = D$, here we cannot determine R25 or R134.
  So, given decomposition is lossy.

7. A database designer observes that a relation R is in 2NF, and has transitive functional dependencies. Relation R is then decomposed into relations R1 and R2, such that the decomposition is 3NF and lossless. Now, the designer observes that, R2 is in 3NF but not in BCNF. Relation R2 is further decomposed into R3 and R4 such that the decomposition is in BCNF, and it satisfies the following conditions:

   - $\mathrm{R2} = \mathrm{R3} \cup \mathrm{R4}$
   - $\mathrm{R3} \cap \mathrm{R4} \to \mathrm{R3}$

   Choose the correct options. [Piyush:MSQ:3Points]

   ◯ The decomposition of R2 into R3 and R4 is lossy.

   √ The decomposition of R2 into R3 and R4 is lossless.

   √ $\mathrm{R} = \mathrm{R1} \bowtie \mathrm{R2}$

   ◯ The number of tuples in R2 is more than the number of tuples in ($\mathrm{R3} \bowtie \mathrm{R4}$)

Solution:

- Since, the decomposition of R into R1 and R2 is lossless, then it must satisfy $\mathrm{R} = \mathrm{R1} \bowtie \mathrm{R2}$.
- From the given conditions, we can say that decomposition of R2 into R3 and R4 is lossless. Since it is lossless decomposition, The number of tuples in R2 is equal to the number of tuples in ($\mathrm{R3} \bowtie \mathrm{R4}$) i.e., $\mathrm{R2} = \mathrm{R3} \bowtie R4$.

8. Consider the scenario given below. [Arup/Anjana: MCQ: 3 points]
A university consists of several **Person** entities. The **Person** entities are either of **Alumnus** type or **Student** type. However, there is a possibility that some **Person** entities can be of both **Alumnus** and **Student** types. As an example, the **Person** might be an alumnus of the same university while also pursuing a separate degree.
Identify the constraints on specialization.

- ◯ Disjoint and partial
- ◯ Overlapping and partial
- ◯ Disjoint and total
- √ Overlapping and total

Solution:

- As a **Person** must be an **Alumnus** or a **Student**, it is a total specialization.
- As a **Person** can be both **Alumnus** and **Student**, it is overlapping specialization.

9. Consider the two relations given in Figure 2. [Arup/Anjana: MSQ: 4 points]

S1

A	B
A1	B1
A2	B2
A3	B3
A4	B4
A5	B5

S2

A	B
A2	B2
A4	B4
A5	B5

Figure 2: Relations **S1** and **S2**

Choose the relational algebra expression(s) that result(s) in the relation given in Figure 3.

A	B
A2	B2
A4	B4
A5	B5

Figure 3: Resulting relation

○ $S1 - S2$

√ $S1 \cap S2$

√ $S1 \bowtie S2$

○ $S1 \times S2$

Solution: The result shown in Figure 3 is the intersection between the relations **S1**, and **S2**, which is presented as $S1 \cap S2$,
and $S1 \bowtie S2$ fetch the same result set as that to $S1 \cap S2$, considering the given tables.

10. Find the equivalent SQL statement corresponding to the below relational algebraic expression :

[Dhannya/ANJANA: MCQ: 2 points]

$\Pi_{emp\_name}\big(\sigma_{employee.dept\_id=department.dept\_id\ \wedge\ dept\_name='Finance'}(\mathbf{employee} \times \mathbf{department})\big)$

- ◯ `select emp_name from employee, department`
  `where dept_name='Finance';`
- ◯ `select e.emp_name from employee e, department d`
  `where d.dept_name='Finance';`
- ◯ `select e.emp_name from employee e, department d`
  `where e.dept_id=d.dept_id or d.dept_name='Finance';`
- √ `select e.emp_name from employee e, department d`
  `where e.dept_id=d.dept_id and d.dept_name='Finance';`

Solution: $\sigma_{employee.dept\_id=department.dept\_id}(\mathbf{employee} \times \mathbf{department})$ will associate employee names with the department details, on equality between employee.dept_id and department.dept_id.

$\sigma_{dept\_name='Finance'}(\sigma_{employee.dept\_id=department.dept\_id}(\mathbf{employee}\times\mathbf{department}))$ will select out the department of Finance.

After simplifying it, we get
$\sigma_{employee.dept\_id=department.dept\_id\ \wedge\ dept\_name='Finance'}(\mathbf{employee} \times \mathbf{department})$

$\Pi_{emp\_name}\big(\sigma_{employee.dept\_id=department.dept\_id\ \wedge\ dept\_name='Finance'}(\mathbf{employee}\times\mathbf{department})\big)$
will project down the employee names.

Option 1, **Option 2** and **Option 3** will give incorrect results, i.e., they fetch the wrong employee names.

Option 4 will give the name of only those employees who work in the 'Finance' department.

11. Let $R(V, W, X, Y, Z)$ be a given relation with the following functional dependencies:
$\mathcal{F} = \{V \rightarrow W, WX \rightarrow Z, YZ \rightarrow V\}$
Then, which among the following is/are the candidate key(s)?

[Dhannya/Subendu: MSQ: 3 points]

- ○ XY
- √ WXY
- √ VXY
- ○ VW

Solution: Consider the closure of each set of attributes given in the options. We can see that the closures of options 2 and 3 contain all attributes. So, both WXY and VXY are super keys. Since both WXY and VXY are minimal, both are candidate keys.

12. Consider relational instance given in Figure 4.

[Piyush/Subendu: MCQ: 2 points]

V	W	X	Y	Z
b	9	8	7	5
9	b	8	7	1
b	9	8	2	2
b	9	8	3	6

Figure 4: Relational instance

Which of the following functional dependencies does not hold on the given table?

- ◯ $V \rightarrow WX$
- ◯ $YZ \rightarrow X$
- √ $X \rightarrow YZ$
- ◯ $WY \rightarrow Z$

Solution: A functional dependency is a relationship between attributes sets. For any relation R, if an attribute Y is functionally dependent on an attribute X, denoted by $X \rightarrow Y$, then for every instance of X, the value of X uniquely determines the value of Y.

Option 3 : For $X \rightarrow YZ$, the value of X in the first tuple, 8, determines 7 AND 5. and the same value of X in the second tuple determines 7 AND 1. So, $X \rightarrow YZ$ violates the basic principles of functional dependencies.
Thus, option 3 is correct.

13. In the relational schema given below, all attributes take atomic values only.
$\mathbf{R}(bike\_name, bike\_model, bike\_engine\_no)$

Suppose **R** satisfies the following functional dependencies:

$$bike\_name \rightarrow bike\_model$$
$$bike\_model \rightarrow bike\_engine\_no$$
$$bike\_engine\_no \rightarrow bike\_name$$

If **R** is decomposed into:
$\mathbf{R1}(bike\_name, bike\_model)$ and
$\mathbf{R2}(bike\_model, bike\_engine\_no)$,
then the decomposition is: [Subendu: MCQ: 3 points]

- √ a lossless decomposition as well as a dependency preserving one
- ◯ not a lossless decomposition but dependency preserving
- ◯ a lossless decomposition but not dependency preserving
- ◯ neither a lossless decomposition nor dependency preserving

Solution:
1.$Attributes(\mathbf{R1}) \cup Attributes(\mathbf{R2}) = \mathbf{R}$
2.$Attributes(\mathbf{R1}) \cap Attributes(\mathbf{R2}) \neq \phi$
3. bike_model is a candidate key of **R2** table
So, decomposition is lossless
$(\mathbf{R1} \cup \mathbf{R2})^+ = (\mathbf{R})^+$
So, dependency is preserved

14. Table **S** initially has ten tuples, as shown.

A	B	C
A1	B1	C1
A1	B2	C2
A1	B3	C3
•	•	•
•	•	•
•	•	•
A1	B10	C10

Figure 5: Table S

In order to make $A \rightarrow\rightarrow B$ to be a valid multivalued dependency on **S**, what is the smallest number of tuples to be inserted into **S**? Note that attributes B and C are mutually independent.

[Bhaskar:NAT:4 points]

Ans: 90

Solution: For definition of MVD check out slide 29.9.
All values under the column B and C are unique and there are 10 tuples with repeated value (i.e. A1) under column A, therefore in order to maintain the MVD $A \rightarrow\rightarrow B$, two tuples corresponding to *t3, t4* has to be added for every pair (*t1, t2*) of tuple present in the table.
Number of ways one can choose a pair of tuples from among the given 10 = $^{10}C_2$
Now, for every pair t1, t2 we are adding two more tuples t3, t4.
Therefore, total number of newly added tuples = $^{10}C_2$ x 2 = 90.

15. Consider the relation $\mathbf{R}(M,\ N,\ O,\ P,\ Q)$ with the functional dependency set $\mathcal{F} = \{N \rightarrow P, Q \rightarrow M, OP \rightarrow Q, M \rightarrow NO\}$.

Choose all the correct statement(s) among the following.

[Bhaskar:MSQ:3 points]

- ◯ **R** is in BCNF and all dependencies in $\mathcal{F}$ are preserved on **R**.
- ◯ If **R** is decomposed into 3NF (but not BCNF) then all dependencies on **R** can not be preserved.
- ◯ **R** can be decomposed into BCNF such that all dependencies are preserved.
- √ If **R** is decomposed into BCNF then all dependencies on **R** can not be preserved.

Solution: Candidate keys of **R** = M, Q, OP, ON.
So all the attributes are prime and hence we can infer that the relation is in 3NF.
Also we can see that all the functional dependencies in $\mathcal{F}$ is applicable on **R** so **R** is a relation which is in 3NF and it is also retaining all the dependencies.
But **R** is not in BCNF since in $N \rightarrow P$ the left hand side i.e. N is not a superkey.
In order to make it BCNF we have to decompose the table further into : $\mathbf{R1}(M,N,O,Q)$ and $\mathbf{R2}(N,P)$.
But in such a decomposition the functional dependency $OP \rightarrow Q$ is lost, so dependecies are not preserved.

Therefore option D is the correct choice.

16. Consider a relation $\mathbf{R}(I, J, K, L, M, N)$ with the following set of functional dependencies.

$\mathcal{F} = \{IK \to N, L \to MN, JK \to L, KN \to JL, IKL \to J, KM \to IN\}$

From among the following options, choose all the sets of functional dependencies which serve as canonical covers of $\mathcal{F}$ on $\mathbf{R}$.

[Bhaskar:MSQ: 4 points]

- ◯ $\mathcal{F}_\mathcal{C} = \{L \to MN, JK \to L, KM \to I, KM \to N\}$
- √ $\mathcal{F}_\mathcal{C} = \{L \to MN, JK \to L, KM \to I, IK \to N, KN \to J\}$
- ◯ $\mathcal{F}_\mathcal{C} = \{L \to MN, JK \to L, KM \to IJ, IK \to J\}$
- √ $\mathcal{F}_\mathcal{C} = \{L \to MN, JK \to L, KM \to I, IK \to J, KN \to L\}$

Solution: Refer slide 24.15, 24.16 for the algorithm to find canonical cover.

17. Pseudo-transitivity is a derived Armstrong's axiom. From among the options, select those basic Armstrong's axiom(s) which are used to derive the pseudo-transitivity axiom.

[Bhaksar:MSQ: 2 points]

- ◯ Composition Axiom
- ◯ Decomposition Axiom
- √ Transitivity Axiom
- √ Augmentation Axiom

Solution: Transitivity and augmentation axiom is used to derive pseudo-transitivity axiom.