Assignment 08 Solutions

1 Assignments

1. You are given a relational schema R = ABCDE satisfying the set of FDs:

   1. AC $\rightarrow$ E
   2. AC $\rightarrow$ CB
   3. E $\rightarrow$ DE
   4. D $\rightarrow$ B

   (a) Compute ω, a minimal cover for α.

Old	**New**
1. AC $\rightarrow$ E	1. AC $\rightarrow$ E
2. AC $\rightarrow$ CB	**2. AC $\rightarrow$ B**
3. E $\rightarrow$ DE	**3. E $\rightarrow$ D**
4. D $\rightarrow$ B	4. D $\rightarrow$ B

New was obtained by removing the "defective" parts of **Old**, which produces a trivially equivalent **New**, so there is nothing to do for proving the equivalence. **New** now becomes **Old**.

Old	**New**
1. AC $\rightarrow$ E	**1. AC $\rightarrow$ EB**
2. AC $\rightarrow$ B	2. E $\rightarrow$ D
3. E $\rightarrow$ D	3. D $\rightarrow$ B
4. D $\rightarrow$ B	

We attempt to simplify 1. and 2. in **Old** getting 1. in **New**. This is an application of the union rule, which always produces an equivalent set. So there is nothing to prove/check and **New** becomes **Old**.

Old	**New**
1. AC $\rightarrow$ EB	**1. AC $\rightarrow$ E**
2. E $\rightarrow$ D	2. E $\rightarrow$ D
3. D $\rightarrow$ B	3. D $\rightarrow$ B

We attempt to simplify 1. in **Old** getting 1. in **New**. **New** could only be weaker, so to prove equivalence we need to prove 1. in **Old** from all in **New**.

We compute $\text{AC}^+ = \text{ACEDB}$. As EB is in ACEDB, we proved equivalence. So **New** becomes **Old**.

We are done because

(a) There are no defective parts

(b) The union rule cannot be applied

(c) No attributes can be removed from either side, so no simplification is possible

Our minimal cover ω is

1. AC $\rightarrow$ E
2. E $\rightarrow$ D
3. D $\rightarrow$ B

Notes

1. You were not required to attempt simplificiations that you believed would not work
2. You were not required to prove that you actually obtained a minimal cover

2. You are given a relational schema R = ABCDE satisfying the set of FDs:

1. AB $\rightarrow$ C
2. A $\rightarrow$ E
3. DE $\rightarrow$ F
4. E $\rightarrow$ EF
5. F $\rightarrow$ B

(a) Compute ω, a minimal cover for α.

Old	**New**
1. AB $\rightarrow$ C	1. AB $\rightarrow$ C
2. A $\rightarrow$ E	2. A $\rightarrow$ E
3. DE $\rightarrow$ F	3. DE $\rightarrow$ F
4. E $\rightarrow$ EF	**4. E $\rightarrow$ F**
5. F $\rightarrow$ B	5. F $\rightarrow$ B

New was obtained by removing the "defective" parts of **Old**, which produces a trivially equivalent **New**, so there is nothing to do for proving the equivalence. **New** now becomes **Old**.

Old	**New**
1. AB $\rightarrow$ C	**1. A $\rightarrow$ C**
2. A $\rightarrow$ E	2. A $\rightarrow$ E
3. DE $\rightarrow$ F	3. DE $\rightarrow$ F
4. E $\rightarrow$ F	4. E $\rightarrow$ F
5. F $\rightarrow$ B	5. F $\rightarrow$ B

We attempt to simplify 1. in **Old** getting 1. in **New**. **New** could only be stronger, so to prove equivalence we need to prove 1. in **New** from all in **Old**.

We compute A^+ = EFB, and as it contains C, we proved equivalence. **New** becomes **Old**.

Old	**New**
1. A $\rightarrow$ C	1. A $\rightarrow$ C
2. A $\rightarrow$ E	2. A $\rightarrow$ E
3. DE $\rightarrow$ F	**3. E $\rightarrow$ F**
4. E $\rightarrow$ F	4. F $\rightarrow$ B
5. F $\rightarrow$ B	

We attempt to simplify 3. and 4. in **Old** getting 3. in **New**. **New** could only be stronger, so to prove equivalence we need to prove 3. in **New** from all in **Old**.

We compute E^+ = FB, and as it contains F, we proved equivalence. **New** becomes **Old**.

Old	**New**
1. A $\rightarrow$ C	1. **A** $\rightarrow$ **EC**
2. A $\rightarrow$ E	2. E $\rightarrow$ F
3. E $\rightarrow$ F	3. F $\rightarrow$ B
4. F $\rightarrow$ B	

We attempt to simplify 1. and 2. in **Old** getting 1. in **New**. This is an application of the union rule, which always produces an equivalent set. So there is nothing to prove/check and **New** becomes **Old**.

We are done because

(a) There are no defective parts

(b) The union rule cannot be applied

(c) No attributes can be removed from either side, so no simplification is possible

Our minimal cover ω is

1. A $\rightarrow$ EC
2. E $\rightarrow$ F
3. F $\rightarrow$ B

Notes

1. You were not required to attempt simplificiations that you believed would not work
2. You were not required to prove that you actually obtained a minimal cover

3. You are given a relational schema R = ABCDEFGH satisfying the set of FDs:

1. AB $\rightarrow$ CD
2. C $\rightarrow$ EF
3. E $\rightarrow$ C
4. F $\rightarrow$ G

(a) Prove that the given set of FDs is already a minimal cover. To do that show that no simplification is possible. Attempt all simplifications.

To show that a simplification is not possible, you will need to compute the closures of the relevant sets of attributes using the FDs in a relevant set of FDs. Do not use any shortcuts or heuristics.

Old	**New**
1. AB $\rightarrow$ CD	**1. B $\rightarrow$ CD**
2. C $\rightarrow$ EF	2. C $\rightarrow$ EF
3. E $\rightarrow$ C	3. E $\rightarrow$ C
4. F $\rightarrow$ G	4. F $\rightarrow$ G

We attempt to simplify 1. in **Old** getting 1. in **New**. **New** could only be stronger, so to prove equivalence we need to prove 1. in **New** from all in **Old**.

We compute $B^+ = B$. As CD is not in B, we proved non-equivalence. No simplification could be made so we continue with **Old**.

Old	**New**
1. AB $\rightarrow$ CD	**1. A $\rightarrow$ CD**
2. C $\rightarrow$ EF	2. C $\rightarrow$ EF
3. E $\rightarrow$ C	3. E $\rightarrow$ C
4. F $\rightarrow$ G	4. F $\rightarrow$ G

We attempt to simplify 1. in **Old** getting 1. in **New**. **New** could only be stronger, so to prove equivalence we need to prove 1. in **New** from all in **Old**.

We compute $A^+ = A$. As CD is not in A, we proved non-equivalence. No simplification could be made so we continue with **Old**.

Old	**New**
1. AB $\rightarrow$ CD	**1. AB $\rightarrow$ C**
2. C $\rightarrow$ EF	2. C $\rightarrow$ EF
3. E $\rightarrow$ C	3. E $\rightarrow$ C
4. F $\rightarrow$ G	4. F $\rightarrow$ G

We attempt to simplify 1. in **Old** getting 1. in **New**. **New** could only be weaker, so to prove equivalence we need to prove 1. in **Old** from all in **New**.

We compute $AB^+ = ABCEFG$. As D is not in ABCEFG, we proved non-equivalence. No simplification could be made so we continue with **Old**.

Old	**New**
1. AB $\rightarrow$ CD	**1. AB $\rightarrow$ D**
2. C $\rightarrow$ EF	2. C $\rightarrow$ EF
3. E $\rightarrow$ C	3. E $\rightarrow$ C
4. F $\rightarrow$ G	4. F $\rightarrow$ G

We attempt to simplify 1. in **Old** getting 1. in **New**. **New** could only be weaker, so to prove equivalence we need to prove 1. in **Old** from all in **New**.

We compute $AB^+ = ABD$. As C is not in ABD, we proved non-equivalence. No simplification could be made so we continue with **Old**.

Old	**New**
1. AB $\to$ CD	1. AB $\to$ D
2. C $\to$ EF	**2. C $\to$ F**
3. E $\to$ C	3. E $\to$ C
4. F $\to$ G	4. F $\to$ G

We attempt to simplify 2. in **Old** getting 2. in **New**. **New** could only be weaker, so to prove equivalence we need to prove 1. in **Old** from all in **New**.

We compute $C^+ =$ CFG. As E is not in CFG, we proved non-equivalence. No simplification could be made so we continue with **Old**.

Old	**New**
1. AB $\to$ CD	1. AB $\to$ D
2. C $\to$ EF	**2. C $\to$ E**
3. E $\to$ C	3. E $\to$ C
4. F $\to$ G	4. F $\to$ G

We attempt to simplify 2. in **Old** getting 2. in **New**. **New** could only be weaker, so to prove equivalence we need to prove 1. in **Old** from all in **New**.

We compute $C^+ =$ CE. As F is not in CE, we proved non-equivalence. No simplification could be made so we continue with **Old**.

We are done because

i. There are no defective parts

ii. The union rule cannot be applied

iii. No attributes can be removed from either side, so no simplification is possible

Since we could not make any simplifications, the given set of FDs is already a minimal cover.

(b) Produce a decomposition satisfying the conditions for **Output** in Section 3.2.

From the minimal cover ω above, we get the following tables/relations

1. ABCD
2. CEF
3. EC
4. FG

We remove EC because it is a subset of CEF and we get

1. ABCD
2. CEF
3. FG

We now proceed to get a global key for R. Perhaps one of the 4 tables already includes a global key for R. We compute

1. $ABCD^+ = ABCDEFG$
2. $CEF^+ = CEFG$
3. $FG^+ = FG$

but we need R = ABCDEFGH.

Or we can directly conclude that none of the 4 tables could include a global key for R because the attribute H does not appear in any of the 3 tables.

We examine all the attributes of R using the FDs that are satisfied. It is simplest to use the minimal cover. We classify the attributes based on where they appear in FDs.

On both sides	Left side only	right side only	Nowhere
C, E, F	A, B	D, G	H

A, B, H appear in every key. D, G do not appear in any key. C, E, F may appear in a key. We start with A, B, H, C, E, F which must contain a key. We cannot try to remove A, B, H but may try to remove C, E, F.

We attempt to remove C. We compute $ABHEF^+ = ABHEFCDG = R$. We can remove C and we continue with ABHEF.

We attempt to remove E. We compute $ABHF^+ = ABHFCDEG = R$. We can remove E and we continue with ABHF.

We attempt to remove F. We compute $ABH^+ = ABHCDEFG = R$. We can remove F and we continue with ABH.

Nothing else can be done so ABH is a global key.

Our final decomposition is

1. ABCD
2. CEF
3. FG
4. ABH