Exercise 3 - Solution

Q1.

No, AB+ = {A,B,C},a proper subset of {A,B,C,D,E}

Yes, ABD+ = {A,B,C,D,E}

Q2.

Let us use the following shorthand notation:

C = CourseNo, SN = SecNo, OD = OfferingDept, CH = CreditHours, CL = CourseLevel,

I = InstructorSSN, S = Semester, Y = Year, D = Days_Hours, RM = RoomNo,

NS = NoOfStudents

Hence, R = {C, SN, OD, CH, CL, I, S, Y, D, RM, NS}, and the following functional

dependencies hold:

{C} -> {OD, CH, CL}

{C, SN, S, Y} -> {D, RM, NS, I}

{RM, D, S, Y} -> {I, C, SN}

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(1) {C}+ = {C, OD, CH, CL}

(2) Since {C, SN, S, Y} -> {D, RM, NS, I}, and {C}+ = {C, OD, CH, CL},

{C, SN, S, Y}+ = {C, SN, S, Y, D, RM, NS, I, OD, CH, CL} = R

(3) Since {RM, D, S, Y} -> {I, C, SN}, we know that {RM, D, S, Y}+ contains {RM, D, S,

Y, I, C, SN}. But {C}+ contains {OD, CH, CL} so these are also contained in {RM, D, S,

Y}+ since C is already there. Finally, since {C, SN, S, Y} are now all in {RM, D, S, Y}+

and {C, SN, S, Y}+ contains {NS} (from (2) above), we get:

{RM, D, S, Y}+ = {RM, D, S, Y, I, C, SN, OD, CH, CL, NS} = R

Hence, both K1 = {C, SN, S, Y} and K2 = {RM, D, S, Y} are (candidate) keys of R.

Q3.

(a)The key for this relation is Book_title,Authorname. This relation is in 1NF and not in 2NF as no attributes are FFD on the key. It is also not in 3NF.

(b)

3NF decomposition:

Book0(Book_title, Authorname)

Book1-1(Book_title, Publisher, Book_type)

Book1-2(Book_type, Listprice)

Book2(Authorname, Author_affil)

Q4.

(a)

- {M} IS NOT a candidate key since it does not functionally determine attributes Y or P.

- {M, Y} IS a candidate key since it functionally determines the remaining attributes P, MP, and C.

- {M, C} IS NOT a candidate key since it does not functionally determine attributes Y or P.

(b)

REFRIG is not in 2NF, due to the partial dependency {M, Y} -> MP (since {M} -> MP holds). Therefore REFRIG is neither in 3NF nor in BCNF.

Alternatively: BCNF can be directly tested by using all of the given dependencies and finding out if the left hand side of each is a superkey (or if the right hand side is a prime attribute). In the two fields in REFRIG: M -> MP and MP -> C. Since neither M nor MP is a superkey, we can conclude that REFRIG is is neither in 3NF nor in BCNF.

(c) Yes. Please follo

Q5.

1) List the candidate keys for R.

EH/ABH/BDH/CDH

2) Determine the highest normal form of R with resp

1NF. Non-prime attribute G is functionally determined by D.

3) Is the decomposition $\{ABCD, DEGH\}$ (with the same FD set F) of R lossless-join?

No.

Decomposition	A	B	C	D	E	G	H
$R_1(A,B,C,D)$	a	a	a	**a**	b	b	b
$R_2(D,E,G,H)$	b	b	b	**a**	a	a	a

Decomposition	A	B	C	D	E	G	H
$R_1(A,B,C,D)$	a	a	a	a	b	**a**	b
$R_2(D,E,G,H)$	**a**	b	b	a	a	a	a

4) Find a minimal cover F_m for F.

$F_m = \{AB \to C, D \to A, D \to G, E \to B, AB \to D, E \to A, CD \to E\}$

5) Decompose into a set of 3NF relations if it is not in 3NF. Make sure your decomposition is dependency-preserving and lossless-join.

For $F_m = \{AB \rightarrow C, D \rightarrow A, D \rightarrow G, E \rightarrow B, AB \rightarrow D, E \rightarrow A, CD \rightarrow E\}$:

From $AB \rightarrow C, AB \rightarrow D$, derive $R_1\{A, B, C, D\}$

From $D \rightarrow A, D \rightarrow G$, derive $R_2\{A, D, G\}$

From $E \rightarrow B, E \rightarrow A$, derive $R_3\{A, B, E\}$

From $CD \rightarrow E$, derive $R_4\{C, D, E\}$

None of the relation schemas contains a key of R, add one relation schema $R_5\{E, H\}$

6) Decompose it into a collection of BCNF relations if it is not in BCNF. Make sure your decomposition is lossless-join.