HW2 Part-C
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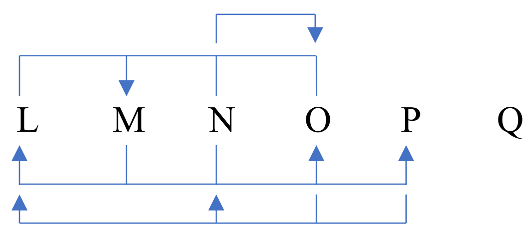
Part C: Functional Dependencies

C-1 Transitive Dependency and Keys

You have a relation R(L,M,N,O,P,Q) R(A,B,C,D,E,F) and a set of functional dependencies F = {LNO→M, MN→LOP, N→O, OP→LN}.

- [2pt] Can we infer NP → LM from F ?
- [3pt] Can we infer NQ → LO from F ?

Solution:



Iterations:

X = {N,P,O} Use: N→O

X = {N,P,O,L} Use: OP→LN

X = {N,P,O,L,M} Use: LNO→M

X = {N,P,O,L,M} Use: MN→LOP

X = {N,P,O,L,M} No more changes to X are possible so X = $\{N,P\}^+$

So, we can infer NP → LM from F.

Iterations:

X = {N,Q,O} Use: N→O

X = {N,Q,O} No more changes to X are possible so X = $\{N,Q\}^+$

So, we cannot infer NQ → LO from F.

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C-2 Keys

(i) [5pt] Find **all** the candidate keys of the Relation R(ABCDE) with FD's:

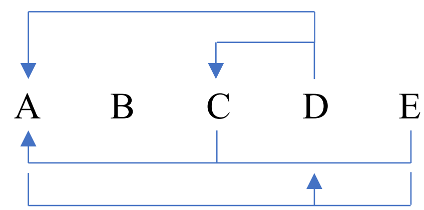
$D \rightarrow C$, $CE \rightarrow A$, $D \rightarrow A$, and $AE \rightarrow D$

(ii) [5pt] Determine **all** the candidate and superkeys of the relation R(ABCDEF) with FD's:

$AEF \rightarrow C$, $BF \rightarrow C$, $EF \rightarrow D$, and $ACDE \rightarrow F$

Solution:

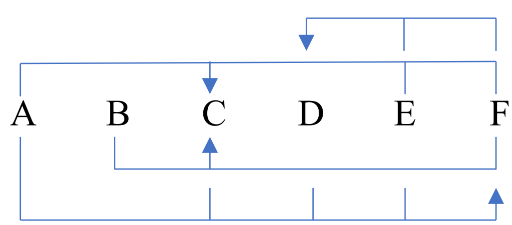
i.



There is no incoming arrow to B and E, so BE cannot be determined by others. It has to be on the left side.

BE → BE
BEA → BEADC
BEC → BECAD
BED → BEDCA
So, the candidate keys are BEA, BEC, BED.

ii.



There is no incoming arrow to A, B and E, so ABE cannot be determined by others. It has to be on the left side.

ABE → ABE
ABEC → ABEC
ABED → ABED
ABEF → ABEFDC
ABECD → ABECDF
ABECF → ABECFD
ABEDF → ABEDFC
ABECDF → ABECDF

So, the candidate keys are ABEF and ABECD. Superkeys are ABEF, ABECD, ABEFC, ABEFD, ABECDF.

C-3 Minimal Cover

[5pt] Find a minimal cover for the following set F of functional dependencies.
A→BC
AB→D
C→AD
D→B
Show your working clearly. Points will be deducted if you do not show the extraneous attributes, and their elimination.

Solution:

F	**F'$_0$**	**F'$_1$**	**F'$_2$**	**F'$_3$**	**F'$_4$**	**F'$_5$**
		Is A→B?	Is A→C?	Is C→A?	Is C→D?	Is D→B?
A→BC AB→D C→AD D→B	A→B A→C AB→D C→A C→D D→B	 A→C AB→D C→A C→D D→B	 AB→D C→A C→D D→B	 A→C AB→D C→D D→B	 A→C AB→D C→A D→B	 A→C AB→D C→A C→D
		A→C→ D→B	NO	NO	NO	NO

F'$_5$ = {A→C, AB→D, C→A, C→D, D→B}. For AB→D we can easily tell A→B, so it's A→D. But A→D can be derived from A→C and C→D.
Finally, F_c = {A → C, C → AD, D→B}

C-4 Equivalence (15 points)

[10pt] Consider the following set of F.Ds. Determine if FD1 is equivalent to FD2 or to FD3:
FD1:
{BC→D, ACD→B, CG→B, CG→D, AB→C, C→A, D→E, BE→C, D→G, CE→A, CE→G}
FD2:
{AB→C, C→A, BC→D, CD→B, D→E, D→G, BE→C, CG→D}
FD3:
{AB→C, C→A, D→G, BE→C, CG→D, CE→G, BC→D, CD→B, D→E}s

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$FD1_{FD1}$: $(BC)^+$ = BCADEG, $(ACD)^+$ = ACDBEG, $(CG)^+$ = CGBDAE, $(AB)^+$ = ABCDEG, C^+ = CA, D^+ = DEG, $(BE)^+$ = BECDAG, $\underline{(CE)^+ = CEAGBD}$

$FD1_{FD2}$: $(BC)^+$ = BCADEG, $(ACD)^+$ = ACDEGB, $(CG)^+$ = CGADEB, $(AB)^+$ = ABCDEG, C^+ = CA, D^+ = DEG, $(BE)^+$ = BECADG, $\underline{(CE)^+ = CEA}$

$FD1_{FD3}$: $(BC)^+$ = BCADEG, $(ACD)^+$ = ACDEGB, $(CG)^+$ = CGADEB, $(AB)^+$ = ABCDEG, C^+ = CA, D^+ = DGE, $(BE)^+$ = BECADG, $\underline{(CE)^+ = CEAGDB}$

$FD2_{FD2}$: $(AB)^+$ = ABCDEG, C^+ = CA, $(BC)^+$ = BCADEG, $(CD)^+$ = CDBAEG, D^+ = DEG, $(BE)^+$ = BECADG, $(CG)^+$ = CGADEB

$FD2_{FD1}$: $(AB)^+$ = ABCDEG, C^+ = CA, $(BC)^+$ = BCDEGA, $(CD)^+$ = CDAEGB, D^+ = DEG, $(BE)^+$ = BECADG, $(CG)^+$ = CGBDEA

$FD3_{FD3}$: $(AB)^+$ = ABCDEG, C^+ = CA, D^+ = DEG, $(BE)^+$ = BECADG, $(CG)^+$ = CGADEB, $(CE)^+$ = CEAGDB, $(BC)^+$ = BCDEGA, $(CD)^+$ = CDAEGB, D^+ = DEG

$FD3_{FD1}$: $(AB)^+$ = ABCDEG, C^+ = CA, D^+ = DEG, $(BE)^+$ = BECADG, $(CG)^+$ = CGDEAB, $(CE)^+$ = CEAGBD, $(BC)^+$ = BCDEGA, $(CD)^+$ = CDAEGB, D^+ = DEG

$(CE)^+$ in FD1 doesn't have the same closure as that in FD2. So FD1 and FD2 are not equivalent. FD1 and FD3 have the same search power. So FD1 is equivalent to FD3.