

HW3

19.2

CD | AB | E

CD^+ CDA^+ CDB^+ CDE^+
 X CDAE CDBEA CDEAB

Keys: ACD, BCD, CDE prime: ABCDE

All attributes are prime: 3NF ✓

A, BC, ED are not superkeys: BCNF violation

R is in 3NF but not in BCNF.

19.3

$Z \rightarrow Y$ X
 $X \rightarrow Y$
 $XZ \rightarrow Y$

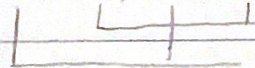
2. Same thing so $Z \rightarrow Y$
 $X \rightarrow Y$
 $XZ \rightarrow Y$

19.5.1

$A \rightarrow B, C \rightarrow D$
 ACE | BD | BD

ACE^+ keys: ACE
 ACEBD non-prime: BD

$A \rightarrow B, C \rightarrow D$



non-prime 2NF violation so 1NF
sub-part of key

BCNF violation $A \rightarrow B$ \longleftrightarrow $R_1 = AB$ $R_3 = ACE$
 $C \rightarrow D$ \longrightarrow $R_2 = CD$

1NF, BCNF decomposition: AB, CD, ACE

2. $AC \rightarrow E, B \rightarrow F$

ABC	EF
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ABC^+ keys: ABC
 $ABCE^+F$ non-prime: EF

$AC \rightarrow E \quad B \rightarrow F$

non-prime 2NF violation
 subpart of k so 1NF

BCNF violation $B \rightarrow F \longrightarrow BF$
 $E \longrightarrow AB$

1NF, BCNF decomposition: AB, BF

3. $D \rightarrow G, G \rightarrow H$

D	G	H
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D^+ keys: D
 DGH

D, G, and H aren't all present in the R3 relation
BCNF

4. $A \rightarrow I, I \rightarrow A$

A and I aren't all present in the R4 relation
BCNF

5. There are no functional dependencies given.
BCNF

19.61. b. $BC \rightarrow A$

2. No, we can only say that some dependencies aren't violated in this instance, like $A \rightarrow B$ and $B \rightarrow C$.

19.71. $C \rightarrow D, C \rightarrow A, B \rightarrow C$

B	C	AD	B^+ BCDA	keys: B non-prime: ACD
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B is a singleton so at least 2NF

$C \rightarrow D$ = not a superkey \rightarrow non-prime: 3NF violation

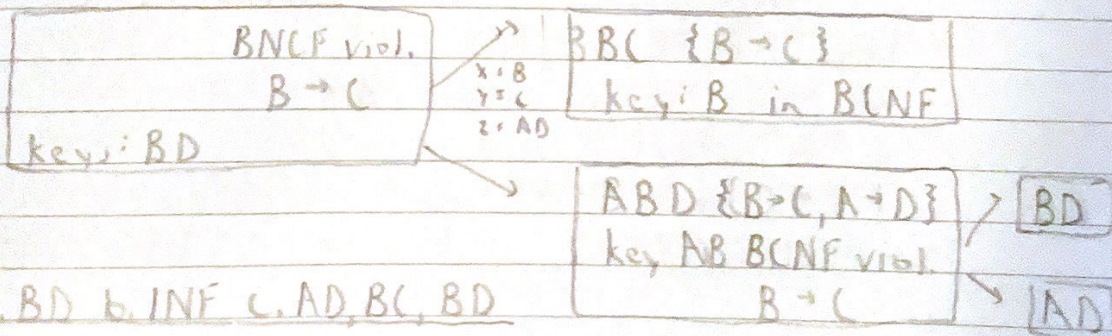
$C \rightarrow D$ and $C \rightarrow A$ are BCNF violations because B is key, so CD, CA, BC.

a. B b. 1NF c. CD, CA, BC

2. $B \rightarrow C, D \rightarrow A$

BD	AC	BD^+ BDCA	keys: BD non-prime: AC
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$B \rightarrow C$ 2NF violation
 $\underbrace{\quad\quad}_\text{subset of key} \rightarrow$ non-prime



a. BD b. 1NF c. AD, BC, BD

3. $ABC \rightarrow D, D \rightarrow A$

		BC^+	BCA^+	BCD^+
BC	AD	BC	BCAD	BCDA

keys: ABC, BCD all prime so at least 3NF

all prime so at least 3NF

$D \rightarrow A$, where D not superkey so BCNF violation.

No way to preserve $ABC \rightarrow D$

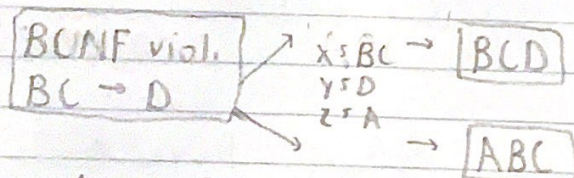
a. ABC, BCD b. 3NF c. No BCNF decomposition.

4. $A \rightarrow B, BC \rightarrow D, A \rightarrow C$

		A^+	keys: A
A	BCD	ABCD	non-prime: BCD

A is singleton so at least 2NF

$BC \rightarrow D$ not a superkey \rightarrow non-prime: 3NF violation



a. A b. 2NF c. ABC, BCD

5. $AB \rightarrow C, AB \rightarrow D, C \rightarrow A, D \rightarrow B$

	AB^+	BC^+	CD^+	AD^+
ABCD	ABCD	BCAD	CDAB	ADBC

keys: AB, BC, CD, AD

all prime so at least 3NF

$C \rightarrow A$ where C not a superkey so BCNF violation.

$AB \rightarrow C$ and $AB \rightarrow D$ won't be preserved.

a. AB, BC, CD, AD b. 3NF c. No BCNF decomposition.

19.81. a. i. $AB \rightarrow C, AC \rightarrow B, BC \rightarrow A$

Already a minimal cover.

ii. In BCNF since AB, AC, BC all candidate keys for ABC .

iii. No decomposition, since in BCNF.

b. i. $AB \rightarrow C, AC \rightarrow B, B \rightarrow D, BC \rightarrow A$

Already a minimal cover.

ii. In INF

ABC	D

keys: AB, AC, BC
 $B \rightarrow D$

subset of key \rightarrow non-prime
 2NF viol.

iii. ABC, BD $\boxed{B \rightarrow D} \rightarrow \begin{matrix} x: B \rightarrow \boxed{BD} \\ y: D \rightarrow \boxed{BD} \\ z: AC \rightarrow \boxed{ABC} \end{matrix}$

c. i. $AB \rightarrow C, AC \rightarrow B, BC \rightarrow A, E \rightarrow G$

Already a minimal cover.

ii. In INF

E	ABC	G
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keys: ABE, ACE, BCE
 $E \rightarrow G$

subset of key \rightarrow non-prime
 2NF viol.

iii. ABC, ABE, EG $\boxed{E \rightarrow G} \rightarrow \begin{matrix} x: E \rightarrow \boxed{EG} \\ y: G \rightarrow \boxed{EG} \\ z: ABC \rightarrow \boxed{ABCE} \end{matrix} \rightarrow \begin{matrix} \boxed{ABCE} \rightarrow \boxed{ABC} \\ \rightarrow \boxed{ABE} \end{matrix}$

d. i. $E \rightarrow G$

Already a minimal cover.

ii. In 1NF

CDEH	G
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keys: CDEH

$E \rightarrow G$

subset of key \rightarrow non-prime
2NF viol.

iii. CDEH, EG

$E \rightarrow G$

$x = E$
 $y = G$
 $z = CDEH$

\rightarrow EG

CDEH

e. i. No FDs

This is a minimal cover.

ii. In BCNF

ACEH

key: ACEH

iii. No decomposition, since in BCNF.

2. a. is a dependency-preserving

b. is b. lossless-join