

Question 1:

$\Pi_{P.pid} (P \bowtie_{K1.pid1=P.pid} K1 \bowtie_{K2.pid1=P.pid \wedge K1.pid2 <> K2.pid2} K2 \bowtie_{(W.pid=K1.pid2 \vee W.pid=K2.pid2) \wedge (W.cname='Apple' \vee W.cname='Netflix')} W)$

$\Pi_{P.pid} (P \bowtie_{K1.pid1=P.pid} K1 \bowtie_{K2.pid1=P.pid \wedge K1.pid2 <> K2.pid2} K2 \bowtie_{(W.pid=K1.pid2 \vee W.pid=K2.pid2)} (\sigma_{W.cname='Apple' \vee W.cname='Netflix'} W))$

-> Push selection in

$\Pi_{P.pid} (P \bowtie_{K1.pid1=P.pid} K1 \bowtie_{K2.pid1=P.pid \wedge K1.pid2 <> K2.pid2} K2 \bowtie_{(W.pid=K1.pid2 \vee W.pid=K2.pid2)} \Pi_{W.pid} (\sigma_{W.cname='Apple' \vee W.cname='Netflix'} W))$

-> Attribute elimination

$\Pi_{P.pid} (P \bowtie_{K1.pid1=P.pid \wedge K1.pid2 <> K2.pid2} K2 \bowtie_{(W.pid=K1.pid2 \vee W.pid=K2.pid2)} \Pi_{W.pid} (\sigma_{W.cname='Apple' \vee W.cname='Netflix'} W)))$

-> Semi Join

Question 2:

$$Q_1 = \Pi_{P.pid, C.cname}(P \bowtie W \bowtie C \bowtie M_{M.eid=P.pid} \bowtie pS1_{pS1.pid=M.mid} \bowtie pS2_{pS2.pid=M.mid \wedge pS1.skill <> pS2.skill})$$

$$Q_1 = \Pi_{W.pid, W.cname}(W \bowtie M_{M.eid=W.pid} \bowtie pS1_{pS1.pid=M.mid} \bowtie pS2_{pS2.pid=M.mid \wedge pS1.skill <> pS2.skill})$$

-> FK elimination

$$Q_2 = \Pi_{P.pid, C.cname}(P \bowtie W \bowtie C)$$

$$Q_2 = \Pi_{W.pid, W.cname}(W) \text{ -> FK elimination}$$

$$Q_3 = \Pi_{P.pid, C.cname}(P \bowtie W \bowtie C \bowtie K_{K.pid1=P.pid} \bowtie P1_{P1.pid=K.pid2 \wedge P1.city='Seattle'})$$

$$Q_3 = \Pi_{W.pid, W.cname}(W \bowtie K_{K.pid1=W.pid} \bowtie P1_{P1.pid=K.pid2 \wedge P1.city='Seattle'}) \text{ -> FK elimination}$$

$$Q_3 = \Pi_{W.pid, W.cname}(W \bowtie K_{K.pid1=W.pid} \bowtie P1_{P1.pid=K.pid2}(\sigma_{P1.city='Seattle'} P1)) \text{ -> Push Selection In}$$

$$Q_1 \cap (Q_2 - Q_3)$$

Question 3:

$$\Pi_{S.Skill} (S \bowtie_{pS1.Skill=pS2.Skill \wedge pS1.pid < > pS2.pid} pS2 \bowtie_{P.city='Bloomington' \wedge (P.pid=pS1.pid \vee P.pid=pS2.pid)} P)$$

$$\Pi_{S.Skill} (S \bowtie_{pS1.Skill=pS2.Skill \wedge pS1.pid < > pS2.pid} pS2 \bowtie_{(P.pid=pS1.pid \vee P.pid=pS2.pid) \wedge P.city='Bloomington'} P)$$

-> Commutativity Rule

$$\Pi_{S.Skill} (S \bowtie_{pS1.Skill=pS2.Skill \wedge pS1.pid < > pS2.pid} pS2 \bowtie_{P.pid=pS1.pid \vee P.pid=pS2.pid} (\sigma_{P.city='Bloomington'} P))$$

-> Push selection In

$$\Pi_{S.Skill} (S \bowtie_{pS1.Skill=pS2.Skill \wedge pS1.pid < > pS2.pid} pS2 \bowtie_{(P.pid=pS1.pid \vee P.pid=pS2.pid)} \Pi_{P.pid} (\sigma_{P.city='Bloomington'} P))$$

-> Attribute Elimination

$$\Pi_{pS1.Skill} (pS1 \bowtie_{pS1.Skill=pS2.Skill \wedge pS1.pid < > pS2.pid} pS2 \bowtie_{(P.pid=pS1.pid \vee P.pid=pS2.pid)} \Pi_{P.pid} (\sigma_{P.city='Bloomington'} P))$$

-> FK Elimination

Question 4:

$$Q_1 = \Pi_{P.pid} (P \bowtie_{W.pid=P.pid} W \bowtie_{W.cname=C.cname \wedge C.headquarter='MountainView'} C)$$

$$Q_1 = \Pi_{P.pid} (P \bowtie_{W.pid=P.pid} W \bowtie_{W.cname=C.cname} (\sigma_{C.headquarter='MountainView'} C))$$

-> Push Selection In

$$Q_1 = \Pi_{W.pid} (W \bowtie_{W.cname=C.cname} (\sigma_{C.headquarter='MountainView'} C))$$

-> FK Elimination

$$Q_1 = \Pi_{W.pid} (W \bowtie (\sigma_{C.headquarter='MountainView'} C))$$

-> Semi Join

$$Q_2 = \Pi_{Q1.Pid, W.salary} (Q_1 \bowtie_{K.pid2=Q1.pid} K \bowtie_{W.pid=K.pid1} W)$$

$$\Pi_{pid, salary} (Q_2 - \Pi_{Q2} . (Q_2 \bowtie_{Q2.salary > Q_2^1.salary \wedge Q2.pid = Q_2^1.pid} Q_2^1))$$

Question 5:

$$Q_1 = \Pi_{C.name}(C \bowtie W \bowtie_{(pS.pid=W.pid \wedge pS.skill='OperatingSystems')} pS)$$

$$Q_1 = \Pi_{C.name}(C \bowtie W \bowtie_{pS.pid=W.pid}(\sigma_{pS.skill='OperatingSystems'} pS)) \rightarrow \text{Push Selection In}$$

$$Q_1 = \Pi_{W.name}(W \bowtie_{pS.pid=W.pid}(\sigma_{pS.skill='OperatingSystems'} pS)) \rightarrow \text{FK Elimination}$$

$$Q_1 = \Pi_{W.name}(W \bowtie_{pS.pid=W.pid} \Pi_{pS.pid}(\sigma_{pS.skill='OperatingSystems'} pS)) \rightarrow \text{Attribute Elimination}$$

$$Q_1 = \Pi_{W.name}(W \bowtie \Pi_{pS.pid}(\sigma_{pS.skill='OperatingSystems'} pS)) \rightarrow \text{Semi Join}$$

$$Q_2 = \Pi_{C.name}(C \bowtie W1 \bowtie_{C.name=W2.name \wedge W1.pid <> W2.pid} W2 \bowtie_{W1.pid=P1.pid} P1 \bowtie_{P1.city <> P2.city \wedge W2.pid=P2.pid} P2)$$

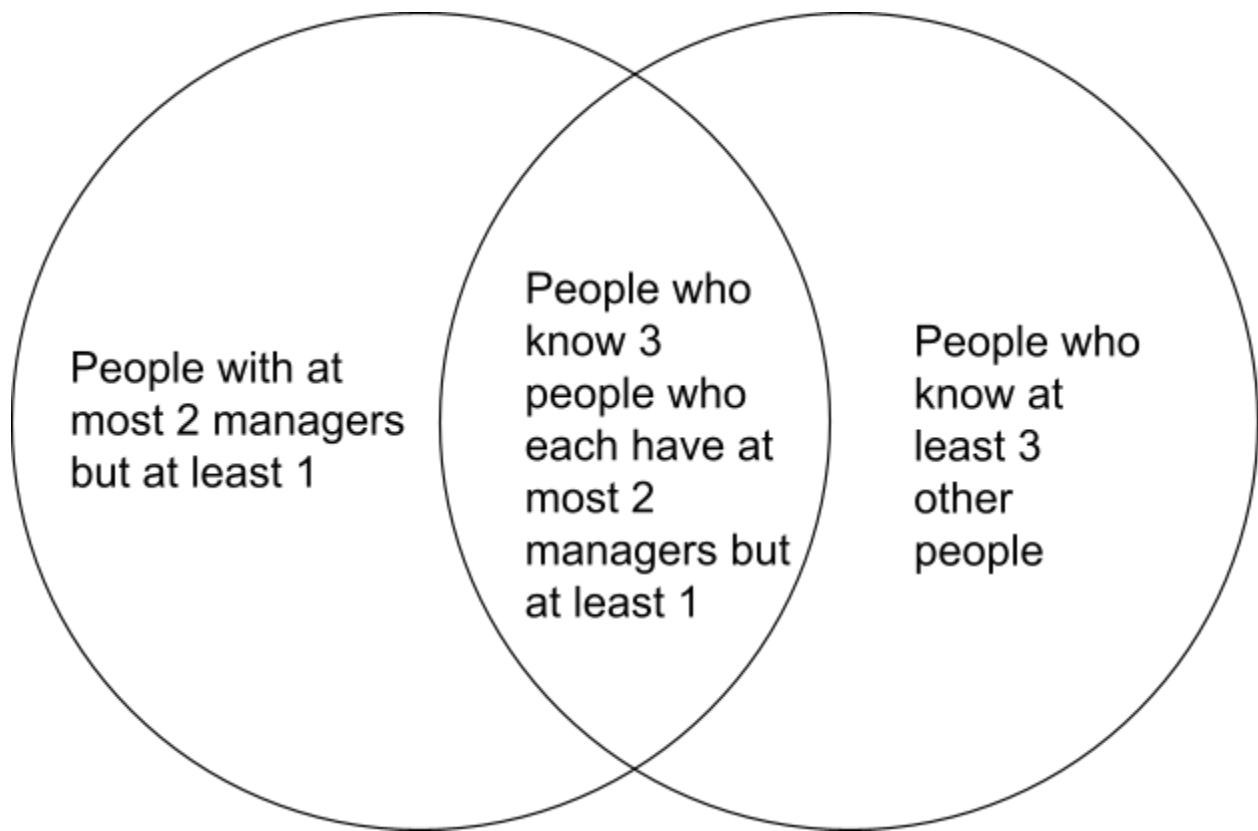
$$Q_2 = \Pi_{W1.name}(W1 \bowtie_{W1.name=W2.name \wedge W1.pid <> W2.pid} W2 \bowtie_{W1.pid=P1.pid} P1$$

$$\bowtie_{P1.city <> P2.city \wedge W2.pid=P2.pid} P2)$$

\rightarrow FK Elimination

$$Q_1 \cap Q_2$$

Question 9:



Question 10:

