Problem 8. Formulate the following query in the relational algebra: You can use the abbreviations P, C, jS, pS, W, and M for the relations Person, Company, JobSkill, PersonSkill, worksFor, and Manages.

Find the cname of each company that is located in 'Bloomington' but in no other city.

$$\pi_{cname}(\sigma_{city\,=\,Bloomington}\,(C)) - \pi_{cname}(\sigma_{city\,\neq\,Bloomington}\,(C))$$

Problem 9. Formulate the following query in the relational algebra: You can use the abbreviations P, C, jS, pS, W, and M for the relations Person, Company, JobSkill, PersonSkill, worksFor, and Manages.

Find the cname of each company that not only employs persons who live in Bloomington or in Indianapolis.

$$\pi_{cname}(C) - \pi_{cname}(C \bowtie W \bowtie \sigma_{city\,=\,Bloomington\,\lor\,city\,=\,Indianapolis}\,(P))$$

Problem 12. Optimize the following relational algebra expression. Show the intermediate steps and specify the optimization rule(s) that you have used.

1. Given RA

$$\pi_{P.pid}(\sigma_{P.pid=W.pid\,\land\,W.salary=20000\,\land\,W.pid=M.mid\,\land\,M.eid=1001}(PXWXM))$$

2. PUSH SELECTION AND PROJECTION OVER JOIN FOR M

$$\pi_{P.pid}(\sigma_{P.pid=W.pid\,\land\,W.salary=20000}(PXW \bowtie_{W.pid=M.mid} (\pi_{mid}(\sigma_{M.eid=1001}(M)))$$

3. PUSH SELECTION AND PROJECTION OVER JOIN FOR W

$$\pi_{P.pid}(P \bowtie_{P.pid=W.pid} (\pi_{pid}(\sigma_{W.salary=20000}(W))) \bowtie_{W.pid=M.mid} (\pi_{mid}(\sigma_{M.eid=1001}(M)))$$

4. REMOVE P BASED ON FOREIGN KEY

$$\pi_{W.pid}((\pi_{pid}(\sigma_{W.salary=20000}(W))) \bowtie_{W.pid=M.mid} (\pi_{mid}(\sigma_{M.eid=1001}(M)))$$