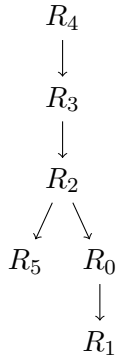


9 Exercise Sheet 9

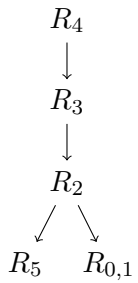
9.1 Exercise 1

9.1.1 linearize the search space

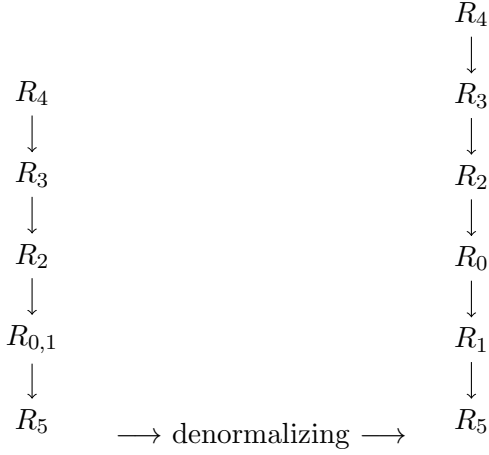


Relation	n	s	C	T	rank
R_3	40	0.3	12	12	$\frac{11}{12} = 0.9167$
R_2	50	0.2	10	10	$\frac{9}{10} = 0.9$
R_5	55	0.2	11	11	$\frac{10}{11} = 0.9091$
R_0	20	0.2	4	4	$\frac{3}{4} = 0.75$
R_1	10	0.1	1	1	0

merge R_0 and R_1



Relation	n	s	C	T	rank
R_3	40	0.3	12	12	$\frac{11}{12} = 0.9167$
R_2	50	0.2	10	10	$\frac{9}{10} = 0.9$
R_5	55	0.2	11	11	$\frac{10}{11} = 0.9091$
$R_{0,1}$			8	4	$\frac{3}{8} = 0.375$
R_0	20	0.2	4	4	$\frac{3}{4} = 0.75$
R_1	10	0.1	1	1	0



9.1.2 perform linearized DP

$R_4 \quad R_3 \quad R_2 \quad R_0 \quad R_1 \quad R_5$

Two Relations:

$(R_4 \bowtie R_3)$	R_2	R_0	R_1	R_5	$\{R_3, R_4\}$	$C_{out} = 600$
R_4	$(R_3 \bowtie R_2)$	R_0	R_1	R_5	$\{R_2, R_3\}$	$C_{out} = 400$
R_4	R_3	$(R_2 \bowtie R_0)$	R_1	R_5	$\{R_0, R_2\}$	$C_{out} = 200$
R_4	R_3	R_2	$(R_0 \bowtie R_1)$	R_5	$\{R_0, R_1\}$	$C_{out} = 20$
R_4	R_3	R_2	R_0	$(R_1 \bowtie R_5)$	$\{R_1, R_5\}$	\nexists

Three Relations:

$(R_4 \bowtie (R_3 \bowtie R_2))$	R_0	R_1	R_5	$\{R_2, R_3, R_4\}$	$C_{out} = 6400$
$((R_4 \bowtie R_3) \bowtie R_2)$	R_0	R_1	R_5	$\{R_2, R_3, R_4\}$	$C_{out} = 6600$
R_4	$(R_3 \bowtie (R_2 \bowtie R_0))$	R_1	R_5	$\{R_0, R_2, R_3\}$	$C_{out} = 1800$
R_4	$((R_3 \bowtie R_2) \bowtie R_0)$	R_1	R_5	$\{R_0, R_2, R_3\}$	$C_{out} = 2000$
R_4	R_3	$(R_2 \bowtie (R_0 \bowtie R_1))$	R_5	$\{R_0, R_1, R_2\}$	$C_{out} = 220$
R_4	R_3	$((R_2 \bowtie R_0) \bowtie R_1)$	R_5	$\{R_0, R_1, R_2\}$	$C_{out} = 400$
R_4	R_3	R_2	$(R_0 \bowtie (R_1 \bowtie R_5))$	$\{R_0, R_1, R_5\}$	\nexists
R_4	R_3	R_2	$((R_0 \bowtie R_1) \bowtie R_5)$	$\{R_0, R_1, R_5\}$	\nexists

Four Relations:

$(R_4 \bowtie (R_3 \bowtie (R_2 \bowtie R_0)))$	R_1	R_5	$\{R_0, R_2, R_3, R_4\}$	$C_{out} = 24400$
$(R_4 \bowtie R_3) \bowtie (R_2 \bowtie R_0)$	R_1	R_5	$\{R_0, R_2, R_3, R_4\}$	$C_{out} = 24800$
$((R_4 \bowtie (R_3 \bowtie R_2)) \bowtie R_0)$	R_1	R_5	$\{R_0, R_2, R_3, R_4\}$	$C_{out} = 30400$
R_4	$(R_3 \bowtie (R_2 \bowtie (R_0 \bowtie R_1)))$	R_5	$\{R_0, R_1, R_2, R_3\}$	$C_{out} = 1820$
R_4	$(R_3 \bowtie R_2) \bowtie (R_0 \bowtie R_1)$	R_5	$\{R_0, R_1, R_2, R_3\}$	$C_{out} = 2020$
R_4	$((R_3 \bowtie (R_2 \bowtie R_0)) \bowtie R_1)$	R_5	$\{R_0, R_1, R_2, R_3\}$	$C_{out} = 3400$
R_4	R_3	$((R_2 \bowtie (R_0 \bowtie R_1)) \bowtie R_5)$	$\{R_0, R_1, R_2, R_5\}$	$C_{out} = 2420$

Five Relations:

$(R_4 \bowtie (R_3 \bowtie (R_2 \bowtie (R_0 \bowtie R_1))))$	R_5	$\{R_0, R_1, R_2, R_3, R_4\}$	$C_{out} = 24000 + 1820 = 25820$
$((R_4 \bowtie R_3) \bowtie (R_2 \bowtie (R_0 \bowtie R_1)))$	R_5	$\{R_0, R_1, R_2, R_3, R_4\}$	$C_{out} = 24000 + 220 + 600 = 24820$

$$\begin{aligned}
& ((R_4 \bowtie (R_3 \bowtie R_2)) \bowtie (R_0 \bowtie R_1)) \bowtie R_5 \longrightarrow \{R_0, R_1, R_2, R_3, R_4\} \longrightarrow C_{out} = 24000 + 6400 + 20 = 30420 \\
& ((R_4 \bowtie (R_3 \bowtie (R_2 \bowtie R_0))) \bowtie R_1) \bowtie R_5 \longrightarrow \{R_0, R_1, R_2, R_3, R_4\} \longrightarrow C_{out} = 24000 + 24400 = 48400 \\
& R_4 \longrightarrow (R_3 \bowtie ((R_2 \bowtie (R_0 \bowtie R_1)) \bowtie R_5)) \longrightarrow \{R_0, R_1, R_2, R_3, R_5\} \longrightarrow C_{out} = 17600 + 2420 = 20020 \\
& R_4 \quad ((R_3 \bowtie (R_2 \bowtie (R_0 \bowtie R_1))) \bowtie R_5) \quad \{R_0, R_1, R_2, R_3, R_5\} \quad C_{out} = 17600 + 1820 = 19420
\end{aligned}$$

Six Relations:

$$\begin{aligned}
& (R_4 \bowtie ((R_3 \bowtie (R_2 \bowtie (R_0 \bowtie R_1))) \bowtie R_5)) \longrightarrow \{R_0, R_1, R_2, R_3, R_5\} \longrightarrow C_{out} = 264000 + 19420 = 283420 \\
& ((R_4 \bowtie R_3) \bowtie ((R_2 \bowtie (R_0 \bowtie R_1)) \bowtie R_5)) \quad \{R_0, R_1, R_2, R_3, R_5\} \quad C_{out} = 264000 + 600 + 2420 = 267020 \\
& ((R_4 \bowtie (R_3 \bowtie (R_2 \bowtie (R_0 \bowtie R_1))) \bowtie R_5)) \longrightarrow \{R_0, R_1, R_2, R_3, R_5\} \longrightarrow C_{out} = 264000 + 25820 = 289820
\end{aligned}$$

9.1.3 perform a full DP

Size = 2:

$$\begin{aligned}
& \{R_0, R_1\} \\
& (R_0 \bowtie R_1) \quad C_{out} = 20
\end{aligned}$$

$$\begin{aligned}
& \{R_0, R_2\} \\
& (R_0 \bowtie R_2) \quad C_{out} = 200
\end{aligned}$$

$$\begin{aligned}
& \{R_2, R_3\} \\
& (R_2 \bowtie R_3) \quad C_{out} = 400
\end{aligned}$$

$$\begin{aligned}
& \{R_2, R_5\} \\
& (R_2 \bowtie R_5) \quad C_{out} = 550
\end{aligned}$$

$$\begin{aligned}
& \{R_3, R_4\} \\
& (R_3 \bowtie R_4) \quad C_{out} = 600
\end{aligned}$$

Size = 3:

$$\begin{aligned}
& \{R_0, R_1, R_2\} \\
& (\{R_0, R_1\} \bowtie R_2) \quad C_{out} = 220 \\
& (\{R_0, R_2\} \bowtie R_1) \longrightarrow C_{out} = 400
\end{aligned}$$

$$\begin{aligned}
& \{R_0, R_2, R_5\} \\
& (\{R_0, R_2\} \bowtie R_5) \quad C_{out} = 2'400 \\
& (\{R_2, R_5\} \bowtie R_0) \longrightarrow C_{out} = 2'600
\end{aligned}$$

$$\begin{aligned}
& \{R_0, R_2, R_3\} \\
& (\{R_0, R_2\} \bowtie R_3) \quad C_{out} = 1'800 \\
& (\{R_2, R_3\} \bowtie R_0) \longrightarrow C_{out} = 2'000
\end{aligned}$$

$$\begin{aligned}
& \{R_2, R_3, R_5\} \\
& (\{R_2, R_3\} \bowtie R_5) \quad C_{out} = 4'800 \\
& (\{R_2, R_5\} \bowtie R_3) \longrightarrow C_{out} = 4'950
\end{aligned}$$

$$\begin{aligned}
&\{R_2, R_3, R_4\} \\
&(\{R_2, R_3\} \bowtie R_4) \quad C_{out} = 6'400 \\
&(\{R_3, R_4\} \bowtie R_2) \quad C_{out} = 6'600
\end{aligned}$$

Size = 4:

$$\begin{aligned}
&\{R_0, R_1, R_2, R_5\} \\
&(\{R_0, R_1, R_2\} \bowtie R_5) \quad C_{out} = 2'420 \\
&(\{R_0, R_2, R_5\} \bowtie R_1) \quad C_{out} = 4'600 \\
&(\{R_0, R_1\} \bowtie \{R_2, R_5\}) \quad C_{out} = 2'770
\end{aligned}$$

$$\begin{aligned}
&\{R_0, R_1, R_2, R_3\} \\
&(\{R_0, R_1, R_2\} \bowtie R_3) \quad C_{out} = 1'820 \\
&(\{R_0, R_2, R_3\} \bowtie R_1) \quad C_{out} = 3'400 \\
&(\{R_0, R_1\} \bowtie \{R_2, R_3\}) \quad C_{out} = 2'020
\end{aligned}$$

$$\begin{aligned}
&\{R_0, R_2, R_3, R_5\} \\
&(\{R_0, R_2, R_5\} \bowtie R_3) \quad C_{out} = 20'000 \\
&(\{R_0, R_2, R_3\} \bowtie R_5) \quad C_{out} = 19'400 \\
&(\{R_2, R_3, R_5\} \bowtie R_0) \quad C_{out} = 22'400
\end{aligned}$$

$$\begin{aligned}
&\{R_0, R_2, R_3, R_4\} \\
&(\{R_0, R_2, R_3\} \bowtie R_4) \quad C_{out} = 25'800 \\
&(\{R_2, R_3, R_4\} \bowtie R_0) \quad C_{out} = 30'400 \\
&(\{R_0, R_2\} \bowtie \{R_3, R_4\}) \quad C_{out} = 24'800
\end{aligned}$$

$$\begin{aligned}
&\{R_2, R_3, R_4, R_5\} \\
&(\{R_2, R_3, R_4\} \bowtie R_5) \quad C_{out} = 72'400 \\
&(\{R_2, R_3, R_5\} \bowtie R_4) \quad C_{out} = 70'800 \\
&(\{R_2, R_5\} \bowtie \{R_3, R_4\}) \quad C_{out} = 67'150
\end{aligned}$$

Size = 5:

$$\begin{aligned}
&\{R_0, R_1, R_2, R_3, R_4\} \\
&(\{R_0, R_1, R_2, R_3\} \bowtie R_4) \quad C_{out} = 25'820 \\
&(\{R_0, R_2, R_3, R_4\} \bowtie R_1) \quad C_{out} = 48'800 \\
&(\{R_0, R_1, R_2\} \bowtie \{R_3, R_4\}) \quad C_{out} = 24'820 \\
&(\{R_2, R_3, R_4\} \bowtie \{R_0, R_1\}) \quad C_{out} = 30'420
\end{aligned}$$

$$\begin{aligned}
&\{R_0, R_1, R_2, R_3, R_5\} \\
&(\{R_0, R_1, R_2, R_5\} \bowtie R_3) \quad C_{out} = 20'020 \\
&(\{R_0, R_1, R_2, R_3\} \bowtie R_5) \quad C_{out} = 19'420 \\
&(\{R_0, R_2, R_3, R_5\} \bowtie R_1) \quad C_{out} = 37'000 \\
&(\{R_2, R_3, R_5\} \bowtie \{R_0, R_1\}) \quad C_{out} = 22'420
\end{aligned}$$

$$\begin{aligned}
&\{R_0, R_2, R_3, R_4, R_5\} \\
&(\{R_0, R_2, R_3, R_5\} \bowtie R_4) \text{---} C_{out} = 45'800 \\
&(\{R_0, R_2, R_3, R_4\} \bowtie R_5) \text{---} C_{out} = 51'200 \\
&(\{R_2, R_3, R_4, R_5\} \bowtie R_0) \text{---} C_{out} = 93'550 \\
&(\{R_0, R_2, R_5\} \bowtie \{R_3, R_4\}) \quad C_{out} = 29'400
\end{aligned}$$

Size = 6:

$$\begin{aligned}
&\{R_0, R_1, R_2, R_3, R_4, R_5\} \\
&(\{R_0, R_1, R_2, R_3, R_4\} \bowtie R_5) \text{---} C_{out} = 288'820 \\
&(\{R_0, R_1, R_2, R_3, R_5\} \bowtie R_4) \text{---} C_{out} = 283'420 \\
&(\{R_0, R_2, R_3, R_4, R_5\} \bowtie R_1) \text{---} C_{out} = 293'400 \\
&(\{R_2, R_3, R_4, R_5\} \bowtie \{R_0, R_1\}) \text{---} C_{out} = 331'170 \\
&(\{R_0, R_1, R_2, R_5\} \bowtie \{R_3, R_4\}) \quad C_{out} = 267'020
\end{aligned}$$

Finally the best query is:

$$(((R_0 \bowtie R_1) \bowtie R_2) \bowtie R_5) \bowtie (R_3 \bowtie R_4)$$

9.1.4 compare

Both algorithms come up with an optimal solution. The cost is the same, the join tree is not.