Exercise 6

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1 EXERCISE 1

With BFS result in following ordering of nodes: $R_0 < R_1 < R_3 < R_2 < R_4$. Figure 1.1 shows the execution of the *EnumerateCsg(G)* algorithm, and table 1.1 shows the *EnumerateCmp(G,S1)* algorithm. The stars in table 1.1 denote the execution of *EnumerateCsgRec()*. Empty rows depict multiple outputs for the step above them. (See the next pages)

S	X	N	emit
$\{R_4\}$	$\{R_0..R_4\}$	$\emptyset$	$\{R_4\}$
$\{R_2\}$	$\{R_0,R_1,R_2,R_3\}$	$\emptyset$	$\{R_2\}$
$\{R_3\}$	$\{R_0,R_1,R_3\}$	$\{R_2\}$	$\{R_3\}$
			$\{R_2,R_3\}$
$\{R_2,R_3\}$	$\{R_0,R_1,R_2,R_3\}$	$\emptyset$	-
$\{R_1\}$	$\{R_0,R_1\}$	$\{R_2,R_4\}$	$\{R_1\}$
			$\{R_1,R_2\}$
			$\{R_1,R_4\}$
			$\{R_1,R_2,R_4\}$
$\{R_1,R_2\}$	$\{R_0,R_1,R_2,R_4\}$	$\{R_3\}$	$\{R_1,R_2,R_3\}$
$\{R_1,R_2,R_3\}$	$\{R_0,R_1,R_2,R_3,R_4\}$	$\emptyset$	-
$\{R_1,R_4\}$	$\{R_0,R_1,R_2,R_4\}$	$\emptyset$	-
$\{R_1,R_2,R_4\}$	$\{R_0,R_1,R_2,R_4\}$	$\{R_3\}$	$\{R_1,R_2,R_3,R_4\}$
$\{R_1,R_2,R_3,R_4\}$	$\{R_0,R_1,R_2,R_3,R_4\}$	$\emptyset$	-
$\{R_0\}$	$\{R_0\}$	$\{R_1,R_3\}$	$\{R_0\}$
			$\{R_0,R_1\}$
			$\{R_0,R_3\}$
			$\{R_0,R_1,R_3\}$
$\{R_0,R_1\}$	$\{R_0,R_1,R_3\}$	$\{R_2,R_4\}$	$\{R_0,R_1,R_2\}$
			$\{R_0,R_1,R_4\}$
			$\{R_0,R_1,R_2,R_4\}$
$\{R_0,R_1,R_2\}$	$\{R_0,R_1,R_2,R_3,R_4\}$	$\emptyset$	-
$\{R_0,R_1,R_4\}$	$\{R_0,R_1,R_2,R_3,R_4\}$	$\emptyset$	-
$\{R_0,R_1,R_2,R_4\}$	$\{R_0,R_1,R_2,R_3,R_4\}$	$\emptyset$	-
$\{R_0,R_3\}$	$\{R_0,R_1,R_3\}$	$\{R_2\}$	$\{R_0,R_2,R_3\}$
$\{R_0,R_2,R_3\}$	$\{R_0,R_1,R_2,R_3\}$	$\emptyset$	-
$\{R_0,R_1,R_3\}$	$\{R_0,R_1,R_3\}$	$\{R_4\}$	$\{R_0,R_1,R_3,R_4\}$
$\{R_0,R_1,R_3,R_4\}$	$\{R_0,R_1,R_3,R_4\}$	$\{R_2\}$	$\{R_0,R_1,R_2,R_3,R_4\}$
$\{R_0,R_1,R_2,R_3,R_4\}$	$\{R_0,R_1,R_2,R_3,R_4\}$	$\emptyset$	-

Figure 1.1: Connected Subgraph Enumeration

S	X	N	emit
$\{R_4\}$	$\{R_0..R_4\}$	$\emptyset$	-
$\{R_2\}$	$\{R_0, R_1, R_2, R_3\}$	$\emptyset$	-
$\{R_3\}$	$\{R_0, R_1, R_3\}$	$\{R_2\}$	$\{R_2\}$
* $\{R_2\}$	$\{R_0, R_1, R_2, R_3\}$	$\emptyset$	-
$\{R_2, R_3\}$	$\{R_0, R_1, R_2, R_3\}$	$\emptyset$	-
$\{R_1\}$	$\{R_0, R_1\}$	$\{R_2, R_4\}$	$\{R_4\}$
			$\{R_2\}$
* $\{R_4\}$	$\{R_0, R_1, R_2, R_4\}$	$\emptyset$	-
* $\{R_2\}$	$\{R_0, R_1, R_2\}$	$\{R_3\}$	$\{R_2, R_3\}$
* $\{R_2, R_3\}$	$\{R_0, R_1, R_2, R_3\}$	$\emptyset$	-
$\{R_1, R_2,\}$	$\{R_0, R_1, R_2\}$	$\{R_3, R_4\}$	$\{R_4\}$
			$\{R_3\}$
* $\{R_4\}$	$\{R_0, R_1, R_2, R_3, R_4\}$	$\emptyset$	-
* $\{R_3\}$	$\{R_0, R_1, R_2, R_3\}$	$\emptyset$	-
$\{R_1, R_2, R_3\}$	$\{R_0, R_1, R_2, R_3\}$	$\{R_4\}$	$\{R_4\}$
* $\{R_4\}$	$\{R_0, R_1, R_2, R_3, R_4\}$	$\emptyset$	-
$\{R_1, R_4\}$	$\{R_0, R_1, R_4\}$	$\{R_2\}$	$\{R_2\}$
* $\{R_2\}$	$\{R_0, R_1, R_2\}$	$\{R_3\}$	$\{R_2, R_3\}$
* $\{R_2, R_3\}$	$\{R_0, R_1, R_2, R_3, R_4\}$	$\emptyset$	-
$\{R_1, R_2, R_4\}$	$\{R_0, R_1, R_2, R_4\}$	$\{R_3\}$	$\{R_1, R_2, R_3, R_4\}$
* $\{R_3\}$	$\{R_0, R_1, R_2, R_3, R_4\}$	$\emptyset$	-
$\{R_1, R_2, R_3, R_4\}$	$\{R_0, R_1, R_2, R_3, R_4\}$	$\emptyset$	-
$\{R_0\}$	$\{R_0\}$	$\{R_1, R_3\}$	$\{R_3\}$
			$\{R_1\}$
* $\{R_3\}$	$\{R_0, R_1, R_3\}$	$\{R_2\}$	$\{R_2, R_3\}$
* $\{R_2, R_3\}$	$\{R_0, R_1, R_2, R_3\}$	$\emptyset$	-
* $\{R_1\}$	$\{R_0, R_1\}$	$\{R_2, R_4\}$	$\{R_1, R_2\}$
			$\{R_1, R_4\}$
* $\{R_1, R_2\}$	$\{R_0, R_1, R_2, R_4\}$	$\{R_3\}$	$\{R_1, R_2, R_3\}$
* $\{R_1, R_2, R_3\}$	$\{R_0, R_1, R_2, R_3, R_4\}$	$\emptyset$	-
* $\{R_1, R_4\}$	$\{R_0, R_1, R_2, R_4\}$	$\emptyset$	-
$\{R_0, R_1\}$	$\{R_0, R_1\}$	$\{R_2, R_3, R_4\}$	$\{R_4\}$
			$\{R_2\}$
			$\{R_3\}$
* $\{R_4\}$	$\{R_0, R_1, R_2, R_3, R_4\}$	$\emptyset$	-
* $\{R_2\}$	$\{R_0, R_1, R_2, R_3\}$	$\emptyset$	-
* $\{R_3\}$	$\{R_0, R_1, R_3\}$	$\{R_2\}$	$\{R_2, R_3\}$
* $\{R_2, R_3\}$	$\{R_0, R_1, R_2, R_3\}$	$\emptyset$	-
$\{R_0, R_1, R_2\}$	$\{R_0, R_1, R_2\}$	$\{R_3, R_4\}$	$\{R_4\}$
			$\{R_3\}$
* $\{R_4\}$	$\{R_0, R_1, R_2, R_3, R_4\}$	$\emptyset$	-
* $\{R_3\}$	$\{R_0, R_1, R_2, R_3\}$	$\emptyset$	-
$\{R_0, R_1, R_4\}$	$\{R_0, R_1, R_4\}$	$\{R_2, R_3\}$	$\{R_2\}$
			$\{R_3\}$

* $\{R_2\}$	$\{R_0, R_1, R_2, R_3, R_4\}$	$\emptyset$	-
* $\{R_3\}$	$\{R_0, R_1, R_3, R_4\}$	$\{R_2\}$	$\{R_2, R_3\}$
* $\{R_2, R_3\}$	$\{R_0, R_1, R_2, R_3, R_4\}$	$\emptyset$	-
$\{R_0, R_1, R_2, R_4\}$	$\{R_0, R_1, R_2, R_4\}$	$\{R_3\}$	$\{R_3\}$
* $\{R_3\}$	$\{R_0, R_1, R_2, R_3, R_4\}$	$\emptyset$	-
$\{R_0, R_3\}$	$\{R_0, R_3\}$	$\{R_1, R_2\}$	$\{R_2\}$
			$\{R_1\}$
* $\{R_2\}$	$\{R_0, R_1, R_2, R_3\}$	$\emptyset$	-
* $\{R_1\}$	$\{R_0, R_1, R_3\}$	$\{R_2\}$	$\{R_1, R_2\}$
$\{R_0, R_2, R_3\}$	$\{R_0, R_2, R_3\}$	$\{R_1\}$	$\{R_1\}$
* $\{R_1\}$	$\{R_0, R_1, R_2, R_3\}$	$\{R_4\}$	$\{R_1, R_4\}$
* $\{R_1, R_4\}$	$\{R_0, R_1, R_2, R_3, R_4\}$	$\emptyset$	-
$\{R_0, R_1, R_3\}$	$\{R_0, R_1, R_3\}$	$\{R_2, R_4\}$	$\{R_4\}$
			$\{R_2\}$
* $\{R_4\}$	$\{R_0, R_1, R_2, R_3, R_4\}$	$\emptyset$	-
* $\{R_2\}$	$\{R_0, R_1, R_2, R_3\}$	$\emptyset$	-
$\{R_0, R_1, R_3, R_4\}$	$\{R_0, R_1, R_3\}$	$\{R_2\}$	$\{R_2\}$
* $\{R_2\}$	$\{R_0, R_1, R_2, R_3, R_4\}$	$\emptyset$	-
$\{R_0, R_1, R_2, R_3, R_4\}$	$\{R_0, R_1, R_2, R_3, R_4\}$	$\emptyset$	-

Table 1.1: Enumerating Complementary Subgraphs

2 Exercise 2

Below $B()$ denotes the benefit function and all numbers i beside the Joins depict the relation R_i. Step 1 of the simplification shows that the relations R_2 and R_3 should be joined before joining them with R_0. Figure (2.1) shows the resulting query graph after this first step. The arrow determines the reading direction of the hyper edge. In this case: Join R_2 and R_3 before R_1.

Step 1:

$$B(0 \bowtie 1, 0 \bowtie 3) = \frac{C((0 \bowtie 1) \bowtie 3)}{C((0 \bowtie 3) \bowtie 1)} = \frac{20 + 2000}{1000 + 2000} = 0,673$$

$$B(1 \bowtie 0, 1 \bowtie 2) = \frac{C((1 \bowtie 0) \bowtie 2)}{C((1 \bowtie 2) \bowtie 0)} = \frac{20 + 100}{100 + 100} = 0,6$$

$$B(1 \bowtie 0, 1 \bowtie 4) = \frac{C((1 \bowtie 0) \bowtie 4)}{C((1 \bowtie 4) \bowtie 0)} = \frac{20 + 5000}{5000 + 5000} = 0,502$$

$$B(1 \bowtie 2, 1 \bowtie 4) = \frac{C((1 \bowtie 2) \bowtie 4)}{C((1 \bowtie 4) \bowtie 2)} = \frac{100 + 25000}{5000 + 25000} = 0,836$$

$$B(1 \bowtie 2, 2 \bowtie 3) = \frac{C((1 \bowtie 2) \bowtie 3)}{C((2 \bowtie 3) \bowtie 1)} = \frac{100 + 500}{250 + 500} = 0,8$$

$$B(0 \bowtie 3, 3 \bowtie 2) = \frac{C((0 \bowtie 3) \bowtie 2)}{C((2 \bowtie 3) \bowtie 0)} = \frac{1000 + 500}{250 + 500} = 2$$

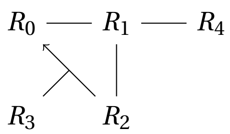

Figure 2.1: First step of simplification

For Step 2 we re-use the old calculations except those affected by the new hyper edge. The resulting graph is shown in Figure (3.3). The benefit of joining relations R_0 and R_1 before R_4 is this step's biggest benefit, wherefore a hyper edge between those relations is introduced.

Step 2:

$$
\begin{aligned}
B(0 \bowtie \{2,3\}, \{2,3\} \bowtie 1) &= \frac{C((0 \bowtie \{2,3\}) \bowtie 1)}{C((1 \bowtie \{2,3\}) \bowtie 0)} = \frac{750+1000}{750+1000} = 1 \\
B(0 \bowtie 1, 0 \bowtie \{2,3\}) &= \frac{C((0 \bowtie 1) \bowtie \{2,3\})}{C((0 \bowtie \{2,3\}) \bowtie 1)} = \frac{20+1000}{750+1000} = 0,68
\end{aligned}
$$

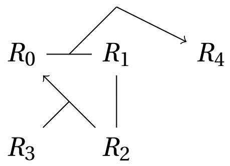

Figure 2.2: Second step of simplification

3 Exercise 3

Figure 3.1 shows the given join tree. Numbers in brackets identify each join for the following figure (3.2), which shows the reordering restrictions. Figure 3.3 shows the resulting query graph by *DPhyp*.

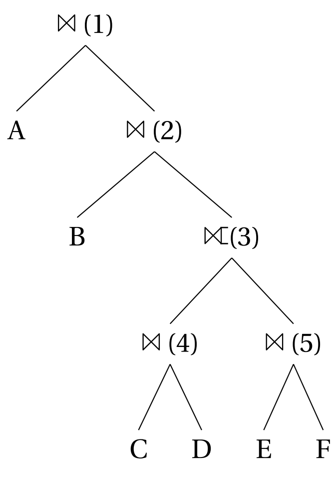

Figure 3.1: Given join tree

Join	SES	TES
1	{A,B}	{A,B,C,E,D}
2	{B,C}	{B,C,E,D}
3	{C,E}	{C,E,D}
4	{C,D}	{C,D}
5	{E,F}	{E,F}

Figure 3.2: Syntactic- and total eligibility set

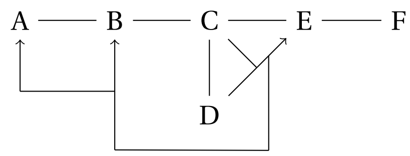

Figure 3.3: DPhyp graph