E0 272

Formal Methods in Software Engineering

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Assignment 1

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Problem 5:

1. Rentals: n_0

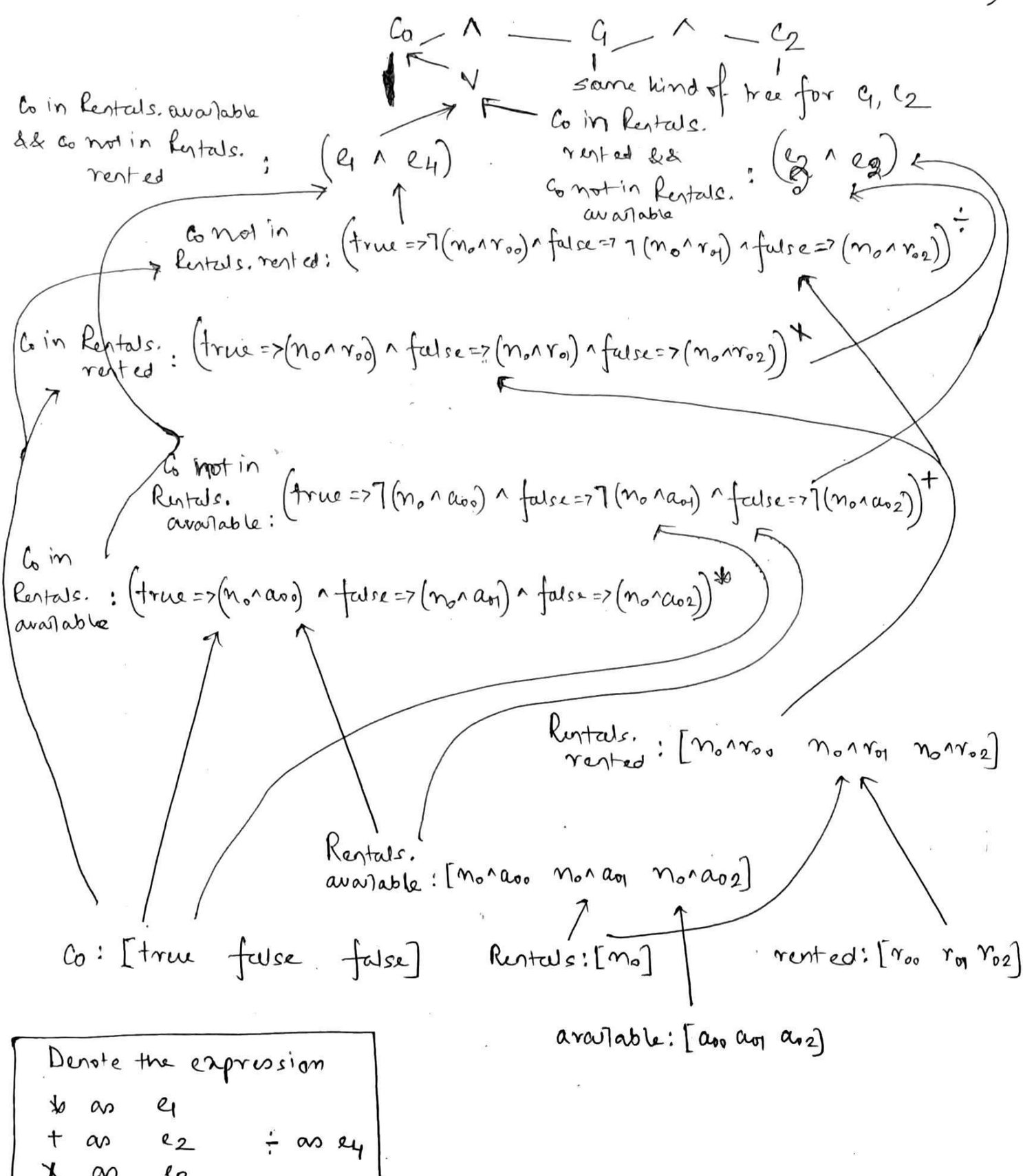
   Car : c_0, c_1, c_2

   available: a_{00}, a_{01}, a_{02}

   rented: r_{00}, r_{01}, r_{02}

all c: Car | (c in Rentals.available && c not in Rentals.rented)

or (c in Rentals.rented && c not in Rentals.available)



Denote the expression

* as e_1
+ as e_2
× as e_3
÷ as e_4

Full Expression:

$$
\begin{aligned}
&\Big((true \Rightarrow (n_0 \wedge a_{00}) \wedge false \Rightarrow (n_0 \wedge a_{01}) \wedge false \Rightarrow (n_0 \wedge a_{02}) \\
&\quad \wedge true \Rightarrow \neg(n_0 \wedge \neg r_{00}) \wedge false \Rightarrow \neg(n_0 \wedge \neg r_{01}) \wedge false \Rightarrow \neg(n_0 \wedge \neg r_{02})) \\
&\quad \vee (true \Rightarrow (n_0 \wedge r_{00}) \wedge false \Rightarrow (n_0 \wedge r_{01}) \wedge false \Rightarrow (n_0 \wedge r_{02}) \\
&\qquad \wedge true \Rightarrow \neg(n_0 \wedge a_{00}) \wedge false \Rightarrow \neg(n_0 \wedge a_{01}) \wedge false \Rightarrow \neg(n_0 \wedge a_{02})) \Big) \\
\wedge &\Big((false \Rightarrow (n_0 \wedge a_{00}) \wedge true \Rightarrow (n_0 \wedge a_{01}) \wedge false \Rightarrow (n_0 \wedge a_{02}) \\
&\quad \wedge false \Rightarrow \neg(n_0 \wedge \neg r_{00}) \wedge true \Rightarrow \neg(n_0 \wedge r_{01}) \wedge false \Rightarrow \neg(n_0 \wedge r_{02})) \\
&\quad \vee (false \Rightarrow (n_0 \wedge r_{00}) \wedge true \Rightarrow (n_0 \wedge r_{01}) \wedge false \Rightarrow (n_0 \wedge r_{02}) \\
&\qquad \wedge false \Rightarrow \neg(n_0 \wedge a_{00}) \wedge true \Rightarrow \neg(n_0 \wedge a_{01}) \wedge false \Rightarrow \neg(n_0 \wedge a_{02})) \Big) \\
\wedge &\Big((false \Rightarrow (n_0 \wedge a_{00}) \wedge false \Rightarrow (n_0 \wedge a_{01}) \wedge false \Rightarrow (n_0 \wedge a_{02}) \\
&\quad \wedge false \Rightarrow \neg(n_0 \wedge r_{00}) \wedge false \Rightarrow \neg(n_0 \wedge r_{01}) \wedge true \Rightarrow \neg(n_0 \wedge r_{02})) \\
&\quad \vee (false \Rightarrow (n_0 \wedge r_{00}) \wedge false \Rightarrow (n_0 \wedge r_{01}) \wedge true \Rightarrow (n_0 \wedge r_{02}) \\
&\qquad \wedge false \Rightarrow \neg(n_0 \wedge a_{00}) \wedge false \Rightarrow \neg(n_0 \wedge a_{01}) \wedge true \Rightarrow \neg(n_0 \wedge a_{02})) \Big)
\end{aligned}
$$

In part (1) and part (2) we have used the propositional fact that: "false implies anything is true".

Problem 5:

2.

Rentals : r_0

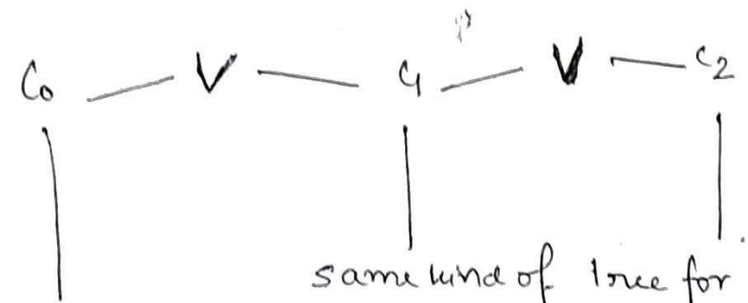
Car : c_0, c_1, c_2

available : a_{00}, a_{01}, a_{02}

rented : r_{00}, r_{01}, r_{02}

some c: Car | c in Rentals.available

Tree:



c_0 in Rentals.available : $(true \Rightarrow (r_0 \wedge a_{00}) \wedge false \Rightarrow (r_0 \wedge a_{01}) \wedge false \Rightarrow (r_0 \wedge a_{02}))$

Rentals.available : $[(r_0 \wedge a_{00}) \ (r_0 \wedge a_{01}) \ (r_0 \wedge a_{02})]$

c_0 : [true false false]

Rentals: $[r_0]$ available: $[a_{00} \ a_{01} \ a_{02}]$

Full Expression: $(true \Rightarrow (r_0 \wedge a_{00}) \wedge false \Rightarrow (r_0 \wedge a_{01}) \wedge false \Rightarrow (r_0 \wedge a_{02})$

$\vee$

$false \Rightarrow (r_0 \wedge a_{00}) \wedge true \Rightarrow (r_0 \wedge a_{01}) \wedge false \Rightarrow (r_0 \wedge a_{02})$

$\vee$

$false \Rightarrow (r_0 \wedge a_{00}) \wedge false \Rightarrow (r_0 \wedge a_{01}) \wedge true \Rightarrow (r_0 \wedge a_{02})\Big)$