UNIT 6

(10)

GO-THROUG (x, y, z):

$\boxed{\text{Prec}}$ open(x), robot-in (y), connect(x, y, z)

$\boxed{\text{Effe:}}$ ¬robot-in (y), robot-in (z)

CARR-THROUGH(c, h1, h2, p):

$\boxed{\text{Prec:}}$ open (p), connects (p, h1, h2), robot-in (h1), in(c, h1)

$\boxed{\text{Effe:}}$ ¬robot-in(h1), ¬in(c, h1), robot-in(h2), in (c, h2)

CLOSE (x):

$\boxed{\text{Prec:}}$ open (x), robot-in (h1), connects (x, h1, h2)

$\boxed{\text{Effe:}}$ ¬open (x)

OPEN (x):

$\boxed{\text{Prec:}}$ ¬open (x), robot-in (h1), connects (x, h1, h2)

$\boxed{\text{Effe:}}$ open (x)

(12)

$$\begin{tikzcd}
\{P2\} & \{P1\} \arrow[l, "A"'] \arrow[d, "B"] \arrow[rr, "D"] & & \{P1, P4\} \arrow[dl, "A"'] \arrow[d, "B"] \\
& \{P3\} & \{P2, P4\} \arrow[dl, "C"'] & \{P3, P4\} \\
& \{P1, P2, P4\} \arrow[d, "B"] & & \\
& \{P2, P3, P4\} & &
\end{tikzcd}$$

(*)

(* *)

Final state.

(*) Actions C and D are applicable but we obtain repeated states in branch

(**) The same for actions A, C and D

Solution found: D, A, C, B

(19) Action:

CRUSH()
Prec: {}
Effe: $\neg$QUIET, $\neg$GIFT, GOOD-SMELL

TAKEOUT()
Prec: {}
Effe: $\neg$CLEAN-HANDS, GOOD-SMELL

COOK()
Prec: CLEAN-HANDS
Effe: $\neg$CLEAN-HANDS, DINNER

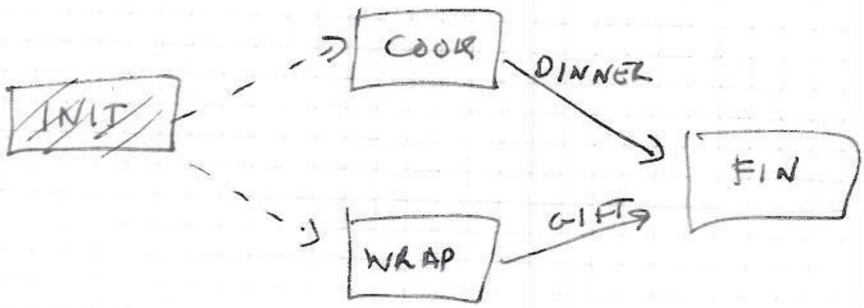
WRAP()
Prec: QUIET, CLEAN-HANDS
Effe: GIFT

WASH-HANDS
Prec: {}
Effec: CLEAN-HANDS

- Initial state: {QUIET, CLEN-HANDS}
- Goal: {DINNER, GIFT, CLEAN-HANDS, GOOD-SMELL}

Let us apply the POP algorithm to solve this planning probeem:

We close preconditions DINNER and GIFT of FIN by using actions COOK and WRAP, respectively (no alternatives)

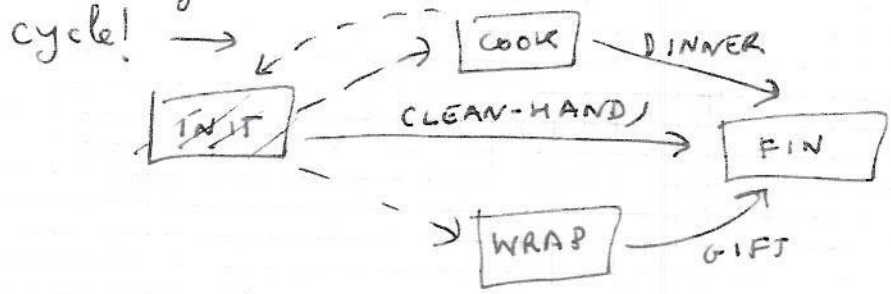


The precondition CLEAN-HANDS can be closed by actions: INIT (simple establishment) or WASH-HANDS (new action). We try first with INIT and go back to WASH-HANDS in case of failure:

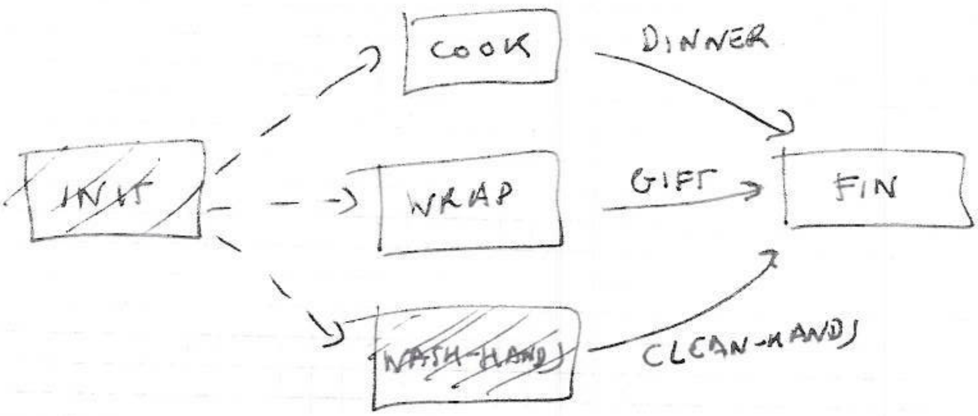
Now we have a threat: COOK threats the causal link INIT $\xrightarrow{\text{CLEAN-HANDS}}$ FIN.

We try to solve it by promotion (and in case of failure, then demotion):

So we try demotion instead:



Since we cannot fix the threat, we go back to the last alternative point: instead of INIT, we use WASH-HANDS to close CLEAN-HANDS:

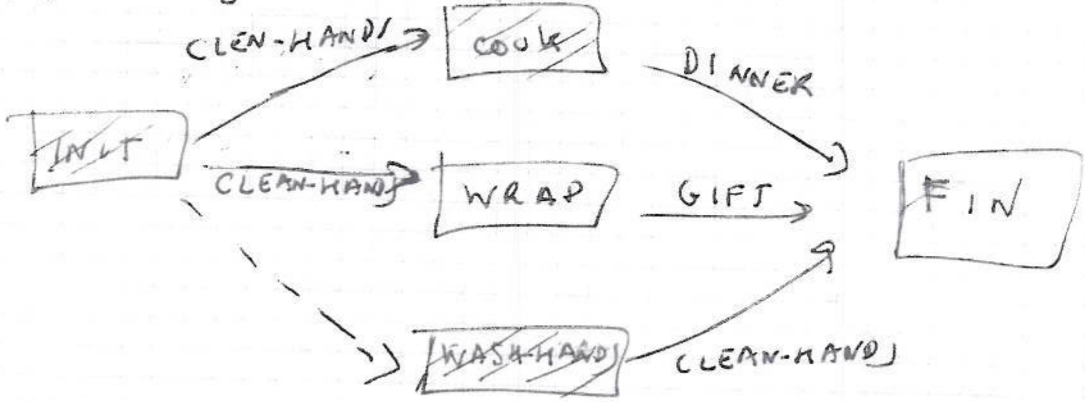


Now we close the precondition CLEAN-HANDS of COOK

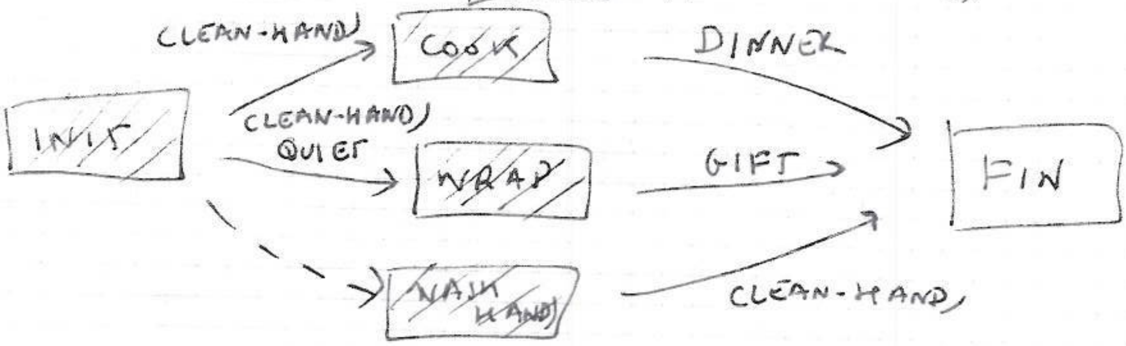
We have three alternatives for that:

- INIT (simple establishment)
- WASH-HANDS (simple establishment)
- WASH-HANDS (new action)

We first try $\boxed{\text{INIT}}$:

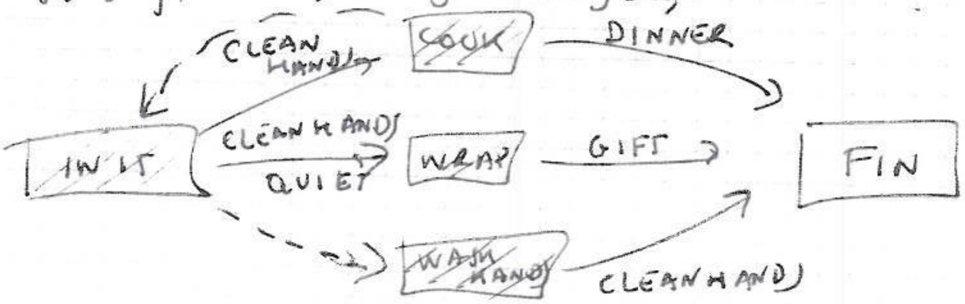


We now close QUIET of $\boxed{\text{WRAP}}$ using simple establishment with $\boxed{\text{INIT}}$ (no alternative)

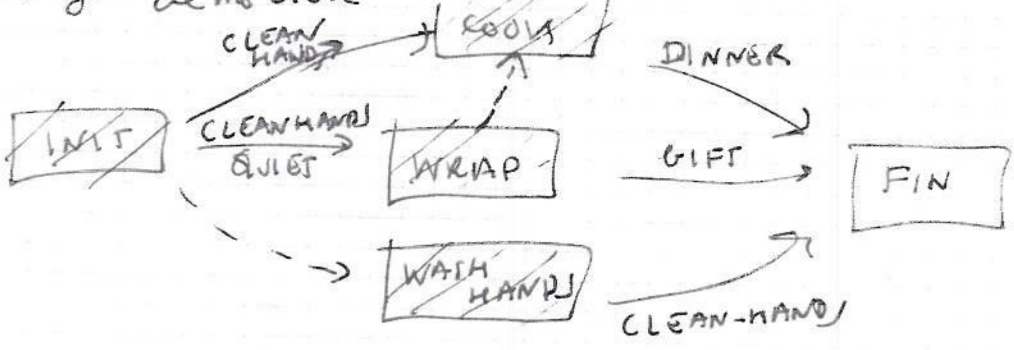


We have a threat of $\boxed{\text{COOK}}$ over $\boxed{\text{INIT}} \xrightarrow{\text{CLEAN-HANDS}} \boxed{\text{WRAP}}$

IF we apply promotion, we get a cycle,

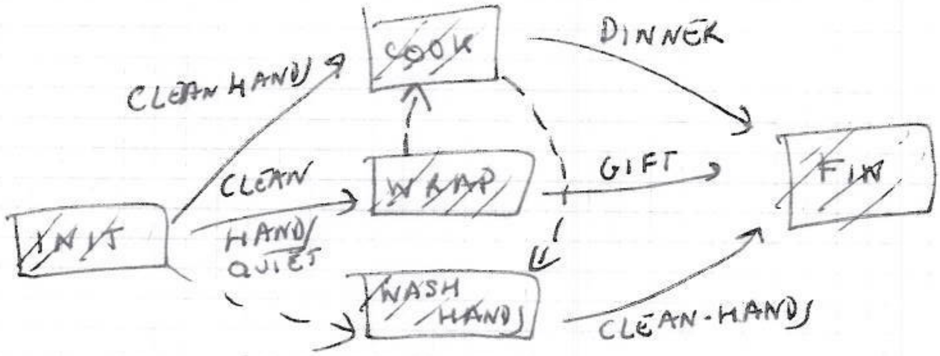


So we try demotion



Again, $\boxed{\text{COOK}}$ is a threat for $\boxed{\text{WASH HANDS}} \xrightarrow{\text{CLEAN-HANDS}} \boxed{\text{FIN}}$

Again, promotion creates a cycle (we omit the graph), so we try demotion:

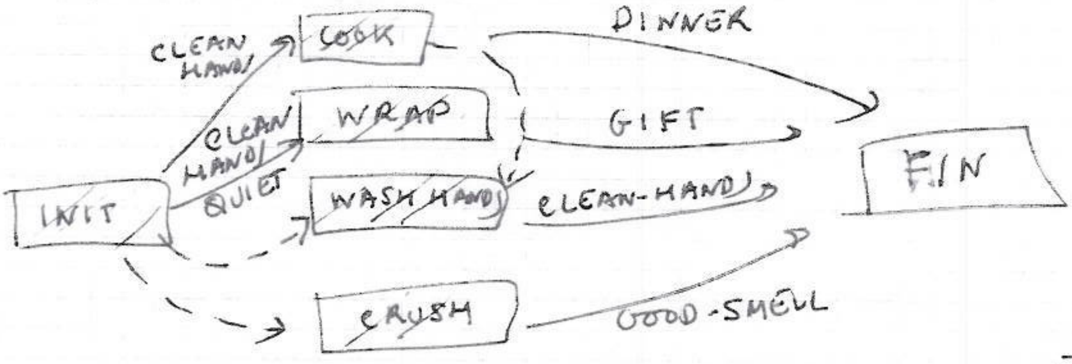


Now we close precondition GOOD-SMELL of $\boxed{\text{FIN}}$.

We can do it in two ways:

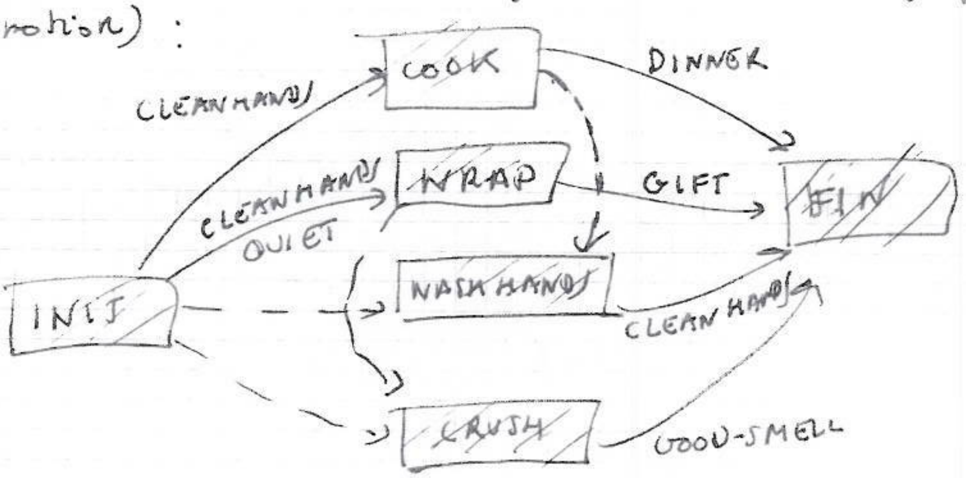
- $\boxed{\text{CRUSH}}$ (new action), or
- $\boxed{\text{TAKE-OUT}}$ (new action).

We try first $\boxed{\text{CRUSH}}$:



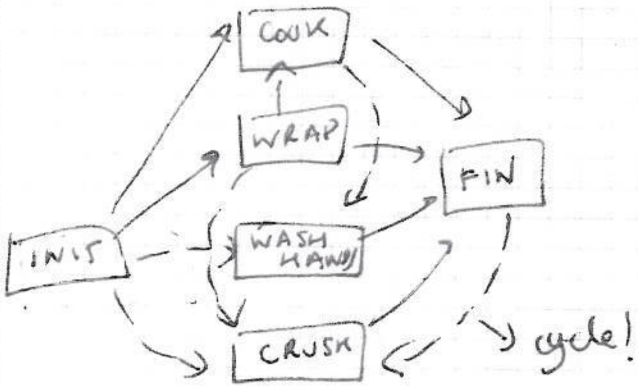
Now $\boxed{\text{CRUSH}}$ is a threat for $\boxed{\text{INIT}} \xrightarrow{\text{QUIET}} \boxed{\text{WRAP}}$

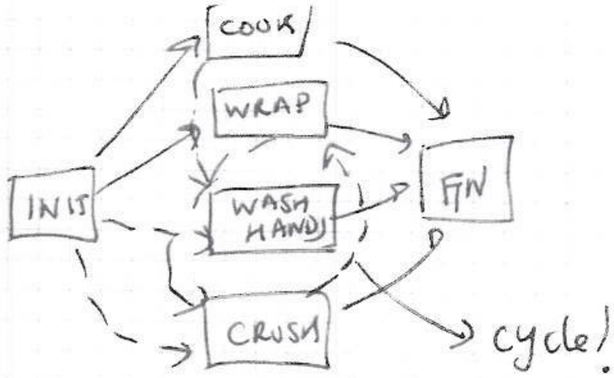
We try to solve it by promotion (and if failure, demotion):



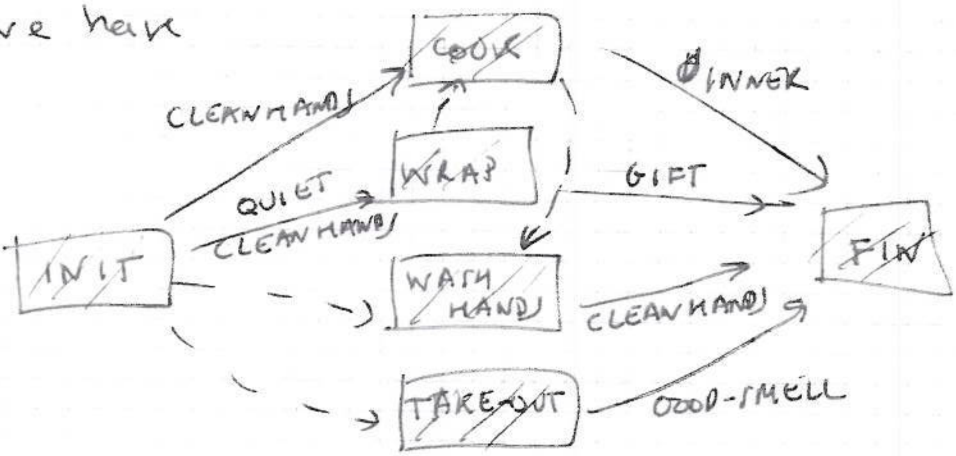
Now $\boxed{\text{CRUSH}}$ is a threat for $\boxed{\text{WRAP}} \xrightarrow{\text{GIFT}} \boxed{\text{FIN}}$

Bot promotion and demotion create cycles:

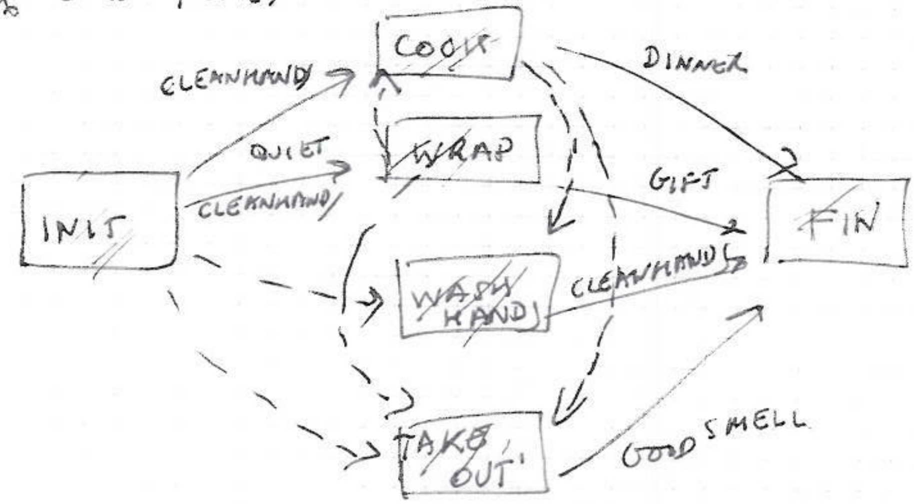




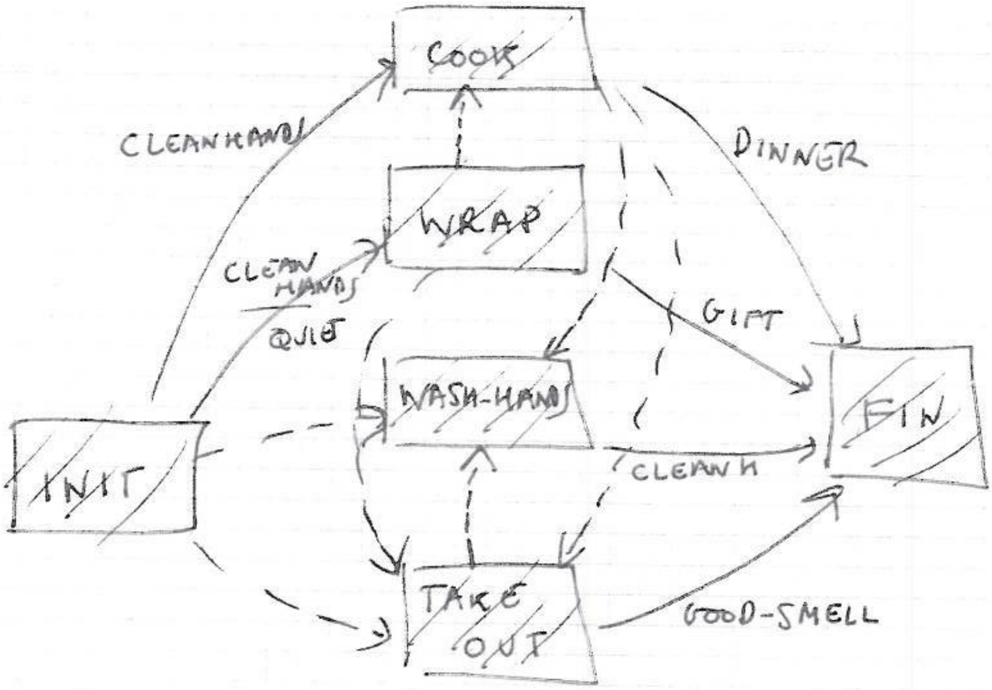
So, we go back, and insted of $\boxed{\text{CRUSH}}$, we use $\boxed{\text{TAKE-OUT}}$ to close precondition GOOD-SMELL of $\boxed{\text{FIN}}$, so we have



Now $\boxed{\text{TAKE-OUT}}$ threats $\boxed{\text{INIT}} \xrightarrow{\text{CLEAN-HANDS}} \boxed{\text{COOK}}$ and also $\boxed{\text{INIT}} \xrightarrow{\text{CLEAN-HANDS}} \boxed{\text{WRAP}}$. Both can be solved by promotion (we will try demotion only if this fails)



We have also that $\boxed{\text{TAKE OUT}}$ threats $\boxed{\text{WASH HANDS}} \xrightarrow{\text{CLEAN HANDS}} \boxed{\text{FIN}}$
Promotion creates a cycle (we omit it), so we try demotion:



Now we have a partial plan with no threats, no cycles and no open preconditions. So we have a partial plan and we can extract from it a <u>solution</u> to our planning problem, just linearizing the actions:

WRAP → COOK → TAKE OUT → WASH HANDS

(20)

7. Actions:

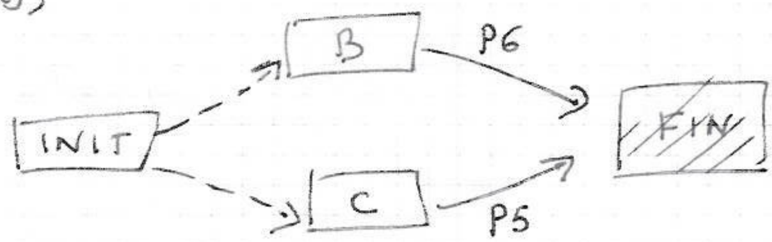
A	B	C
Prec: P1	Prec: P2, P4	Prec: P3
Effec: P3, P4	Effec: ¬P3, ¬P5, P6	Effec: ¬P3, P5

Initial state: {P1, P2}

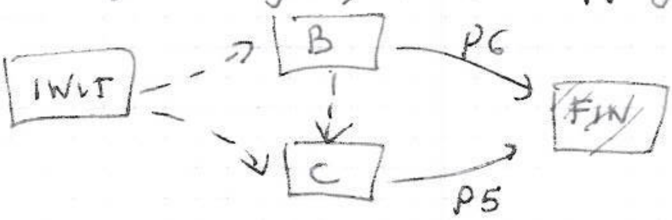
Goal: {P5, P6}

Let us apply the POP algorithm to solve this problem:

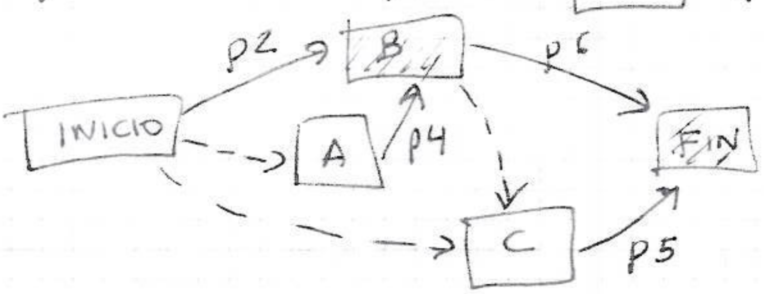
We close preconditions P6 and P5 of $\boxed{FIN}$, using (new actions) $\boxed{B}$ and $\boxed{C}$, respectively (no alternatives)



Now $\boxed{B}$ is a threat for $\boxed{C} \xrightarrow{P5} \boxed{FIN}$. If we apply promotion, we get a cycle, so we apply demotion:



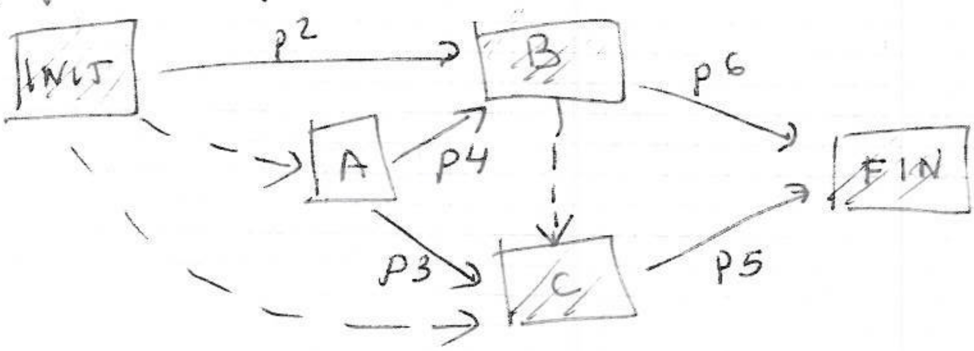
We now close p2 and p4 of $\boxed{B}$ using $\boxed{INIT}$ (simple establishment) and $\boxed{A}$ (new action) [no alternatives]:



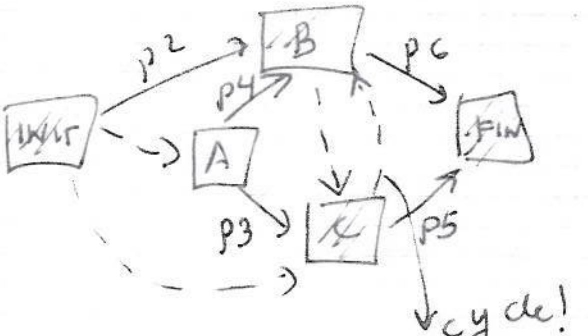
Now we close precondition p3 of $\boxed{C}$, and we have two alternatives:

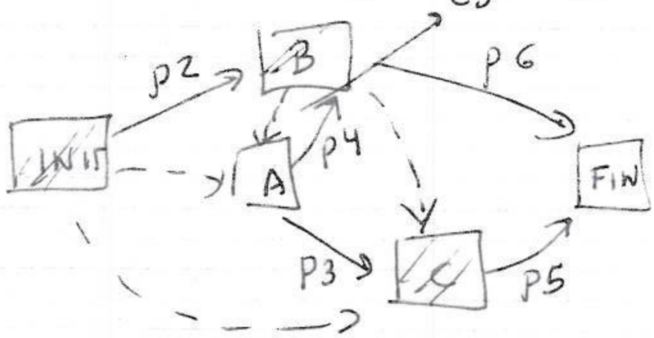
- Simple establishment with $\boxed{A}$
- New action with $\boxed{A}$

We try first simple establishment with $\boxed{A}$

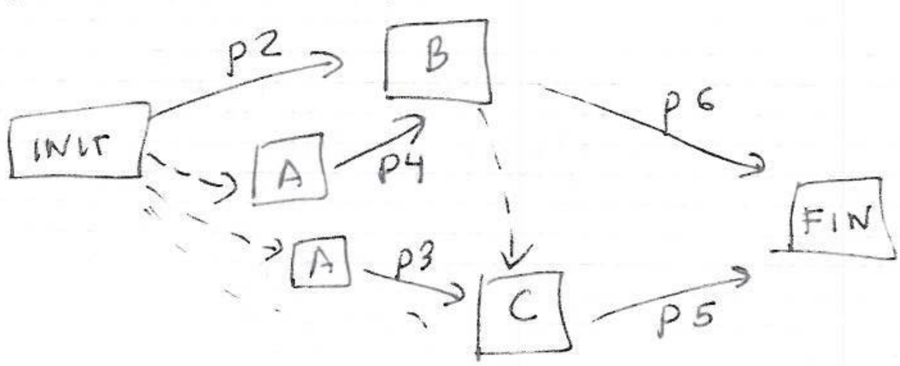


Now $\boxed{B}$ threats $\boxed{A} \xrightarrow{p3} \boxed{C}$, but both promotion and demotion create an cycle:

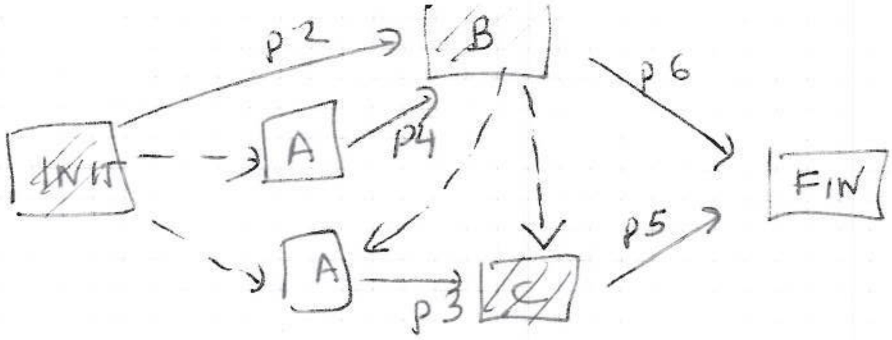




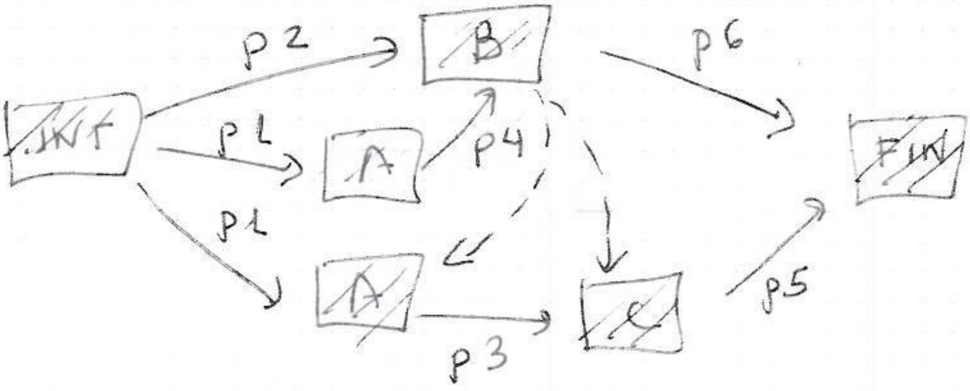
So we go back and we use new action $\boxed{A}$ instead of simple establishment.



Now $\boxed{B}$ is a threat for $\boxed{A} \xrightarrow{p3} \boxed{C}$. Promotion creates a cycle (we omit it), so we try demotion:



We finally close preconditions p1 of the two actions $\boxed{A}$ in the plan. We close both using $\boxed{\text{INIT}}$ (simple establishment):



Now we have a final partial plan; and we obtain a solution linearizing it:

$\boxed{A} \longrightarrow \boxed{B} \longrightarrow \boxed{A} \longrightarrow \boxed{C}$

Let us check that indeed is a solution.

$\{p1, p2\} \xrightarrow{A} \{p1, p2, p3, p4\} \xrightarrow{B} \{p1, p2, p4, p6\} \xrightarrow{A} \{p1, p2, p3, p4, p$

$\xrightarrow{C} \{p1, p2, p4, p5, p6\}$

This is a final state, since it satisfies the goal $\{p5, p6\}$