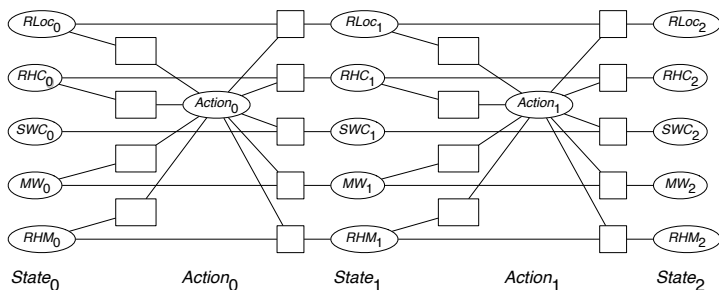


- In forward planning, the nodes considered are constrained to be reachable, even if they don't lead to goal.
- In regression planning, the nodes considered are constrained to be ones from which we can achieve the goal, even if they are not reachable.
- When representing planning as a CSP, we can constrain the states by the starting state and the goal.  
... but we can only do this if we know the number of steps.
- Search over planning horizons (number of time steps).
- For each planning horizon, create a CSP constraining possible actions and features

Choose a planning horizon  $k$ .

- Create a variable for each state feature and each time from 0 to  $k$ .
- Create a variable for the action for each time in the range 0 to  $k - 1$ .

# CSP for Delivery Robot for a planning horizon of 2



$RLoc_i$  — Rob's location  
 $RHC_i$  — Rob has coffee  
 $SWC_i$  — Sam wants coffee  
 $MW_i$  — Mail is waiting  
 $RHM_i$  — Rob has mail

$Move_i$  — Rob's move action  
 $PUC_i$  — Rob picks up coffee  
 $DelC$  — Rob delivers coffee  
 $PUM_i$  — Rob picks up mail  
 $DelM_i$  — Rob delivers mail

- **precondition constraints** between state variables at time  $t$  and action variable at time  $t$ , specify constraints on what actions are available from a state.
- **effect constraints** between state variables at time  $t$ , action variable at time  $t$  and state variables at time  $t + 1$  constrain the resulting state to be one that satisfies the effects.
- **frame constraints** among state variables at time  $t$ , action variables at time  $t$ , and state variables at time  $t + 1$  for values of variables that do not change.
- **initial state constraints** that are usually domain constraints on the initial state (at time 0).
- **goal constraints** that constrains the final state to be a state that satisfies the goals that are to be achieved.

# Example Constraints

precondition constraint  $RLoc_i = cs \leftarrow Action_i = puc$

is violated when  $RLoc_i \neq cs \wedge Action_i = puc$

effect constraint  $rhc_{i+1} \leftarrow Act_i = puc$

is violated when  $RHC_{i+1} = false \wedge Act_i = puc$ .

frame constraint Rob has mail at any time if it had mail before and the action wasn't to pickup mail or deliver mail:

$$RHM_{i+1} = RHM_i \leftarrow Act_i \notin \{pum, dm\}$$

violated when

$$RHM_{i+1} \neq RHM_i \wedge Act_i \neq pum \wedge Act_i \neq dm$$

