

# Principles of AI Planning

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## Exercise Sheet 10

Due: January 24th, 2012

**Exercise 10.1** (Merge-and-Shrink abstractions, 2+3+4+1 points)

Consider the (SAS<sup>+</sup>) Gripper planning task  $\Pi = \langle V, I, O, \gamma \rangle$  with two balls  $B_1$  and  $B_2$ :

- $V = \{pos_{B_1}, pos_{B_2}, pos_{Robby}, status_{G_1}, status_{G_2}\}$   
 $\mathcal{D}_{pos_{B_1}} = \mathcal{D}_{pos_{B_2}} = \{L, R, G_1, G_2\}$ ,  $\mathcal{D}_{pos_{Robby}} = \{L, R\}$   
 $\mathcal{D}_{status_{G_1}} = \mathcal{D}_{status_{G_2}} = \{E, F\}$  (empty and full)
  - $I(pos_{B_1}) = I(pos_{B_2}) = I(pos_{Robby}) = L$ ,  $I(status_{G_1}) = I(status_{G_2}) = E$
  - $O = \{ML, MR\} \cup \{ABXG \mid A \in \{P, D\}, B \in \{B_1, B_2\}, X \in \{L, R\}, G \in \{G_1, G_2\}\}$ 
    - $ML = \langle pos_{Robby} = R, pos_{Robby} := L \rangle$  (move left)
    - $MR = \langle pos_{Robby} = L, pos_{Robby} := R \rangle$  (move right)
    - $PBXG = \langle pos_{Robby} = X \wedge pos_B = X \wedge status_G = E, pos_B := G \wedge status_G := F \rangle$   
for  $B \in \{B_1, B_2\}, G \in \{G_1, G_2\}, X \in \{L, R\}$  (pick ball  $B$  with gripper  $G$  in room  $X$ )
    - $DBXG = \langle pos_{Robby} = X \wedge pos_B = G, pos_B := X \wedge status_G := E \rangle$   
for  $B \in \{B_1, B_2\}, G \in \{G_1, G_2\}, X \in \{L, R\}$  (drop ball  $B$  from gripper  $G$  in room  $X$ )
  - $\gamma = (pos_{B_1} = R \wedge pos_{B_2} = R)$
- (a) Visualize  $T^\pi\{pos_{B_1}\}$ ,  $T^\pi\{pos_{Robby}\}$  and  $T^\pi\{status_{G_1}\}$  and specify the according one-dimensional tables.
- (b) Visualize  $T^\pi\{pos_{B_1}\} \otimes T^\pi\{status_{G_1}\}$  and specify the according two-dimensional table.
- (c) Shrink the graph from (b) by collapsing all nodes with identical  $g$  and  $h$  values. Use linked lists to renumber the nodes. Visualize the resulting graph, and specify the resulting new two-dimensional table and the final status of the linked list.
- (d) Which heuristic value do we get for  $s = \{pos_{B_1} \mapsto L, pos_{B_2} \mapsto G_1, pos_{Robby} \mapsto R, status_{G_1} \mapsto F, status_{G_2} \mapsto E\}$  and how is the look-up of the value performed?

*Note:* The exercise sheets may and should be worked on in groups of two students. Please state both names on your solution (this also holds for submissions by e-mail).