CSCI3230
Fundamentals of Artificial Intelligence
Written Assignment 1 (Optional)
Suggested Solutions

September 19, 2013

1 Function Evaluation

$f(n) = g(n)$	Uniform-cost search	[5 marks]
$f(n) = h(n)$	Heuristic search	[5 marks]
$f(n) = g(n) + h(n)$	A* search	[5 marks]

Differences between them:

Method	**Optimality**	**Completeness**	**Time Complexity**	
Uniform-cost search	Yes	Yes, if step cost $\geq \epsilon$ (epsilon, small positive real no)	# of nodes with $g \leq$ cost of optimal solution, $O(b^{\lceil C^*/\epsilon \rceil})$ Where C^* is the cost of the optimal solution	[8 marks]
Heuristic search	No	No, can get stuck in loops. Complete in finite space with repeated-state checking.	$O(b^m)$, but a good heuristic can give dramatic improvement	[8 marks]
A* search	Yes	Yes, unless there are infinitely many nodes with $f \leq f(G)$	Exponential in [relative error in h x length of solution]	[9 marks]

2 Two Water Tanks

1. (a) State Space: $\{(x, y) : x, y \in Z, 0 \leq x \leq M, 0 \leq y \leq N\}$

   (b) State Transitions:

i. Fill in a tank:
Tank 1 $(x, y) \longmapsto (M, y)$
Tank 2 $(x, y) \longmapsto (x, N)$

ii. Empty a tank:
Tank 1 $(x, y) \longmapsto (0, y)$
Tank 2 $(x, y) \longmapsto (x, 0)$

iii. Pour water from one tank to another (without spilling):
Tank 1 to Tank 2 $(x, y) \longmapsto (x - \delta, y + \delta)$ where $\delta = min(x, N - y)$
Tank 2 to Tank 1 $(x, y) \longmapsto (x + \epsilon, y - \epsilon)$ where $\epsilon = min(M - x, y)$

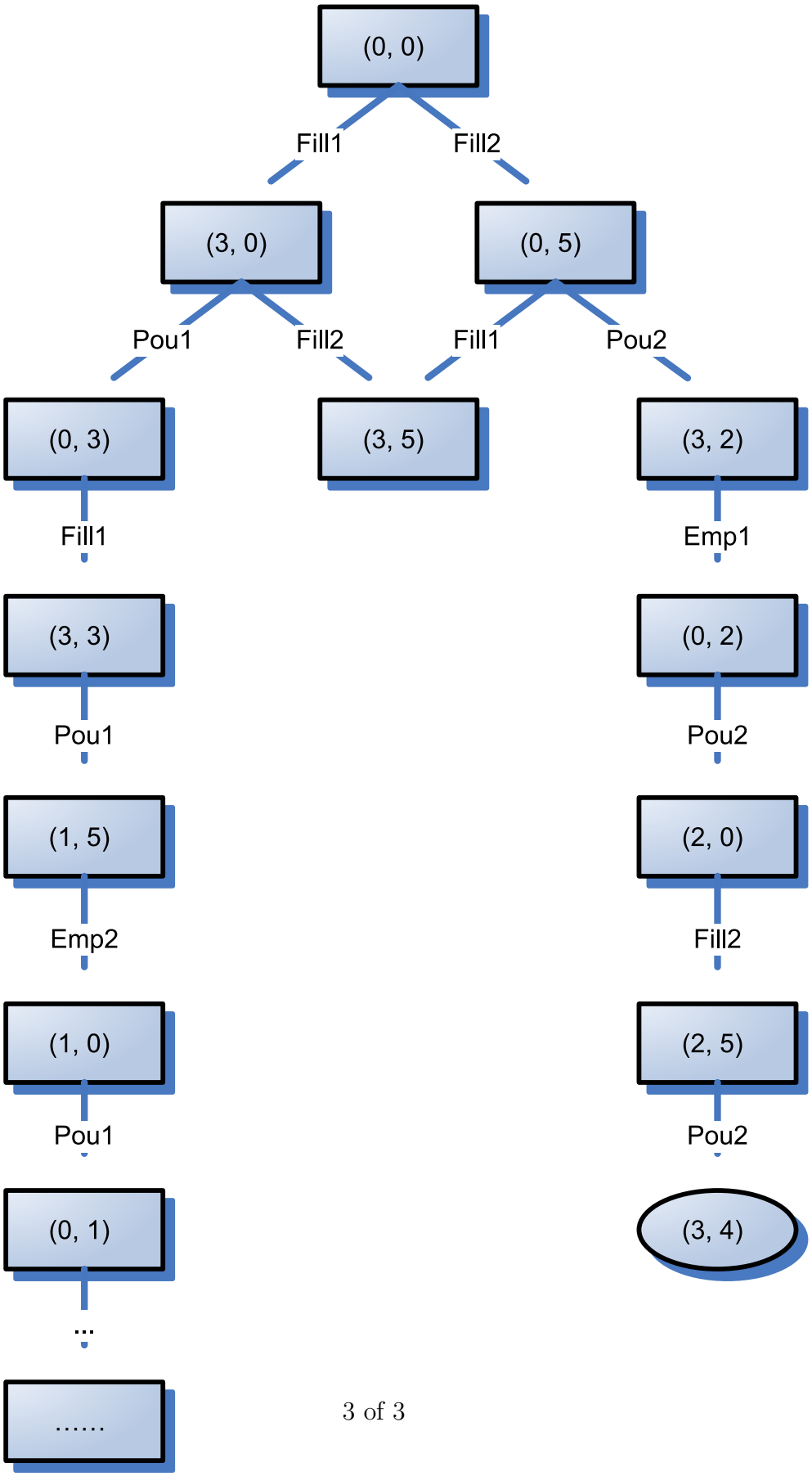
(c) Goal State(s): $\{(x, G) : x \in Z, 0 \leq x \leq M, G < N\} \cup \{(G, y) : y \in Z, 0 \leq y \leq N, G \leq M\}$

2. The table:

From	To					
	Fill1	Fill2	Emp1	Emp2	Pou1	Pou2
(0,0)	(3,0)	(0,5)				
(3,0)		(3,5)	(0,0)		(0,3)	
(0,5)	(3,5)			(0,0)		(3,2)
(3,5)			(0,5)	(3,0)		
(0,3)	(3,3)	(0,5)		(0,0)		(3,0)
(3,2)		(3,5)	(0,2)	(3,0)	(0,5)	
(3,3)		(3,5)	(0,3)	(3,0)	(1,5)	
(0,2)	(3,2)	(0,5)		(0,0)		(2,0)
(1,5)	(3,5)		(0,5)	(1,0)		(3,3)
(2,0)	(3,0)	(2,5)	(0,0)		(0,2)	
(1,0)	(3,0)	(1,5)	(0,0)		(0,1)	
(2,5)	(3,5)		(0,5)	(2,0)		(3,4)
(0,1)	(3,1)	(0,5)		(0,0)		(1,0)
(3,4)		(3,5)	(0,4)	(3,0)	(2,5)	
(3,1)		(3,5)	(0,1)	(3,0)	(0,4)	
(0,4)	(3,4)	(0,5)		(0,0)		(3,1)

3. Two: $(3, 4)$ and $(0, 4)$

4. $(0, 0) \overset{Fill2}{\rightarrow} (0, 5) \overset{Pou2}{\rightarrow} (3, 2) \overset{Emp1}{\rightarrow} (0, 2) \overset{Pou2}{\rightarrow} (2, 0) \overset{Fill2}{\rightarrow} (2, 5) \overset{Pou2}{\rightarrow}$ **(3,4)**


(0, 0)
Fill1
Fill2
(3, 0)
(0, 5)
Pou1
Fill2
Fill1
Pou2
(0, 3)
(3, 5)
(3, 2)
Fill1
Emp1
(3, 3)
(0, 2)
Pou1
Pou2
(1, 5)
(2, 0)
Emp2
Fill2
(1, 0)
(2, 5)
Pou1
Pou2
(0, 1)
(3, 4)
...
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