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Homework 3

Problem 1

a. **Initial Sate**: Empty planar map
Goal State: Colored map such that no two adjacent regions are the same color
Successor Function: Coloring an empty region
Cost Function: Number of regions colored

b. **Initial State:** Room with suspended bananas from the ceiling
Goal State: Room with no bananas suspended from the ceiling
Successor Function: Stack crate, move crates, climb on crates, climb off crates, remove bananas when on crates
Cost Function: Number actions performed

c. **Initial State:** Unlabeled records
Goal State: Record with "illegal input record" message
Successor Function: Process record
Cost Function: Number of records processed

d. **Initial State:** Three empty jugs
Goal State: A jug with one gallon of water
Successor Function: Fill jug, empty jug to another, empty jug to the ground
Cost Function: Number of jug actions taken

Problem 2

a. **BFS**: 12, 10, 13, 9, 11, 7, 5, 8, 4, 6, 14, 2, 15, 16, 1, 3, 17, 18, 21, 19, 23, 20, 24, 25, 22, 26, 27, 28, 29, 30
DFS: 12, 10, 9, 7, 5, 4, 6, 2, 1, 3, 21, 19, 20, 22, 24, 23, 25, 26, 28, 30
IDS: 0: 12
1: 12, 10, 13
2: 12, 10, 9, 13, 11
3: 12, 10, 9, 7, 11, 13
4: 12, 10, 9, 7, 5, 8, 11, 13
5: 12, 10, 9, 7, 5, 4, 8, 14, 11, 13
6: 12, 10, 9, 7, 5, 4, 6, 8, 14, 15, 16, 11, 13
7: 12, 10, 9, 7, 5, 4, 6, 2, 8, 14, 15, 16, 17, 18, 11, 13
8: 12, 10, 9, 7, 5, 4, 6, 2, 1, 3, 8, 14, 15, 17, 16, 18, 11, 13
9: 12, 10, 9, 7, 5, 4, 6, 2, 1, 3, 21, 8, 14, 15, 16, 17, 18, 11, 13

10: 12, 10, 9, 7, 5, 4, 6, 2, 1, 3, 21, 19, 23, 8, 14, 15, 17, 16, 18, 11, 13

11: 12, 10, 9, 7, 5, 4, 6, 2, 1, 3, 21, 19, 23, 20, 24, 25, 8, 14, 15, 17, 18, 16, 11, 13

12: 12, 10, 9, 7, 5, 4, 6, 2, 1, 3, 21, 19, 20, 24, 25, 22, 26, 27, 8, 14, 15, 17, 18, 16, 11, 13

13: 12, 10, 9, 7, 5, 4, 6, 2, 1, 3, 21, 19, 20, 22, 23, 25, 26, 27, 28, 29, 8, 14, 15, 17, 18, 16, 11, 13

14: 12, 10, 9, 7, 5, 4, 6, 2, 1, 3, 21, 19, 20, 22, 24, 23, 25, 26, 27, 28, 29, 30, end

b. Starting from 12: 12, 10, 13, 9, 11, 7, 5, 8, 4, 6, 14, 2, 15, 16, 1, 3
Starting from 30: 30, 28, 29, 26, 27, 25, 23, 24, 20, 21, 19, 22, 3, 1, 2
They meet at node 1 at depth 7.

c. **Back of homework packet**

d.

a. The heuristic is dismissible because from each cluster the lowest cost path taken is greater than or equal to the heuristic estimate.

Shortest Path Start Node	Shortest Path Length	>=?	Heuristic	T/F
A: 3	7		3	**True**
B: 6	10		4	**True**
C: 9	14		5	**True**
D: 14	12		5	**True**
F: 23	4		2	**True**
E(!30): 28	1		1	**True**
30	0		0	**True**

b. The heuristic is consistent if for every node N and each successor P of N, the estimated cost of reaching the goal from N is no greater than the step cost of getting to P plus the estimated cost of reaching the goal from P.
   i. h(N) <= c(N,P) + h(P)
   ii. h(G) = 0

   Check all closest paths, all other paths will have a greater number on right hand side
   Cluster A: N=3, P=21 -> h(3) <=? c(3,21) + h(21) -> 3 <= 1 + 2 **TRUE**
   Cluster B: N=6, P=2 -> h(6) <=? c(6,2) + h(2) -> 4 <= 1 + 3 **TRUE**
   Cluster C: N=9, P=7 -> h(9) <=? c(9,7) + h(7) -> 5 <= 1 + 4 **TRUE**
   Cluster D: N=14, P=8 -> h(14) <=? c(14,8) + h(8) -> 5 <= 1 + 4 **TRUE**
   Cluster E: N=23, P=25 -> h(23) <=? c(23,25) + h(25) -> 2<= 1 + 1 **TRUE**
   h(30) = 0 **TRUE**

c. A* Search Algorithm minimize f(n) = g(n) + h(n)
   g(n) = length of path from start to n
   h(n) = heuristic approximation

d. **Back of homework packet**

Problem 3:

Back of homework packet

Problem 4:

Back of homework packet

Problem 5

a. Unbiased estimator for $Y|T=1 \Rightarrow \sum^{N}_{i=1} (T_i * Y_i) / (p)$
   Unbiased estimator for $Y|T=0 \Rightarrow \sum^{N}_{i=1} ((1-T_i) * Y_i) / (1-p)$
   ATE unbiased estimator = $1/N \left[\sum^{N}_{i=1} (T_i * Y_i) / (p) - \sum^{N}_{i=1} ((1-T_i) * Y_i) / (1-p)\right.$

b. $p = \mu(X_i)$
   Unbiased estimator for $Y|T=1 \Rightarrow \sum^{N}_{i=1} (T_i * Y_i) / (\mu(X_i))$
   Unbiased estimator for $Y|T=0 \Rightarrow \sum^{N}_{i=1} ((1-T_i) * Y_i) / (1-(\mu(X_i)))$
   ATE unbiased estimator = $1/N \left[\sum^{N}_{i=1} (T_i * Y_i) / (\mu(X_i)) - \sum^{N}_{i=1} ((1-T_i) * Y_i) / (1-(\mu(X_i)))\right]$

c. The regret bound is the additional errors that a random person would make in comparison to an expert(doctor) when determining what person to give the a prescription to. The regret bound is a function of the number of mistakes an expert will make.