CS 188
Summer 2023

Discussion 2A Solutions

Q1. Local Search

(a) Hill Climbing

(i) Hill-climbing is complete. ☐ True ■ False

Consider hill-climbing for 8-queen.

(ii) Hill-climbing is optimal. ☐ True ■ False

no completeness indicates no optimality.

(b) Simulated Annealing

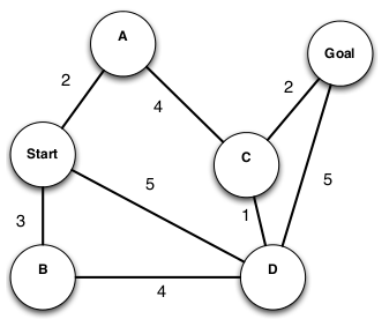
(i) The higher the temperature T is, the more likely the randomly chosen state will be expanded.

■ True ☐ False

The higher T is, the larger $e^{\Delta E/T}$ is given ΔE is negative.

(ii) On a undirected graph, If T decreases slowly enough, simulated annealing is guaranteed to converge to the optimal state exponentially slowly. ■ True ☐ False

(c) Local Beam Search



The following state graph is being explored with 2-beam graph search. A state's score is its accumulated distance to the start state and lower scores are considered better. Which of the following statements are true?

■ States A and B will be expanded before C and D.

☐ States A and D will be expanded before B and C.

☐ States B and D will be expanded before A and C.

☐ None of above.

(d) Genetic Algorithm

(i) In genetic algorithm, cross-over combine the genetic information of two parents to generate new offspring. ■ True ☐ False

(ii) In genetic algorithm, mutation involves a probability that some arbitrary bits in a genetic sequence will be flipped from its original state. ■ True ☐ False

(e) Gradient Descent

(i) Gradient descent is optimal. ☐ True ■ False

False. Gradient descent can become trapped in a local minimum.

(ii) For a function $f(x)$ with derivative $f'(x)$, write down the gradient descent update to go from x_t to x_{t+1}. Learning rate is α.

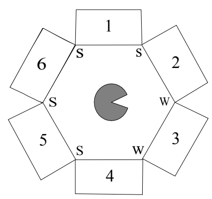
$x_{t+1} = x_t - \alpha f'(x_t)$, where α is the learning rate.

2 CSPs: Trapped Pacman

Pacman is trapped! He is surrounded by mysterious corridors, each of which leads to either a pit (P), a ghost (G), or an exit (E). In order to escape, he needs to figure out which corridors, if any, lead to an exit and freedom, rather than the certain doom of a pit or a ghost.

The one sign of what lies behind the corridors is the wind: a pit produces a strong breeze (S) and an exit produces a weak breeze (W), while a ghost doesn't produce any breeze at all. Unfortunately, Pacman cannot measure the strength of the breeze at a specific corridor. Instead, he can stand *between* two adjacent corridors and feel the max of the two breezes. For example, if he stands between a pit and an exit he will sense a strong (S) breeze, while if he stands between an exit and a ghost, he will sense a weak (W) breeze. The measurements for all intersections are shown in the figure below.

Also, while the total number of exits might be zero, one, or more, Pacman knows that two neighboring squares will *not* both be exits.



Pacman models this problem using variables X_i for each corridor i and domains P, G, and E.

(a) State the binary and/or unary constraints for this CSP (either implicitly or explicitly).

Binary:

$X_1 = P$ or $X_2 = P$, $X_2 = E$ or $X_3 = E$,
$X_3 = E$ or $X_4 = E$, $X_4 = P$ or $X_5 = P$,
$X_5 = P$ or $X_6 = P$, $X_1 = P$ or $X_6 = P$,
$\forall i, j$ s.t. $\text{Adj}(i, j)$ $\neg(X_i = E$ and $X_j = E)$

Unary:

$X_2 \neq P$,
$X_3 \neq P$,
$X_4 \neq P$

Note: This is just one of many solutions. The answers below will be based on this formulation.

(b) Suppose we assign X_1 to E. Perform forward checking after this assignment. Also, enforce unary constraints.

X_1			E
X_2			
X_3		G	E
X_4		G	E
X_5	P	G	E
X_6	P		

(c) Suppose forward checking returns the following set of possible assignments:

X_1	P		
X_2		G	E
X_3		G	E
X_4		G	E
X_5	P		
X_6	P	G	E

According to MRV, which variable or variables could the solver assign first?

X_1 or X_5 (tie breaking)

(d) Assume that Pacman knows that $X_6 = G$. List all the solutions of this CSP or write *none* if no solutions exist.

(P,E,G,E,P,G)
(P,G,E,G,P,G)