4. Give the name that results from each of the following special cases:

a. Local beam search with k=1.
a. Local beam search with k = 1 is hill-climbing search.

b. Local beam search with one initial state and no limit on the number of states retained.
b. Local beam search with k = ∞: strictly speaking, this doesn't make sense. The idea is that if every successor is retained (because k is unbounded), then the search resembles breadth-first search in that it adds one complete layer of nodes before adding the next layer. Starting from one state, the algorithm would be essentially identical to breadth-first search except that each layer is generated all at once.

c. Simulated annealing with T=0 at all times (and omitting the termination test).
c. Simulated annealing with T = 0 at all times: ignoring the fact that the termination step would be triggered immediately, the search would be identical to first-choice hill climbing because every downward successor would be rejected with probability 1.

d. Simulated annealing with T=infinity at all times.
d. Simulated annealing with T = infinity at all times: ignoring the fact that the termination step would never be triggered, the search would be identical to a random walk because every successor would be accepted with probability 1. Note that, in this case, a random walk is approximately equivalent to depth-first search.

e. Genetic algorithm with population size N=1.
e. Genetic algorithm with population size N = 1: if the population size is 1, then the two selected parents will be the same individual; crossover yields an exact copy of the individual; then there is a small chance of mutation. Thus, the algorithm executes a random walk in the space of individuals.

2. (20 points total, 5 pts off for each wrong answer, but not negative) Label the following as T (= True) or F (= False). Unless stated otherwise, assume a finite branching factor, step costs ≥ ε > 0, and at least one goal at a finite depth. You may be in either a tree or a graph.

a. (5 pts) An admissible heuristic NEVER OVER-ESTIMATES the remaining cost (or distance) to the goal.

TRUE, by definition of admissible.

b. (5 pts) Best-first search when the queue is sorted by f(n) = g(n) + h (n) is both complete and optimal when the heuristic is admissible and the total cost estimate f(n) is monotonic increasing on any path ~~to a goal node~~.

TRUE, because the search described is A* and the heuristic described is both admissible and consistent.

c. (5 pts) Most search effort is expended while examining the interior branch nodes of a search tree.

FALSE. Most search effort is expended while examining leaf node of the tree.

d. (5 pts) Uniform-cost search (sort queue by g(n)) is both complete and optimal when the path cost never decreases.

TRUE, because uniform-cost search is A* search with h(n) = 0, which is admissible.

e. (5 pts) Greedy best-first search (sort queue by h(n)) is both complete and optimal when the heuristic is admissible and the path cost never decreases.

FALSE. Your book gives a counter-example (Fig. 3.23, 3rd ed.; Fig. 4.2, 2nd ed.).

f. (5 pts) Beam search uses O(bd) space and O(bd) time.

FALSE. For a beam search in a tree using k nodes total, the space used is O(bk) and the time is O(bmk). For a beam search in a graph, the space is again O(bk) but it can waste time in loops.

g. (5 pts) Simulated annealing uses O(constant) space and can escape from local optima.

TRUE. The space is constant and it accepts bad moves with probability exp(-delta(Value)).

h. (5 pts) Genetic algorithms use O(constant) space and can escape from local optima.

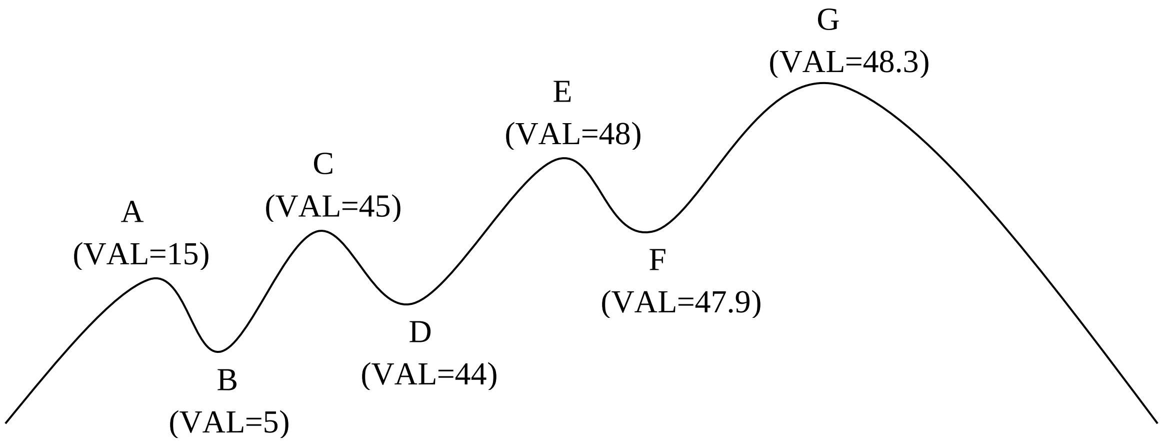
TRUE. The space is constant and it can accept bad moves by creating bad offspring.

i. (5 pts) Gradient descent uses O(constant) space and can escape from local optima.

FALSE. The space is constant, but it generally moves toward, and gets stuck on, a local optima.

3. (20 points total, 5 pts each) Perform Simulated Annealing search to maximize value in the following search space.

Recall that a good move (increases value) is always accepted (P = 1.0); a bad move (decreases value) is accepted with probability $P = e^{\Delta VAL/T}$, where $\Delta VAL = VAL(Next) - VAL(Current)$.



Use this temperature schedule:

Time Step	*1–100*	*101–200*	*201–300*
Temperature (T)	*10*	*1.0*	*0.1*

This table of values of e may be useful:

x	*0.0*	-1.0	-4.0	*-4.3*	-40.0	-43.0
e^x	*1.0*	≈ 0.37	≈ 0.018	≈ 0.014	$\approx 4.0*10^{-18}$	$\approx 2.1*10^{-19}$

a. (5 points total, 1 pt off for each wrong answer, but not negative)Analyze the following possible moves in the search. The first one is

done for you as an example.

Time	*From*	*To*	*T*	*ΔVAL*	*ΔVAL/T*	*P*
57	*A*	*B*	*10*	*−10*	*−1*	*0.37*
78	*C*	*B*	10	−40	−4	≈0.018
132	*C*	*B*	1.0	−40	−40	$\approx 4.0*10^{-18}$
158	*C*	*D*	1.0	−1	−1	≈0.37
194	*E*	*D*	1.0	−4	−4	≈0.018
194	*E*	*B*	1.0	−43	−43	$\approx 2.1*10^{-19}$
238	*E*	*D*	0.1	−4	−40	$\approx 4.0*10^{-18}$
263	*E*	*F*	0.1	−0.1	−1	≈0.37
289	*G*	*F*	0.1	−0.4	−4	≈0.018
289	*G*	*D*	0.1	−4.3	−43	$\approx 2.1*10^{-19}$

b. (5 pts) At Time=100, is the search more likely to be in state A or in state C? (ignore E, G)

C.

c. (5 pts) At Time=200, is the search more likely to be in state A, C, or E? (ignore G)

E.

d. (5 pts) At Time=300, is the search more likely to be in state A, C, E, or G?

G.