CSC242: Homework 1.6
AIMA Chapter 4.1.3–4.1.4

1. What are the advantages and disadvantages of keeping track of more than one state during local search?

   ANSWER: Advantages: The set of successor states can come from any of the "promising" current states.

   Disadvantage: Uses more space (although only a constant factor more). Takes longer to generate successors.

2. Compare parallel local search with local beam search.

   ANSWER: With k local searches run in parallel, some of the searches are bound to end up in bad (unpromising) parts of the search from which it is is diffcult to reach a solution. Nonetheless, they will run to completion (although one could imagine cutting them off and starting a new search).

   By using local beam search with a beam of width k, states that generate uniformly poor successors will just get left behind. "In a local beam search, useful information is passed among the parallel search threads." (AIMA p.126) It is worth noting that it is harder to parallelize local beam search, precisely because of this information sharing aspect.

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

   (a) Local beam search with $k = 1$.
   ANSWER: Hill-climbing (greedy local search).

   (b) Local beam search with one initial state and no limit on the number of states retained.
   ANSWER: Breadth-first search (with each level generated all at once).

   (c) Simulated annealing with $T = 0$ at all times (and omitting the termination test).
   ANSWER: "First-choice" hill-climbing (never takes a "bad" move). AIMA p. 124.

   (d) Simulated annealing with $T = \infty$ at all times.
   ANSWER: Random walk.

   (e) Genetic algorithm with population size $N = 1$.
   ANSWER: Parents are always two copies of the one individual. Crossover therefore has no effect. Result is a (slow) random walk due entirely to mutations.

4. Suppose you're working on a problem at your job. Your officemate suggests an approach based on hill climbing. The boss asks for your opinion on the spot. You have about 10 seconds. What would you say?

   ANSWER: "The success of hill climbing depends very much on the shape of the state-space landscape: if there are few local maxima and plateaux, random-restart hill climbing will find a good solution very quickly." (AIMA p. 125) So the answer is (a) it depends on whether there are many local maxima, and (b) random restarts would be A Good Idea. And watch out for balding porcupines...

5. Give a hill climbing algorithm for solving Travelling Salesman problems: "Given a list of cities and the distances between each pair of cities, what is the shortest possible route that visits each city exactly once and returns to the origin city?" (Wikipedia)

   ANSWER: A state is a complete path between all the cities. The goal is the shortest such path. A hill climbing algorithm is then:

   (a) Start with an arbitrary path containing all the cities.

   (b) Pick two cities along the path at random.

   (c) Split the path at those cities, producing three segments.

   (d) Try all six possible ways to connect the three segments into a full path.

   (e) Make the best (shortest) path the current path.

   (f) Repeat until no improvement is observed for a while.

6. Apply local beam search with $k = 2$ and $k = 3$ to the "polygon world" pathfinding problem from the previous homework (like AIMA 3.31). Make up different configurations to test local beam search against basic hill climbing.

   ANSWER: Left as an exercise. Be sure to show the current state(s), the possible successors, and their costs, at each step of the algorithms.