CSI 5165 Combinatorial Algorithms — Winter 2009
Computer Science — University of Ottawa

Homework Assignment #2 (100 points, weight 15%)
Due: Thursday, March 12, at 8:50 a.m. (in lecture)

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1. (25 points) **Backtracking for self avoiding walks** (written question)
   A self-avoiding walk is described by a sequence of edges in the Euclidean plane, beginning at the origin, such that each of the edges is a horizontal or vertical segment of length 1, and such that no point in the plane is visited more than once. There are precisely 4 such walks of length 1, 12 walks of length 2, and 36 walks of length 3. Dene choice sets and describe a backtracking algorithm for the problem of nding all self-avoiding walks of length n.

2. (25 points) **Estimating backtracking tree size** (written question)
   Write an algorithm in pseudocode that uses the method of estimating the size of a backtrack tree described in Section 4.4, in order to estimate the total number of cliques of a given graph. The input for your algorithm consists of a graph G and the number P of probes, and the output is the estimated number of cliques of the graph based on P probes.

3. (50 points) **Heuristic searches for Maximum cliques** (written question)
   Develop a hill-climbing algorithm, a simulated annealing algorithm, a tabu search algorithm and a genetic algorithm for the Maximum Clique problem (the problem of finding a clique of maximum cardinality in a graph).

   Before giving the **pseudocode** for each algorithm, describe your choices for neighbourhood function, profit, etc. as well as mating scheme, mutation, etc. for the case of genetic algorithm. If some of these features are common to more than one algorithm, please explain them only once, indicating in which algorithms they will be used.

   For each algorithm, write a paragraph explaining which parameter variations you recommend to be tried in order to experiment with each algorithm.

   You will be marked for clarity, conciseness, and quality of algorithm design. I expect to assign approx 30 points for HC+SA+TS and 20 points for genetic algorithm.

4. **Extra question** - for Assignment#3: (implementation of one algorithm in 3.)
   THIS QUESTION IS TO BE HANDED IN WITH ASSIGNMENT 3; YOU MAY START EARLY IN ORDER TO REDUCE THE TIME NEEDED FOR YOUR LAST ASSIGNMENT, AND DEDICATE MORE TIME TO THE PROJECT.
   Choose one of last 3 algorithms developed above (tabu search, simulated annealing or genetic algorithm) and implement it (provide a copy of the pseudocode and description used: a copy of the corresponding answer to the above question or a revised pseudocode, if applicable). Use your algorithm to try to find maximum cliques in each of the graphs given in Exercise 4.9 of the textbook. For each graph, experiment with several parameter variations for your algorithm, and provide a table summarizing your results (tabulate time, number of iterations, largest clique found, etc for each parameter variation considered).