Assignment 1 14 June 2007

This assignment covers Modules 1-4. It is due on Thu, 21 June 2007 at the beginning of class. If possible, please send me a PDF file (which may be obtained by scanning handwritten pages) via e-mail to hoos@cs.ubc.ca and give me a hardcopy marked with your name.

Feel free to discuss the problems and solution ideas with other students, but you need to work out and write down the actual solutions on your own.

Problem 1 (5+10+10+15=40 marks)

(a) Find a real-world combinatorial problem that has been solved using an SLS algorithm and give a reference to a research paper that describes the problem and the algorithm. Try to find a problem from one of your areas of interest or expertise that is reasonably easy to explain (see part b).

(b) Briefly describe the combinatorial problem from part (a); your description can be informal and should be reasonably short (about one paragraph), yet as precise as possible.

(c) For the problem from part (b):

- What are the solution components?
- Is it a decision or optimisation problems?
- If it is a decision problem, what are the conditions that characterise a solution? If it is an optimisation problem, what is its objective function?

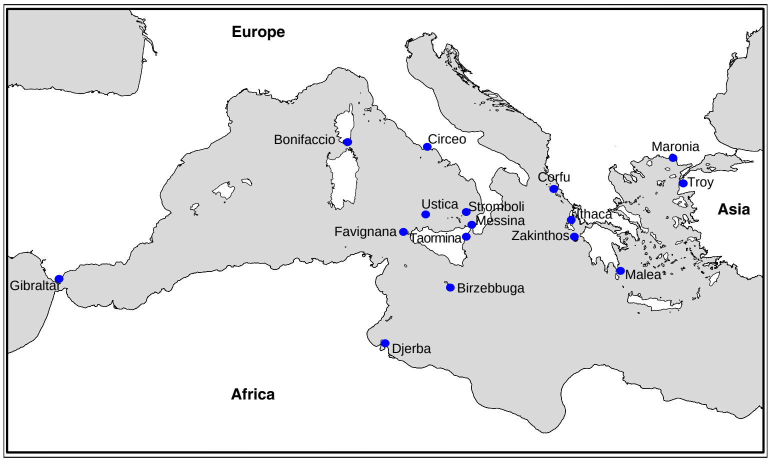
(d) Briefly outline the SLS algorithm you found in part (a). As in part (b), your description can be informal and should be reasonably short (about one paragraph), yet as precise as possible. State which general SLS method is underlying the algorithm and highlight interesting features.

Problem 2 (Bonus problem; no marks, just good karma)

Find and list one or more additional references to papers that deal with the combinatorial problem from Problem 1 or a closely related problem.

Problem 3 (4+3+3+5=15 marks)

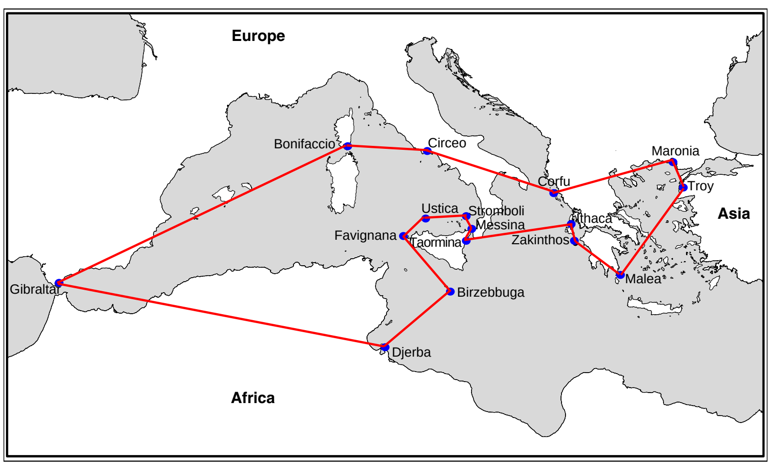
(a) Consider the following Euclidean TSP instance (for the purpose of this problem we revert to the ancient belief that the surface of the earth is perfectly planar):



Specify a result obtained from the Nearest Neighbour Heuristic on this instance.

(b) Given an arbitrary TSP instance G, does the Nearest Neighbour Heuristic (as defined in Section 1.4 of SLS:FA and in class) always return the same solution, that is, does G have a uniquely defined nearest neighbour tour? (Justify your answer.)

(c) Show a 2-exchange neighbour of the following candidate solution of the TSP instance from part (a):



(d) For a TSP instance with n vertices and a complete edge relation (*i.e.*, there is an edge between any pair of vertices), how many 2-exchange neighbours are there for any round trip? (Give the precise number of neighbours and justify your answer.)

Problem 4 (3+3+3=9 marks)

Briefly explain the difference between:

(a) evaluation functions and objective functions;

(b) Iterative Improvement and Iterated Local Search;

(c) Randomised Iterative First Improvement and Random-Order Iterative First Improvement;

(Focus on the key differences. Your answer for each part should be no longer than two sentences.)

Problem 5 (5+10=15 marks)

Show formally that Iterative Improvement and Randomised Iterative Improvement can be seen as special cases of Probabilistic Iterative Improvement.

Caution: Make sure you don't confuse the general PII method with the specific example of Metropolis PII for the TSP!

Problem 6 (6+15=21 marks)

(a) Why do many high-performance dynamic local search (DLS) algorithms occasionally reduce penalties? (Aim for a brief and clear answer covering all relevant arguments.)

(b) Briefly outline a (simple) DLS algorithm for the graph colouring problem. Give a high-level outline of the algorithm and make sure to specify how penalties are used and updated within the algorithm.

Problem 7 (Bonus problem; no marks, just good karma) Specify a population-based extension of ILS and describe its application to the TSP. (You don't have to implement your algorithm.)