GAGP Tutorial 7 (week 9)
Meta-heuristics: Ant Colonies and Particle Swarms

1. Consider **one** of the following problems (or any other one that seems to be interesting) and explain how you would use ant colony optimization to find an acceptable solution: Sequential ordering, classification (e.g. of images), graph colouring, the knapsack problem (or the cutting stock problem), protein folding, the shortest common supersequence problem (for details cf. wikipedia). For this purpose, Dorigo has suggested to answer the following questions:
   a. Define a set of candidate solutions and the set of feasible solutions.
   b. Define a greedy construction heuristic:
      i. What are the solution components?
      ii. How do you measure the objective function contribution of addition a solution components
      iii. Is it always possible to construct feasible solutions?
      iv. How many different solutions can be generated with the constructive heuristic?
   c. Define a local search algorithm:
      i. How can local changes be defined?
      ii. How many solution components are involved in each local search step?
      iii. How do you choose which neighbouring solution to move to?
      iv. Does the local search always maintain feasibility of solutions?

2. Recall the main algorithms that we were dealing with (i.e. GA, ES, GP, ACO, PS and possibly variants of these, if this makes a difference) and classify them according to Dorigo's the criteria for the classification of solvers of combinatorial optimisation problems:
   a. Is the solution obtained by direct construction or by the use of local search?
   b. Are population of solutions used or not?
   c. Is a memory used within the search process or not?
   d. Is the evaluation function fixed or is it modified during search?
   e. Several neighbourhoods or only a single one?
   f. Inspired by nature or artificial?

   You could represent the answer to this question as a table containing check-marks.

3. How are social behaviours in living organisms helpful in developing optimization techniques? (Think of examples other than foraging ants.)

4. Run some example simulations at http://cs.gmu.edu/~eclab/projects/mason/ If possible choose an interesting example and parameter set to be shown in class.

5. Implement a particle swarm optimization program for the travelling sales man problem (this one, if you prefer, for the following week).