

NAT Tutorial 4: Genetic programming

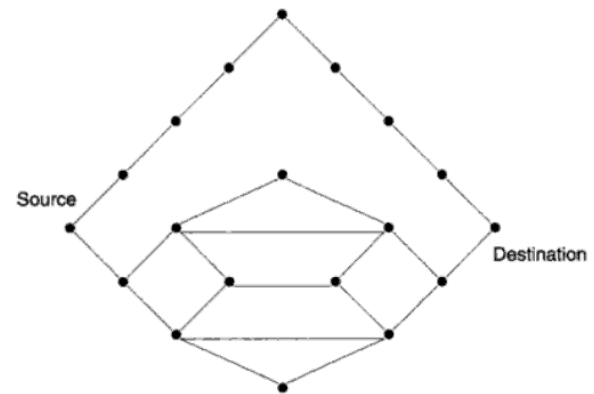
1. A GP system is employed to evolve a controller for a mobile robot. The fitness function evaluates the robot performance starting from 50 initial positions. In a long series of tests the system is observed to produce a satisfactory controller in 70% of runs.

The system designer decides to improve the GP system by speeding it up, and reduces the number of fitness cases to 25. The system now produces a satisfactory controller in only 50% of runs. Is this an improvement?

Hint: Consider the amount of work the system must do to produce a satisfactory controller.

2. What is Meta-Genetic Programming?
3. Which of the existing implementations of GP would you recommend? Why?
4. Consider the following (very small) TSP:
 $d(A,B) = 2$, $d(A,C) = 3$, $d(A,D) = 5$, $d(B,C) = 3$, $d(B,D) = 3$, $d(C,D) = 4$.
What is the optimal (shortest) tour? How many different tours are possible? How many tours are possible with a TSP containing N cities? How long does it take at least to solve the above problem by an ant system? Assume a convergence probability of 50% and establish an (possibly trivial) upper bound based on the assumption of a minimal pheromone level at each link of the graph.

5. The figure on the right shows an example from the ACO book by Dorigo and Stuetzle. What results do you expect for an ant colony algorithm that does not use taboo lists (except for inhibition of immediate return to the previous node)?



6. Assume that ants are allowed to lay pheromone on a path at every time step, so that the pheromone update rule is applied at each time step. Come up with a combination local/global updating scheme that encourages exploration and exploitation– consider what parameters influence this.
7. How would you apply ACO to finding the cheapest way to fly from Edinburgh airport to the airport of Bora Bora (Leeward group of Society Islands of French Polynesia)?
8. Discuss the application of ACO to the eight-queens puzzle. This puzzle is the problem of putting eight chess queens on an 8x8 chessboard such that none of them are able to capture any other using the standard chess queen's moves, cf. http://en.wikipedia.org/wiki/Eight_queens_puzzle.
9. Computer exercise: Run the standard ACO on the travelling salesperson problem with N cities. You may use code from <http://www.aco-metaheuristic.org/aco-code/> or elsewhere or partially reuse your code from the 1st assignment. Start with $n_{ants}=N$, $\alpha=1$, $\beta=2$, $\rho=0.75$. How can you influence the quality of the stationary solution. Consider the standard deviation of the tour length over the ants during one iteration.