Twelfth problem set

Topic: Genetic programming

Due date: 2019 May 23, 9.00

You have to send your solutions via email (evolalghf@gmail.com). You have to solve them unassisted, unless it's marked with a star. The problems marked * can be solved in groups of two. You can get maximum 10 points.

1. (5 points) Construct the trees representing the following expressions!

   - $3x + \exp(\max\{5x + 1, 3x \sin x\})$
   - $(x \wedge true) \rightarrow ((x \vee y) \vee (z \leftrightarrow (x \wedge y)))$

   Number the vertices in order of the depth-first search as well.

2. (5 points) Assume that a function is given for a symbolic regression problem that gives the value of the tree representing the function on the base points (raw fitness). What fitness values would you assign to the trees depending on the objective function, and how do you select parents? Why?

3. **Applications**: Try to design a genetic algorithm to solve the following problems. Describe the representation used for the solutions. Describe the fitness function.

   a, *Decision tree*

   Assume we have a data set, where for each person we keep track of their salary, marital status, number of children, age and number of years spent working. The goal is to determine whether a given person can be granted a loan (we only need a yes-no decision). A test database of 50 people is available with the same information and whether they had a problem in repaying the loan or not.

   b, *Car controls*

   A car is given which can move straight. The car has a side thruster that can accelerate with $1 \frac{m}{s^2}$ left or right. Initially, the car is moving

ahead with unknown speed v_0 from position x_0. We can query the position and speed of the car at regular time intervals, then decide if we want to accelerate left or right next. The goal is to make the car stop at a given point (you can assume it to be 0).

c, *Artificial ant*

An $n \times n$ lattice is given in the 2-dimensional plane. Some positions contain food, the others are empty. We control an artificial ant that can go left, right or ahead from its current position. The ant has a sensor that can tell if there is food in the position ahead. If it enters a position with food, it eats it (the food is gone). Then it continues; the direction may depend on whether the current position contained food or if it sees food in the position ahead.

The goal is to eat as many food as possible in a given number of steps. The ant is initially in the bottom left corner, looking up.

d, *11 multiplexer*

A bit sequence of length 11 is given. 8 of the bits is data, 3 are address. For a bit sequence of length 11, the multiplexer sends a 1 bit reply: the data bit that is in the position determined by the 3 address bits. The goal is to represent the multiplexer with "and" and "or" operators.