ARIN5102 2025-26 Fall Semester Assignment #1

Date assigned: Thursday, Sep 18, 2025

Due time: 23:59pm on Tuesday, Sep 30, 2025

How to submit it: Submit it on canvas.ust.hk.

Penalties on late papers: 20% off each day (anytime after the due time is considered late by one day)

Problem 1. (40%) Consider a 10x10 grid with an obstacle occuping the three center cells in the middle row: $(4, 5), (5, 5), (6, 5)$, and a robot with the same specification as our boundary following robot: eight sensors and four actions.

- Design a production system to control the robot to go to one of the four corners, wherever its initial position is. Write a production system just for this task without calling the boundary following production system in the lecture note.
- Use gpt-4o-mini to come up a python program to do the same task with the following APIs:
  - sense() - returns the list of eight binary sensor readings $[s_1, ..., s_8]$;
  - north() - send "move north one step" to the robot. Similarly for south(), east(), west(), noOp().

  Give the sequence of prompts that you used for coming up with this program.

Problem 2. (10%) Design a TLU for the Boolean function $(x_1 + x_2)(\overline{x_1} + x_3)$ by hand, if possible.

Problem 3. (20%) Can the following truth table be captured by a linearly separable boolean function? If so, give such a boolean function as a TLU. If not, explain why not.

x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	d
1	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	0	1
1	1	0	0	0	0	0	0	1
1	0	1	0	0	0	0	0	0
1	1	0	0	0	0	0	1	0
1	0	1	0	0	0	0	1	0
1	0	1	0	0	1	1	1	0

Problem 4. (Programming) (30%) Design and implement a genetic programming system to evolve some perceptrons that match well with a given training set. A training set

is a collection of tuples of the form $(x_1, ..., x_n, l)$, where x_i's are real numbers and l is either 1 (positive example) or 0 (negative example). So for your genetic programming system, a "program" is just a tuple $(w_1, ..., w_n, \theta)$ of numbers (weights and the threshold). Answer the following questions:

1. What's your fitness function?
2. What's your crossover operator?
3. What's your copy operator?
4. What's your mutation operator, if you use any?
5. What's the size of the initial generation, and how are programs generated?
6. When do you stop the evolution? Evolve it up to a fixed iteration, when it satisfies a condition on the fitness function, or a combination of the two?
7. What's the output of your system for the provided training set `gp-training-set.csv`?

Problem 5. (Exercise 5.4 of Nilsson) (optional) The female solitary wasp, Sphex, lays her eggs in a cricket that she has paralyzed and brought to her burrow nest. The wasp grubs hatch and then feed on this cricket. According to [Wooldridge 1968, p. 70], the wasp exhibits the following interesting behavior:

> . . . the wasp's routine is to bring the paralyzed cricket to the burrow, leave it on the threshold, go inside to see that all is well, emerge, and then drag the cricket in. If the cricket is moved a few inches away while the wasp is inside making her preliminary inspection, the wasp, on emerging from the burrow, will bring the cricket back to the threshold, but not inside, and will then repeat the preparatory procedure of entering the burrow to see that everything is all right. If again the cricket is removed a few inches while the wasp is inside, once again she will move the cricket up to the threshold and reenter the burrow for a final check. . . . On one occasion this procedure was repeated forty times, always with the same result.

Design this wasp as an agent, either manually or with the help of an LLM.