UNIVERSITY OF KENT

FACULTY OF SCIENCES

LEVEL 5 EXAMINATION

SCHOOL OF COMPUTING

Introduction to Intelligent Systems

Thursday, 18 May 2017 : 09.30 - 11.30

The paper contains THREE questions. Answer ALL the questions.

Calculators are not permitted.

Answer each question in a separate book.

Stationery: White Answer Booklet x 3

1. Assume you are given a large number of points of a graph in terms of (x,y) coordinates. These points fall onto a curve defined by the function of the form,

$$f(x) = ax + bx^2 + cx^3 + dx^4 + ex^5$$

Here, a, b, c, d, e are coefficients. Their values are unknown, but they are restricted to the interval [-1000,1000]. The aim is to find values for the coefficients so that the function f(x) passes through all the given points. For the purpose of this exam question, we use a genetic algorithm to find these coefficients.

(a) Write down an appropriate fitness function for this problem. Make sure you specify whether high fitness is "good" or "bad." [4 marks]

(b) Assuming the population size of the genetic algorithm is 6, write down a possible initial population. [6 marks]

(c) Using 1 point crossover at position 3, write down all possible valid solutions that can be obtained by crossing over your first and your second initial solution. [4 marks]

(d) Subject the first candidate solution from your initial population in (B) to random mutation. [2 marks]

(e) Assuming you use tournament selection with tournament size of 2. If the fitness of the population is (20, 40, 100, 60, 1000, 2000), what could the fitness be after the tournament. In your answer make sure to mention which solutions you choose for the tournament. [4 marks]

2. (a) Sketch an autoassociative neural network trained on the pattern (1, -1 , -1, 1). In your answer draw the neural network and give the weights for all connections. [10 Marks]

(b) Using the neural network from (a) show how a sufficient number of update steps for the input (1, -1, 1, 1) reconstructs the trained pattern. In your answer provide the result but also indicate how the final result was calculated. Make sure to stop when appropriate. Provide your answer using the following template:

Update step block:

Neuron 1: < insert here the calculation to update neuron 1>

Neuron 2: < insert here the calculation to update neuron 2> [3 Marks]

(c) Show that the inverse pattern is an attractor as well. [2 marks]

(d) Assume that you have a Hopfield network with μ memorized pattern and weights w_{ij}. Call the value of neuron i of the n-th pattern $s_i^{(n)}$. Show how to derive the stability criterion for this pattern. Hint: Split the activation into signal and noise. In your answer provide the derivation in no more than 3 steps using mathematical expressions. [5 marks]

3. A man once had to travel with a cat, a rabbit and a box of lettuce. He had to take good care of them, because the cat would like to eat the rabbit, while the rabbit appeared to have a taste for lettuce. After some traveling, the man encountered a ditch, which he could jump across, but only when carrying at most one item of luggage. He cannot leave the cat and rabbit together on either side of the ditch unsupervised. Likewise, he cannot leave the rabbit and lettuce alone. Consider how the man needs to jump back and forth over the ditch, carrying the items, to eventually move all his luggage to the other side of the ditch, while keeping them all safe.

(a) How could state be represented using four or fewer propositional (Boolean) variables? Explain your answer. [4 marks]

(b) What is the start state? [2 marks]

(c) What is the destination state? [2 marks]

(d) Write a Boolean function isSafe in pseudo-code that checks whether a given state is safe. [6 marks]

(e) Show how your isSafe check can be used to enumerate all the safe states which are adjacent to the start state. Hint: you need to consider how much the man can carry. Note too that you only need to provide hand working. [4 marks]

(f) Suggest a suitable search algorithm for addressing this problem, explaining your answer. [2 marks]