_____

SEMESTER 1 EXAMINATIONS 2016-2017

Evolution of Complexity (COMP6202)

DURATION 90 MINS (1.5 Hours)

_____

This paper contains 4 questions

Answer **only THREE** questions**.**

All answers must be in separate answer books

Each question carries 1/3 of the total marks for the exam paper and you should aim to spend about 30 minutes on each.

An outline marking scheme is shown in brackets to the right of each question.

Only University approved calculators may be used.

A foreign language translation dictionary (paper version) is permitted provided it contains no notes, additions or annotations.

5 page paper.

TURN OVER

QUESTION 1

a) Describe in detail (e.g. using pseudocode) an algorithm for implementing UNIFORM crossover.   [4 marks]

b) (i) Describe in detail (e.g. using pseudocode) an algorithm for implementing fitness proportionate selection. Assume a fitness function is provided.   [9 marks]

(ii) Describe in detail (e.g. using pseudocode) the modifications required to change the algorithm in part (i) to implement rank proportionate selection. Assume a function that sorts the population in order of fitness is provided.   [3 marks]

c) Describe in detail (e.g. using pseudocode) a genetic algorithm. Use STEADY STATE reproduction. Assume a selection routine is provided. Assume crossover and mutation functions are provided.   [10 marks]

d) Describe the necessary and sufficient components of evolution by natural selection.   [7 marks]

QUESTION 2

a)   The modern synthesis brought Darwin's theory together with Mendelian genetics. What problem did this resolve for Darwinian evolution? Explain.   [8 marks]

b)   Briefly discuss the validity of the statement "Evolution by natural selection tends to favour increases in complexity?" What arguments in evolutionary theory and what evidence in artificial life models suggests otherwise?   [13 marks]

c)   One of the reasons that coevolution is appealing in artificial evolution is the possibility of an 'open-ended arms race' where one population provides a constant selection pressure on a second population's improvement and that population in turn provides a constant selection pressure on the first's improvement. One might hope that coevolution thereby provides a guaranteed method of open-ended improvement and a route to evolved complexity. Explain some ways in which it might fail.   [12 marks]

TURN OVER

QUESTION 3

a)   What three things are required to define a fitness landscape?

[4 marks]

b)   Consider the four genotypes that are possible for two loci, each with two alleles. Suppose three of the genotypes have fitnesses as follows: f(ab)=3, f(aB)=1, f(Ab)=8. If there was no epistasis, what would the value of f(AB) be? Show your working.

[6 marks]

c)   Consider the following population of four 5-bit genotypes:

       00001
       00000
       00000
       00100

Is this population at linkage equilibrium? Explain.   [4 marks]

d) (i)   Describe (e.g. provide a well-labelled sketch or a verbal description) one example problem or fitness landscape where a genetic algorithm with one-point crossover can find the global optimum more quickly than a stochastic local search process (e.g. a mutation hill-climber).   [10 marks]

    (ii) Explain why this problem requires more time to solve with a hill-climber than a genetic algorithm with crossover. How do the expected times to find the global optimum compare?   [9 marks]

QUESTION 4.

a) Consider the following two genotypes:

11101010010111111
00101010110110110

   (i) How many different offspring genotypes can be produced by a one-point crossover of these two strings? [4 marks]

   (ii) How many different offspring genotypes can be produced by a uniform crossover of these two strings? [4 marks]

b) (i) How many different genotypes are contained in the schema *101*100**0** ? [5 marks]

   (ii) What is the order of this schema and what is its defining length? [4 marks]

c) What is a building block and what is the main motivation for using crossover in genetic algorithms according to the building-block hypothesis? [8 marks]

d) In an NK-landscape (defined by Stuart Kauffman), what does K define and what property of the landscape does it control? [5 marks]

e) Comment briefly on the validity of the statement "Mutation is necessary to generate anything new, so high mutation rates are better in general". [3 marks]

END OF PAPER