UNIVERSITY OF SOUTHAMPTON COMP6202W1

SEMESTER 1 EXAMINATIONS 2018-2019

EVOLUTION OF COMPLEXITY

DURATION 90 MINS (1.5 Hours)

This paper contains 4 questions

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

Please start a new page for each question.

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 dictionary is permitted ONLY IF it is a paper version of a direct 'Word to Word' translation dictionary AND it contains no notes, additions or annotations.

5 page examination paper

QUESTION 1

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

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

c) Describe in detail (e.g. using pseudocode) a genetic algorithm. Use GENERATIONAL 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. If the inside of snail shells had heritable differences in colour, would that mean that the colour would necessarily evolve? Explain briefly. [10 marks]

QUESTION 2

a) How did the particulate nature of inheritance support Darwin's theory of evolution? [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 suggest 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) 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)=6, f(aB)=3, f(Ab)=4. If there was no epistasis, what would the value of f(AB) be? Show your working. [6 marks]

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

00001
00000
00010
00011

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

c) (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- or TWO-POINT crossover can find the global optimum more quickly than both a HILL-CLIMBER and a genetic algorithm with UNIFORM crossover. [9 marks]

(ii) Explain why this problem requires more time to solve with a HILL-CLIMBER than a genetic algorithm with ONE-or TWO-POINT crossover. How do the expected times to find the global optimum compare? [11 marks]

(iii) How is the comparison different for UNIFORM crossover? Explain. [3 marks]

QUESTION 4

a) Consider the following two genotypes:

11001010010111111
00101010110110110

(i) Write down the schema for the set of offspring genotypes that can be produced by a uniform crossover from these two genotypes? [4 marks]

(ii) How many genotypes are in this schema? [4 marks]

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

b) What is the Fisher/Muller model for the benefit of sex? [8 marks]

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

d) Using concepts we have discussed in the course, comment on the validity of the following statement; “Complex life is a product of evolution”. [8 marks]

END OF PAPER