UNIVERSITY OF SOUTHAMPTON COMP6202W1

SEMESTER 1 EXAMINATIONS 2019-2020

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

Q1.

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

b) Describe in detail (e.g. using pseudocode) an algorithm for implementing STOCHASTIC UNIVERSAL SAMPLING. Assume a fitness function is provided. [10 marks]

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

d) Briefly describe some of the properties of a genetic algorithm that might give it different capabilities from stochastic local search. Explain briefly, why these properties might be useful. [9 marks]

Q2.

a) Briefly describe one theory of evolution that pre-dated Darwin's theory of evolution by natural selection? [7 marks]

b) Describe the four necessary and sufficient components of evolution by natural selection. [8 marks]

c) Describe three ways in which competitive coevolutionary algorithms might fail to produce a successful arms-race? [12 marks]

d) Briefly describe, using an example, the kind of problem for which cooperative coevolution can be used. [6 marks]

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Q3.

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)=7, f(aB)=5, f(Ab)=8. 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 2-bit genotypes:

01
00
00
11

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

c) (i) Describe the fitness landscape (e.g. provide a well-labelled sketch or a verbal description) defined by ONE of the 'hurdles function' (Prugel-Bennett) OR the 'two-wells function' (Prugel-Bennett) OR the 'gap function' (Jansen). [10 marks]

(ii) For your choice in (c.i) above, describe the ('big-O') expected time to reach the global optimum in this landscape as a function of the relevant landscape parameters (e.g. number of bits) for both a genetic algorithm with MUTATION only and a genetic algorithm with UNIFORM crossover. Explain briefly why these algorithms have these time complexities. [13 marks]

Q4.

a) Consider the following two genotypes:

11111110000111111
00011111110001111

(i) Write down the schema for the set of offspring genotypes that can be produced by 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 TWO-POINT crossover of these two strings? [4 marks]

b) Describe the 'Muller's Ratchet' model for the benefit of sex. [9 marks]

c) Using concepts and examples we have discussed in the course, comment on the validity of the following statement; "Evolution is expected to increase the complexity of organisms". [12 marks]

END OF PAPER