UNIVERSITY OF SOUTHAMPTON COMP6202W1

SEMESTER 1 EXAMINATIONS 2014-2015

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.

TURN OVER

1. (i) Describe in detail (e.g. using pseudocode) an algorithm for implementing one-point crossover. [4]

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

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

(iii) Describe in detail (e.g. using pseudocode) a genetic algorithm. Use generational reproduction. Assume a fitness function and selection routine are provided. Assume crossover and mutation functions are provided. [13]

(iv) *Reproduction*, *heritability* and *variation* are three of the necessary conditions that Ridley describes for evolution by natural selection. Briefly explain what else is needed? [4]

2. (i) Describe the necessary and sufficient components of evolution by natural selection. [7]

(ii) Why was the assumption of blending inheritance, where a child takes the average properties of its parents, troubling to Darwin? [4]

(iii) The modern synthesis brought Darwin's theory together with Mendelian inheritance. How did this relieve the problem of blending inheritance? [4]

(iv) Does Dan McShea's passive diffusion model exhibit a generic trend for increasing complexity? Does this mean that ADAPTIVE complexity will increase without natural selection? Explain briefly. [7]

(v) (a) Describe an example of an artificial life system where evolution occurs without an explicit fitness function. [4]

(b) What properties of an individual affect its fitness in this system? [4]

(c) Does the complexity of individuals increase in this example? Explain briefly. [3]

TURN OVER

3. (i) What three things are required to define a fitness landscape? [4]

(ii) 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)=5, f(aB)=4, f(Ab)=7. If there was no epistasis, what would the value of f(AB) be? Show your working. [6]

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

10000
00000
00000
10000

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

(iv) (a) 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]

(b) 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]

4. (i) Consider the following two genotypes:

001010101101111110
000110100101101110

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

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

(ii) (a) What is the highest order schema that contains all four of these genotypes:

1101010000100100000
0101110000101010010
1101010010100100110
1101010011000110110

[5]

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

(c) Why is short defining length important for ‘building blocks’? [4]

(iii) 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]

END OF PAPER

