
SEMESTER 1 EXAMINATIONS 2017-2018

Evolution of Complexity (COMP6202)

DURATION 90 MINS (1.5 Hours)

This paper contains 4 questions

Answer **only THREE** questions.

Please start the answer to each question on a new page.

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 paper.

QUESTION 1

- (a) Describe in detail (e.g. using pseudocode) an algorithm for mutating a bit-string individual. Allow a (small) probability of mutation on each locus independently. [5 marks]
- (b) Describe in detail (e.g. using pseudocode) an algorithm for a Random Mutation Hill Climber. Assume a mutation function and fitness function are provided. [6 marks]
- (c) What are the two main characteristics of a genetic algorithm that make it substantially different from stochastic local search (e.g. random mutation hill climbing)? [5 marks]
- (d) Describe in detail (e.g. using pseudocode) an algorithm for implementing fitness proportionate selection. Assume a fitness function is provided. [9 marks]
- (e) Describe in detail (e.g. using pseudocode) an algorithm for implementing tournament selection. Assume a fitness function is provided. Assume a tournament size of 2. [3 marks]
- (f) You are working on a problem where possible fitness values cover a large range but small differences in fitness will be important in fine-tuning good solutions. Explain the advantages/disadvantages of using tournament selection rather than fitness proportionate selection. [5 marks]

QUESTION 2

- (a) What is a fitness landscape and how is it defined?
[6 marks]
- (b) Consider the following set of genotypes and their fitnesses:
- a) 00000000, fitness=2
 - b) 00001111, fitness=4
 - c) 11110000, fitness=4
 - d) 11111111, fitness=8
- i) Which of these genotypes are in the schema ****11***0*** ?
[2 marks]
- ii) How many new genotypes could be created through ONE-POINT crossover of the first two individuals, a and b?
[4 marks]
- iii) How many new genotypes could be created through UNIFORM crossover of the first two individuals, a and b?
[5 marks]
- iv) Does this set of 4 genotypes (a, b, c and d) exhibit epistasis? Explain/show your working.
[5 marks]
- v) If a population contains exactly these four individuals only (a, b, c and d), is the population in linkage equilibrium? Explain.
[5 marks]
- (c) Describe some ways in which epistasis can make a fitness landscape difficult for an evolutionary algorithm?
[6 marks]

TURN OVER

QUESTION 3

- (a) What is a building block and what is its significance to the operation of the genetic algorithm? [7 marks]
- (b) Describe the Royal Road fitness landscape. What was the motivation for defining it and explain how it succeeded and failed. [8 marks]
- (c) Describe (e.g. using a well-labelled diagram of the fitness landscape) one example problem where a genetic algorithm with UNIFORM crossover can find the global optimum more quickly than a stochastic local search process (e.g. a random mutation hill-climber). Explain briefly why it demonstrates the different abilities of these methods. [9 marks]
- (d) Describe (e.g. using a well-labelled diagram of the fitness landscape) one example problem where a genetic algorithm with ONE-POINT crossover can find the global optimum more quickly than a stochastic local search process (e.g. a random mutation hill-climber). Explain briefly why it demonstrates the different abilities of these methods. [9 marks]

QUESTION 4

- (a) Describe briefly two motivations for using competitive (adversarial) coevolutionary techniques that might provide an advantage over single-population evolutionary algorithms. [6 marks]
- (b) Describe one example of the use of competitive coevolution in evolutionary computation (mention the role of individuals in each population). [6 marks]
- (c) Give an example of a game or sport that cannot exhibit intransitive superiority. And an example of one that does. [4 marks]
- (d) In contrast to competitive coevolution, what is the main motivation for using cooperative (or compositional) coevolution in evolutionary algorithms? Explain briefly. [5 marks]
- (e) What is one of the main motivations for using a generative representation such as L-systems or cellular encoding? [3 marks]
- (f) In what way are the motivations of crossover similar to cooperative coevolution? [4 marks]
- (g) Comment briefly on the validity of the statement “Evolution cannot explain the complexity and diversity of life on Earth because it depends on random mutations”. [5 marks]

END OF PAPER