UNIVERSITY OF SOUTHAMPTON COMP6026W1

SEMESTER 1 EXAMINATIONS 2011/12

EVOLUTION OF COMPLEXITY

Duration 90 mins

Answer THREE questions.
(25 marks each, 75 marks total)

University approved calculators MAY be used.

Number of Pages: 5

1.

(a) Describe (e.g. using pseudo-code) an algorithm for mutating a bit-string individual. *(2 marks)*

(b) Describe (e.g. using pseudo-code) an algorithm for one-point crossover between two bit-string individuals. *(3 marks)*

(c) Describe (e.g. using pseudo-code) an algorithm to select a parent for reproduction using tournament selection (tournament size 2). *(4 marks)*

(d) Assuming the mutation, crossover and selection routines are all provided, describe (e.g. using pseudo-code) an algorithm for a steady-state genetic algorithm (you may use random replacement). *(5 marks)*

(e) What is ‘stochastic universal sampling’ and in what ways is it different from fitness proportionate selection with the usual roulette wheel algorithm? *(6 marks)*

(f) What is ‘premature convergence’, how might it be alleviated, and can it be eliminated? *(5 marks)*

2.

(a) Consider the schema 10******11 where '*' can be either 0 or 1. What is the order of this schema? How many strings are in this schema? If strings in this schema had above average fitness, would it be a "building block"? Explain. *(6 marks)*

(b) According to the building block hypothesis, what type of crossover is important for the success of the genetic algorithm? Explain. *(6 marks)*

(c) What is the relationship between a building-block and a module? Does a modular problem necessarily have building-blocks? (Consider the issue of 'tight linkage' and types of modularity). *(6 marks)*

(d) The 'Royal Road' (Mitchell et al 1992) is a problem where blocks of eight consecutive 1s are rewarded. The problem was designed to exemplify what GAs are good for – how was it supposed to work and what went wrong? *(7 marks)*

3.

(a) What is a fitness landscape? What is a local optimum? And what causes multiple local optima in a fitness landscape? *(6 marks)*

(b) "Sex is just like a higher mutation rate because it changes many genes at once" – discuss the validity of this statement. *(4 marks)*

(c) (i) Describe (e.g. provide a well-labelled sketch or a verbal description) one example problem/fitness landscape where a genetic algorithm can find the global optimum quickly but other stochastic local search processes (e.g. a stochastic hill-climber) cannot. *(6 marks)*

(ii) Explain why this problem requires exponential time for a hill-climber. *(4 marks)*

(iii) Explain how a genetic algorithm can solve this type of problem in polynomial time *(5 marks)*

4.

(a) Explain the common representation used in genetic programming and how the genetic operators work.
(7 marks)

(b) What is bloat in genetic programming? Describe a possible benefit of bloat and a potential disadvantage of bloat.
(5 marks)

(c) Describe some of the differences between natural fitness landscapes and the fitness landscapes common to engineering problems. *(5 marks)*

(d) 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. Does coevolution provide a guaranteed method of open-ended improvement and a route to evolved complexity? Explain some ways in which it might fail.
(8 marks)

END OF PAPER