COMP 5660/6660 Fall 2024 Exam 3 Key

This is a closed-book, closed-notes exam. The sum of the max points for all the questions is 58, but note that the max exam score will be capped at 54 (i.e., there are 4 bonus points, but you can't score more than 100%). You have exactly 50 minutes to complete this exam. Keep your answers clear and concise while complete. Good luck!

1. Which of the following are improvements on the base Evolutionary Programming algorithm: [4 pts]

   (a) Borrowing the self-adaptation of mutation step sizes from Evolutionary Strategies.

   (b) Self-adapting covariance matrices.

   (c) Combining Gaussian & Cauchy distributions to generate random mutations.

   (d) Tuning the recombination parameters to optimize performance for a specific problem class.

   Select one of:

   - a [1]
   - b [1]
   - c [1]
   - d [0]; one of the defining characteristics of EP is that it considers each trial solution as representing a different species, hence there is no recombination
   - a and b [2]
   - a and c [2]
   - a and d [0]
   - b and c [2]
   - b and d [0]
   - c and d [0]
   - **a, b, and c**
   - a, b, and d [1]
   - a, c, and d [2]
   - b, c, and d [2]
   - a, b, c, and d [3]
   - none of a, b, c, nor d [0]

2. The current GP practice of strongly limiting the role of mutation in favor of recombination is because: [4 pts]

   (a) Recombination tends to increase genetic diversity in GP, unlike mutation which contrary to in standard EAs which employ a linear representation, has a tendency to destroy critical alleles.

   (b) The generally shared view that in GP, crossover has a large shuffling effect, acting in some sense as a macromutation operator.

   (c) Mutation tends to cause excessive bloat in GP, unlike recombination which has a natural parsimony pressure effect.

   Select one of:

   - a [0]
   - **b**
   - c [0]
   - a and b [2]
   - a and c [0]
   - b and c [2]
   - a, b, and c [1]
   - none of a, b, nor c [0]

3. Given the following function & terminal sets as might be employed in the Pac-Man versus the Ghosts assignment series:

Function set	addition, subtraction, multiplication, protected division, rand(a,b)
Terminal set	**R**

   If each function accepts two inputs and produces one output, and the terminals represent sensor inputs and constants, which of the following statements is true? [4 pts]

   (a) The closure property in GP does not hold, because the arity of the functions in the function set are not all equal.

   (b) The closure property in GP does not hold, because the functions in the function set cannot accept all the terminal types present in the terminal set.

   (c) The closure property in GP does not hold, because there are more functions in the function set than terminals in the terminal set, making it impossible to guarantee closure for each and every terminal.

   (d) The closure property in GP holds.

   Select one of:

   - a [0]
   - b [2]
   - c [0]
   - **d**
   - a and b [1]
   - a and c [0]
   - b and c [1]
   - a, b, and c [0]
   - none of a, b, c, nor d [0]

4. Which of the following EC approaches implement(s) Eldredge and Gould's theory of punctuated equilibria? [4 pts]

   (a) Cellular EAs (aka Diffusion Model EAs)

   (b) Island Model EAs

   (c) Automatic Speciation EAs

   Select one of:

   - a [0]
   - **b**
   - c [0]
   - a and b [2]
   - a and c [0]
   - b and c [2]
   - a, b, and c [1]
   - none of a, b, nor c [0]

5. In fitness sharing, the value of the share radius σ_{share} determines: [4 pts]

   (a) the shape of the sharing function's falloff

   (b) the number of niches that can be maintained

   (c) the granularity with which different niches can be discriminated

   (d) the statistical distribution used to adjust fitness according to the number of individuals falling within some prespecified distance

   Select one of:

   - a [0]
   - b [2]
   - c [2]
   - d [0]
   - a and b [1]
   - a and c [1]
   - a and d [0]
   - **b and c**
   - b and d [1]
   - c and d [1]
   - a, b, and c [3]
   - a, b, and d [0]
   - a, c, and d [0]
   - b, c, and d [3]
   - a, b, c, and d [2]
   - none of a, b, c, nor d [0]

6. Which of the following statements about generative hyper-heuristics are true? [4 pts]

   (a) they are a special type of meta-heuristic which enables the automated design of algorithms by directly searching the space of algorithms/programs

   (b) their use only makes sense when their high computational cost can be amortized over repeated problem solving trials

   (c) while most utilize GP, they can also leverage other meta-heuristics

   (d) when utilizing GP, the type of GP employed matters

   Select one of:

   - a [1]
   - b [1]
   - c [1]
   - d [1]
   - a and b [2]
   - a and c [2]
   - a and d [2]
   - b and c [2]
   - b and d [2]
   - c and d [2]
   - a, b, and c [3]
   - a, b, and d [3]
   - a, c, and d [3]
   - b, c, and d [3]
   - **a, b, c, and d**
   - none of a, b, c, nor d [0]

7. The principal differences between test-based and interactive competitive coevolution are: [4 pts]

   (a) In test-based, players with distinct notions of success that may conflict indirectly are coevolved to test each other, while in interactive, the players have symmetric notions of success that conflict which allows direct interaction.

   (b) In test-based, each subcomponent of a whole solution is tested independently, while in interactive all the subcomponents are tested as an interacting whole.

   (c) Test-based suffers predominantly from the known stability pathologies of cycling and mediocre stability, while interactive suffers predominantly from disengagement and overspecialization.

   Select one of:

   - a [0]
   - b [0]
   - c [0]
   - a and b [0]
   - a and c [0]
   - b and c [0]
   - a, b, and c [0]
   - **none of a, b, nor c**

8. Memetic algorithms can on certain problems obtain improved performance through the Baldwin effect by implementing an EA with one of the following characteristics: [4 pts]

   (a) the result of the local search stage determines fitness and deterministically replaces the individual in the population

   (b) the result of the local search stage determines fitness but does not replace the individual in the population

   (c) the result of the local search stages determines fitness and replaces the individual in the population with a given probability

   (d) the result of the local search stage replaces the individual in the population, but does not determine fitness

   Select one of:

   - a [1]
   - b [3]
   - c [2]
   - d [0]
   - a and b [2]
   - a and c [2]
   - a and d [0]
   - **b and c**
   - b and d [2]
   - c and d [1]
   - a, b, and c [3]
   - a, b, and d [1]
   - a, c, and d [1]
   - b, c, and d [3]
   - a, b, c, and d [2]
   - none of a, b, c, nor d [0]

9. For which of the following is there a notable difference between biological evolution and a standard evolutionary algorithm: [4 pts]

   (a) mutations in nature can add, delete, or rearrange information

   (b) the biochemistry of base pairs means most mutations in nature are neutral

   (c) the biochemistry of base pairs makes some kinds of mutations in nature far more likely than others

   (d) mutations in EAs will always result in a different phenotype

   Select one of:

   - a [0]
   - b [2]
   - c [2]
   - d [0]
   - a and b [1]
   - a and c [1]
   - a and d [0]
   - **b and c**
   - b and d [1]
   - c and d [1]
   - a, b, and c [3]
   - a, b, and d [1]
   - a, c, and d [1]
   - b, c, and d [3]
   - a, b, c, and d [2]
   - none of a, b, c, nor d [0]

10. In the Covariance Matrix Adaptation Evolution Strategy (CMA-ES) algorithm, the population size determines the following: [4 pts]

    (a) The number of times the distribution is sampled each generation.

    (b) A smaller population translates to a greater chance of samples farther from current means, hence results in global search.

    (c) A larger population translates to most samples being near current means, hence results in local search.

    Select one of:

    - **a**
    - b [1]
    - c [1]
    - a and b [2]
    - a and c [2]
    - b and c [1]
    - a, b, and c [2]
    - none of a, b, nor c [0]

11. Given the following bit strings v_1 through v_5 and schema S
$v_1 = (11111111111111)$ $fitness(v_1) = 1$
$v_2 = (00000000000000)$ $fitness(v_2) = 1$
$v_3 = (00000001111111)$ $fitness(v_3) = 2$
$v_4 = (11111110000000)$ $fitness(v_4) = 2$
$v_5 = (10101010101010)$ $fitness(v_5) = 4$
$S = (*********0101*)$

    (a) Compute the *order* of S. [2 pts]
    4

    (b) Compute the *defining length* of S and show your computation. [2 pts]
    13-10=3

    (c) Compute the fitness of S and justify your answer. [2 pts]
    The only string that matches S is v_5, so the fitness of S is 4.

    (d) Do you expect the number of strings matching S to increase or decrease in subsequent generations? Explain your answer! [4 pts]
    Average population fitness $= \frac{1+1+2+2+4}{5} = 2$
    Increase, because the fitness of S is above the average population fitness and S is both low-order and low-defining length.

12. The n-bit multiplexer function consists of k address bits a_i followed by 2^k data bits d_j where $n = k+2^k$ and the function is defined as $a_{k-1}, \ldots, a_1, a_0, d_{2^k-1}, \ldots, d_1, d_0$. Assume a Michigan-style Learning Classifier System (LCS) to solve a 6-bit multiplexer problem with the following rule set:
Rule 1: $101\#\#\# : 1 \rightarrow 10$
Rule 2: $0\#1110 : 1 \rightarrow 40$
Rule 3: $\#01\#\#0 : 0 \rightarrow 60$
Rule 4: $\#\#1\#\#0 : 1 \rightarrow 20$
Rule 5: $\#11010 : 1 \rightarrow 10$
Rule 6: $10\#0\#0 : 0 \rightarrow 50$

    If the input string 101000 is presented to this LCS:

    (a) which rules will the match set consist of? [2 pts]
    Rules 1, 3, 4, 6

    (b) which rules will the action set consist of and what action will the LCS execute? Show how you computed this. [6 pts]
    Group them by advocated action and compute predicted action payoff:
    Action 0: Rules 3 & 6: Mean predicted action payoff: (60+50)/2=55
    Action 1: Rules 1 & 4: Mean predicted action payoff: (10+20)/2=15
    Highest predicted payoff action: Action 0
    Action set: Rules 3 & 6
    LCS executes Action 0