COMP 5970/6970/6976 Fall 2019 Exam 2 Key

This is a closed-book, closed-notes exam. The only items you are allowed to use are writing implements. Mark each sheet of paper you use with your name and the string "COMP 5970/6970/6976 Exam 2". If you are caught cheating, you will receive a zero grade for this exam. The max number of points per question is indicated in square brackets after each question. The sum of the max points for all the questions is 34, but note that the max exam score will be capped at 32 (i.e., there are 2 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!

Multiple Choice Questions - write the letter of your choice on your answer paper, NOT on the question sheet which you may keep

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

   (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 [0]

   (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 [0]

   (d) all of the above [$\frac{1}{2}$]

   (e) none of the above [0]

2. Countermeasures to bloat in GP include: [2]

   (a) increasing mutation rate to maintain genetic diversity [0]

   (b) **increasing parsimony pressure to penalize the fitness of large chromosomes**

   (c) reducing the number of alleles to prevent disproportional tree growth [0]

   (d) all of the above [0]

   (e) none of the above [0]

3. Does the closure property in GP hold for the following combination of function and terminal sets: [2]

Function set	$\{+, -, sin, cos, or, not, and\}$
Terminal set	$\Re \cup \{true, false\}$

   (a) No, because the arity of the functions in the function set are not all equal. [0]

   (b) **No, because the functions in the function set cannot accept all the terminal types present in the terminal set.**

   (c) Yes, because the functions in the function set have equal arity. [0]

   (d) Yes, because there are more functions in the function set than terminals in the terminal set, guaranteeing closure for each and every terminal. [0]

   (e) None of the above. [0]

4. Koza states that a parameterized topology in GP is: [2]
   (a) **a general solution to a problem in the form of a graphical structure whose nodes or edges represent components and where the parameter values of the components are specified by mathematical expressions containing free variables**
   (b) a search landscape for tree representations whose terminal nodes take the values of input parameters [1]
   (c) a graph representation where the terminal node input values are determined employing parameter control [0]
   (d) none of the above [0]

5. Modern Evolutionary Programming (EP) differs from classic EP in: [2]
   (a) representation [1]
   (b) parent selection [0]
   (c) parameter control [1]
   (d) a and b [$\frac{1}{2}$]
   (e) **a and c**
   (f) b and c [$\frac{1}{2}$]
   (g) a, b, and c [$1\frac{1}{2}$]
   (h) none of the above [0]

6. Panmictic mate selection in EAs has the following properties: [2]
   (a) strategy parameters are fixed during an EA run [0]
   (b) **no genotypic restrictions on mating**
   (c) more fit individuals mate more often [0]
   (d) process of tuning mate selection parameters for each problem is time-consuming [0]
   (e) all of the above [$\frac{1}{2}$]
   (f) none of the above [0]

7. In Crowding: [2]
   (a) **new individuals replace similar population members, resulting in the population sharing the niches equally**
   (b) the fitness of individuals immediately prior to selection is adjusted according to the number of individuals falling within some prespecified distance of each other [$\frac{1}{2}$]
   (c) individuals share the fitness of similar population members immediately prior to selection, resulting in the number of individuals per niche being dependent on the niche fitness [1]
   (d) none of the above [0]

8. According to the concept of island model EAs in the context of Eldredge and Gould's theory of punctuated equilibria: [2]

   (a) multiple populations of different species are run in parallel in some kind of communication structure [1]
   (b) after a usually variable number of generations, a number of individuals are selected from each population to be exchanged with others from neighboring populations [$1\frac{1}{2}$]
   (c) **during the migration phase, the injection of individuals of potentially high fitness, and with possibly radically different genotypes, facilitates exploration**
   (d) the migratory injections interrupt periods of evolutionary stasis by rapid growth when the main population is invaded by individuals from a previously spatially isolated group of individuals of a different species. [$1\frac{1}{2}$]
   (e) all of the above [1]
   (f) none of the above [0]

9. In Multi-Objective EAs employing levels of non-domination, increasing the number of conflicting objectives, generally will: [2]

   (a) not impact the number of levels of non-domination [0]
   (b) increase the number of levels of non-domination [0]
   (c) **decrease the number of levels of non-domination**
   (d) either increase or decrease the number of levels of non-domination, depending on the amount of selective pressure [0]

10. In the context of multi-objective problem solving, the term scalarisation refers to combining single objective fitness scores into a weighted cumulative fitness score. This approach suffers from the following drawbacks: [2]

    (a) scalarisation commonly is a computationally expensive process [0]
    (b) the implicit assumption that all the user's preferences can be captured before the range of possible solutions is known [1]
    (c) for repeatedly solving different instances of the same problem, either the user's preferences are assumed to be static, or the user needs to repeatedly provide new weightings [1]
    (d) a and b [$\frac{1}{2}$]
    (e) a and c [$\frac{1}{2}$]
    (f) **b and c**
    (g) a, b, and c [$1\frac{1}{2}$]
    (h) none of the above [0]

11. "Intelligent" initialization in a memetic algorithm can be performed by: [2]

    (a) Seeding [$\frac{1}{2}$]
    (b) Selective Initialization [$\frac{1}{2}$]
    (c) Locally Optimized Random Initialization [$\frac{1}{2}$]
    (d) Mass Mutation [$\frac{1}{2}$]
    (e) **all of the above**
    (f) none of the above [0]

12. The Baldwin Effect is: [2]

    (a) improved EA performance obtained by combining local search with Lamarckian evolution [$\frac{1}{2}$]
    (b) **improved EA performance obtained by applying local search prior to fitness calculation**
    (c) improved EA performance obtained by applying local search after fitness calculation [1]
    (d) decreased EA performance due to Lamarckian evolution negating the benefit of local search [0]
    (e) none of the above [0]

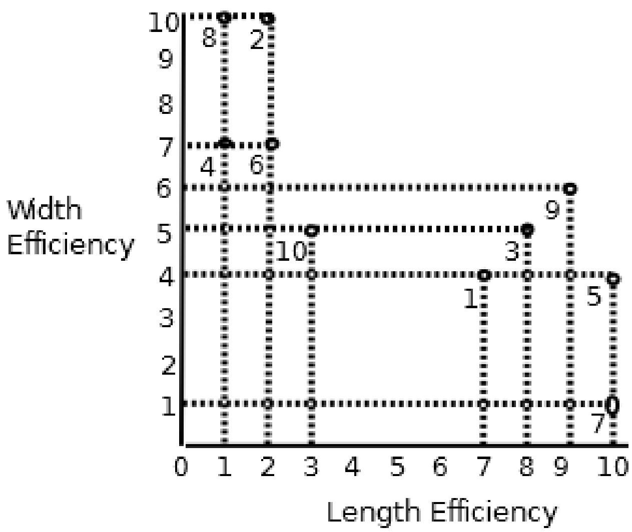
open questions start on the next page

Open Questions - write your answer on your answer paper, NOT on the question sheet which you may keep

13. Say for the cutting stock problem, you want to simultaneously minimize stock length and width. You execute a multi-objective EA and the final population contains the solutions listed in the following table, where higher length efficiency indicates shorter stock length, and higher width efficiency indicates shorter stock width:

ID	Length efficiency	Width Efficiency
1	7	4
2	2	10
3	8	5
4	1	7
5	10	4
6	2	7
7	10	1
8	1	10
9	9	6
10	3	5

(a) Plot the above table and use dotted lines to indicate the area of domination for each element. [2]



(b) List for each element which elements it dominates; indicate elements with their IDs. [2]

ID	Dominates
1	None
2	4,6,8
3	1,10
4	None
5	1,7
6	4
7	None
8	4
9	1,3,10
10	None

(c) Show the population distributed over non-dominated levels like some multi-objective EAs employ, after each addition of an element, starting with element 1 and ending with element 10 increasing the element number one at a time; indicate elements with their IDs. So you need to show ten different population distributions, the first one consisting of a single element, and the last one consisting of ten elements. [6]

After adding element 1:
- **Level 1:** 1

After adding element 2:
- **Level 1:** 1,2

After adding element 3:
- **Level 1:** 2,3
- **Level 2:** 1

After adding element 4:
- **Level 1:** 2,3
- **Level 2:** 1,4

After adding element 5:
- **Level 1:** 2,3,5
- **Level 2:** 1,4

After adding element 6:
- **Level 1:** 2,3,5
- **Level 2:** 1,6
- **Level 3:** 4

After adding element 7:
- **Level 1:** 2,3,5
- **Level 2:** 1,6,7
- **Level 3:** 4

After adding element 8:
- **Level 1:** 2,3,5
- **Level 2:** 1,6,7,8
- **Level 3:** 4

After adding element 9:
- **Level 1:** 2,5,9
- **Level 2:** 3,6,7,8
- **Level 3:** 1,4

After adding element 10:
- **Level 1:** 2,5,9
- **Level 2:** 3,6,7,8
- **Level 3:** 1,4,10