COMP 5660/6660 Fall 2022 Exam 1 Key

This is a closed-book, closed-notes exam. The sum of the max points for all the questions is 90, but note that the max exam score will be capped at 86 (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 is not a con for using an EA: [4 pts]

   (a) Design of genotype, variation operators, decoder function, and fitness function can be difficult
   (b) Tends to suffer premature convergence
   (c) Often computationally intensive
   (d) Parameter optimization often is a difficult problem

   Select one of:

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

2. Mutation has the potential to modify (directly or indirectly) an individual's: [4 pts]

   (a) genotype
   (b) phenotype
   (c) alleles
   (d) fitness

   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]

3. The automated bridge design problem from your Assignment 1 series is: [4 pts]

   (a) An optimization problem because the model is known and you're searching for the optimal inputs to the model
   (b) A modeling problem because you're modeling (designing) a bridge
   (c) A simulation problem because it simulates the physics of your automated design

   Select one of:

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

4. The automated bridge design problem from your Assignment 1 series is in general: [4 pts]

   (a) unimodal because for all problem instances, there is only one globally optimal solution
   (b) unimodal because there exist problem instances for which there is only one local optimum
   (c) multimodal because for all problem instances there are multiple globally optimal solutions
   (d) multimodal because there exist problem instances for which there are multiple local optima

   Select one of:

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

5. The genetic encoding for the automated bridge design problem from your Assignment 1 series is: [4 pts]

   (a) pleitropic (**a gene specifying a coordinate pair can create multiple edges by being within distance d of multiple other nodes, so one gene affecting multiple phenotypic traits)**
   (b) polygenetic (**two genes specifying coordinate pairs for two nodes within distance d of each other will cause an edge to be created in the phenotype, so multiple genes are affecting one phenotypic trait)**
   (c) phenotypic

   Select one of:

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

6. Uniform crossover exhibits: [4 pts]

   (a) distributional bias
   (b) convergence bias
   (c) positional bias

   Select one of:

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

7. A Hamming cliff is: [4 pts]

   (a) a pair of binary strings representing adjacent integers, which differ in many of their bits
   (b) a population of individuals with binary representation whose phenotypes are very similar and whose genotypes all have a large Hamming distance to the global optimum
   (c) a cliff-like plot associated with a binary encoded fitness function belonging to an NP-Complete problem class

   Select one of:

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

8. In an EA which utilizes truncation survival selection: [4 pts]

   (a) the chance of premature convergence is lower than other elitist EAs *(false because truncation survival has the highest selective pressure of all the regular elitist survival mechanisms)*
   (b) the parent selection must not be elitist because that would cause premature convergence *(elitist means that the fittest solution is guaranteed to survive so doesn't apply to parent selection and also doesn't necessarily cause premature convergence)*
   (c) the parent selection should be stochastic to decrease the chance of premature convergence

   Select one of:

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

9. Blend Recombination was created as: [4 pts]

   (a) a special type of multi-parent recombination which blends the genes of more than two parents to increase the allele pool and thus promote genetic diversity

   (b) a special type of arithmetic recombination which can produce new alleles to increase genetic diversity

   (c) a type of recombination which in each locus can create a new allele outside of the range of the alleles of the parents to avoid the range shrinking during evolution

   (d) a type of recombination for creating offspring in a region that is bigger than the n-dimensional rectangle spanned by the parents

   Select one of:

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

10. In an EA employing k-tournament parent selection, increasing k generally leads to: [4 pts]

    (a) increased selective pressure

    (b) decreased selective pressure

    (c) increased chance of premature convergence

    (d) decreased chance of premature convergence

    Select one of:

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

11. What is the binary gray code for the standard binary number 00011100110101? [4 pts]

    00010010101111

12. What is the standard binary number encoded by the binary gray code 00011100110101? [4 pts]

    00010111011001

13. Given the following two parents with permutation representation:
    $p1 = (841372956)$
    $p2 = (483715629)$
    compute the first offspring with Order Crossover, using crossover points between the 3rd and 4th loci and between the 6th and 7th loci. Show your offspring construction steps. [6 pts]

    (a) $\cdot\cdot\cdot372\cdot\cdot$

    (b) **8 1 5 3 7 2 6 9 4**

14. Given the following two parents with permutation representation:
    $p1 = (841372956)$
    $p2 = (483715629)$
    compute the first offspring with Cycle Crossover. Show first the cycles you've identified and then the construction of the offspring. [8 pts]

    Cycle 1: 8-4, cycle 2: 1-3-7, cycle 3: 2-5, cycle 4: 9-6
    Construction of first offspring by scanning parents from left to right, starting at parent 1 and alternating parents:

    (a) Add cycle 1 from parent 1: $84\cdot\cdot\cdot\cdot\cdot\cdot$

    (b) Add cycle 2 from parent 2: $84371\cdot\cdot\cdot\cdot$

    (c) Add cycle 3 from parent 1: $843712\cdot5\cdot$

    (d) Add cycle 4 from parent 2: **8 4 3 7 1 2 6 5 9**

15. Given the following two parents with permutation representation:
    $p1 = (841372956)$
    $p2 = (374815629)$
    compute the first offspring with PMX, using crossover points between the 2nd and 3rd loci and between the 7th and 8th loci. Show your offspring construction steps. [12 pts]

    (a) $\cdot\cdot13729\cdot\cdot$

    (b) $\cdot413729\cdot\cdot$

    (c) $8413729\cdot\cdot$

    (d) $84137295\cdot$

    (e) **8 4 1 3 7 2 9 5 6**

16. Given the following parents with permutation representation:
$p1 = (841372956)$
$p2 = (374815629)$
compute the first offspring with Edge Crossover, except that for each random choice you instead select the lowest element. Show how you arrived at your answer by filling the following templates: [16 pts]
Edge Table: | Element | Edges |

Construction Table: | Element Selected | Reason Selected | Partial Result |

Original Edge Table:

Element	Edges	Element	Edges
1	4,3,8,5	6	5+,8,2
2	7,9+,6	7	3+,2,4
3	1,7+,9	8	6,4+,1
4	8+,1,7	9	2+,5,3
5	9,6+,1		

Construction Table:

Element selected	Reason	Partial result
1	Lowest	1
3	Tied shortest list, so lowest	1,3
7	Common edge	1,3,7
4	Shortest list	1,3,7,4
8	Only element	1,3,7,4,8
6	Only element	1,3,7,4,8,6
5	Common edge	1,3,7,4,8,6,5
9	Only element	1,3,7,4,8,6,5,9
2	Last element	**1,3,7,4,8,6,5,9,2**

Edge Table After Step 1:

Element	Edges	Element	Edges
1	4,3,8,5	6	5+,8,2
2	7,9+,6	7	3+,2,4
3	7+,9	8	6,4+
4	8+,7	9	2+,5,3
5	9,6+		

Edge Table After Step 2:

Element	Edges	Element	Edges
		6	5+,8,2
2	7,9+,6	7	2,4
3	7+,9	8	6,4+
4	8+,7	9	2+,5
5	9,6+		

Edge Table After Step 3:

Element	Edges	Element	Edges
		6	5+,8,2
2	9+,6	7	2,4
		8	6,4+
4	8+	9	2+,5
5	9,6+		

Edge Table After Step 4:

Element	Edges	Element	Edges
		6	5+,8,2
2	9+,6		
		8	6
4	8+	9	2+,5
5	9,6+		

Edge Table After Step 5:

Element	Edges	Element	Edges
		6	5+,2
2	9+,6		
		8	6
		9	2+,5
5	9,6+		

Edge Table After Step 6:

Element	Edges	Element	Edges
		6	5+,2
2	9+		
		9	2+,5
5	9		

Edge Table After Step 7:

Element	Edges	Element	Edges
2	9+		
		9	2+
5	9		

Edge Table After Step 8:

Element	Edges	Element	Edges
2			
		9	2+