CS301 SP2007 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 “cs301sp2007 exam2”. 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 41, but note that the max exam score will be capped at 38 (i.e., there are 3 bonus points but you can’t score more than 100%). While this exam has been designed to be doable in 60 minutes or less, you have up to 75 minutes to complete this exam. Keep your answers clear and concise while complete. Good luck!

Multiple Choice Questions - Circle the letter indicating your choice

1. In an arbitrary unimodal problem: [1]
   (a) all points have exactly one fitter neighbor
   (b) there is only one point which is fitter than all of its neighbors
   (c) there is a unique global optimum but possibly multiple local optima
   (d) none of the above

2. Recombination has the potential to produce an offspring which is different than its parents in its: [1]
   (a) genotype
   (b) number of chromosomes
   (c) alleles
   (d) all of the above

3. Polygeny is defined as: [1]
   (a) one gene affects a single phenotypic trait
   (b) one gene affects multiple phenotypic traits
   (c) multiple genes affect a single phenotypic trait
   (d) multiple genes affect multiple phenotypic traits

4. For traditional Evolutionary Programming which of the following operator sets is correct: [1]
   (a) real-valued vectors, deterministic parent selection, arithmetic crossover, Gaussian mutation, and probabilistic survivor selection
   (b) finite state machines, deterministic parent selection, uniform crossover, Gaussian mutation, and probabilistic survivor selection
   (c) real-valued vectors, deterministic parent selection, no crossover, Gaussian mutation, and probabilistic survivor selection
   (d) none of the above

5. Countermeasures to Bloat in Genetic Programming include: [1]
   (a) reducing the number of alleles to prevent disproportional tree growth
   (b) reducing parsimony pressure to penalize the fitness of large chromosomes
   (c) increasing mutation rate to maintain genetic diversity
   (d) none of the above

6. Learning Classifier Systems are technically speaking: [1]
   (a) a type of Evolutionary Algorithm
   (b) a type of Reinforcement Learning System
   (c) a type of Condition-Action Rule-Based System
   (d) both of the last two types
Regular Questions

7. (a) What is the gray code for the binary number 01011110? [2]
   01110001

(b) What is the binary number encoded by the gray code 011011001? [2]
   010010001

8. Given the following two parents with permutation representation:
   \( p_1 = (918273645) \)
   \( p_2 = (246813579) \)

   (a) Compute the Edge Crossover as specified in your textbook, except that for each random choice
   you instead select the lowest element. [6]

<table>
<thead>
<tr>
<th>Element</th>
<th>Edges</th>
<th>Element</th>
<th>Edges</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9,8+,3</td>
<td>6</td>
<td>3,4+,8</td>
</tr>
<tr>
<td>2</td>
<td>8,7,4,9</td>
<td>7</td>
<td>2,3,5,9</td>
</tr>
<tr>
<td>3</td>
<td>7,6,1,5</td>
<td>8</td>
<td>1+,2,6</td>
</tr>
<tr>
<td>4</td>
<td>6+,5,2</td>
<td>9</td>
<td>5,1,7,2</td>
</tr>
<tr>
<td>5</td>
<td>4,9,3,7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   **Original Edge Table:**

   **Construction Table:**

<table>
<thead>
<tr>
<th>Element selected</th>
<th>Reason</th>
<th>Partial result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lowest</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Common edge</td>
<td>18</td>
</tr>
<tr>
<td>6</td>
<td>Shortest list</td>
<td>186</td>
</tr>
<tr>
<td>4</td>
<td>Common edge</td>
<td>1864</td>
</tr>
<tr>
<td>2</td>
<td>Shortest list</td>
<td>18642</td>
</tr>
<tr>
<td>9</td>
<td>Shortest list</td>
<td>186429</td>
</tr>
<tr>
<td>5</td>
<td>Equal list size, so lowest</td>
<td>1864295</td>
</tr>
<tr>
<td>3</td>
<td>Equal list size, so lowest</td>
<td>18642953</td>
</tr>
<tr>
<td>7</td>
<td>Last element</td>
<td>186429537</td>
</tr>
</tbody>
</table>

   **Edge Table After Step 1:**

   **Edge Table After Step 2:**

   **Edge Table After Step 3:**
(b) Compute the Cycle Crossover as specified in your textbook. [4]

Cycle 1: 9-2-8-6-5, cycle 2: 1-4-7, cycle 3: 3

Construction of first offspring by scanning parents from left to right, starting at parent 1 and alternating parents:

i. Add cycle 1 from parent 1: 9 · 8 · 6 · 5

ii. Add cycle 2 from parent 2: 94821 · 675

iii. Add cycle 3 from parent 1: 948213675

9. Explain briefly the difference between “parameter tuning” and “parameter control”. [4]

Parameter tuning refers to the a priori optimization of fixed strategy parameters, while parameter control refers to the on-the-fly optimization of dynamic strategy parameters.

10. Explain concisely Rechenberg’s 1/5 success rule. [4]

It refers to the optimal ratio of successful versus total mutations in Evolution Strategies where mutation step size is increased if the ratio is greater than 1/5 and decreased if the ratio is smaller than 1/5.

11. Given the parents (2.4, 1.7, 3.5, 4.2) and (1.4, 0.3, 1.1, 2.6), what single offspring would be created by intermediary recombination? [2]

(1.9, 1.0, 2.3, 3.4)

12. Describe briefly the characteristics of Genetic Programming which set it apart from other types of Evolutionary Algorithms. [5]

GP is a class of EA’s aimed at the automatic generation of computer programs, typically represented by parse trees (more in general, GP can be used for the automatic generation of symbolic expressions representing computer programs, mathematical equations, etc.). Each individual encodes a complete computer program in some programming language. To evaluate an individual the program encoded in its genes is executed and the fitness function assigns some degree of success to its execution. Special genetic operators that work on parse trees are required. Special care has to be taken to satisfy the constraint of producing legal computer programs.
13. What is the closure property in Genetic Programming? [2]

Each function in the function set can take any valid expression as an argument.


This is not applicable because per definition all the rules in the action set advocate the same action.

15. Describe concisely the difference between the Pitt approach and the Michigan approach in Learning Classifier Systems. [2]

In the Pitt approach each individual represents a complete rule set, while in the Michigan approach each individual represents a single rule and the entire population represents the complete rule set.