CMPUT 355 Quiz 4 Marking Rubric

Grading Rubric

```
Problem 1
    +0.5 points for each item

Problem 2
    +2 points for each part

Problem 3
    +1 point for correct code modification
    +1 point for correct explanation

Problem 4
    +1 point for correct number of winning moves
    +1 point for correct winning move (number and pile)
    +2 points for work shown, that demonstrates complete understanding
       + 1 point for work shown that demonstates partial understanding

       For full marks, must show the XOR value of the piles,
       and an XOR with one of the piles to get a winning move

Problem 5
    +0.2 points for each correct answer

Problem 6
    See below

Problem 7
    +0.33 points for each correct value

Problem 8
    a) Full marks are given for answers that demonstrate a strategy for Black that
       leads to the minimax score B-W=9
    b) 1 mark given if both the move and the B-W are correct
    c) 2 marks given for sufficient explanation
```

Quiz 4a

1. a) Tree of all continuations: 600,000
   b) Tree + isomorphism: 60,000
   c) DAG + isomorphism: 8,000
   d) DAG of all continuations: 16,000

2. a) 14
   b) 1/6

3. Here are a few examples of possible answers:

   (a) Change lines 2, 3, and 4 to be `== 'x'` instead of `== z`

   (b) Add before line 1:

   ```
   if z == 'o':
       return False
   ```

   (c) Add before line 2:

   ```
   if z == 'x':
       line2
       line3
       line4
       ...
   ```

4. There are 3 winning moves.
   Remove 3 from pile a, or b, or remove 1 from c.

5.
```
(0 0 0) L    (0 1 1) W    (1 1 1) L    (0 2 2) L
(0 0 1) L    (0 0 3) W    (0 0 4) W    (1 1 2) W
(0 0 2) W    (0 1 2) W    (0 1 3) W
```

6. There is a winning move from a pile if the binary representation of the pile size has a 1 in the same bit position as the left-most 1 in the binary representation of the xorsum of all the piles (from the course notes). (1 point) For there to be exactly two winning moves, there would have to be only two piles with a 1 in this bit position, but that would make the xorsum of the piles 0 for that bit position, when it must be 1. (1 point) Therefore, it's not possible to have exactly 2 winning moves.

7. Score: 1, 0, 1, 0, 1, 0

8. a) Strategy tree (for Black) shows one strategy from Black, and all opposing moves from White.

```
          .X.
          OXX
          OX.
           |
           | B[a3]
           |
          XX.
          .XX
          .X.
          /|\
W[a1] / | \ W[a2]
       /  |  \
      /   |   \
     /    |W:p \
XX.     XX.     XX.
.XX     .XX     OXX
OX.     .X.     .X.
 |       |       |
 |B[a2]  |B[a2]  |B[a1]
 |       |       |
XX.     XX.     XX.
XXX     XXX     .XX
.X.     .X.     XX.
```

b) W[b2], B - W = 3

c) On a 3x3 board, if either player forms a middle-3 or bent-3 shape, they can win 9-0, because they have split the board into two regions that the other cannot play in. As Black already has a middle-3 shape by move 5, it knows that it will 9-0.

Quiz 4b

1. a) DAG of all continuations: 16,000
   b) DAG + isomorphism: 8,000
   c) Tree + isomorphism: 60,000
   d) Tree of all continuations: 600,000

2. a) 12
   b) 1/5

3. Here are a few examples of possible answers:

   (a) Change lines 21, 22, and 23 to be `== ‘x’` instead of `== z`

   (b) Add before line 20:

   ```
   if z == ’o’:
       return False
   ```

   (c) Add before line 21:

   ```
   if z == ’x’:
       line2
       line3
       line4
       ...
   ```

4. There is 1 winning move.
   Remove 6 from pile *d*.

5.
```
(0 0 0) W    (0 1 1) L    (1 1 1) W    (0 2 2) W
(0 0 1) W    (0 0 3) W    (0 0 4) W    (1 1 2) W
(0 0 2) L    (0 1 2) W    (0 1 3) W
```

6. There is a winning move from a pile if the binary representation of the pile size has a 1 in the same bit position as the left-most 1 in the binary representation of the xorsum of all the piles (from the course notes). (1 point) For there to be exactly two winning moves, there would have to be only two piles with a 1 in this bit position, but that would make the xorsum of the piles 0 for that bit position, when it must be 1. (1 point) Therefore, it’s not possible to have exactly 2 winning moves.

7. Score: 0, 1, 0, 1, 0, 1

8. a) Strategy tree (for Black) shows one strategy from Black, and all opposing moves from White.

```
       .X.
       XXO
       .XO
        |
        | B[c3]
        |
       .XX
       XX.
       .X.
       /|\
W[c1] / | \ W[c2]
     /  |  \
    /   |   \
   /    |W:p \
.XX    .XX    .XX
XX.    XX.    XXO
.XO    .X.    .X.
 |      |      |
 |B[c2] |B[c2] |B[c1]
 |      |      |
.XX    .XX    .XX
XXX    XXX    XX.
.X.    .X.    .XX
```

b) W[b2], B - W = 3

c) On a 3x3 board, if either player forms a middle-3 or bent-3 shape, they can win 9-0, because they have split the board into two regions that the other cannot play in. As Black already has a middle-3 shape by move 5, it knows that it will 9-0.

Quiz 4c

1. a) DAG + isomorphism: 8,000
   b) Tree of all continuations: 600,000
   c) DAG of all continuations: 16,000
   d) Tree + isomorphism: 60,000

2. a) 9
   b) 1/7

3. Here are a few examples of possible answers:

   (a) Change lines 15, 16, and 17 to be `== 'x'` instead of `== z`

   (b) Add before line 14:

   ```
   if z == 'o':
       return False
   ```

   (c) Add before line 15:

   ```
   if z == 'x':
       line2
       line3
       line4
       ...
   ```

4. There are 3 winning moves.
   Remove 2 from pile a, b, or c.

5.
```
(0 0 0) W    (0 1 1) W    (1 1 1) L    (0 2 2) L
(0 0 1) L    (0 0 3) W    (0 0 4) W    (1 1 2) W
(0 0 2) W    (0 1 2) W    (0 1 3) W
```

6. There is a winning move from a pile if the binary representation of the pile size has a 1 in the same bit position as the left-most 1 in the binary representation of the xorsum of all the piles (from the course notes). (1 point) For there to be exactly two winning moves, there would have to be only two piles with a 1 in this bit position, but that would make the xorsum of the piles 0 for that bit position, when it must be 1. (1 point) Therefore, it's not possible to have exactly 2 winning moves.

7. Score: 0, 1, 0, 1, 0, 1

8. a) Strategy tree (for Black) shows one strategy from Black, and all opposing moves from White.

```
          OO.
          XXX
          .X.
           |
           | B[c3]
           |
          ..X
          XXX
          .X.
          /|\
W[a3] / | \ W[b3]
     /  |  \
    /   |   \
   /    |W:p \
O.X    ..X    .OX
XXX    XXX    XXX
.X.    .X.    .X.
 |      |      |
 |B[b3] |B[b3] |B[a3]
 |      |      |
.XX    .XX    X.X
XXX    XXX    XXX
.X.    .X.    .X.
```

b) W[b2], B - W = 3

c) On a 3x3 board, if either player forms a middle-3 or bent-3 shape, they can win 9-0, because they have split the board into two regions that the other cannot play in. As Black already has a middle-3 shape by move 5, it knows that it will 9-0.