CPSC 481
Handout – Bio. Search & Machine learning & Stochastic

I. Short answer questions

1. What are the three main differences between GP and GA?

2. What is Swarm Particle Optimization (PSO), how does it work? What's the main difference between PSO and GA?

3. What are the main differences between classification and clustering? Give an example.

4. List three advantages of Naïve Bayes approach.

II. Connect the machine learning algorithms on the left column with the categories on the right column. Connect as many as applicable.

K-means Clustering	Non-symbolic learning
McCulloch-Pitts Neuron Model	Symbolic learning
Decision Tree Induction	Supervised learning
Winston's Learning Program	Unsupervised learning
Multi-layer Neural Networks	

III. Decision Tree

You are a robot in an animal shelter, and must learn to discriminate Dogs from Cats. You are given the following training data set.

Example	Sound	Fur	Color	Class
Example #1	Meow	Coarse	Brown	Dog
Example #2	Bark	Fine	Brown	Dog
Example #3	Bark	Coarse	Black	Dog
Example #4	Bark	Coarse	Black	Dog
Example #5	Meow	Fine	Brown	Cat
Example #6	Meow	Coarse	Black	Cat
Example #7	Bark	Fine	Black	Cat
Example #8	Meow	Fine	Brown	Cat

1) (4 pts) Which attribute would information gain choose as the root of the tree?

2) (16 pts) Draw the decision tree that would be constructed by recursively applying information gain to select roots of sub-trees.

3) (4 pts) Classify the following new example as Dog or Cat using your decision tree above.

What class is [Sound=Bark, Fur=Coarse, Color=Brown]?

IV. Naïve Bayes

Using the same training dataset above, you choose to learn a Naïve Bayes classifier this time.

a) Fill in numerical values for the following expressions. Leave your answers as common fractions (e.g., 1/4, 3/5).

P(Dog)= P(Cat)=

P(Sound=Bark | Class=Dog)= P(Fur=Coarse | Class=Cat)=

P(Color=Brown | Class=Dog)=

b) Consider the same new example (Sound=Bark ^ Fur=Coarse ^ Color=Brown). Write these class probabilities. Assume P(Sound=Bark ^ Fur=Coarse ^ Color=Brown) = α, which a constant.

P(Class=Dog | Sound=Bark ^ Fur=Coarse ^ Color=Brown) =

P(Class=Cat | Sound=Bark ^ Fur=Coarse ^ Color=Brown) =

c) For this new example, what class it should belong to based on Maximum Likelihood Hypothesis?

V. GA

Assume we have the following function

$$f(x) = x^3 - 60x^2 + 900x + 100$$

where x is constrained to 0…31. We wish to maximize f(x) (the optimal is x=10).
Using a binary representation, we can represent x using five binary digits.

1) Given the following four chromosomes give the values for x and f(x) (you can give intermediate values for f(x)).

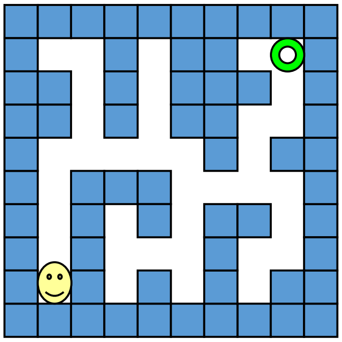
Chromosome	**Binary String**	**x**	**f(x)**
P_1	11100		
P_2	01111		
P_3	10111		
P_4	00100		

2) If P_3 and P_2 are chosen as parents and we apply single-point crossover show the resulting children, C_1 and C_2. Use a crossover position of 1 (where 0 is to the very left of the chromosome). Do the same using P_4 and P_2 with a crossover position of 2 and create C_3 and C_4. List the binary strings for C_1, C_2, C_3 and C_4.

Chromosome	**Binary String**
C_1	
C_2	
C_3	
C_4	

3) Assume the initial population was x= {17, 21, 4 and 28}. Using single-point crossover, what is the probability of finding the optimal solution? Explain your reasons.

VI. GP



Apply Genetic Programming to the problem of navigating a maze.

Function Set = {If-Movement-Blocked, While-Not-At-Cheese*}

Terminal Set = {Move-Forward one space, Turn-Left 90 degrees, Turn-Right 90 degrees}

Fitness function: Each function and terminal other than the root node shall cost one unit to execute. If the mouse spends more than 100 units, it dies of hunger. The fitness measure for a program is determined be executing the program, then squaring the sum of the total units spent and the final distance from the exit.

1. Draw the parse tree for the following program.

```
While not at the cheese
  If the way ahead is blocked
    Turn right 90 degrees
    Move forward one space
    Move forward one space
    Move forward one space
  Otherwise
    Move forward one space
    Turn right 90 degrees
    Move forward one space
    Move forward one space
    Turn left 90 degrees
    If the way ahead is blocked
      Turn left 90 degrees
    Otherwise
      Move forward one space
```

2. Based on the above program, use mutation to generate a new program. You can choose any mutation point at your preference. Write down the new program. You should circle the mutation point on the above parse tree.

3. Use the fitness function provided to evaluate the new program generated above. Is the new program better than the original? Why or why not?