CISC 5800 – Machine Learning
Homework 0
Due September 6
74 points total
Submit Parts A and B on paper at the start of class September 6;
Submit Part C on your erdos account by 11:59pm September 6 (see Part C instructions below).

Much of this homework should be review of concepts you have learned prior to this semester
in algebra, probability, and programming.

A. Probability:
Consider the following joint probability table:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>P(A,B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0.4</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0.3</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

1. What is P(A=1|B=0)? 0.4 / (0.4+0.3) = 4/7 = 0.57
2. What is P(B=1)? 0.2+0.1 = 0.3
3. What is P(A=0, B=1)? 0.1
4. What is P(A=1 or B=0)? 0.4 + 0.3 + 0.2 = 0.9

Consider the following joint probability table:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>P(A,B,C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.02</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0.03</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0.07</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0.10</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0.20</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0.05</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.03</td>
</tr>
</tbody>
</table>

5. Are variables A and B independent? P(A=1) = .1+.2+.05+.03 = .38   P(A=1|B=0) = (.1+.2)/(.1+.2+.02+.03) = .3/.35 = .86   Since P(A=1) ≠ P(A=1|B=0), A & B dependent
6. Are variables A and C independent? P(A=1) = .1+.2+.05+.03 = .38   P(A=1|C=0) = (.1+.05)/(.1+.05+.02+.5) = .15/.67 = .22   Since P(A=1) ≠ P(A=1|C=0), A & C dependent
Consider the multi-valued random variables M, A, and S, where M is an animal, A is the attitude of the animal, and S is the size of the animal.

- M can take on the values: cat, dog, zebra, elephant
- A can take on the values: hostile, friendly, shy
- S can take on the values: small, middle, large

Which of the following represent a single probability value, and which represent a function (e.g., a “probability density function” or a “probability table”)?

7. P(S=small, A) function
10. P(S=middle | A=shy) value
9. P(M) function
10. P(A=hostile, N=cat) value

B. Algebra/Calculus

Express x as a function of y.

Example question: 3y=6x+7
Example answer: \( x = \frac{3y-7}{6} \)

1. 3x-1=5(y-x) -> 3x-1 = 5y - 5x -> 8x = 5y +1 -> \( x = \frac{5y+1}{8} \)

2. 6y+3x= y^2+6 -> 3x = y^2 - 6y + 6 -> \( x = \frac{y^2 - 2y + 2}{3} \)

3. \( x^2 = -9y^2+2x^2 \) -> 9y^2 = x^2 -> \( x = \pm 3y \)

Consider the function \( f(x)=5x^3+2x^2+1 \)

4. What is the derivative of \( f(x) \)?
\( f'(x) = 15x^2+4x \)

5. For what value of x is \( f'(x)=0 \)?
\( 15x^2+4x = 0 \) -> x=0 or \( 15x=-4 \) \( x=0 \) or \( x=-4/15 \)
Consider the function \( g(y) = y(y^2 - 1) \)

6. What is the value of \( g(y) \) when \( y = 2 \)?

\[
2(2^2 - 1) = 2(4 - 1) = 2 \times 3 = 6
\]

7. What is the value of the derivative of \( g(y) \) when \( y = 1 \)?

\[
g(y) = y^3 - y \\
g'(y) = 3y^2 - 1 \\
g'(1) = 3 \times 1^2 - 1 = 3 - 1 = 2
\]

C. Programming:

Use a programming language you know to perform the following tasks. Provide the code and tell me what language you are using. I most recommend you use Matlab, C++, or Python, if you already know one of these languages. If you do not, you must e-mail me for my approval to use another language. The code for questions 2 and 3 each must use at least one loop.

Matlab code is NOT required for this assignment, but is permitted if you wish.

Submission instructions for Part C: Log into your erdos account (erdos.dsm.fordham.edu) – you can use Terminal on Mac or Putty on Windows (see Resources section on our course website). Inside your folder called “private”

- Linux command: cd private
- create a folder called “CIS5800”.
- Linux command: mkdir CIS5800

Save the three programs, triple, range, and flip, inside private/CIS5800/. As course instructor, I will be able to access your files inside private/CIS5800/. You must have the necessary files in the proper directory by January 24 at 11:59pm.

You are welcome to write your programs on your local computer (or on erdos). To transfer files from your local computer to erdos, you may use a program such as FileZilla https://filezilla-project.org/. Make sure you transfer your files into your private/CIS5800/ directory! Connect to erdos using port 22.

If you have trouble accessing erdos for this assignment, you may e-mail me your programs by January 24, 11:59pm – however, we will use erdos for code submission throughout the rest of the semester, so you must resolve your erdos troubles by the time the next homework is due!

1. Write a function called triple that takes in a real number. The function will return three times the value of the input. For example \( x = \text{triple}(5) \) will place the number 15 into \( x \). Note: the function RETURNS a number, it does NOT print out a number to the screen.

```python
def triple(in):
    return 3*in
```
2. Write a function called `range` that takes in a list/array/vector of numbers and returns the difference between the smallest and biggest number in the list. For example, if you provide the list `{2, -2, 4, 5}`, `x=range(list)` will place the number 7 into `x`. **Use a loop.**

```python
def range(list):
    minNum=list[0]
    maxNum=list[0]
    # look at each element of list, one at a time
    for num in list:
        if (num>maxNum):
            maxNum=num
        if (num<minNum):
            minNum=num
    return maxNum-minNum
```

3. Write a function called `flip` that takes in a two-dimensional array/list/matrix with R rows, and returns a new two-dimensional array/list/matrix where the n\(^{th}\) row of the new matrix contains the entries of the (M-n+1)\(^{th}\) row of the original matrix. In other words, flip the row order. For example, the flip of \(A=\{\{1, 2, 3\}, \{4, 5, 6\}, \{7, 8, 9\}\}\) is \(A^F=\{\{7,8,9\}, \{4,5,6\}, \{1,2,3\}\}\) **Use a loop.**

```python
def flip(Mat):
    outMat=[]
    numRows = len(Mat)
    # add Mat's rows into outMat in reverse order
    # count up from 0 to numRows-1
    for i in range(0,numRows):
        outMat.append(Mat[numRows-i])
    return outMat