Information Theory 2023
Programming Assignment 1

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Due on Jan 31, 11.59pm

Submission Link

~~The Google Form for submitting your assignment is here:~~
~~`https://forms.gle/cSbVghgLG1rNjCgL9`~~

Please submit on Google Classrooms.

Sample Input

The file `Sample_pmf.npy` in Google Classrooms contains a sample array `pmf`. You can use this to debug your code. For this `pmf`, we have

$$I(X_1;X_0) \approx 0.105,\ I(X_2;X_0) \approx 0.001,\ I(X_3;X_0) \approx 0.105,\ I(X_3;X_1) \approx 0.001.$$

Submission Format

You must submit a single python script file with .py extension. The name of the file must be "Serial_num.py" where 'num' is your serial number. For instance, if your serial number is 7, then your submission will be "Serial_7.py".

The file submitted must contain the definition of a python function by the name `mutual_information`. This function must be callable as follows.

```
import numpy as np

# import the function from your submission "Serial_7.py"
from Serial_7 import mutual_information

# generating a probability mass function 'pmf'
pmf = np.random.rand(10_000)
pmf = pmf / sum(pmf)

# computing the mutual information between
# two random variables X_i and X_j, i not equal to j
# i, j belong to the set {0,1,2,3}
i = 0
j = 3
MI = mutual_information(pmf,i,j)
print(MI)
```

If there is an error when your function is called as above, I will not be able to debug your submission, and no marks will be awarded.

Problem Description

Assume there are 4 random variables X_0, X_1, X_2, X_3, each taking values in the set $\{0, 1, \ldots, 9\}$. These random variables are not necessarily independent. Their joint distribution is given by the numpy array `pmf` as follows. The length of the array `pmf` is 10,000 and the index ranges from 0 till 9,999. Suppose `a` $\in \{0, 1, \ldots, 9999\}$, and let the decimal expansion of `a` be

$$\texttt{a} = a_0 + 10a_1 + 100a_2 + 1000a_3,$$

where $a_0, \ldots, a_3 \in \{0, 1, \ldots, 9\}$. Then the value of the numpy array `pmf` at index `a` is the following probability

$$\texttt{pmf[a]} = P\left[X_0 = a_0, X_1 = a_1, X_2 = a_2, X_3 = a_3\right].$$

Your function definition for `mutual_information` must return the value of the mutual information (computed in the unit 'bits') between random variables X_i, X_j when called as follows

```
MI = mutual_information(pmf,i,j)
```

Evaluation

The maximum marks for this assignment is 10. Each student must work individually, and submit a file on their own.
