Indian Statistical Institute

Semester-I 2023–2024

M.Tech.(CS) - First Year

Lab Test 1 (28 August, 2023)

Subject: Computing Laboratory

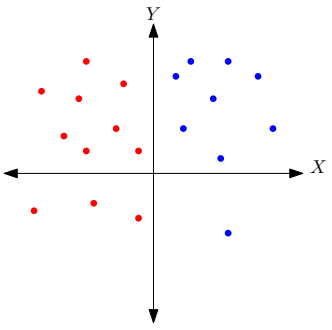
Total: 60 marks Duration: 3 hrs.

INSTRUCTIONS

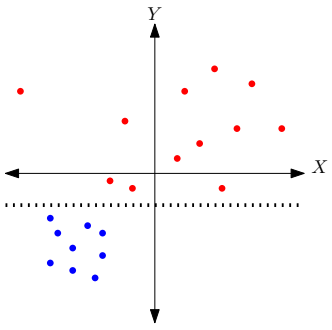
1. You may consult or use slides / programs provided to you as course material, or programs that you have written yourself as part of classwork / homework for this course, but please **do not** consult or use material from other Internet sources, your classmates, or anyone else.
2. Please make sure that your programs adhere strictly to the specified input and output format. **Your program may not pass the test cases provided, if your program violates the input and output requirements.**
3. Submissions from different students having significant match will be **debarred from evaluation**.

NOTE: Unless otherwise specified, all programs should take the required inputs from stdin, and print the desired outputs to stdout.

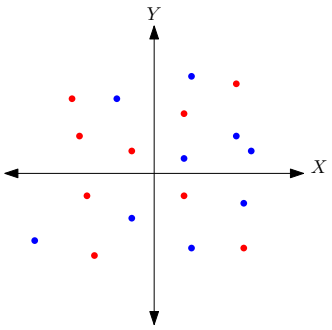
Q1. You are given the coordinates of $N \leq 1000$ points in the X-Y plane. Some of the points are coloured red, while the remaining points are coloured blue as shown in the figures below. Write a program to determine whether the red and blue points can be separated by a horizontal and/or vertical line. [20]



The red and blue points can be separated by the Y-axis (and infinitely many other lines parallel to the Y-axis).



The red and blue points can be separated by the dotted line, which is parallel to the X-axis.



The red and blue points cannot be separated by any line that is parallel to the X or the Y-axis.

Input format: The first line of the input will consist of the single integer $N \leq 1000$. This will be followed by N lines, each of which will contain 3 space-separated fields: 2 floating point numbers corresponding to the X and Y coordinates of the point, and a single letter, `R` or `B`, denoting the colour of the point.

Output format: Your program should print `X` and/or `Y`, if the points can be separated by a line parallel to the X and/or Y axis. If the points cannot be separated in this way, your program should print `Not possible`.

Sample input 1:

```
3
576.7917 600.9445 R
792.9193 496.3221 R
408.2261 808.3936 B
```

Sample output 1: `XY`

Sample input 2:

```
4
312.6470 472.3536 B
824.7356 480.2515 R
616.5823 648.6834 R
512.1858 112.3059 R
```

Sample output 2: `Y`

Sample input 3:

```
7
632.1380 336.4848 B
960.3505 384.4847 B
800.9382 536.1495 R
864.9716 712.3475 R
232.1350 592.0440 R
352.1127 304.5831 R
80.4339 464.8508 B
```

Sample output 3: `Not possible`

Q2. Given an array of at most 1000 non-negative digits (0–9), find the largest multiple of 3 that can be formed from these digits.

Input format: The input (to be read from stdin) comprises a sequence of successive digits 0–9. The end of the sequence is marked by a newline.

Output format: The largest multiple of 3 that can be formed from the digits provided should be printed to stdout as a single number. Note that this number may be too large to be stored in a built-in type of C. [20]

Sample input 0: `81760`

Sample output 0: `8760`

Sample input 1: `198`

Sample output 1: `981`

Sample input 2: `19234493219`

Sample output 2: `9994433211`

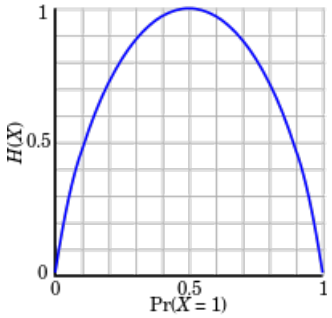
Q3. Suppose a *noisy* bitstream is represented by a sequence of characters from the set $\{0, 1, ?\}$. The special character ? represents a *noisy* bit whose value is not known, and can either be 0 or 1. For example, the following is a noisy bitstream.

001?101001?01001?01

Write a program to find out the minimum and maximum possible values of the Shannon entropy of a noisy bitstream of **even length**, provided by the user. Recall that the Shannon entropy $H(X)$ of a bitstream can be computed as follows:

$$H(X) = -\sum_{\substack{i \in \{0,1\} \text{ and} \\ Pr(X=i)>0}} Pr(X=i) \log_2 \Big(Pr(X=i) \Big),$$

where $Pr(X = i)$ denotes the occurrence probability of i in the bitstream. The figure below shows how entropy varies with $Pr(X = 1)$, the probability of occurrence of 1 in a given bitstream.



[20]

Input format: The input (to be read from stdin) comprises a sequence of successive characters from the set $\{0, 1, ?\}$. The end of the sequence is marked by a newline. The length of the input bitstream is not known in advance, but is small enough to be stored in an `int`.

Output format: The output (to be printed to stdout) should consist of a single line containing two floating point numbers, corresponding respectively to the minimum and maximum possible values of Shannon entropy for the given bit string. The values should be rounded off to **three** decimal places.

Sample input 0: `1111111111111111`

Sample output 0: `0.000 0.000`

Explanation: There is no noisy bit, and all the bits are the same, so the entropy of the above bitstream is 0 (fixed and minimum possible value).

Sample input 1: `01110010101100100101`

Sample output 1: `1.000 1.000`

Explanation: There is no noisy bit, and there are an equal number of 0s and 1s, so the entropy for this bitstream is 1 (fixed and maximum possible value).

Sample input 2: `0111001010110010101`

Sample output 2: `0.993 1.000`

Explanation: If the single noisy bit has the value 0, the bitstream will have an equal number of 0s and 1s with an entropy of 1; if it has the value 1, the bitstream will have entropy 0.993.

Sample input 3: `1111100000??11111111`

Sample output 3: `0.811 0.934`

Explanation: If both the noisy bits have the values 0, the bitstream will have entropy 0.934068; if both of them have the values 1, the bitstream will have entropy 0.811278.