The homework for Xmas holidays has 3 different projects.
Do them individually and explain the design in a word document.
Upload them in the virtual campus before the 15 January 2023.

Good Luck

First project

Given the function

$$f(x) = \ln(x) \;\; x\epsilon[1, e]$$

You must develop an algorithm that performs the following tasks.

1. Perform the continuous regression of $\boldsymbol{f(x)}$ onto the subspace $\langle \mathbf{1}, \boldsymbol{x}, \boldsymbol{x^2} \rangle$, using the symbolic tools in Matlab. Plot the result (the function and the fitting).

2. Perform the discrete regression of $\boldsymbol{f}$ onto $\langle \mathbf{1}, \boldsymbol{x}, \boldsymbol{x^2} \rangle$. For that purpose:

    1. Introduce as regular sampler of the interval $[\mathbf{1}, \boldsymbol{e}]$ using 1000 points. Call this sampler $\boldsymbol{x_s}$.
    2. Evaluate $\boldsymbol{f(x)}$ on $\boldsymbol{x_s}$, and the basis functions $\mathbf{1}, \boldsymbol{x}, \boldsymbol{x^2}$ to generate $\{\mathbf{1}, \boldsymbol{x}, \boldsymbol{x^2}, \boldsymbol{f}\}$.
    3. Perform the regression of $\boldsymbol{f}$ onto $\langle \mathbf{1}, \boldsymbol{x}, \boldsymbol{x^2} \rangle$.
    4. Plot the result (the function and the fitting).

Second project

A company invest 8000 dollars in marketing to acquire new clients.
The company also has the following informations:

1. The cost of getting a new client is 40 dollars.
2. The average sales per customer (fee) is 30 dollars per month.
3. The percentage of clients that stay after the first month is as follows (churn):

```
Churn(%)=[100,85,60,50,30,25,20,9,5,1,0];
Months=[1,2,3,4,5,6,7,8,9,10,11];
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that is, the clients that stay for the second month and pay the fee is 85% of the clients that were acquired during the first month, etc …

Write a program to find the cumulative sells curve for every month till all the clients churns.

Sells(1), Sells(1)+Sells(2), Sell(1)+Sells(2)+Sells(3), …

Write a program to fit this curve using a polynomial. Define the degree.

Third project

Create an algorithm that generates new intelligent bets on the Euromillones draw.

You must download the data (excel sheet) on the web:
https://www.lotoideas.com/euromillones-resultados-historicos-de-todos-los-sorteos/
Call the file EuroMillon.xlsx

The algorithm must do the following:

Note. You program must have different subsections corresponding to the different tasks 1, 2, etc.

1. Read the data using xlsread, and recover the different fields in different arrays:
    - Fecha: date
    - Comb. Ganadora (five numbers): winners
    - Estrellas (2 numbers): stars

2. For each column of winner finding the different outcomes and their relative frequency, that is the percentage of times that they appear on the draw.
3. Do the same with the column's stars individually and with its sum.
4. Also finding the relative frequency of the sum of the 5 winners (comb. Ganadora).

5. Considering the results 2, 3 and 4, draw a new random winner combination. Explain how you design the drawing algorithm. You are free on the design.

6. Do the same with the stars.

7. Plot on the screen 10 different wining combinations.

The teachers
Oviedo 13 December 2022