BM20A5001 Principles of Technical Computing
LUT University / LENS
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Exercise 3

Submit the codes via Matlab Grader by Sunday, 22.9. midnight.

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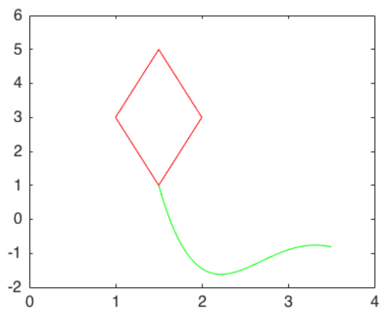
1. Reproduce the kite from the graph, with same colors and axis limits set to exactly same values. The equation describing the green string is as follows:

$$y = -\frac{1}{3}(x-2)(x-2.5)(\frac{x}{2}-2.75)(\frac{x}{5}-3.25)(x-4)-1.45$$

   The edges of the kite body are simply straight lines between the corners which are in points (1,3), (1.5,5), (2,3) and (1.5,1).



2. Load the given data file `Data_AHW_big.mat` (use command `load`). It contains two variables: data matrix `D` and cell array `vars` storing column names. The matrix `D` contains 237 rows of boys and girls data: gender, age, height, weight (columns in this exact order). The gender column has 1 for a girl and 2 for a boy. The age is expressed in years, height in centimeters and weight in kilograms.

   (a) Seperate the original matrix `D` into two separate matrices `G` which only has the data of girls and matrix `B` which only has data of boys.

   (b) Check how many boys and girls are in the group and store the information in variables `Ngirls` and `Nboys`. Put both in a row vector `N = [Ngirls Nboys]`.

   (c) Calculate averages of age, height and weight of girls and boys separately, and store them as two row vectors `Mgirls` (1x3) and `Mboys` (1x3). Put both vectors in one matrix `M` sized (2x3).

   (d) Create variables `CompH` and `CompW` which check (logical 0-false, 1-true) whether the average height of all girls is smaller than the average height of all boys, and analogically the same for the weight.

   (e) Create a column vector `GirlsH` which has 7 values of respective means of

      - Height of girls of age 11 or more but not yet 12

- Height of girls of age 12 or more but not yet 13
- ...
- Height of girls of age 16 or more but not yet 17
- Height of girls of age 17 or more but not yet 18

Then create analogical vectors `GirlsW` for girls' weight, `BoysH` for boys' height and `BoysW` for boys' weights.

Note that the **smart** way to do these is using loops...

(f) Using the vectors created in point (e), check whether girls in the specific age groups are always shorter than boys from respective groups, and whether girls in specific age groups always have lower weight than boys from respective groups. Name the comparison variables `CompAgeH` and `CompAgeW`.

3. Load the given data file `Data_AHW_big.mat` (use command `load`). It contains two variables: data matrix D and cell array vars storing column names. The matrix D contains 237 rows of boys and girls data: gender, age, height, weight (columns in this exact order). The gender column has 1 for a girl and 2 for a boy. The age is expressed in years, height in centimeters and weight in kilograms.

(a) Present scatter plots for girls' and boys' weight versus height. Label the plots accordingly. The two plots can be either two separate figures or two subplots in one figure. Set the axis limits of both graphs to the same (X axis having values from minimum to maximum of all kids' height and Y axis having values from minimum to maximum of all kids' weight). Axis limits can be set using command `axis([xmin xmax ymin ymax])`, where `xmin`, etc. have your chosen values.

(b) Do the same kind of plot as in point a) but in the same single figures using magenta asterisks for girls and blue circles for boys. Add the legend.

(c) Same as in Task 4, create a column vector `GirlsH` which has 7 values of respective means of

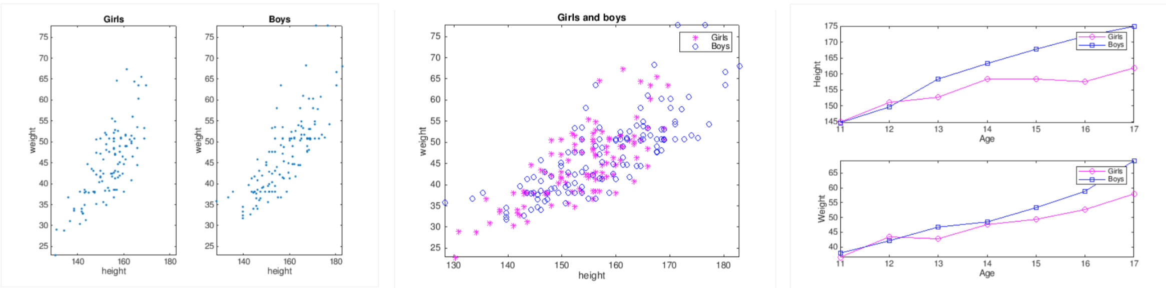
- Height of girls of age 11 or more but not yet 12
- Height of girls of age 12 or more but not yet 13
- ...
- Height of girls of age 16 or more but not yet 17
- Height of girls of age 17 or more but not yet 18

Then create analogical vectors GirlsW for girls' weight, BoysH for boys' height and BoysW for boys' weights.

Note that the **smart** way to do these is using loops...

(d) Use the vectors created in point c) to plot girls' and boys' height versus age and girls' and boys' weight versus age. Use magenta line with circular markers for girls and blue line with square markers for boys. Set axis to tight limits. The plots can be either two separate figures or two subplots in one figure. Label the plots accordingly.

The three plots from points (a), (b) and (d) should look roughly like this:



4. A person's body mass index (BMI) is calculated using the following formula:

$$\text{BMI} = \frac{\text{kg}}{\text{m}^2}$$

where kg represents a person's weight in kilograms and m represents a person's height in meters.

Write a code which will calculate BMI of a set of persons whose weights and heights (in cm) are given by the matrix:

```
data = [ 75   67   43   56   78   49   66   71  120
        164  168  152  169  170  157  167  181  170]
```

A person's BMI is considered healthy if it is within interval 18.5 – 24.9. Make a scatter plot of the persons' weights (y-axis) versus their heights (x-axis), with normal BMI persons plotted as green points, underweight persons as blue points and the overweight persons as red points.

<u>Hint:</u> Example two ways to solve it:

- write the formula correctly so that it works when given vectors, then perform conditional plotting using logical indexing,
- calculate and plot one at a time each person's BMI in a loop.

5. Pressure P [Pa] exerted by n moles of V [m^3] of an ideal gas at temperature T [K] can be expressed via the equation:

$$P = \frac{nRT}{V}$$

where R is the gas constant $R = 8.31$ [J mol^{-1} K^{-1}].

Calculate the pressure exerted by 0.1 moles of an ideal gas at:

(a) a fixed temperature of 50^{o}C and volume ranging from 500 to 2500 [cm^3] with increment 10 ,

(b) a fixed volume of 1500 [cm^3] and temperature varying from 0 to 100^{o}C with increment 1.

Use the variable name ”`V1`” for the volume vector ranging from 500 to 2500 [cm^3] and ”`P1`” for the corresponding pressure vector.

Use the variable name ”`T2`” for the temperature vector varying from 0 to 100^{o}C and ”`P2`” for the corresponding pressure vector.

Note the need of converting the given values into standard units (1 m^3 = 1000000 cm^3, 0^{o}C = 273 K).

Plot both cases (pressure as a function of volume and pressure as a function of temperature) in one figure but two separate subplots.

Hint: You just have to define the fixed values, for each case and then vectors for the changing variables(temperature vector for the first case and volume vector for the second case), and then use the formula twice (making sure it works for vectors). Then plot the resulting values of the formula twice, versus the respective changing vector.

6. This task was removed form the list

7. Consider the function $y = \sin(2x)\exp(x - 4)$. Plot it for values x in the interval [-2,2], using solid black line. Draw a random sample of 10 values of x (for instance generate randomly 10 indices between 1 and length of x, hint: command `randi(100)` generates one random integer between 1 and 100, command `randi(20,1,10)` generated 10 random integers between 1 and 20), and display the respective (x, y) points on the graph with distinct markers. Label the graph accordingly (x,y-axes, title, legend).

   The plot should look roughly as below.