IND522
Advanced Statistical Modelling

Fall 2025

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Assignment ♯1: Due October 6

1) If C and F are Celsius and Fahrenheit temperatures, respectively, the formula for conversion from Celsius to Fahrenheit is $F = 9C/5 + 32$.

a. Write a script that will ask you for the Celsius temperature and display the Fahrenheit equivalent with some sort of comment, such as

```
The Fahrenheit temperature is:...
```

Try it out on the following Celsius temperatures (answers in parentheses): 0 (32), 100 (212), -40 (-40), 37 (normal human temperature: 98.6).

b. Change the script to use vectors and array operations to compute the Fahrenheit equivalents of Celsius temperatures ranging from 20^0 to 30^0 in steps of 1^0, and display them in two columns with a heading, like this:

```
 Celsius  Fahrenheit
  20.00      68.00
  21.00      69.80
   ...        ...
  30.00      86.00
```

2) Work out by hand the output of the following script for `n = 4`:

```
n = input( 'Number of terms?'  );
s = 0;
for k = 1:n
  s = s + 1 / (k ^ 2);
end
```

If you run this script for larger and larger values of `n`, you will find that the output approaches a well-known limit. Can you figure out what it is? Now rewrite the script using vectors and array operations.

3) Work through the following script by hand. Draw up a table of the values of i, j, and m to show how they change while the script executes. Check your answers by running the script.

```
v = [3 1 5];
i = 1;
for j = v
  i = i + 1;
  if i == 3
    i = i + 2;
    m = i + j;
  end
end
```

4) The electricity accounts of residents in a very small town are calculated as follows:

- **a.** If 500 units or fewer are used, the cost is 2 cents per unit.
- **b.** If more than 500 but not more than 1000 units are used, the cost is \$10 for the first 500 units and 5 cents for every unit in excess of 500.
- **c.** If more than 1000 units are used, the cost is \$35 for the first 1000 units plus 10 cents for every unit in excess of 1000.
- **d.** A basic service fee of \$5 is charged, no matter how much electricity is used.

Write a program that enters the following five consumptions into a vector and uses a for loop to calculate and display the total charge for each one: 200, 500, 700, 1000, 1500.

5) It has been suggested that the population of the United States may be modeled by the formula

$$P(t) = \frac{197,273,000}{1 + e^{-0.03134(t-1913.25)}}$$

where t is the date in years. Write a program to compute and display the population every `ten` years from 1790 to 2000. Try to plot a graph of the population against time as well. Use your program to find out if the population ever reaches a "steady state" (i.e., stops changing).

6) Write a script for the general solution to the quadratic equation $ax^2 + bx + c = 0$. Use the structure plan below. Your script should be able to handle all possible values of the data a, b, and c. Try it out on the following values:

- **a.** 1, 1, 1 (complex roots)
- **b.** 2, 4, 2 (equal roots of -1.0)
- **c.** 2, 2, -12 (roots of 2.0 and -3.0)

The below structure plan is for programming languages that cannot handle complex numbers. MATLAB can. Adjust your script so that it can also find complex roots. Test it on case (a); the roots are $-0.5 \pm 0.866i$.

QUADRATIC EQUATION STRUCTURE PLAN

1. Start
2. Input data (a, b, c)
3. If $a = 0$ then
   - If $b = 0$ then
     - If $c = 0$ then
       - Display 'Solution indeterminate'
     - else
       - Display 'There is no solution'
   - else
     - $x = -c/b$
     - Display x (only one root: equation is linear)
   - else if $b^2 < 4ac$ then
     - Display 'Complex roots'
   - else if $b^2 = 4ac$ then
     - $x = -b/(2a)$
     - Display x (equal roots)
   - else
     - $x_1 = (-b + \sqrt{b^2 - 4ac})/(2a)$
     - $x_2 = (-b - \sqrt{b^2 - 4ac})/(2a)$
     - Display x_1, x_2
4. Stop.

7) Let's examine the shape of a uniform cable hanging under its own weight. The shape is described by the formula $y = \cosh(x/c)$. This shape is called a uniform catenary. The parameter c is the vertical distance from $y = 0$ where the bottom of the catenary is located. Plot the shape of the catenary between $x = -10$ and $x = 10$ for $c = 5$. Compare this with the same result for $c = 4$.

Hint: The hyperbolic cosine, cosh, is a built-in MATLAB function that is used in a similar way to the sine function, sin.

8) Design an algorithm (i.e., write the structure plan) for a machine which must give the correct amount of change from a \$100 note for any purchase costing less than \$100. The plan must specify the number and type of all notes and coins in the change, and should in all cases give as few notes and coins as possible. (If you are not familiar with dollars and cents, use your Turkish Lira.)