VG151 Big RC

Section 1 - Homeworks and Labs

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Ex.2 - Basic MATLAB knowledge

Let $x = \begin{pmatrix} 3 \\ 2 \\ 6 \\ 8 \end{pmatrix}$ and $y = \begin{pmatrix} 4 \\ 1 \\ 3 \\ 5 \end{pmatrix}$

- Define x and y in MATLAB.
- Add the sum of the elements in x at the end of y.

```
x = [3; 2; 6; 8];
y = [4; 1; 3; 5];
disp([y; sum(x)]);
```

Notice: Difference between x = [3; 2; 6; 8] and x = [3 2 6 8].

h1 ex2

Ex.2 - Basic MATLAB knowledge

- Raise each element of *x* to the power specified by thecorresponding element in *y*.
- Divide each element of *y* by the corresponding element in *x*.

```
disp(x.^y);
disp(y);
disp(x.\y);
disp(x);
```

Notice: The dot . between x and operator.

h1 ex2

Ex.2 - Basic MATLAB knowledge

- Multiply each element in x by the corresponding element in y, andstore the result in a variable z.
- Add up the elements in z and assign the result to a variable w.
- Compute x'*y-w and explain the result.

```
z = x .* y;
disp(z);
w = sum(z);
disp(w);
disp(x' * y - w);
```

Notice: A is a matrix, difference between sum(A), sum(A, 1) and sum(A, 2).How to calculate the sum of all elements in a matrix?

h1 ex5

Ex.5 - Algorithms

Around 240 BC Eratosthenes calculated the circumference of the Earthusing basic mathematics and without leaving Egypt.

```
dst = 800;
degree = 7.2;
circ = dst * 360 / degree;
radius = circ / 2 / pi;
disp (circ)
disp (radius)
```

How to write an algorithm in README?

- Input and Output.
- How to calculate each step.

h1 ex6

Ex. 6 - Vectors

In Great Britain and Ireland human body weight is often measured in stones. A stone is defined as 14 pounds or 6.35 kg. Write a MATLAB script converting from stones to pounds, from pounds to kg and from kg to stones.

```matlab
list_value = input('');
conversion = input('','s');
switch conversion
    case 'stones to pounds'
        re = list_value .* 14;
    case 'pounds to kg'
        re = list_value .* 0.454;
    case 'kg to stones'
        re = list_value ./ 6.35;
    otherwise re = 0;
end
```

h1 ex6

Ex. 6 - Vectors
In Great Britain and Ireland human body weight is often measured in stones. A stone is defined as 14 pounds or 6.35 kg. Write a MATLAB script converting from stones to pounds, from pounds to kg and from kg to stones.

- How to input a string.
- Difference between if and switch and when to use them.

h2 ex2

Ex. 2 - Algorithms and loops

Pythagorean prime is an odd prime number that can be written asthe sum of two squares. Such primes are of the form p = 4n + 1, forsome integer n. Write a MATLAB script that (i) reads a number fromthe keyboard, then (ii) finds the next Pythagorean prime and (iii)returns the two corresponding squares.

- **Basic idea:** iterates from y, where y is the first 4n+ 1 number after x. Each iteration, i = i+ 4. For each iteration, check whether i is prime and can be represented by sum of squares.
- **Output formula**:

```
fprintf('%d = %d^2 + %d^2\n',p,a,b);
```

h2 ex4

Ex. 4 - Mathematical functions, loops, and recursion.
Given a continuous function f over an interval $[x_0, x_1]$ such that $sign(f(x_0)) \neq sign(f(x_1))$ find $r \in [x_0, x_1]$ such that f(r) $=$ 0. The secant method is defined through the following recurrence relation.

$$x_n = \frac{x_{n-2}f(x_{n-1}) - x_{n-1}f(x_{n-2})}{f(x_{n-1}) - f(x_{n-2})}$$

Write two MATLAB functions: one iterative and one recursive. Their inputs should be (i) a mathematical function, (ii) an interval containing a root, and (iii) a precision (number of decimal places). They should return the root of the function in the interval provided in the input.

h2 ex4

- **Recursive**
  ① Solve(x, y, f)
  ② End Condition:
  $|f(x)| < 0.0000001$, return x
  $|f(y)| < 0.0000001$, return y
  ③ Recursive Step:
  calculate z $=$ ...
  solve(y, z, f)
- **Iterative**:
  ① End Condition:
  $|f(z)| < 0.0000001$, return x
  ② Iterative Step:
  calculate z $=$ ...
  while $|f(z)| > 0.0000001$, do...

h2 ex5

Ex. 5 - Control statements
A positive integer n is an Armstrong number if the sum of the i-th power of each of its digits is n itself, with i the number of digits in n. For instance 153 is an Armstrong number for (i) it has three digits and (ii) $1^3 + 5^3 + 3^3 = 153$. Similarly 1 is also an Armstrong number since (i) 1 has 1 digit and (ii) $1 = 1^1$. Write a MATLAB function which given a number n returns the next Armstrong number or n if n is an Armstrong number.

h2 ex5

```
  function [a] = check (n)
  sum = 0; cnt = 0; m = n;
  while m>0
      cnt = cnt + 1;
      m = floor(m/10);
  end
  m = n;
  while n > 0
      sum = sum + power(mod(n,10),cnt);
      n = floor(n/10);
  end
  if sum == m
      a = 1;
  else
      a = 0;
  end
end
```

h3 ex1

Ex. 1 - Accurate calculations

The inventor replied that he wanted one grain of wheat on the first square of the chess board, two on the second, four on the third, eight on the fourth, and so forth ... It took more than a week to the treasurer to calculate the amount a wheat required. Write a MATLAB script to help him determine how many grains of wheat had to be exactly given to the creator of Chess. The story ends with the creator of Chess becoming the new king.

```matlab
cnt = input('');
sum = uint64(0);
for i = 1 : cnt
  sum = sum + power(2,i-1);
end
disp(sum);
disp(power(2,cnt)-1);
```

h3 ex3

Ex 3. - Structures

The following table summarizes a wardrobe inventory. Create an appropriate MATLAB structure to represent the data, and write a script to determine (i) which item (Type + Color) is in the largest quantity and (ii) how old are the items in average – age in years, rounded down.

```
item(1) = struct('Type','Jumpers','Color','Blue',...
    'Quantity',2,'Bought',[4 2005]);
2020-mean([item(1:9).Bought(2)])
```

h3 ex5

Ex. 5 — Algorithm, function, conditional statements, and loops
Given a continuous function f over an interval [a,b] such that $sign(f(a)) = sign(f(b))$. Find $r \in [a, b]$ such that $f(r) = 0$. The bisection method consists in dividing the interval $[a, b]$ into two sub-intervals $[a, c]$ and $[c, b]$ of equal size. Then either $f(a)$ and $f(c)$ or $f(c)$ and $f(b)$ will have different signs. In case $c = r$ we stop and return c, otherwise the process is repeated over the interval where the sign changes. The process of narrowing down the interval will only end when the error is smaller than a bound specified by the user.

h3 ex5

```
s = input('','s');
f = inline(s);
a = input('');
b = input('');
anser = solve(a,b,f);
disp(anser);

function [result] = solve(a,b,f)
    mid = (a+b)/2;
    if abs(f(mid)) <= 0.000001
        result = mid;
    elseif f(a)*f(mid) < 0
        result = solve(a,mid,f);
    else
        result = solve(mid,b,f);
    end
end
```

Contents

lab 2

Magic Square

- How to deal with the boundary condition: mod
- Iteration to place the number

lab 3

Maze

- How to read from a file
- How to use recursion to implement *dfs*
- End condition and recursive step of recursive function

Good luck in Mid 1!