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Numerical Linear Algebra

Introduction to MATLAB
Prestudy No. 1 (Autumn 2014)

Matlab is short for MATrix LABoratory. It provides an interactive environment in which you can solve problems from scratch quite quickly. Let us get familiar with MATLAB and implement some small functions and programs.

Problem 1.1: The fibonacci numbers are defined as

$$\text{fib}(n) = \begin{cases} 0, & \text{for } n = 0, \\ 1, & \text{for } n = 1, \\ \text{fib}(n-1) + \text{fib}(n-2), & \text{for } n > 1. \end{cases}$$

Write a program in MATLAB to compute fib(25). Going through the following steps might help you if you are not yet so familiar with MATLAB.

1. Click on file → new → m-file. This opens a new m-file. In this file we can now write the instructions for the algorithm. But before we do that, name the file fib.m and open it in an editor.

The syntax should look like:

```
function result = fib(n)
  if(n == 0)
    result = ...
  elseif(n == 1)
    result = ...
  else
    result = ...
  end
```

Fill in the blanks ... and save the file. Now you can call the function in the directory in which you saved the file form the command line in MATLAB:

```
>> fib(25)
```

Problem 1.2: MATLAB is a matrix based tool. This means that everything in MATLAB is seen as a matrix. A scalar is a special matrix of size 1×1. Let us now learn how to plot a function in MATLAB. Therfore copy the following function in a m-file and save it with the name of the function.

```
function result = fun(x)
tmp = x + sin(x);
result = tmp.^2;
```

1. Which result is computed by this function?
2. Plot the function on the interval $I = [0, 1]$ at 10 equidistant points. This can be achieved in MATLAB by the instruction `v = 0 : 0.1 : 1;` and calling `plot (v, fun(v), 'r-');`
3. Functions can have more than one parameter for input and output, e.g.:
   `function[res1, res2] = fun2(x,A,c)`

Problem 1.3: Compute the value of the polynomial

$$p(x) = 0.01x^3 + 5.7x - 45$$

at the points $x = -3, -1, 1, 3, 5$. Which predefined functions within MATLAB can be used? Consider MATLAB help.

Problem 1.4: Write a program in MATLAB to approximate the exponential function

$$e^x = \sum_{k=0}^{\infty} \frac{x^k}{k!}, \quad x \in \mathbb{R}$$

by the Taylor sum

$$T_n(x) = \sum_{k=0}^{n} \frac{x^k}{k!}, \quad x \in \mathbb{R}, n \in \mathbb{N}.$$

Plot the relative error for $n \in [0, 20]$ and points $x \in \{10, 1, -1, -10\}$. What do you observe?

If you need more help on MATLAB's syntax, please consider online tutorials, the help in MATLAB or take a look into your favourite textbook about MATLAB.
Send your solutions to `barbel@kth.se` until October 11th, 2014.