

Numerical Algorithms (MU4IN910)

Practical 1 - Introduction to MATLAB and floating-point arithmetic

Exercise 1 (A computer counts wrong!).

1. What should the following program normally display?

```
format longE;
function res = Higham(x)
  for i=1:52
        x=sqrt(x);
  end
  for i=1:52
        x = x.^2;
  end
  res = x;
end
Higham(4)
```

- **2.** Run the program on a computer. What is the result? Explain.
- **3.** Run the following program:

```
x = logspace(0, 1, 2013);
y = Higham(x);
plot(x, y, 'k.', x, x, '--')
```

Explain the graph (identify points such as y = x).

Exercise 2 (Recursion). We want to evaluate the definite integral I_n defined by

$$I_n = \int_0^1 x^n \cdot e^{-x} dx.$$

For this we consider the following recurrence relation: $I_0 = 1 - e^{-1}$ et $I_n = -e^{-1} + n I_{n-1}$.

- 1. Write a program using this recurrence relation for calculating this integral in double precision.
- **2.** Give a simple enclosure of $x^n e^{-x}$ on [0,1] and then give an enclosure for I_n . Compare to the results of your calculations for different values of n.
- **3.** Deduce from the previous formula a recurrence relation giving I_n as a function of I_{n+1} .
- **4.** Write a program using this new recurrence relation to calculate I_n from n + m by initializing arbitrarily with $I_{n+m} = 12$ and m = 50.
- **5.** Comment, at n fixed, the results obtained for m = 10, m = 20, m = 50 and m = 100. For comparison here is the exact value of I_n for some values of n:

n	I_n
5	0.071302178109803159860
10	0.036461334624107272383

Exercise 3 (Using BLAS).

1. Let A be a matrix of size $m \times n$. Write a MATLAB column-oriented program calculating

$$s_i = \sum_{j=1}^n |a_{ij}|$$

for i = 1, 2, ..., m. Then use BLAS (with the norm command) to calculate the s_i . Compare the efficiency of these two algorithms.

2. Given 2 matrices *A* and *B* of size $n \times n$. Write a program which calculates *AB*. Compare the effectiveness of your program with the command A*B.

Exercise 4 (Implementation of the LU decomposition).

- 1. Implement the LUP decomposition of a square matrix using the partial pivoting strategy.
- **2.** Test your implementation on concrete examples.
- 3. Compare your implementation with the one of MATLAB (command lu).

Remark: for time measurements, you will use the commands tic and toc from MATLAB

tic;
program;
toc