Numerical Methods, project A, Number 31

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Introduction

Chapter 2

Problem 1 - Finding machine epsilion

2.1 Problem

Write a program finding macheps in the MATLAB environment

2.1.1 Definition of machine epsilion

Machine epsilion is the maximal possible relative error of the floating-point representation. (Tatjewski, p.14) Machine epsilion is equal to 2^{-t} where t is number of bits in the mantissa. In our case when we use IEEE Standard 754, mantissa is 53 bits long with first bit omitted as it is always equal to '1', so we technicaly work with 52 bits mantissa which makes the machine epsilion equal to: $2^{-52} = 2.220446\text{e}{-16}$

2.2 Solution

2.2.1 Matlab code

```
1 macheps = 1;
2 while 1.0 + macheps / 2 > 1.0
3     macheps = macheps/2;
4 end
```

Code above shifts macheps one bit to the right each iteration (by dividing by 2), it ends when we run out of mantissa bits which renders us unable to save smaller number. Due to underflow the value of macheps becomes 0 and therefore $1.0 >$ (macheps / 2) > 1.0 will become false.

```
1 format long
```

```
disp(Display calculated macheps:)
disp(macheps);
disp(Display actual eps:)
disp(eps);
disp(Display 2^-52)disp(2^-52)disp(Display difference between
    calculated macheps and actual eps:)disp(macheps -
    eps)disp(Display difference between 2^−52 and actual eps:
    )disp(2^-52 -
    eps)disp(Display difference between calculated macheps and
    2^−52:)disp(macheps -
    2^-52)
```

Display calculated macheps:

$$2.220446049250313e{-}16$$

Display actual eps:

$$2.220446049250313e{-}16$$

Display 2^{-52}:

$$2.220446049250313e{-}16$$

Display difference between calculated macheps and actual eps: 0
Display difference between 2^{-52} and actual eps: 0
Display difference between calculated macheps and 2^{-52}: 0
As expected they are all equal to eachother.

2.3 Discussion of the result

Chapter 3

Problem 2 - Solving a system of n linear equations - indicated method

Chapter 4

Problem 3 - Solving a system of n linear equations - iterative algorithm

Chapter 5

Problem 4 - QR method of finding eigenvalues

5.1 Problem

5.2 Solution

5.3 Discussion of the result

Bibliography

[1] Piotr Tatjewski (2014) *Numerical Methods*, Oficyna Wydawnicza Politechniki Warszawskiej