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SUT

numerical methods

numerical differentiation, lab report

1. INTRODUCTION

We will implement a program for numerical differentiation for three different functions, for a given point (x0), for a given differentiation order (k), and for a given degree of deference operators (n) and for a given differentiation step (h).

After implementing it we will execute it and we will analyse the results obtained

These are the functions which we are going to implement and analyse:

* Polynomial function:
* Non-lineal function:
* Trigonometric function:

1. RESULTS

# Polynomial function

At x0 = 130

## k = 1

Analytical result = 1.428100702E9

### Decreasing step h:

#### n = 5, h = 1E-1

Numerical result = 1.4281007020005085E9

Absolute error = 5.085468292236328E-4

Relative error = 3.561001185080524E-13

#### n = 5, h =1E-3

Numerical result = 1.428100701953252E9

Absolute error = 0.04674792289733887

Relative error = 3.273433227213613E-11

#### n = 5, h =1E-6

Numerical result = 1.428100633875529E9

Absolute error = 68.12447094917297

Relative error = 4.770284816313533E-8

### Increasing n

#### n = 5, h = 1E-6

Numerical result = 1.428100633875529E9

Absolute error = 68.12447094917297

Relative error = 4.770284816313533E-8

#### n = 10, h = 1E-6

Numerical result = 1.4280994033329072E9

Absolute error = 1298.6670928001404

Relative error = 9.093666090783424E-7

#### n = 15, h = 1E-6

Numerical result = 1.4280719171362932E9

Absolute error = 28784.863706827164

Relative error = 2.015604618533908E-5

## k = 2

Analytical result = 4.394078E7

### Decreasing step h:

#### n = 5, h = 1E-1

Numerical result = 4.394077994892544E7

Absolute error = 0.0510745570063591

Relative error = 1.162349803675745E-9

#### n = 5, h =1E-3

Numerical result = 4.3941266208224826E7

Absolute error = 486.20822482556105

Relative error = 1.1065079518969875E-5

#### n = 5, h =1E-6

Numerical result = 3.963046603732639E8

Absolute error = 3.523638803732639E8

Relative error = 8.019062938192356

### Increasing n

#### n = 5, h = 1E-6

Numerical result = 3.963046603732639E8

Absolute error = 3.523638803732639E8

Relative error = 8.019062938192356

#### n = 10, h = 1E-6

Numerical result = 1.4456434098501053E10

Absolute error = 1.4412493318501053E10

Relative error = 327.99812198374843

#### n = 15, h = 1E-6

Numerical result = 3.241823764414422E11

Absolute error = 3.241384356614422E11

Relative error = 7376.711011079962

# Non-linear function

At x0 = 30

## k = 1

Analytical result = 1.428100702E9

### Decreasing step h:

#### n = 5, h = 1E-1

Numerical result = 0.0011098779133758006

Absolute error = 5.3722217646656745E-14

Relative error = 4.840371809963773E-11

#### n = 5, h =1E-3

Numerical result = 0.001109877913267147

Absolute error = 1.6237575520272607E-13

Relative error = 1.463005554376562E-10

#### n = 5, h =1E-6

Numerical result = 0.001109878207857425

Absolute error = 2.9442790219769144E-10

Relative error = 2.6527953988012E-7

### Increasing n

#### n = 5, h = 1E-6

Numerical result = 0.001109878207857425

Absolute error = 2.9442790219769144E-10

Relative error = 2.6527953988012E-7

#### n = 10, h = 1E-6

Numerical result = 0.0011098760682990534

Absolute error = 1.8451304694203086E-9

Relative error = 1.662462552947698E-6

#### n = 15, h = 1E-6

Numerical result = 0.0011099653045690344

Absolute error = 8.7391139511582E-8

Relative error = 7.873941669993539E-5

## k = 2

Analytical result = -0.06659267480577137

### Decreasing step h:

#### n = 5, h = 1E-1

Numerical result = -7.390973873009106E-5

Absolute error = 0.06651876506704128

Relative error = 0.9988901220900699

#### n = 5, h =1E-3

Numerical result = -7.391031860611481E-5

Absolute error = 0.06651876448716526

Relative error = 0.998890113382265

#### n = 5, h =1E-6

Numerical result = -1.4062824978585317E-4

Absolute error = 0.06645204655598552

Relative error = 0.9978882324490492

### Increasing n

#### n = 5, h = 1E-6

Numerical result = -1.4062824978585317E-4

Absolute error = 0.06645204655598552

Relative error = 0.9978882324490492

#### n = 10, h = 1E-6

Numerical result = 0.009435644505587665

Absolute error = 0.07602831931135903

Relative error = 1.1416919283255746

#### n = 15, h = 1E-6

Numerical result = -1.3249259062294563

Absolute error = 1.2583332314236848

Relative error = 18.895970691878997

# Trigonometric function

At x0 = 2\*

## k = 1

Analytical result = 2.4492935982947064E-16

### Decreasing step h:

#### n = 5, h = 1E-1

Numerical result = -1.625229237208411E-6

Absolute error = 1.6252292374533403E-6

Relative error = 6.635501920165423E9

#### n = 5, h =1E-3

Numerical result = 2.0539125955565396E-13

Absolute error = 2.051463301958245E-13

Relative error = 837.573455214415

#### n = 5, h =1E-6

Numerical result = -2.4054832200211723E-10

Absolute error = 2.4054856693147705E-10

Relative error = 982114.055656522

### Increasing n

#### n = 5, h = 1E-6

Numerical result = -2.4054832200211723E-10

Absolute error = 2.4054856693147705E-10

Relative error = 982114.055656522

#### n = 10, h = 1E-6

Numerical result = 4.680999855810432E-9

Absolute error = 4.680999610881072E-9

Relative error = 1.9111631264378294E7

#### n = 15, h = 1E-6

Numerical result = 2.955518995756245E-8

Absolute error = 2.955518971263309E-8

Relative error = 1.2066821933152711E8

## k = 2

Analytical result = -1.0

### Decreasing step h:

#### n = 5, h = 1E-1

Numerical result = -0.9999982227592679

Absolute error = 1.777240732137031E-6

Relative error = 1.777240732137031E-6

#### n = 5, h =1E-3

Numerical result = -1.0000000009391385

Absolute error = 9.391385447088396E-10

Relative error = 9.391385447088396E-10

#### n = 5, h =1E-6

Numerical result = -0.9999482723325552

Absolute error = 5.172766744476753E-5

Relative error = 5.172766744476753E-5

### Increasing n

#### n = 5, h = 1E-6

Numerical result = -0.9999482723325552

Absolute error = 5.172766744476753E-5

Relative error = 5.172766744476753E-5

#### n = 10, h = 1E-6

Numerical result = -1.0499458004960027

Absolute error = 0.049945800496002724

Relative error = 0.049945800496002724

#### n = 15, h = 1E-6

Numerical result = -1.029703383325778

Absolute error = 0.029703383325778043

Relative error = 0.029703383325778043

1. PLOTS

Let’s plot some of the results obtained:

1. Polynomial function k = 1 increasing h:
2. Increasing n:
3. CONCLUSIONS