ESO208 Programming Assignment – 04:

Integration and ODE: Initial Value Problems

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Section – J3

1. Write a computer program for Romberg integration starting from the trapezoidal rule,and Gauss-Legendre Quadrature to evaluate one-dimensional integrals.The program should have the following features:

Input: The program should read - (i) the function to be integrated, $f(x)$ (ii) lower limit, a, and upper limit, b, of integration domain; and (iii) the maximum allowable approximate relative error (%).

Options: The user should have the option of selecting one or more of the following methods–

a. Romberg Integration: Start with $h=b-a$, and keep halving the step size till the approximate error is within allowable limit. Apply the Romberg algorithm up to the maximum possible accuracy before halving the step size.

b. Gauss-Legendre quadrature: Start with 1 Gauss point and keep increasing till the approximate error is within allowable limit

Output: The output from the program should be in the form of

(a) the value of integral, I ;

(b) number of intervals or the number of Gauss points, needed to achieve the desired accuracy;

(c) approximate relative error in the estimated value of the integral; and

(d) a figure showing the location of points where the function was evaluated and the corresponding function value.

Which method you want to use?

1. Romberg Integration

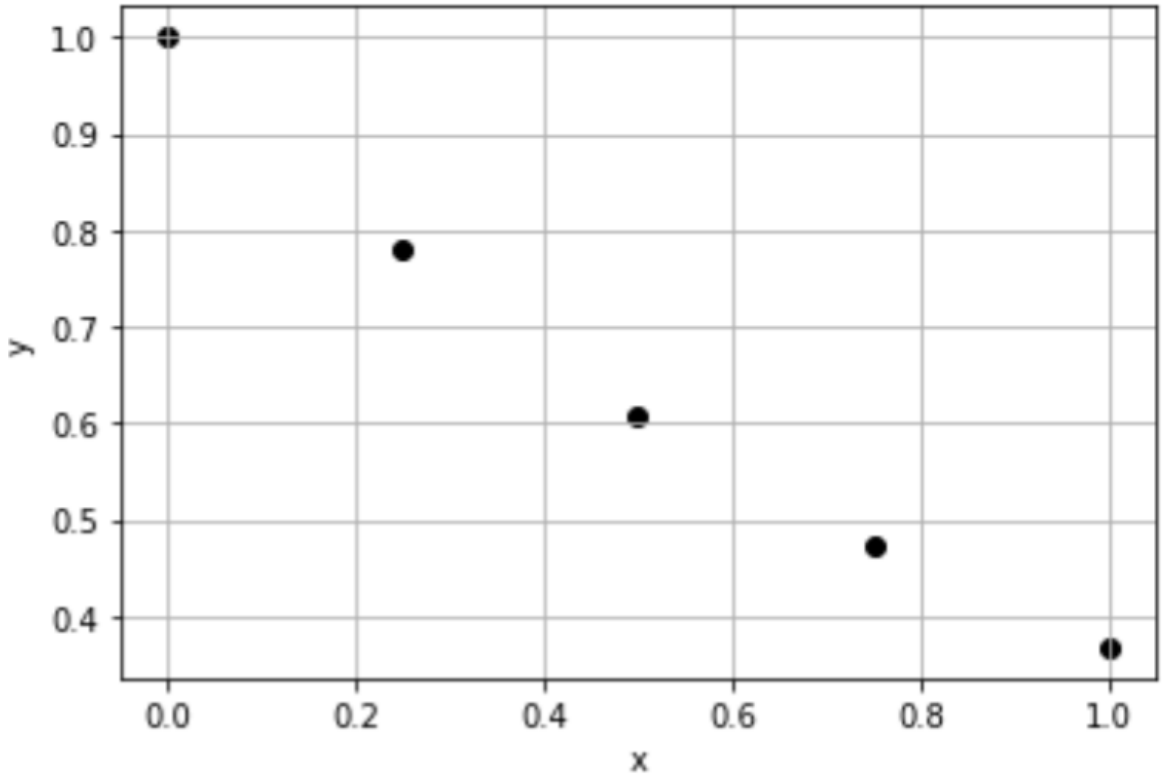
2. Gauss-Legendre Quadrature

1

I = 0.6321205589519759

Number of Intervals = 3

Approximate relative error (%) = -3.2e-05



Which method you want to use?

1. Romberg Integration

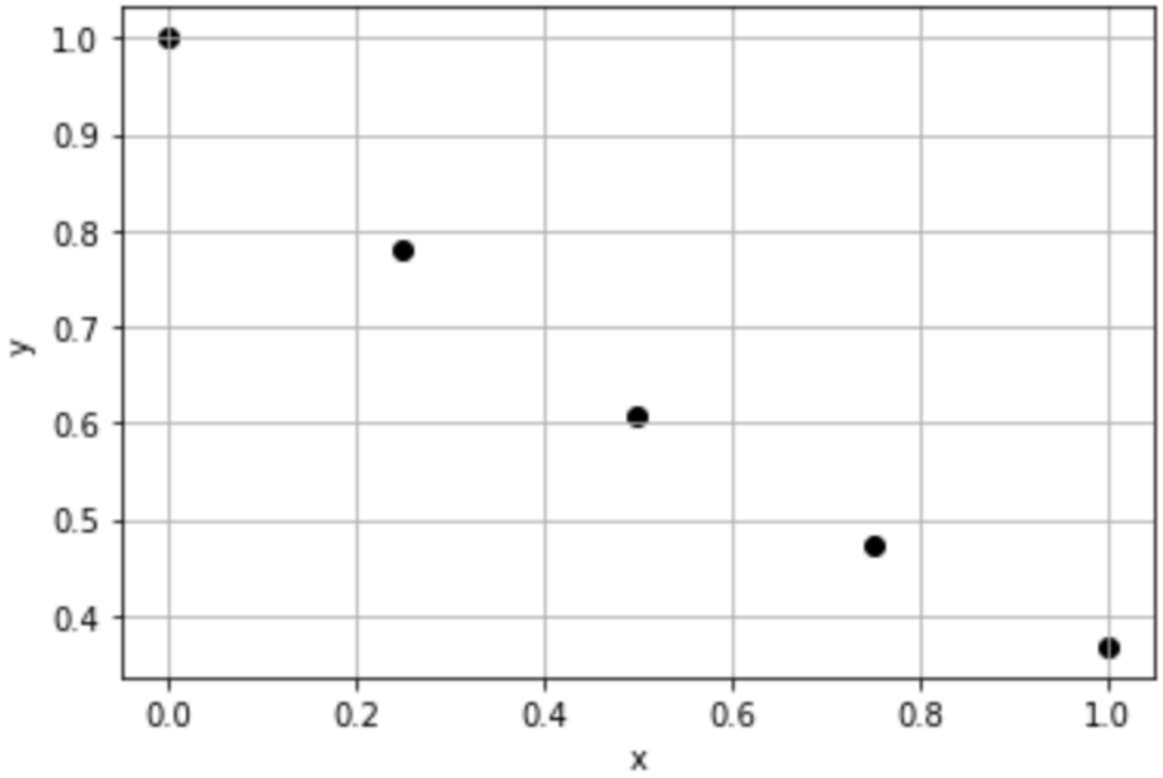
2. Gauss-Legendre Quadrature

2

I = 0.632120461911347

Number of Intervals = 4

Approximate relative error (%) = -0.000651



2. Write a computer program for solving Initial Value Problems. The program should have the following features:

Input:(i) Ordinary differential equation to be solved $\frac{dy}{dt} = f(t, y)$; (ii) initial values t_0 and y_0; (iii) final value t_f and (iv) interval size h.

Options: The user should have the option of selecting one or more of the following –

a) Forward Euler method
b) 2nd order RK method (Midpoint method)
c) 4th order RK method

Output: The output from the program should be:

(a) A text file containing the values of t_i and corresponding y_i;

(b) A figure showing *y* vs t.

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Which method you want to use?

1. Forward Euler method
2. 2nd order RK method (Midpoint method)
3. 4th order RK method
1

t, y

0.0 1.0

0.0 1.0

0.1 1.0

0.2 0.99

0.3 0.970398

0.4 0.94214783

0.5 0.90664213

0.6 0.86554213

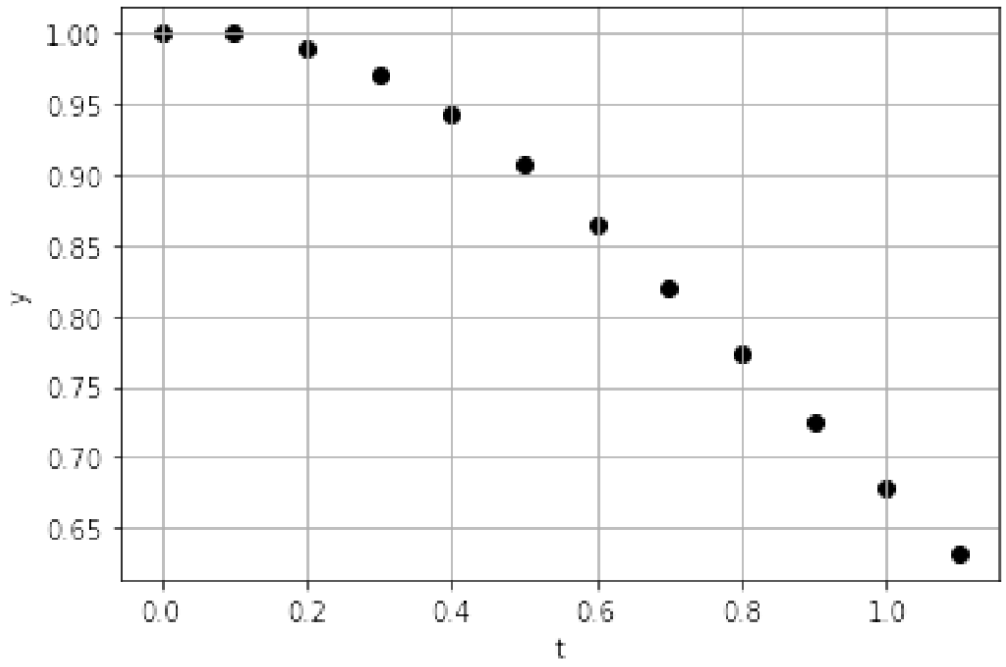
0.7 0.82059234

0.8 0.77345632

0.9 0.72559754

1.0 0.67821328

Text(0, 0.5, 'y')
```



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Which method you want to use?
1. Forward Euler method
2. 2nd order RK method (Midpoint method)
3. 4th order RK method
2

t, y

0.0 1.0

0.0 1.0

0.1 0.995

0.2 0.98029702

0.3 0.95674118

0.4 0.92561675

0.5 0.88847651

0.6 0.84696734

0.7 0.80267879

0.8 0.75703375

0.9 0.7112258

1.0 0.66619759

Text(0, 0.5, 'y')
```

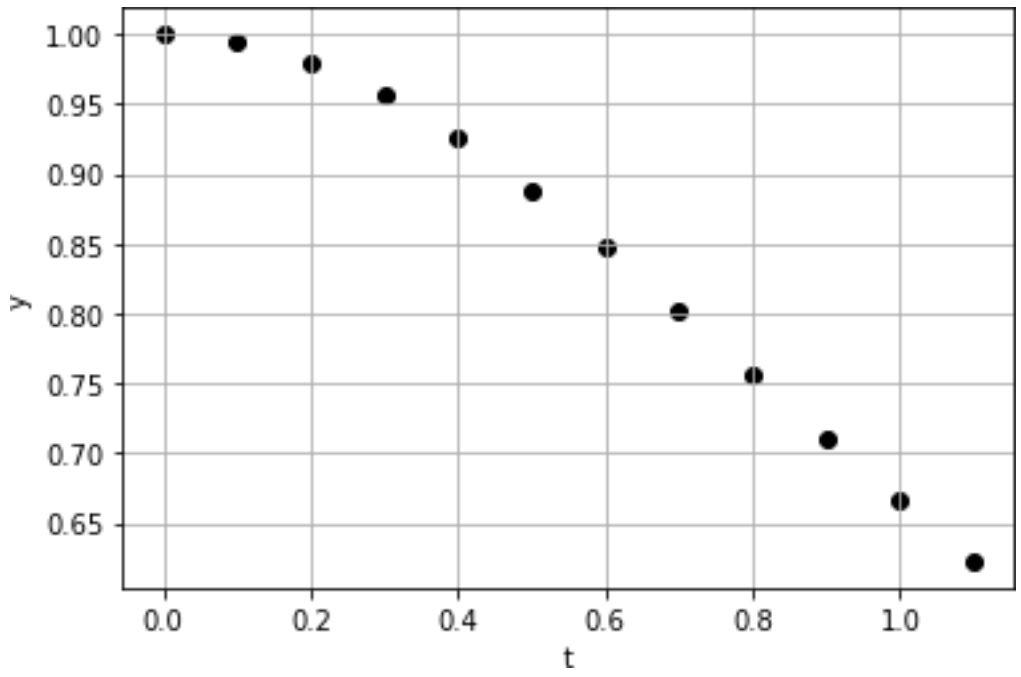


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Which method you want to use?
1. Forward Euler method
2. 2nd order RK method (Midpoint method)
3. 4th order RK method
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```
3

t, y

0.0 1.0

0.1 0.99502487

0.2 0.98039212

0.3 0.95693772

0.4 0.9259258

0.5 0.88888872

0.6 0.84745744

0.7 0.80321267

0.8 0.75757561

0.9 0.71174366

1.0 0.66666661

Text(0, 0.5, 'y')
```