Lab 4A

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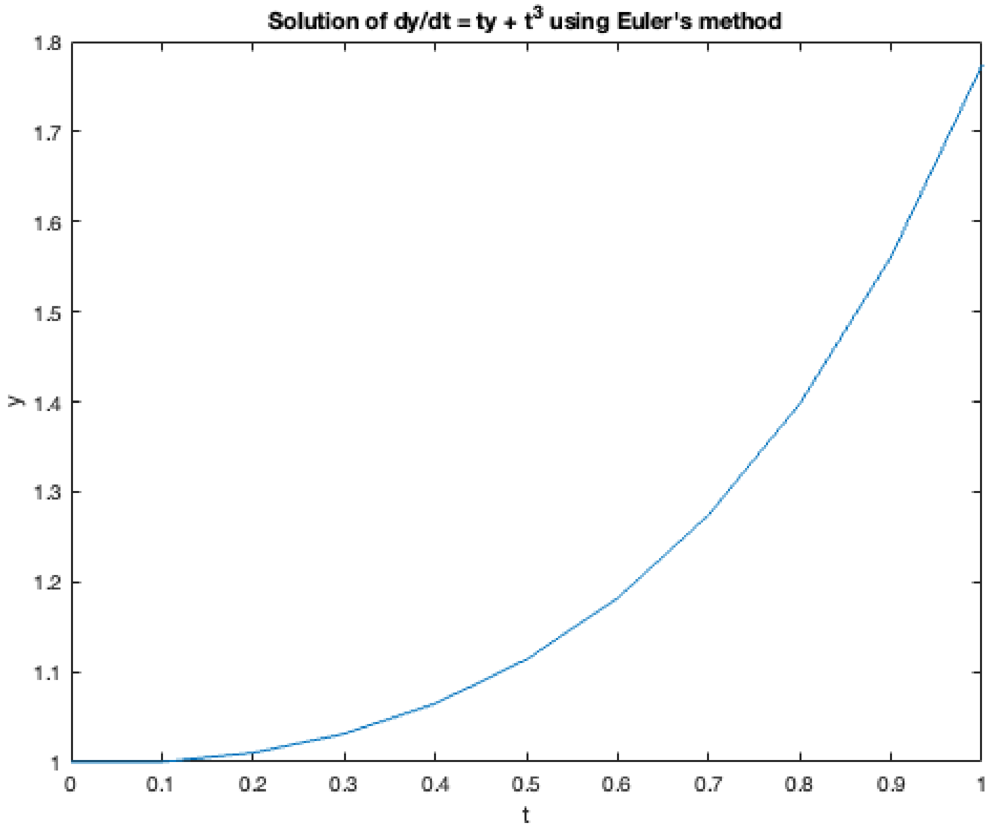
1. The below code adds the feature of plotting the solution.

```
function [t, y] = euler_method(f, tspan, y0, h)
    % Euler's method for solving first-order ODE
    % f: function handle representing the ODE dy/dt = f(t, y)
    % tspan: vector [t0, tf] representing the interval of integration
    % y0: initial condition
    % h: step size
    % Returns:
    % t: vector of time points
    % y: vector of solution values at corresponding time points

    % Initialize time vector
    t = tspan(1):h:tspan(2);

    % Initialize solution vector
    y = zeros(size(t));
    y(1) = y0;

    % Iterate over time points
    for i = 1:length(t)-1
        % Update solution using Euler's method
        y(i+1) = y(i) + h * f(t(i), y(i));
    end
end
```

euler_method.m

```
tspan = [0, 1]; % time span
y0 = 1; % initial condition
h = 0.1; % step size
f = @(t, y) t * y + t^3;
[t, y] = euler_method(f, tspan, y0, h)

% Plot the solution
plot(t, y);
xlabel('t');
ylabel('y');
title('Solution of dy/dt = ty + t^3 using Euler''s method');
```

test_euler_method.m



2. We obtain the following values

t	y
0	1.0000
0.1000	1.0000
0.2000	1.0101
0.3000	1.0311
0.4000	1.0647
0.5000	1.1137
0.6000	1.1819
0.7000	1.2744
0.8000	1.3979
0.9000	1.5610
1.0000	1.7744

Table 1: Values of t and y obtained from Euler's method

which are similar to the text.

3. Skipped.

4. The Hodgkin-Huxley model created the field of computational neuroscience by using differential equations to mode the action potential: the electrical signal that propagates along

neurons. It was developed through experiments on the giant squid axon, proposing that the action potential arises from the sequential opening and closing of voltage-gated ion channel.

5. Numerical differential equations were used to study the Tacoma Bridge's oscillations by modeling the structural dynamics through systems of ordinary differential equations (ODEs) governing the bridge's motion. By numerically solving these ODEs, researchers could simulate the bridge's behavior under different conditions, predict its response to wind gusts, and identify potential instabilities leading to the bridge's catastrophic collapse.

6. The Lorenz equations, a set of three nonlinear differential equations, are utilized in climate modeling to describe complex atmospheric dynamics, including convection, turbulence, and chaotic behavior. These equations capture the system's sensitivity to initial conditions, enabling simulations that elucidate climate patterns, predict weather phenomena, and assess long-term climate trends.

7. Skipped.