MATLAB Marina: Numerical Differentiation Examples

Numerical Differentiation of Exponential Function

The MATLAB program of Figure 1a computes the numerical derivative the exponential function $h(t) = 5.0e^{-25t}, t \geq 0s$. Figure 1b shows the function and its numerical derivative.

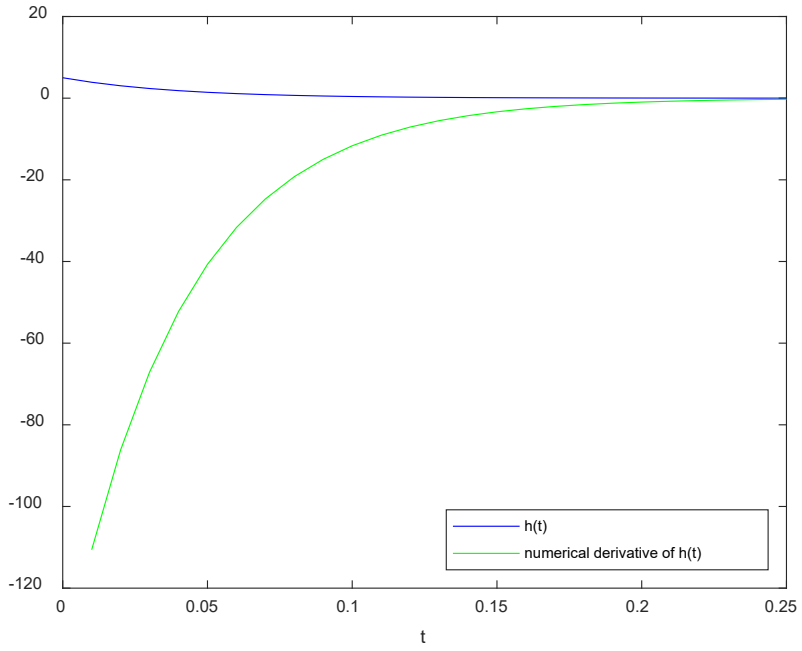

Figure 1a. MATLAB Program for Numerical Derivative of Exponential Function

```
% function h(t) = 5e^(-25t), t > 0
t = 0 : 0.01 : 0.25;
h = 5*exp(-25*t);

% numerical backwards derivative of h(t)
dh = diff(h);
dt = diff(t);
dhdt = dh./dt;

figure(1)
plot(t,h,'b-',t(2:end),dhdt,'g-')
xlabel('t')
legend('h(t)','numerical derivative of h(t)');
```

Figure 1b. Plot of Exponential Function and Numerical Derivative

The analytical derivative of h(t) is $\frac{dh(t)}{dt} = \frac{d}{dt}\left(5.0e^{-25t}\right) = -25 \cdot 5 \cdot e^{-25t} = -125e^{-25t}$ which corresponds to the plot of the numerical derivative.

Numerical Differentiation of Sinusoidal Function

The MATLAB program of Figure 2a computes the numerical derivative the sinusoidal function $h(t) = 5.0e^{-25t}, t \geq 0s$. Figure 2b shows the function and its numerical derivative.

```
% function x(t) = 7.5*cos(10*pi*t)
f = 5;
t = 0 : 1/(20*f) : 2/f;
x = 7.5*cos(10*pi*t);

% numerical backwards derivative of x(t)
dx = diff(x);
dt = diff(t);
dxdt = dx./dt;

figure(1)
plot(t,x,'b-',t(2:end),dxdt,'g-')
xlabel('t'), legend('x(t)','numerical derivative of x(t)');
```

Figure 2a. MATLAB Program for Numerical Derivative of Sinusoidal Function

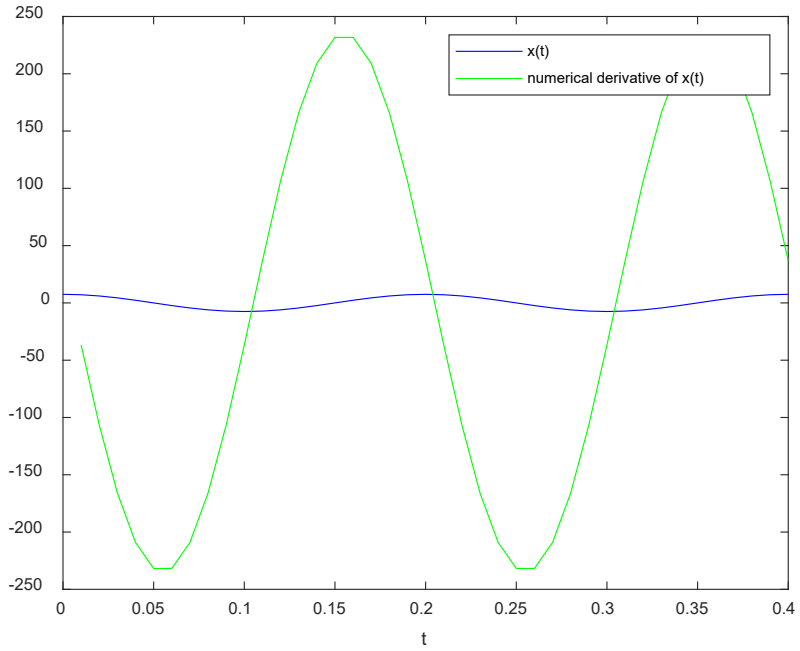

Figure 2b. Plot of Sinusoidal Function and Numerical Derivative

The analytical derivative of x(t) is

$\frac{dx(t)}{dt} = \frac{d}{dt}\left(7.5\cos(10\pi t)\right) = -10\pi \cdot 7.5\cos(10\pi t) = -75\pi\cos(10\pi t)$ which corresponds to the plot of the numerical derivative.

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