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%Global error comparision of Euler and Trapezoid methods.
%Input: f(t,y), [a,b],y(a)=ya - initial vale, m - number of subintervals
%       yreal - exact solution of y'=f(t,y) y(a)=ya.
%Output: ye - Euler method solution, eEuler - Euler method global error
%        yt - Trapezoid method solution, eTrapez -Trapezoid method global
%          error. Plotting and producing tables of the errors

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function[ye yt eEuler eTrapez]=eultrap(f,a,b,ya,m,yreal)
h=(b-a)/m; ye(1)=ya; yt(1)=ya; t(1)=a;
eEuler(1)=0; eTrapez(1)=0;
%Iteration
for k=2:m+1;
    t(k)=a+(k-1)*h;
    ye(k)=ye(k-1)+h*f(t(k-1),ye(k-1));
    eEuler(k)=abs(ye(k)-yreal(t(k)));
    yt(k)=yt(k-1)+(h/2)*(f(t(k-1),yt(k-1))+f(t(k),ye(k)));
    eTrapez(k)=abs(yt(k)-yreal(t(k)));
end
% Plotting results
w=0:0.05:2;
ysol=exp(-w.^2/2);
subplot(1,2,1); plot(w,ysol,t,ye,t,yt);
grid
legend('Exact Solution','Euler method Solution','Trapezoid method Solution');
xlabel('t');
ylabel('y');
title('Solutions of dy/dt=-ty, y(0)=1. (m=10)');
subplot(1,2,2); plot(t,eEuler,t,eTrapez)
grid
legend('Euler method global error','Trapezoid method global error')
xlabel('t')
ylabel('y')
title('Global Errors (m=10)')
%Producing the global error table
disp(' Table of the global errors (m=10) ')
disp(' tk          Error(Euler)          Error(Trapez) ')
disp('-----')
for k=1:m+1
    disp(sprintf('%7.3e    %7.5e    %7.5e ',t(k),eEuler(k),eTrapez(k)))
end

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a=0;b=2;ya=1; m=10;
f=inline('-t*y');
yreal=inline('exp(-t^2/2)');
[ye yt eE eT]=eultrap(f,a,b,ya,m,yreal);
Table of the global errors (m=10)
tk          Error(Euler)          Error(Trapez)
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0.000e+000  0.000000e+000    0.000000e+000
2.000e-001  1.98013e-002     1.98673e-004
4.000e-001  3.68837e-002     1.11635e-003
6.000e-001  4.79298e-002     3.14221e-003
8.000e-001  5.10670e-002     6.12600e-003
1.000e+000  4.63308e-002     9.39561e-003
1.200e+000  3.55369e-002     1.20054e-002
1.400e+000  2.16287e-002     1.31054e-002
1.600e+000  7.75932e-003     1.22679e-002
1.800e+000  3.55699e-003     9.63390e-003
2.000e+000  1.09566e-002     5.83389e-003

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