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% Midpoint Method (RK2) and Runge-Kutta method of order 4 (RK4)
% Solves y'=f(t,y), y(a)=ya, a=<t=<b
% Input: f(t,y), [a,b] -interval , ya -initial value, m -number of subintervals
% Output: rk2 - Midpoint method solution and rk4 - RK4 method solution.
function[rk2 rk4 t]=rungekut(f,a,b,ya,m)
h=(b-a)/m; rk2(1)=ya; rk4(1)=ya; t(1)=a;
for k=2:m+1
    t(k)=a+(k-1)*h;
 % Midpoint iteration
    rk2(k)=rk2(k-1)+h*f(t(k-1)+h/2,rk2(k-1)+(h/2)*f(t(k-1),rk2(k-1)));
 %RK4 iteration
 f1=f(t(k-1),rk4(k-1));
 f2=f(t(k-1)+h/2,rk4(k-1)+(h/2)*f1);
 f3=f(t(k-1)+h/2,rk4(k-1)+(h/2)*f2);
 f4=f(t(k-1)+h,rk4(k-1)+h*f3);
 rk4(k)=rk4(k-1)+(h/6)*(f1+2*f2+2*f3+f4);
end
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clear;
f=inline('t^2-y','t','y');
a=0;b=3;
[rk2 rk4 t]=rungekut(f,a,b,1,5)
% Plotting it exact solution y(t)=-exp(-t)+t^2-2t+2
w=a:0.05:b;
y=-exp(-w)+w.^2-2*w+2
plot(t,rk2,'r',t,rk4,w,y)
grid
legend('Midpoint method solution (m=5)','RK4 - solution (m=5)','Exact solution')
xlabel('t')
ylabel('y')
title('Solution of dy/dt=t^2-y, y(0)=1, t in [0,3]')
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