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% Joshua Oates - Aero 300 - lab 7

section 0 - clean up

```
close all;
clear all;
clc;
```

section 1 - use rkf45 and ode45 on ode

```
% y(0)=1
y0 = 1; % use given intital conditions
tspan = [0,pi/3]; % set domain to plot over
rTol = 1e-6;
opts = odeset('AbsTol',rTol);
[T1,Y1] = rkf45(@my_ode, tspan, y0,.1 ,rTol); % get output from rkf45
[T2,Y2] = ode45(@my_ode, tspan, y0, opts); % get output from ode45

figure
hold on
plot(T1, Y1)
plot(T2, Y2) % create and label plots

legend("y-rkf45","y-ode45")
xlabel("t axis")
ylabel("y axis")
title("y' =(y-t-1)^2 +2")

y = @(t) 1+t+tan(t); % true solution
e1 = abs(Y1-y(T1));
e2 = abs(Y2-y(T2));

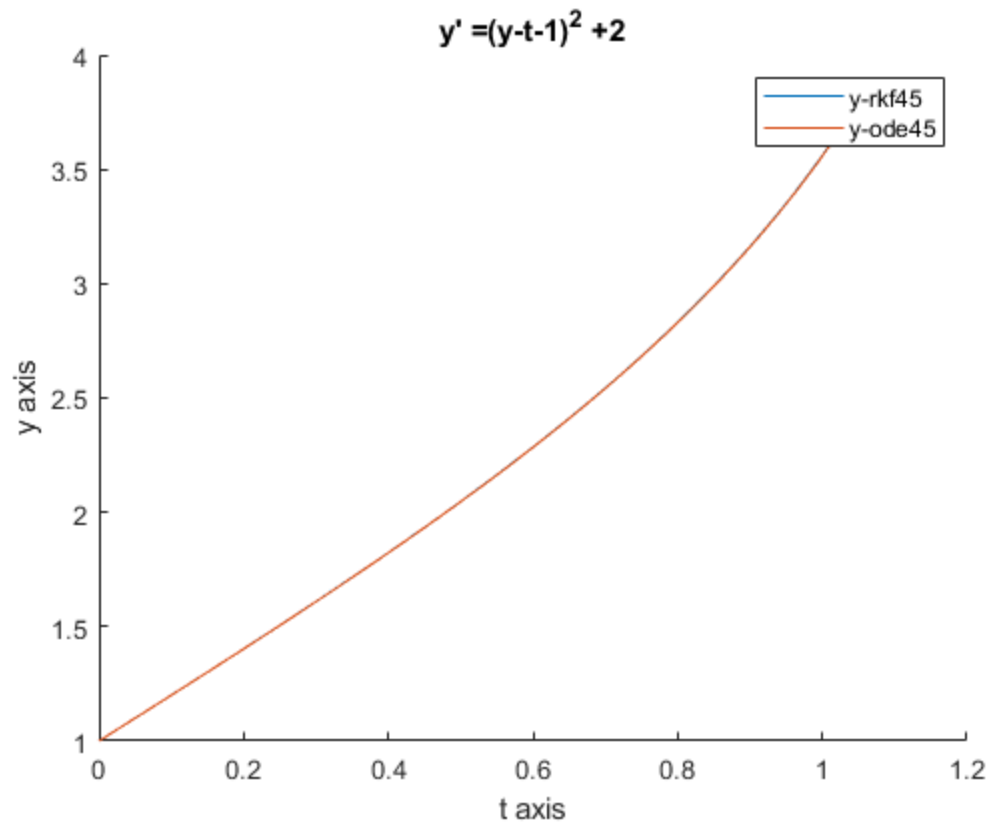
figure
hold on
plot(T1, e1)
plot(T2, e2) % create and label plots
ax = gca();
ax.YScale = "log";

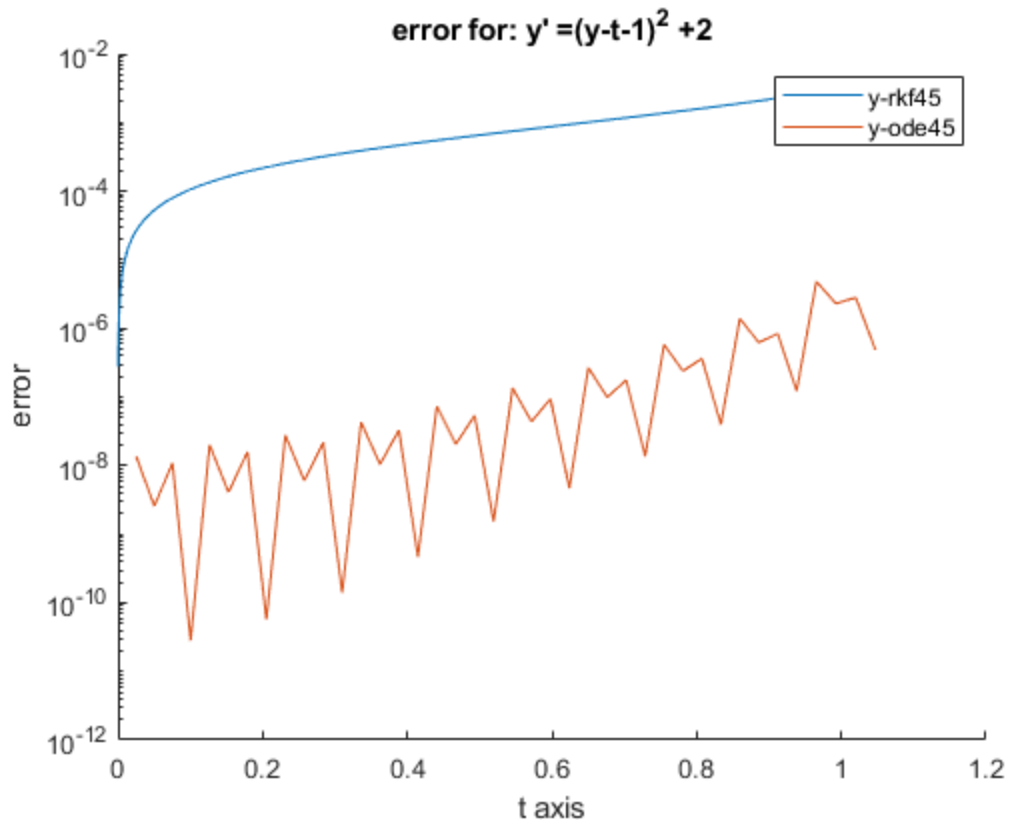
legend("y-rkf45","y-ode45")
```

```
xlabel("t axis")
ylabel("error")
title("error for: y' =(y-t-1)^2 +2")
```

```
disp("My function has aproximately 100 times more absolute error than ode45.
    Additionally, ode45 has a much less constant error than rkf45. This is likely
    becuae ODE 45 will increase h again after the relative error is sufficently
    low where as my rkf 45 will only ever decrease h.")
```

```
clear all
```





section 2 - Lorenz equation

```

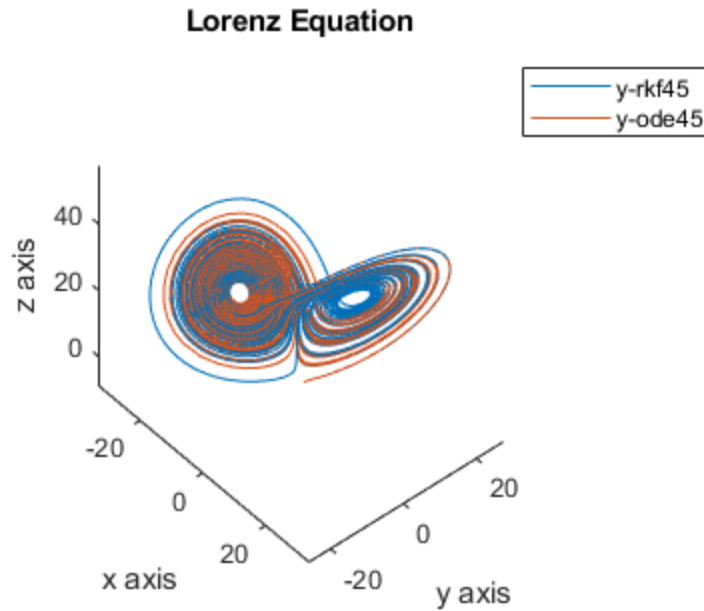
y0 = [1,1,1];
tspan = [0,50];
rTol = 1e-4;

opts = odeset('AbsTol',1e-6);
[T1,Y1] = rkf45(@lorenz_ode,tspan,y0,.001,rTol);
[T2,Y2] = ode45(@lorenz_ode,tspan,y0,opts); % Runge-Kutta 4th/5th order ODE
solver

figure
hold on
plot3(Y1(1,:),Y1(2,:),Y1(3,:))
plot3(Y2(:,1),Y2(:,2),Y2(:,3))
axis("equal")
campos([30,-25,40])
camtarget([1,0,0])

legend("y-rkf45","y-ode45")
xlabel("x axis")
ylabel("y axis")
zlabel("z axis")
title("Lorenz Equation")

```



- function def

```
function [dydt] = my_ode(t,Y)

y = Y(1);
yp = (y-t-1)^2 + 2;

dydt = yp;
end
```

My function has approximately 100 times more absolute error than ode45. Additionally, ode45 has a much less constant error than rkf45. This is likely because ODE 45 will increase h again after the relative error is sufficiently low where as my rkf 45 will only ever decrease h.

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