Numerical Solution of Ordinary Differential Equations

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This script illustrates how to call to Matlab's built-in Runge-Kutta-Fehlberg (RKF45) method and also demos the supplied routines for the Euler, improved Euler, and RK4 methods. This is for the ODE $u'(t) = sin(u(t)) - tu(t)$ with initial condition $u(0) = 1$ on the interval $0 \le t \le 5$.

```
f = @(t,u) sin(u)-t*u; %Define right side of u' = f(t,u)
ic = 1.0; inittime = 0.0; finalT = 5.0; %Solve with u(0)=ic on interval [inittime, finalT]
[tm,um] = ode45(f,[inittime,finalT], ic); %Matlab's solver
figure(1); %Plot results
plot(tm,um)
```

Here is a demo for the supplied routines "eulers_method()", "imp_euler()", and "rk4_method()", with stepsize 0.1 in each case.

```
stepsize = 0.1;
[teuler,ueuler] = eulers_method(f,[inittime,finalT],ic,stepsize);
[timp,uimp] = imp_euler(f,[inittime,finalT],ic,stepsize);
[trk4,urk4] = rk4_method(f,[inittime,finalT],ic,stepsize);
```

A comparision of each method when $t = 2$:

```
fprintf('Matlab RKF45 %f\n',um(end))
fprintf('Euler %f\n',ueuler(end))
fprintf('Improved Euler %f\n',uimp(end))
fprintf('RK4 %f\n',urk4(end))
```