PHY425
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Lab-3

23 January 2020

Aim: Solve the following problems using Numerical Methods

1) Find solution for Lotka-Volterra equations (known as predatory-prey equations)

$$\frac{dx}{dt} = \alpha x - \beta xy \qquad \frac{dy}{dt} = \delta xy - \gamma y$$

x is number of deers, *y* is number of Lion.
α, β, γ, δ are positive real parameters describing the interactions of two species

Use $$\alpha = 1.2,\ \beta = 0.6,\ \delta = 0.3,\ \text{and}\ \gamma = 0.8$$

x(0)=2, y(0)=1, Plot *x,y* vs *t* from t=0 till 50 and plot *x* vs *y*
Play with *α, β, γ* and *δ*

This set should be able to provide proper distribution.

2) Lorenz equations for simple model for atmospheric fluid dynamics

$$\frac{dx}{dt} = -\sigma x + \sigma y, \qquad \frac{dy}{dt} = rx - y - xz, \text{ and } \frac{dz}{dt} = -bz + xy$$

$$\text{I.C. } x(0) = y(0) = z(0) = 5$$

Assume $\sigma = 10,\ b = 2.66667,\ \text{and } r = 28$

Use 4th order RK

t= 0 to 50

Lorenz developed these equations to relate intensity of atmospheric fluid motion *x*, to temperature variations, *y* and *z* in horizontal and vertical directions.

Plot x vs t
x vs y
x vs z

3) Try to solve the pendulum with

$$\frac{d^2\theta}{dt^2} + \frac{g}{l}\sin\theta = 0 \qquad \theta(0) = 0.1, \frac{d\theta}{dt} = 0$$

Length =1m. Also try with different length(5,10)

Use RK5 method to solve

Change initial theta and see the result.

Also check how result is affected by *h* choice

4) Solve the following IVP from t= 1.0 to t=2.5

$$\frac{dy}{dt} = \frac{-2y}{1+t}$$

Use fourth-order Adams method. Employ a step size of 0.25 and fourth-order RK method to preduct the start up values if y(0)=2.

Use both explicit and implicit method.

http://mysite.science.uottawa.ca/rsmith43/Zombies.pdf

5) Zombie population modeling

$$\frac{dS}{dt} = \pi - \beta SZ - \delta S, \quad \frac{dZ}{dt} = \beta SZ + \zeta R - \alpha SZ \text{ and } \frac{dR}{dt} = \delta S + \alpha SZ - \zeta R$$

Susceptible (S), Zombie (Z) and Removed (R)

$\text{Non} - \text{zombie} - \text{related death} : \delta$

π birth rate is a constant,

$\beta :$ encounter with a zombie

$\alpha :$ destroying the brain of zombie

$\zeta :$ humans in removed class resurrect and become zombie

$$\pi = 0,\ \alpha = 0.005,\ \beta = 0.0095\ , \zeta = 0.0001 \text{ and } \delta = 0.0001$$

S(0)=500, Z(0)=5, R(0)=0