

3 Numerical Solution of Differential Equations

One of the simplest mathematical models known in epidemiology is so-called SIRD model¹. It is defined by the following system of differential equations

$$\begin{cases} S'(t) = -\frac{\beta}{N}I(t)S(t) \\ I'(t) = \frac{\beta}{N}I(t)S(t) - \alpha I(t) - \gamma I(t) \\ R'(t) = \alpha I(t) \\ D'(t) = \gamma I(t) \end{cases}$$

where $S(t)$ denotes the number of susceptible individuals, $I(t)$ denotes the number of infected individuals, $R(t)$ denotes the number of recovered individuals, $D(t)$ denotes the number of deceased individuals, β is the infection rate, α is the recovery rate, γ is the mortality rate, and $N = S + I + R + D$. Assume that $S(0) = 997$, $I(0) = 3$, $R(0) = 0$, $D(0) = 0$, $\beta = 0.4$, $\alpha = 0.035$, $\gamma = 0.005$, and $t \in [0, 150]$.

- Use Matlab ODE solver *ode45* to calculate the numerical solution of SIRD model with given parameters and initial conditions. Plot in one frame the numerical solutions of $S(t)$, $I(t)$, $R(t)$, and $D(t)$ against time. What do you observe from the plots and how do you interpret the dynamics of the system?
- Write the code implementing the third order Runge-Kutta method (*RK3*) given by the following Butcher table:

0			
1/2	1/2		
1	-1	2	
	1/6	2/3	1/6

Use *RK3* method with stepsize $\tau = 10^{-3}$ to find the numerical solution of SIRD model with given parameters and initial conditions. Plot in one frame the numerical solutions of $S(t)$, $I(t)$, $R(t)$, and $D(t)$ against time. Make a qualitative comparison with the results obtained with *ode45* solver.

Numerical Solution Of Differential Equat

Daniela Niemeyer



Numerical Solution Of Differential Equat:

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