VBD-MODE
Interveiw Exercise

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1 Instructions

As preparatory work for your interview, we ask that you write code covering all tasks listed below (see Subsection 1.1). The source code should be written in *Python*, *R*, or *Julia*. Additionally, please create a public repository on *GitHub* and upload your files. A link to the repository should be sent to us at **peter.fransson@iwr.uni-heidelberg.de** no later than **Monday, December 1, 14:00 CET**. If you have any questions, please contact us at **peter.fransson@iwr.uni-heidelberg.de**.

1.1 Tasks

- Implement Algorithms 1 and 2 (see Section 2).
- Declare the variables: $\beta = 24$, $\delta_E = 0.6$, $\mu_E = 0.15$, $\delta_J = 0.08$, $\mu_J = 0.05$, $\alpha = 0.003$, $\omega = 0.5$, $\mu_A = 0.1$, $t_0 = 0$, $t_{\text{end}} = 365$, $h = 0.01$, and the vector $y_0 = [10, 0, 0]$.
- Create a vector T where the elements follow the pattern $t_0 + h(i-1)$, where i denotes the position of the element in T. Thus, t_0 is the first element in T, and t_{end} should be the last.
- Create a `for`-loop which iterates over the integers 1 to t_{end}/h, where:
  1. In the first iteration, call the function *RK4* (Algorithm 1) with the function f (Algorithm 2), y_0, the first element of T, and h as input.
  2. In the second iteration, call the function *RK4* with the function f, the output from *RK4* in the first iteration, the second element of T, and h as input.
  3. The remaining iterations follow the same pattern.
- Save y_0 together with the *RK4* outputs from the `for`-loop in a new variable Y.
- Create a plot with three subplots with the following specifications:

1. The first subplot should plot a curve where the x-axis values are given by T and the y-axis values are given by the corresponding first elements of y_0 and the *RK4* outputs. The x- and y-axes should be labeled “T” and “E”, respectively.
2. The second subplot should plot a curve where the x-axis values are given by T and the y-axis values are given by the corresponding second elements of y_0 and the *RK4* outputs. The x- and y-axes should be labeled “T” and “J”, respectively.
3. The third subplot should plot a curve where the x-axis values are given by T and the y-axis values are given by the corresponding third elements of y_0 and the *RK4* outputs. The x- and y-axes should be labeled “T” and “A”, respectively.

2 Algorithms

Algorithm 1 RK4 Function

function RK4(f,y_n,t_n,h)
  $k_1 \leftarrow f(t_n, y_n)$ ▷ f is a function of t_n and y_t
  $k_2 \leftarrow f(t_n + \frac{1}{2}h, y_n + \frac{1}{2}hk_1)$
  $k_3 \leftarrow f(t_n + \frac{1}{2}h, y_n + \frac{1}{2}hk_2)$
  $k_4 \leftarrow f(t_n + h, y_n + hk_3)$
  $y_{n+1} \leftarrow y_n + \frac{1}{6}h(k_1 + 2K_2 + 2k_3 + k_4)$
  return y_{n+1}
end function

Algorithm 2 f Function

function $f(t_n, y_n, \beta, \delta_E, \mu_E, \delta_J, \mu_J, \alpha, \omega, \mu_A)$
  $E \leftarrow y_n[1]$ ▷ First element of y_t
  $J \leftarrow y_n[2]$
  $A \leftarrow y_n[3]$
  $dE \leftarrow \beta A - \delta_E E - \mu_E E$
  $dJ \leftarrow \delta_E E - \delta_J J - \alpha J^2 - \mu_J J$
  $dA \leftarrow \omega \delta_J J - \mu_A A$
  $dy \leftarrow [dE, dJ, dA]$ ▷ dy is a vector
  return dy
end function