

Algorithm I . Simulasi gerak bola bekel dengan hambatan udara ( Kel 1B )

1: Baca input:

$v_0$ , launch\_angle (derajat), initial\_height, k, mass, g,  $\Delta t$ , t\_max

2:  $\theta \leftarrow \text{radians}(\text{launch\_angle})$

3:  $v_{x0} \leftarrow v_0 * \cos(\theta)$

4:  $v_{y0} \leftarrow v_0 * \sin(\theta)$

5:  $t \leftarrow 0$ ;  $x \leftarrow 0$ ;  $y \leftarrow \text{initial\_height}$ ;  $v_x \leftarrow v_{x0}$ ;  $v_y \leftarrow v_{y0}$

6: times  $\leftarrow [t]$ ; x\_vals  $\leftarrow [x]$ ; y\_vals  $\leftarrow [y]$

7: Function accel(state):

8:  $(x, y, v_x, v_y) \leftarrow \text{state}$

9:  $v \leftarrow \text{sqrt}(v_x^2 + v_y^2)$

10:  $F_x \leftarrow -k * v * v_x$

11:  $F_y \leftarrow -k * v * v_y$

12:  $a_x \leftarrow F_x / \text{mass}$

13:  $a_y \leftarrow (F_y - \text{mass} * g) / \text{mass}$

14: return  $[v_x, v_y, a_x, a_y]$

15: Function (state, t,  $\Delta t$ ):

16:  $k_1 \leftarrow \text{accel}(\text{state})$

17:  $k_2 \leftarrow \text{accel}(\text{state} + 0.5 * \Delta t * k_1)$

18:  $k_3 \leftarrow \text{accel}(\text{state} + 0.5 * \Delta t * k_2)$

19:  $k_4 \leftarrow \text{accel}(\text{state} + \Delta t * k_3)$

20: state\_new  $\leftarrow \text{state} + (\Delta t / 6) * (k_1 + 2 * k_2 + 2 * k_3 + k_4)$

21: return state\_new

22: **while**  $t \leq t_{\text{max}}$  and  $y \geq 0$  **do**

23: state  $\leftarrow [x, y, v_x, v_y]$

24: state  $\leftarrow \text{RK4\_step}(\text{state}, t, \Delta t)$

25:  $(x, y, v_x, v_y) \leftarrow \text{state}$

26:  $t \leftarrow t + \Delta t$

27: append times  $\leftarrow t$ ; append x\_vals  $\leftarrow x$ ; append y\_vals  $\leftarrow y$

28: **end while**

29: flight\_time  $\leftarrow \text{times}[-1]$

30: Tampilkan plot(x\_vals, y\_vals) dengan label sumbu dan judul

31: Tampilkan plot(times, y\_vals) dengan label sumbu dan judul

32: Cetak : "Waktu di Udara =", waktu\_terbang, "detik"