Assignment 2

Python Programming for Life Science Students
Due 5:00 PM, 7 April 2025 (Monday)

Submit your code in the form of a Jupyter notebook with all information. Late submissions will not be accepted.

Exercise: A Model for Fish Growth

A biologically inspired model describes the growth of a fish by relating its weight, $W(t)$, to its age, t, (in weeks). The rate of weight change is influenced by both tissue growth and tissue breakdown, and is given by the nonlinear differential equation:

$$\frac{dW}{dt} = rW^{2/3}\left[1 - \left(1 - \frac{W}{K}\right)^{1/3}\right], \tag{1}$$

where:

- $W(t)$ is the weight of the fish (e.g., in grams),
- r is a growth rate constant (e.g., in $g^{1/3}$/week),
- K is the maximum adult weight,
- t is time in weeks.

This model captures surface area-driven growth ($W^{2/3}$) and slowdown near maturity (as $W \to K$).

Tasks

1. Choose meaningful values for:
   - Growth rate r (e.g., between 0.05 and 0.5),
   - Adult weight K (e.g., 1000 grams),
   - Initial weight $W(0)$ (e.g., 1–5 grams for a young fish).
2. Use `scipy.integrate.odeint` to solve the differential equation over a time range of 0 to 100 weeks.
3. Plot the weight $W(t)$ over time and describe the shape of the curve.

Extension: Harvesting

Real fisheries often remove fish over time. You can modify the equation to include a constant *harvesting rate h*:

$$\frac{dW}{dt} = rW^{2/3}\left[1 - \left(1 - \frac{W}{K}\right)^{1/3}\right] - h \tag{2}$$

Try experimenting with different values of h and see how they affect long-term fish growth. **What happens if harvesting exceeds growth?** Can you visualize this effect through plotting?