

# Programming Techniques for Scientific Simulations

## Exercise 10

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**Problem 10.1 Penna Model with Fishing**

(*S. Moss de Oliveira et al., Physica A 215, 298 (1995)*)

Implement a Penna fish simulation to observe how a slight increase of fishing may destroy an initially stable population. The following is how you should modify your original Penna simulation:

1. At a time-step M1 when the fish population becomes stable, introduce the concept of fishing. Here, any fish can die due to illness or fishing with probabilities  $p_n$  and  $p_f$  respectively.
2. Observe that an increase in fishing (ie. with a larger  $p_f$  after time M1) will destabilize the fish population.
3. Instead of (2) above, observe what will happen if fishing is only allowed for the adult species after time M1.

**Problem 10.2 Comparison between Vector and List in Penna Model Implementation**

1. Implement the Penna population class based on a vector instead of a list.
2. Compare the performance of the two versions.