Numerical Analysis and Programming

Lab Worksheet #12

We will simulate a spontaneous decay process of nuclei in this exercise. The decay rate of the radioactive nuclei is given by

$$\frac{dN}{dt} = -\frac{1}{\tau}N$$

where N is the number of undecayed nuclei at time t, and τ is the life-time. Rewrite the equation in the discrete time, and set $\Delta t = 1$, we have

$$\Delta N = -\frac{1}{\tau}N = -\lambda N$$

The probability of a nucleus to decay per generation is then λ with $0 \leq \lambda \leq 1$.

1. Assume at the beginning we have $N_0 = 10000$ Co^{60} nuclei with a half-life $t_{1/2} = 5.27$ years. Notice $t_{1/2} = \tau \ln(2)$. Write a program to simulate the decay process with the updating scheme:

   (a) Scan through each nucleus. Examine whether the nucleus has decayed. If not, generate a random number r between 0 and 1.

   (b) If $r < \lambda$ then mark the nucleus as decayed, otherwise the nucleus remains undecayed.

   (c) Repeat the process until no nucleus is found undecayed.

   Assume Δt= 1 month and monitor the number of the undecayed nuclei. Estimate the half-life from your data.