Assignment of Monte-Carlo Methods

Due on: Mar 14, 2022

1. Write a program to simulate radioactive decay, using the information that a nucleus undergoes radioactive decay in time Δt with probability $p = \alpha\Delta t$, with $\alpha\Delta t<<1$. You may want to proceed as follows: Consider a system initially having N_0 stable nuclei. How does the number of parent nuclei, N, change in time? Graph the number of remaining nuclei as a function of time for the following cases: $N_0 = 100$, $\alpha = 0.01\ s^{-1}$, $\Delta t = 1$ sec; and $N_0 = 5000$, $\alpha = 0.03\ s^{-1}$, $\Delta t = 1$ sec. Show the results on both linear and logarithmic scales for times between 0 and 300 secs. In addition, plot the same graphs (the expected curves) given $dN = - N\alpha dt$ i.e., $N(t) = N_0\ e^{-\alpha t}$.

2. Modify the above program to simulate an experiment that counts the number of decays observed in a time interval, T. Allow the experiment to be repeated and the histogram the distribution of number of decays for the following two cases:
   a) $N_0 = 500$, $\alpha = 4x10^{-5}\ s^{-1}$, $\Delta t = 10$ sec, T=100 sec
   b) $N_0 = 500$, $\alpha = 2x10^{-5}\ s^{-1}$, $\Delta t = 10$ sec, T=100 sec
   In each case, show the distribution using 1000 experiments and overlay the expected Poisson distributions .

3. Write a program to generate the distribution $f(\theta)=1./(\sin^2\theta+ a.\cos^2\theta)$, where $0\leq\theta\leq\pi$. Compare your results using the inversion technique and the acceptance-rejection technique: 10000 trials each for values of a=0.5 and 0.001. You should overlay the plots for four different $f(\theta)$ distributions, properly normalized.