Monte Carlo simulations 2002. Exercise 2

To be handed in Tue 10.2. 12:15, solutions given Thu 12.2 12:15.

1. (6 p) In nuclear physics one of the most important distributions is given by the Breit-Wigner formula

$$\sigma(E) = a\frac{\Gamma^2}{(E - E_R)^2 + \Gamma^2/4}$$

which for instance gives the shape of single, isolated nuclear resonances at an energy E_R. You can assume $E_R >> \Gamma$. Write a program which generates random numbers in this distribution using the analytical inversion method. Verify the correctness by plotting the distribution and an analytical prediction with the same parameter values on top of each other (use proper normalization). Hand in the code and plot.

2. (6 p) Write a program which generates random numbers distributed as

$$f(t) = \sin^2(t)e^{-t}$$

in the interval $[0, \infty]$ by a hit-and-miss method of your choice. Let the code also report the number of hits and misses. Hand in code, plot, and report of number of hits and misses in a long run.

3. (12 p) Write a program which reads in an arbitrary discrete distribution from a file with data in x_i, p_i format, with the x data evenly distributed, and generates random numbers in this distribution. The p_i data does not need to be normalized. The program should output the random distribution as well as the ratio between the random and original data.

Apply the program to generate 100000 points in the distribution given in the file 'bimodal.dat' on the course web page, and return two plots: the original vs. the random data, and the fraction between the two data sets. Also return the source code.