

Statistical Analysis of Data
Problem sheet #3

Please send by the announced due date to Glen Cowan, Physics Dept., Royal Holloway, University of London, Egham, Surrey, TW20 0EX, or e-mail to g.cowan@rhul.ac.uk.

For these exercises you will need a random number generator to produce random values uniformly distributed between zero and one. Simple FORTRAN and C++ examples are given in the files `random.f` and `random.cc` from alephwww.cern.ch/~cowan/stat/compute.html. These routines are mainly for pedagogical purposes and simple applications. More sophisticated routines such as RANMAR or RANLUX can be found in the CERN Program Library. Alternatively, you may implement the solutions using whatever computer tools you prefer, e.g. ROOT.

Exercise 3.1: Using `random.cc` or another random number generator, write a short program to generate 10000 random values uniformly distributed between zero and one, and display the result as a histogram with 100 bins. Optional: try implementing your own random number generator as described in the lecture.

Exercise 3.2 Suppose the independent random variables r_i are uniformly distributed between zero and one. Write a computer program to make histograms of

- (a) $x = r_1 + r_2 - 1$
- (b) $x = r_1 + r_2 + r_3 + r_4 - 2$
- (c) $x = \sum_{i=1}^{12} r_i - 6$

What are the means and variances of the variables histogrammed in (a)–(c)? Comment on the connection between your histograms and the central limit theorem.

Exercise 3.3: Consider a sawtooth p.d.f.,

$$f(x) = \begin{cases} \frac{2x}{x_{\max}^2} & 0 < x < x_{\max}, \\ 0 & \text{otherwise.} \end{cases} \quad (1)$$

- (a) Use the transformation method to find the function $x(r)$ to generate random numbers according $f(x)$. Implement the method in a short computer program and make a histogram of the results. (Use e.g. $x_{\max} = 1$.)
- (b) Write a program to generate random numbers according to the sawtooth p.d.f. using the acceptance-rejection technique. Plot a histogram of the results.