Homework set #3

1. Simulate a random walk in 1-dimension.
   - **a)** Take a test particle at x=0, t=0. In every time step, the particle has a 50% probability of moving one step to the right or one step to the left (use a random number generator to decide the direction).
   - **b)** Track the particle for 1000 time steps and then store the end position in a histogram.
   - **c)** Repeat for many particles. Produce a histogram using ROOT framework. What distribution do you see in the histogram? (Explain the results)

2. Calculate π using the Monte Carlo Method based on below conditions:
   - **a)** Randomly generate *N* number of events within the range $-1 \le x \le 1$, $-1 \le y \le 1$, $-1 \le z \le 1$.
   - **b)** Compare *n* number of events that satisfy $x^2+y^2+z^2<1$.

3. Implement below steps in a ROOT macro:
   - **a)** Create a 2-dimensional histogram in x, y plane with the range [-5,5] and [-5,5] and 50 bins in x and y axis.
   - **b)** Produce a histogram filled by correlated random numbers, 'a' and 'b'. You need to generate the two random numbers (a, b) in the Gaussian functions (mean=0, sigma=1) in x, y axis respectively.
   - **c)** Then Fill the histogram with x=a and y=0.5*a+b
   - **d)** Plot the histogram using color boxes (COLZ).
   - **e)** Finally, compute the correlation between x and y values using TH1::GetCorrelationFactor.

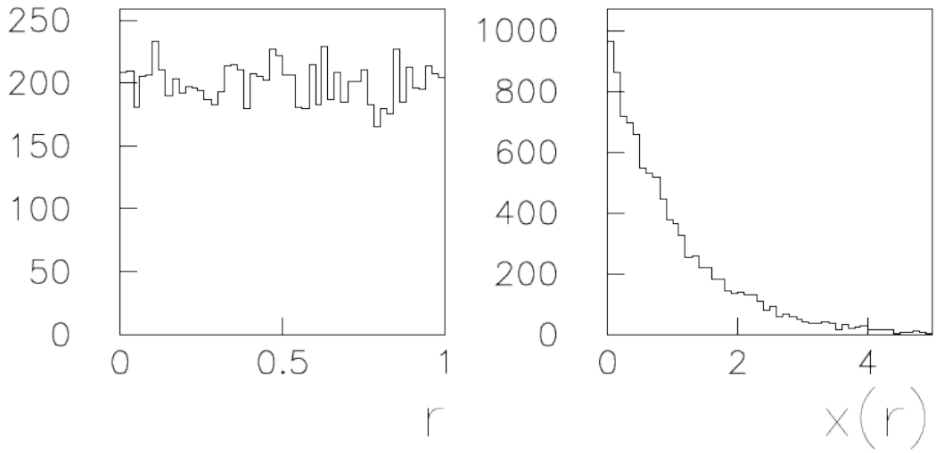
4. Carry out below two steps:
   - **a)** Make a ROOT macro to create a histogram filled with exponential P.D.F. Then fit it and write it in a ROOT file.
   - **b)** Make a macro to read the histogram from above ROOT file and plot it.

5. Follow below steps.
   - **a)** Create a histogram produced by the Gaussian P.D.F.(mean: 5, sigma: 1) in [0,10] with 1000 events and 100 bins.
   - **b)** Create another histogram by uniform distribution in [0,10] with 100 bins and 10000 events.
   - **c)** Add above two histograms into a new one histogram using TH1::Add
   - **d)** Produce another histogram for uniform distribution (200000 events, 100 bins). Normalize it to get a total integral of 10000 using TH1::Scale.
   - **e)** Subtract the above normalized uniform histogram from the combined histogram with the sum of the uniform and the Gaussian histograms.
   - **f)** Plot the above subtracted histogram using the error option. Check whether the error make sense or not. If not, how you can get correct bin errors?

6. Consider random numbers according to:

$$f(x,\lambda) = \begin{cases} \lambda e^{-\lambda x}, & x>0 \\ 0, & x\leq 0 \end{cases}$$

Find x(r) as a function of r in order to have below x(r) distribution from uniform distribution r (0<r<1) using the transformation method.



Develop the ROOT macro to produce above plots for r and x(r) distributions.

This assignment must be submitted to the LMS in a complete report format including source codes and your comments on them. The report has to include the explanation of each problem and result plots. Source codes files are additionally required to be uploaded in the LMS in order to verify your solution.