Homework assignment 7

Giodano, page 188, Question 7.2 (modified).

2. Simulate a random walk in two dimensions allowing the walker to make steps of unit length in random directions; don't restrict the walker to sites on a discrete lattice. Show that the motion is diffusive, that is, $< r^2 > = Dt$. Find the value of D.

7.0.3. Sample code 7.4.3 is for a 1-D random walk. It simulates the spreading of an initial distribution of walkers concentrated in a point initially. At a fixed time t, the density distribution can be described by a Gaussian curve described by

$$y(x) = A \exp\left[-\frac{(x-\mu)^2}{2\sigma^2} \right]; \; A \text{ is the normalisation constant}, \; \sigma \text{ the width of the curve}, \; \mu \text{ the average value},$$

$= L/2$ in our case here. Write a code to show that the width of the distribution varies with time as $\sigma(n) = (2Dn)^{1/2}$, $D = \frac{1}{2}$ for the 1-D walkers. *Hint*: you may use FindFit to fit the data from the density distribution against a Gaussian curve. Essentially, you need to show that the density distribution coincides with the curve $y(n) = \sqrt{n}$ for large n.

3. Download the data file from http://www2.fizik.usm.my/tlyoon/teaching/ZCE111/1112SEM2/assignment/HA7.dat. This is a set of data point $\{x_i\}$. It is known that these data has a Gaussian distribution characterised by the variance σ^2 and are centered around the mean value of $\mu = 0$. In practice you can conveniently use Mathematica command `Histogram` to bin these data points into a histogram of N bins, such as `Histogram[HA7.dat, 30, "ProbabilityDensity"]`. The option `"ProbabilityDensity"` asks the Mathematica to normalise the histogram. The figure below is the resultant histogram. Now, your assignment is to construct the histogram with 30 bins based on HA7.dat by **developing your own algorithm** without using the command `Histogram`. You are NOT supposed to use also the Mathematica commands `BinCounts` or `Sort`. Use your own algorithm.
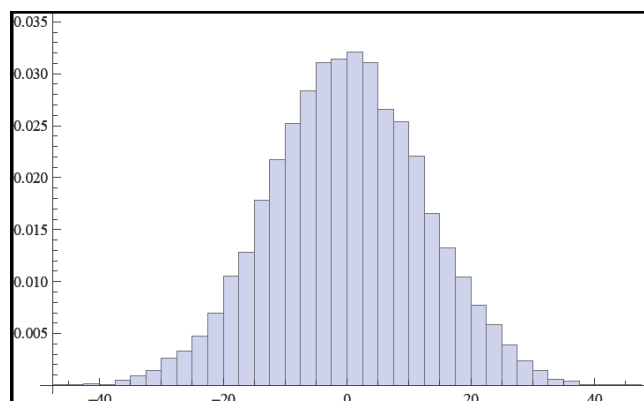
After you have developed you own code to sort these data points into a histogram with 30 bins, provide answers to the following questions:

i)   How many data points are there in HA7.dat? Show how you ask Mathematica to "count" the number of data in HA7.dat.

ii)   What is the value of σ? Explain clearly how you obtain the answer in your code.