Monte Carlo, Exercise Session 4

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March 1, 2017

1 Exercise 1

Files: Ex1.*.

Answer: Figure 1.

```
Exercise 1
N= 10^2
<E> = 0.041826
<Rrms> = 0.035347
N= 10^3
<E> = 0.0400146
<Rrms> = 0.0313272
N= 10^4
<E> = 0.0376474
<Rrms> = 0.0305431
N= 10^5
<E> = 0.0383512
<Rrms> = 0.0310065
N= 10^6
<E> = 0.0388437
<Rrms> = 0.0316816
N= 10^7
<E> = 0.0388288
<Rrms> = 0.031746
N= 10^8
<E> = 0.0387774
<Rrms> = 0.0316724

Process returned 0 (0x0)   execution time : 437.306 s
Press ENTER to continue.
```

Figure 1: Ex1 answer.

The other main question is log- plot, visualized in Figure 2.

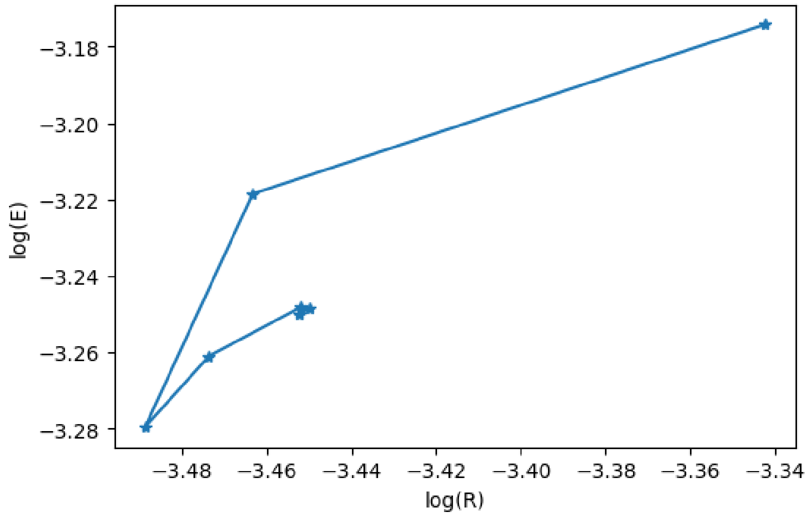

Figure 2: Ex1 log plot.

And point in the upper right corner is obtained at the smallest N=100. (line connects to N=$10^3 \rightarrow 10^4$...) Therefore, the maximal absolute value of log(E) allowed should be 3.29.

Solution details:

1. Algorithm is done basing on page 8 from Lecture notes on MCMC.

2. V is set to 1.

3. Setting the range and $\triangle X_{max}$

First let's take a look at the function without zooming. Figure 3

It can be noticed, that it is pretty flat, so now lets zoom into interesting part, Figure 4.

From Figure 4 it can be seen that setting x_0 to vary from 0 to 0.1, and $\triangle X_{max}$ to 0.05 is enough to generate most values. From lecture notes, it is told that x_0 doesn't really matter, on a long run, all the generated values will be distribution based distributed.

After generating random values and plotting them, the distribution obtained is presented in Figure 5.

The shape looks pretty much according to the theory presented in earlier figures.

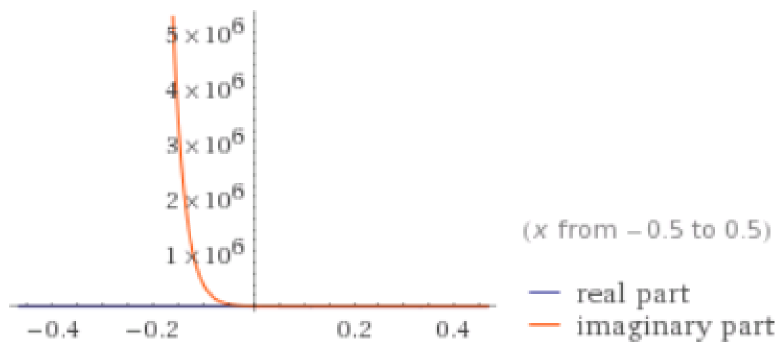

Figure 3: Ex1, view on the function with 0.5. Function plotted with wolframalpha.

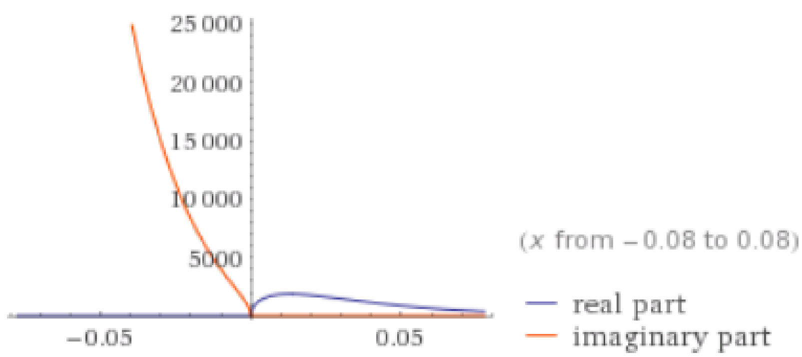

Figure 4: Ex1, autozoom into real part. Function plotted with wolframalpha.

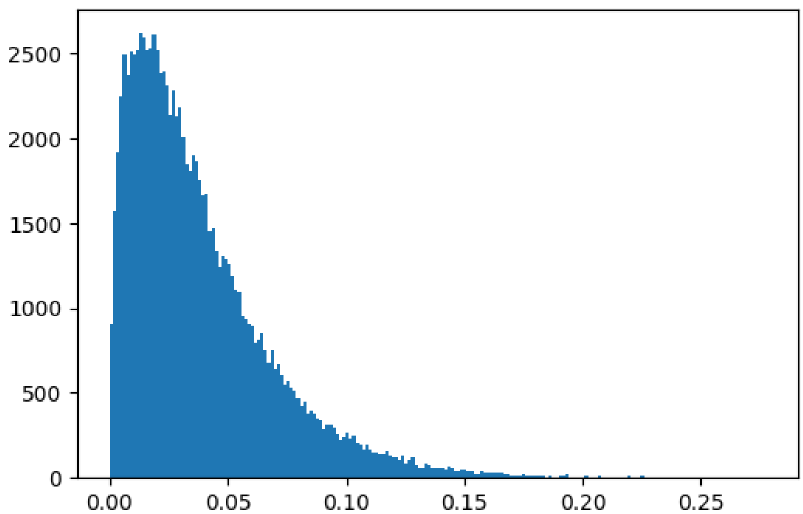

Figure 5: Ex1, histogram of random values provided by the code.

2 Exercise 2

This exercise requires a lot of plotting, so will be done in Python using the Mersenne twister. File: Ex2.py Images are automatically generated into a subdirectory data, and some of them are duplicated into tex folder.

Synthetic data:

Using the lecture notes, the synthetic data, two of which are visualized in Figures 6 and 7, is generated.

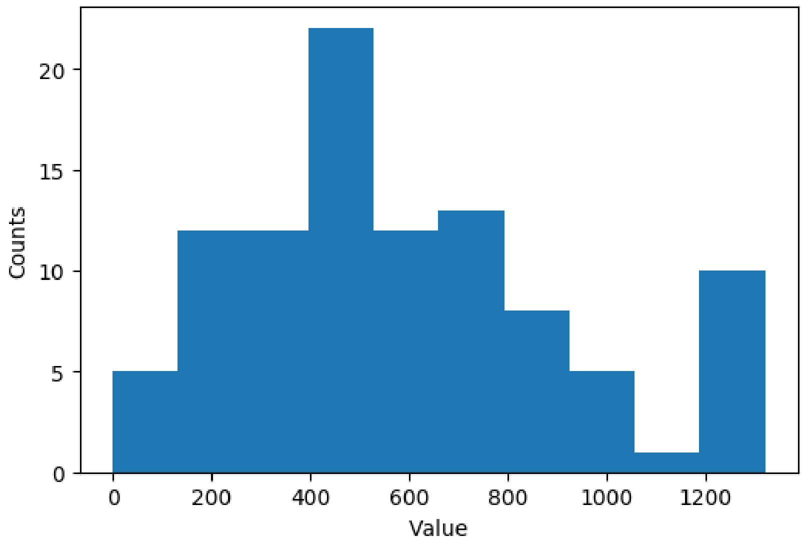

Figure 6: Ex2, an example of generated synthetic data.

The generated synthetic data of 100, is has some sort of similarity, but they are still different.

For an example data lets calculate the CDF, and get 1 σ uncertainty limit. Figure 8.

The values of the edges are presented in Figure 9. It can be noticed that they are not symmetric and variance is large.

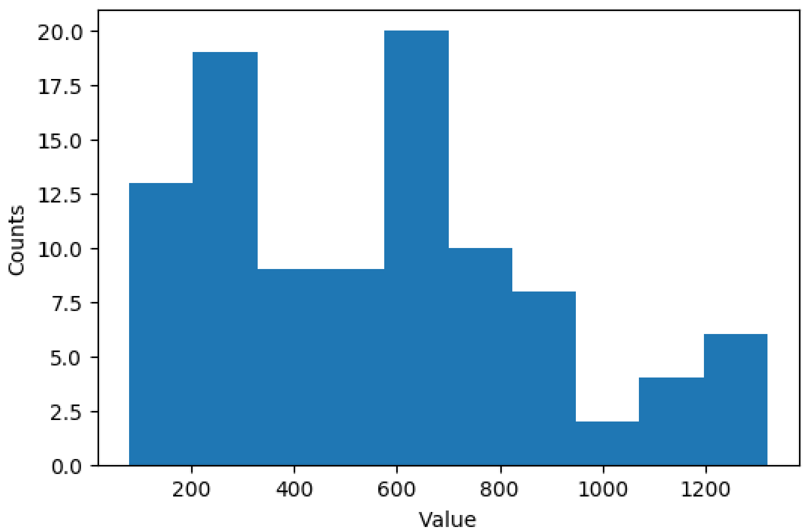

Figure 7: Ex2, an example of generated synthetic data.

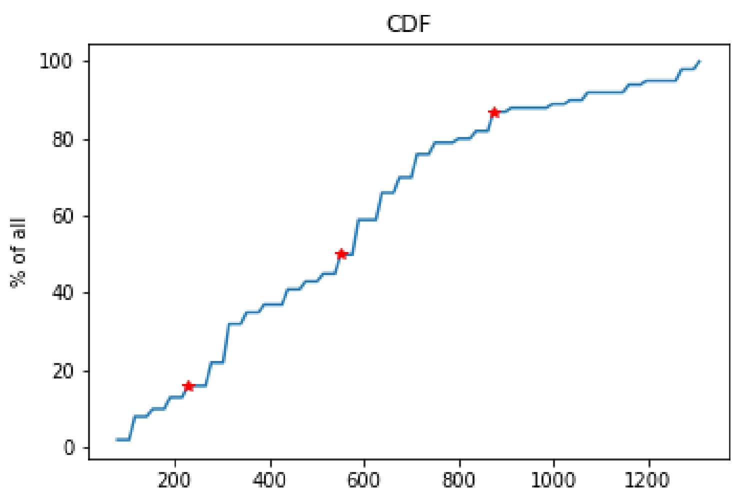

Figure 8: Ex2, cdf of a single set with red starts marking 1σ limits. x-axis is the data values.

```
514.8 (+ 277.2 , -  237.6 )
475.2 (+ 356.4 , -  198.0 )
514.8 (+ 396.0 , -  237.6 )
514.8 (+ 475.2 , -  237.6 )
551.2 (+ 322.4 , -  228.8 )
```

Figure 9: Ex2, single measurements cdf 1σ limits.