Figure 1: Enter Caption

Assignment 2

Advanced Methods in Applied statistics

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Date of Submisson:	28-02-2024

1

1.1

A, B

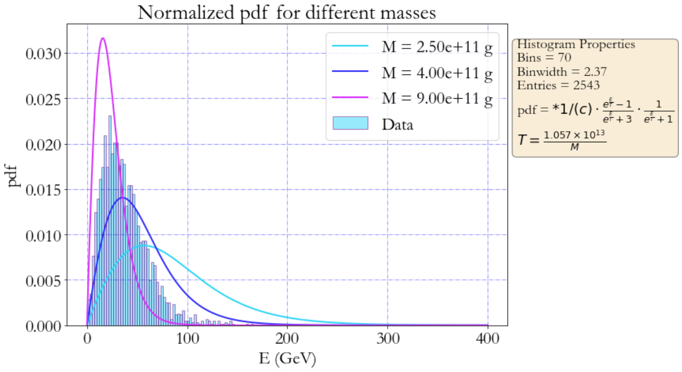

Figure 2: Histogrammed data, with normalized pdf function for different masses

In general, a higher mass looks to lower the peak of the PDF and to flatten the PDF. with a mass of $2.5 * 10^{11}g$. the mass looks a little too small as the peak is not high enough and the data is shifted slightly to higher energies. for $4 * 10^{11}g$. the data looks shifted right compared to the PDF and the peak is not high enough. A guess would be that the true value would at $3.5 * 10^{11}g$

1.2

First, i made a raster scan in the range of masses $(2.5 : 4) * 10^{11}g$. But the raster scan seemed to be increasing a higher values than $4 * 10^{11}g$ and I chose the range up to $10^{12}g$, which showed a clear maximum. the estimate Normalized PDF on top of a normalized histogram of the data table of ln

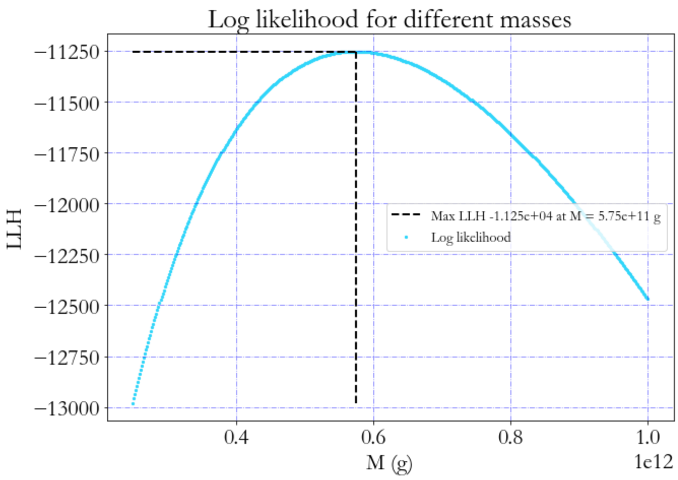

Figure 3: Rasterscan of mass of a black whole and log likelyhood

likelyhood for different masses

1.3

I used minuit to find the mass $5.71 * 10^{11}g$. The two results are slightly different. I'm not sure exactly how Minuit fits the function, but if it uses the likelihood method, it surely has a higher resolution. the distance between the mass data points was $1.5 * 10^9 g$ which is a natural limit to the precision of the calculation of of the mass. Further, it might want to minimize using other fitting tools as well.

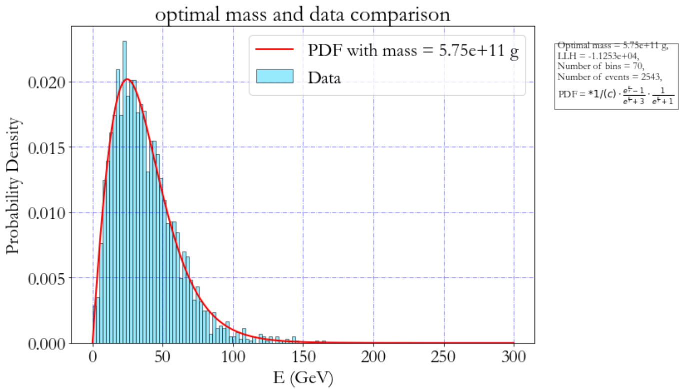

Figure 4: Normalized binned data with PDF of mass found with raster scan

Mass (10^{11} g)	LLH
2.5	-12979
4.0	-11638
5.75	-11253
9.0	-12025

Table 1: LLH values for different masses

the error on the parameter is found by finding the masses corresponding max(lnlikely)-0.5 on both sides of the likelihood as the distribution is slightly asymmetric. due to discretization of the same upper uncertainty and lower bound uncertainty. $\sigma_{upper} = \sigma_{lower} = 7.5 * 10^9 g$. to improve the precision one would have to lower the distance between the mass data point. This corresponds to that the mass found by the log-likelihood method is within one sigma as that found by the minimizer and the two agree.

2

2.1

Bellow the normalized posterior, likelihood and prior can be seen. The posterior has a maximum at x = 0.5 and y=0.68

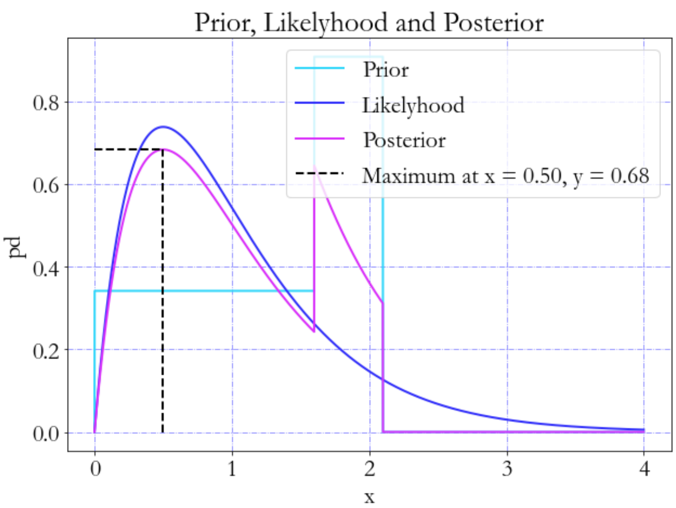

Figure 5: Enter Caption

3

3.1

bellow a scatter plot of the crab's movement can be seen.

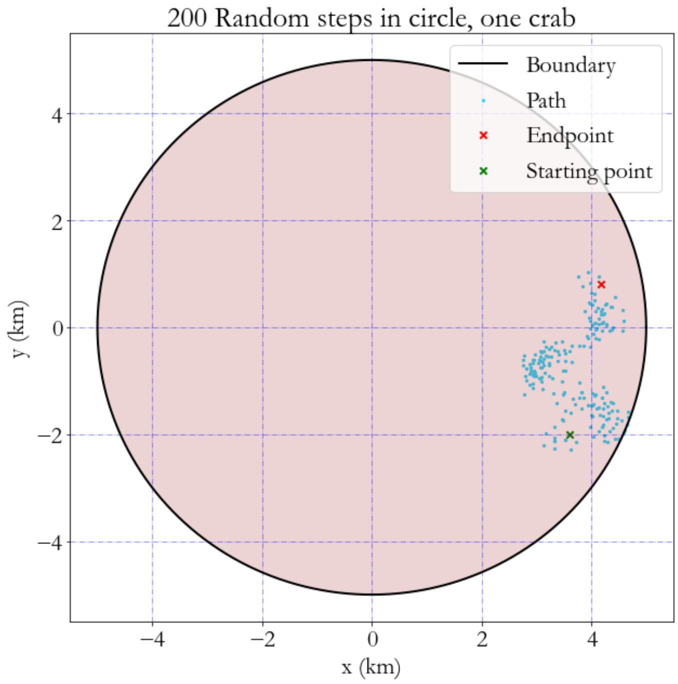

Figure 6: crab traveling in a random direction for an increment of 0.2 km with the edge as a boundary

In the figure below a zoomed-in version of a another random walk, where it's possible to that the crab can spend an extended period of time a the boundary of the circle.

3.2

Bellow shows a histogram of how man crabs traveled a certain distance before reaching the edge

3.3

After 500 pseudo-experiments of how many crabs alive after 200 days. The most likely number of crabs alive after 200 days is 13 crabs. Sometimes it should be noted that running the psuedo experiment again and again sometimes shows 12 crabs alive. The most likely mass of the largest crab live is 3 kg after 200 days with 500 experiments.

3.4

Now the distribution of days it takes before there are 10 crabs alive are shown in the plot below. The width of each bin is 20 days. To find the most likely number of days I find the highest bin width and take the middle of the center. This is an unprecise practice as the highest bin center depends on the bin width, plus it's not easy to see that the most like days is not due to statistical fluctuations. Another way to do this is to find the mean, but this is not necessarily the most likely bin. At last to find the uncertainty i count up the bins on each side of the maximum until i reach the most likely days is 279 days. $\sigma_{lower} = 10 days$

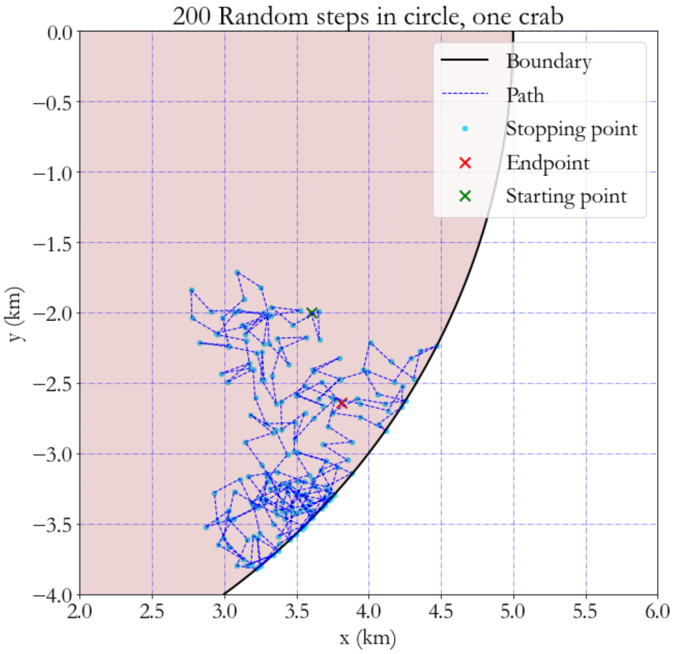

Figure 7: random walk of crab. crab stuck at the edge

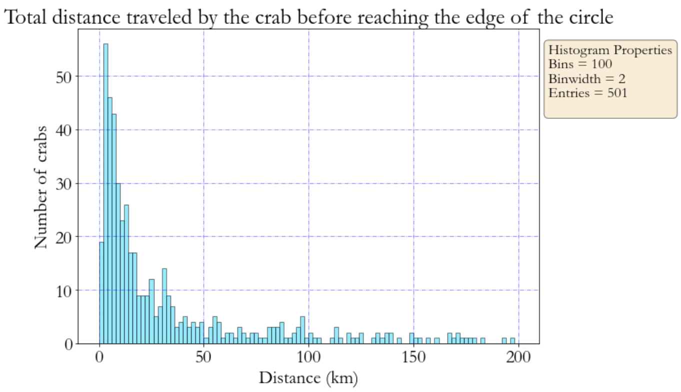

Figure 8: 500 pseudo experiment of crab traveling in a random direction of 0.2 km

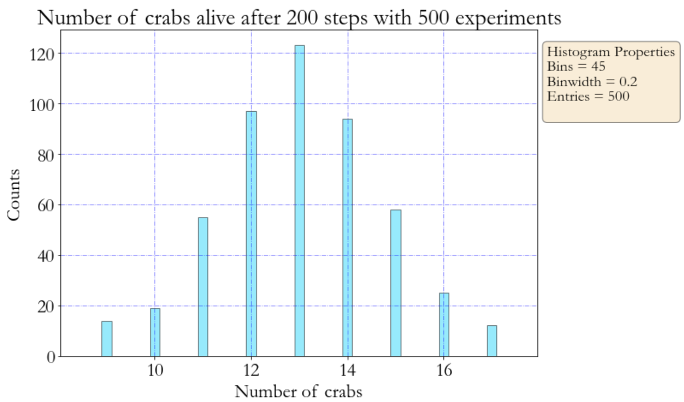

Figure 9: 500 pseudo experiment of how many crabs are alive after 200 days

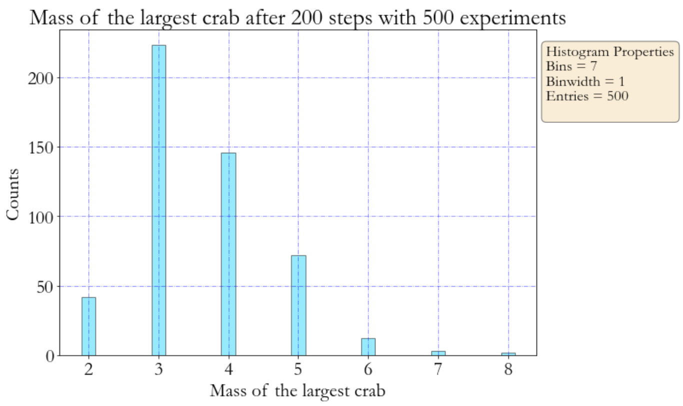

Figure 10

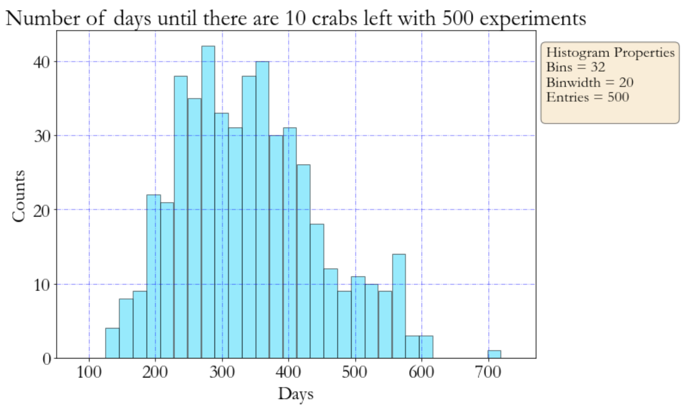

Figure 11: Enter Caption