

Caitlyn Jones

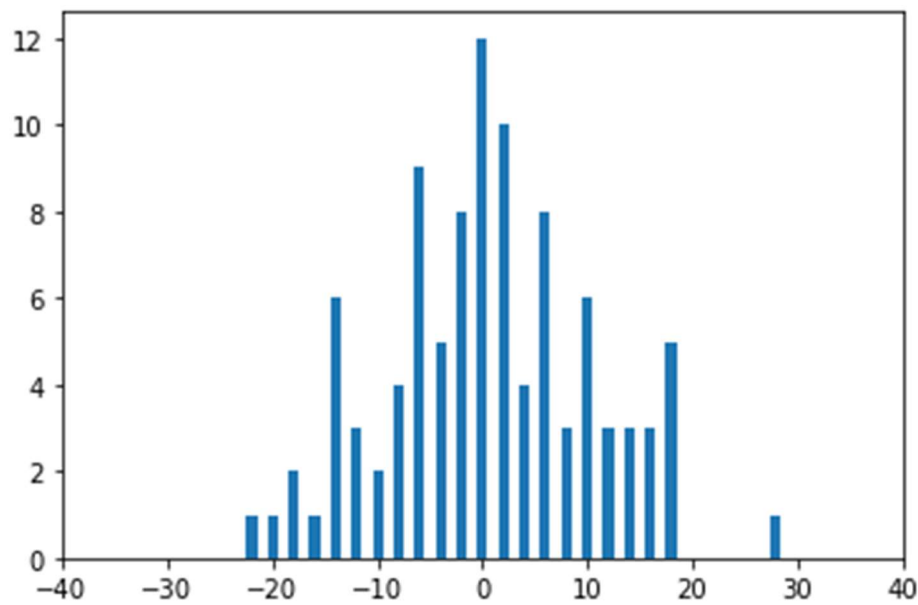
Prof. Yangyang Wang

MATH 40A: Intro to Applied Math

20 December 2024

Lab 5

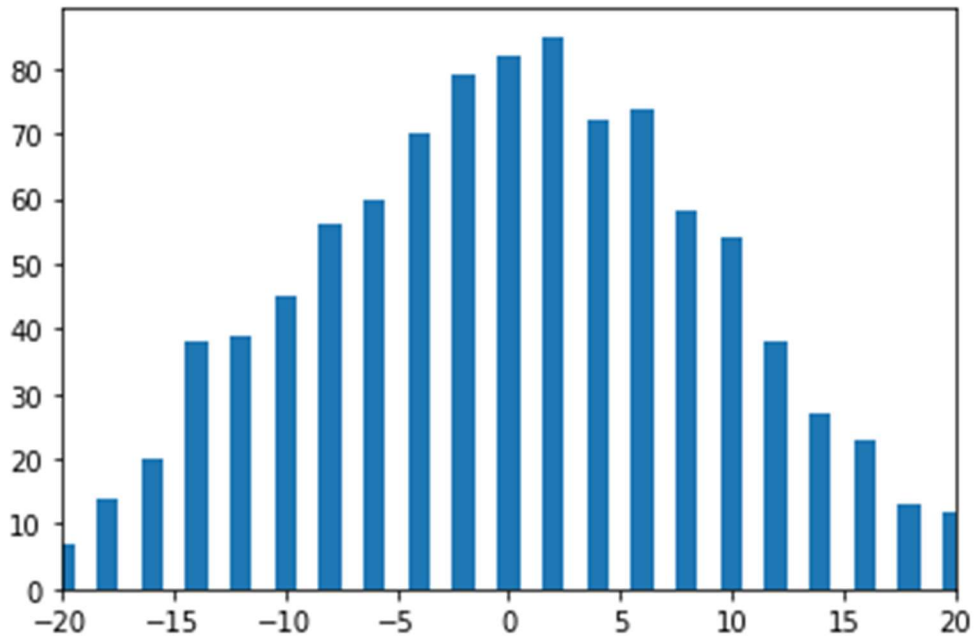
- Below is the original histogram, based off the limits given in the code (using `walker_hist(100)` for more accurate comparisons).



When changing the number of walkers to 1000 and the limits to be 20 instead of 10, we get the following histogram.

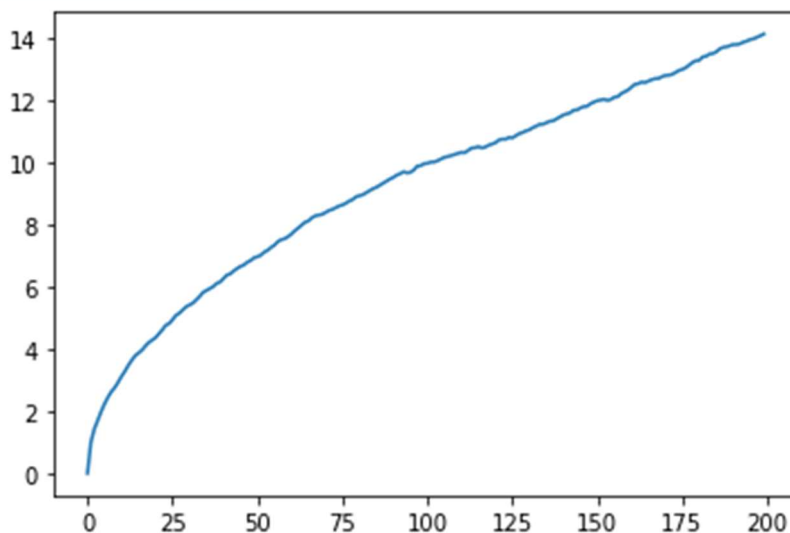
```
nwalkers = 1000
```

```
plt.xlim([-nmax/20, nmax/20])
```



Compared to the original one, we can see that by changing the limits and number of walkers for the histograms, we start to get a zoomed in look at the data. In the original one, we get a general view of the data, but in the changed one, we can see denser and more precise data given the change in limits. Below is the graph displaying the width of the distribution over time.

```
plt.figure()
plt.plot(widthx)
plt.show()
```



As you can see, the width increases steadily over time.

2. First, I made a loglog plot of $\sigma(t)$ and verified that the slope is $\frac{1}{2}$

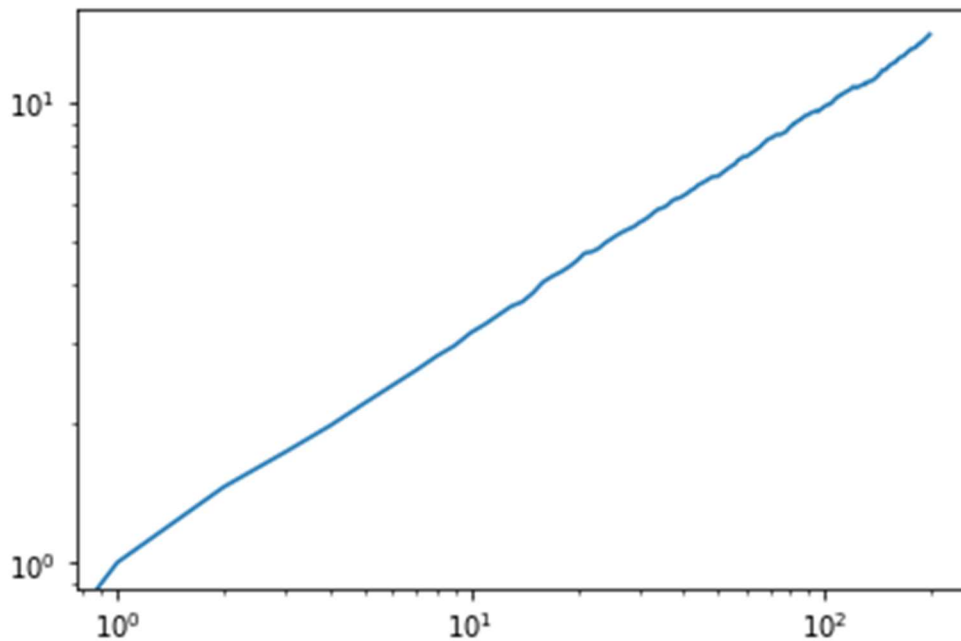
```
plt.figure()
plt.loglog(widthx)
#plt.plot(widthx)
plt.show()

log_t = np.log(np.arange(1,tmax))
log_sigma = np.log(widthx[1:])

slope,intercept = np.polyfit(log_t, log_sigma,1)
print("Slope = ", slope)
```

```
Slope = 0.48928747251282473
```

Here, we can round the slope up to 0.5, verifying that it is equal to $\frac{1}{2}$.



Then, I verified that the diffusion constant was correct. Because we know that

$\sigma(t) = \sqrt{2Dt}$, we can rewrite this as $D = \frac{\sigma(t)^2}{2t}$. Using this equation, we can verify that

$D = \frac{1}{2}$.

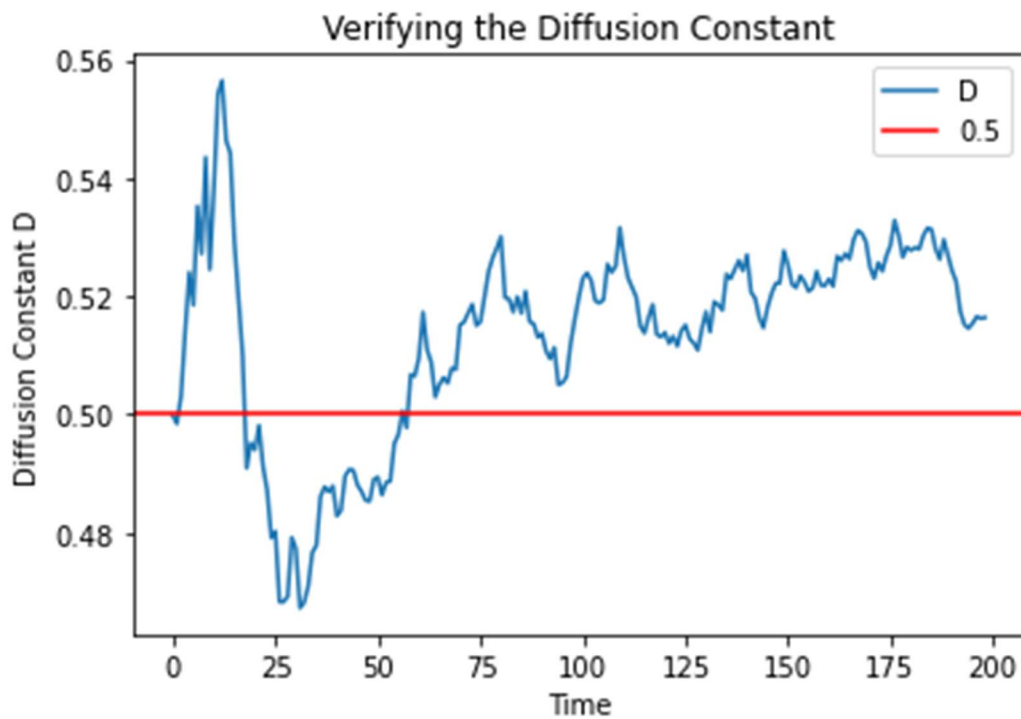
```

time = np.arange(1,tmax)
sigma_t = np.array(widthx[1:])

diffusion_constant = (sigma_t**2)/ (2*time)

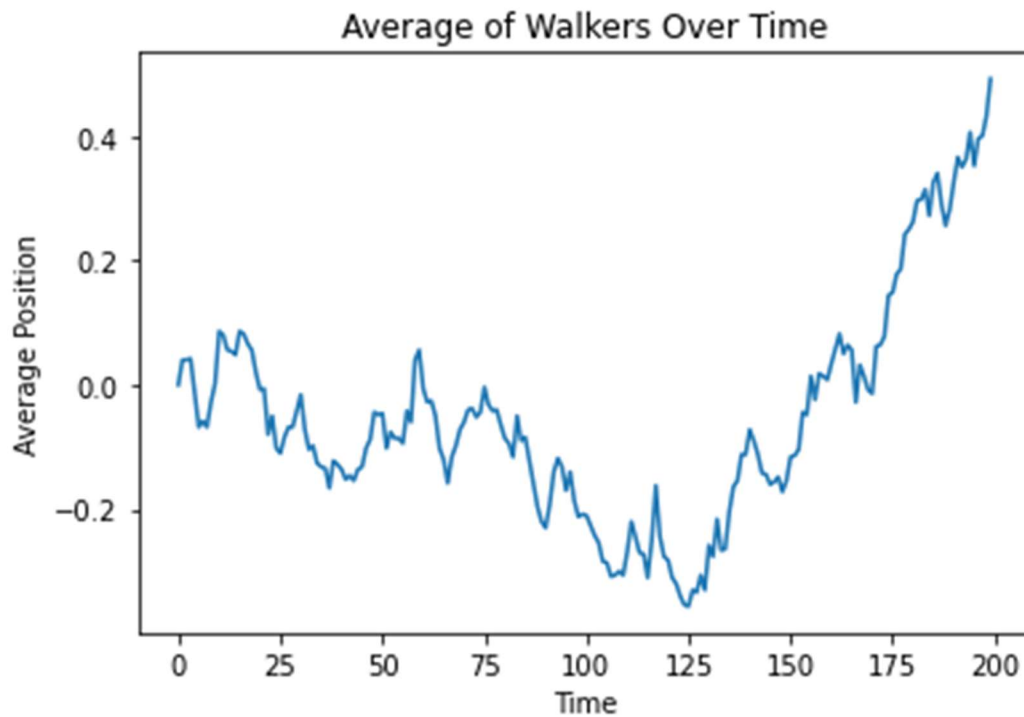
plt.figure()
#plt.loglog(widthx)
plt.plot(diffusion_constant, label = "D")
plt.axhline(0.5, color = "r", label = "0.5")
plt.legend()
plt.title("Verifying the Diffusion Constant")
plt.xlabel("Time")
plt.ylabel("Diffusion Constant D")
#plt.plot(widthx)
plt.show()

```



As you can see in the image above, the diffusion constant stabilizes around 0.5 as time increases. Though some values are deviating by values above or below the midline, the numbers themselves will round up or down to 0.5, verifying that the diffusion constant is correct. Lastly, I need to plot the average of the walkers over time.

```
plt.figure()
#plt.loglog(widthx)
plt.plot(meanx)
plt.title("Average of Walkers Over Time")
plt.axhline(0.5, color = "r", label = "0.5")
plt.xlabel("Time")
plt.ylabel("Average Position")
#plt.plot(widthx)
plt.show()
```



As you can see in the graph, the mean oscillates to 0, which represents that there is no bias in the random walks.

Project Proposal:

Group Members are Rachel Weiss and Caitlyn Jones. The paper that we will be doing for our project is *A Contribution to the Mathematical Theory of Epidemics*. This paper talks about the concepts of the SIR model, which describes how infections spread based on three categories of a population: susceptible, infected, and recovered. The question our project will attempt to answer: to what extent does the basic reproduction number influence the threshold condition for an epidemic to occur, and how can interventions alter the course of the outbreak? To answer this question, we could first simulate the model for different values of R_0 , which will help us determine a critical threshold. We could also explore how the various intervention strategies change the peak infection rate and the duration of the epidemic.