For my project I have used LIGO data that was taken from the third confident events from the O3b observing run for LIGO and Virgo, as described in the GWTC-3 catalog paper. These candidate events have a probability of astrophysical origin (probability of being a gravitational-wave signal versus being instrumental noise) assuming a compact binary (such as a binary black hole, neutron star-black hole binary or binary neutron star) coalescence source. I decided to show if there was any correlation between the network matched filter SNR (signal to noise ratio) and the total mass of the binary source, as well as looking at the relationship between the luminosity and the total mass of the binary sources.

I started by downloading a CSV file from the website provided in the comments of the code. I used numpy, pandas, matplotlib, and scipy in this project to accurately show the relationships of the data. I started by extracting the data using pandas and printing the data out. I then went a little further and took out the data that I did not plan on using to clean up these tables and only show the points that I was intending to use. I then started with the total mass of the binary source and the network matched filter SNR and used matplotlib and pandas to graph a scatter plot of the data. I just showed a linear fit to get a line of best fit for this data and then showed the slope and intercept. The slope was slightly negative showing that potentially the more massive the binary source the less SNR you will have in your measurements. To find the error in the slope I used a covariance matrix that I then took the square root of to get an error which was fairly large..

I then moved on to plotting the relationship between the total mass source and the luminosity distance of the binary source. This scatter plot showed a much clearer linear relationship between the total mass source and the luminosity distance. I went on to fit a linear fit

to this scatter plot and printed out the slope of this linear fit. Similar to above I took the square root of the covariance matrix to find the error of this slope which was fairly small.

In coding and seeing these relationships I feel that I can say that there is little relationship between the network matched filter SNR and the total mass source. This could be because the SNR is something that depends more on the instrumentation used to measure the gravitational wave events, as well as interference from other events. The relationship between the total mass source and the luminosity distance was much more conclusive on the other hand. It seemed to be a clear linear fit showing that as the mass increased the luminosity distance of the gravitational waves increased linearly as well. Our error was not very large in comparison to our slope showing that we had little error in these measurements and showing a linear model is a good representation of the data. I found that while there seemed to be no real relation to the SNR and the total mass of the binary source there seemed to be a strong linear relationship between the total mass of the binary source and the luminosity distance.