Project 4 PR Input: Distinguishing AGN populations based on Redshift

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April 2023

1 Introduction

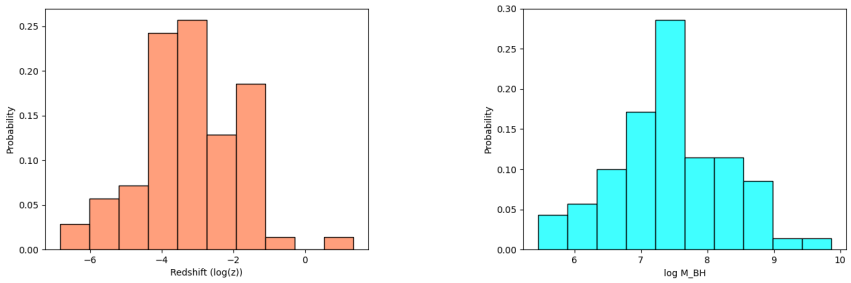
In the center of most massive galaxies, there exists a supermassive black hole. If the black hole is accreting matter, we call this an active galactic nucleus (AGN). What we would like to do is obtain a maximum estimate whether an AGN is closer (low redshift) or farther (high redshift) based on their masses, and the likelihood that the log(mass) is above a certain threshold given a particular redshift.

Exploratory Data Analysis

We use a dataset from *AGN Black Hole Mass Database* based on work by Katz and Bentz [1]. This database contains the masses, positions, and redshifts of approximately 90 AGNs whose masses are obtained using reverberation mapping. Reverberation mapping is a technique to estimate masses based on the velocity of the matter around the central black hole and a parameter f. It follows the relation

$$GM_{BH} = fR_{BLR}(\Delta\ V)^2$$

where M_{BH} is the mass of the central black hole, R_{BLR} is the radius of the broad line region, $\Delta\ V$ is the RMS velocity of the gas near the broad line emission region of the black hole. Ultimately, w will perform this for different values of the f parameter.

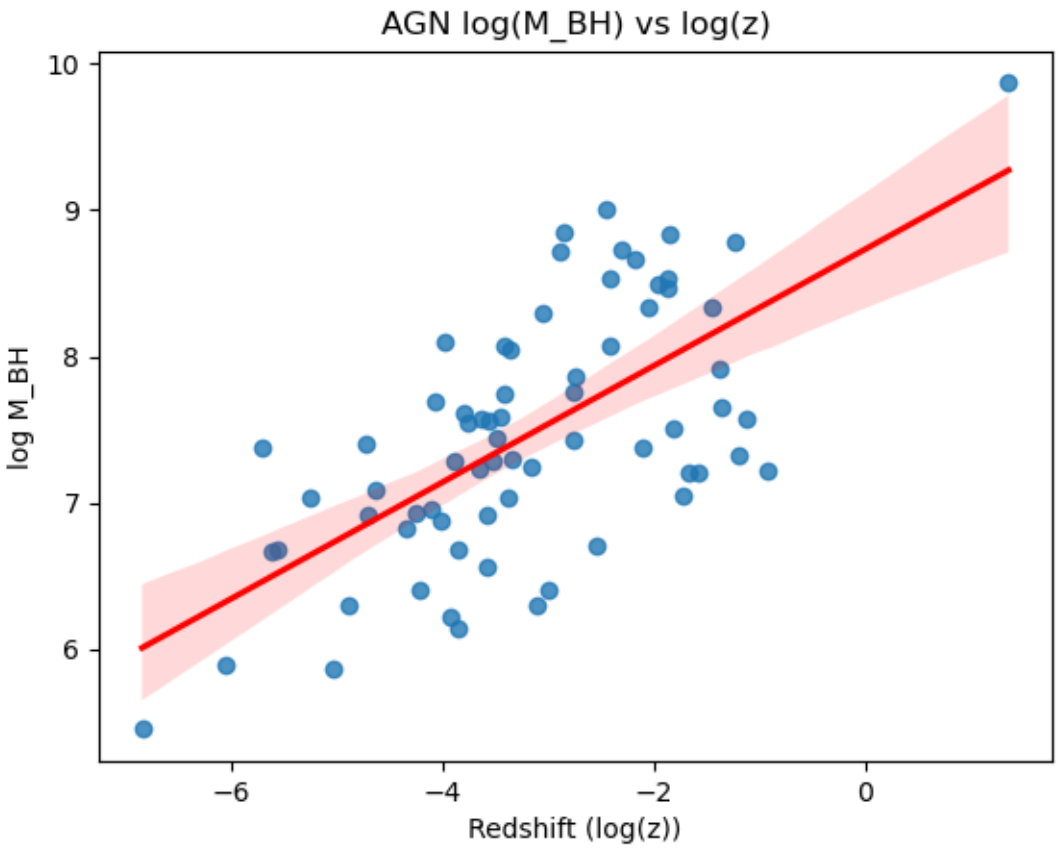


(a) Log Z

(b) Log of black hole mass

Figure 1: Log Z and Log mass histograms

Figure 1 shows histograms of each AGN by the log of redshift z and log of mass. We use log-log plots since there is a high dynamic range of the data. Prima facie, both seem to follow a normal distribution. Furthermore, Figure 2 plots the log mass vs log redshift, and fitted to a regression line. It does appear that since the trend is approximately linear, we will assume the normal distribution in our modelling.



We can build a likelihood function by declaring x_i as the log-mass of the AGN, P_A is the probability that $log\ z > -4$, and $P_B = 1 - P(A)$ The log-likelihood ration therefore becomes

$$\sum_i \log\left(\frac{P(X_i|P_A)}{P(X_i|P_B)}\right)$$

Our probability function in both cases will follow the normal distribution

$$X \sim \mathcal{N}(\mu, \sigma) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

References

[1] Misty C. Bentz and Sarah Katz. The agn black hole mass database. *Publications of the Astronomical Society of the Pacific*, 127(947):67, jan 2015.