



# Open Clusters: Distance, Age and Membership Classification



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## INTRODUCTION

Open clusters are stars clusters made of up a few thousand stars formed from same giant molecular cloud and have roughly same age. [1] Our objectives are to determine the age and distance of an open cluster (NGC 129), as well as the stars that are members of the clusters based on their characteristics (NGC 6633), which are available in GAIA databases. The importance of our research is to provide up-to-date information about open clusters, which helps with further study on stellar evolution, stellar interactions and dynamical evolution in gravitationally bound systems. Through characterization we can determine which stars are members of an open cluster and better understand images of such clusters.

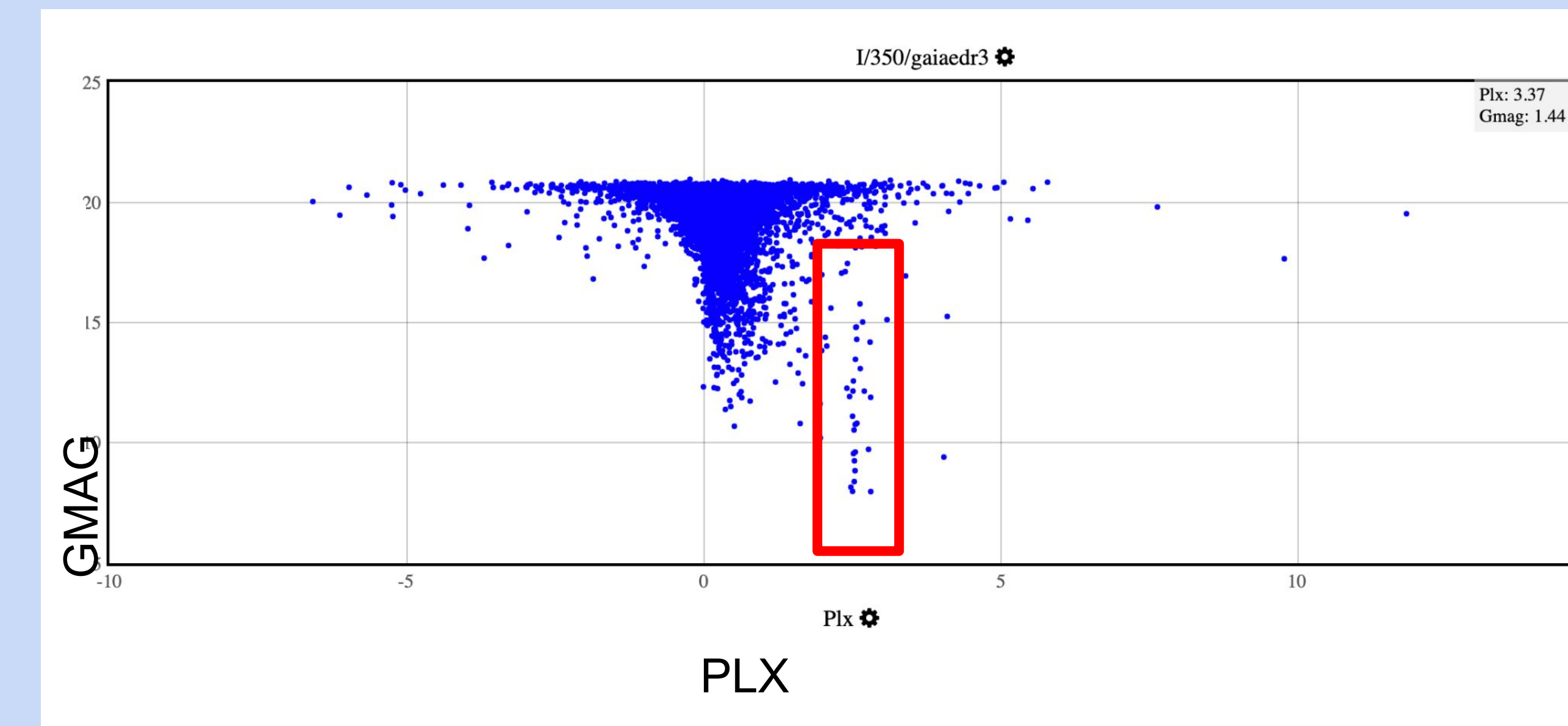


**NGC 129 (Dara)**  
Observed using PlaneWave Telescope at Whitin Observatory on Oct. 6th, 2021 10-11PM



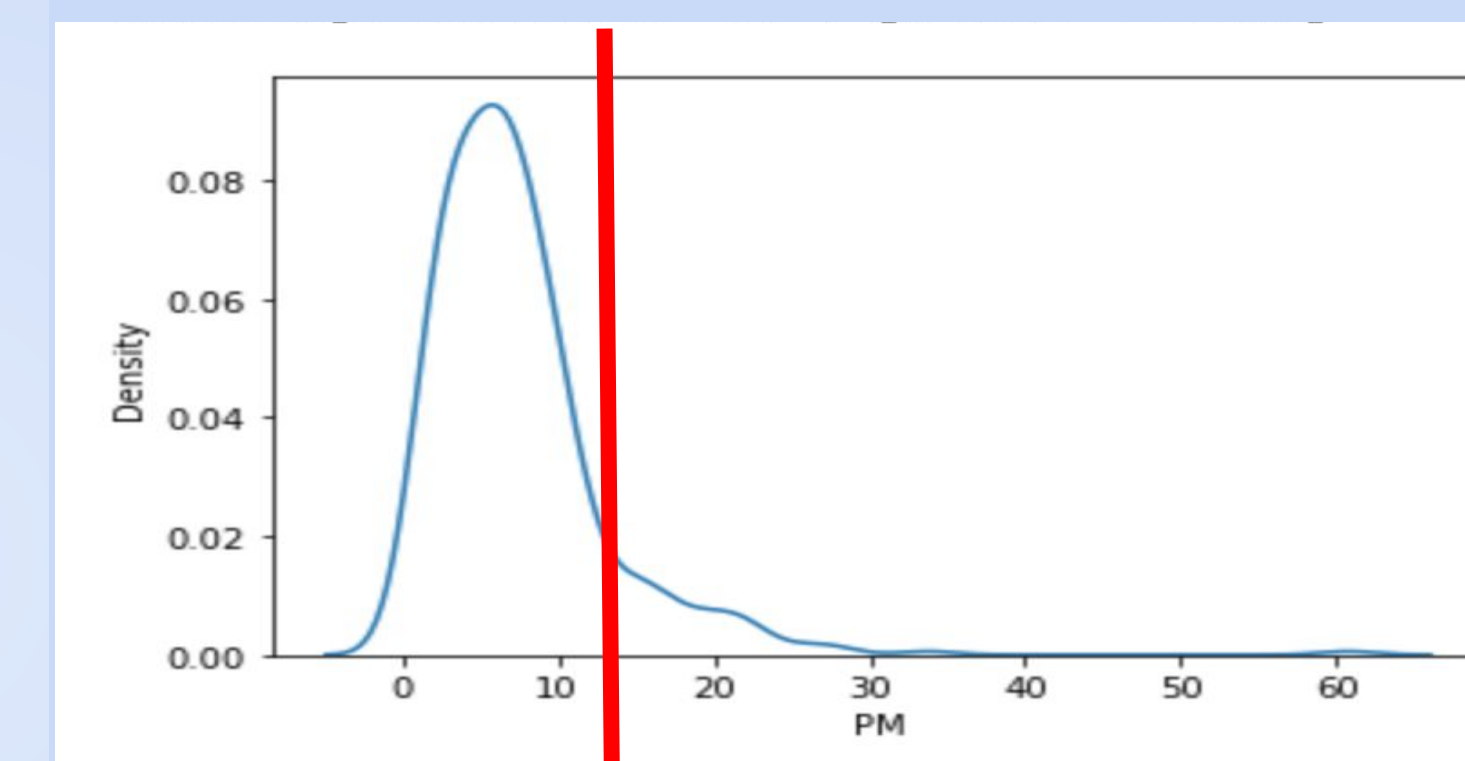
**NGC 6633 (Zeynep)**  
Observed using PlaneWave Telescope at Whitin Observatory on Oct. 6th, 2021 7:30-8:30 PM

## For NGC 6633

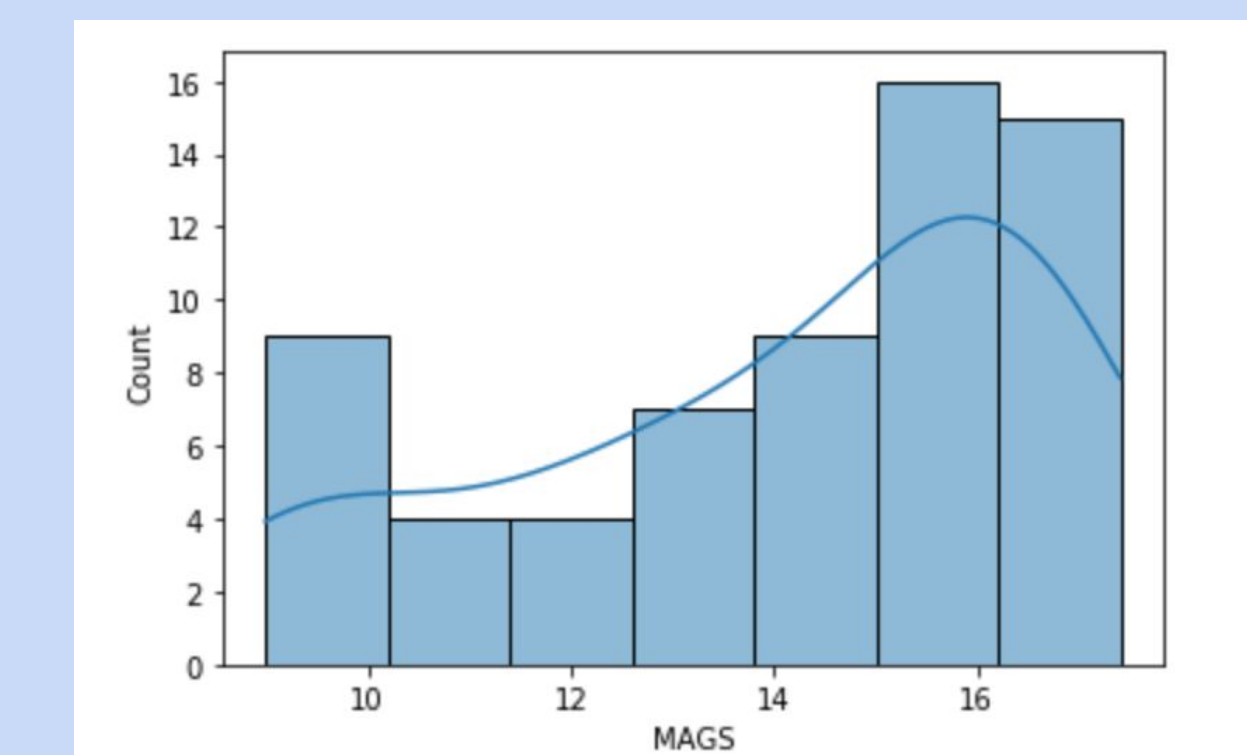


**Objective:** combine data science, data sets, statistical analysis with astronomy. Determining star membership based on 3 characteristics. Starting membership on database: More than 6500 members

**Step 1:** Making parallax cuts based on the GAIA dr3 dataset and using statistical analysis, clear Gaussian cut. Calculated parallax: 2.74725274725 milliarcseconds\ Final applied parallax cuts: 1.4 and 3.1 350 members.



**Step 2:** Making proper motion cuts. Right skewed distribution. Final cut made at 15 PM. value. Cuts match 350 members remain.

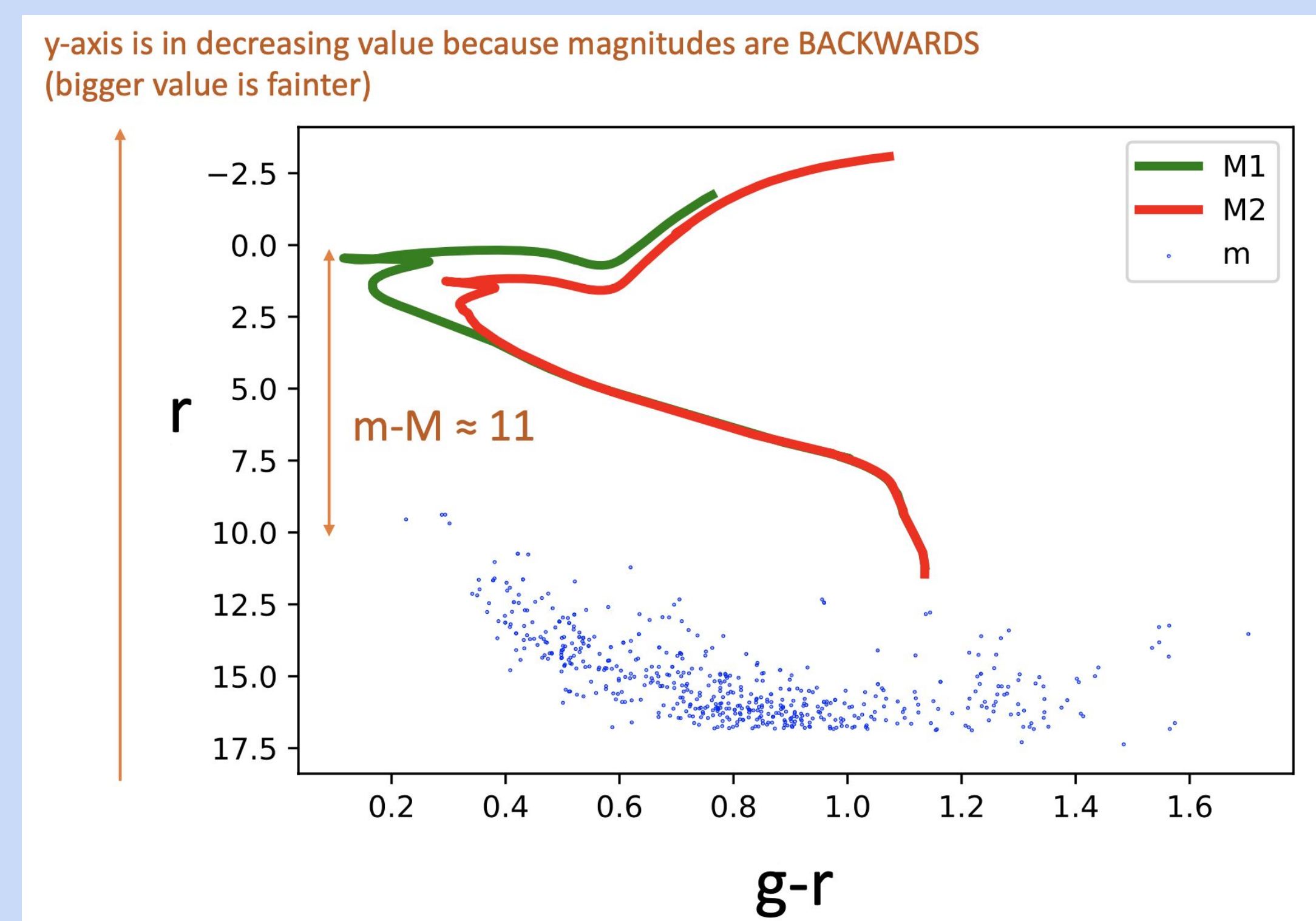


**Step 3:** Making magnitude cuts using photometry. Based on the statistical trends & correspondence to the image itself cut off magnitude set as 17.8

## For NGC 129

To determine the distance we use:  $m-M = 5\log_{10} d_{pc} - 5$

- **m** is apparent magnitude from color-magnitude diagram through doing photometry using AstrolmageJ
- **M** is absolute magnitude from isochrones (Dartmouth database [2])

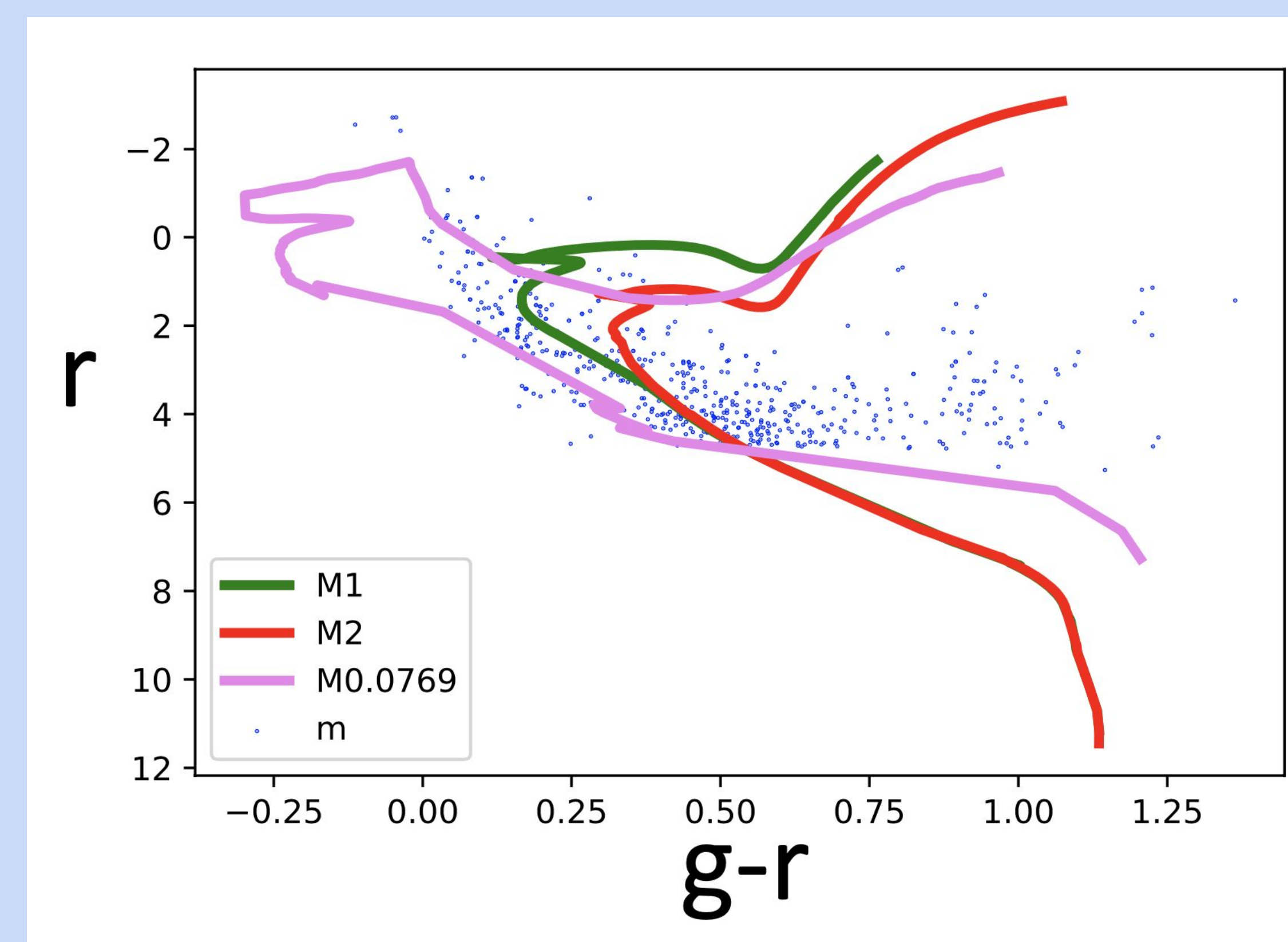


Align apparent magnitude  $m$  with absolute magnitude  $M$  (1 Gyr [M1] and 2 Gyr [M2]),  $m-M \approx 11$

Thus  $d_{pc} = 103.2 = 1584.89$ , which is very close to catalogued value on WEBDA (1625 pc). [3]

## Conclusion for NGC 129

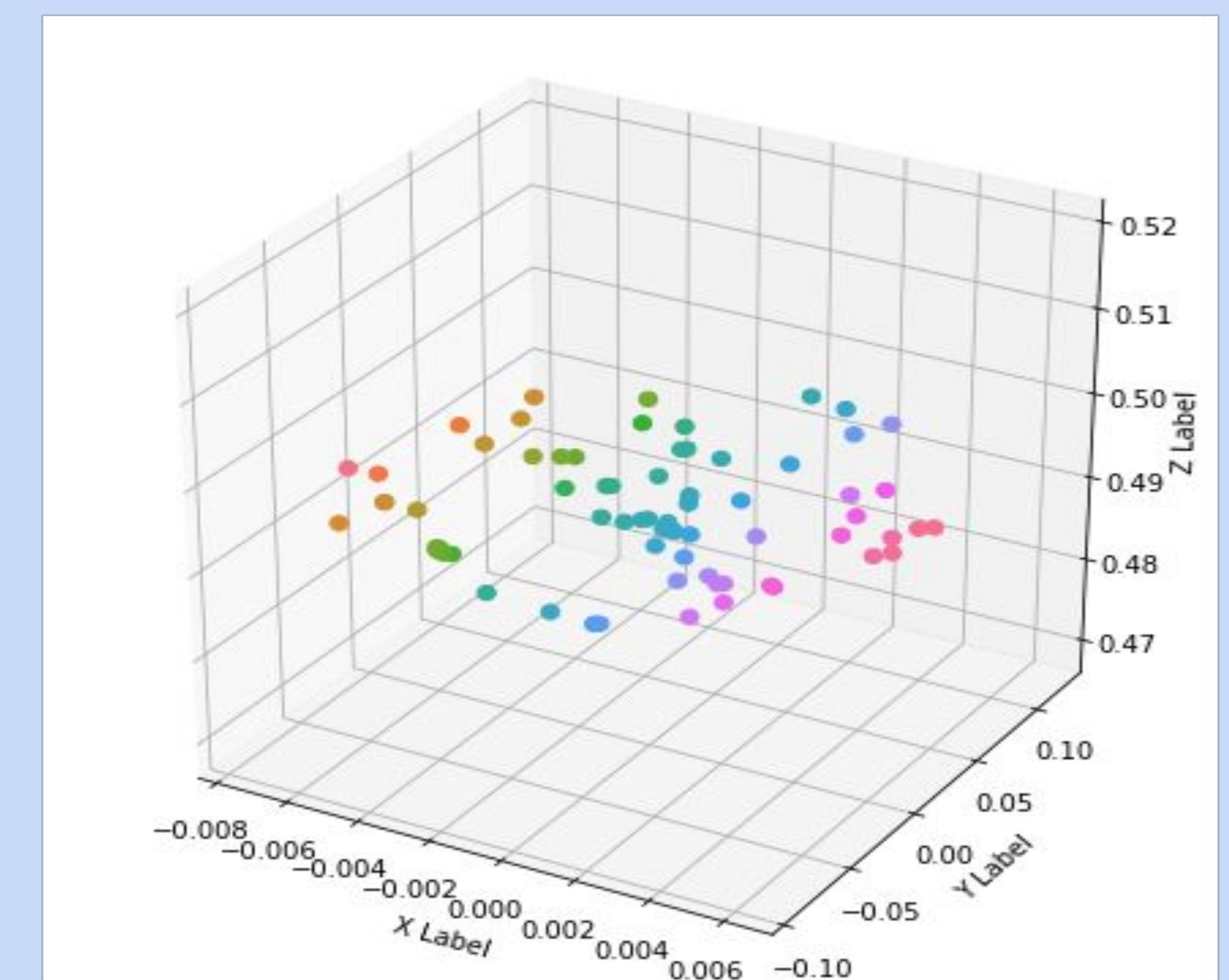
Distance of NGC 129 is around 1600 parsec, which matches current catalogue from WEBDA. Age of NGC 129 is <1 Gyr, the exact value 0.0769 Gyr [M0.0769] matches in the main sequence from the plot. In the future, more accuracy can be given to the calculation.



Correct for reddening: 0.33896 (horizontal)  
Adjust  $r$  values: -2.1 (vertical)  
Plot age 0.0769 Gyr (from WEBDA: log age 7.886) [3]

## Conclusion for NGC 6633

Cuts made using parallax, proper motion and magnitudes reveal that in an area of 3.5' there are 70 stars that are definitely a member of the open cluster NGC 6633.



3-D graph above displays the 70 members where the X-axis is the Right Ascension (RA) corrected for the center, the Y-axis is the Declination (DEC) corrected for the center and Z-axis is the average distance from the center.

**Acknowledgements & Resources** Special thanks to Professor Kim McLeod for her guidance and support. Python packages astropy, numpy, matplotlib were used to perform some of the data reduction and analysis in this project.  
[1] Frommert, Hartmut; Kronberg, Christine (August 27, 2007). "Open Star Clusters". *SEDS*. University of Arizona, Lunar and Planetary Lab.  
[2] "Isochrone and LF Generator." *Dartmouth Stellar Evolution Database*, [http://stellar.dartmouth.edu/models/isolf\\_new.html](http://stellar.dartmouth.edu/models/isolf_new.html).  
[3] "WEBDA Page for Open Cluster NGC 129." *WEBDA*, [https://webda.physics.muni.cz/cgi-bin/ocl\\_page.cgi?cluster=NGC129](https://webda.physics.muni.cz/cgi-bin/ocl_page.cgi?cluster=NGC129).