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ANALYSIS OF COMOVING STELLAR STREAMS USING TOPCAT AND MACHINE LEARNING WITH GAIA DR3

Abstract

European Space Agency released the GAIA Data Release 3 (DR3) dataset in June, 2022. The objective of the GAIA telescope is to create the largest and most precise three-dimensional map of the Milky Way Galaxy by surveying as many stars as possible. DR3 is currently the most accurate and up to date catalogue of stars in our galaxy and contains approximately 1.8 billion candidates. This research project introduces Topcat software, an astrometry and visualization tool for manipulating tabular datasets and machine learning techniques to make an analysis of the candidates obtained by cross matching Cantat-Gaudin 2020 catalogue of open clusters with the GAIA DR3 dataset, existing within the solar neighborhood. The project aims to introduce the software and produce an updated cluster catalogue with lower uncertainties.

Open clusters are stellar groups having hundreds to thousands of stars. The members within such clusters have similar characteristics such as age, metallicity and chemical composition and it is comparatively easy to determine their physical characteristics than isolated stars. Such clusters contain information about the stellar evolution and can also reveal crucial information about the evolution of the Milky Way galaxy and are also considered key objects for dark matter research. Correct measurements and reduced uncertainty in the data are important before using it for research. This project uses Topcat and discusses methodology to source different sets of data from different sources and how to perform analysis on astrometric data. Analysis of the Cantat-Gaudin 2020 open cluster catalogue is done with respect to DR3 to find possible outliers from each cluster group to produce a more accurate and optimised catalogue with lower uncertainties. The analysis focuses on parameters such as parallax (> 2 milli-arcsecond), RUWE (< 1.4), radial velocity and calculation of actions to have a balance between lower uncertainties and well measured samples. The report also includes a brief discussion about machine learning techniques used to perform the outlier analysis. The result analysis from both methods will help understand the dispersions in stellar actions and determine the difference between new and previous measurements. DR3 contains information that was previously unavailable. If time permits, the scope of this project would be extended towards finding new members of existing clusters by comparing the common properties of a candidate with the targetted cluster and analyzing the results to produce a new catalogue with updated information.