

## From star clusters to field populations: survived, destroyed and migrated clusters



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# Parameter Estimation for Open Clusters using an Artificial Neural Network with a QuadTree-based Feature Extractor

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With the unprecedented increase of known star clusters, quick and modern tools are needed for their analysis. In this work, we develop an artificial neural network trained on synthetic clusters to estimate the age, metallicity, extinction, and distance of *Gaia* open clusters. We implement a novel technique to extract features from the colour-magnitude diagram of clusters by means of the QuadTree tool and we adopt a multi-band approach. We obtain reliable parameters for ~5400 clusters. We demonstrate the effectiveness of our methodology in accurately determining crucial parameters of *Gaia* open clusters by performing a comprehensive scientific validation. In particular, with the parameters produced by our neural network, we obtain a Galactic metallicity gradient in agreement with the observed ones thus it demonstrates that our method reliably extracts information on metallicity from color-magnitude diagrams (CMDs) of stellar clusters. For the sample of clusters studied, we find an intriguing systematic older age compared to previous analyses present in the literature. This work introduces a novel approach to feature extraction using a QuadTree algorithm, effectively tracing sequences in CMDs despite photometric errors and outliers. The adoption of ANNs, rather than Convolutional Neural Networks, maintains the full positional information and improves performance, while also demonstrating the potential for deriving clusters' parameters from simultaneous analysis of multiple photometric bands, beneficial for upcoming telescopes like the Vera Rubin Observatory. The implementation of ANN tools with robust isochrone fit techniques could provide further improvements in the quest for open clusters' parameters.

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