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PHYS6013 Midterm Report: A Machine Learning Approach to Cool Star Spin-Down

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ABSTRACT
Observations of young open clusters have shown a bimodal distribution in the rotation periods of cool stars. This bi-modality stems from stars having fast or slow rotation periods. The evolution of this trend through time suggests a fast transition from fast to slow rotating. Our current understanding of cool star spin down, through magnetic braking, accounts for the slow rotators branch, while the fast rotators remain somewhat of a mystery.

Our goal is to build a predictive probabilistic spin-down model that links the period of a star at any given mass and age. We use machine learning to predict the age at which each star transitions from fast to slow-rotation. Using a graphical model we will translate the distribution of initial periods into a rotation period probability distribution for a given mass and age.

1 INTRODUCTION

- Establish the context of the work being reported.
  - Lay out the physics of the problem
  - Discuss relevant primary research literature (with citations)
  - Summarize current understanding of the problem
- State the purpose of the work
  - Hypothesis/
  - Question/
  - Or problem you investigated
- Explain your rationale and approach and, whenever possible, the possible outcomes your study can reveal.

2 DATA COLLECTION

2.0.1 Data Trimming

2.0.2 MIST Tables

2.0.3 Interpolation of Results

2.0.4 Clusters - Displayed

2.0.5 Clusters - Combined

3 PRELIMINARY METHODS

3.1 Unsupervised Clustering

3.2 Polynomial Ridge Regression

4 GAUSSIAN MIXTURE MODELS

Clustering is an unsupervised learning problem where we intend to find clusters of points in our dataset that share some common characteristics.

One important characteristic of K-means is that it is a hard clustering method, which means that it will associate each point to one and only one cluster. A limitation to this approach is that there is no uncertainty measure or probability that tells us how much a data point is associated with a specific cluster.

A Gaussian Mixture is a function that is comprised of several Gaussians, each identified by $k \in \{1, \ldots, K\}$, where K is the number of clusters of our dataset. Each Gaussian k in the mixture is comprised of the following parameters:

5 FINAL MODEL ANALYSIS

5.0.1

5.1 The Importance of Initial Period, P_i

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