Preliminary Work on Stellar Archeology: A Maximum Likelihood Approach

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Future

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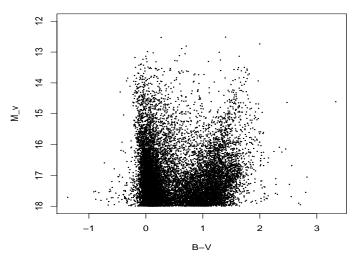
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Color-Magnitude Diagram

CM Diagram of 14753 SMC stars



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Additional Information

- Errors on each observation (σ is known)
- Independence among color bands
- Multivariate Normal assumption is quite reasonable
- Let's find an age, by the maximum likelihood or the maximum entropy method.

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Maximum Likelihood Approach

$$I(M_v^i, BV^i|Age_j) = \frac{1}{\sqrt{2\pi\Sigma_i}} exp\left(-\frac{1}{2}(X_i - \mu_{ij})^T \Sigma_i^{-1} (X_i - \mu_{ij})\right)$$

where $X_i = (M_v^i, BV^i)^T$ of the i^{th} star. (NOTE: I use Vmag as X axis)

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Estimating mu

Let I_j indicate the j^{th} isochrone

$$\hat{\mu}_{ij} = \arg\min_{\mu_{ij} \in I_j} dist(X_i, \mu_{ij}),$$

 $\hat{\mu}_{ij}$ achieves the goal of maximizing likelihood (entropy).

- Yet, I_j is given as a set of points.
- [Q] What distance metric to choose?
- [Q] Does $\hat{\mu}_{ij}$ represent the true age of the i^{th} star?

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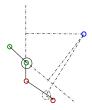
Distance

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Defining a point of min. distance

Finding a minimum distance and its associated point to a curve represented by a set of points with Euclidean norm.



СМП

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Distance

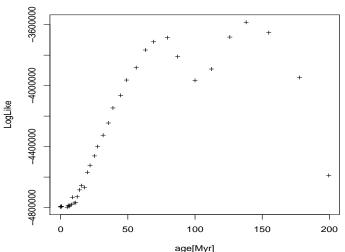
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Ages of a Star Cluster

Center of SMC, v<18, 14753 stars



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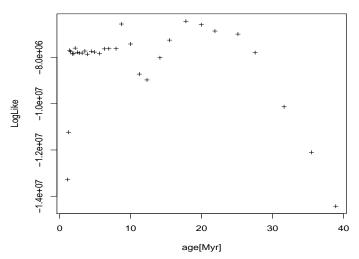
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Ages of a Star Cluster

NGC346, v<22, i<22, 9982 stars



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Future Work

- Enrich the likelihood function (retrieving the best age information of the star w.r.t. the given isochrone; missing data or nuisance parameters)
- Choose proper priors accommodating astronomical information (IMF, censoring/truncation, mixtureforeground contamination, errors)
- Design efficient methods for Bayesian analysis (for posterior distribution to provide the uncertainty of age estimate)