Preliminary Work on Stellar Archeology: A Maximum Likelihood Approach

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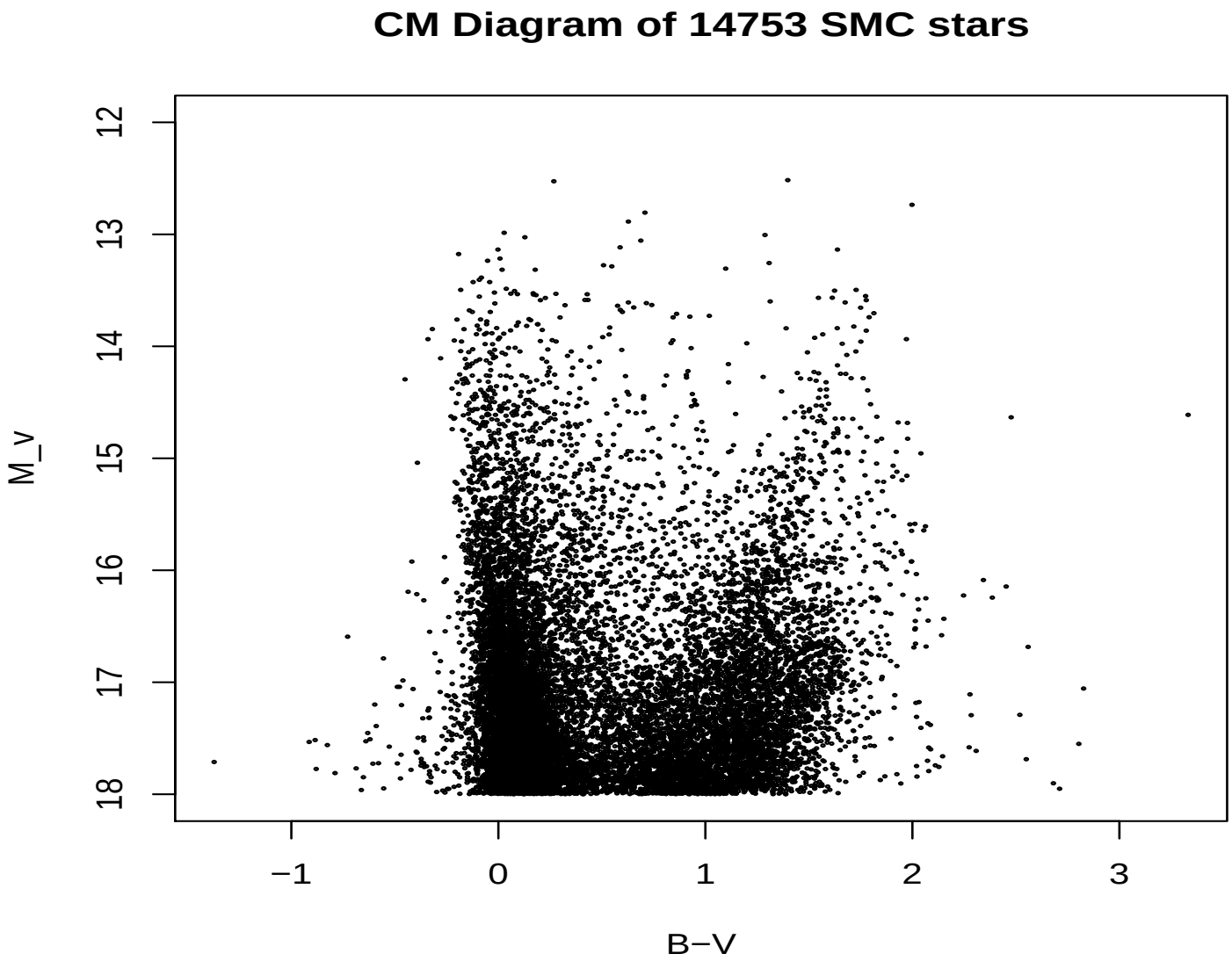
Color-Magnitude Diagram



Additional Information

- Errors on each observation (σ is known)
- Independence among color bands
- Multivariate Normal assumption is quite reasonable

$\longrightarrow$ Let's find an age, by the maximum likelihood or the maximum entropy method.

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)

Estimating mu

Let I_j indicate the j^{th} isochrone

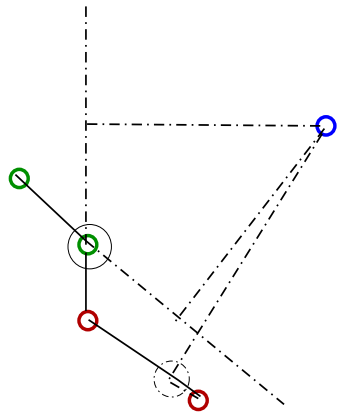
$$\hat{\mu}_{ij} = \arg\min_{\mu_{ij} \in I_j} dist(X_i, \mu_{ij}),$$

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

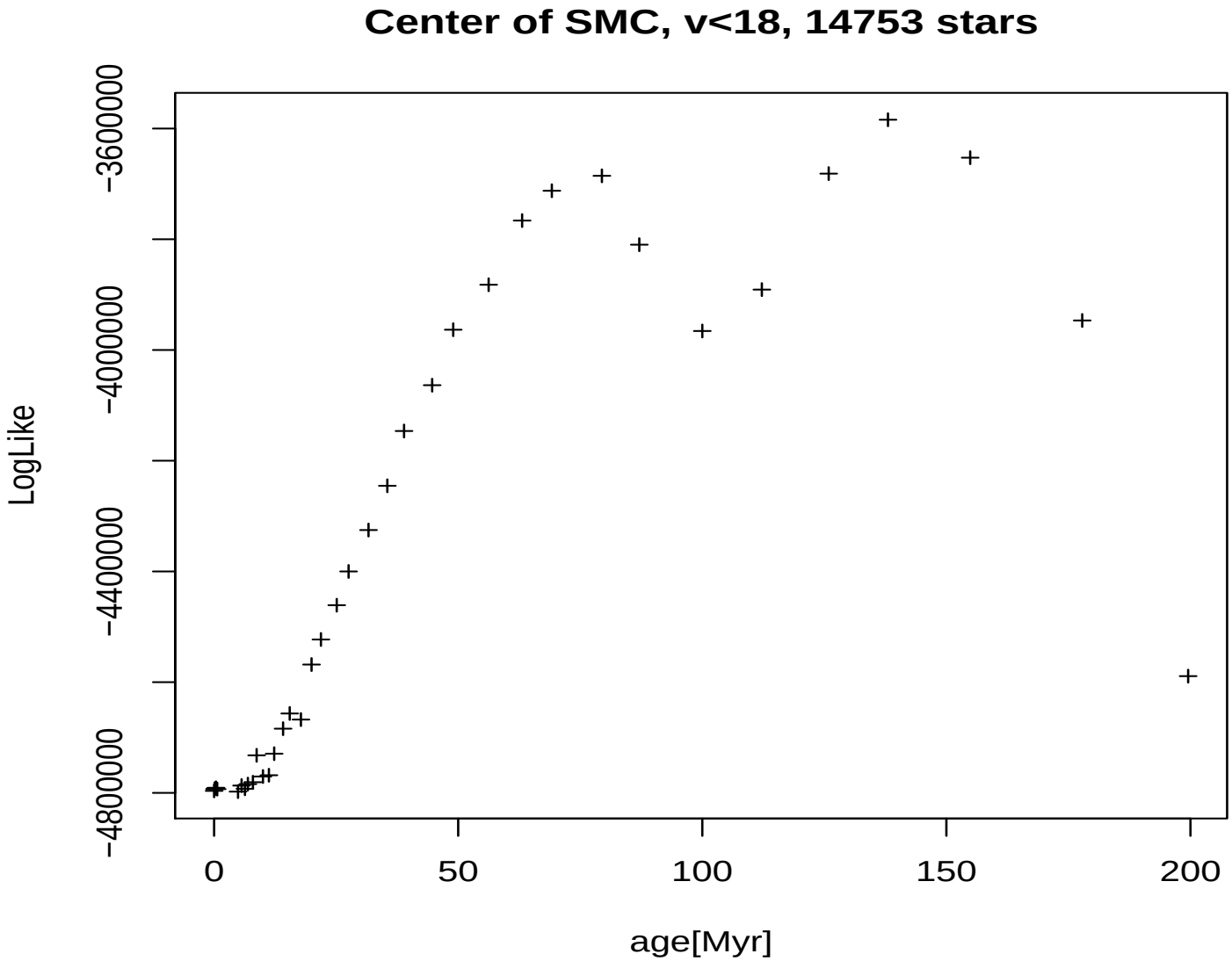
- Yet, I_j is given as a set of points.
- [Q] What distance metric to choose?
- [Q] Does $\hat{\mu}_{ij}$ represent the true age of the i^{th} star?

Defining a point of min. distance

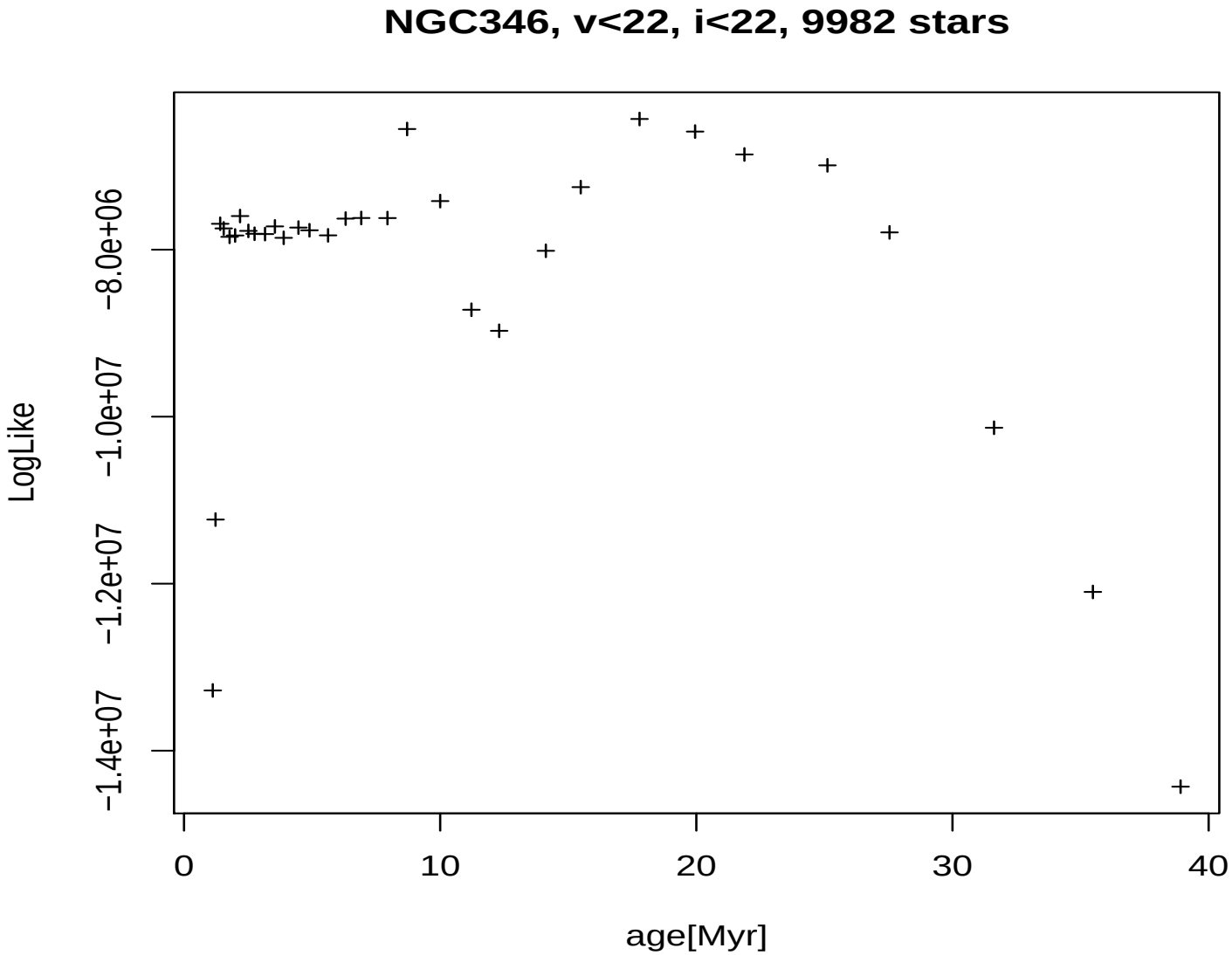
Finding a minimum distance and its associated point to a curve represented by a set of points with Euclidean norm.



Ages of a Star Cluster



Ages of a Star Cluster



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, mixture-foreground contamination, errors)
- Design efficient methods for Bayesian analysis (for posterior distribution to provide the uncertainty of age estimate)