Sagitta: a Neural Network Approach to Identifying and Predicting Ages of YSOs

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Sagitta: Photometric CNN Model for YSOs

Young stars are redder and brighter than the main sequence, but making an unbiased and free-of-contamination selection of YSOs among the more evolved stars across the entire sky can be difficult. Similarly, ages of YSO can be derived using isochrone fitting, but this process is computationally expensive for large numbers of sources and sensitive to extinction and other contamination.

We train a set of three convolution neural network (CNN) models – **Sagitta** – to classify young stars and predict their ages from *Gaia* DR2 and 2MASS photometry.

- An extinction map uses on-sky position to characterize extinction per star (inputs: l, b, parallax)
- A classifier stage assigns each source's probability of being a YSO (inputs: *Gaia* parallax, predicted A_V, G, G_{BP}, $G_{RP,}$ 2MASS J, H, K)
- A regressor stage predicts stellar ages for all classified YSOs (inputs: same as classifier)

Sagitta was trained to operate on sources within 5 kpc.

All-Sky Results

Figures 1 and 2 show the all-sky distribution of sources identified by Sagitta to various degrees of classifier certainty. Higher certainties are limited to the youngest regions, while at lower certainties it is also possible to identify older stars (due to them being closer to the main sequence) at the expense of increased contamination.

SFR Results

Individual star-forming regions can be isolated with appropriate cuts on YSO certainty, age, parallax, etc. For example, Sagitta recovers the age gradient previously observed in the Orion Complex (Figure 3). Similar fine-scale age structure can also be seen in other regions.

Solar-Neighborhood Star Formation

The full distribution of young stars suggests the presence of two solar-centric rings, at distance of ~100 pc and 250 pc (Figure 4). The populations associated with these rings make up the Gould's belt, and are coincident with the Local Bubble. Existing RV measurements (such as from LAMOST) show that the young stars have a strong preference for moving radially away from the center of the bubble, suggesting a common origin.

Fig. 1: All-sky model outputs with 95% certainty, noteworthy local SFRs labeled. Predicted ages are shown in Myr.

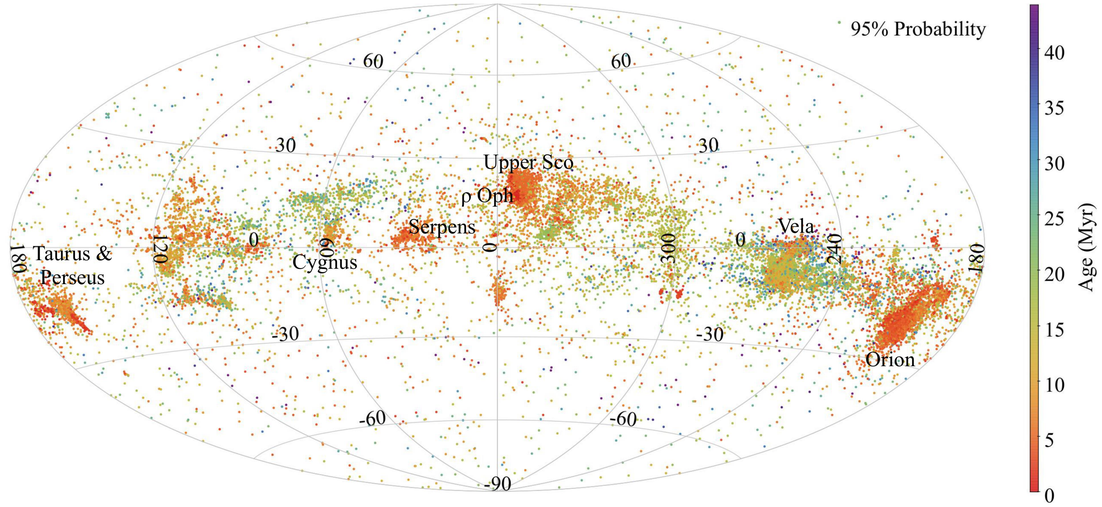

Fig. 2: Sagitta outputs for 85% classifier certainty. Note the increase in recovered older regions, with the disadvantage of added contamination.

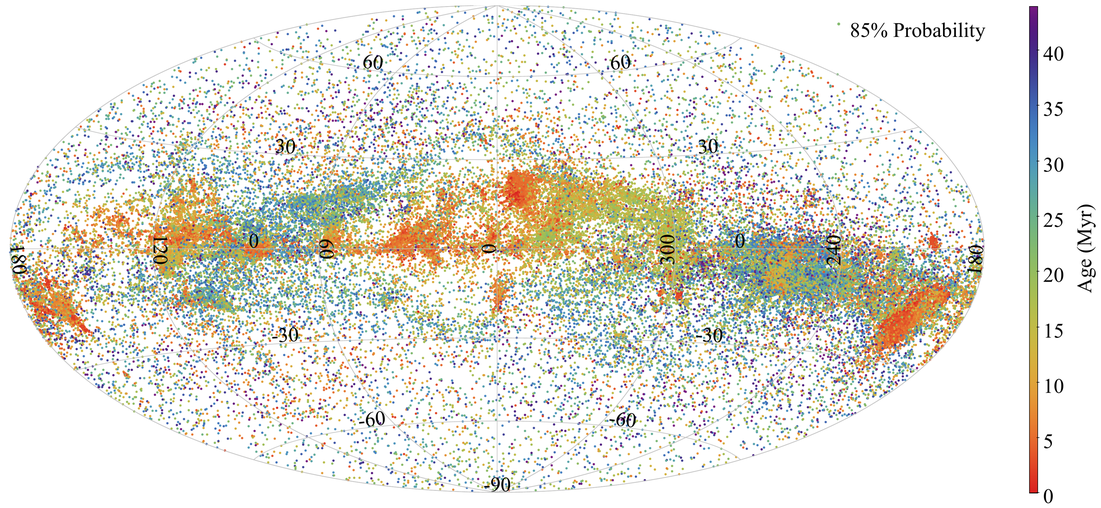

Fig. 3 (left): Sagitta outputs for the Orion Complex at 90% certainty.

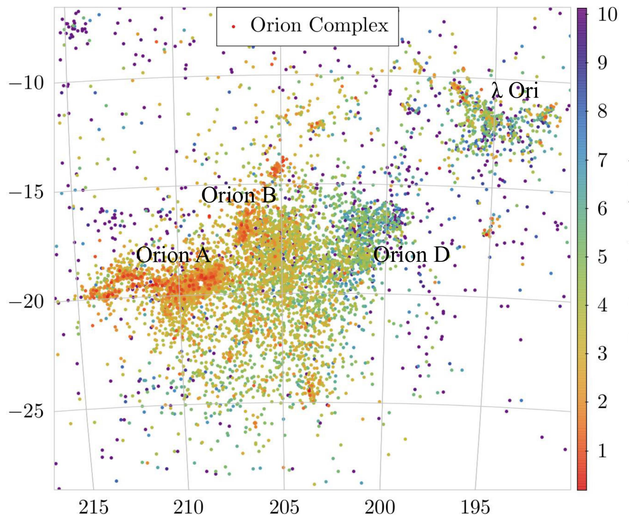

Fig. 4 (right): View from above the galactic plane of solar-neighborhood SFRs, sources with 85% certainty.