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Application of Machine Learning to Identify Stellar Feedback

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Stellar feedback, such as stellar winds and outflows, plays a significant role in both physical and chemical evolution of molecular clouds. This energy and momentum leave identifiable signatures (bubbles and outflows) that affect the dynamics and structure of the cloud. Most feedback feature searches are performed “by-eye”, which are usually time-consuming, subjective and difficult to calibrate. Automatic classifications based on machine learning make it possible to perform systematic, quantifiable and repeatable searches for stellar feedback features. I will first introduce a machine learning algorithm based on random forests, Brut, and quantitatively evaluate its performance in identifying bubbles using synthetic dust observations. I will show that synthetic observations combined with observational bubbles identified by citizen scientist significantly improve machine learning classification in dust emission. I will also introduce a new deep learning method CASI-3D (Convolutional Approach to Structure Identification-3D) to identify stellar feedback signatures in molecular line spectra. The CASI models are able to identify all previously identified feedback features in Taurus and Perseus, and identify new feedback structures as well. Meanwhile, the CASI models indicate that the mass, momentum and energy from feedback are overestimated by a large factor in previous studies. Consequently, feedback (bubbles+outflows) is not sufficient to support turbulence in Taurus. I will also discuss multiple astrostatistics that indicate the presence of stellar feedback in observations.

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