Contribution ID: **263** Type: **Poster**

Contrastive Reinforcement Learning for Classifying MeV Scale Physics in Liquid Argon Time Projection Chambers

Friday, 21 June 2024 17:30 (2 hours)

Identifying low energy activity in LArTPCs presents two main challenges: (1) the local topology is quite complex and highly variable, (2) interesting physics consists of several spatially separated blips which must be collected together. The first challenge makes separating different blip signatures which have similar underlying physics extremely difficult, since the distribution of their event topologies will often be indistinguishable. The second challenge refers to the fact that some low energy activity of interest, such as neutron captures, will necessarily consist of several blip topologies that are spread out in the detector, which must be exclusively associated to each other. To address these two challenges we introduce *BlipNet*, which consists of two main parts tailored to each of the challenges.

To combat the first challenge, we introduce a contrastive learning technique called *BlipGraph* which simply put, learns to separate the complex topologies of different low energy physics signatures by utilizing the various physical symmetries present in the data. Low energy activity is represented by point clouds which *BlipGraph* learns to separate by embedding them in a high-dimensional representation that respects rotational, translational and other symmetries. For the second challenge, we complement *BlipGraph* by constructing a topological representation of a LArTPC event called a decorated merge tree.

We present results for training *BlipGraph* and *BlipNet* on a simulated dataset for the ProtoDUNE single phase detector equipped with the pulsed neutron source. The *BlipGraph* model is optimized according to the linear evaluation protocol.

Poster prize

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Session Classification: Poster session and reception 2

Track Classification: Supernova neutrinos