

Combining Maximum-Likelihood with Deep Learning for Event Reconstruction in IceCube

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What:

- Reconstruction method that combines strengths of maximum-likelihood with those of deep learning

Why:

- Maximum-likelihood based methods in IceCube are able to utilize domain knowledge (symmetries, physics laws, detector properties, ...), but they are often forced to make simplifications due to computational constraints and complexity of high-dimensional PDF
- Common deep learning architectures, such as convolutional, recurrent and graph neural networks, can improve upon standard reconstructions in certain areas, but cannot fully exploit available domain knowledge

How:

- Generative model to approximate high-dimensional PDF
- Domain knowledge directly incorporated into NN architecture, analogously to simulation
- Once trained, the model is used in a traditional maximum-likelihood setting for event reconstruction

Conclusions:

- New hybrid reconstruction method that combines strengths of maximum-likelihood with those of deep learning
 - Efficient approximation of high-dimensional PDF
 - Utilize available symmetries, physics laws, detector properties
- Versatile tool: reconstruction/simulation/likelihood scans
- Exploitation of domain knowledge without need for simplifications leads to significantly improved reconstruction accuracy

