T 120: Data, AI, Computing 9 (generative models & simulation)

Time: Friday 9:00–10:30 Location: Geb. 30.34: LTI

T 120.1 Fri 9:00 Geb. 30.34: LTI

Faster Simulations of Instrument Response Functions for Imaging Air Cherenkov Telescopes through Methods of Adaptive Sampling — •Tristan Gradetzke and Stefan Fröse — TU Dortmund University, Dortmund, Germany

Monte Carlo simulations of particle induced extensive air showers are of crucial importance to the analysis chain of data taken by Imaging Air Cherenkov Telescopes (IACTs). Besides for the training of particle classifiers and energy estimators, they are necessary to calculate the instrument response in the form of the Instrument Response Functions (IRFs). There usage however, comes at the extensive cost of computational resources. Therefore much effort has been made to this day, to make these simulations more efficient. This work, aims at investigating how to use them more efficiently for IRF calculations, thus reducing the amount needed. This is sought to be achieved by simulating only discrete points in energy and field of view, instead of continuous distributions currently used. The goal is to only sample the regions improving uncertainty and event statistics. The achieved uncertainties and event statistics are then compared to the standard approach. An outlook is given, on how methods of machine learning can be used to fasten the process even further.

T 120.2 Fri 9:15 Geb. 30.34: LTI

Accelerating event generation in Sherpa with deep learning with matrix element weight surrogates — •Tim Herrmann[1], Timo Janssen[2], Steffen Schumann[2], and Frank Siegert[1] — [1]Technische Universität Dresden, Germany — [2]Universität Göttingen, Germany

To calculate theory predictions for high energy physics (HEP) experiments, Monte Carlo (MC) methods are needed. Accelerating MC generation is needed to fulfil the future needs of HEP experiments. Unit-weight events are generated on particle level to make the most use of the following computationally expensive detector simulation. But making unit-weight events can also be time-consuming.

One way to save computation time during unit-weight event generation is to use a fast full matrix element weight surrogate. The surrogate is estimated via a deep neural network, which can be calculated much faster than the full matrix element. The estimate is corrected in a second step to get an unbiased prediction. This approach has already been shown to be effective. This work focuses on further optimizing it and working towards an implementation in an official Sherpa release.

T 120.3 Fri 9:30 Geb. 30.34: LTI

Neural Networks for simulating Air-Shower Radio Emission — •Pranav Sampathkumar[1] and Tim Huege[1,2] — [1]Karlsruher Institut für Technologie, Institut für Astroteilchenphysik, Karlsruhe, Germany — [2]Astrophysical Institute, Vrije Universiteit, Brussel, Belgium

Radio Measurements of Extensive Air Showers are gaining importance as a technique for high energy cosmic ray measurements since they have been reliable in the estimation of energy and Xmax. As the array of antennas grows bigger, the need for simulations in-order to fit the data and estimate shower parameters grows larger. The current way of microscopically calculating the pulses individually for every antenna is very time intensive and scales with the number of antennas. Novel methods are needed for interpolation and generation of radio simulations.

This work, presents a neural network model which is trained to provide radio pulses taking shower parameters and antenna positions as input. Preliminary results on the generated pulses are presented and the underlying physics potentially learned by the network is discussed along with the limitations and future possibilities of the current training methodology.

T 120.4 Fri 9:45 Geb. 30.34: LTI

Equivariant Point Cloud GAN for 4-dimensional Calorimeter Clouds. — •william korcari[1], erik buhmann[1], frank gaede[2], gregor kasieczka[1,3], anatolii korol[2], katja krüger[2], and peter mckeown[2] — [1]Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany — [3]Center for Data and Computing in Natural Sciences CDCS, Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany

Fast simulation of the energy depositions in high-granular detectors is crucial for future collider experiments with increasing luminosity. Many proofs of concepts show how generative machine learning models can speed up and augment the traditional simulation chain in physics analysis. EPiC GAN has already shown promising results with very high-fidelity simulation of the physics of top jets with cardinality going as high as 150 particles and characterized by 3 dimensions. We show an extension of such a model, capable of conditional generation of photon calorimeter showers with even higher cardinality and an extra dimension.

T 120.5 Fri 10:00 Geb. 30.34: LTI

Study of data-augmentation for simulated ATLAS data sets using machine learning — •Lukas Vicenik, Boris Flach, and Andre Sopczak — Czech Technical University in Prague

Limitations on available simulated data sets have a strong impact on the uncertainty in searches for new particles and in precision measurements. This also applies to machine learning algorithms that aim to separate signal from background events. We propose to use Variational autoencoders (VAE) for augmenting and enriching simulated data sets. We consider two variants for training VAEs - the standard ELBO learning and a novel Nash equilibrium learning approach. The resulting generated data are validated and compared by studying their agreement with the original data sets.

T 120.6 Fri 10:15 Geb. 30.34: LTI

Exploring tomorrow's Monte-Carlo generators: MC Validation in ATLAS with PAVER — Frank Ellinghaus, Dominic Hirschbühl, •Johanna Wanda Kraus, Joshua Reidelstürz, Mustafa Schmidt, and Anna Vorländer — Bergische Universität Wuppertal

Monte-Carlo (MC) simulations play a key role in high energy physics, for example at the ATLAS experiment. MC generators are constantly evolved, where a periodic validation is indispensable for obtaining reliable physics simulations.

For that purpose, an automated and central validation system was developed: PMG Architecture for Validating Evgen with Rivet (PAVER). It provides an MC event generator validation procedure that allows a regular evaluation of new revisions and updates for commonly used MC generators in ATLAS as well as comparisons to measured data. The result is a robust, fast, and easily accessible MC validation setup that is constantly developed further. This way, issues in simulated samples can be detected before generating large samples for the collaboration, which is crucial for a sustainable and low-cost MC production procedure in ATLAS.