AKPIK 1: AKPIK I

Time: Wednesday 16:30–18:30 Location: H-HS XII

AKPIK 1.1 Wed 16:30 H-HS XII

Deep learning on stereoscopic CTA images — •Richard Wiemann, Maximilian Nöthe, and Lukas Nickel — Lehrstuhl für Experimentelle Physik Vb, Fakultät Physik, Dortmund, Deutschland

With its two arrays of more than 100 Imaging Atmospheric Cherenkov telescopes (IACTs) the Cherenkov Telescope Array (CTA) will be the largest ground-based gamma-ray observatory. The rapid development in the area of machine learning on image data motivates the attempt of using deep learning computer vision methods for gamma-hadron separation. This talk presents convolutional and recurrent deep neural network approaches for mono and stereo IACT data analysis using the open-source machine learning framework PyTorch.

AKPIK 1.2 Wed 16:45 H-HS XII

aict-tools – Event Reconstruction for Imaging Air Cherenkov Telescopes — •Maximilian Nöthe and Lukas Nickel — Exp. Physik 5, TU Dortmund, Otto-Hahn-Str. 4a, 44227 Dortmund

Imaging Air Cherenkov Telescopes (IACTs) cover the highest energy ranges in the electromagnetic spectrum of astronomy. These telescopes record the faint, nano-second scale flashes of Cherenkov radiation emitted by extensive air showers.

All IACTs face the same three reconstruction tasks: for each event, the primary particle's energy, direction and particle type have to be estimated. The particle type classification is necessary, as most extensive air showers are induced by charged cosmic rays.

Most commonly, IACTs record multiple time slices for each pixel in the camera for each shower, which is subsequently reduced to a few parameters describing each event.

The aict-tools use classical machine learning approaches as implemented by scikit-learn to reconstruct the gamma-ray properties from these image parameters.

The package provides executables to train, validate and apply models for all reconstruction tasks mentioned above. Major emphasis has been laid on exact reproducibility of models and results. YAML is used for configuration files and models can be stored in the pickle, PMML and ONNX formats, allowing application of the models in other programming languages than python.

AKPIK 1.3 Wed 17:00 H-HS XII

Real-time Data Analysis and Automation using Deep Learning at Accelerator-based light sources — •Mohammed Bawatna, Jan Deinert, and Sergey Kovalev — Institute of Radiation Physics, HZDR, Dresden, Germany

Accelerator-based light sources are constantly advancing and offer insights into the world of molecules, atoms, and particles on the ever shorter length and timescales. This goes along with a rapid and highly accurate transformation of analog quantities into discrete values for electronic storage and processing with exponentially increasing amounts of data. The current lack of real-time data analysis impedes the direct feedback and the possibility for fine*tuning in time-critical beam*time experiments, and data collection, storage, data management, and curation of the data become more and more challenging. This contribution is focusing on real-time analysis methods using deep learning and evaluation of large data volumes generated at the superradiant terahertz facility (TELBE) at Helmholtz Zentrum Dresden Rossendorf (HZDR). Here, the pulse-resolved data acquisition at a 100 kHz repetition rate enables femtosecond timing accuracy and high dynamic range but creates datasets at a rate of GB per minute, which are challenging to handle. We will also introduce our online ultrafast DAQ system that uses a GPU platform for real-time image processing, and a custom high-performance FPGA board for interfacing the image sensors and provide a continuous data transfer.

AKPIK 1.4 Wed 17:15 H-HS XII

Belle II pixeldetector cluster analyses using neural network algorithms — Stephanie Kaes[1], Irina Heinz[1], Soeren Lange[1], and •Katharina Dort[1,2] for the Belle II-Collaboration — [1]II Physics Institute, Justus Liebig University Giessen, Germany — [2]CERN, Geneva, Switzerland

The Belle II DEPFET pixeldetector is operating since 2019, presently with 4M pixels and trigger rates up to 5 kHz. The pixeldetector has the unique ability to detect exotic highly ionizing particles such as antideuterons or stable tetraquarks which due to their high energy loss do not reach the outer sub-detectors, and thus generate no reconstructable track. In order to identify these highly ionizing particles multivariate analyses of pixeldetector clusters is performed. The multidimensional input space consists of variables such as single-pixel signals, cluster observables, or Zernicke moments. We present results for cluster classification using three different neural network algorithms: multilayer perceptrons, Kohonen-type networks (often denoted as self-organizing maps) and Hopfield-type networks (often denoted as associate memories). Data preprocessing by Principal Components analysis and possible implementation on an FPGA for online reconstruction are discussed as well.

AKPIK 1.5 Wed 17:30 H-HS XII

Search for the supersymmetric tau lepton using Run2 data of the CMS experiment — •Leonid Didukh, Isabell Melzer-Pellmann, and Dirk Krücker — Deutsches Elektronen Synchrotron (DESY), Hamburg, Deutschland

Supersymmetry is a popular theory of new physics beyond the Standard Model. Particularly searches for the supersymmetric partner of the tau lepton $\tilde{\tau}$ still remain a promising approach, since the $\tilde{\tau}$ pair production has a very small cross-section that can be probed with the full Run2 luminosity.

This talk contains the status of the search for direct stau production using data collected by the CMS Collaboration at the CERN LHC during 2016-2018 at a center-of-mass-energy of 13TeV. The presented analysis is based on a final state with missing energy and two taus, one hadronically decaying tau and one electron or muon produced from the second tau decay. Unlike the previous analysis that contains data from 2016-2017, this analysis explores more MVA tools and will show how these models (DNN, BDT, combined models architectures for heterogeneous tabular data) can significantly improve the results.

AKPIK 1.6 Wed 17:45 H-HS XII

Analyzing Radio Interferometric Data with Neural Networks — •Kevin Schmidt, Felix Geyer, and Simone Mender — TU Dortmund

Very long baseline radio interferometry allows the observation of distant astronomical objects with the highest resolution. In this technique, the data of several radio telescopes are combined to achieve an effective diameter equal to the greatest baseline.

Radio interferometers measure visibilities depending on the baselines between the individual telescopes. Based on their sparse distribution, much visibility space remains uncovered. This lack of information causes noise artifacts in the recorded data, which have to be removed to receive a clean image.

With increasing data rates of modern radio interferometers, fast solutions are necessary to analyze observations in a reasonable time. One approach is the usage of machine learning techniques like neural networks. In this talk, the feasibility study of reconstructing sparse radio interferometric data using convolutional neural networks is presented based on a toy Monte Carlo data set.

AKPIK 1.7 Wed 18:00 H-HS XII

Reconstructing Interferometric Data Using Neural Networks — •Felix Geyer and Kevin Schmidt — TU Dortmund

Radio interferometry is used to monitor and observe distant astronomical sources and objects with high resolution. Especially Very Long Baseline Interferometry allows to achieve the highest resolutions by combining the data of multiple telescopes. This results in an effective diameter corresponding to the greatest distance between two telescopes. The taken data consists of visibilities, which depend on the baselines between the telescopes. Because the distribution of these baselines is sparse, the sample of visibilities is incomplete. This influences the reconstruction of the image of the observed source in a negative way. A new and fast approach to reconstruct missing data reasonable is using neural networks. A critical component of a neural network is the loss function, which is different for each individual underlying task. One approach for the loss function in case of image reconstruction for high resolution images is called 'Perceptual Losses' (Johnson et al., 2016). This talk gives an overview of the first results of applying this loss function to reconstruct radio interferometric data.

AKPIK 1.8 Wed 18:15 H-HS XII

Information field theory: artifical intelligence with a knowledge driven design — •Torsten Ensslin — MPI für Astrophysik

Information field theory (IFT) describes probabilistic image reconstruction from incomplete and noisy data. Based on field theoretical concepts IFT provides optimal methods to generate images exploiting all available information. IFT algorithms can be regarded as interpretable neural networks, with a design determined by the physical knowledge on the observed system. Applications in astrophysics are galactic tomography, gamma- and radio- astronomical imaging, and the analysis of cosmic microwave background data.