T 29: Deep Learning II

Zeit: Dienstag 16:00–18:30 Raum: H06

T 29.1 Di 16:00 H06

Reconstruction of Muons with Recurrent Neural Networks for the IceCube Experiment — •Gerrit Wrede, Gisela Anton, and Thorsten Glüsenkamp for the IceCube-Collaboration — Erlangen Centre for Astroparticle Physics, Erlangen, Germany

The IceCube neutrino observatory is searching for point sources in the astrophysical neutrino flux. Relativistic muons created by muon neutrinos offer a good angular resolution and are thus an ideal channel for the detection of point sources. Recurrent neural networks are a class of artificial neural networks designed to handle time series data, such as the signatures created by muons traveling through the IceCube detector. In this talk, I will present an approach to use recurrent neural networks for muon reconstruction in IceCube.

T 29.2 Di 16:15 H06

Antiproton to proton ratio determination using deep neural networks with AMS-02 — •Sichen Li — I. Physikalisches Institut B, RWTH Aachen, Germany

AMS-02 is a high precision detector for charged cosmic rays installed on the International Space Station. A discrepancy occurs between the current observation for antiproton to proton ratio and the prediction from collisions of ordinary cosmic rays, which could be explained by dark matter annihilation or other astrophysical phenomena. To test models precisely, an antiproton to proton ratio in a larger energy range is required.

Charge confusion occurs when a proton is mis-reconstructed as an antiproton. The reasons for this are interactions with AMS materials and detector resolution. To extend the energy range of the measurement, a rejection power against charge-confused protons in excess of 1 in 1 million is needed, due to the tiny fraction of antiprotons in cosmic rays.

We build a deep neural network to improve the separation for charge confusion from interactions. With this approach, we have a good potential to extend energy range for antiproton to proton ratio.

T 29.3 Di 16:30 H06

Particle Identification using Deep Learning at AMS — •Robin Sonnabend — RWTH Aachen, Aachen, Germany

The Alpha Magnetic Spectrometer (AMS-02) on the International Space Station performs precision measurements of cosmic rays in the GeV to TeV energy range. One of the challenges of measuring the electron and positron fluxes is rejecting the proton background. The published analyses of these fluxes rely on Multivariate Analysis (MVA) using shower shape observables from the electromagnetic calorimeter (ECAL) for particle identification and background rejection.

A new method to identify particles with Deep Convolutional Neural Networks using the energy depositions measured by the AMS-02 ECAL directly will be presented.

T 29.4 Di 16:45 H06

Particle Discrimination via Deep Learning with JUNO — •Thilo Birkenfeld, Achim Stahl, and Christopher Wiebusch — III. Physikalisches Institut B, RWTH Aachen University

The JUNO detector is going to be a 20kt liquid scintillator neutrino observatory, currently under construction near Kaiping, China, with a baseline of about 50km to two nuclear reactor plants. With its excellent energy resolution and large fiducial volume, it will be able to determine the neutrino mass hierarchy from their energy spectrum. The neutrinos are detected by measuring the signature of the inverse beta decay (IBD), which consists of a prompt positron- and a delayed neutron capture signal. Although this coincidence is well recognizable, there are still some background events left. Most of these backgrounds have of an electron component instead of a positron. Electron and positron signals are very similar in a liquid scintillator. The only difference is the missing annihilation for electrons. New developments in deep learning techniques give the possibility to distinguish the different event shapes. This talk focuses on a method to discriminate positrons and electrons via a neural network.

T 29.5 Di 17:00 H06

Search for Ultra High Energy Photons with the Pierre Auger Observatory using Deep Learning Techniques — •Tobias Pan, Thomas Bretz, Paulo Ferreira, Adrianna García, Thomas Hebbeker, Julian Kemp, and Christine Peters — III. Physikalisches Institut A, RWTH Aachen University

The Pierre Auger Observatory in Argentina measures extensive air showers induced by ultra high energy cosmic rays using a surface array of 1660 water Cherenkov detectors and 27 fluorescence telescopes. Besides the detailed measurement of the hadronic cosmic ray flux at the highest energies above 1 EeV, the Pierre Auger Observatory is also able to search for a flux of ultra high energy photons.

Until now, no ultra high energy photons have been discovered. Due to the high flux of hadronic cosmic rays, a good separation between photon and hadron induced air showers is crucial. A method has been developed to separate photon induced extensive air shower events from the hadronic events detected by the Pierre Auger Observatory. Deep learning methods are applied for this purpose. Trained on simulated air showers, the deep neural network will then be able to separate events in measured data.

T 29.6 Di 17:15 H06

Signal-background discrimination with Deep Learning in the EXO-200 experiment — •Tobias Ziegler[1], Mike Jewell[2], Johannes Link[1], Federico Bontempo[1], Gisela Anton[1], and Thilo Michel[1] — [1]Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP — [2]Stanford University, California, USA

The EXO-200 experiment searches for the neutrinoless double beta ($0\nu\beta\beta$) decay in ^{136}Xe with an ultra-low background single-phase time projection chamber (TPC) filled with 175 kg isotopically enriched liquid xenon (LXe). The detector has demonstrated good energy resolution and background rejection capabilities by simultaneously collecting scintillation light and ionization charge from the LXe and by a multi-parameter analysis. Advances in computational performance in recent years have made novel Deep Learning techniques applicable to the physics community. This contribution presents the concept of the detector and summarizes the work on applying Deep Learning methods for signal-background discrimination in the EXO-200 experiment.

T 29.7 Di 17:30 H06

Event Reconstruction with Machine Learning methods in JUNO — •Yu Xu[1,2], Yaping Cheng[1,2], Christoph Genster[1,2], Alexandre Göttel[1,2], Livia Ludhova[1,2], Philipp Kampmann[1,2], Michaela Schever[1,2], Achim Stahl[1,2], and Christopher Wiebusch[1] — [1]IKP-2, Forschungszentrum Jülich — [2]III Physikalisches Institut, RWTH Aachen University

Jiangmen Underground Neutrino Observatory (JUNO) experiment aims to determine the unknown neutrino mass ordering at a 3-4 sigma significance with 6 year*s data, which requires 3

T 29.8 Di 17:45 H06

Application of Deep Neural Networks to Event Type Classification in IceCube — •Maximilian Kronmüller and Theo Glauch for the IceCube-Collaboration — Technical University of Munich

The IceCube Neutrino Telescope is able to measure an all-flavor neutrino flux in an energy range between 100 GeV and several PeV. Due to the different features of the neutrino interactions and the geometry of the detector all high-level analyses require a selection of suitable events as a first step. However, up to today, no algorithm exists that gives a generic prediction of an event's topology. One possible solution to this is the usage of deep neural networks, i.e. classification networks similar to the ones used in image recognition. The classifier that we present here is based on a modern InceptionResNet architecture and includes multi-task learning in order to broaden the field of application and increase the overall accuracy of the result. Despite a detailed discussion of the network's architecture we will also examine the performance and speed of the classifier for various tasks and possible applications in IceCube.

T 29.9 Di 18:00 H06

Deep Learning based Air Shower Reconstruction at the Pierre Auger Observatory — •Jonas Glombitza, Martin Erdmann, Maximilian Vieweg, and Michael Dohmen — III. Physikalisches Institut A, RWTH Aachen

The surface detector of the Pierre Auger Observatory measures the footprint of ultra-high energy cosmic ray induced air showers on ground level. Furthermore, fluorescence telescopes allow hybrid detection of air showers and hence, for an independent crosscheck. Reconstructing observables sensitive to the cosmic ray mass, is a challenging task and mainly based on the fluorescence detector which, however, has a small duty cycle. Recently, great progress has been made in multiple fields of machine learning by using deep neural networks and associated techniques. Applying these new techniques on air shower physics provides a new and independent reconstruction.

In this talk, we present AixNet, a deep convolutional neural network for the reconstruction of ultra-high energy cosmic rays properties [1]. First, we assess the performance on CORSIKA based air showers, discuss the performance limit and compare the performance achieved on data by cross-calibrating with the fluorescence detector. Furthermore, we visualize the multidimensional differences between data and simulation using deep neural networks to understand differences in the reconstruction and prepare the simulation for refinement studies [2].

[1] DOI: 10.1016/j.astropartphys.2017.10.006
[2] DOI: 10.1007/s41781-018-0008-x

T 29.10 Di 18:15 H06

Image Recognition with Deep Neural Networks for IceAct Air-Cherenkov Telescopes — •Matthias Thiesmeyer, Jan Auffenberg, Pascal Backes, Thomas Bretz, Erik Ganster, Maurice Günder, Merlin Schaufel, Jöran Stettner, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen

Deep Neural Networks (DNNs) have brought new possibilities to image analysis. We use these for particle identification in IceAct, which is an array of SiPM-based Imaging Air Cherenkov Telescopes, planned as a surface component of IceCube. One Goal of IceAct is improving composition and gamma ray measurements of the IceCube Neutrino Observatory by the hybrid measurement of air showers. Within the hybrid measurement by the surface detector IceTop, the in-ice detector IceCube, and IceAct, IceTop provides the direction and energy of the shower, IceCube a measurement of the high-energy muon component, and IceAct images the shower development in the atmosphere. We present first results from DNNs trained on simulations of air showers with CORSIKA to separate gamma rays from protons in the energy range from 10-100 TeV.