AKPIK 1: Arbeitskreis Physik, IT & KI (AKPIK) I

Zeit: Montag 16:30–18:45 Raum: 70 - HS 00.107

AKPIK 1.1 Mo 16:30 70 - HS 00.107

Gruppenbericht: SFB 876 Verfügbarkeit von Information durch Analyse unter Ressourcenbeschränkung — •Tim Ruhe, Wolfgang Rhode, Maximilian Meier und Mirco Hünnefeld — TU Dortmund

Der Sonderforschungsbereich SFB 876 entwickelt in seinen Anwendungsprojekten Methoden aus dem Bereich des maschinellen Lernens und der künstlichen Intelligenz mit dem Ziel der unmittelbaren Anwendbarkeit in Großexperimenten aus den Bereichen Teilchen- (LHCb) und Astroteilchenphysik (IceCube, FACT, CTA). Die entwickelten Methoden decken dabei unter anderem die Analyse hochfrequenter und detektornaher Daten, die hocheffiziente und hochgradig robuste Trennung von Signal- und Untergrundereignissen sowie die Rekonstruktion von Energiespektren auf der Basis multidimensionaler Verteilungen ab. Ressourchenoptimierte Algorithmen im Bereich der Monte Carlo Simulationen runden das Profil des SFB ab.

Die im Rahmen des SFB 876 entwickelten Analysemethoden sind dabei ebenso vielfältig wie die Herausforderungen im Bereich der Datenanalyse und umfassen neben eher traditionellen entscheidungsbaumbasierten Algorithmen auch neuartige und hochkomplexe Algorithmen wie *Convolutional Neural Networks* und die Analyse von Datenströmen im *streams framework*. Der Vortrag gibt einen Überblick über die Arbeit innerhalb des Sonderforschungsbereichs und stellt wesentliche Entwicklungen des SFB heraus. Im Fokus steht dabei die Anwendung der entwickelten Algorithmen in Experimenten aus der Teilchen- und Astroteilchenpyhsik.

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Online Event Reconstruction in IceCube Using Deep Learning Techniques — Mirco Hünnefeld, Max Meier, •Thorben Menne, Felix Neubürger, Tobias Hoinka, Joshua Luckey, Jan Soedingrekso, and Jan Spinne for the IceCube-Collaboration — TU Dortmund, Germany

The IceCube Neutrino Observatory is a Cherenkov detector deep in the Antarctic ice. Due to limited computational resources and the high data rate, only simplified reconstructions restricted to a small subset of data can be run on-site at the South Pole. However, in order to perform online analyses and to issue real-time alerts, fast and powerful reconstructions are desired.

Recent advances, especially in image recognition, have shown the capabilities of deep learning. Deep neural networks can be extremely powerful and their usage is computationally inexpensive once the networks are trained. These characteristics make a deep learning-based reconstruction an excellent candidate for the application on-site at the South Pole. In contrast to image recognition tasks, the reconstruction in IceCube poses additional challenges as the data is four-dimensional, highly variable in length, and distributed on an imperfect triangular grid.

A deep learning-based reconstruction method is presented which can significantly increase the reconstruction accuracy while reducing the runtime in comparison to standard reconstruction methods in IceCube.

AKPIK 1.3 Mo 17:15 70 - HS 00.107

FACT – Improving the Angular Resolution of FACT-Tools Using Machine Learning — •Maximilian Nöthe and Kai Arno Brügge for the FACT-Collaboration — Exp. Physik 5b, TU Dortmund, Otto-Hahn-Str. 4a, 44227 Dortmund, Deutschland

The First G-APD Cherenkov Telescope (FACT) is pioneering the usage of solid state photo sensors (G-APDs aka SiPMs) for groundbased gamma-ray astronomy. FACT is located on the Roque de los Muchachos on the canary Island of La Palma. Since October 2011, the FACT collaboration has successfully been showing the reliability of SiPM for the IACT technique and blazar monitoring.

One of the most challenging tasks in Imaging Air Cherenkov Telescopes is the reconstruction of the origin of incoming particles. Based on the recorded image of the Cherenkov photons, the origin of the gamma ray has to be estimated. This is an especially hard task for single telescopes.

In this contribution, the improvements of the angular resolution and sensitivity of the FACT-Tools analysis are presented, which were gained by using a machine learning based implementation of the so called disp method.

For this approach, two random forests have been trained. First, a random forest regressor to estimate the absolute value and second a random forest classifier to perform the head/tail-disambiguation of the shower.

The results shown were achieved on the publicly available FACT raw data using open source software.

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Prototyping CTA's Real-Time-Analysis — •Kai Arno Brügge[1], Alexey Egorov[2], and Maximilian Nöthe[1] — [1]TU Dortmund, Astroparticle Physics, Dortmund, Germany — [2]TU Dortmund, Artificial Intelligence, Dortmund, Germany

The Cherenkov Telescope Array (CTA) will be able to map the gamma-ray sky in a wide energy range from several tens of GeV to some hundreds of TeV and will be more sensitive than previous experiments by an order of magnitude. It opens up the opportunity to observe transient phenomena like gamma-ray bursts (GRBs) and flaring active galactic nuclei (AGN).

In order to successfully trigger multi-wavelength observations of transients, CTA has to be able to alert other observatories as quickly as possible. Multi-wavelength observations are essential for gaining insights into the processes occurring within these sources of such high energy radiation.

During observation CTA will produce a stream of up to 20 000 images per second. Multivariate machine learning models are applied to the data stream in real time to perform background suppression and energy estimation. Restricted computing power of a single machine and the limits of network data transfer rates become a bottleneck for stream processing systems in a traditional single-machine setting. We use the Apache Flink framework for distributed stream analysis on multiple machines. Here we present results of our investigation and show a first prototype capable of analyzing CTA data in real time.

AKPIK 1.5 Mo 17:45 70 - HS 00.107

Convolutional Neural Networks applied to Images of the MAGIC Telescopes — •Philipp Hoffmann and Alicia Fattorini for the MAGIC-Collaboration — TU Dortmund

MAGIC is a stereoscopic system of two Imaging Air Cherenkov Telescopes (IACT) located at the Rouque de los Muchachos Oberservatory on the Canary Island of La Palma at 2200m above sea level. They operate at an energy range of 50 GeV to 50 TeV.

Convolutional neural networks (CNNs) are used in image recognition and often yield a more accurate image analysis for low quality images than other methods. Applying CNNs to images produced by IACTs is thus of high interest, especially for the reconstruction of low energy events. I will motivate explore and present the usage of CNNs in the context of energy reconstruction in comparison to the standard MAGIC analysis chain.

For the CNN to be a viable analysis method, its outputs have to reproduce the spectra and other properties of well known sources like the crab pulsar and have a agreement between experimental and monte carlo data.

AKPIK 1.6 Mo 18:00 70 - HS 00.107

Deep Neural Networks for IceCube Online Classification — •Jan Spinne, Philipp Hoffmann, and Felix Neubürger for the IceCube-Collaboration — TU Dortmund

IceCube is a neutrino detector located at the geographic South Pole, which detects Cherenkov light emitted by charged secondary particles passing through the ice. A key challenge for the real-time analysis framework in IceCube is the classification of events based on their corresponding topology. For example, topologies can include cascade-like events for electron neutrino interactions and track-like events of charged-current muon neutrino interactions. The detector's high event rate and limited computational resources available on site, complicate the classification task. Real-time analyses should therefore be fast and effective.

This talk aims to motivate and show the usage of deep neural networks, which are predestined due to its fast model application and potentially high accuracy.

AKPIK 1.7 Mo 18:15 70 - HS 00.107

e + /e - Discrimination with Deep Learning Method — •Yu Xu[1,2], Yaping Cheng[1], Christoph Genster[1,2], Philipp Kampmann[1,2], Livia Ludhova[1,2], Michaela Schever[1,2], Rikhav Shah[1,2], Achim Stahl[1,2], and Christopher Wiebusch[1,2] for the JUNO-Collaboration — [1]IKP-2 Forschungszentrum Jülich — [2]III. Physikalisches Institut B, RWTH Aachen University

The Jiangman Underground Neutrino Observation (JUNO) is a multipur- pose neutrino experiment, including the determination of neutrino mass hier- archy, the observation of supernova neutrino and diffuse supernova neutrino background (DSNB), the study of solar neutrino and geo-neutrino, etc. In these studies, it is very helpful and even neccessary to have a good particle discrim- ination. To improve the performance, we are trying to solve this problem with deep learning method, which is really popular nowadays. Deep learning is a ma- chine learning algorithm which learns intrinsic representations of complex data by multi-layer abstractions of information. Recently, this method has been ap- plied in different fields including visual object recognition and detection, speech recognition and many other artificial intelligence computing tasks. We will show our result here.

AKPIK 1.8 Mo 18:30 70 - HS 00.107

Can Artificial Intelligence Advance Fundamental Physics? — •Alexander Unzicker — Pestalozzi-Gymnasium München

Recent successes of Deep Neural Networks suggest that this kind of artificial intelligence (AI) will be of outstanding importance in the analysis of scientific data. The talk discusses motivation, prerequisites and strategies of how to apply AI to fundamental questions in astrophysics and particle physics, the two 'big data' fields where the new techniques appear to be most promising in principle.