Arbeitskreis Physik, Moderne IT und Künstliche Intelligenz (AKPIK)

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Der Arbeitskreis PIK dient als neues DPG Forum für das fachübergreifende Thema "Data Science" mit seinen physikrelevanten Aspekten wie z.B. Methoden zur Verarbeitung großer Datenmengen, Informationstheorie und -technologie, maschinelles Lernen, künstliche Intelligenz, Robotik, smarte Sensoren oder Technikfolgenabschätzung. Mitglieder aus allen Fachverbänden sind willkommen und eingeladen, diese Entwicklung aktiv mitzugestalten.

Übersicht der Hauptvorträge und Fachsitzungen

(Hörsaal 70 - HS 00.107)

Hauptvorträge

AKPIK 2.2	Di	16:45–17:10	70 - HS 00.107	**Understanding the World with AI: Do we need a "CERN for AI"?** — •Phillip Slusallek

Fachsitzungen

AKPIK 1.1–1.8	Mo	16:30–18:45	70 - HS 00.107	**Arbeitskreis Physik, IT & KI (AKPIK) I**
AKPIK 2.1–2.6	Di	16:30–18:50	70 - HS 00.107	**Arbeitskreis Physik, IT & KI (AKPIK) II**
AKPIK 3	Di	18:50–19:20	70 - HS 00.107	**Mitgliederversammlung des Arbeitskreises Physik, moderne Informationstechnologie und Künstliche Intelligenz**

Mitgliederversammlung AKPIK

Dienstag 20.03.2018 18:50–19:20 Gebäude 70 (00.017)

- Bericht
- Wahl
- Verschiedenes

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.

AKPIK 1.2 Mo 17:00 70 - HS 00.107

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.

AKPIK 1.4 Mo 17:30 70 - HS 00.107

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.

AKPIK 2: Arbeitskreis Physik, IT & KI (AKPIK) II

Zeit: Dienstag 16:30–18:50 Raum: 70 - HS 00.107

AKPIK 2.1 Di 16:30 70 - HS 00.107

Introducing the new AKPIK — •Karl Mannheim — Universität Würzburg

The DPG invites members engaged in data-intensive physics, modern information technology, or artifical intelligence to work together in the frame of the new working group AKPIK.

Five major topics will be addressed by AKPIK: (1) big data and information theory, (2) information technology solutions to next-level data challenges, (3) artificial intelligence and robotics, (4) data science education, and (5) industry and society.

The first election of the steering board members for the next two-year term will be carried out. Nominations of candidates are welcome.

Hauptvortrag AKPIK 2.2 Di 16:45 70 - HS 00.107

Understanding the World with AI: Do we need a "CERN for AI"? — •Phillip Slusallek — Deutsches Forschungszentrum für Künstliche Intelligenz (DFKI)

How can intelligent system support us in better understanding the complex world around us? And how can we use such systems to build better tools for science and many other applications?

Modern AI techniques like Deep Learning allow us to extract representations and models from big and complex data sets. If this data comes from sensors of the world around us, the resulting models form a sort of "Digital Reality" that allows us to simulate how we believe the world works. By simulating many relevant scenarios and through techniques like Reinforcement Learning then enables us to do learn strategies to reach goals in such environments. Finally, comparing the data derived from the simulations with data from the real world enables us to validate our models as well as incrementally improve them – and thus our understanding of the world.

In my presentation I will discuss this Digital Reality in different domains ranging from (i)intelligent imaging sensors that incrementally adapt and refine their measurements based on prior knowledge and previous measurements, (ii) data analysis tools that use synthetic data from simulations to derive adaptive filters to scan large amount of sensor data for evidence, all the way to (iii) Autonomous Vehicles that need to understand the world around them to safely bring us to our destinations.

AKPIK 2.3 Di 17:10 70 - HS 00.107

Information field theory: theortical physics methods for imging — •Torsten Ensslin — MPI für Astrophysik, Gaching, Deutschland

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. Applications in astrophysics are galactic tomography, gamma- and radio- astronomical imaging, and the analysis of cosmic microwave background data. A novel IFT-based gamma ray sky image derived from data of the Fermi-satellite provides insights into the high energy properties of the Milky Way. Multi-frequency and multi-instrument imaging in the spatial, spectral, and temporal domains simultaneously is in preparation and will be made publicly available as an Universal Bayesian Imaging toolKit (UBIK).

AKPIK 2.4 Di 17:35 70 - HS 00.107

Machine Learning in Astroparticle Physics: Gamma Rays and Neutrinos — •Wolfgang Rhode — Fakultät Physik, TU Dortmund

The umbrella term 'machine learning' covers a large variety of computer science methods for classification and information extraction, such as Random Forests, Deep Learning, and others. Because of its comparably simple data structures and sometimes time-critical applications for target-of-opportunity observations of variable sources, Astroparticle Physics yields an ideal field for such applications. The talk gives an overview of problems and their solutions from the information extraction from raw data, over signal background separation to the solution for the final inverse problem and multi-messenger classifications.

AKPIK 2.5 Di 18:00 70 - HS 00.107

Bayesische Statistik: Wie mit Methoden aus der Astrophysik industrielle Fertigungsprozesse optimiert werden können. — •Theo Steininger — Max-Planck Institut für Astrophysik, Garching, Deutschland

Moderne Fertigungsprozesse in der produzierenden Industrie sind hochautomatisiert und informatisiert. Vor dem Hintergrund einer immensen Datenverfügbarkeit stößt der Mensch nun an seine Grenzen diese Prozesse zu kontrollieren und gezielt zu steuern. Bayesische Methoden aus dem Bereich der Astrophysik machen es möglich den Menschen hier zu unterstützen und Handlungsempfehlungen zu ermitteln.

AKPIK 2.6 Di 18:25 70 - HS 00.107

Stand der Initiative für ein Analyse- und Datenzentrum in der Astroteilchenphysik — •Andreas Haungs[1] und viele Andere[2] — [1]Karlsruher Institut für Technologie - IKP — [2]deutsche Astroteilchenphysik-Gemeinschaft

In einem 2017 erschienenen White Paper des Komitee für Astroteilchenphysik in Deutschland (KAT) mit dem Titel 'Astroteilchenphysik im Licht der Digitalen Agenda der Bundesregierung' wurden notwendige Strategieentwicklungen für die kommenden Jahre beschrieben. Eine dedizierte Digitale Agenda ist aufgrund der geografischen und experimentellen Vielfalt grundlegend für die Astroteilchenphysik. Für eine effektive Umsetzung mit Nutzen für Wissenschaft und Gesellschaft sind vier strategische Punkte definiert: I. Einrichtung eines oder mehrerer nationaler Rechenzentren. II. Entwicklung von Methoden zur Erhaltung der Messdaten. III. Entwicklung und Weiterentwicklung von Anwendungen moderner Methoden in der Datenanalyse. IV. Auf- und Ausbau von Kursen zur Ausbildung des wissenschaftlichen Nachwuchses in modernen Analysemethoden.

Ziel der Initiative eines Analyse- und Datenzentrums in der Astroteilchenphysik ist es, ein interdisziplinäres Konzept zu entwickeln und umzusetzen, das den Bedürfnissen der Digitalisierung des Forschungsfeldes gerecht wird und auch für die Gesellschaft attraktiv ist. Ziel ist eine effizientere Analyse der Daten, die in verschiedenen, weltweit verstreuten Observatorien gewonnen wurden (Multi-Messenger-Analysen), sowie eine moderne Ausbildung zum Big Data Wissenschaftler in der Synergie zwischen Grundlagenforschung und Informationsgesellschaft.

AKPIK 3: Mitgliederversammlung des Arbeitskreises Physik, moderne Informationstechnologie und Künstliche Intelligenz

Zeit: Dienstag 18:50–19:20 Raum: 70 - HS 00.107

30 min. MV