Arbeitskreis Physik, moderne Informationstechnologie und Künstliche Intelligenz (AKPIK)

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Der AKPIK ist ein Forum für das fachübergreifende Thema *Data Science* mit seinen physikrelevanten Aspekten wie z.B. Big Data Analysemethoden, Informationstheorie und -technologie, maschinelles Lernen, künstliche Intelligenz, Robotik, intelligente Sensoren oder Technikfolgenabschätzung.

Übersicht der Hauptvorträge und Fachsitzungen

(HS 6 und HS 10)

Tutorium

AKPIK 1.1	Mo	9:00–12:00	H06	**Tutorial: Introduction to Data Analysis and Machine Learning** — •Maximilian Nöthe, Kai Arno Brügge

Fachsitzungen

AKPIK 1.1–1.1	Mo	9:00–12:00	H06	**AKPIK Machine-Learning Tutorial**
AKPIK 2.1–2.11	Di	16:00–17:50	H10	**Machine-learning methods and computing in particle physics**
AKPIK 3.1–3.11	Mi	16:00–17:50	H06	**Machine-learning methods and computing in astroparticle physics**
AKPIK 4.1–4.3	Mi	18:00–18:30	C.A.R.L. Foyer EG	**Postersession AKPIK**
AKPIK 5	Mi	18:30–19:00	H06	**Mitgliederversammlung AKPIK**

Mitgliederversammlung Arbeitskreis Physik, moderne Informationstechnologie und Künstliche Intelligenz

Mittwoch 18:30–19:00 HS 6

- Bericht 2018
- Ausblick 2019
- Wahl des neuen Vorsitzenden
- Mitteilungen und Verschiedenes
- Diskussion

AKPIK 1: AKPIK Machine-Learning Tutorial

Zeit: Montag 9:00–12:00 Raum: H06

Tutorium AKPIK 1.1 Mo 9:00 H06
Tutorial: Introduction to Data Analysis and Machine Learning — •Maximilian Nöthe and Kai Arno Brügge — Exp. Physik 5, TU Dortmund, Germany

Data analysis using machine learning is an integral part in most areas of experimental high energy physics.

In this tutorial targeted at beginners, we will teach you the basics of the most common machine learning algorithms using the scientific python stack, most importantly pandas for data preparation and scikit-learn for Machine Learning.

The tutorial will cover several supervised machine learning algorithms, e. g. using example physics data from Imaging Air Cherenkov Astronomy.

Participants should bring their Laptops with a working python 3 installation and download the example data files beforehand. Setup instructions will be available at https://github.com/tudo-astroparticlephysics/dpg2019-ml-tutorial

AKPIK 2: Machine-learning methods and computing in particle physics

Zeit: Dienstag 16:00–17:50 Raum: H10

AKPIK 2.1 Di 16:00 H10
Pixel detector background simulation using generative adversarial networks at Belle II — •Matej Srebre — Ludwig-Maximilians-Universität München

The Pixel Vertex Detector (PXD) is an essential part of the Belle II experiment, allowing us to determinate the location of particle trajectories and decay vertices. The combined data from multiple detector subsystems along with PXD information is crucial in the event reconstruction phase to determine particle types, their tracks, and the decay chain. To model the effect of unwanted background noise on the track reconstruction in simulation we add simulated or recorded background data to the simulated detector signals from the generated physics process of interest. A large batch of statistically independent samples of background noise is required to not be biased by statistical fluctuations in the background data. The data from the PXD, however, is high in volume and requires a substantial amount of storage and bandwidth. As an efficient way of producing background noise we explore the idea of an on-demand noise generator using Generative Adversarial Networks.

AKPIK 2.2 Di 16:10 H10
Photon position reconstruction using Machine Learning with the Belle II electromagnetic calorimeter — •Yu Hu — DESY Notkestraße 85 22607 Hamburg

The Belle II experiment at the SuperKEKB accelerator in Tsukuba, Japan is the successor to the B factory experiment Belle at KEKB. In 2018, the experiment completed its first run of commissioning collisions, and is currently preparing for physics data taking later in 2019. The electromagnetic calorimeter of the Belle II detector is mainly used to measure photons from the decays of B mesons. This talk will describe a new neural networks based photon position reconstruction algorithm. This can improve the photon position resolution, the photon position bias, and has an impact on the reconstruction of pi0 decays.

AKPIK 2.3 Di 16:20 H10
Analysis of GERDA detector surface events with deep learning algorithms — •Péter Kicsiny for the GERDA-Collaboration — Max-Planck-Institut für Physik, München, Deutschland

The Gerda experiment searches for the neutrinoless double beta ($0\nu\beta\beta$) decay of the ^{76}Ge in high purity germanium detectors enriched in this isotope. The detectors are operated in liquid argon. A primary background source around the Q-value of the $0\nu\beta\beta$ decay ($Q_{\beta\beta} = 2039$ keV) are β-decays of ^{42}K resulting from the contamination of natural argon with the isotope ^{42}Ar. The β-particles from the decay deposit their energy close to the detector surface. The rejection of these events is currently performed by a one parameter cut based on the current pulse amplitude divided by the total energy. In order to identify surface β-events separated from Compton scattered γ-events, more sophisticated methods are investigated. Artificial neural networks with advanced deep learning architectures are becoming more efficient in such classification tasks. Preliminary results on surface event classification using deep learning algorithms will be discussed using training data from ^{39}Ar β-decays present in the background spectrum at low energies ($Q_{\beta} = 565$ keV).

AKPIK 2.4 Di 16:30 H10
Learning to rank Higgs-Boson candidates — •Lukas Pensel, Alexander Segner, Marius Köppel, Martin Wagener, Andreas Karwath, Christian Schmitt, and Stefan Kramer — Johannes Gutenberg University Mainz, Germany

The Higgs boson was discovered in July 2012 and the Nobel prize was awarded for its theoretical prediction of this boson subsequently in 2013. The current research focus is now on the precise measurement of the Higgs boson couplings and the search for possible deviations from the predictions by the standard model of particle physics in as many production and decay channels as possible. One of the interesting channels is the production of the Higgs Boson via vector boson fusion, with subsequent decay $H \to WW^* \to l\nu l\nu$. Since this channel, as well as many others, is limited by large background contributions, in this case dileptonic $t\bar{t}$ decays, maximizing the signal to background ratio is a crucial step in these analyses. Commonly, machine learning models using boosted decision trees and standard neural networks are trained to differentiate these signals from background. Machine learning approaches can also be employed for ranking problems aiming to sort a list according to the relevance labels of its elements. This can be done by pairwise comparison of all instances in the list. Recently, neuronal networks have been used for this task as well. Here, we present a method using such a pairwise approach from the field of *learning to rank* combined with neuronal networks to sort a list of Higgs-events, depending on their relevance class, into signal and background.

AKPIK 2.5 Di 16:40 H10
Refining the EXO-200 detector simulation using GANs — •Federico Bontempo, Johannes Link, Tobias Ziegler, Gisela Anton, and Thilo Michel — Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP

The EXO-200 experiment searches for the neutrinoless double beta ($0\nu\beta\beta$) decay of ^{136}Xe with a single-phase liquid xenon (LXe) time projection chamber (TPC) filled with enriched LXe. The TPC provides the deposited energy of events in LXe together with their 3D position. A GEANT4 Monte Carlo (MC) simulation is used to model the physics interactions and the resulting detector response. These simulations are crucial for most physics analyses. In this study, we apply Deep Learning methods, esp. Generative Adversarial Networks (GAN), to improve the MC simulations by reducing potential imprecisions compared to measurements. Improvements pave the way for applying other Deep Learning based methods that rely on an accurate detector modelling.

AKPIK 2.6 Di 16:50 H10
Event reconstruction in EXO-200 using Deep Learning — •Johannes Link, Federico Bontempo, Tobias Ziegler, Gisela Anton, and Thilo Michel — Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP

The EXO-200 experiment searches for the neutrinoless double beta decay ($0\nu\beta\beta$) of ^{136}Xe using a time projection chamber (TPC) filled with enriched liquid xenon. An event taking place in the TPC leads to secondary electrons and scintillation light. The electrons drift in an electric field, where in the first plane of wires the induction signal and in the second plane of wires the collection signal is measured. In this contribution, we present an alternative approach of event reconstruction using Deep Learning methods, e.g. Convolutional Neural Networks

(CNN). Raw collection and induction wire signals are used to reconstruct the energy and the position of events in the EXO-200 detector. We compare the performance of the Machine Learning approach to the conventional reconstruction in EXO-200.

AKPIK 2.7 Di 17:00 H10

Circuit Synthesis of the Kuramoto Model and Electrical Interpretation of its Synchronization Condition — Karlheinz Ochs[1], •Dennis Michaelis[1], Julian Roggendorf[1], Petro Feketa[2], Alexander Schaum[2], and Thomas Meurerer[2] — [1]Ruhr-University Bochum, Bochum, Germany — [2]Christian-Albrechts-Universität zu Kiel, Kiel, Germany

The authors present a circuit synthesis of the well-known Kuramoto model. It is a fundamental setup which consists of non-linearly coupled oscillators, making it an interesting subject in the context of synchronization. The circuit synthesis consists of synthesizing the oscillators first and then deriving a circuit of a general resistive interconnection network. Additionally, the standard Kuramoto model implies a strongly connected interconnection network which we generalize to an arbitrary connection topology. Based on the resulting electrical circuit, a sufficient synchronization condition is derived that coincides with the system-theoretic synchronization condition that is known from the literature. By interpreting the electrical quantities, simulation results explain in detail how the different kinds of synchronization known to be present in the Kuramoto model (zero-sum, anti-phase, complete synchronization) can occur. A simulation scenario focuses on an auxiliary oscillator aiding the transition from an anti-phase configuration to a state of complete synchronization. The structured approach of the synthesis and its electrical interpretation is seen as a general procedure to derive perspectives on neural networks, which typically require circuits for reasons of efficiency, low costs and high speed.

AKPIK 2.8 Di 17:10 H10

HfO_2-based Memristive Navigation Processor — Karlheinz Ochs, •Enver Solan, Dennis Michaelis, and Leonard Hilgers — Ruhr-University Bochum, Bochum, Germany

Mathematically complex optimization problems are historically interesting subjects of research. That is because convergence time of such problems does not scale well with the complexity. One of these problems is the np-hard navigations process problem, where the shortest path between an entry and an exit in a maze is desired. Electrical circuits are proper tools to solve this problem efficiently and the reasons are twofold. First, a current naturally chooses the path of least resistance in any given circuit, which is a desirable feature in this context. Second, electrical circuits are inherently massively parallel which lead to fast convergence times. To this end, a self-organizing electrical circuit with HfO_2-based resistive random access memory-cells (RRAM-cells) is proposed that obtains a solution within a convergence time that is linearly proportional to the length of the shortest path. RRAM-cells are known to have a fast switching behavior which is favorable for quick convergence. All necessary details on how to construct an arbitrarily sized maze and what occurs in the switching process of the RRAM-cells to obtain the optimal solution are presented. The authors also propose an emulator of the electrical circuit based on the wave digital method which could be implemented in embedded systems, e.g. digital signal processors or field programmable gate arrays. Different simulation scenarios confirm the previously derived theoretical results.

AKPIK 2.9 Di 17:20 H10

Universal Self-Organizing Logic Gates: A Wave Digital Emulation — Karlheinz Ochs, •Enver Solan, Dennis Michaelis, and Leon Schmitz — Ruhr-University Bochum, Bochum, Germany

Self-organizing logic gates are logic gates that can be operated in 'reverse' mode, meaning that every node can electively used as input or output node. This property can be exploited in the context of cryptographic methods, which rely on one-way functions. A commonly deployed one-way function in today's cryptographic approaches is the prime factorization where it is easy to check whether a given prime factorization results in a certain number, but it is difficult to obtain the prime factorization of a given number. In this work, the authors show a general electrical circuit with multiple memristors that can function as either a self-organzing or-gate or and-gate. It is known that it is possible to construct any logical conjunction with these two gates. The authors then exploit the wave digital method, which is known to preserve stability, to obtain a highly flexible emulator of the electrical circuit that for example could be implemented on a digital signal processor. This enables live parameter optimization and sensitivity analyses, making it a powerful tool to investigate different physical memristor models in this application. The simulation results verify a proper functioning of the emulator.

AKPIK 2.10 Di 17:30 H10

Solving the Np-complete Subset Sum Problem with an Electrical Circuit Using Physical Memristor Models — Karlheinz Ochs, Enver Solan, •Dennis Michaelis, and Maximilian Herbrechter — Ruhr-University Bochum, Bochum, Germany

Logic gates are the building blocks to set up any logical conjunction. To do so, they have predetermined input and output nodes. Subject to current research are self-organizing (SO) logic gates which can be operated 'backwards', meaning that the role of input and output nodes can be reversed. With this functionality, mathematically complex problems, such as np-hard or even np-complete problems, can potentially be solved efficiently. Such problems are utilized for cryptographic systems, where many of today's encryption techniques are based on the np-hard prime factorization. In the upcoming times of quantum computing, more sophisticated encryption techniques are required. One of the proposed methods for post-quantum systems in the literature is based on the np-complete subset sum problem. In this work, we show an electrical circuit that deploys models of real memristors to solve the subset sum problem for three 3-bit numbers. To this end, we utilize SO half- and full-adders, which consist of SO and- and xor-gates with HfO_2-based resistive random access memory cells. These devices are known to have rapid switching behavior, making them a suitable choice for solving complex optimization problems in a short amount of time. This could indicate that methods based on the subset sum-problem might not be sufficient to ensure proper encryption of data since memcomputing techniques exist to solve this problem efficiently.

AKPIK 2.11 Di 17:40 H10

Was ist Geometrische Algebra? Auf dem Weg zu einer modernen Mathematikausbildung in der Ingenieurinformatik — •Martin Erik Horn — Hochschule für Technik und Wirtschaft Berlin

Konforme geometrische Strukturen werden in der Informatik zur Animation, zur Simulation, zur Mustererkennung sowie in der Robotik zur Steuerung von Bewegungsabläufen und in zahlreichen weiteren Bereichen eingesetzt. Die Mathematik konformer geometrischer Strukturen sollte deshalb auch elementarer Bestandteil der Informatikausbildung sein.

Diese mathematische Richtung kann – beispielsweise auf der Grundlage von Ansätzen wie www.phydid.de/index.php/phydid-b/article/view/550 – physikalisch fundiert werden. Im Vortrag wird dieser Ansatz vorgestellt und gezeigt, wie die Geometrische Algebra unter Rückgriff auf physikalische Erklärungsmuster der Pauli- und Dirac-Algebra in einem Mathematikkurs des Bachelor-Studiengangs Ingenieurinformatik eingeführt und diskutiert wurde.

AKPIK 3: Machine-learning methods and computing in astroparticle physics

Zeit: Mittwoch 16:00–17:50 Raum: H06

AKPIK 3.1 Mi 16:00 H06

Exploring Optical Properties of Antarctic Ice with IceCube Using Gradient Descent — •Alexander Harnisch for the IceCube-Collaboration — TU Dortmund

The IceCube Neutrino Observatory detects Cherenkov photons emitted by charged particles passing through the antarctic ice. The properties of light propagation in and around the detector must be well understood to be able to learn about the interacting particles and their sources. This talk gives an overview of how to use in-situ light sources to derive ice model parameters by performing gradient descent optimization instead of grid searches. To be able to do so, it is necessary to differentiate the photon propagation simulation. Here we present a working method to differentiate the simulation with respect to absorption coefficients. The derived gradient is fed to an optimizer which performs gradient descent optimization to find the best fitting coefficients.

AKPIK 3.2 Mi 16:10 H06

Possible ways to improve the DeepCore NMO analysis — •Jan Weldert and Sebastian Böser for the IceCube-Collaboration — JGU, Mainz, Germany

The neutrino mass ordering (NMO) is one of the driving questions in the field of neutrino physics. The NMO sensitivity potential of atmospheric neutrino detectors like the IceCube low energy extension DeepCore is limited by the achievable resolutions.
Two of the most promising ways to increase the DeepCore NMO sensitivity are:

1) Relaxing the background cuts to increase the number of events considered in the analysis

2) A better classification of the different event types (current track-like and cascade-like events).

While improvements in both of these are likely computationally expensive, the analysis of future detectors/detector upgrades will also benefit from advances made for current detectors.
This talk will discuss the potential of these improvements and possible ways to realize them, especially focusing on the application of neural networks to classify low energetic DeepCore events.

AKPIK 3.3 Mi 16:20 H06

Using ANNs to Find Anomalies in Waveforms Detected by IceCube — •Max Pernklau for the IceCube-Collaboration — Lehrstuhl für Experimentelle Physik Vb, TU Dortmund, Germany

Modern particle detectors such as the IceCube Neutrino Observatory produce large amounts of data. Almost all events detected are background events, so stringent cuts are made to ensure a usable signal-to-noise ratio. That means only phenomena which are actively searched for can be discovered, since events that cannot be properly reconstructed are removed from the analysis.

This talk deals with the viability of using artificial neural networks to search for anomalies in low-level waveform data produced by photomultiplier tubes. Unsupervised learners like Autoencoders are employed to detect unusual waveforms caused by e.g. double pulses or hardware artifacts. This approach seems promising as prior knowledge about the shape of the outlier waveforms is not required. Results might lead to a better understanding of possible detector artifacts.

AKPIK 3.4 Mi 16:30 H06

Determination of Antarctic Ice Parameters Using a Neural Network — •Sebastian Bange, Mirco Hünnefeld, and Alexander Harnisch for the IceCube-Collaboration — TU Dortmund, Dortmund, Deutschland

The IceCube Neutrino Observatory uses digital optical modules to detect Cherenkov photons emitted by particles on their way through the detector. They use the available antarctic ice as a medium for the particles to react in. It naturally shows depth dependent und a priori unknown effects on how it changes the path of the photons. This talk gives an overview on how to use a neural network to obtain the scattering coefficients for the currently used ice model. This works approach is to approximate the waveform of the detected photons by inputting the scattering coefficients. The network can then be reversed to obtain the scattering coefficients belonging to one specific waveform.

AKPIK 3.5 Mi 16:40 H06

Search for new Source Populations with Autoencoding Neural Networks — •Simone Mender, Tobias Hoinka, and Kevin Schmidt — TU Dortmund

Active Galactic Nuclei (AGN) are astrophysical objects, whose emission range covers the entire electromagnetic spectrum. Based on the observations in different wavelengths, various source catalogs were published. In these catalogs, lots of unclassified sources are included. For example, the Fermi-LAT third source catalog (3FGL) contains 1010 unassociated sources.

In order to classify these sources, machine learning methods can be applied. With the use of supervised learning, it is possible to enlarge well-known source populations. To find new populations, unsupervised learning is a promising approach. Unknown source populations are expected to feature different characteristics compared to well-known populations. For outlier detection, an autoencoding neural network is a useful unsupervised machine learning technique. In this talk, we present our results of the application of autoencoding neural networks to gamma-ray and radio datasets.

AKPIK 3.6 Mi 16:50 H06

Cascade Reconstruction in IceCube using Generative Neural Networks — •Mirco Huennefeld, Tobias Hoinka, Jan Soedingrekso, Sebastian Bange, and Alexander Harnisch for the IceCube-Collaboration — TU Dortmund, Dortmund, Deutschland

Reliable and accurate reconstruction methods are vital to the success of high-energy physics experiments such as IceCube. Machine learning based techniques, in particular deep neural networks, can provide a viable alternative to maximum-likelihood methods. Most common neural network architectures originate from non-physical domains such as image recognition. While these methods can enhance the reconstruction performance in IceCube, there is much potential for tailored techniques. In the typical physics use-case, many symmetries, invariances and prior knowledge exist in the data, which are yet to be exploited by current network architectures. Novel and specialized deep learning-based reconstruction techniques are desired which can leverage the physics potential of experiments like IceCube. A new approach using generative neural networks for the reconstruction of cascade-like events in IceCube is presented.

AKPIK 3.7 Mi 17:00 H06

Towards online triggering for the radio detection of air showers using deep neural networks — •Florian Führer[1,2] and Anne Zilles[1] — [1]Institut d'Astrophysique de Paris — [2]Institut Lagrange de Paris

The future Giant Radio Array for Neutrino Detection (GRAND) is designed as a huge standalone radio array to detect UHE neutrinos.

The detection of air-shower events induced by high-energetic particles via the emitted radio signals only requires the development of a trigger algorithm for a clean discrimination between signal and background events.

In this contribution we will describe an approach to trigger air-shower events on a single-antenna level as well as performing an online reconstruction of the shower parameters using neural networks. If time permits we will outline strategies to compress and hence speed-up the evaluation of neural networks, hence allowing to apply neural network based triggers in real-time.

AKPIK 3.8 Mi 17:10 H06

German-Russian Astroparticle Data Life Cycle Initiative — •Victoria Tokareva for the KRAD/APPDS-Collaboration — Institut für Kernphysik, Karlsruher Institut für Technologie, DE-76021 Karlsruhe, Germany

Data life cycle (DLC) is a high-level data processing pipeline that involves data acquisition, event reconstruction, data analysis, publication, archiving, and sharing. While such approach to data management is widespread in HEP experiments, such as CMS, ALICE, COMPASS, Belle-2, LHCb, etc., it is still not the case for the astroparticle physics community, and no conventional approach has been developed for that purpose yet.

According to Astroparticle Physics European Consortium, the joint data rate for modern astroparticle experiments is comparable to the one for the LHC, and tends to grow significantly in the nearest future. Meanwhile, the studies of rare phenomena in the approach of multi-messenger astronomy make it crucial to develop field-specific solutions for the joint analysis of data.

The German-Russian Astroparticle Data Life Cycle Initiative is a joint project aiming at the development of a concept and creation of a DLC prototype that takes into account the data processing features specific for the astroparticle physics.

The work was financially supported by Russian Science Foundation Grant 18-41-06003 (Sections 2 and 3) and Helmholtz Society Grant HRSF-0027.

AKPIK 3.9 Mi 17:20 H06

Benchmarking of compute resources — •Benoit Roland, Felix Buehrer, Anton Gamel, and Markus Schumacher — Albert Ludwigs Universitaet Freiburg, Freiburg, Germany

The high luminosity phase of the LHC will be accompanied by a considerable increase in the need of compute resources and storage. In addition to dedicated GRID-sites, opportunistic resources can be used to fulfill the increasing requirements. These resources are heteroge- neous and their rapid classification is useful for an efficient utilization. The use of fast benchmarks as representative of CPU workload for GRID activity is presented within this context, with the aim to provide site monitoring and prompt matching between workload and available compute resources. The performance of several fast benchmarks have been studied and compared to the one of the legacy HEP-SPEC06 suite. The results have been obtained for different system configura- tions, with a particular focus on the behavior of the benchmarks when hyperthreading is active and their performance loss when virtualiza- tion is used.

AKPIK 3.10 Mi 17:30 H06

Highly parallel CORSIKA processing — •Dominik Baack — TU Dortmund, Dortmund, Germany

The increasing amount of simulation necessary for an effective analysis in the high energy regime requires new approaches for the optimization of the existing simulation software like CORSIKA.

The dominating factor for the simulations including Cherenkov photons is the creation and propagation of those. With more than half of the overall runtime and billions of executions for each shower this part benefits heavily from any possible optimization. The approach taken for the acceleration of this part is the parallel implementation in OpenCL. This can be used on CPU or even faster on specialized hardware like GPUs.

The second approach focuses on the distribution of a single simulation over multiple independent nodes over the network with the ZeroMQ library. This allows the parallel work of multiple nodes of different architecture on a single shower or the control of multiple independent showers via a single control instance. Optimization focusing on low power usage allows the distribution over hundreds of low power ARM cores via a central computing node.

The methods used and first results of different experiments done will be shown.

AKPIK 3.11 Mi 17:40 H06

Resistive Plate Chamber (RPC) tests as muon detector — •Victor Barbosa Martins[1], Vitor de Souza[2], Luis Lopes[3], and Sofia Andringa[4] — [1]IFSC- USP, São Carlos, Brasilien, now at DESY, Zeuthen, Deutschland — [2]IFSC - USP, São Carlos, Brasilien — [3]LIP, Coimbra, Portugal — [4]LIP, Lissabon, Portugal

Cosmic rays are the most energetic particles in the universe. Their production, propagation, and detection are objects of numerous studies. Surface detectors aim to identify particles from extensive air showers (EAS), which are the result of cosmic rays interacting with the atmosphere. Resistive Plate Chambers (RPCs) have shown to be a suitable muon detector to be integrated into the Pierre Auger Observatory. Data from RPCs by the Pierre Auger Collaboration in Coimbra (POR) were analyzed. The detector efficiency to muons was calculated and is approximately 88%, which is in good agreement with the values quoted in the literature. Direction maps were built to investigate the muon incoming direction and the quantity of matter traversed by the muons. The dependence of the muon flux on the zenith angle was calculated and compared with results from simulations. A square cosine dependence is expected, though it is seen that the building structure has enough matter to block some of the incident muons and alter the dependence curve. The total muon flux was estimated based on the detector efficiencies and solid angle and then compared with the literature. The results show an absorption by the building of approximately 77% of the incident muons.

AKPIK 4: Postersession AKPIK

Zeit: Mittwoch 18:00–18:30 Raum: C.A.R.L. Foyer EG

AKPIK 4.1 Mi 18:00 C.A.R.L. Foyer EG

Towards Realizing Machine Learning Using Spin Qubits based on GaAs — •Zheng Zeng[1], Yulin Hu[2], Beata Kardynał[1], and Anke Schmeink[2] — [1]Peter Grünberg Institute (PGI-9), Forschungszentrum Jülich, D-52425 Jülich, Germany — [2]Theoretische Informationstechnik, RWTH Aachen University, D-52056 Aachen, Germany

Machine learning (ML) has been a powerful tool for executing advanced inference tasks. Recently, implementing ML on a powerful quantum computer becomes an attractive research filed as it has been shown that quantum computers exhibit square-root and even exponential speedups over classical computers in some machine learning methods based on quantum algorithms. Different from classical computers, quantum computers are able to process information using effects like quantum coherence and entanglement. Therefore, as a basic unit of quantum computation, a qubit has a high information capacity, i.e., it could carry much more information than a classical bit. In this work, we are motivated to investigate a possibility to improve the performance of ML programs by utilizing the high information capacity characteristic of qubits. In particular, we provide a case study to realize a neural network via a set of a few spin qubits. We propose a protocol to encode the training set of the neural network by manipulating the spin qubits on the Bloch sphere using radio frequency (RF) pulses, and finally evaluate the performance of the neural network.

AKPIK 4.2 Mi 18:00 C.A.R.L. Foyer EG

The Influence of Labeling Statistics on Supervised Learning — •Christian Haase-Schuetz — Institute of Radio Frequency Engineering and Electronics, Karlsruhe Institute of Technology

Recent progress in Deep Learning is based on Supervised Learning. Deep Neural Networks (DNNs) used as powerful function approximators learn a mapping from inputs x to labels y, i.e. $\mathrm{DNN}(x) = \hat{y}$. Training progress is based on the suitably measured distance of the predicted label $\hat{y}$ to the reference label y. The distance is measured using a cost function $C(y, \hat{y})$. While these algorithms have proven to be useful in a large number of applications for some of them it is tedious and expensive to generate the reference labels y. Often human annotators are involved in creating the reference labels y. There is a non-zero probability of human annotators creating reference labels that are incomplete or flawed.
Let y^* be the perfect label, for each sample i we assume $y_i = y_i^* \pm \Delta y_i$ where $\Delta y_i \sim N(0, \sigma)$ is called labeling noise and follows a normal distribution. Varying σ enables to study the performance of the network a function of the labeling noise i.e. $\min_{\text{training}} C(y^*, \hat{y})[\sigma]$. We do so for a classification and a regression setting.

AKPIK 4.3 Mi 18:00 C.A.R.L. Foyer EG

Study of direct CP-violation in B → K π with Belle II - Overview and Prospects — •Benedikt Wach for the Belle 2-Collaboration — Max-Planck-Institut fuer Physik, Muenchen, Deutschland

Although the Standard Model (SM) is an established and well-tested theory, mysteries such as the matter-antimatter-asymmetry call for new physics lying beyond. The Belle II experiment will help to test theoretical predictions, provide necessary experimental input and look for non-SM phenomena.

With an expected integrated luminosity 50 times that of its precursor Belle, the Belle II experiment will allow to measure the flavor dynamics of B-meson decays with unprecedented precision.

Charmless B meson decays to K-π final states represent a powerful tool to better understand B decay mechanisms and further provide excellent sensitivity for new physics, in particular, phenomena related to CPV.

An overview of the basic concepts of charge-parity violation (CPV) in the B meson sector is given, focusing on neutral and charged B → K π decay channels. Furthermore, a prospect for Belle II is provided, taking into account the expected increase in integrated luminosity.

AKPIK 5: Mitgliederversammlung AKPIK

Zeit: Mittwoch 18:30–19:00 Raum: H06

TOPs: Bericht 2018, Ausblick 2019, Wahl des neuen Vorsitzenden, Mitteilungen und Verschiedenes, Diskussion