T 87: Datenanalyse

Zeit: Donnerstag 16:30–19:00 Raum: Z6 - SR 2.005

T 87.1 Do 16:30 Z6 - SR 2.005

Adversarial networks used in a single-top-quark analysis in ATLAS — •Rui Zhang and Ian C. Brock — Rheinische Friedrich-Wilhelms-Universität Bonn

Multivariate analysis (MVA) techniques are widely used in high energy physics to separate interesting signal processes from a large amount of background events. The training of the MVA is usually done using nominal signal and background samples. However, the imperfect knowledge of the detector performance and physics model results in the presence of systematic uncertainties that affect the classifier. A step further would be to construct a classifier insensitive to systematic variations, which are usually parametrised by nuisance parameters (NP). Adversarial networks, which consist of a system of neural networks contesting each other, are a clear candidate to solve such problem. This talk will investigate the possibilities of using this technique in a single-top-quark analysis in ATLAS. Monte Carlo events are split into training and test samples for both nominal and systematic variations. Adversarial networks are built by Keras, where the discriminative network is trying to distinguish signal and backgrounds while cheating the generative network, which tries to predict NP values.

T 87.2 Do 16:45 Z6 - SR 2.005

Modernized track reconstruction in ATLAS with the ACTS software project — •Paul Gessinger[1,2], Andreas Salzburger[2], and Stefan Tapprogge[1] — [1]Johannes Gutenberg-Universität Mainz — [2]CERN

Track reconstruction is the process of forming particle trajectories from individual track detector measurements in specialized tracking geometries. In presence of high event activity, e.g. due to pile-up, it is usually the most CPU intensive part of event reconstruction. The LHC experiments have led successful data taking campaigns during the first LHC runs and continuously improved the event reconstruction software. However, the planned increase of pile-up for the high luminosity LHC era and beyond will create the need for further optimization. The ACTS (A Common Tracking Software) project aims to encapsulate the current ATLAS tracking software, and apply modern language patterns and computing concepts. A central strategy is to allow concurrent usage of the ACTS toolkit in order to react to future computing architectures. Eventual re-integration into the ATLAS software suite is one of the primary goals. This talk will focus on the improvements which ACTS enables, and establishes a proof-of-concept which demonstrates that current and future ATLAS tracking geometries can be accommodated.

T 87.3 Do 17:00 Z6 - SR 2.005

Deep Learning mit unbalancierten Datensätzen — •Stefan Geisselsöder für die ANTARES-KM3NeT-Erlangen-Kollaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP

Deep Learning bezeichnet eine gegenwärtig in vielen Anwendungsbereichen sehr erfolgreiche und flexibel einsetzbare Gruppe von Algorithmen, die einen hohen Grad an automatisch erzielter Abstraktion gemeinsam haben. Gleichzeitig benötigen moderne Großexperimente in der Teilchenphysik oft unerreichte Präzision bei ihren Messungen um auch subdominante Effekte beobachten zu können. Die dabei simulierten und gemessenen, oft sehr großen Datensätze sind zwar einerseits gut zur Verarbeitung mit Deep Learning geeignet, andererseits sind sie häufig sehr unbalanciert. Beispielsweise können viele, für eine angestrebte Datenanalyse aber unerhebliche Daten enthalten sein, ein Energiespektrum resultiert in unterschiedlich vielen Ereignisse für verschiedene Energiebereiche oder möglicherweise besonders interessante Extremfälle sind selten.

Der Vortrag vergleicht Methoden, wie das Training und die Anwendung von Convolutional Neural Networks an diese stark unbalancierten Datensätze angepasst werden können, um eine möglichst hohe Genauigkeit bei der Datenanalyse zu erzielen. Die Vergleiche werden teilweise anhand von Simulationen für das KM3NeT Neutrinoteleskop gezeigt, das gegenwärtig am Grund des Mittelmeeres im Aufbau ist.

T 87.4 Do 17:15 Z6 - SR 2.005

Distributed make-like Analyses on the Grid based on Spotify's Pipelining Package luigi — •Marcel Rieger, Martin Erdmann, Benjamin Fischer, and Ralf Florian von Cube — III. Physikalisches Institut A, RWTH Aachen University

In particle physics, workflow management systems are primarily used as tailored solutions in dedicated areas such as Monte Carlo production. However, physicists performing data analyses are usually required to steer their individual workflows manually which is time- consuming and often leads to undocumented relations between particular workloads. We present the luigi analysis workflow (law) Python package which is based on the open- source pipelining package luigi, originally developed by Spotify. It entails a generic analysis design pattern with make-like execution allowing for the definition of arbitrary workloads and all dependencies between them in a scalable structure which shifts the focus from executing to defining an analysis. To cope with the sophisticated demands of end-to-end HEP analyses, it provides remote execution on WLCG infrastructure, remote file access through Grid File Access Library (GFAL2), and a software sandboxing mechanism with support for Docker and Singularity containers. The novel approach was successfully applied in a ttH cross section measurement with CMS.

T 87.5 Do 17:30 Z6 - SR 2.005

KM3NeT/ORCA data analysis using unsupervised Deep Learning — •Stefan Reck for the ANTARES-KM3NeT-Erlangen-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP

KM3NeT/ORCA is a water-Cherenkov neutrino detector, currently under construction in the Mediterranean Sea at a depth of 2450 meters. Its main goal will be to determine the neutrino mass hierarchy by measuring the energy- and zenith angle dependency of the oscillation probabilities of atmospheric neutrinos after travelling through the Earth.

Deep Learning provides a promising method to analyse the signatures produced by the particles travelling through the detector. A common point of critique of the popular supervised Deep Learning techniques is their dependency on simulated data. If this data contains features that deviate from measured data, networks can become sensitive to them, and their performance on measurements will fall behind expectations. Ultimately, the network might fixate on effects only present in the simulations, or become unaware of properties of measured data.

This talk will cover an unsupervised learning approach with convolutional autoencoders, which tackles the problem of learning unwanted features by making it possible to train large parts of the network on measured data.

T 87.6 Do 17:45 Z6 - SR 2.005

Jet-Rekonstruktion mit neuronalen Netzen im ATLAS Level-1 Kalorimeter Trigger — •Bastian Schlag[1], Volker Büscher[1], Christian Schmitt[1], Stefan Kramer[2] und Andreas Karwath[2] — [1]Institut für Physik, Johannes Gutenberg Universität Mainz — [2]Institut für Informatik, Johannes Gutenberg Universität Mainz

In den kommenden Ausbaustufen des LHCs werden Schwerpunktsenergie und Luminosität weiter steigen. Die Entwicklung neuer Methoden zur Jet-Rekonstruktion in der ersten Stufe des FPGA-basierten ATLAS-Triggersystems ist somit essentiell, um eine effiziente Selektion gewünschter Ereignisse gewährleisten zu können.

Fasst man die Kalorimeter-Informationen als zweidimensionales Bild auf, so sind moderne Verfahren der Bilderkennung wie *Convolutional Deep Neural Networks* vielversprechende Kandidaten für diese komplexe Aufgabe. Hierbei müssen 40 Millionen Bilder pro Sekunde analysiert werden, wobei pro Bild lediglich eine Zeit von max. 125ns zur Verfügung steht. Die angestrebte Implementierung auf FPGAs beschränkt zudem die Architektur des neuronalen Netzes sowie die verfügbaren Aktivierungsfunktionen.

Ziel ist es, ein neuronales Netz zu entwickeln, welches die konventionellen Methoden der Jet-Rekonstruktion im Level-1 Trigger übertrifft und zugleich eine mögliche Implementierung auf FPGAs gestattet. Im Vortrag wird der aktuelle Stand der Arbeit präsentiert.

T 87.7 Do 18:00 Z6 - SR 2.005

Studies on Convolutional Neural Networks with deconvolution methods on galaxy image data — •Andriy Borovkov, Christoph Garbers, Peter Schleper, and Hartmut Stadie —

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Machine learning tools advance in different areas of science, not least in particle physics. Therefore it is crucial to get a deeper understanding of its mechanisms especially with regard to future applications in particle physics. As convolutional neural networks are the main tools for visual data classifications, different studies on these networks have been performed. The focus is on deconvolution methods to visualize the learned classification rules. For these studies image data of galaxies from the Galaxy Zoo has been used as an example.

T 87.8 Do 18:15 Z6 - SR 2.005

Studies for Top Quark Reconstruction with Deep Learning — •Tim Kallage, Johannes Erdmann, Olaf Nackenhorst, and Kevin Kröninger — TU Dortmund, Experimentelle Physik IV

Deep learning techniques are attracting attention in recent years and show potential in high energy physics applications. In analyses of $t\bar{t}$ processes, a reconstruction of the association of measured jets to partons in the decay topology is often useful. A deep neural network approach for this goal is presented in this talk for semileptonic $t\bar{t}$ decays. The algorithm is trained and tested on pp collisions at $\sqrt{s} = 13$ TeV using a simplified simulation of the ATLAS detector. The performance is studied and compared with a commonly used kinematic likelihood fit (KLFitter).

T 87.9 Do 18:30 Z6 - SR 2.005

Jet-Klassifizierung mithilfe von „domain adaption“ in tiefen künstlichen neuronalen Netzen — Matthias Mozer, Thomas Müller und •David Walter — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Am CMS-Experiment beim LHC entstehen beim hadronischen Zerfall von hochenergetischen Teilchen wie Quarks und Gluonen Teilchenschauer, sogenannte Jets, die nur schwer ihren Ausgangsteilchen zuzuordnen sind. Bei der höheren Schwerpunktsenergie von $\sqrt{s} = 13\,\text{TeV}$ bei Run II steigt außerdem die Wahrscheinlichkeit, dass mehrere Zerfallsteilchen als ein Jet rekonstruiert werden (z.B. $\mathrm{Z} \rightarrow \mathrm{b\bar{b}} \rightarrow$ Jet).

Mit multivariaten Verfahren wird versucht diese Jets ihren Ausgangsteilchen zuzuordnen. Eine recht neue Methode mit künstlichen neuronalen Netzen liefert bisher bei simulierten Daten gute Ergebnisse. Die Klassifizierung auf Messdatenaten ist im Vergleich dazu schlechter. Unter der Zuhilfenahme von Informationen aus den Messdaten beim Training solcher Netze soll versucht werden, die Übereinstimmung von Simulation und Daten zu verbessern.

T 87.10 Do 18:45 Z6 - SR 2.005

Tau neutrino appearance studies with KM3NeT-ORCA using Deep Learning techniques — •Michael Moser for the ANTARES-KM3NeT-Erlangen-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP

An important open question in neutrino physics is the unitarity of the PMNS matrix. Currently, the uncertainties on several matrix elements are too large to draw significant conclusions on the unitarity. This is mostly due to the low experimental statistics in the tau neutrino sector.

KM3NeT-ORCA is a water Cherenkov detector under construction with several megatons of instrumented volume. It will observe about 2400 tau neutrinos per year and it will significantly improve the available tau neutrino statistics. In ORCA, tau neutrinos will be identified by observing a statistical excess of cascade-like events with respect to the electron neutrino expectation from the atmosphere. Hence, the development of an algorithm for the separation of track-like ($\nu_\mu - CC$) and cascade-like (other flavors) neutrino events is necessary.

Currently, event properties inspired by the different event types are used with shallow machine learning, in order to discriminate the two classes. Recent advances in computational performance have made it possible to employ deep artificial neural networks. In this approach, the experimental raw data is used for training a deep neural network. Here, the network builds a representation of the typical event properties that can be exploited to distinguish track-like from shower-like events. In this talk, the current status of the ORCA deep learning efforts with respect to the measurement of tau neutrino appearance is presented.