T 54: Data, AI, Computing, Electronics V (Anomaly Detection, Event Selection)

Time: Wednesday 16:15–18:15 Location: VG 2.101

T 54.1 Wed 16:15 VG 2.101

Latest developments of CATHODE — •Tore von Schwartz, Gregor Kasieczka, Louis Moureaux, Chitrakshee Yede, and Manuel Sommerhalder — Institut für Experimentalphysik, Universität Hamburg

Despite an extensive search program at the LHC, no hints for new physics have been found so far. Anomaly detection has been introduced as a bridge between generic searches and searches targeting a specific signal. CATHODE as a model-agnostic anomaly detection method is designed to enhance resonant signals in the smoothly falling dijet invariant mass spectrum. It has been applied in the latest CMS anomaly search. We present the most recent developments to CATHODE improving its reliability and versatility in uncovering potential new physics signals.

T 54.2 Wed 16:30 VG 2.101

Anomaly Detection Using Machine Learning at Belle II — •David Giesegh, Nikolai Krug, and Thomas Kuhr — LMU Munich, Germany

In modern High Energy Physics, searches for New Physics are often inspired by specific theoretical models suggesting extensions to the Standard Model. Since, as of yet, none of these could be experimentally verified, the question arises if we are looking in the wrong places. For this reason recent years have seen increasing interest in model-agnostic alternatives to classical analyses, among them Machine Learning assisted methods such as Anomaly Detection. In this project we explored the application of two specific Anomaly Detection procedures based on autoencoders and density estimation at the Belle II Experiment. It could be shown on simulated data scenarios that both methods have the potential to increase the visibility of an unknown small signal on realistic backgrounds, providing a proof of concept for further development of such methods at Belle II.

T 54.3 Wed 16:45 VG 2.101

BGNet: A neural network for real-time background prediction and decomposition for Belle II — •Yannik Buch, Ariane Frey, Benjamin Schwenker, and Lukas Herzberg — Georg-August-Universität Göttingen, Göttingen, Deutschland

The Belle II detector investigates the b-sector by measuring the decays of the $\Upsilon(4S)$ resonance. These resonances are produced by the SuperKEKB accelerator at KEK in Tsukuba, Japan. The goal of SuperKEKB is to achieve an instantaneous luminosity of 6.5×10^{35} $\mathrm{cm}^{-2}\mathrm{s}^{-1}$. Currently, a luminosity of 5×10^{34} $\mathrm{cm}^{-2}\mathrm{s}^{-1}$ is reached, showing that considerable improvements to the beam focusing and increases of the ring currents are still necessary. At the same time, however, the Belle II detector must not be damaged or its performance compromised by extensive radiation and hit rates. The beam backgrounds at Belle II are mostly composed of storage backgrounds, luminosity-based backgrounds and injection backgrounds of both rings due to continuous top-up injections. BGNet is trained to predict the overall hit rates and their decomposition in terms of background source for various Belle II sub-detectors.

The input data for BGNet are 1 Hz time series of diagnostic variables describing the state of the SuperKEKB collider subsystems. Using real-time data from the EPICS slow control system BGNet can be used to obtain a real-time beam background decomposition, enabling diagnostic background monitoring for all beam background components simultaneously.

T 54.4 Wed 17:00 VG 2.101

Using End-to-End Optimized Summary Statistics in IceCube — •Oliver Janik and Christian Haack — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg

The characterization of the astrophysical neutrino flux with the IceCube Neutrino Observatory traditionally relies on a binned forward-folding likelihood approach. However, this method is constrained by the need for sufficient Monte Carlo (MC) statistics in each bin, which limits both the granularity and dimensionality of the binning scheme. By employing a neural network to learn a one-dimensional summary statistic, it becomes possible to optimize the binning scheme for the analysis while maintaining adequate MC statistics per bin. This, for example, allows the use of a larger number of observables in order to improve the analysis performance. The talk will go into detail on the application of end-to-end optimized summary statistics in the context of analyzing and characterizing the galactic neutrino flux.

T 54.5 Wed 17:15 VG 2.101

Novel Event Selection Techniques to Discriminate between Proton Decay and Atmospheric Neutrino Backgrounds in JUNO — •Korbinian Stangler, Ulrike Fahrendholz, Lothar Oberauer, and Carsten Dittrich — TUM School of Natural Sciences, Physics Department, James-Franck-Str. 1, 85748 Garching

The Jiangmen Underground Neutrino Observatory (JUNO) is a large liquid scintillator detector, capable of searching for the hypothetical proton decay $p \to \bar{\nu}K^+$, which is predicted by supersymmetric Grand Unified Theories. As the momentum of the daughter kaon is below the Cherenkov threshold in water, JUNO will be able to provide competitive results in comparison to the current partial lifetime limit of $\tau > 5.9 \cdot 10^{33}$ years, established by the Super-Kamiokande collaboration.

This talk presents a new machine-learning based strategy to discriminate proton decay events from atmospheric neutrino interactions in JUNO. From the resulting estimated sensitivity on $p \to \bar{\nu}K^+$, an improvement of the vertex reconstruction algorithm is suggested.

T 54.6 Wed 17:30 VG 2.101

Sterile Neutrino Search with Neural Networks at KATRIN — •Luca Fallböhmer for the KATRIN-Collaboration — Technical University Munich

The KATRIN experiment aims to search for keV sterile neutrinos in the full beta decay spectrum of tritium using the TRISTAN detector and DAQ system after the end of the neutrino mass measurement. Thanks to the high source activity of KATRIN, a sterile neutrino signature can be probed down to the parts per million level. Because the modelling of the deep differential tritium spectrum is very complex and the involved Monte Carlo simulations require long computing times to reach the necessary statistics, a fit of the sterile parameters is very challenging with the current model. Thus, neural networks are used to search directly for the sterile neutrino signature. In this talk, we demonstrate the sensitivity of the neural network method to the sterile neutrino signature. Additionally, we discuss the robustness of the neural network approach in the presence of experimental effects, their uncertainties, and modelling inaccuracies.

T 54.7 Wed 17:45 VG 2.101

Enhancing the identification of $HH \to b\bar{b}b\bar{b}$ by Triplet Learning — •Bao Tai Le, Lars Linden, Otmar Biebel, Stephanie Götz, Celine Stauch, Valerio D'Amico, and Tim Rexrodt — Ludwig-Maximilians-Universität, München, Deutschland

In recent years various machine learning techniques have proven to be quite successful in particle physics replacing old methodology and introducing new ways of thinking. One of those ways is Triplet Training. Its appeal comes from its resilience against noisy data by forming a more salient feature space leading to better categorization performances across many different categorization architectures.The production of a pair of Higgs bosons is possible due to the Higgs self interaction. However, the cross section of this process is tiny and the largest branching ratio of the Higgs decay involves bottom quarks which are also abundantly produced by strong interaction in proton-proton collisions. Even though bottom quark jets can be identified e.g. by secondary decay vertices, it is an experimental challenge to maintain a high efficiency to identify the four b-quark jets from a $HH \to 4b$ event. Due to the resilience of Triplet Learning against noisy data its application seems promising for enhancing the identification efficiency of $HH \to 4b$ events.

T 54.8 Wed 18:00 VG 2.101

MVA Based Selection for $B \to K_S\,(\pi^+\pi^-)\,l^+\,l^-$ — Ariane Frey[1], Thibaud Humair[1,2], •Dennis Rodermund[1], and Benjamin Schwenker[1] — [1]II. Physikalisches Institut, Georg-August-Universität Göttingen, 37073 Göttingen, Germany — [2]Deutsches Elektronen Synchrotron (DESY), 22607 Hamburg, Germany

Decays of B mesons mediated by a $b \to s\,l\,l$ transition are of high

interest to search for physics beyond the Standard Model. The CP-violation content of such transitions has however been explored very little to date. The $B \to K_s\, l\, l$ transitions allow for measuring the CP-violation in the interference with mixing. This decay has a very small branching fraction and hence a good selection is needed in order to isolate signal events.

This talk focuses on the selection based on a BDT. The BDT takes event- and particle based variables like Fox-Wolfram moments or angular distributions as input and tries to predict if the considered event is either signal or background. A sophisticated BDT model thus provides a way to separate signal and background processes based on the BDT output, making further analyses possible.