AKPIK 4: Neural Networks II

Time: Wednesday 15:45–17:00 Location: ZEU/0118

AKPIK 4.1 Wed 15:45 ZEU/0118

Morphological Classification of Radio Galaxies with wGAN-supported Augmentation — •Janis Kummer[1,3], Florian Griese[1,4,5], Lennart Rustige[1,2], Kerstin Borras[2,6], Marcus Brüggen[3], Patrick Connor[1,7], Frank Gaede[2], Gregor Kasieczka[7], Tobias Knopp[4,5], and Peter Schleper[7] — [1]Center for Data and Computing in Natural Sciences (CDCS), Hamburg, German — [2]Deutsches Elektronen-Synchrotron DESY, Hamburg, German — [3]Hamburger Sternwarte, Hamburg, Germany — [4]University Medical Center Hamburg-Eppendorf, Hamburg, Germany — [5]Hamburg University of Technology,Hamburg, Germany — [6]RWTH Aachen University, Aachen, Germany — [7]Universität Hamburg, Hamburg, German

Supervised deep learning models for the morphological classification of radio galaxies are very important for processing the data of future large radio surveys. However, labelled training data for such models is limited. We demonstrate the use of generative models, specifically a Wasserstein Generative Adversarial Network (wGAN), to generate artificial data for different classes of radio galaxies. Further, we study the impact of augmenting the training data with images from our wGAN on different classification architectures. We find that it is indeed possible to improve models for the morphological classification of radio galaxies with this technique. In addition, fast simulations of radio galaxies with our wGAN are useful to validate new interferometric machine-learning algorithms.

AKPIK 4.2 Wed 16:00 ZEU/0118

Uncertainty estimations for deep learning-based imaging — •Felix Geyer, Arne Poggenpohl, and Kevin Schmidt — Astroparticle Physics WG Elsässer, TU Dortmund University, Germany

Radio interferometry is used to monitor and observe distant astronomical sources and objects with high resolution. Especially Very Long Baseline Interferometry (VLBI) allows for achieving the highest resolutions by combining the data of multiple telescopes. This results in an effective diameter corresponding to the greatest distance between two telescopes. The taken data consists of visibilities in Fourier space, which depend on the baselines between the telescopes. Because the distribution of these baselines is sparse, the sample of visibilities is incomplete. After transforming this sample to spatial space, this so-called "dirty image" is inadequate for physical inference and analyses.

In traditional methods, the image then undergoes an elongated and mostly manually performed cleaning process in order to remove background artifacts and restore the original source distribution. Contrary, a new and fast approach to reconstructing missing data reasonably is using neural networks. As an additional advantage, these networks can also be used to estimate the uncertainty of the prediction. This is done by not only predicting the mean value of the pixels but also the standard deviation by feeding the input and the prediction to a separate network. All of this is part of our framework called `radionets`, which is another focus of this talk.

AKPIK 4.3 Wed 16:15 ZEU/0118

Partition Pooling for Convolutional Graph Network Applications in Particle Physics — •Philipp Soldin, Markus Bachlechner, Thilo Birkenfeld, Achim Stahl, and Christopher Wiebusch — III. Physikalisches Institut B, RWTH Aachen University

Convolutional Neural Networks (CNN) are often used in particle physics applications for classification and reconstruction tasks. Since the individual sensors in a particle detector are often arranged in complex geometries, the information must be projected onto regular grids to use CNNs. Convolutional Graph Networks (CGN) can encode the individual sensor positions as a static graph to prevent projection effects. However, with the number of sensors in modern particle physics detectors, the CGN performance can be limited by the considerable number of parameters. A dimensionality reduction scheme analogous to conventional pooling on images that uses graph partitioning to create pooling kernels is presented. Different CGN architectures, including partition pooling, are presented with an exemplary vertex reconstruction in an idealized neutrino detector.

AKPIK 4.4 Wed 16:30 ZEU/0118

Gamma Source Detection using Deep Multitask Networks and Noisy Label Learning — •Lukas Pfahler — TU Dortmund University, Artificial Intelligence Group, Dortmund, Germany

Machine learning has been established as an effective tool for data analysis in modern high energy particle experiments. For the FACT telescope, we solve three supervised learning tasks - gamma-hadron separation, energy estimation, and origin estimation - using simulated training data and manual feature extraction. We outline how we can replace the manual feature engineering currently applied with a learned representation trained with multitask supervision. Our approach will train a shared representation that can solve all three prediction tasks with specialized prediction networks build on top of the shared representation. Furthermore, we look into an alternative source of supervision that reduces the burden of simulating training data by using real telescope recordings. We rely on the concept of noisy labels and introduce a novel method for learning under label noise where only one noise rate is known. We show how gamma-hadron separation can be framed in this setting and illustrate that the method allows us to train accurate classifiers.

AKPIK 4.5 Wed 16:45 ZEU/0118

Binary Black Hole Parameter Estimation using Deep Neural Networks — •Markus Bachlechner, David Bertram, Philipp Otto, Oliver Pooth, and Achim Stahl — III. Physikalisches Institut B, RWTH Aachen

As the first of the third-generation of gravitational wave detectors, the proposed Einstein Telescope is expected to be at least an order of magnitude more sensitive compared to current interferometers like LIGO and Virgo. On the one hand, the higher sensitivity increases the observable volume. On the other hand, high sensitivity in the low-frequency band leads to significantly earlier detection and observation for some coalescences like binary neutron stars. These early observations make it possible to send multi-messenger alerts before the merger. Applying a fast analysis handling event detection, classification, and estimation in real time is essential. This talk presents an approach for parameter estimation of binary black holes using deep neural networks.