AKPIK 4: Simulation and Workflows

Time: Friday 9:00–10:30 Location: Theo 0.134

AKPIK 4.1 Fri 9:00 Theo 0.134

Integration of a data centre for high-energy astroparticle physics in PUNCH4NFDI infrastructure — •Victoria Tokareva — Karlsruhe Institute of Technology, Institute for Astroparticle Physics, 76021 Karlsruhe, Germany

The PUNCH4NFDI (Particle, Universe, NuClei and Hadrons for Nationale Forschungsdaten Infrastruktur) consortium brings together experts from astro-, nuclear, astroparticle and particle physics to develop an infrastructure and tools for data-intensive research. The PUNCH4NFDI Science Data Platform (SDP) aims to provide users with access to the data resources of the data providers participating in the consortium, while offering advanced features such as enhanced search capabilities for data objects, support for reproducible workflows, and online data analysis.

One such data provider is the KCDC (KASCADE Cosmic-ray Data Centre). Established in 2013, KCDC was the first online platform to provide full open access to data from the high-energy astroparticle physics experiment KASCADE and its successor KASCADE-Grande. Over time, its scope expanded to include data from other astroparticle physics experiments as well as a wider range of digital objects such as simulations, software codes, user manuals, tutorials, and cosmic-ray spectra. This contribution shows the status of the integration of KCDC's data objects into the PUNCH4NFDI SDP, addresses encountered challenges, and describes strategies and technical solutions chosen for this purpose. This work is partially supported by the DFG fund 'NFDI 39/1' for the PUNCH4NFDI consortium.

AKPIK 4.2 Fri 9:15 Theo 0.134

The Lecture Notes Makeover with AI — •Soraya Thiess, Ilya Segal, and Mikhail Mikhasenko — Ruhr University Bochum, Bochum, Germany

Artificial intelligence is rapidly advancing, offering powerful tools to automate and enhance various workflows. This research project aims to accelerate the creation of scientific scriptures with the use of Large Language Models (LLM). We use a programming interface (API) to an advanced LLM provided by OpenAI to transform raw lecture material, like audio transcriptions and handwritten notes, into well-phrased and organized formats. In a multi-step process, beginning with the segmentation of the input into distinct topics, the content gets rephrased to enhance readability while ensuring contextual accuracy by addressing any out-of-place terminology. The user can choose the desired output format, such as Markdown or LaTeX, and incorporate images afterwards. While designed for the input of audio transcriptions and notes of hadronphysics lectures, this model could be adapted for any field requiring the transformation of spoken or handwritten content into structured, publication-ready material.

AKPIK 4.3 Fri 9:30 Theo 0.134

Parametrizing workflows with ParaO and Luigi — Martin Erdmann and •Benjamin Fischer — III. Physikalisches Institut A, RWTH Aachen University

Workflow tools provide the means to codify complex multi-step processes, thus enabling reproducibility, preservation, and reinterpretation efforts. Their powerful bookkeeping also directly supports the research process, especially where intermediate results are produced, inspected, and iterated upon frequently.

In Luigi, such a complex workflow graph is composed of individual tasks that depend on one another, where every part can be customized at runtime through parametrization. However, Luigi falls short with regards to the steering of parameters, accounting for the consequences thereof, and the modification or reuse of task graphs.

This is where the parameter handling of ParaO shines: it has vastly extended key mechanics and value coercion while automatically propagating their effects throughout the task graph. Since the dependencies are described through parameters too, the same principles can be used to freely alter or transplant (parts of) the task graph, thereby empowering reuse. At the same time, ParaO remains largely compatible with plain Luigi and packages building upon it, such as Law.

AKPIK 4.4 Fri 9:45 Theo 0.134

Simulation of radio galaxies with 2D Gaussian distributions — •Christian Arauner, Anno Knierim, Tom Gross, and Kevin Schmitz — TU Dortmund University, Dortmund, Germany

Radio interferometry enables high-resolution observations of astronomical objects. Due to the incomplete coverage of the (u, v) space, these observations are very noisy. The state of the art cleaning algorithms are time-consuming and not scalable for the expected data volumes of the next gen telescopes As an alternative, neural networks can be used, which can automate and accelerate the cleaning of many measurements. However, training a neural network requires large amounts of training data that have the same properties as the observed objects.

Due to the fact that neural networks are a new approach, there are still very few simulations of training data. The observations from the MOJAVE archive are particularly suitable for the development of simulation software. The archive comprises a large data set of high-quality data that has been measured over a long period of time under similar conditions. The individual components of the galaxies can be generated with multidimensional Gaussian distributions, and a complete galaxy can be simulated from the sum of the components.

In this talk, I will present a novel approach to simulate radio galaxies with multidimensional Gaussian distributions.

AKPIK 4.5 Fri 10:00 Theo 0.134

Simulating Polarisation in Radio Interferometry Experiments Using pyvisgen — •Anno Knierim, Christian Arauner, and Kevin Schmitz — TU Dortmund University, Dortmund, Germany

Recent approaches in radio astronomy aim to improve image cleaning in radio interferometry measurements using machine learning techniques. Reconstructing sources using these novel techniques has the advantage of being agnostic to initial parameters used in traditional cleaning algorithms.

The radionets project is a deep-learning framework developed at TU Dortmund University. The goal is to reconstruct calibrated observations with convolutional neural networks to produce high-resolution images. Deep learning approaches such as radionets require large amounts of training and validation data. One approach to simulating the required datasets is provided by the simulation tool pyvisgen.

pyvisgen utilises the Radio Interferometer Measurement Equation (RIME) to represent the measurement process of a radio interferometer. It produces images suitable as input to train deep-learning-based cleaning approaches. This talk presents the recent implementation of polarisation effects on radio waves.

AKPIK 4.6 Fri 10:15 Theo 0.134

Binary Black Hole Parameter Estimation using a Conditioned Normalizing Flow — •Markus Bachlechner and Achim Stahl — III. Physikalisches Institut B, RWTH Aachen

The proposed Einstein Telescope is the first of the third-generation gravitational wave detectors. It is expected to reach a noise level at least an order of magnitude lower than current interferometers like LIGO and Virgo. The thus improved sensitivity increases the observable volume and extends the time window in which the inspiral phase of binary systems is measurable. To analyze the resulting vast amounts of data efficiently, Neural Networks (NNs) can be utilized. This talk presents a fast Binary Black Hole parameter reconstruction by applying a conventional convolutional NN which conditions a subsequent Normalizing Flow (NF). Using the NF, an approximated posterior parameter distribution on an event-by-event basis is obtained, and thus uncertainties can be estimated.