AKPIK 1: Poster

Time: Monday 16:00–18:00 Location: HSZ OG2

AKPIK 1.1 Mon 16:00 HSZ OG2

Learning Electron Bunch Distribution along a Beamline by Normalising Flows — •Anna Willmann[1], Jurjen Couperus Cabadağ[1], Yen-Yu Chang[1], Richard Pausch[1], Amin Ghaith[1,4], Alexander Debus[1], Arie Irman[1], Michael Bussmann[2], Ulrich Schramm[1,3], and Nico Hoffmann[1] — [1]Helmholtz Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Center for Advanced Systems Understanding, Görlitz, Germany — [3]Technische Universität Dresden, Germany — [4]Synchrotron SOLEIL, Saint-Aubin, Germany

Understanding and control of Laser-driven Free Electron Lasers remain to be difficult problems that require highly intensive experimental and theoretical research. The gap between simulated and experimentally collected data might complicate studies and interpretation of obtained results. In this work we developed a deep learning based surrogate that could help to fill in this gap. We introduce a surrogate model based on normalising flows for conditional phase-space representation of electron clouds in a FEL beamline. Achieved results let us discuss further benefits and limitations in exploitability of the models to gain deeper understanding of fundamental processes within a beamline.

AKPIK 1.2 Mon 16:00 HSZ OG2

Predicting volatile wind energy: Stochastic forward modeling and machine learning — Juan Medina, •Marten Klein, Mark Simon Schöps, and Heiko Schmidt — BTU Cottbus-Senftenberg, Cottbus, Germany

Forecasting power output from wind farms is a standing challenge due to complex dynamical processes in the atmospheric boundary layer that manifest themselves by a strong spatio-temporal variability of the wind field. Statistical postprocessing of numerical weather prediction (NWP) ensemble data using machine learning, e.g., by multivariate Gaussian regression, has been utilized to estimate the probability of power ramp events for near-future power grid regulation. However, predictions on the scale of single turbines are not possible demonstrating that there is a lack in modeling for short-term forecasting. In this contribution, this lack is addressed by an economical stochastic modeling approach that autonomously evolves vertical profiles of the wind velocity and temperature. The model aims to reproduce turbulent cascade phenomenology by a stochastic process, respecting fundamental physical conservation principles in a dimensionally reduced setting. As a first step, standalone model predictions of wind field fluctuations in weakly and strongly stratified atmospheric conditions are analyzed by conventional and event-based statistics, including clustering and regression of model output. Forthcoming research aims at developing an economical tool for physics-informed downscaling of NWP data. Coupling with wind power plant models and abstraction by neural networks might hence provide additional physical details to power grid models.

AKPIK 1.3 Mon 16:00 HSZ OG2

Amortized Bayesian Inference of GISAXS Data with Normalizing Flows — •Maksim Zhdanov[1], Lisa Randolph[2], Thomas Kluge[1], Motoaki Nakatsutsumi[2], Christian Gutt[3], Michael Bussmann[5], Marina Ganeva[4], and Nico Hoffmann[1] — [1]HZDR, Dresden, Germany — [2]European XFEL, Germany — [3]University of Siegen, Siegen, Germany — [4]Forschungszentrum Jülich, Jülich, Germany — [5]CASUS, Görlitz, Germany

Grazing-Incidence Small-Angle X-ray Scattering (GISAXS) is a modern imaging technique used in material research to study nanoscale materials. Reconstruction of the parameters of an imaged object imposes an ill-posed inverse problem that is further complicated when only an in-plane GISAXS signal is available. Traditionally used inference algorithms such as Approximate Bayesian Computation (ABC) rely on computationally expensive scattering simulation software, rendering analysis highly time-consuming. We propose a simulation-based framework that combines variational auto-encoders and normalizing flows to estimate the posterior distribution of object parameters given its GISAXS data. We apply the inference pipeline to experimental data and demonstrate that our method reduces the inference cost by orders of magnitude while producing consistent results with ABC.

AKPIK 1.4 Mon 16:00 HSZ OG2

Control System for Autonomous Race Car — •Vadim Melnik — Bolshaya Semenovskaya str., 38, Moscow, Russia

Self-driving cars help significantly improve safety, universal access, convenience, efficiency, and reduced costs. In order to fulfill SAE level 4 autonomy, no driver must be required, even in emergency situations and under heavy weather conditions. Despite the fact that major part of autonomous driving on public roads will happen in standard situations, a critical aspect to reach full autonomy is the ability to operate a vehicle close to its limits of handling, i.e. in avoidance maneuvers or in case of slippery surfaces.

Testing such systems on closed tracks or in simulators reduces the risks of human injury.

The proposed system uses path planning algorithm based on the information received from cameras and LiDAR, estimates its position using IMU and linear algebra methods, and is controlled by Model Predictive Control technique. Successful completion of tests in simulator allows the system to be transferred to a real vehicle to proceed to live tests and data validation.

AKPIK 1.5 Mon 16:00 HSZ OG2

Quantum machine learning for calorimeter data generation — •Alexis-Harilaos Verney-Provatas[1,2], Kerstin Borras[1,2], and Dirk Krücker[1] — [1]DESY, Hamburg, Germany — [2]RWTH Aachen, Aachen, Germany

Rapid advances in Quantum Computing technology promise applications in a number of computational problems relevant to a wide range of scientific disciplines. Calorimeter simulation is crucial to Experimental High Energy Physics analyses. However, due to the rising computational cost of traditional simulation methods, machine learning has become a tool used to accelerate data generation. Calorimeter data exhibits strong correlations, which many classical machine learning models struggle to recreate. Properties of quantum states, such as entanglement, which directly imply strong correlations, may be a tool for capturing the full data complexity. Preliminary models, using hybrid Quantum-Classical machine learning architectures are presented and explored.