IN2P3/IRFU Machine Learning workshop

Rapport sur les contributions

https://indico.in2p3.fr/e/20187

ID de Contribution: **3** Type: **Non spécifié**

Generative Adversarial Networks for Fast Simulation in ATLAS

mercredi 22 janvier 2020 11:55 (30 minutes)

Accurate simulations of a showers from particles from the Large Hadron Collider in the ATLAS calorimeter are incredibly resource intensive, consuming the largest fraction of CPU time on the CERN computing grid. Generative Adversarial Networks, where one Generative Network is trained to fool two Adversarial Networks are investigated as a scalable solution for modelling the response of the electromagnetic calorimeter for photons over a range of energies. Steps have been taken to inject detailed knowledge about the detector geometry as well as physics metrics of importance into the training procedure of the network. The synthesised showers show good agreement to showers from a computationally expensive full detector simulation using Geant4. They also show good agreement on several new complex physics variable distributions that are only possible to study after integrating the trained generative model into the ATLAS software. Timing studies indicate at least three orders of magnitude improvement in speed when showers are generated in serial on a CPU. For the first time, the integration into the ATLAS software allows a fair comparison with more traditional fast simulation techniques developed by a team of physicists over the past years in ATLAS. This study demonstrates the potential of using such deep learning algorithms as a scalable solution for fast detector simulation in the future.

Auteurs principaux: GHOSH, Aishik (LAL); ROUSSEAU, David (LAL-Orsay)

Orateur: GHOSH, Aishik (LAL)

Classification de thématique: ML for simulation and surrogate model : Application of Machine Learning to simulation or other cases where it is deemed to replace an existing complex model

ID de Contribution: **4** Type: **Non spécifié**

Measuring Quantum Interference in the Off-shell Higgs to 4 Leptons by Learning the Likelihood Ratio

jeudi 23 janvier 2020 15:15 (25 minutes)

The traditional methods of training a classifier to separate signal and background events for measurement of a theory parameter break down in the context of quantum interference between signal and background processes. How can we train a Machine Learning model without the concept of labels?
A first feasibility study is performed to bringing the recently developed Likelihood-free inference based Madminer methods to ATLAS for the off-shell Higgs to four leptons signal strength measurement. Advantages of this method might include an optimal method for various values of the signal strength, training without class labels, as well as the possibility to have a machine learning method be aware of certain systematic uncertainties. We show that a machine learning algorithm that is aware of the physics at the full range of the theory parameter performs better at constraining the measurement compared to an algorithm only aware of the physics near the Standard Model.

Auteurs principaux: GHOSH, Aishik (LAL); ROUSSEAU, David (LAL-Orsay)

Orateur: GHOSH, Aishik (LAL)

Classification de thématique: ML for analysis : Application of Machine Learning to analysis, event classification and fundamental parameters inference

ID de Contribution: **5** Type: **Non spécifié**

Using DNNs and Keras for the W mass precise measurement

jeudi 23 janvier 2020 14:50 (25 minutes)

The precise measurement of the W boson mass is an important task from both experimental and theoretical point of view. One of the key observables for the measurement is called hadronic recoil. It allows to reconstruct the W pT spectrum based on the calorimeter response to the particle flow objects that compensate the W pT. Due to the calorimeter resolution effects the hadronic recoil also introduces a considerable uncertainty into the result.
The usage of deep neural networks to calibrate the hadronic recoil allows to improve the the precision in both W mass and W pT spectrum measurement.

Orateur: KHANDOGA, Mykola (CEA)

Classification de thématique: ML for analysis : Application of Machine Learning to analysis, event classification and fundamental parameters inference

ID de Contribution: **6** Type: **Non spécifié**

Search for New Physics using semi-supervised ML techniques

jeudi 23 janvier 2020 11:45 (25 minutes)

Preliminary studies for model-independent search for new physics at the LHC will be presented in the context of anomaly detection by training semi-supervised methods (e.g. autoencoders). The use-case of a search for a dijet resonance on a QCD background will be considered using toy datasets (Delphes sample and the LHC Olympics 2020 data).

Auteurs principaux: DONINI, Julien (UBP/LPC/IN2P3); VASLIN, Louis (LPC Clermont); DINU, Ioan (INFIN-HH / LPC)

Orateurs: DONINI, Julien (UBP/LPC/IN2P3); VASLIN, Louis (LPC Clermont); DINU, Ioan (INFIN-HH / LPC)

Classification de thématique: ML for analysis : Application of Machine Learning to analysis, event classification and fundamental parameters inference

ID de Contribution: **7** Type: **Non spécifié**

Using an Optical Processing Unit for tracking and calorimetry at the LHC

jeudi 23 janvier 2020 12:10 (25 minutes)

The High Luminosity Large Hadron Collider is expected to have a 10 times higher readout rate than the current state, significantly increasing the computational load required. It is then essential to explore new hardware paradigms. In this work we consider the Optical Processing Units (OPU) from LightOn, which compute random matrix multiplications on large datasets in an analog, fast and economic way, fostering faster machine learning results on a dataset of reduced dimension. We consider two case studies.

1) "Event classification": high energy proton collision at the Large Hadron Collider have been simulated, each collision being recorded as an image representing the energy flux in the detector. Two classes of events have been simulated: « signal » are created by a hypothetical supersymmetric particle, and « background » by known processes. The task is to train a classifier to separate the signal from the background. Several techniques using the OPU will be presented, compared with more classical particle physics approaches.

2) "Tracking": high energy proton collisions at the LHC yield billions of records with typically 100,000 3D points corresponding to the trajectory of 10.000 particles. Using two datasets from previous tracking challenges, we investigate the OPU potential to solve similar or related problems in high-energy physics, in terms of dimensionality reduction, data representation, and preliminary results.

Auteurs principaux: ROUSSEAU, David (LAL-Orsay); BASARA, Laurent (LAL/LRI, Université Paris Saclay); GHOSH, Aishik (LAL); BISWAS, Biswajit (LAL-Orsay)

Orateur: BASARA, Laurent (LAL/LRI, Université Paris Saclay)

Classification de thématique: ML for data reduction : Application of Machine Learning to data reduction, reconstruction, building/tagging of intermediate object

ID de Contribution: **8** Type: **Non spécifié**

GammaLearn: Deep learning applied to the Cherenkov Telescope Array data analysis

mercredi 22 janvier 2020 14:50 (25 minutes)

The Cherenkov Telescope Array (CTA) is the next generation of ground-based gamma-ray telescopes. Two arrays will be deployed composed of 19 telescopes in the Northern hemisphere and 99 telescopes in the Southern hemisphere. Observatory operations are planned to start in 2021 but CTA is currently in pre-production phase, prototypes already producing data, and first data from on site prototypes should be available already in 2019. Due to its very high sensitivity, CTA will record a tremendous amount of data that represent a computing challenge to the reconstruction software. Moreover, the vast majority of triggered events come from protons whereas only photons are of interest for the study of astrophysical sources.
Since the 2012 Imagenet breakthrough, deep learning advances have shown dramatic improvements in data analysis across a variety of experiments. These deep learning algorithms look particularly suited to the task of analysing CTA's simulated and real data. Moreover, the trained neural networks show very good computing performances during execution.
Here we present a deep multi-task learning architecture applied to CTA simulated data to perform the energy and direction reconstruction of the particles as well as the discrimination of gamma photons among cosmic rays. This architecture is implemented with indexed operations allowing to process specific CTA camera images without preprocessing.

Auteurs principaux: JACQUEMONT, Mikaël; Dr VUILLAUME, Thomas (LAPP, CNRS)

Co-auteurs: BENOIT, Alexandre; Prof. LAMBERT, Patrick (LISTIC, Université SAvoie Mont Blanc); Dr MAURIN, Gilles (LAPP - Université Savoie Mont-Blanc); LAMANNA, Giovanni (LAPP - IN2P3/CNRS)

Orateur: JACQUEMONT, Mikaël

Classification de thématique: ML for data reduction : Application of Machine Learning to data reduction, reconstruction, building/tagging of intermediate object

ID de Contribution: **9** Type: **Non spécifié**

Waveform Processing using Artificial Neural Networks

mercredi 22 janvier 2020 14:25 (25 minutes)

With the advent of digital electronics, signals from detectors can be sampled and processed by complex algorithms.
Such processing can be performed online, in FPGA and/or in computer farms.
In some cases, sampled signals are also registered on disk for offline re-processing : in nuclear physics, this is the case for the gamma-ray tracking array AGATA
and the neutron detector NEDA.
Machine Learning technics could be applied at different stages along the processing chain. We will present some results based on data from an AGATA/NEDA/DIAMANT
experiment , data on which several neural network architectures (Multilayer Perceptron, Convolutional Network and Long Short Term Memory) have been applied to performed neutron-gamma discrimination in NEDA.
Some studies on auto encoders, in particular for data reduction, anomaly detections and signal generation, will be presented. Foreseen applications of Machine Learning technologies will be also underlined.

Auteurs principaux: STEZOWSKI, Olivier (IP2I); BAULIEU, Guillaume (IP2I); FABIAN, Xavier (IPN Lyon); DUCROUX, Laurent (IPNL/UCBL); Dr DUDOUET, Jérémie (IP2I)

Orateur: STEZOWSKI, Olivier (IP2I)

Classification de thématique: ML for data reduction : Application of Machine Learning to data reduction, reconstruction, building/tagging of intermediate object

ID de Contribution: **10** Type: **Non spécifié**

Deblending galaxies with variational autoencoders

mercredi 22 janvier 2020 15:35 (25 minutes)

The apparent superposition of galaxies with other astrophysical objects along the line of sight, a problem known as blending, will be a major challenge for upcoming, ground-based, deep, photometric galaxy surveys, such as the Large Synoptic Survey Telescope (LSST). Blending contributes to the systematic error budget of weak lensing studies by perturbing object detection and affecting photometric and shape measurements. Existing deblenders suffer from the lack of flexible yet accurate models of galaxy morphologies and therefore rely on assumptions (analytic profiles, symmetry, sparsity in a profile basis) to isolate galaxies within a blended scene. In this paper, we propose instead to use generative models based on deep neural networks, namely variational autoencoders (VAE), to learn a Bayesian model directly from data, which we then use as a prior to perform deblending. Specifically, we train a VAE on images of centered, isolated galaxies, which we reuse in a second VAE-like neural network in charge of deblending galaxies. We train our networks on simulated images, created with the GalSim software from a catalog of Hubble Space Telescope observations in the COSMOS field, including all six LSST bandpass filters as well as the visible and near-infrared bands of the Euclid satellite, as our method naturally generalizes to multi-bands and multi-instruments data. We validate our model and quantify deblending performances by measuring reproduction errors in galaxy shapes and magnitudes, as a function of signal-to-noise ratio (SNR) and two blendedness metrics. We obtain median errors on ellipticities between ± 0.01 and on r-band magnitude between ± 0.05 in most cases and shear multiplicative biases under 10^{-2} in the optimal configuration. We also study the impact of decentering as deblending is tightly coupled to the detection pipeline performances and show the method to be robust, expectedly degrading with decentering and at low SNR. Finally, we discuss future challenges about training on real data (for instance from deep fields) and suggest to apply transfer learning.

Auteurs principaux: ARCELIN, Bastien (APC); Dr CYRILLE, Doux (University of Pennsylvania)

Co-auteurs: Dr AUBOURG, Eric (APC); Dr ROUCELLE, Cécille (APC)

Orateur: ARCELIN, Bastien (APC)

Classification de thématique: ML for analysis : Application of Machine Learning to analysis, event classification and fundamental parameters inference

ID de Contribution: **11** Type: **Non spécifié**

Deep learning in ATLAS ttH(H->bb) analysis

jeudi 23 janvier 2020 11:20 (25 minutes)

The associated ttH production was observed at the LHC in 2018, mostly driven by the multilepton and gammagamma final states. The H->bb final state remains so far elusive. The latest results from ATLAS in this channel rely on boosted decision trees, used to assign jets to partons and to separate the ttH signal from the main ttbar+HF background. In this talk several new ways to tackle this challenging analysis are investigated, using RNN based on jet combinations, testing the performance with low-level variables rather than physics-motivated ones, and integrating physics knowledge into the learning procedure via parse trees.

Auteurs principaux: COADOU, Yann (CPPM, Aix-Marseille Université, CNRS/IN2P3); GUO, Ziyu (CPPM)

Orateur: COADOU, Yann (CPPM, Aix-Marseille Université, CNRS/IN2P3)

Classification de thématique: ML for analysis : Application of Machine Learning to analysis, event classification and fundamental parameters inference

ID de Contribution: **12** Type: **Non spécifié**

Interpretable ML for CLAS12 data analysis: adaptation of Generalized Additive Models

jeudi 23 janvier 2020 14:00 (25 minutes)

The Generalized Parton Distributions (GPDs) describe the correlations between the transverse position and the longitudinal momentum of the partons (i.e. quarks and gluons) inside the nucleon. They can be extracted from exclusive inelastic processes, i.e. processes with a fully characterized final state. In the Hall B of the Jefferson Laboratory, the CLAS12 collaboration probes the inner structure of the proton by colliding 11 GeV electrons into a fixed proton target. Among the exclusive inelastic processes that are produced, we focus on the Deeply Virtual Compton Scattering (DVCS) in which the collided proton emits a high-energy photon. The objective is to be able to isolate these events in CLAS12 data, and notably separate the DVCS from mimicking exclusive Pi0 production events since Pi0 decays instantly into two photons.

We propose to use interpretable machine learning algorithms to perform event classification in CLAS12 data. Interpretable or transparent algorithms are preferred for the sake of trust or for further understanding the patterns in the data. Currently, Generalized Additive (Squared) Models (GAM and GA2M) are gaining interest in other application domains because of their ability to fit the data well while at the same being intelligible.

In this talk, we propose to introduce the GAM/GA2M and our improved versions better suited to our particular event classification task. We focus in particular on how to incorporate prior physics knowledge by building high-level variables that are the most relevant to the task and using assumptions on their distributions.

Auteurs principaux: CHERRIER, Noëlie (CEA, Irfu and LIST); DEFURNE, Maxime (CEA); POLI, Jean-Philippe (CEA LIST)

Orateur: CHERRIER, Noëlie (CEA, Irfu and LIST)

Classification de thématique: ML for analysis : Application of Machine Learning to analysis, event classification and fundamental parameters inference

ID de Contribution: **13** Type: **Non spécifié**

Impression from NeurIPS 2019 in Vancouver

mercredi 22 janvier 2020 17:35 (25 minutes)

How does it feel to be among the handful of physicists present in a 10k+ conference of experts in ML?

Auteurs principaux: COADOU, Yann (CPPM, Aix-Marseille Université, CNRS/IN2P3); Dr ISHIDA, Emille (LPC-UCA)

Orateur: COADOU, Yann (CPPM, Aix-Marseille Université, CNRS/IN2P3)

Classification de thématique: Special contribution

ID de Contribution: **14** Type: **Non spécifié**

School of Statistics 2020

jeudi 23 janvier 2020 10:00 (10 minutes)

The 2020 edition of the School on Statistical data analysis
will be held in South-eastern France near Marseille from May 11th to 15th, 2020. Block the date! The school targets PHD students, post-docs and senior scientists wishing to strengthen their knowledge or discover new methods in statistical analysis applied
in subatomic and astroparticle physics and cosmology.

The program will be available soon. Lectures will be given
in English and span from fundamental concepts to advanced topics. A special focus will be put on machine learning techniques and tools. A significant amount of time will be dedicated to hands-on sessions to introduce advanced tools (scikit-learn library, keras,
tensorflow, jupyter notebook, …) and their applications to our domain.

Information will appear on the school indico site:
https://indico.in2p3.fr/e/SOS2020.

Orateur: CRÉPÉ-RENAUDIN, Sabine (LPSC Grenoble; IN2P3-CNRS)

Classification de thématique: ML training, courses and tutorials

ID de Contribution: **15** Type: **Non spécifié**

Training of a Neural Network to Model the MYRRHA LEBT for Reliability Improvements

mercredi 22 janvier 2020 11:10 (30 minutes)

The MYRRHA (Multi-purpose hYbrid Research Reactor Reactor for High-tech Applications) linear accelerator has to meet very high reliability and stability requirements, i.e. during one operating cycle of 3 months a maximum of 10 beam trips longer than 3 seconds are allowed. To meet this requirements, multiple innovative solutions are planned such as redundancies and an optimized control system. This is especially the case for the tuning and control of the injector beam dynamics to minimize beam losses in the following elements of the linac. Here we present a potential solution by tuning a beam dynamics model of the MYRRHA low energy beam transport line based on neural network and supervised learning. The performances of a neural network trained using experimental data are presented and discussed.

Auteur principal: DEBONGNIE, Mathieu (ACS-LPSC)

Co-auteurs: BOULY, Frédéric (CNRS/IN2P3/LPSC); DE CONTO, Jean-Marie (LPSC/UGA); KOCHEBINA, Olga (ACS); DAVIN, François (SCK-CEN)

Orateur: DEBONGNIE, Mathieu (ACS-LPSC)

Classification de thématique: ML for particle accelerators

ID de Contribution: **16** Type: **Non spécifié**

(Machine) Learning the production cross sections of the Inert Doublet Model.

jeudi 23 janvier 2020 09:25 (25 minutes)

In phenomenological studies of BSM theories, the computation of production cross sections over large parameter spaces usually takes a large amount of time. A proposed solution is to build deep neural networks (DNN) that accurately predict the production cross sections of a given BSM model substantially reducing computational costs. In this contribution, I will present a status report on the implementation of a DNN applied to the Inert Doublet Model with this objective. Furthermore, I will comment on the ongoing project consisting on creating an open library of classifiers and regressors applied in particle physics phenomenology.

Auteurs principaux: REYES-GONZÁLEZ, Humberto (LPSC Grenoble); Dr LESSA, Andre (Universidade Federal do ABC, Santo André, Brazil.); Dr OTTEN, Sydney

Orateur: REYES-GONZÁLEZ, Humberto (LPSC Grenoble)

Classification de thématique: ML for phenomenology and theory

ID de Contribution: **17** Type: **Non spécifié**

ML study program for particle accelerators at IJCLAB

mercredi 22 janvier 2020 11:40 (15 minutes)

Our goal is investigation and demonstration of applicability and efficient use of Machine Learning (ML) techniques for advanced control and optimization of particle accelerators. With main effort concentrated on the application of novel algorithms to projects we already working on, we will qualify ML concepts for possible generalization and application for particle accelerators. Recently, ML has been successfully applied to a variety of real-world tasks for the scientific/engineering problems, which gives the justified indications of the success of the ML-based approaches for particle accelerators.

The advanced control and optimization techniques will be used to improve accelerators by solving following tasks: machine tuning and beam dynamics (ThomX), beam parameters extraction, dealing with noisy data; complex diagnostics and control of high intensity laser (LaserX, industries), which is crucial for the optimization operation of laser-plasma based accelerators; construction and training of virtual detectors for machine monitoring purposes.

Auteurs principaux: GULER, Hayg (LAL); KUBYTSKYI, Viacheslav

Orateurs: GULER, Hayg (LAL); KUBYTSKYI, Viacheslav

Classification de thématique: ML for particle accelerators

ID de Contribution: **18** Type: **Non spécifié**

Towards probabilistic models for capturing uncertainty

mercredi 22 janvier 2020 16:55 (25 minutes)

Many applications of machine learning in physics are currently limited by their lack of uncertainty propagation and estimation through the model. Such limitation can partly be overcome by shifting to the use of probabilistic models, which provide an output distribution instead of single values. I will show an example of such shift on image processing in astrophysics.

Auteur principal: BOUCAUD, Alexandre (APC / IN2P3)

Orateur: BOUCAUD, Alexandre (APC / IN2P3)

Classification de thématique: ML for data reduction : Application of Machine Learning to data reduction, reconstruction, building/tagging of intermediate object

ID de Contribution: **19** Type: **Non spécifié**

ML techniques for the WZ leptonic analyses in ATLAS

jeudi 23 janvier 2020 10:55 (25 minutes)

Measurements of production of multiple electroweak bosons at the LHC constitute a stringent test of the electroweak sector and provide model-independent means to search for new physics at the TeV scale.

In particular, the full leptonic WZ process is among the most suitable channels for such studies. This talk reviews some promising approches investigated to tackle the challenges specific to this channel in the context of the full LHC Run2 pp dataset collected by the ATLAS Experiment, totalling to ~140 fb^-1 at sqrt(s)=13TeV, which is a perfect playground to test the latest development in machine learning for particle physics.

Firstly, the presence of a leptonically decaying W requires the reconstruction of the unknown component along the beam axis of the neutrino momentum. This reconstruction can only be approximated. In this talk the possibility of using regression methods based on deep neural networks to estimate the neutrino longitudinal momentum is explored.

Additionally, as for the study of the WZ production through vector boson scattering is concerned, the modelling of the associated hadronic radiation by current Monte Carlo simulation presents large uncertainties. Methods based on adversarial neural networks in order to reduce the impact of such systematic uncertainties are investigated.

Last but not least, to fully exploit the kinematic information of the event to distinguish the electroweak production from the main sources of irreducible backgrounds (the dominant one being the WZjj production containing also QCD vertexes) specific neural network architectures that use the 4-momenta of the final state particles to extract discriminating features are tested.

Auteur principal: PORTALES, Louis (LAPP / USMB)

Co-auteur: COSTANZA, Francesco (LAPP)

Orateur: PORTALES, Louis (LAPP / USMB)

Classification de thématique: ML for analysis : Application of Machine Learning to analysis, event classification and fundamental parameters inference

ID de Contribution: **20** Type: **Non spécifié**

Application of Bayesian Convolutional Neural Network to spectral identification of radionuclides for nuclear monitoring

jeudi 23 janvier 2020 09:00 (25 minutes)

We apply artificial neural networks to spectral identification of radionuclides for nuclear monitoring of unknown scenes, which requires a fast and fully automatic remote sensing analysis.
We propose a new Bayesian Convolutional Neural Network (BCNN) architecture able to perform fast identification of radionuclides whose signal is recorded in a spectrum by means of a compact CdTe based imaging spectrometer, namely Caliste. Our BCNN is able to identify the presence of a source in a mixture of sources, with high precision even in a low counting statistics regime. In addition, we developed a process to estimate the uncertainty of the output of the algorithm. The learning database has been generated by using only synthetic datasets, simulated thanks to Geant4 and convolved with a simplified model of the response of the detector, allowing the detection of sources that the detector has never measured before.
We evaluated the performances of the synthetically trained network on real data registered in the lab with calibration sources. We recorded the event list with Caliste, developed by the astrophysics department of the CEA. Caliste is a 256 pixelated detector with 625 µm pitch. Each channel is an independent spectrometer and the data to be analysed are the calibrated sum of all single events recorded in all the channels. Caliste has an energy resolution of ~1% FWHM at 60 keV and 662 keV and operates in the range from 2 keV up to 1 MeV. We report on the precision and recall of our algorithm and demonstrate its capability of radionuclide identification. We applied the process to real-time measurements, running permanently our neural networks on the last acquired photons, illustrating its performance in case of moving sources or moving detector as this is relevant to robotic exploration of post-accidental scenes.

Auteur principal: DANIEL, Geoffrey (CEA/Irfu/DAp)

Co-auteurs: MEURIS, Aline (CEA/Saclay); MAIER, Daniel (CEA); CERAUDO, Francesco (INAF/IAPS); LIMOUSIN, Olivier (CEA SACLAY)

Orateur: DANIEL, Geoffrey (CEA/Irfu/DAp)

Classification de thématique: ML algorithms : Machine Learning development across applications

ID de Contribution: **21** Type: **Non spécifié**

Status and plan of the GPU farms of CC-IN2P3

mercredi 22 janvier 2020 17:20 (15 minutes)

In this talk, we will present the two currently available GPU farms available at the CC-IN2P3 Computing Center.
In the first part we will discuss both the hardware specifications of the farms, and the software environment available.
In a second part we will show the last year usage of the farms, and discuss the resources'requests for 2020.
Finally we will draw some conclusions and perspectives.

Auteur principal: RIGAUD, Bertrand (CC-IN2P3)

Co-auteur: GADRAT, Sébastien (CC-IN2P3)

Orateur: RIGAUD, Bertrand (CC-IN2P3)

Classification de thématique: ML infrastructure : Hardware and software for Machine Learning

ID de Contribution: **22** Type: **Non spécifié**

IN2P3ML

mercredi 22 janvier 2020 10:30 (20 minutes)

Orateur: ROUSSEAU, David (LAL-Orsay)

ID de Contribution: **23** Type: **Non spécifié**

InTheArt

mercredi 22 janvier 2020 10:50 (20 minutes)

Orateur: GAUTARD, Valérie (CEA-Irfu)

ID de Contribution: **26** Type: **Non spécifié**

Status and Plans of GPU farms at CEA

jeudi 23 janvier 2020 10:10 (15 minutes)

Orateur: HONORÉ, Pierre-François (CEA/DRF/Irfu - Université Paris Saclay)

ID de Contribution: **27** Type: **Non spécifié**

Ecole Machine Learning IN2P3/IRFU

jeudi 23 janvier 2020 09:50 (10 minutes)

Orateur: BOUVET, Françoise (IMNC)

ID de Contribution: **28** Type: **Non spécifié**

Denoising a data spectrum

jeudi 23 janvier 2020 14:25 (25 minutes)

Many of the searches for new physics consist in a bump hunt on invariant mass spectrum. In the cases for which the turn-on region may contain signal the usual fit methods do not apply.
This talk presents the first ingredients towards a fitting method, based on DNN, that would allow to fit the entire spectrum, from the turn-on to the tail.

Auteur principal: CALVET, Samuel (LPC)

Orateur: CALVET, Samuel (LPC)

Classification de thématique: ML for analysis : Application of Machine Learning to analysis, event classification and fundamental parameters inference

ID de Contribution: **29** Type: **Non spécifié**

Boosting performance in Machine Learning of Turbulent and Geophysical Flows via scale separation

mercredi 22 janvier 2020 16:30 (25 minutes)

Recent advances in statistical learning have opened the possibility to forecast the behavior of chaotic systems using recurrent neural networks. In this letter we investigate the applicability of this framework to geophysical flows, known to be intermittent and turbulent. We show that both turbulence and intermittency introduce severe limitations on the applicability of recurrent neural networks, both for short term forecasts as well as for the reconstruction of the underlying attractor. We test these ideas on global sea-level pressure data for the past 40 years, issued from the NCEP reanalysis datase, a proxy of the atmospheric circulation dynamics. The performance of recurrent neural network in predicting both short and long term behaviors rapidly drops when the systems are perturbed with noise. However, we found that a good predictability is partially recovered when scale separation is performed via a moving average filter. We suggest that possible strategies to overcome limitations should be based on separating the smooth large-scale dynamics, from the intermittent/turbulent features.

Auteur principal: FARANDA, Davide (Davide)

Orateur: FARANDA, Davide (Davide)

Classification de thématique: ML algorithms : Machine Learning development across applications

ID de Contribution: **31** Type: **Non spécifié**

Calorimeter reconstruction with computer vision at LHCb

mercredi 22 janvier 2020 15:15 (20 minutes)

LHCb is a single-arm forward spectrometer designed to study b-physics at the LHC. As the beam luminosity will increase in the upcoming years, new challenges are expected in reconstructing high density events. The electromagnetic calorimeter in particular will be subject to much larger occupancy and the overlap of showers is expected to drastically limit reconstruction efficiency with current methods. In this project we explore the potential for novel techniques in computer vision to improve reconstruction of EM showers in the LHCb detector. In the current starting phase of the project we are exploring simple solutions using CNNs, but we anticipate the non-uniform geometry of the LHCb calorimeter may pose problems given the translation invariance inductive bias of CNNs. Dealing with this issue may require more sophisticated models including Graph NNs and super-resolution techniques. In this talk I will give an overview of the motivation and status of the project.

Auteur principal: COELHO, Joao (IJCLab)

Orateur: COELHO, Joao (IJCLab)

Classification de thématique: ML for data reduction : Application of Machine Learning to data reduction, reconstruction, building/tagging of intermediate object

ID de Contribution: **32** Type: **Non spécifié**

Illustration of AI use in CEA Fundamental Research Direction

mercredi 22 janvier 2020 14:00 (25 minutes)

In this talk we will address several ongoing works related to ML and/or DL in CEA Fundamental Research Direction division (thought this is not an exhaustive list of ML/DL ongoing work). We will present several test cases on how ML/DL helped to accelerate time to solution or efficiently analyze data. We will then present several ongoing CEA collaborations and European/International consortium of interests for ML/DL users.

Auteurs principaux: BOILLOD-CERNEUX, France (DRF/D3P); CALVIN, Christophe (DRF/D3P)

Orateur: BOILLOD-CERNEUX, France (DRF/D3P)

Classification de thématique: ML algorithms : Machine Learning development across applications

ID de Contribution: **33** Type: **Non spécifié**

Machine Learning for gravitational waves at APC

jeudi 23 janvier 2020 15:40 (25 minutes)

Despite the breakthrough discoveries of multiple gravitational wave (GW) events made by the LIGO and Virgo detectors, the exploitation of the gravitational-wave data is still limited by the non-Gaussian transient noises, called "glitches"that contaminate the data and mimic the astrophysical signal. Separate the glitches from the astrophysical signal is a very challenging task, since glitches vary widely in duration, frequency range and morphology. The glitches complex and time-evolving nature make their identification and reduction an ideal case to apply machine learning, and in particular deep learning, algorithms.

At APC we are working on two projects that uses machine learning to ease data analysis acting on the background of the searches.
One project focus on the data taken when a single GW detector is active. In this case it is not possible to use the temporal coincidence in two or more detectors that allows to avoid the contamination by glitches, so these data are not completely assessed. We propose a classifier based on convolutional neural network to separate glitches from the astrophysical signal.
The other project is a denoising autoencoder-based search algorithm dedicated to the search for coalescing compact binaries plunged in real GW detectors data.

In the presentation I'll give an overview of the two projects.

Auteur principal: TROVATO, Agata (APC-CNRS)

Co-auteurs: CHASSANDE-MOTTIN, Eric (CNRS AstroParticule et Cosmologie); BACON, Philippe (Laboratoire Astroparticule et Cosmologie); BEJGER, Michal

Orateurs: TROVATO, Agata (APC-CNRS); CHASSANDE-MOTTIN, Eric (CNRS AstroParticule et Cosmologie)

Classification de thématique: ML for astroparticle

ID de Contribution: **34** Type: **Non spécifié**

DNN for VBS (TBC)

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ID de Contribution: **35** Type: **Non spécifié**

Towards polarization fraction measurement in Vector Boson Scattering at the HL-LHC with Deep Neural Networks

jeudi 23 janvier 2020 16:05 (25 minutes)

Vector boson scattering (VBS) is a pure electroweak process arising in high-energy collisions and playing a crucial role in the electroweak symmetry breaking. The analysis of VBS processes, with the measurement of the longitudinal polarization of the vector bosons, constitutes a promising way to investigate unitarity restoration with the Higgs mechanism, and search for possible new physics. This very rare process will be accessible but very difficult to observe at the HL-LHC. A new architecture of Deep Neural Networks, called "particle-based"DNN, is proposed to improve the discovery potential, and is applied to same sign WW scattering and ZZ scattering. It is also shown how the preparation of input features and post-processing can improve the significance.

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Classification de thématique: ML for analysis : Application of Machine Learning to analysis, event classification and fundamental parameters inference