pyhf Users and Developers Workshop 2023

Report of Contributions

Contribution ID: **1**   Type: **not specified**

HEPData and pyhf

Tuesday 5 December 2023 10:00 (30 minutes)

I will give an overview of the HEPData project (hepdata.net), a repository for publication-related data from experimental particle physics. I will describe current support for hosting statistical models in the HistFactory JSON format used by pyhf, as well as links with analysis frameworks like Rivet and MadAnalysis 5. The HEPData software is open source under the @HEPData organization on GitHub and external contributions are welcome.

Primary author: WATT, Graeme

Presenter: WATT, Graeme

Session Classification: Users Section

Contribution ID: **2** Type: **not specified**

HEPExplorer, an interactive visualization tool for pyhf HistFactory workspaces.

Monday 4 December 2023 15:00 (30 minutes)

HEPExplorer is a web based viewer for high energy particle physics that allows users to view various types of plots from data formatted as HistFactory workspaces. This simple tool provides an easy-to-use and convenient way to generate plots, perform fits, and to investigate the impact of various parameters on the model performance using HistFactory workspaces.

HF Explorer is intended to be a tool for high energy physicists working with HistFactory data. It allows for a quick and easy way to view results and to perform some very basic exploration of model parameters. The benefit of this web based approach is that this tool can be used quickly without any software installation, and it provides a means of easily sharing results via url. It is intended to provide convenience and simplicity over installing and running the pyhf / cabinetry tools locally via command line. This type of tool is intended to encourage collaboration by encouraging data sharing and interaction.

Benefits:
Easy to use workspace visualization.
No software installation required.
Runs on any internet connected device.
Easily share results via url.

Features:
Display histograms.
Display pull plots.
Display and interact with model parameters.
Perform fits.
Lock selected model parameters during the fit process.
Sort model parameters by name or by importance / impact.
Compare channel histograms side by side.

The application is available at: https://hepexplorer.net. The code is Open Source (MIT License) and available from: https://github.com/UW-Madison-DSI/HFExplorer

We look forward to user feedback and to an opportunity to make this simple viewing tool better serve the HEP community.

Primary author: MEGAHED, Abe (Data Science Institute, University of Wisconsin-Madison)

Presenter: MEGAHED, Abe (Data Science Institute, University of Wisconsin-Madison)

Session Classification: Users Section

Contribution ID: **3** Type: **not specified**

WorkspaceExplorer

Monday 4 December 2023 15:30 (30 minutes)

pyhf, in combination with cabinetry, has been used successfully in a statistical combination of searches for Beyond-Standard-Model particles by the ATLAS Combination. Since for the individual searches various different frameworks were used to perform the statistical analysis, an essential part of the combination effort consisted of validating the statistical workspaces after they had been converted into the pyhf format for full likelihoods. As part of the validation process, I developed a web-based interface to easily and quickly visualise workspace contents and perform fits. This so-called WorkspaceExplorer is available at workspaceexplorer.app.cern.ch. In addition to validation, it can for example also serve educational purposes or aid in exploration of unfamiliar statistical models. In this talk, I will present available features and discuss possible use cases for the tool as well as the potential for further developments.

Primary author: AUSTRUP, Volker Andreas (University of Manchester (GB))

Presenter: AUSTRUP, Volker Andreas (University of Manchester (GB))

Session Classification: Users Section

Contribution ID: 4   Type: **not specified**

dilax: Differentiable Binned Likelihoods in JAX

Thursday 7 December 2023 10:00 (30 minutes)

dilax is a software package for statistical inference with binned likelihoods. It focusses on three key concepts: performance, differentiability, and object-oriented statistical model building. Thus, dilax is build upon the shoulders of a deep learning giant: JAX - a popular autodifferentiation Python framework. By making *every* component in dilax a PyTree, each component can be jit-compiled (jax.jit), vectorized (jax.vmap) and differentiated (jax.grad). This does not only fulfil all key concepts, but also enables novel computational concepts, such as running thousands of fits simultaneously on a GPU.

We present the key concepts of dilax, show its features, and discuss performance benchmarks with toy datasets.

Primary author: FACKELDEY, Manfred Peter (RWTH Aachen University (DE))

Presenter: FACKELDEY, Manfred Peter (RWTH Aachen University (DE))

Contribution ID: **5**   Type: **not specified**

Signal region combination in CheckMATE

Tuesday 5 December 2023 10:30 (30 minutes)

I will present new features of CheckMATE, in particular implementation of multibin fits in a number of ATLAS and CMS searches.
I will discuss some examples of implemented analysis, show an application of the method to electroweakino scenarios and discuss notable improvements in exclusion range due to CMS multijet search.

Primary author: LARA PEREZ, Iñaki

Presenter: LARA PEREZ, Iñaki

Session Classification: Users Section

Contribution ID: **6**   Type: **not specified**

Modernizing the ATLAS Statistical Analysis: Implementing HistFitter Strategies with pyhf in Supersymmetry search

Monday 4 December 2023 11:40 (30 minutes)

This contribution signifies a shift in ATLAS statistical data analysis by implementing traditional fit strategies utilizing the pyhf library, alongside the cabinetry library. Leveraging a toy Supersymmetry search analysis, three fit strategies inspired by the HistFitter framework are implemented. The "background-only fit," "model-dependent signal fit," and "model-independent signal fit" strategies show the adaptability of pyhf, liberating the analysis from dependence on traditional ROOT-based tools. In addition to enhancing clarity regarding the statistical model itself, this implementation signifies a broader shift towards contemporary standards in data analytics.

Primary author: KOURLITIS, Vangelis (Technische Universitat Munchen (DE))

Presenter: KOURLITIS, Vangelis (Technische Universitat Munchen (DE))

Session Classification: Users Section

Contribution ID: **7**   Type: **not specified**

Searching for BSM physics with the MicroBooNE detector

Tuesday 5 December 2023 14:00 (30 minutes)

The MicroBooNE detector is a liquid argon time projection chamber located on the Fermilab campus. It has excellent calorimetric and spatial reconstruction capabilities. Moreover, MicroBooNE is exposed to two neutrino beams, the Booster Neutrino Beam (on-axis) and the Neutrinos at the Main Injector beam (off-axis). These outstanding features make MicroBooNE an ideal experiment to search for beyond the Standard Model (BSM) signatures, such as eV-scale sterile neutrinos, heavy neutral leptons (HNLs), millicharged particles, and light dark matter. Probing the existence of any of these BSM candidates involves using statistical methods such as hypothesis testing and limit setting. Pyhf offers a stand-alone framework that implements many of the statistical methods used in high energy physics. In this talk, we present the experience of MicroBooNE with pyhf in the context of HNL and light-dark matter searches. We highlight the advantages that pyhf offered to both analyses. In addition, we discuss a set of desired features that could be implemented in the framework.

Primary author: MORA LEPIN, Luis Alberto (University of Manchester (GB))

Presenter: MORA LEPIN, Luis Alberto (University of Manchester (GB))

Session Classification: Users Section

Contribution ID: **9**   Type: **not specified**

Usage of full likelihoods in reinterpretation studies

Tuesday 5 December 2023 16:00 (30 minutes)

In this talk, we will provide an overview of the usage of full likelihoods through pyhf package within LHC reinterpretation studies and software such as MadAnalysis 5, SModelS and spey. We will also provide a summary of future directions involving pyhf package, such as the combination of statistical models, simplified likelihoods via ML approaches and converting full statistical models to a simplified likelihood framework.

Primary author: ARAZ, Jack Y. (Jefferson Lab)

Presenter: ARAZ, Jack Y. (Jefferson Lab)

Session Classification: Users Section

Contribution ID: **10**   Type: **not specified**

Feedback from SModelS

Tuesday 5 December 2023 15:00 (30 minutes)

I will discuss the use we make of published statistical models and patchsets in SModelS. I'll cover benefits as well as difficulties encountered, and wishes for future developments.

Primary author: KRAML, Sabine (LPSC Grenoble)

Presenter: KRAML, Sabine (LPSC Grenoble)

Session Classification: Users Section

Contribution ID: **11**   Type: **not specified**

Staying on Top of likelihood analyses: Using pyhf in the context of global SMEFT analyses with SFitter

Tuesday 5 December 2023 11:00 (30 minutes)

The SFitter analysis framework has been used for many global analyses, making use of a comprehensive treatment of uncertainties and their correlations to provide constraints on the Standard Model Effective Field Theory (SMEFT). Due to the nature of global analyses, this requires the implementation of a large number of different experimental measurements. The publication of likelihoods by the experimental collaborations, along with the use of pyhf, now allows for a new approach to the implementation of this data into SFitter. I will give an overview of the SFitter framework, highlighting in particular how it takes uncertainties and correlations between measurements into account and demonstrating the use of pyhf for the implementation of likelihoods in this context.

Primary author: SCHMAL, Nikita

Presenter: SCHMAL, Nikita

Session Classification: Users Section

Contribution ID: **12**   Type: **not specified**

Constructing and steering pyhf models with cabinetry

Monday 4 December 2023 11:00 (40 minutes)

The cabinetry library provides interfaces and functionality for both the creation and use of statistical models together with pyhf. Models can be built from instructions provided in a declarative configuration. A high-level inference API and visualization utilities help study and disseminate fit results.

This talk will provide an overview of cabinetry and also highlight recent additions and ongoing developments.

Primary author: HELD, Alexander (University of Wisconsin Madison (US))

Presenter: HELD, Alexander (University of Wisconsin Madison (US))

Session Classification: Users Section

Contribution ID: **13**   Type: **not specified**

Workshop welcome

Monday 4 December 2023 10:00 (10 minutes)

Presenter: FEICKERT, Matthew (University of Wisconsin Madison (US))

Session Classification: Users Section

Contribution ID: **14**   Type: **not specified**

BoF Overview

Thursday 7 December 2023 11:00 (15 minutes)

Presenters: Dr STARK, Giordon Holtsberg (University of California,Santa Cruz (US)); HEINRICH, Lukas Alexander (Technische Universitat Munchen (DE)); FEICKERT, Matthew (University of Wisconsin Madison (US))

Session Classification: Developers Section

Contribution ID: 15 Type: **not specified**

BoF Breakouts (TBD)

Thursday 7 December 2023 11:15 (45 minutes)

Presenters: Dr STARK, Giordon Holtsberg (University of California,Santa Cruz (US)); HEINRICH, Lukas Alexander (Technische Universitat Munchen (DE)); FEICKERT, Matthew (University of Wisconsin Madison (US))

Session Classification: Developers Section

Contribution ID: **16**   Type: **not specified**

pyhf Overview and Basic Tutorial

Monday 4 December 2023 10:10 (50 minutes)

This will warm up new users to what pyhf can do. Experienced users of pyhf will be able to sit back and gain a nice refresher.

Presenter: Dr STARK, Giordon Holtsberg (University of California,Santa Cruz (US))

Session Classification: Users Section

Contribution ID: **18**   Type: **not specified**

Introduction to the Belle II collaboration and feedback from its analyzers

Tuesday 5 December 2023 14:30 (30 minutes)

The Belle II experiment, located at the SuperKEKB e^+e^- collider at KEK (Japan), precisely measures the Standard Model parameters analyzing various flavor physics processes to search for new physics beyond the Standard Model. It has collected a data set with an integrated luminosity of 428 fb^{-1} and a peak instantaneous luminosity of 4.7×10^{34} cm^{-2} s^{-1}. The physic program of Belle II covers a wide scope, including B, charm, τ, quarkonium physics, electroweak precision measurements and dark sector searches. This talk will give an introduction to the Belle II detector, its collected data and the collaboration structure. It will give an overview of the ongoing physics analyses, with a focus on the underlying fitting frameworks. In addition, it contains feedback for the pyhf-developers collected within the Belle II collaboration.

Primary author: BECHERER, Fabian (DESY)

Presenter: BECHERER, Fabian (DESY)

Session Classification: Users Section

Contribution ID: **19**   Type: **not specified**

The HEP Statistics Serialization Standard (HS³)

Monday 4 December 2023 14:30 (30 minutes)

The HEP Statistics Serialization Standard is a new format in which to write, store, exchange and archive statistical models. It is based on JSON and easily readable and writable for both machines and humans. It is fully interoperable with ROOT workspaces, the current de-facto standard in the experimental HEP community, and has a concept implementation in Julia / BAT.jl and intends to be interoperable with pyhf, zfit and any other large-scale, general-purpose statistical modeling library used in HEP. It supports binned and unbinned datasets and models, as well as a growing library of distributions and auxiliary functions. It is bidirecionally convertible to ROOT workspaces and pyhf JSON files.

While the standard is already in-use and implementations covering most currently defined features exist, the development of the standard is ongoing, and community feedback of any type is highly welcome.

Primary authors: Dr BURGARD, Carsten (Technische Universitaet Dortmund (DE)); GRUNWALD, Cornelius (TU Dortmund); SCHULZ, Oliver (MPI for Physics, Munich); PELKNER, Robin (Technische Universitaet Dortmund (DE)); DADO, Tomas (Technische Universitaet Dortmund (DE))

Presenters: Dr BURGARD, Carsten (Technische Universitaet Dortmund (DE)); PELKNER, Robin (Technische Universitaet Dortmund (DE))

Session Classification: Users Section

Contribution ID: **20**   Type: **not specified**

A decade of HistFactory

Tuesday 5 December 2023 16:30 (30 minutes)

I'll share a few thoughts on the past, present, and future of the HistFactory specification and pyhf.

Primary author: CRANMER, Kyle Stuart (University of Wisconsin Madison (US))

Presenter: CRANMER, Kyle Stuart (University of Wisconsin Madison (US))

Session Classification: Users Section

Contribution ID: **21**   Type: **not specified**

Introducing the FAIROS-HEP Research Coordination Network

Tuesday 5 December 2023 17:00 (20 minutes)

The US National Science Foundation has funded a 3-year "Research Coordination Network" called FAIROS-HEP. FAIROS-HEP aims to foster the adoption of practices and cyberinfrastructure to enable reuse and reinterpretation of high energy physics (HEP) datasets. The network has funds to support international workshops and to contribute directly to cyberinfrastructure components such as INSPIRE, HEPData, etc. A specific aim of FAIROS-HEP is to aid in developing a framework for EFT global fits as conceptualized by the community through meetings such as the LHC EFT WG and to aid in other BSM reinterpretation activities. The purpose of this talk is just to announce the project and the availability of funds for participants to attend dedicated workshops and targeted contributions to cyberinfrastructure components.

Primary author: CRANMER, Kyle Stuart (University of Wisconsin Madison (US))

Presenter: CRANMER, Kyle Stuart (University of Wisconsin Madison (US))

Session Classification: Users Section

Contribution ID: **22**   Type: **not specified**

abcd_pyhf: Likelihood-based ABCD method for background estimation and hypothesis testing with pyhf

Monday 4 December 2023 14:00 (30 minutes)

The ABCD method is a common background estimation method used by many physics searches in particle collider experiments and involves defining four regions based on two uncorrelated observables. The regions are defined such that there is a search region (where most signal events are expected to be) and three control regions. A likelihood-based version of the ABCD method, also referred to as the "modified ABCD method", can be used even when there may be significant contamination of the control regions by signal events. abcd_pyhf is a standalone implementation of this method utilizing pyhf. This implementation does not make any assumptions about the underlying analysis and can thus be used or adapted in any analysis using the ABCD method. This lightning talk will summarize the abcd_pyhf project and its current status.

Primary author: PROFFITT, Mason (University of Washington (US))

Presenter: PROFFITT, Mason (University of Washington (US))

Session Classification: Users Section

Contribution ID: **23**   Type: **not specified**

Coffee/Tea Break

Tuesday 5 December 2023 15:30 (30 minutes)

Session Classification: Users Section

Contribution ID: **24**   Type: **not specified**

Group Photo

Wednesday 6 December 2023 16:00 (10 minutes)

Presenters: Dr STARK, Giordon Holtsberg (University of California,Santa Cruz (US)); FEICKERT, Matthew (University of Wisconsin Madison (US))

Contribution ID: **25**   Type: **not specified**

Discussion of Common Problems

Wednesday 6 December 2023 10:00 (2 hours)

Presenters: Dr STARK, Giordon Holtsberg (University of California,Santa Cruz (US));   FEICKERT, Matthew (University of Wisconsin Madison (US))

Session Classification: Users Section

Contribution ID: **26**   Type: **not specified**

Discussion of New Ideas

Wednesday 6 December 2023 14:00 (2 hours)

Presenters: Dr STARK, Giordon Holtsberg (University of California,Santa Cruz (US)); HEINRICH, Lukas Alexander (Technische Universitat Munchen (DE)); FEICKERT, Matthew (University of Wisconsin Madison (US))

Session Classification: Users Section