

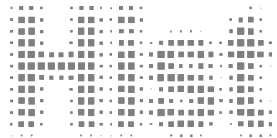
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Hist Serialization and Interactivity

October 05, 2022 — IRIS-HEP Fellowship

Aman Goel, University of Delhi

Mentor: Henry Schreiner, Princeton University



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About Me



Recent Graduate in Computer Science and Mathematics from the *University of Delhi*



IRIS-HEP Fellow, 2021 and 2022

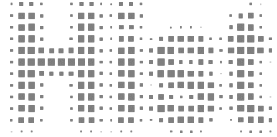


HSF Training Working Group Member



Interested in *Research Software Engineering*





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Analysis Systems Working Group

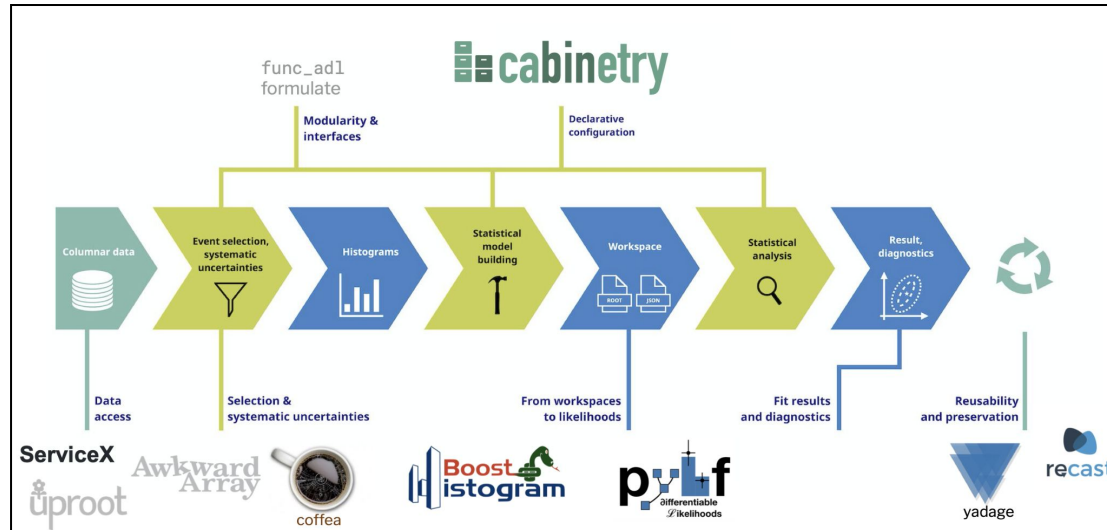
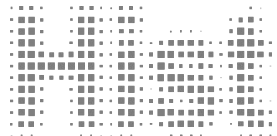


Image 01: Scope of Analysis Systems, Source: IRIS-HEP



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About the Hist library

Hist is a powerful Histogramming tool for analysis based on *boost-histogram* (the *Python* binding of the Histogram library in *Boost*). It is a friendly analysis-focused project that uses *boost-histogram* as a backend to do the work, but provides plotting tools, shortcuts, and new ideas.

The latest release of *Hist* is **Version 2.6.2** which includes a variety of features and improvements.

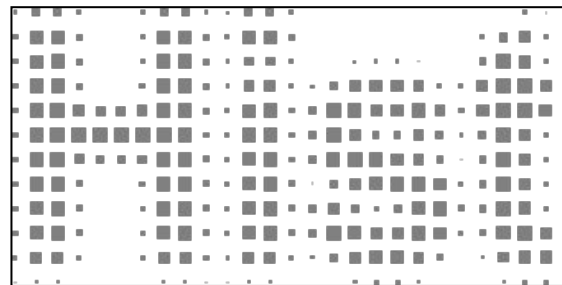
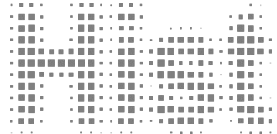


Image 02: Hist Logo, Source: Scikit-HEP



Histograms & their Object Representation

- ❑ The graphical representation of a grouped frequency distribution with continuous classes is called a Histogram.
- ❑ In *Hist*, a histogram is treated as an object in *Python*. We treat it as a collection of **Axis objects** and a **storage**.

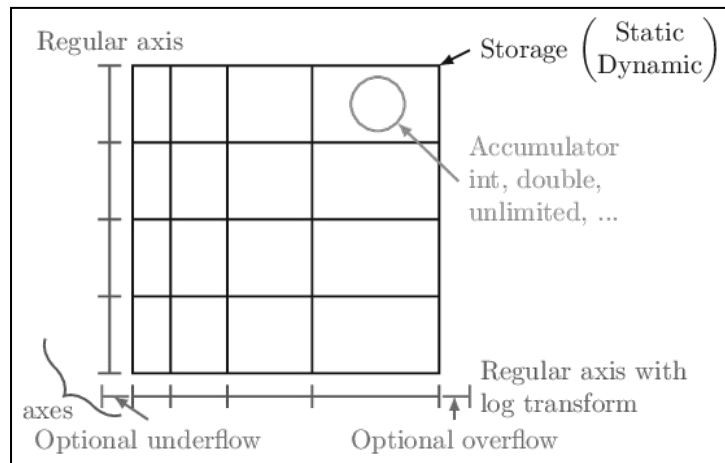
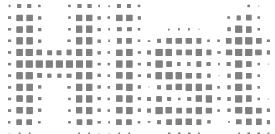


Figure 01: Representation of a Hist object



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Extended Documentation

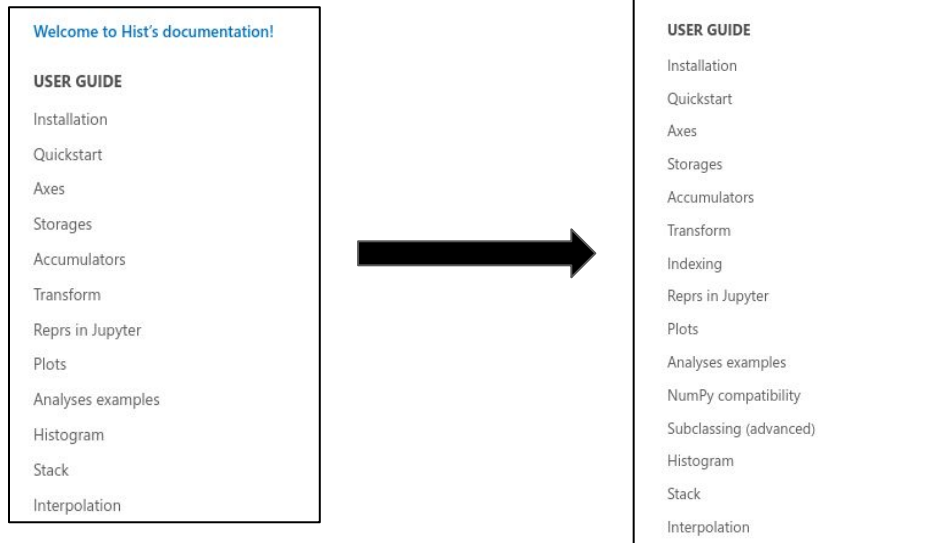
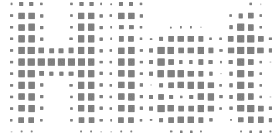


Figure 02: Extended Documentation



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Binder Support

Binder helps in sharing interactive and reproducible environments primarily based on Jupyter notebooks.

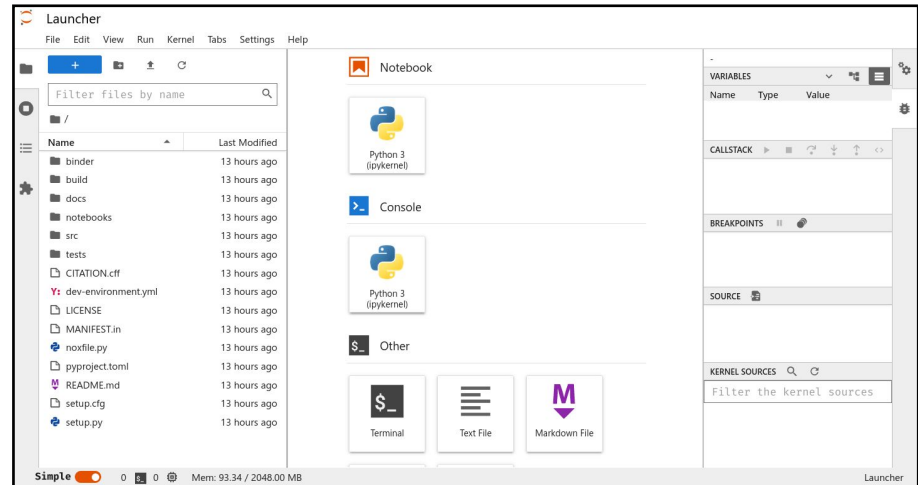
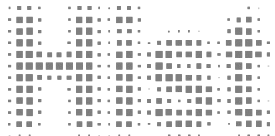


Figure 03: Hist Binder

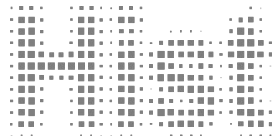


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Miscellaneous Features in Hist

- ❑ *SciPy* is now an optional dependency. This helps in improving costs since *SciPy* is a big library and is now only required if it is used.
- ❑ Empty axis causing a **segfault** has been fixed now. The bug resulted in the kernel crashing and required a restart to fix.
- ❑ The *Hist* library falls back on the normal repr if the histogram object is too large.
- ❑ The *Hist* library now allows overwriting the labels for the plot.
- ❑ *Hist* now supports two new Nox sessions: **regenerate** and **pylint**



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About the uproot-browser Library

uproot-browser is a *plotext* based command line library in which the command line interface is provided by *Click*. It is powered by *Hist* and it's TUI is put together by *Textual*.

Its aim is to enable a user to browse and look inside a *ROOT* file, completely via the terminal. It takes its inspiration from the *ROOT object browser*.

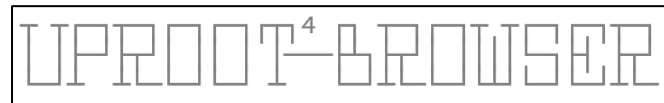


Image 03: uproot-browser Logo, Source: Scikit-HEP



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Why uproot-browser?

- ❑ **Tbrowser** uses *ROOT*, while *uproot-browser* uses *uproot*. The *ROOT* framework is large, which amounts to unnecessary storage and performance costs, even for fairly simple tasks. Further, **Tbrowser** requires either a GUI or a web browser to function.
- ❑ Hence, there was a need for an alternative solution which is **high performance**, **lightweight** and **efficient**, accessible via a **universal user interface**.

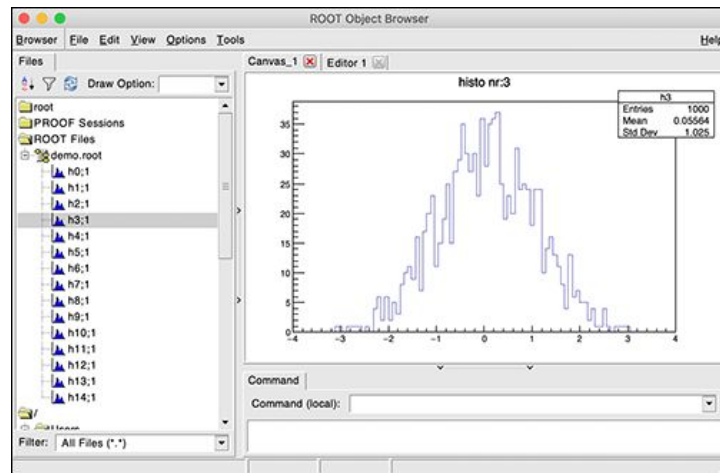


Image 04: ROOT object browser, Source: CERN



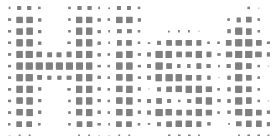
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uproot-browser Features

uproot-browser currently provides the following features (get help with **-h** or **--help**):

- ❑ **browse** can be used to display a TUI (terminal user interface).
- ❑ **plot** can be used to display a plot.
- ❑ **tree** can be used to display a tree.
- ❑ **--iterm** if user is on *macOS* and using *iTerm2*



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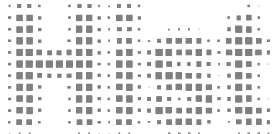


tree Command

The **tree** command gives a tree view of the **.root** file and shows all the object inside it for easy navigation. It also gives metadata about the object such as its signature, type, and value count.

```
uproot-browser tree uproot-Event.root
└─ uproot-Event.root
   └─ ? <unnamed> TProcessID
      └─ 🌴 T (1000)
         └─ 🍁 fEvtHdr.fDate int32_t
            └─ ... other objects
               └─ 🌿 fTriggerBits.fAllBits uint8_t[]
                  └─ 🍁 fTriggerBits.fNbits uint32_t
                     └─ 📊 hstat TH1F (100)
                        └─ 📊 htime TH1F (10)
```

Figure 04: uproot-browser tree command



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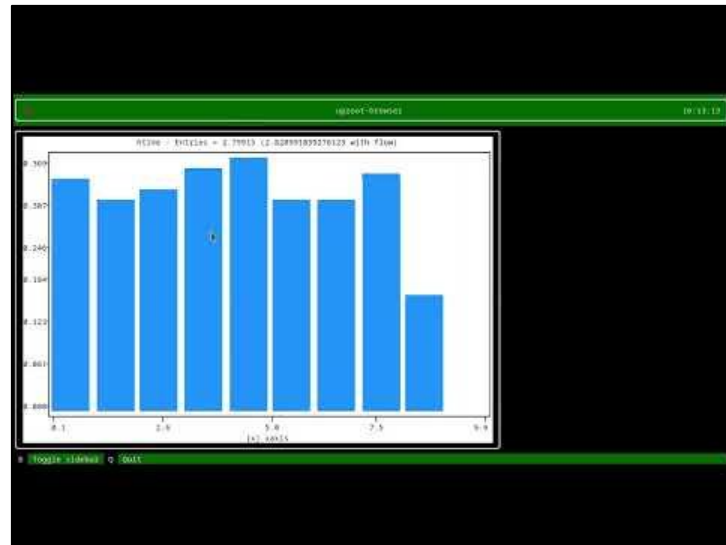


Terminal User Interface

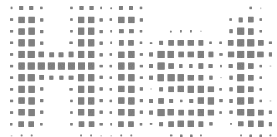
The **browse** command can be used to bring up the TUI. It deploys a terminal application which can be navigated via the mouse or the keyboard.

It combines the tree and the plot functionality and has various modes and features.

It can be controlled via keybindings too. It interfaces via *Click* and *Textual*, while using *plotext* and *Hist* in the backend.



Demo 1: uproot-browser TUI

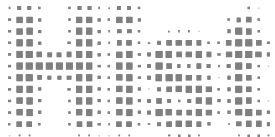


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Miscellaneous Features in uproot-browser

- ☐ Dump to terminal on quit [#31](#)
- ☐ Adding a test for tree view [#30](#)
- ☐ Add browse command and update README.md [#24](#)
- ☐ Reimplement header with modifications [#20](#)
- ☐ Add better plot information [#16](#)

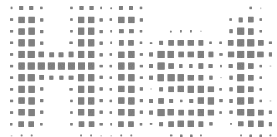


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HSF Training Working Group

- ❑ Helped in development of the *Matplotlib for HEP* module under the *HSF Training Working Group* as a part of education and outreach efforts.
- ❑ Instructor at the *Matplotlib Training* held in April 2022 which aimed to inculcate computational and analysis skills in students via holistic teaching methods.
- ❑ Mentor at the *Software Carpentry Workshop* in March 2022 helping participants with Bash, Git, Python, and ROOT.
- ❑ Instructor for Scikit-HEP and Uproot at the *Software Carpentry Workshop* held in July 2022.

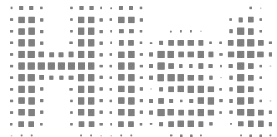


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Presentations

- ❑ **boost-histogram / hist**
 - ❑ Delivered at *PyHEP WG topical meeting - boost-histogram / Hist* on 2nd March 2022
 - ❑ Talk URL: <https://indico.cern.ch/event/1133099>
- ❑ **Histograms as Objects: Tools for Efficient Analysis and Interactivity**
 - ❑ Delivered at *PyHEP 2022 Workshop* on 12th September 2022
 - ❑ Talk URL: <https://indico.cern.ch/event/1150631/contributions/5014273>
- ❑ **Teaching Python the Sustainable Way: Lessons Learned at HSF Training**
 - ❑ Delivered at *PyHEP 2022 Workshop* on 12th September 2022
 - ❑ Talk URL: <https://indico.cern.ch/event/1150631/contributions/5014278>

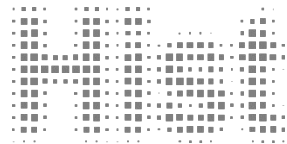


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Acknowledgement

- ❑ I would like to extend my sincere gratitude to Henry Schreiner who guided me throughout the project, helped me in understanding important concepts, and answered all my queries and doubts. It has been a wonderful experience to have him as my mentor.
- ❑ I would also like to thank Peter Elmer and the Princeton Computing Group for their valuable feedback and support.
- ❑ And finally, I am really grateful the whole IRIS-HEP community for being warm, welcoming and supportive throughout the fellowship.



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Thank You!

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