Advancing the Hist library

IRIS-HEP Fellowship

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About Me

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Background

*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 2.5.1** which includes a variety of features and improvements.
Stacked Histograms

A histogram stack holds multiple 1-D histograms into a stack, whose axes are required to match. The most common way to create one is with a categorical axes.

```python
ax = hist.axis.Regular(25, -5, 5, flow=False, name="x")
cax = hist.axis.StrCategory(["signal", "upper", "lower"], name="c")
full_hist = Hist(ax, cax)

full_hist.fill(x=np.random.normal(size=600), c="signal")
full_hist.fill(x=2 * np.random.normal(size=500) + 2, c="upper")
full_hist.fill(x=2 * np.random.normal(size=500) - 2, c="lower")

s = full_hist.stack("c")
```
Stacked Histograms

We can also build it using shortcuts such as:

```
hist.Stack(h1, h2, h3)
```

or

```
hist.Stack.from_iter([h1, h2, h3])
```

or

```
hist.Stack.from_dict({"signal": h1, "lower": h2, "upper": h3})
```
Stacked Histograms

We can also obtain the “stacked” style of plot via `mplhep`. Although we need to use slicing to obtain the correct order since it gets reversed.

```python
s[::-1].plot(stack=True, histtype="fill")
plt.legend()
plt.show()
```
Stacked Histograms

We can also print the stacked histograms to the console via `histoprint` which can be accessed via `.show()` which gives us the following:
Stacked Histograms

- Stacks can also save names of the histograms that are present in it.
- They can be scaled too or an item in the stack can be scaled inplace.
- Various math operations can be performed on stacks.
Interpolation

We can perform interpolation in Hist using SciPy in the following way:

```python
x = np.linspace(-27, 27, num=250, endpoint=True)

linear_interp = interpolate.interp1d(h.axes[0].centers, h.values(), kind="linear")
```
Interpolation

We can perform interpolation in Hist using SciPy in the following way:

```python
x = np.linspace(-27, 27, num=250, endpoint=True)

cubic_interp = interpolate.interp1d(h.axes[0].centers, h.values(), kind="cubic")
```

![Interpolation Example](image)
Since *Hist* builds upon the features of *boost-histogram*, the documentation has been updated to include a similar structure to that of *boost-histogram*. It uses the same conventions and features and adds on to them where the only major difference is the dependency on *hist* rather than *bh*. 

Documentation

Welcome to Hist’s documentation!

CONTENTS
- Installation
- User Guide
- Examples
- Contributing
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Welcome to Hist’s documentation!

USER GUIDE
- Installation
- Quickstart
- Axis
- Storages
- Accumulators
- Transform
- Reps in Jupyter
- Plots
- Analyses examples
- Histogram
- Stack
- Interpolation
Other Features

- QuickConstruct in Hist can directly pass `name=` and `label=` as arguments while defining the histogram.

  ```python
  data = np.array([18, 27, 9, 36, 1, 8, 45, 7, 2, 108])
  h = Hist.new.Regular(10, 0, 90, name="x").Double(name="h", label="y", data = data)
  ```

- There is now a `hist.new` alias for `hist.Hist.new`. 
Other Features

- Dropped Python 3.6 support.
- Uses boost-histogram 1.2.x series, includes all features and fixes, and Python 3.10 support.
- No longer require scipy or iminuit unless actually needed.
- Improve and clarify treatment of confidence intervals in intervals submodule.
- Use NumPy 1.21 for static typing.
- Support running tests without plotting requirements.
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