Histogram Unfolding in Python

An Investigation into implementations of unfolding outside of the ROOT environment.
PynFold

● Used for first investigations:
  ○ ROOT -> pyROOT -> numpy

● Use cases:
  ○ Any ROOT independent analysis setup

● Independent of RooUnfold
  ○ Possible to use without any knowledge of ROOT
  ○ Decoupled from upstream algorithm implementations and fixes

● Useful for comparisons with existing non-hep implementations:
  ○ Other implementations do not use histograms.
  ○ 1:1 comparison not always possible
  ○ Useful for cross checks.

pynFold - Unfolding with python

pynFold (pronounced penfold) is a pythonic implementation of the RooUnfold ROOT Unfolding Framework aiming to compare unfolding methods with those provided outside of high energy physics and to increase robustness by eliminating dependencies on the ROOT libraries basing algorithms only on numpy.

Unfolding relates to the problem of estimating probability distributions in cases where no parametric form is available, and where the data are subject to additional random fluctuations due to limited resolution. The same mathematics can be found under the general heading of inverse problems, and is also called deconvolution or deconvolution.

This project is currently under development. If you would like to be involved please contact vincent.croft at cern.ch or contact me on slack.
Fully Bayesian Unfolding

- Available on pypy
- Depends on:
  - Numpy
  - Matplotlib
  - PyMC
- Implements new algorithm:
- Already used for several ATLAS top quark measurements.

https://pypi.python.org/pypi/fbu/0.0.2
Inverse Problem

\[ x = A^{-1}b \]

- Infer information about \( x \) from measurement \( A \) using response \( b \)
- Most problems are large ill-conditioned linear systems
- Lots of solutions exist

Or solve

\[ \beta = (X^T X)^{-1}(X^T Y) \]

- Edwin
  
  [https://pypi.python.org/pypi/edwin/0.1.0](https://pypi.python.org/pypi/edwin/0.1.0)
  
  ○ Package for bayesian inversion for numerical computation of the inverse problem

- pinvprob
  
  [https://github.com/HajimeKawahara/pinvprob](https://github.com/HajimeKawahara/pinvprob)
  
  ○ Python codes for the linear inverse problem including the generalized inverse matrix truncated SVD Tikhonov regularization, L-curve criterion

- Inverseproblem
  
  [https://pypi.python.org/pypi/InverseProblem/1.0](https://pypi.python.org/pypi/InverseProblem/1.0)
  
  ○ Iterative approach to using Tikhonov regularisation for inverting a matrix
Summary

- Several codes exist for unfolding outside of ROOT for both HEP and non-HEP uses.
  - Up to date?
  - Variety
  - Verified correct

- Specific mathematical considerations must be taken into account when using each case.
  - Can we build in checks to control these cases

- Histograms -
  - Commonplace in HEP
  - Allow for use of 2D histogram for response matrix.
  - Introduces new issues.