RooFitUnfold

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Introduction to RooFitUnfold

Idea: Updated implementation of RooUnfold directly in RooFit

- Includes: Improved handling of uncertainties
    - Uses error propagation from any NPs to the unfolded distribution
    - Allows for inclusion of uncertainties coming from migration matrix
- Handels different input formats
    - Histograms (as RooUnfold did)
    - pdfs -> Means unbinned distributions can now be unfolded
        - Binned methods allow setting of internal binning
        - unbinned methods can technically be included in the future
- Lives in workspaces

Methods

All RooUnfold methods included

- Iterative Bayes
- IDS
- SVD
- TUnfold
- Gaussian Processes unfolding (NEW)
- Unregularised
    - Bin-by-bin
    - Matrix inversion
- Can easily include more methods

Documentation: https://gitlab.cern.ch/roofitunfold-tutorial-2019/RooUnfold/blob/master/README.md

https://arxiv.org/pdf/1105.1160.pdf

Error propagation

- Default RooUnfold can propagate simple uncertainties
  - Statistical uncertainties on Data
  - Bin-by-bin correlations
  - No handling of systematic uncertainties!
- RooFit functions (pdfs) can depend on arbitrarily many parameters
  - automatic error propagation from input parameters to all outputs by RooFit
  - ony requirement: the output needs to be a RooFit object
  - Nuisance parameter treatment comes "for free" with RooUnfold integration in RooFit
- No explicit handling of systematic uncertainties needed in RooUnfold
  - RooUnfold+RooFit handles uncertainties neatly :)
  - Some toy sampling methods required for bias calculation, but error bands on plots come directly from RooFit

Technical aspects: Inputs

- Truth distristributions
  - Histograms (TH1) or pdf (RooFit/Workspace)
- Reco distributions
  - Histograms (TH1) or pdf (RooFit/Workspace)
- Response matrix
  - 2D Histogram (TH2) or pdf (RooFit/Workspace)
- Data: background subtracted if needed
  - binned (TH1 or RooDataHist) or unbinned (TTree or RooDataSet)

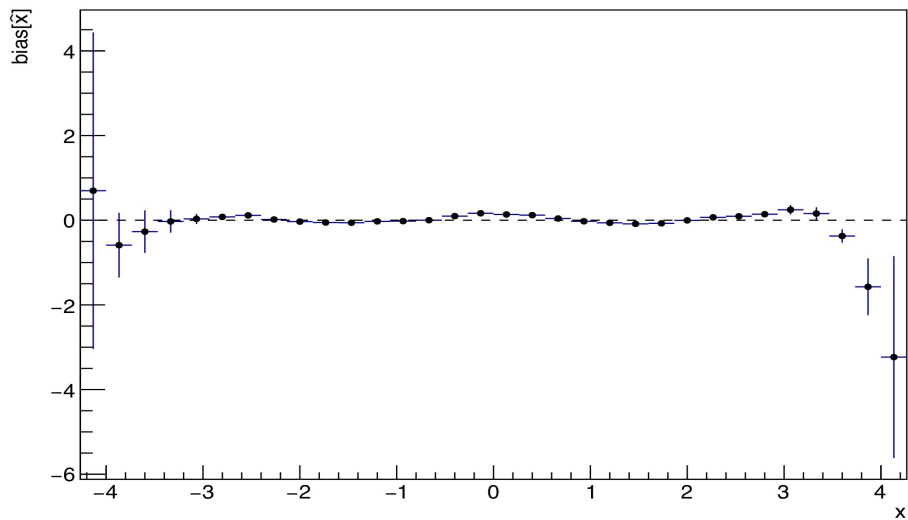# Workspace write out

Directly written out into a workspace

- At any level of the analysis
- Saves all information to be able to do a change of unfolding method on the fly
- Includes error propagation
- Writes out for ALL unfolding methods
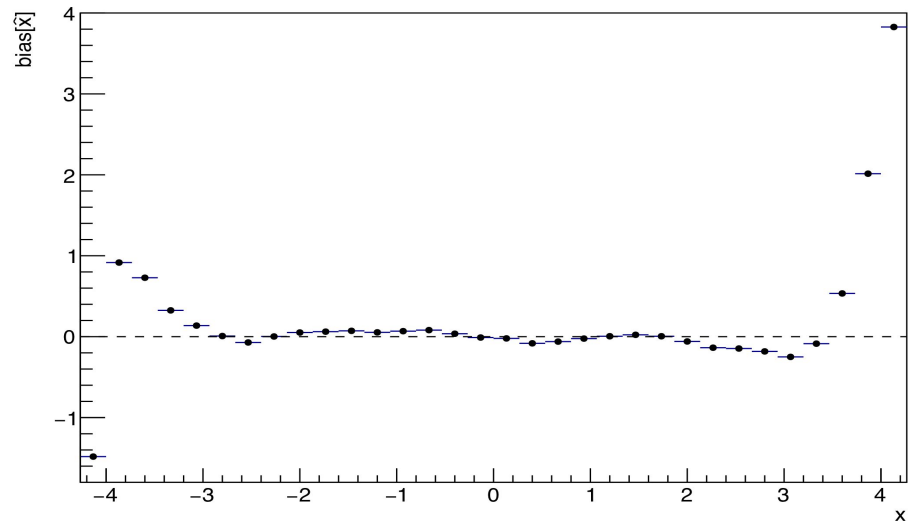   - So also for regularised methods

Bias

Two bias calculations included

Bias estimate without toys and a full bias calculation

Summary

Updates with respect to RooUnfold

- Updated uncertainties handling
- Writes out workspace directly
    - And allows for on-the-fly change of unfolding method
- Automated bias calculations

RooFitUnfold only needs next ROOT release