Neutron Data Standards: Software and Method Developments

Georg Schnabel

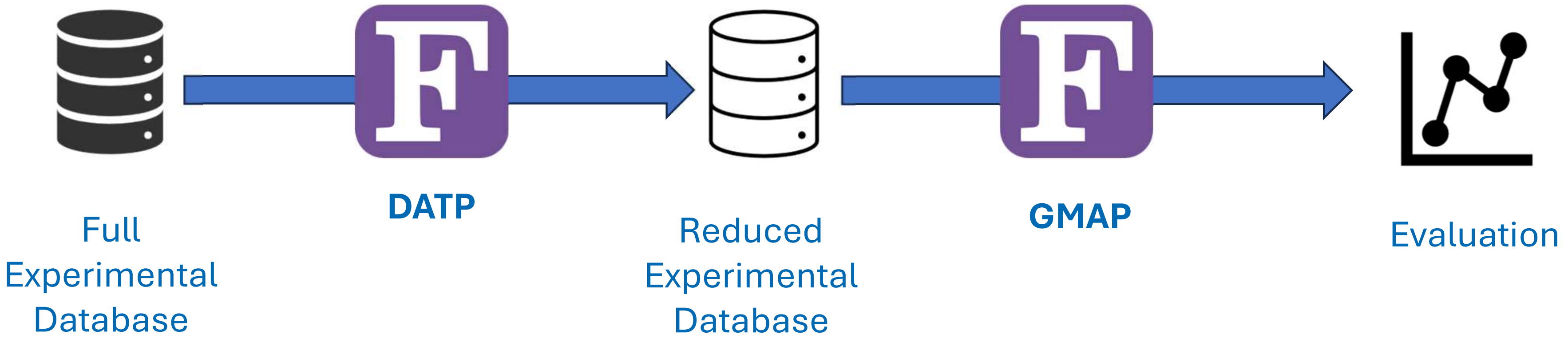
IAEA/NAPC/Nuclear Data Section

CSEWG Meeting on 8 January 2026

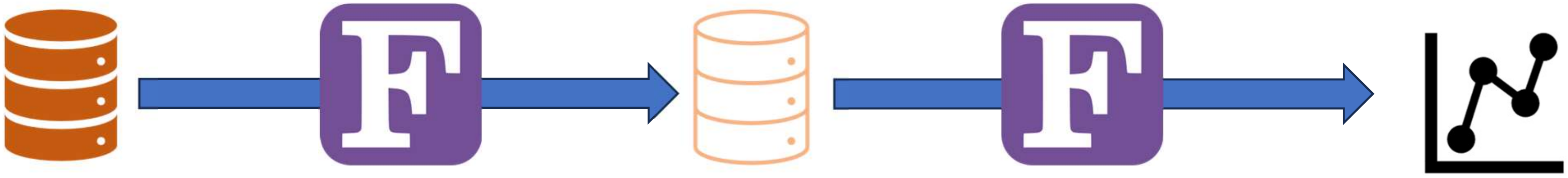
Outline

- Software modernization
- Method developments
- Brief update on neutron standards developments

Neutron Standards Pipeline



Data format modernization

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 UNCERTAINTIES
 3 STATISTICS
 4 BACKGROUND
 5 B DET. EFF.
 6 FF DET. EFF.
11 MERC TO REDUCE THE DIFFERENCE WITH A POSTERIOR *REV*
  .00  .00  .00
  .00  .00  .00
  .00  .00  .00
  .50  .50  .50
  .50  .50  .50
  .50  .50  .50
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  .00  .00  .00
  .00  .00  .00
  .50  .50  .50
  0  0  9  2  2  2  0  0  0  0  1
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 .2500E-03 .4776E+00   .0 20.0  1.0  1.5   .1   .2   .0   .0   .0   .0  1.7  1.8
 .3500E-03 .2598E+00   .0 14.3  1.0  1.5   .1   .2   .0   .0   .0   .0   .0  1.8
```

Legacy format


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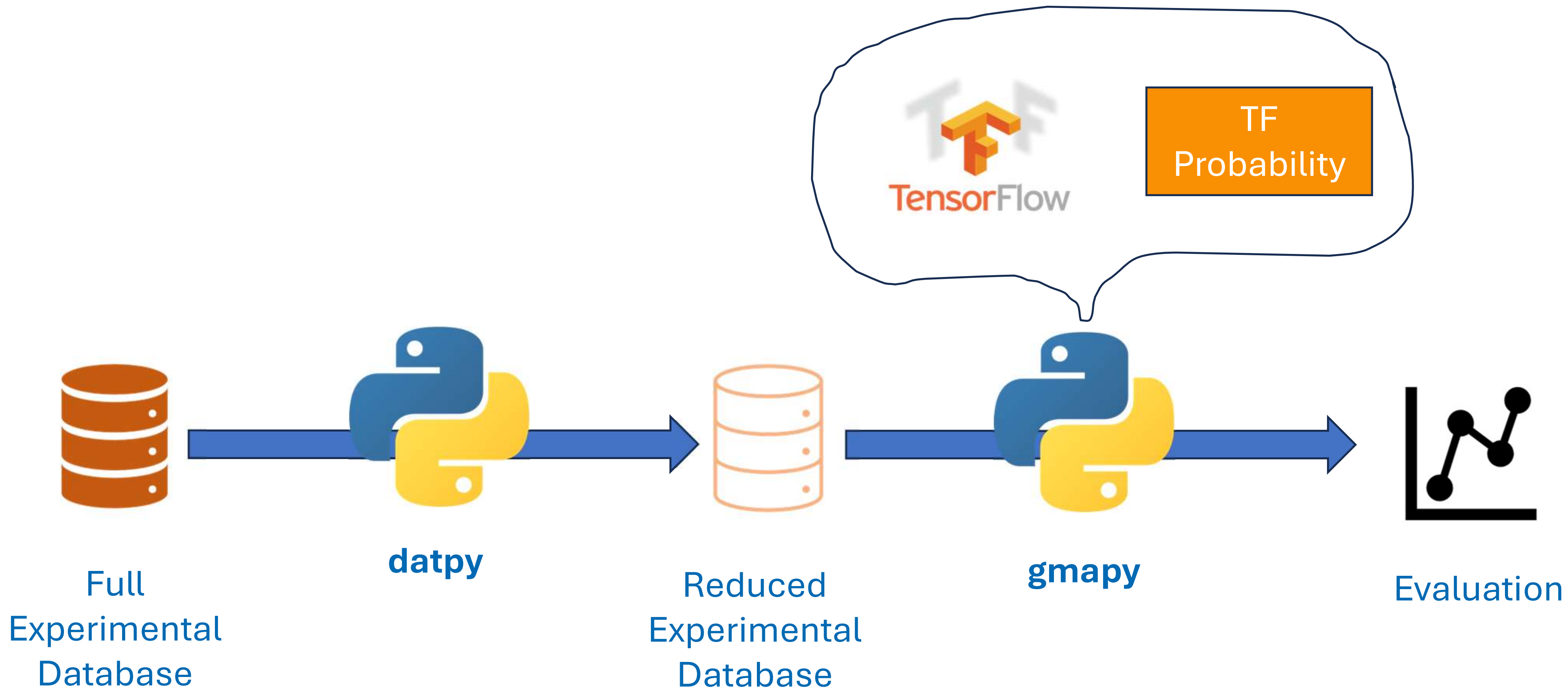
Modern format (JSON)

Code modernization



Flexibility in method choice

TensorFlow + TF Probability

$$\log p(\vec{x} \mid \vec{d}) = -\frac{1}{2}\left(n \log(2\pi) + \log\det\Sigma + \chi^2(\vec{x})\right)$$

$$\chi^2(\vec{x}) = \left(\vec{d} - f(\vec{x})\right)^T \Sigma^{-1} \left(\vec{d} - f(\vec{x})\right)$$

$$\Sigma = \left[(f(\vec{x})^T f(x)\right] \odot \Sigma_{\text{rel}}$$

Maximum Likelihood / Maximum A-Posteriori: Find x to maximize log p(x|d))
ChiSquare minimization: Find x to minimize χ^2
Generalized Least Squares: Apply iteratively GLS equation (Fortran GMAP approach)
Bayesian inference: Sample from posterior distribution by MCMC (e.g. Hamiltonian Monte Carlo)

Support for statistical model extensions

Cut posteriors
(cut-Bayes)

Bayesian hierarchical modeling
“Uncertain Uncertainties”

$$\rho(\vec{\sigma}_{\rm true}, \boldsymbol{\Sigma}'_{\rm exp} \,|\, \vec{\sigma}_{\rm exp}) \propto \rho(\vec{\sigma}_{\rm exp} \,|\, \vec{\sigma}_{\rm true}, \boldsymbol{\Sigma}'_{\rm exp})\, \rho(\vec{\sigma}_{\rm true})\rho(\boldsymbol{\Sigma}'_{\rm exp})$$

Summary

- Significant code modernization (with extensive validation)
- Traceability and reproducibility significantly enhanced (JSON database, modular code structure)
- New ML backend (TensorFlow) allows choice of statistical method (and makes extensions possible)
- Decision on which method to use not yet taken
- Within Standards committee: Progress in dataset preparation, R-matrix, TNC and Cf-252(s.f.) PFNS evaluation
- Next IAEA technical meeting on Neutron Data Standards: 26-30 January 2026

GitHub repositories

- https://github.com/iaea-nds/gmapy
- https://github.com/IAEA-NDS/datp-python
- https://github.com/IAEA-NDS/gmap-fortran
- https://github.com/IAEA-NDS/datp-fortran
- https://github.com/IAEA-NDS/neutron-standards-evaluation
- https://github.com/IAEA-NDS/neutron-standards-pipeline
- https://github.com/IAEA-NDS/neutron-standards-database

Important Disclaimers:

- All of these repos are work in progress (especially on dev and feature branches)
- Most documentation non-existent (but will be created eventually)
- Therefore, at present repos mostly relevant for standard contributors (not the general public)