



Contribution ID: 451

Type: Talk

## BAT.jl, the Bayesian Analysis Toolkit in Julia

Wednesday 23 October 2024 17:09 (18 minutes)

The Bayesian Analysis Toolkit in Julia (BAT.jl) is an open source software package that provides user-friendly tooling to tackle statistical problems encountered in Bayesian (an not just Bayesian) inference.

BAT.jl succeeds the very successful BAT-C++ (over 500 citations) using modern Julia language. We chose Julia because of its high performance, native automatic differentiation, support for parallel CPU/GPU computing and state-of-the-art package management. BAT.jl is developed in cooperation with the Julia HEP community and is also the basis for the prototype Julia implementation of the HEP Statistics Serialization Standard (HS3), opening a path for direct compatibility with RooFit, HistFactory and pyHF models. EFTFitter is based on BAT.jl as well.

BAT.jl is intended both for quick-and-easy inference but also for use cases that cannot easily be expressed in a domain-specific language (like STAN) or that are computationally costly or require interfacing with existing C/FORTRAN models. A recent application has been inference of parton PDFs from HERA data, combining BAT.jl in Julia with the FORTRAN QCDNUM package.

BAT.jl provides a range of posterior sampling algorithms like Metropolis-MCMC, HMC, MGVI and nested sampling under a common API, as well as methods for evidence estimation, with added tooling for quick plotting, reporting and exporting results.

Recently, we have added more concepts from measure theory, building on BATs capability of using pre-computed normalizing flows to transform problems into spaces optimized for each given algorithm. We also have preliminary support for machine-learned normalizing flows as additional posterior-transform and -approximation tools.

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**Session Classification:** Parallel (Track 5)

**Track Classification:** Track 5 - Simulation and analysis tools