"Rather than learning how to solve that, shouldn't we be learning how to operate software that can solve that problem?"

Probabilistic programming with Stan

Erik Štrumbelj

2019

Stan software for Bayesian inference

Stan is composed of

1. a probabilistic programming language,
2. a math and auto-differentiation library,
3. MCMC sampling-based inference algorithm.

We describe our model in Stan and Stan does the computation!

Stan

`http://mc-stan.org/`

Summary:

- Software tool for Bayesian statistics,
- inference based on Hamiltonian Monte Carlo,
- written in C++ (Win, Mac, Linux),
- interfaces in R, Python, MATLAB, Julia, Stata, Mathematica, Scala...
- open source (BSD, PLv3),
- great documentation (manual, studies; see website),
- constant development, active community (`discourse.mc-stan.org/`).

Stan - other functionality

Several inference algorithms:

- NUTS (No-U-Turn Sampler, variant of HMC).
- HMC.
- Structural approximation (Variational Inference, Laplace approximation).
- Classic gradient-based optimization (L-BFGS, BFGS).

User-friendly interfaces and tools in R:

- `RStanArm`: Bayesian equivalents of `lm()`, `glm()`,`polr()`...
- `ShinyStan`: Interactive summary of results and MCMC diagnostics.
- `loo`: Model evaluation and comparison.

Further reading

The Stan Language Reference manual contains a lot of valuable information both on how to use Stan and on standard statistical models written in Stan.

Stan/rstan reference sheet:
`https://github.com/sieste/Stan_cheatsheet`

A good book on Bayesian statistics aimed at practitioners of statistics and not heavy on the math:

> Kruschke, John. Doing Bayesian data analysis: A tutorial with R, JAGS, and Stan. Academic Press, 2014.