

Debugging Stan Programs

Diagnosing, Understanding, and Fixing Stan Programs

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What We'll Cover

- Recognize common Stan pathologies
- Diagnose non-identifiable parameters
- Fix divergences and runtime issues
- Build a debugging workflow
- Tools & resources

Please Ask Questions

- I'm great at debugging Stan.
- I'm even better at breaking it.
- What's second nature to me might not be to you — and vice versa!

Debugging 101

1. Reproduce the bug
2. Simplify the code until it breaks
3. Inspect state
4. Check assumptions
5. Fix and test

What Makes Debugging in Stan Hard?

- Stan program output is stochastic
- "Bug" is a vibe
 - R-hat isn't great, parameter inferences don't feel right
- Reproduce the bug
 - Dependent on seed, data
- Inspect state
 - Print, blocks, gradients / autodiff stack

Examples

Non-identifiability

- Most common problem
 - Not "is parameter identifiable" in statistical sense
- Simple: additive, multiplicative, label-switching
- Complex:
 - Non-linear functions
 - Parameter scales, "harmonics" / periodic effects

What is a Divergence?

- Hamiltonian Monte Carlo (HMC) simulates trajectories
 - Numerical integration, step sizes
- Divergence occurs when integration fails to follow the true trajectory
 - Energy is not conserved: potential energy + kinetic energy = constant
- Happens when posterior geometry is tricky
 - Gradients differ in magnitude wildly with different parameter values

Improving Runtime Speed

- Don't mix code optimization and model changes
- Measure what you can
- Create reproducible examples
- There's a difference between
 - Speed of computing log prob (with gradients)
 - Speed of algorithm providing high effective samples
- Number of parameters isn't the problem

Open Debugging Session

- Any particular issues?
- <https://mc-stan.org/docs/stan-users-guide/index.html>
 - Trap state
 - Simplify models

Wrap-Up & Q&A

Key Takeaways

- Understand the error message
- Simplify → Reparameterize → Validate
- Debugging is model building

Please Reach Out

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