

Fast approximate Bayesian inference for the Naomi model

Machine Learning and Global Health Network

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Doing precision public health requires granular data

1. The right interventions
2. in the right place
3. to the right populations
4. at the right time

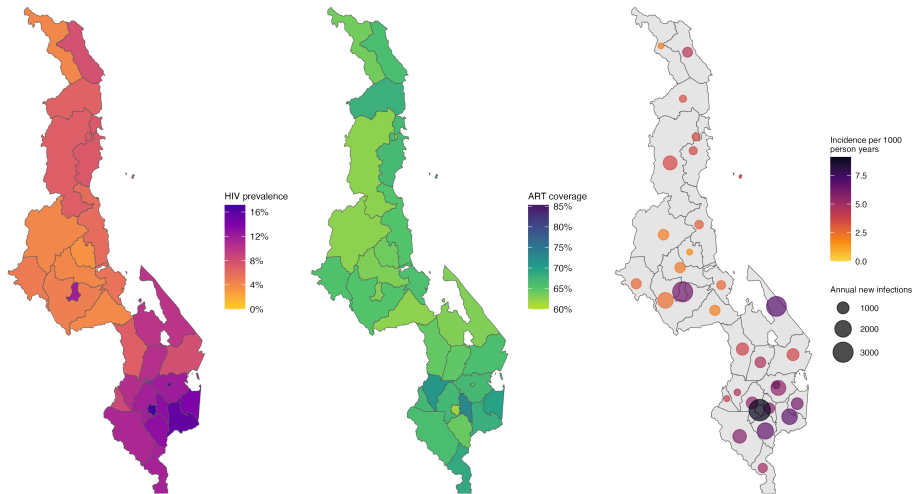


Figure 1: Naomi is a district-level model of HIV indicators.

1 2 3 4 5 6 7

Upload inputs Review inputs Model options Fit model Calibrate model Review output Save results

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Spectrum file (required)

Select new file Browse

Area boundary file (required)

Select new file Browse

Population (required)

Select new file Browse

Household Survey (required)

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ART

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ANC Testing

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Figure 2: Web interface promotes data ownership, data use, and data quality. From <https://naomi.unaids.org/>.

Better estimates by triangulating information

1. Household surveys infrequent, but gold-standard
2. Antenatal care clinic data frequent, only for pregnant women
3. Treatment service provision data frequent, but hard to interpret

Put together, it's a challenging Bayesian inference problem

We want our inference procedure to be

1. Fast enough for interactive review of estimates
2. Accurate enough for precision public health
3. Flexible enough for compatibility with a complex model

The model has a big Gaussian latent field

Approximate the marginal posterior of \mathbf{x} by a Gaussian

Given hyperparameters $\boldsymbol{\theta}$ we compute this as

$$\tilde{p}_G(\mathbf{x} \mid \boldsymbol{\theta}, \mathbf{y}) = \mathcal{N}(\hat{\mathbf{x}}(\boldsymbol{\theta}), \hat{\mathbf{H}}(\boldsymbol{\theta}))$$

If you input $\theta_1, \dots, \theta_{24}$ then it'll return a 467 length mean vector $\mathbf{x}(\boldsymbol{\theta})$ and 467×467 length covariance matrix $\hat{\mathbf{H}}(\boldsymbol{\theta})$

Get in touch to chat about

1. Further directions for this research
including my suggestions for short masters or PhD projects
2. Impactful academic or industry jobs using Bayesian statistics
to begin around the end of this year when I graduate (I hope!)

For more information

- Code and notebooks: github.com/athowes/elgm-inf
- Working paper on the way¹: Fast approximate Bayesian inference for small-area estimation of HIV indicators using the Naomi model
Adam Howes, Alex Stringer, Seth Flaxman, Jeff Eaton

¹For sufficiently vague definition of “on the way”



Figure 3: Much of this work done in Waterloo, Canada visiting Alex Stringer last fall! Would definitely recommend the SAS department.

References I