

Interpretation of Bayesian inference results

Jonas Dehning

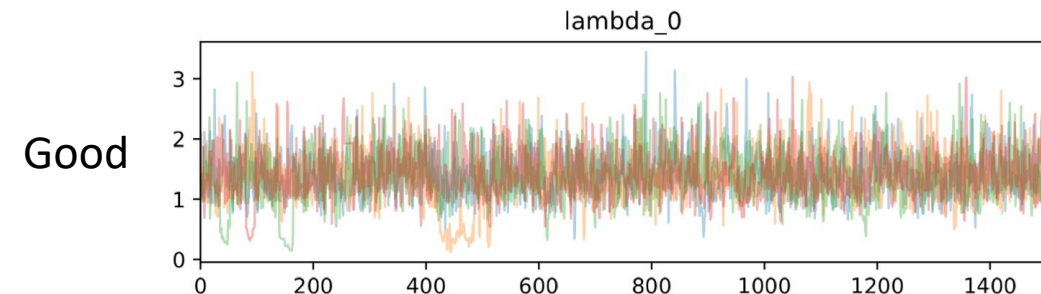
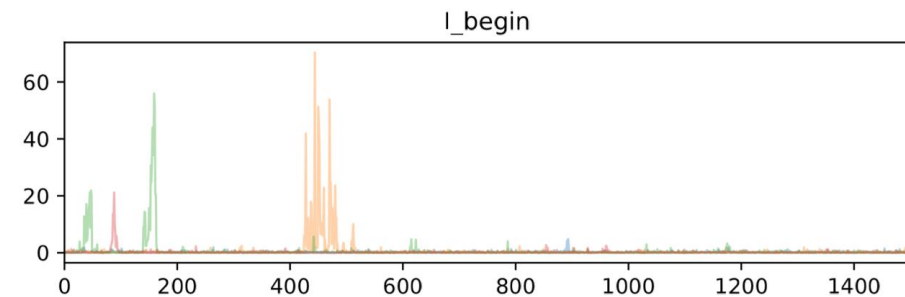
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Checking correctness

- Are the chains converged?
 - > Chains well mixed: R-hat statistic (<https://docs.pymc.io/api/stats.html#pymc3.stats.rhat>)
- Does the sampling works well?
 - > Chains uncorrelated across time

(from <https://www.medrxiv.org/content/10.1101/2020.04.28.20083873v1>) Bad



-> No divergences?

(https://colcarroll.github.io/pymc3/notebooks/Diagnosing_biased_Inference_with_Divergences.html,
<https://arxiv.org/abs/1701.02434>)

What are the assumptions? Example: forecast

- Forecasting, how to parametrize?
 - Future change points?
 - When, how many, how strong?
 - Use random walk: every day a change point, with prior set to previous day
 - See <https://rt.live/> as an example
- For longer forecasts, need to think about future policies, behavior of people...

What are the assumptions? Example: mean field assumptions

- For this model, we made mean field assumptions:
 - Every person can potentially infect every other persons
 - Every person infects on average the same number of persons as every other
- Not correct because:
 - Regional contacts, epidemics
 - Some persons have a lot more contacts than others
(<https://www.nature.com/articles/nature04153>)
 - Different age groups have different contact structure and disease dynamics
- Leads to an underestimate of the variance and biased results

Need to make models as fine-grained as possible

- If possible, include different age groups or regions in the model
- Or if not, try to find an effective description of the added uncertainty (but I don't know how...)
- Related, could potentially lead to Simpson's paradox
(https://en.wikipedia.org/wiki/Simpson%27s_paradox, <https://arxiv.org/abs/2005.07180>)

Causality?

- Always be careful when making causal statements
- Bayesian model is built in a causal manner (when A large \rightarrow B large)
- However think about whether other causes can lead to the same outcome
- Example: Changes of spreading rate:
 - Influenced by governmental interventions,
 - But also by individual behavior changes, media coverage,...
- Refs: The Book of Why by Judea Pearl, https://github.com/Priesemann-Group/covid19_inference_forecast/blob/master/technical_notes.md Chapter: What conclusions can one draw from a Bayesian analysis?