Sequential Monte Carlo

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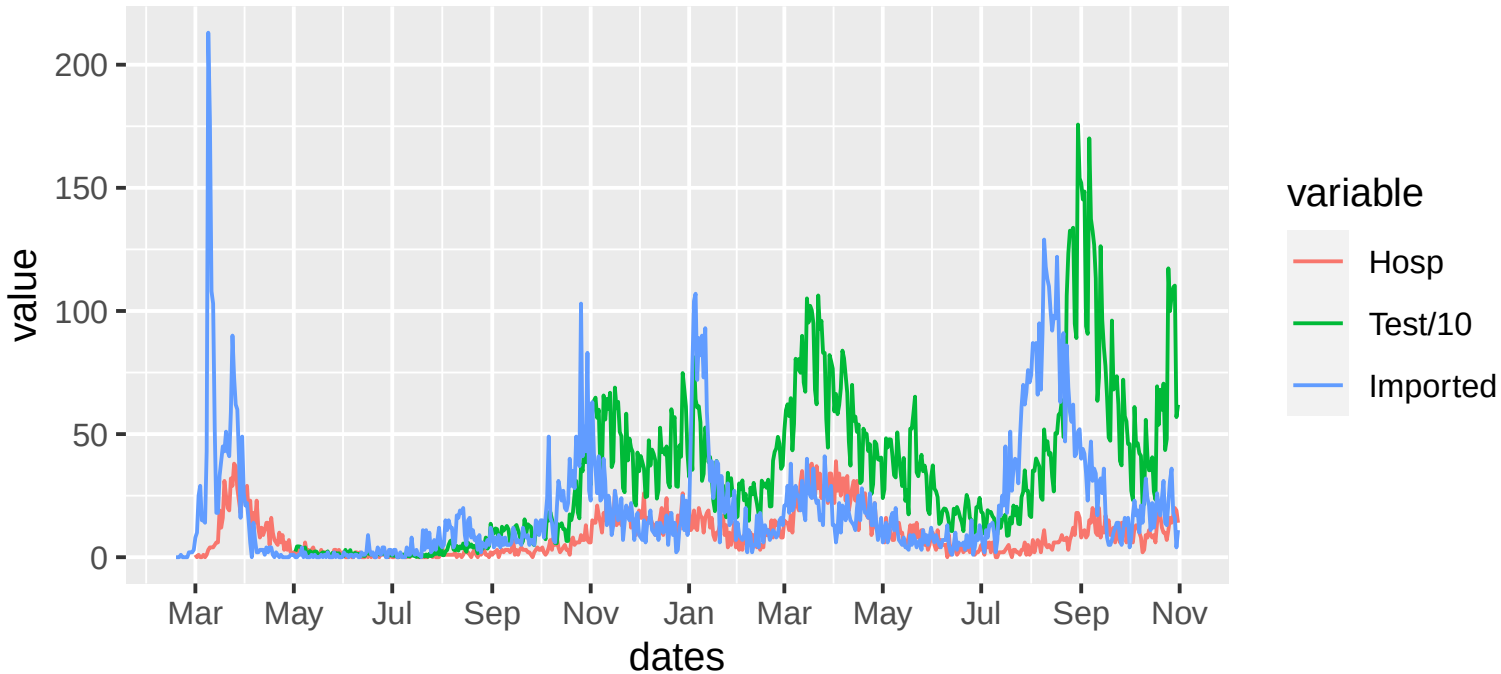
A Case study - Covid 19

Daily reproduction numbers

- Estimates based on available data sources
  - Hospital prevalence
  - Test positives (and total tests)
  - Imported cases
  - Mobility data

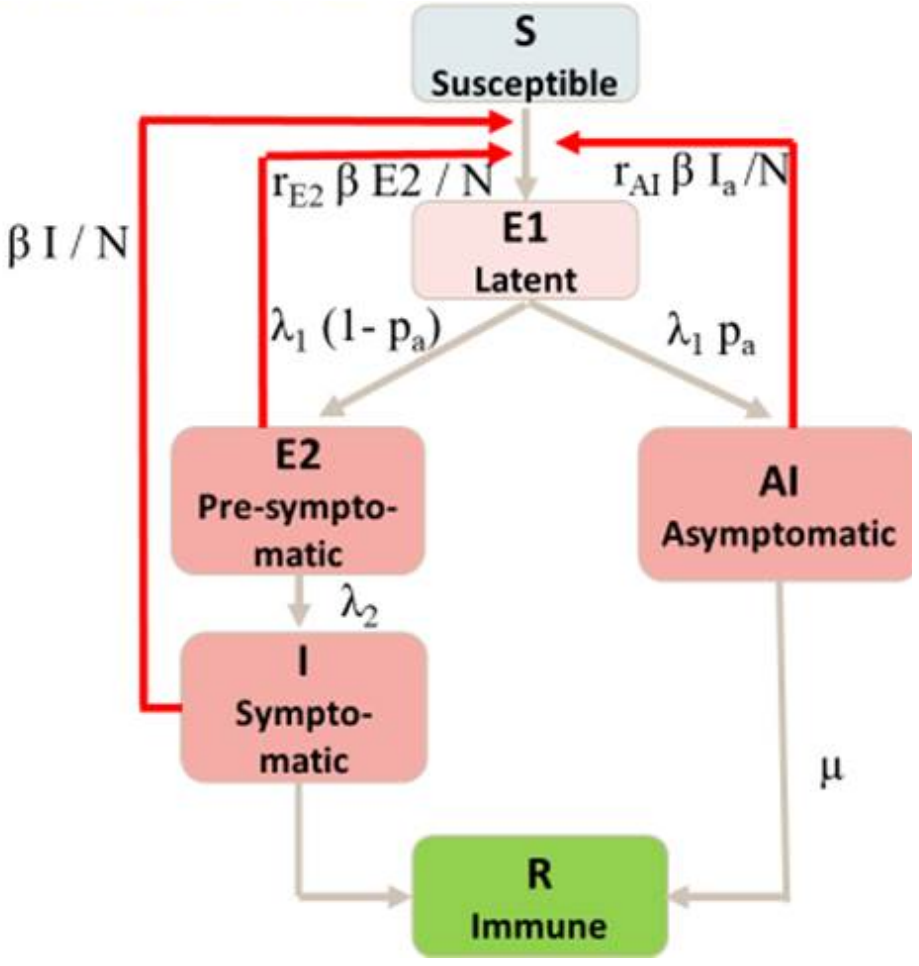


- Part of the weekly reports from Norwegian institute of Public Health

Model setup

- Dynamic stochastic model
- Two main components
  1. Model for transmission: Compartmental SEIR model
  2. Likelihood/model for observations, test data, hospital admissions
- In addition: Model for daily reproduction numbers $\{R_t\}$:
  - National (or regional)
- Statistical inference on
  - Daily reproduction numbers
  - Numbers of infected
  - ...
- Based on Storvik et al. (2022)

Transmission model



- β proportional to reproduction number R
- R change with time (daily), $R = R_t$

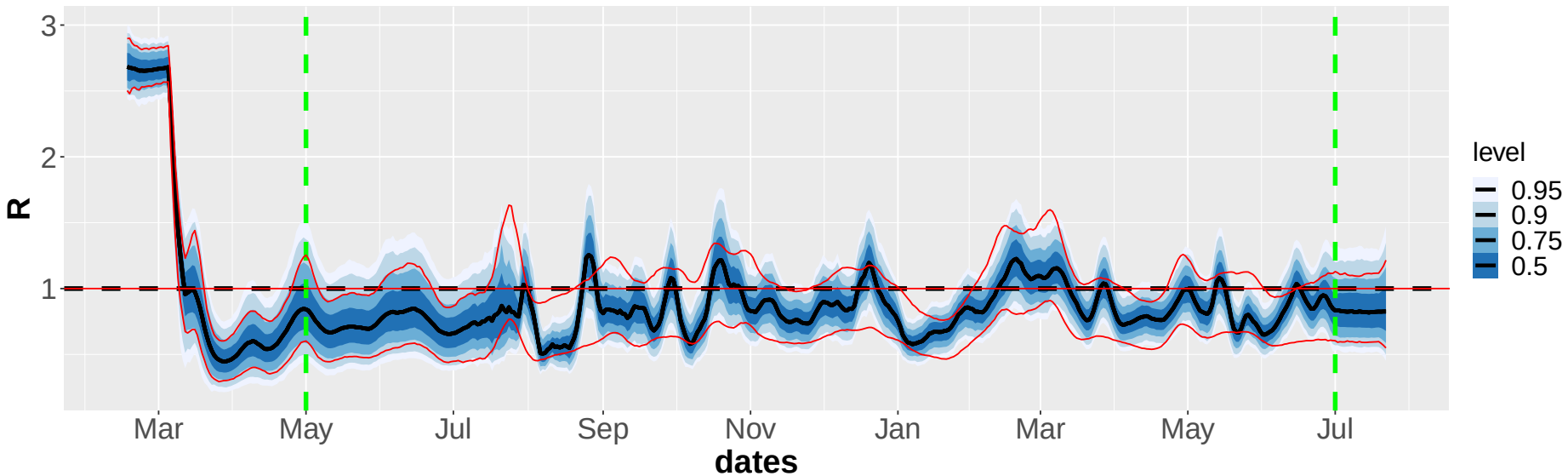
Full model setup

- State space model ($\boldsymbol{S}_t = (S_t, E_{1,t}, E_{2,t}, I_{a,t}, I_t)$)

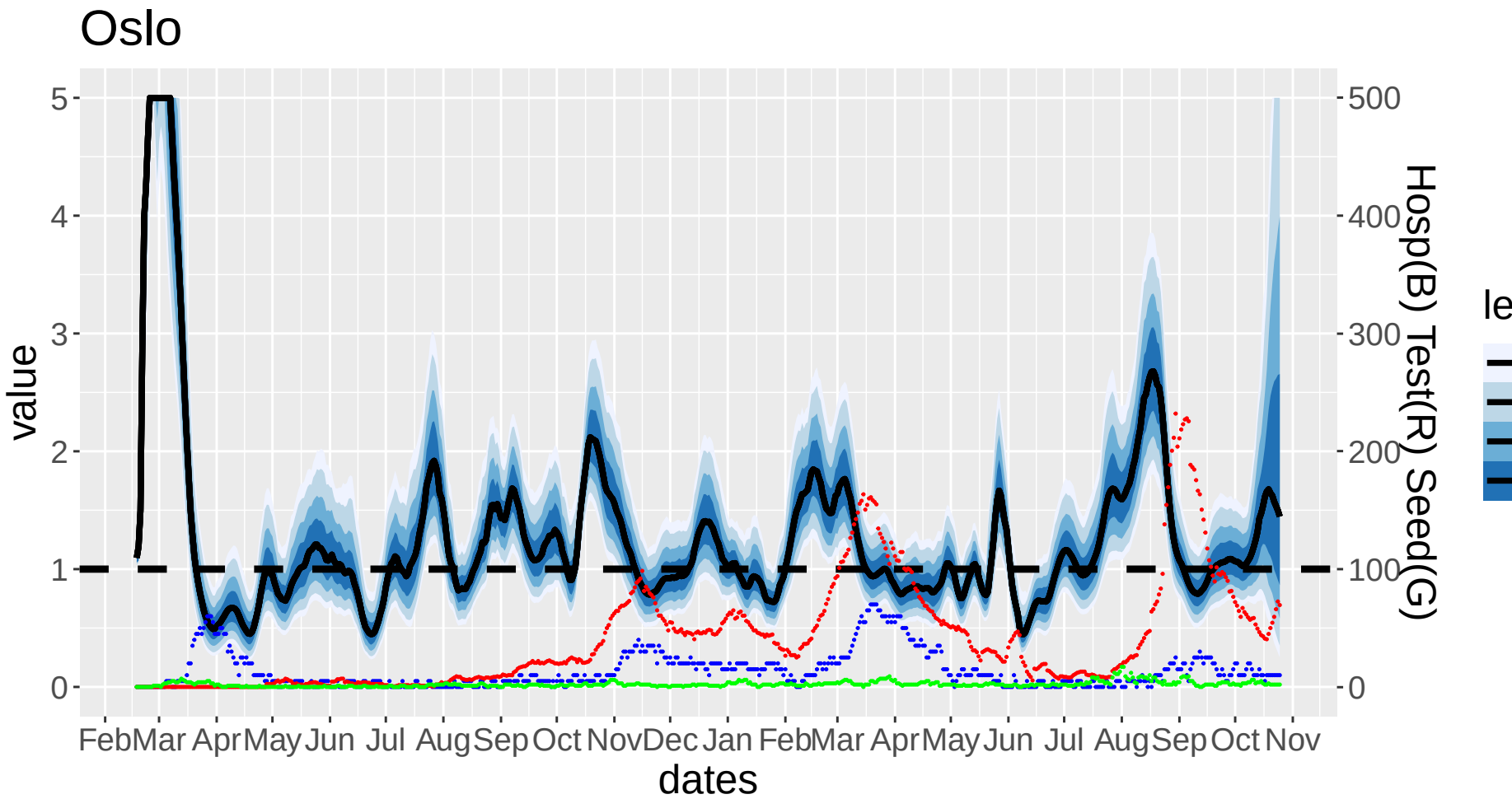
$$\begin{aligned} \boldsymbol{R}_t &\sim p(\boldsymbol{R}_t | \boldsymbol{R}_{t-1}; \theta_1) && \text{Regional model for } R \\ \boldsymbol{S}_t &\sim p(\boldsymbol{S}_t | \boldsymbol{S}_{t-1}, \boldsymbol{R}_t; \theta_2) && \text{SEIR model} \\ \boldsymbol{y}_t &\sim p(\boldsymbol{y}_t | \boldsymbol{S}_{1:t}; \theta_3) && \text{Hosp/Test data} \end{aligned}$$

- $\theta = (\theta_1, \theta_2, \theta_3)$: Parameters involved
- Aim: Inference based on $p(\theta, \boldsymbol{R}_{1:T}, \boldsymbol{S}_{1:T} | \boldsymbol{y}_{1:T})$.
  - Several parameters specified through
    - Other datasets
    - Literature/expert knowledge

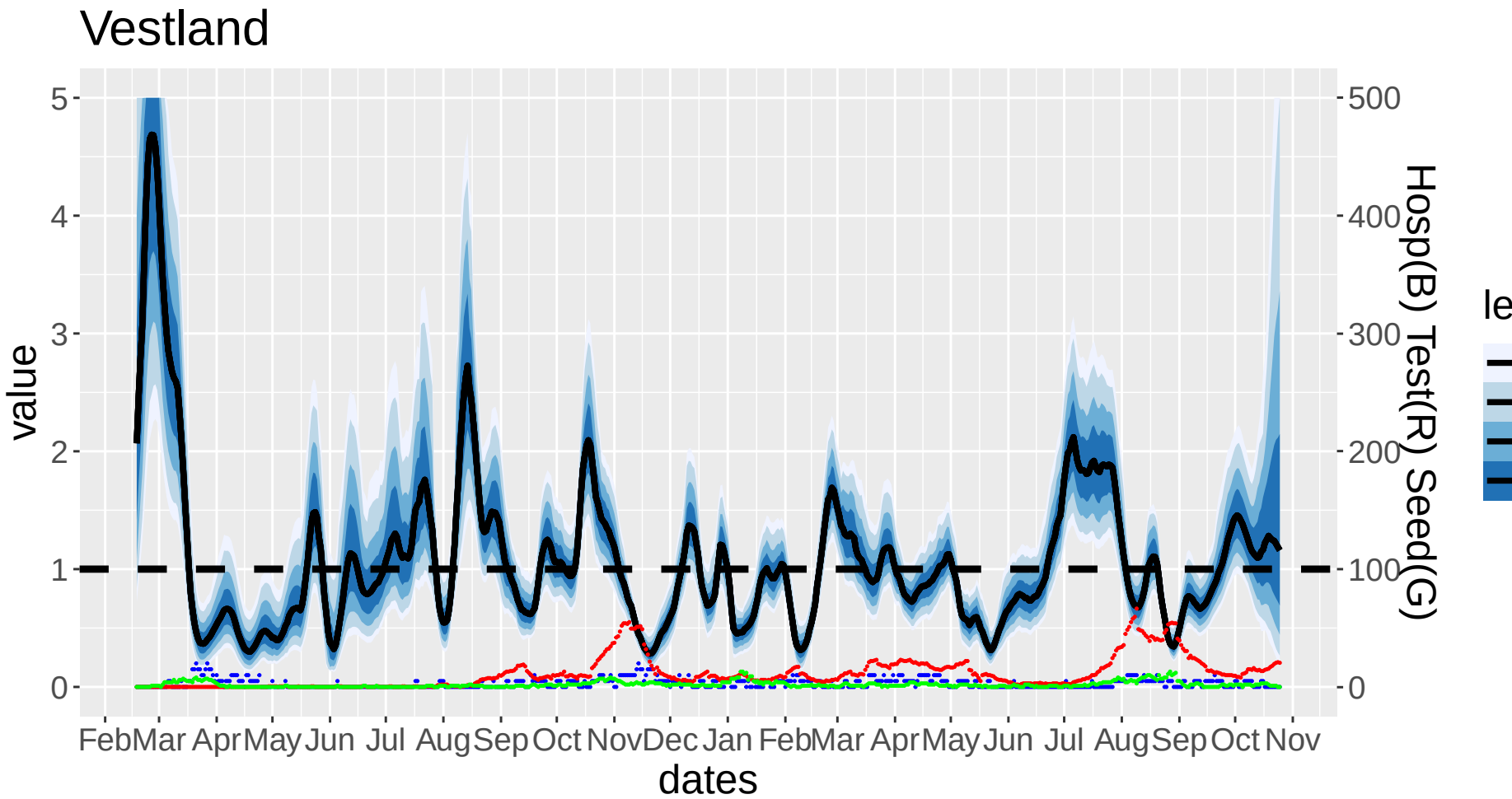
Results - national model for R_t



Results - regional model for R_t



Results - regional model for R_t



G. Storvik, A. D.-L. Palomares, S. Engebretsen, G. Ø. I. Rø, K. Engø-Monsen, A. B. Kristoffersen, B. F. de Blasio, and A. Frigessi. A sequential monte carlo approach to estimate the time varying reproduction number for covid-19 compartmental models. Accepted as a discussion paper in JRSSA, read before the Royal Statistical Society May 2022, 2022.