A particle filter for continuous time partially observed Markov processes in high dimension via intermediate resampling

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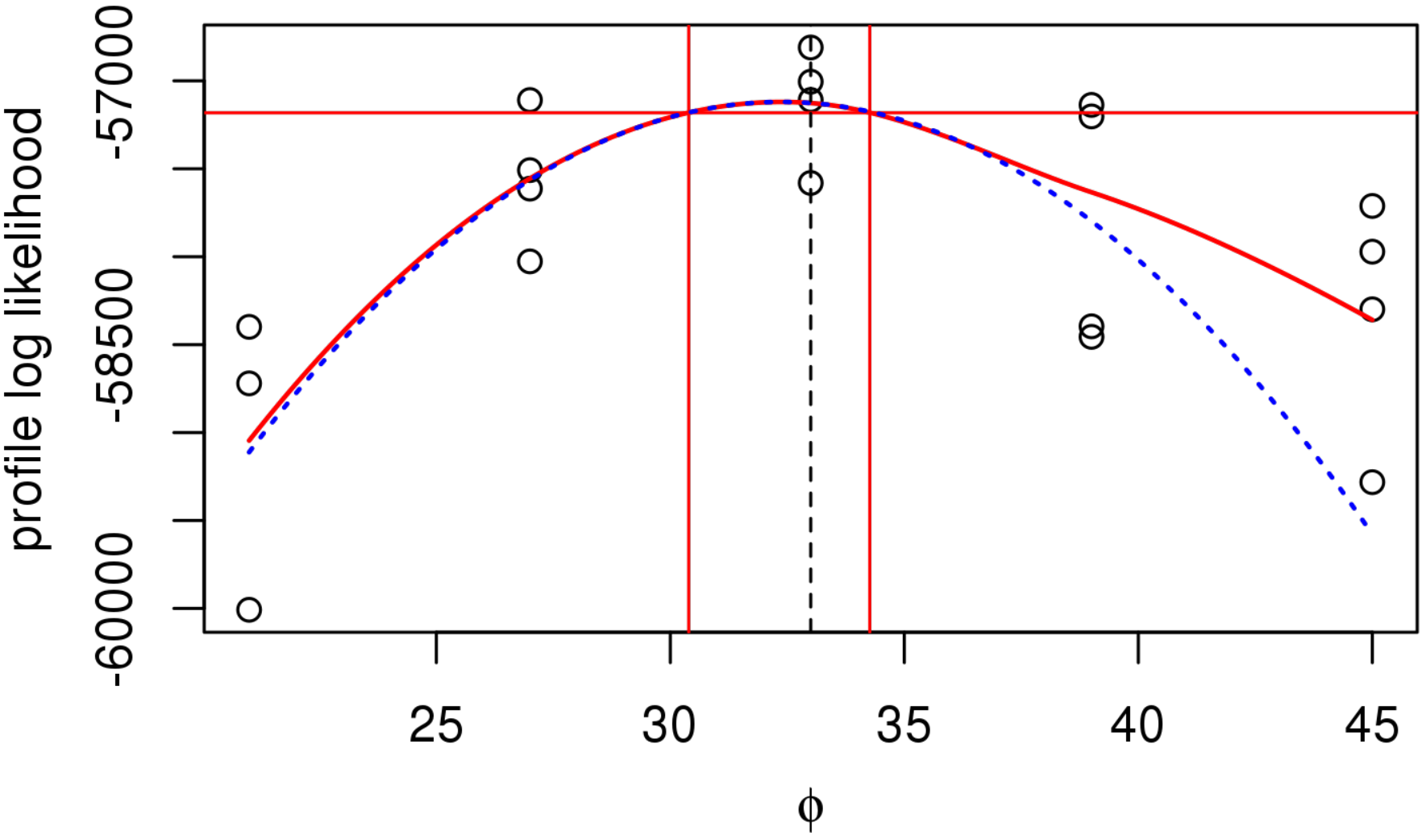
Summary

- **Sequential Monte Carlo (SMC)**, a.k.a. **the particle filter**, is a standard tool for fitting mechanistic dynamic models to nonlinear non-Gaussian time series.
- SMC allows full-information statistical inference. Most other methods involve information loss or approximations.
- SMC struggles with a **curse of dimensionality** preventing the use of the basic algorithm when the dimension of the dynamic system gets large (in practice, say, more than 20 dimensions).
- Theoretical results suggest that, in some situations, this curse can avoided.
- We have a method that partially avoids the curse and is practical on some problems with 80 dimensions: SEIR dynamics for measles in 20 connected cities.

Coupled measles SEIR in 20 cities: profiling contact rate



Key ideas

- **Monte Carlo adjusted profile** methodology lets us get valid (and often precise) statistical inferences even with Monte Carlo uncertainty of hundreds of log units on the likelihood.
- The **Guided intermediate resampling filter (GIRF)** breaks up the information in the data into small pieces that are used incrementally to inform the particles and "guide" them toward the next observation.
- The curse of dimensionality is, in some sense, a **curse of too much information**: a high-dimensional observation is so informative that forecasted Monte Carlo particles are unlikely to be consistent with each new observation.