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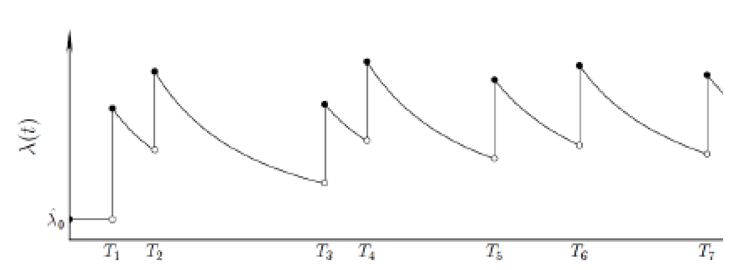
When data from a Hawkes Process is missing, estimation becomes difficult. ABC can help.



Intensity function $\lambda(t)$.

Hawkes processes are a particular type of point process we use when events occur in clusters or bursts. They are very popular in the earthquake literature, but are also used to model retweets on Twitter or crimes in a city.
The Hawkes process for events $Y = (t_1 \dots t_n)$ is parametrised by an intensity function $\lambda(t)$ of the form:

$$\lambda(t) = \mu + \sum_{i:\, t_i < t} K\, \beta \exp(-\beta(t - t_i)).$$

There are three parameters: background rate μ, area of the spike K, and rate of decay of the spike β.

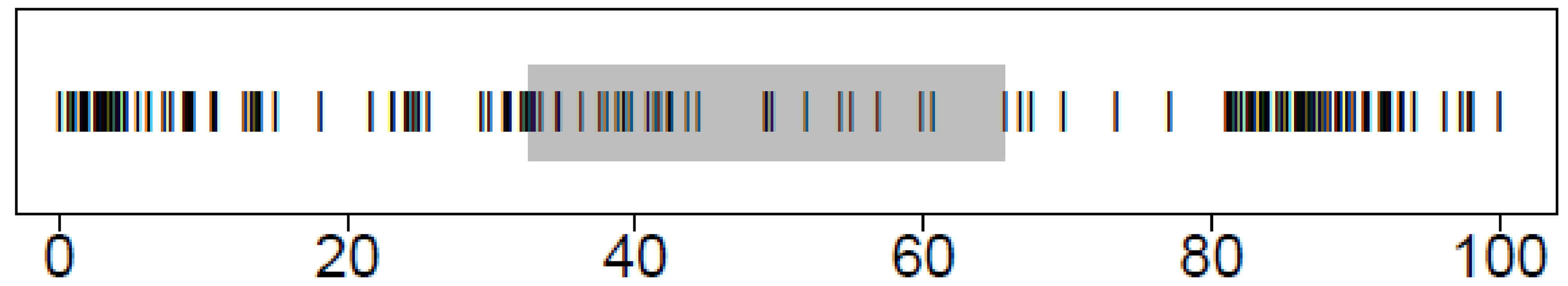
As typical for point processes, our data structure is driven by the arrival of events. We write t_i for the time at which the i^th event happened, resulting in data $Y = (t_1 \dots t_n)$.

When we collect data, we might not record all of the events correctly. This is particularly prevalent in some of the applications of a Hawkes process. In earthquakes we fail to detect small earthquakes that happen directly after a big one.

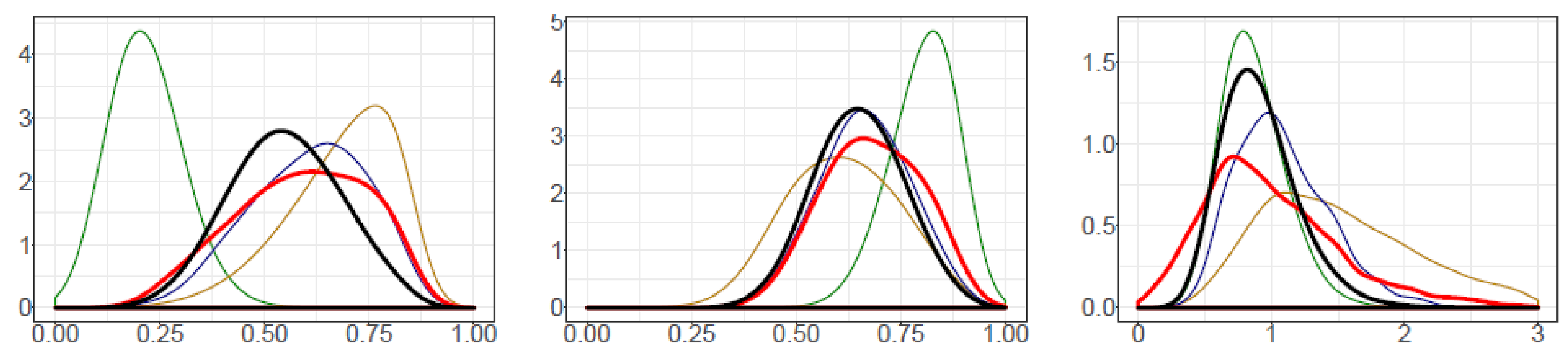
Approximate Bayesian Computation provides posterior samples without evaluating the likelihood. We assume that if two data sets are “close”, then the parameters that produced those data sets are also similar. We therefore propose a parameter θ^*, simulate a data set Y^* from it, and if the data set is similar to the observed data Y, we accept θ^* as a draw from an approximate posterior distribution.

When data from a Hawkes process is missing, it is impossible to integrate out the missing events, due to the particular form of the likelihood. This means our likelihood becomes intractable and classic sampling methods cannot be applied.

Example: Twitter



We have a data set of tweets and retweets of a particular news article, with events indicated by horizontal lines. While we have the complete data available, we manually “delete” a portion of data (in the grey box).



We estimate posterior densities for μ, K, and β. In black is the true posterior on full data, red is our ABC-MCMC on missing data. All other are competing methods on missing data.

For our ABC-MCMC approach use seven bespoke summary statistics that determine closeness between simulated and observed data. When we compare ABC-MCMC to other methods, only those that take missing data into account perform well.

Unlike other state-of-the art methods, our approach can handle a variety of missing data| scenarios (gap in the data, missing according to a time-dependent function). It even works when parameters that govern the missingess are unknown.

Poster Menu

Option 1: Scan QR Code for arXiv paper

arxiv.org/abs/2006.09015

Option 2: Tap your phone for arXiv paper

NFC

Option 3: Choose your talk!

1 min	2 min	4 min
		Next Steps
		Example
	ABC-MCMC	ABC-MCMC
	ABC	ABC
Solution	Solution	Solution
Problem	Problem	Problem
Hawkes	Hawkes	Hawkes

Looking for $\hat{\theta}$? Take one!