

# Shared latent fields for mark-location dependence in a log-Gaussian Cox process

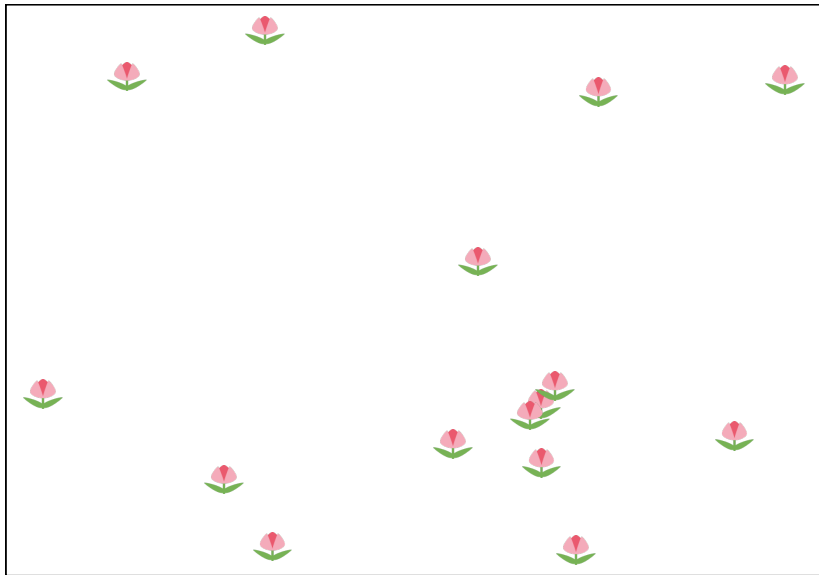
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**NIWA**

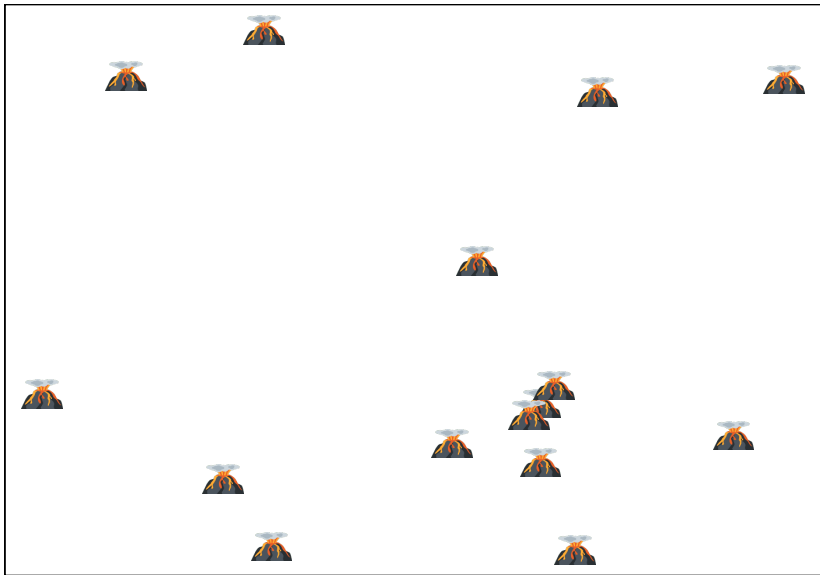
Taihoru Nukurangi

# Point patterns

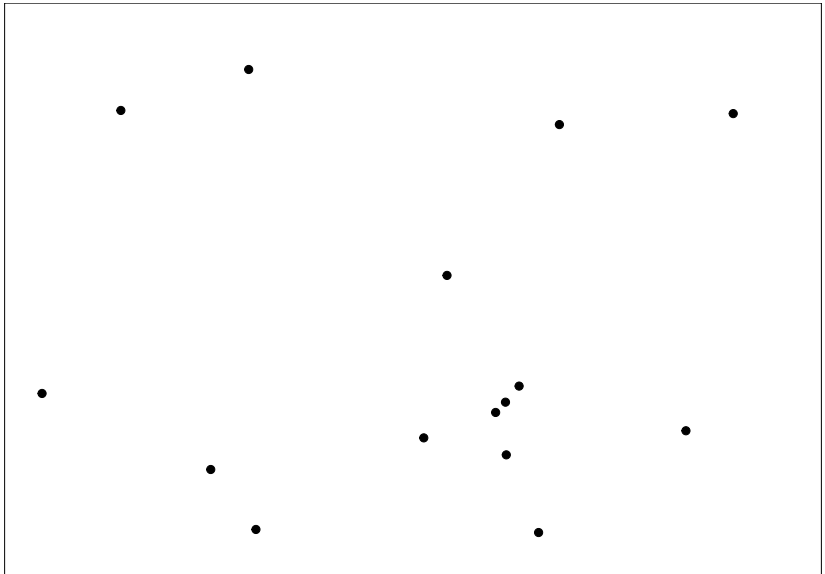


**emoGG:** <https://github.com/dill/emoGG>

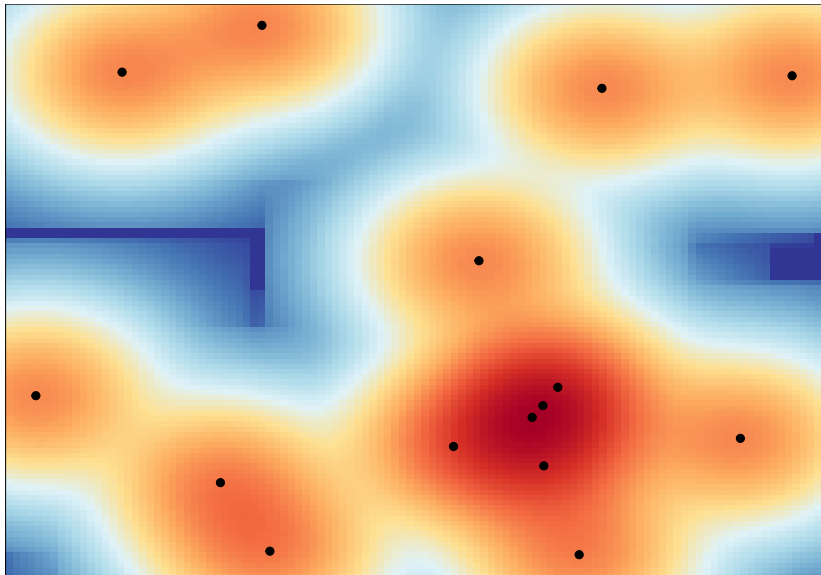
# Point patterns



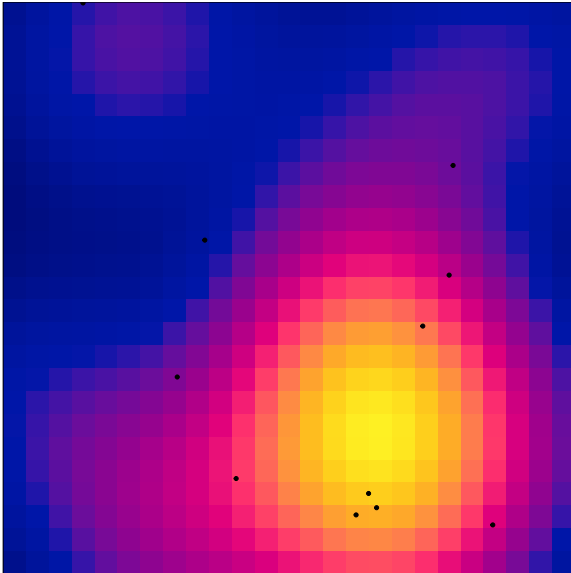
# Point process



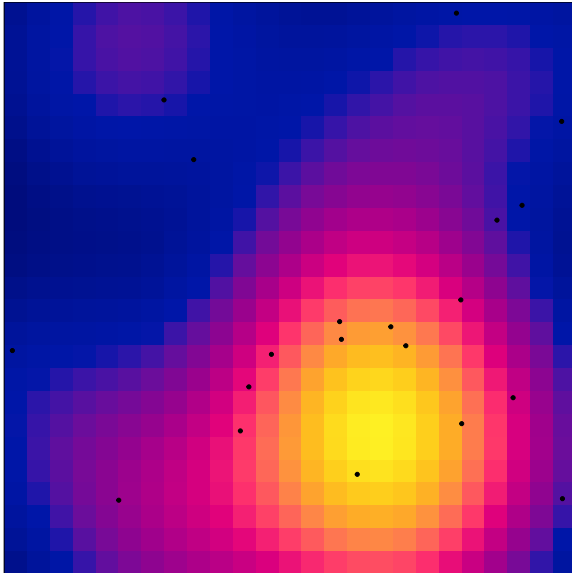
## Point process



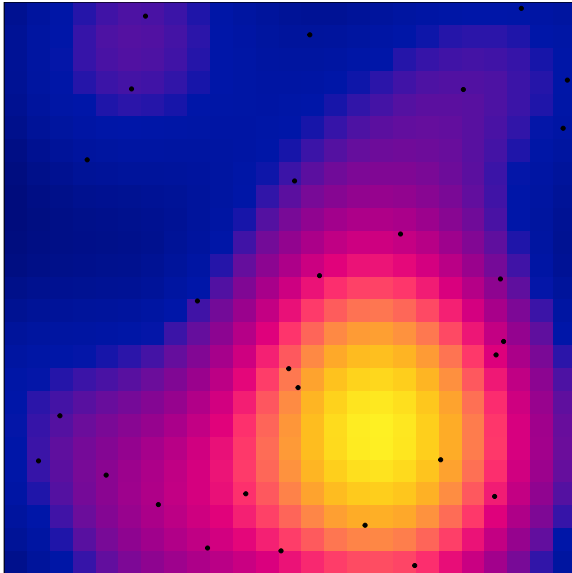
# Point process



# Point process



# Point process



# The log-Gaussian Cox process

A log-Gaussian Cox process (LGCP) considers the number of points within some region  $\Omega$ ,  $N(\Omega)$ , to be given by,

$$N(\Omega) \sim \text{Poisson} \left( \int_{\Omega} \lambda(\mathbf{s}) ds \right).$$

Here

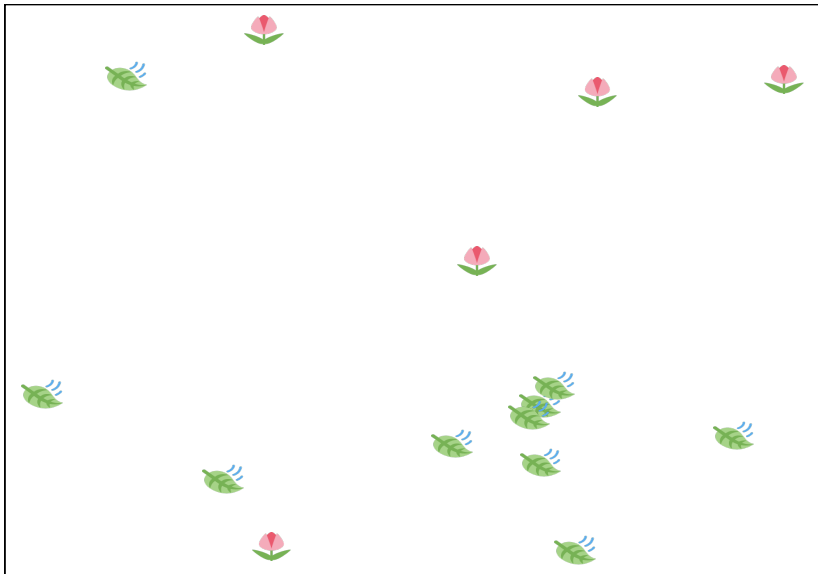
$$\int_{\Omega} \lambda(\mathbf{s}) ds = \Lambda(\mathbf{s}) = \exp(z(\mathbf{s}))$$

with  $z(\mathbf{s})$  being a realisation of a Gaussian process.

## A marked point pattern

Consider a LGCP where each point in the pattern has some characteristic: either a quantitative or qualitative mark.

## A marked point pattern



## A marked point pattern

These marks are themselves a realisation of some stochastic process  $M(\mathbf{s})$  that may be dependent on the intensity of the LGCP.

Here, the point process

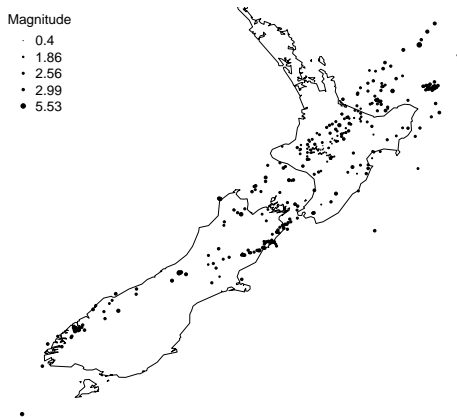
$$\Lambda(\mathbf{s}) = \int_{\Omega} \lambda(\mathbf{s}) d\mathbf{s} = \exp(z(\mathbf{s}))$$

and the mark

$$\nu(M(\mathbf{s})) = \beta_0 + \beta z(\mathbf{s}) + z_m(\mathbf{s})$$

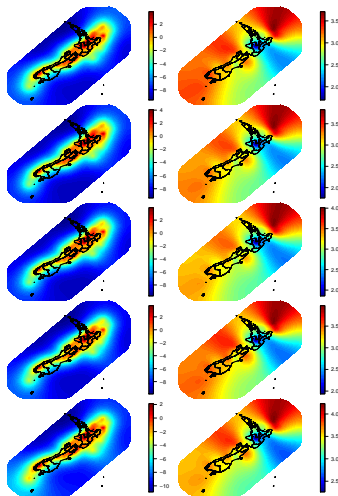
are linked through the Gaussian random field  $z(\mathbf{s})$ .

# NZ earthquakes



Epicentre locations of earthquakes in and around New Zealand  
(March–April, 2018)

# NZ earthquakes

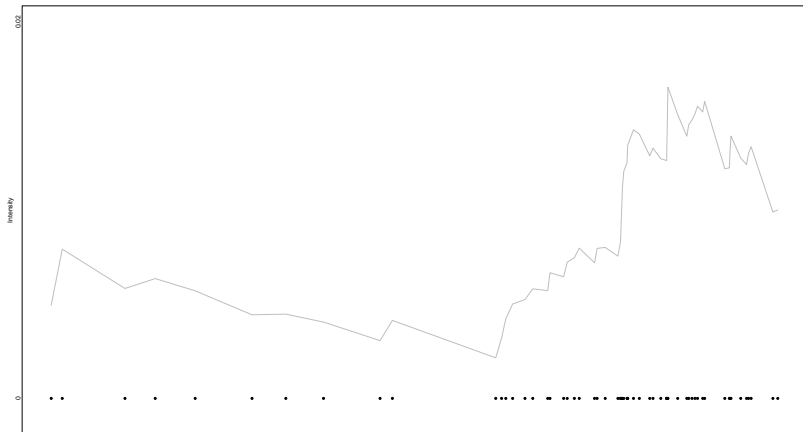


Posterior random fields for both the LGCP and the mark (magnitude)

## In summary

- ▶ use shared stochastic structures to infer the dependency inherent in marked point pattern data,
- ▶ incorporate both the dependencies between the marks and point locations, and the relationship between marks conditional on their locations,
- ▶ dependencies are represented by shared latent spatial random effects.

## Other point processes



Hawkes process intensity