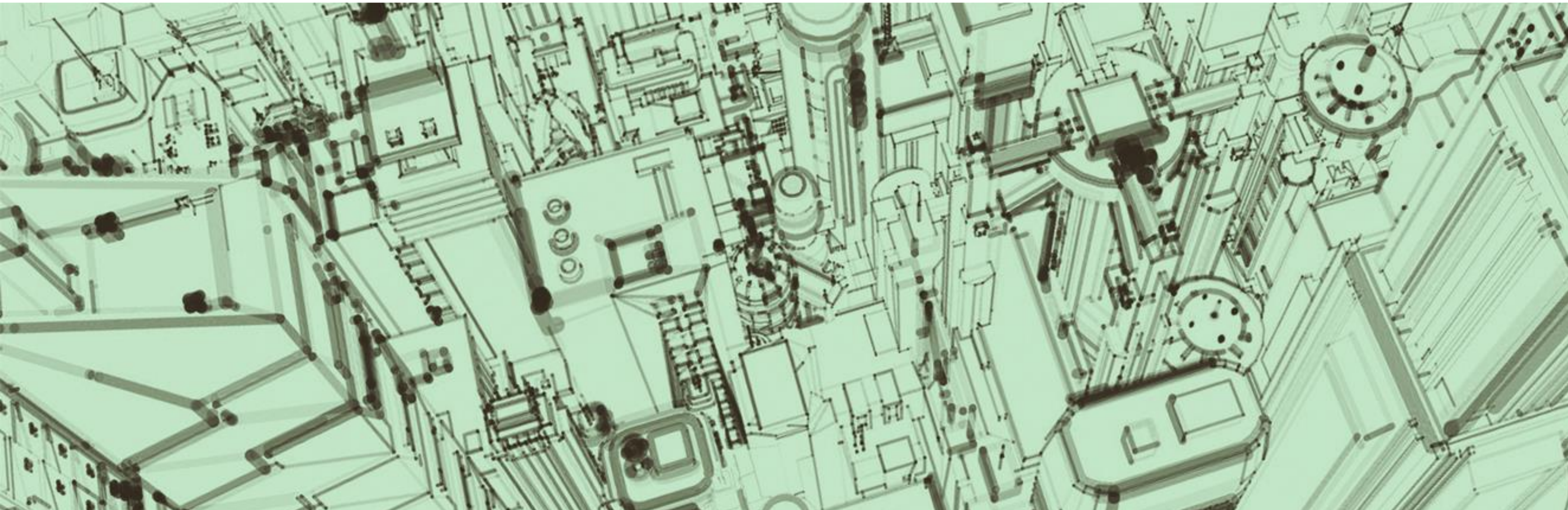


Crime in Greater London

[redacted]

Motivation

- Criminology is the study of criminal behavior in general
- There have been many studies that attempt to explain criminal behavior from various angles
  - Gender
  - Race/immigrant status
  - Socioeconomic status
  - Religion
  - Psychological traits
  - Etc.
- We would like to use as much information as possible to try to manage crime.

Introduction to Data

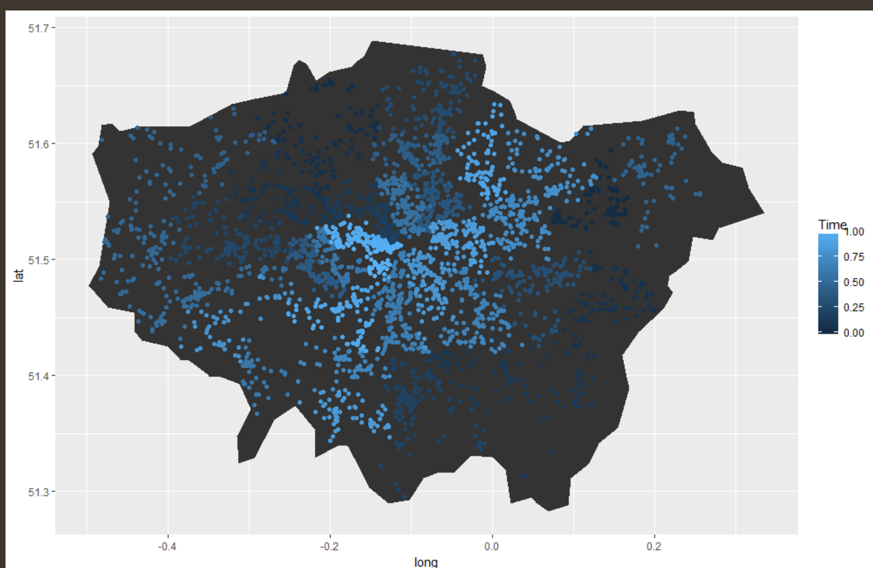
- Open data from the United Kingdom about policing in England, Wales and North Ireland
- Specifically, we will focus on crimes in the Greater London area
  - During March 2017 only
  - Look only at crimes that disrupted the "public order"
    - "Offenses which cause fear, alarm, or distress"

Caveats with the Data

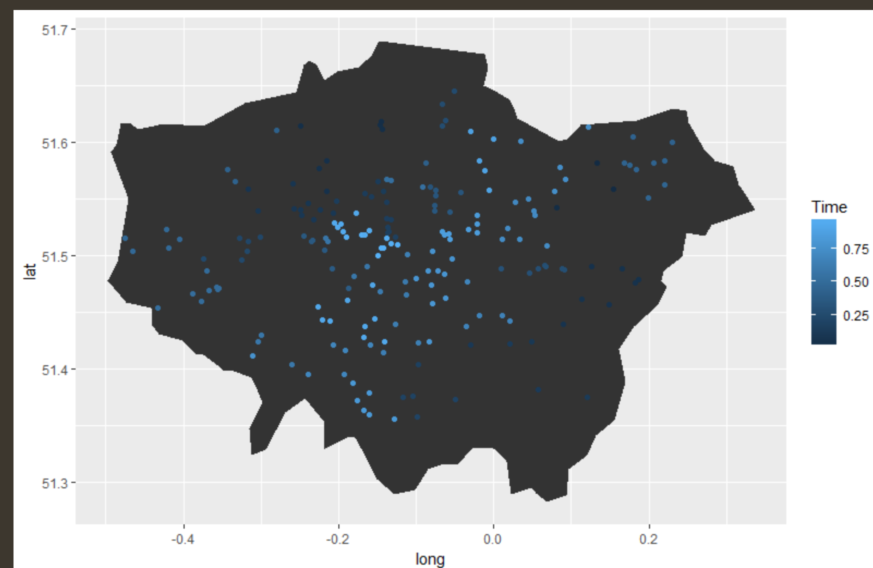
- Due to privacy concerns, the data is somewhat lacking detail
- Namely, while the data contains the month and year in which the incidents occurred, it does not contain even the actual date
  - However, the data should come in chronological order
  - For the purposes of this presentation, we assume the events are evenly spaced out.
- Also, locations of crime incidents are shifted slightly from their actual locations
  - Shifted to center of the nearest street or to a public place such as a park

Original Data of Crime Incident Locations

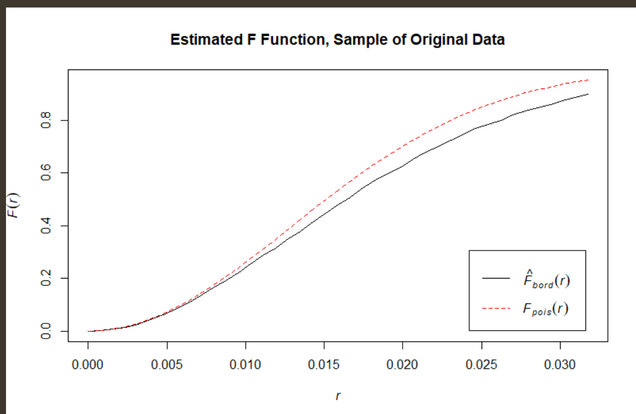
Full Original Data

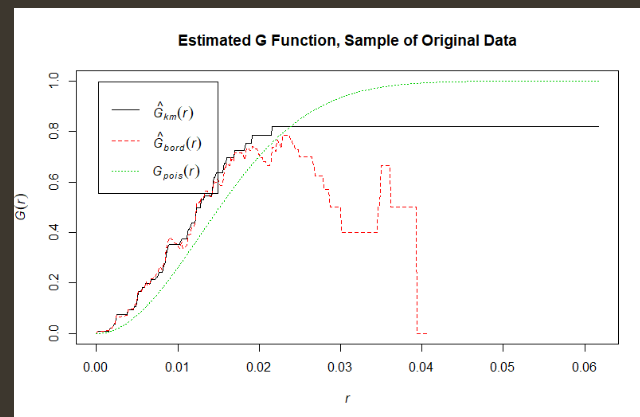


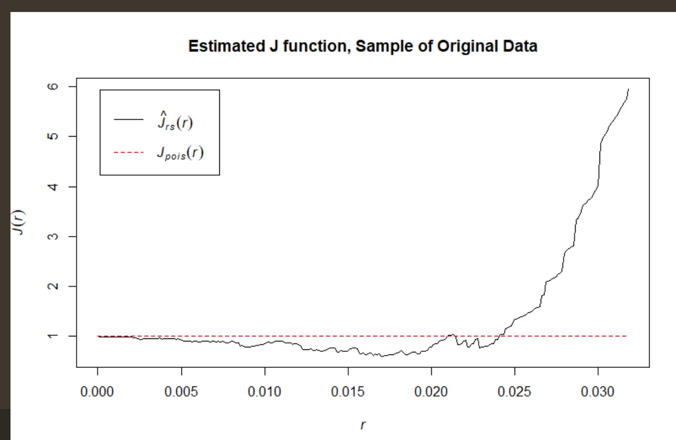
Sample that we will work with



Diagnostics – F, G, and J functions







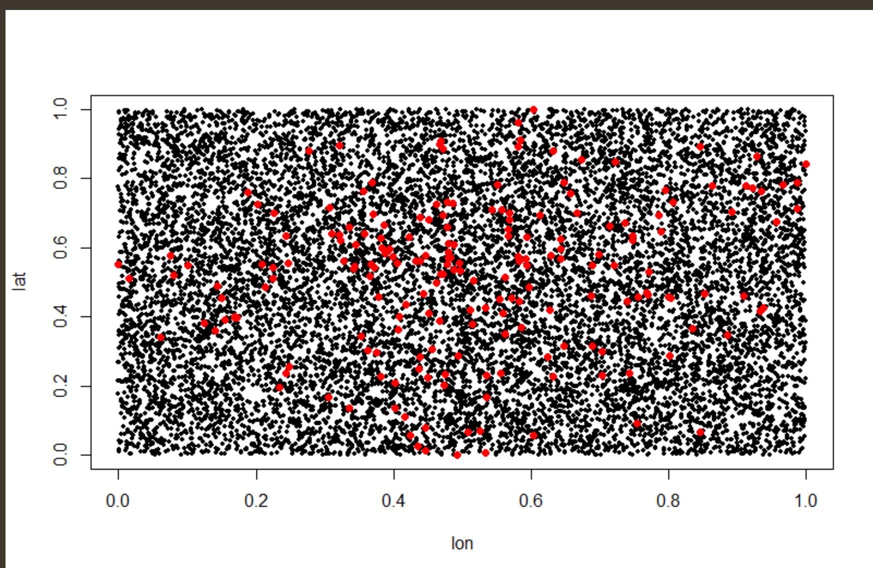
Fitting a Hawkes Process

- $\lambda(t,x,y) = \mu\, \rho(x,y) + \kappa \sum_{\{t',x',y' :\, t' < t\}} g(t-t_i)\, g(x-x_i, y-y_i)$
- Where:
  - $\rho(x,y) = \frac{1}{X_1 Y_1}$
  - $g(t) = \beta e^{-\beta t}$
  - $g(x,y) = \frac{\alpha}{\pi} e^{-\alpha r^2}$, $x^2 + y^2 = r^2$
  - Over the space S = $[0, X_1]$ x $[0, Y_1]$ in time [0, 1]. Here, we set $X_1 = Y_1 = 1$, so over unit square.
  - Parameters: $\mu, \kappa, \alpha, \beta$

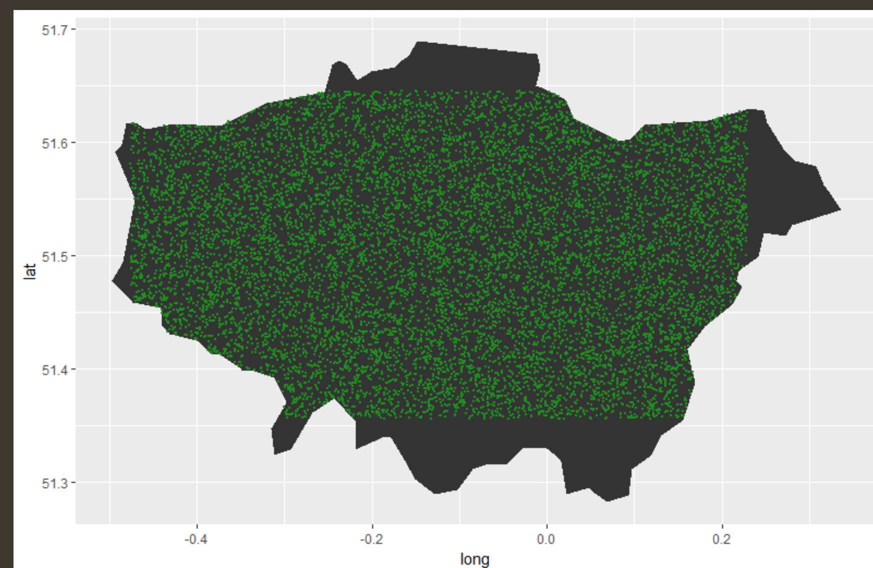
Parameter	μ	κ	α	β
Estimate	36.185	0.605	4.528	705.646
Std. Error	21.503	0.043	0.324	69.656

Super-thinning on Fitted Hawkes Process

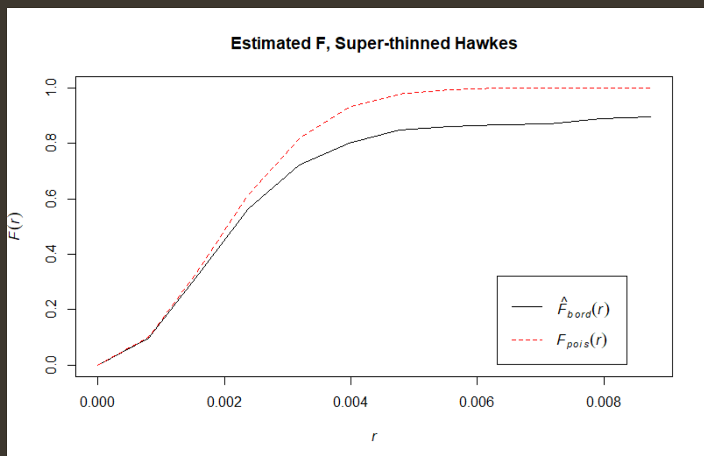
Super-thinned Points on Unit Square

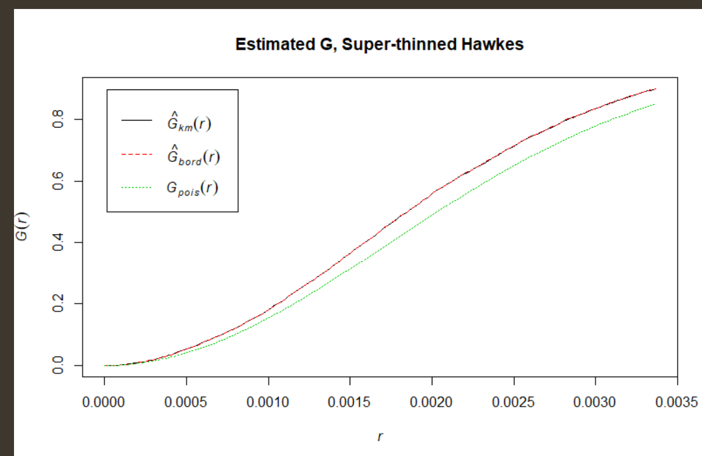


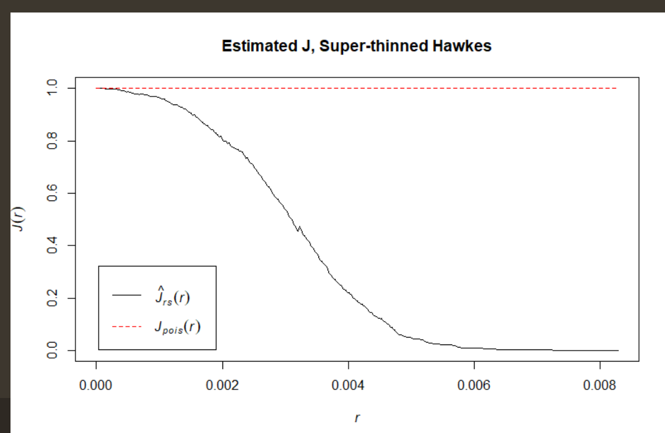
Super-thinned points on London



F, G, and J functions on Super-thinned fitted Hawkes







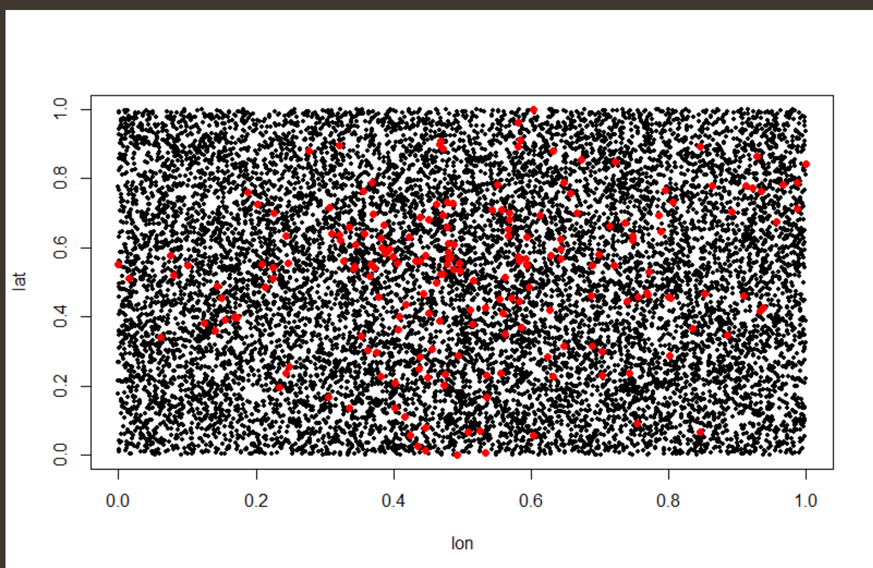
Fitting an Inhomogeneous Poisson Process

- $\lambda(t,x,y) = \beta_1 + \beta_2 x + \beta_3 y$
- Over the space S = [0, 1] x [0, 1] in time [0, 1].
- Parameters: $\beta_1, \beta_2, \beta_3$

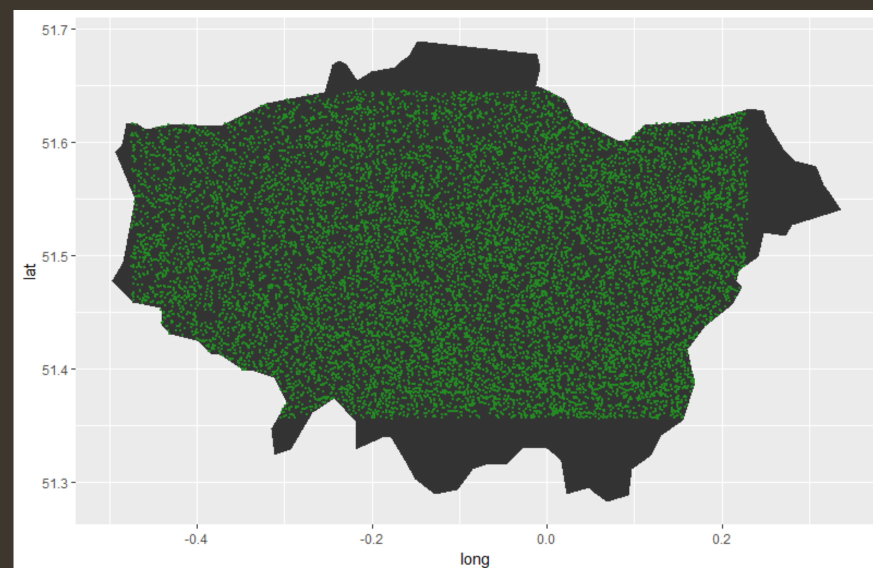
Parameter	β_1	β_2	β_3
Estimate	26.298	-27.656	27.137

Super-thinning on Fitted Poisson Process

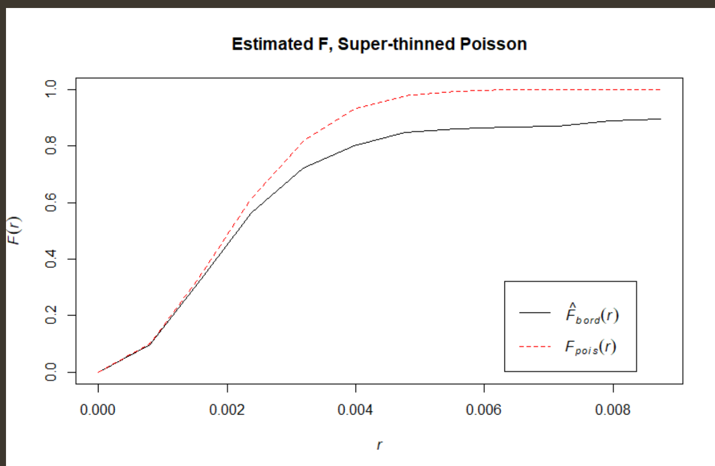
Super-thinned Points on Unit Square

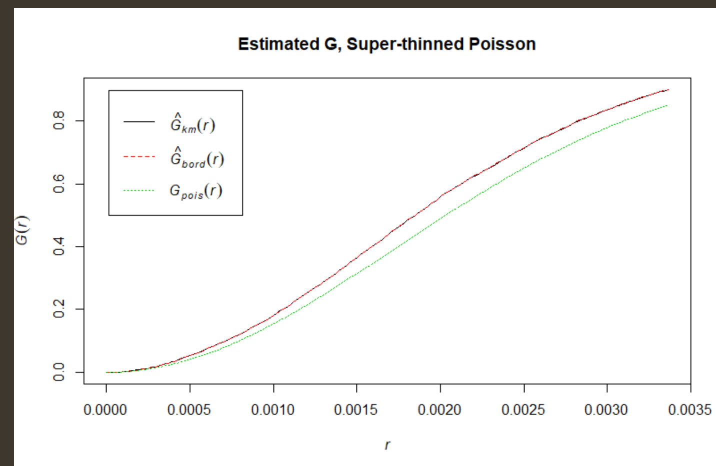


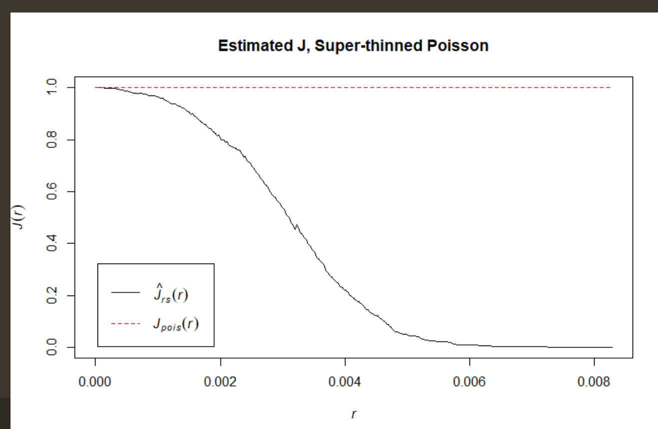
Super-thinned Points on London



F, G, and J functions on Super-thinned fitted Poisson







Conclusion and Further Extensions

- The Hawkes process and Poisson process seem to do as well as each other in fitting the data
  - That is, they both fit reasonably well but don't fit excellently
- Overall, more can be done to further expand the project
  - Analyze different types of crime (theft, drugs, arson, etc.)
  - Look at data over several months
  - Look at a bigger set of data, not just a sample
  - Get better data – with more details about each incident as well as more exact time and locations
  - Fit even more models (like Poisson processes of different forms, models with covariates, repulsion models like the Gibbs, Strauss, and Matern processes)

References

- Ellis, Lee, Kevin M. Beaver, and John Paul. Wright. *Handbook of Crime Correlates*. Amsterdam: Elsevier/Academic, 2009. Print.
- "About Data.police.uk." *Data.Police.UK*. Government of the United Kingdom, n.d. Web. 1 June 2017.

Thank you for listening!