

# SPATIAL POINTERS: BRIDGING THE GAP BETWEEN GEOSPATIAL ANALYSIS AND EASE OF USE



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SPATIAL  
POINTERS

## Problem & Motivation

Countless data sources exist in the form of spatial data, with geographic elements such as the shape, size or location of the features. Such spatial data could be analysed to generate useful insights or drive insightful decisions such as planning locations of facilities and understanding more about Ecology.

However, not many people are technically trained to do such spatial analysis. Additionally, the only way for them to improve their breadth and depth of knowledge pertaining to this area is limited to online resources. Without proper foundation, any analysis done could be highly inaccurate as well.

Therefore, our main focus is to develop a web-based geospatial analytical tool dedicated to Point Pattern Analysis (PPA), with two methods available for use.

Through this geospatial application, we hope to give pointers to and allow users to conduct PPA for their selected data with ease, regardless of their technical background.

## Approach

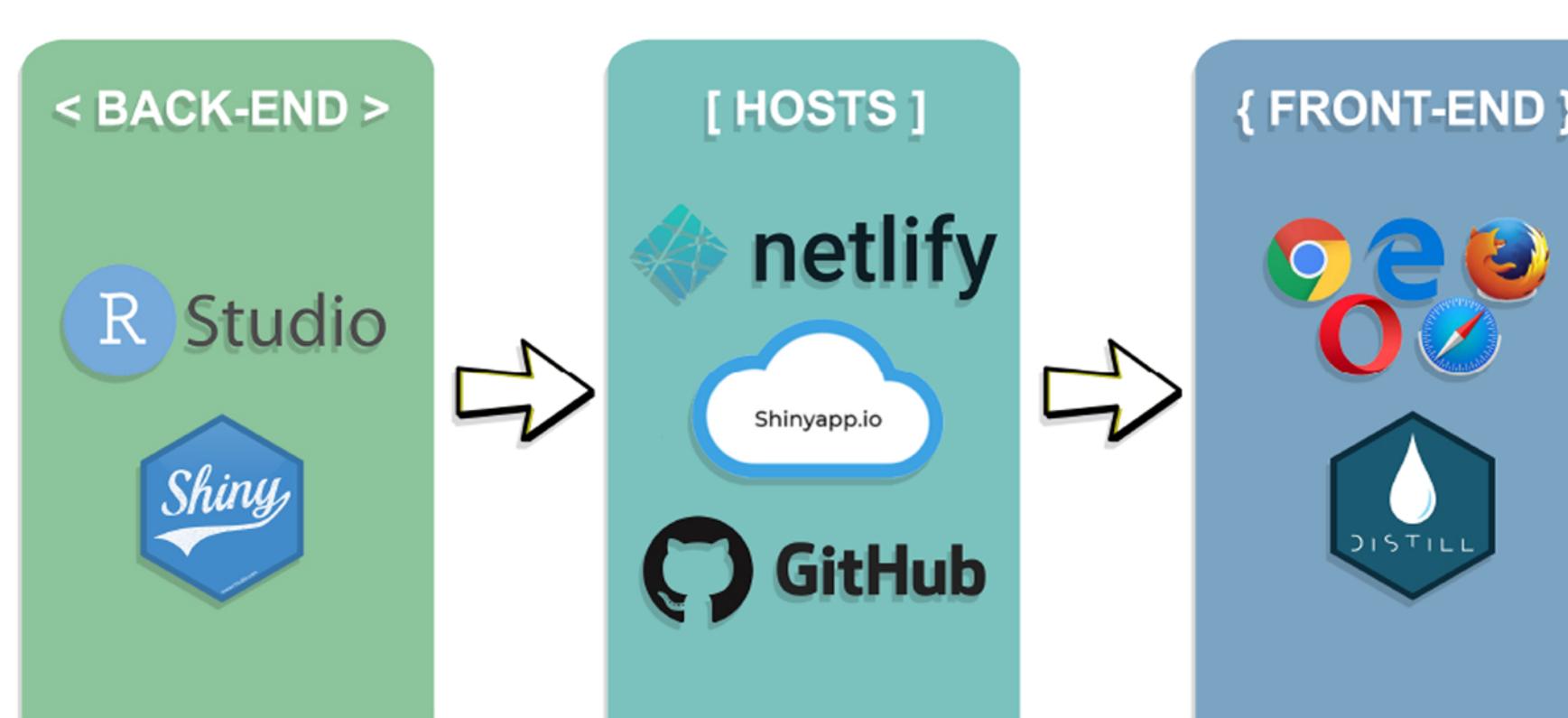
### Data Collection

We collated several data sets to be used as sample use cases for our application, such as the locations of McDonalds' outlets in Singapore and MRT Stations in Punggol, Singapore. The wide range of data consists of both CSV and Shapefile formats.

### Data Wrangling

We checked through the respective data sets and ran Exploratory Data Analysis (EDA) with them to check for any outliers and anomalies in the data. The relevant checks were then done with the help of various R packages, such as ensuring the imported objects have the correct Coordinate Reference System (CRS) information with `spTransform()` and confining the data to the study area through an `owin` object.

### Application Architecture



## Overview of Spatial Pointers

# SPATIAL POINTERS

Our design for our application closely follows a standardized layout for the various tabs: a main visualization panel on the left and a side panel for selection of inputs on the right. With this layout, it allows users to get a quick overview of the chosen tab at one glance.

### 1. Home Page



What does Point Pattern Analysis do?

Point Pattern Analysis methods helps provide insights about where things occur, how the distribution of incidents or the arrangement of data aligns with other features in the landscape, and what the patterns may reveal about potential connections and correlations.

About our application: Spatial Pointers

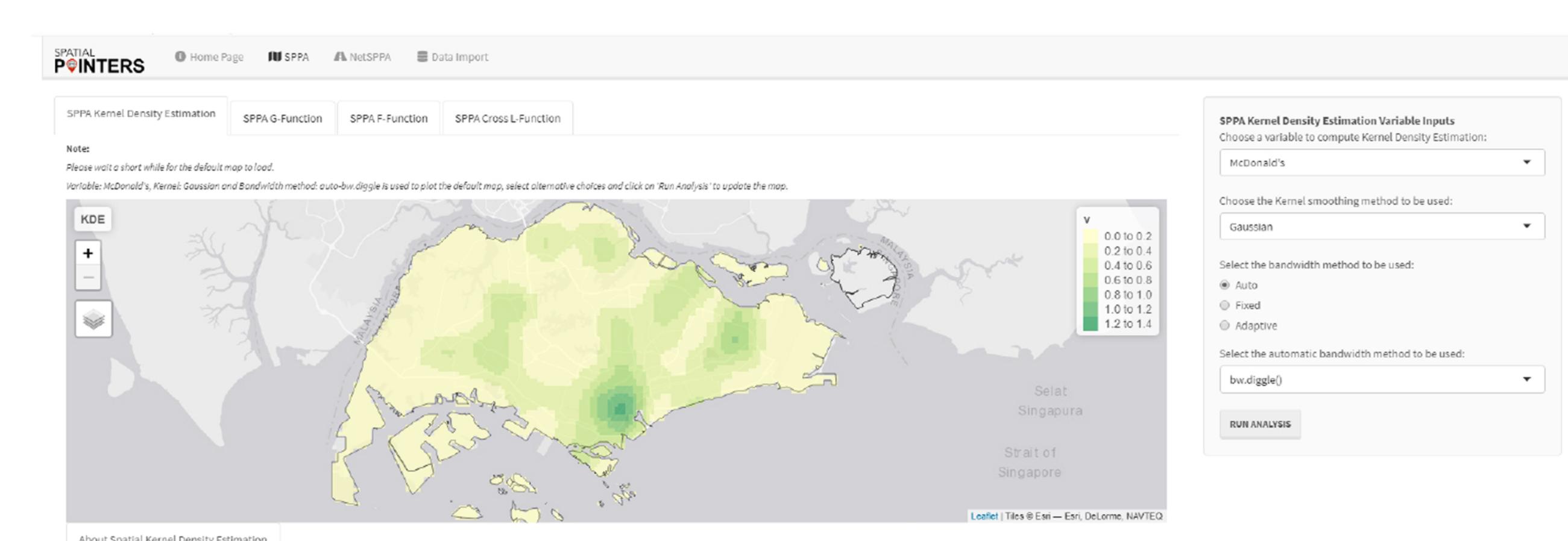
Our application will assist users with two methods of Point Pattern Analysis:

- Spatial Point Patterns Analysis (SPPA)
- Network Constrained Point Patterns Analysis (NetSPPA)

For each analysis, our application is able to provide users with kernel density maps of the input spatial point datasets and conduct various hypothesis tests to derive statistical conclusions on the distributions of datasets.

From this Home Page, you can have a quick overview of the motivation behind our application, what our application is all about and also gain a quick understanding of what Point Pattern Analysis can do for you.

### 2. Spatial Point Patterns Analysis (SPPA)



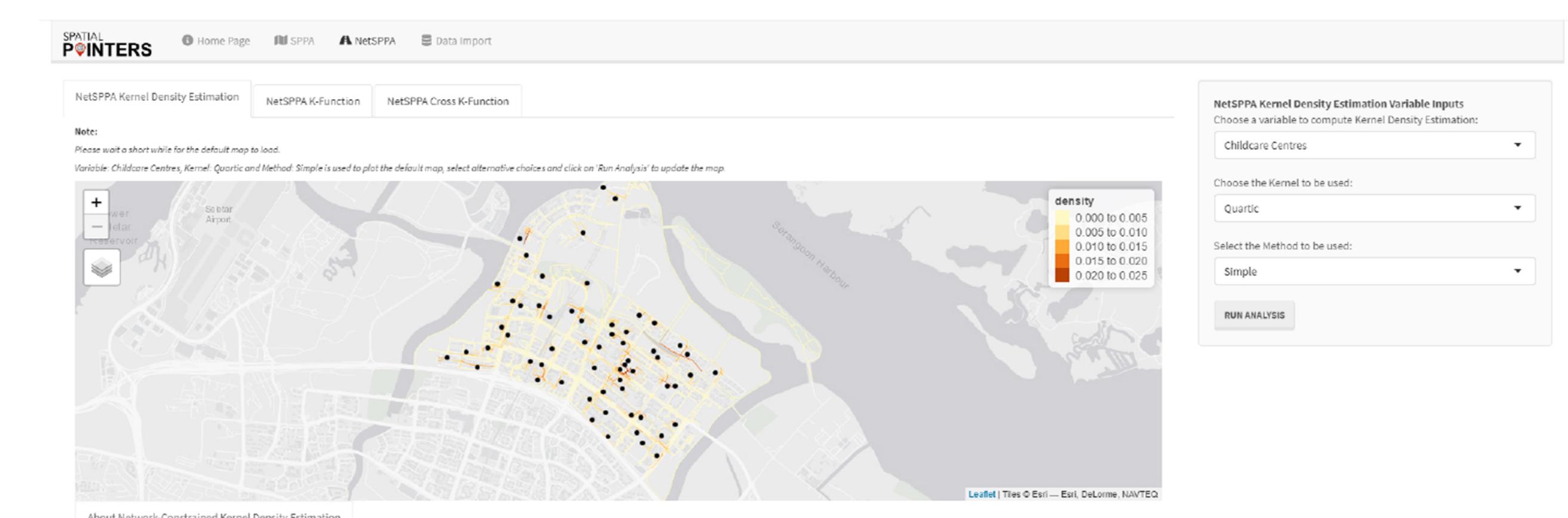
What is Spatial Kernel Density Estimation?  
Kernel Density Estimation (KDE) is a non-parametric way to estimate local density. It creates a grid which each cell is assigned the density value of the kernel window centered on that cell. The density value is estimated by counting the number of objects events in that kernel window.

How to Interpret the output?

The v in the legend indicates the number of object/events in kernel window centered in each grid. Essentially, the darker the color of the area, the higher the intensity of points density in that area.

The SPPA page is the second page that you can access in our application with four sub tabs made available for use: 1) SPPA Kernel Density Estimation, 2) SPPA G-Function, 3) SPPA F-Function, 4) SPPA Cross L-Function .

### 3. Network Constrained Spatial Point Patterns Analysis (NetSPPA)



What is Network-Constrained Kernel Density Estimation?  
A standard kernel density estimation (KDE) estimates the continuous density of a set of events in a two-dimensional space, which is not suitable for analysing density of events occurring on a network. Therefore, the modified network-constrained kernel density estimation is used to calculate density of events occurring on the edges of a network.

How to Interpret the output?  
Essentially, the darker the color of the road, the higher the relative density of the point features as compared to road segments with lighter color (meaning lower density).

The NetSPPA page is the third page that you can access in our application with three sub tabs made available for use: 1) NetSPPA Kernel Density Estimation, 2) NetSPPA K-Function, 3) NetSPPA Cross K-Function .

### 4. Data Import

The Data Import page is the fourth page that you can access in our application. This tab allows users to import their data in shapefile format.

## Future Work

Further improvements could be made to the application, such as:

### 1. Enabling a more generic Data Import function

Currently, our application only accepts data uploaded in shapefile format, which could be limiting for certain use cases.

### 2. Add additional PPA methods into the application

Additional point pattern analysis methods can be added to further enhance the application's capabilities.

### 3. Integrating with real-time databases

Our application could be integrated with real-time databases to provide more substantial demonstrations for users.

## Conclusion

We designed the application in a way that is user-friendly, and offer users the simplest explanations possible to make map/graph results easy to interpret and understand. The application allows users to perform SPPA and NetSPPA with ease, serving as an effective exploratory tool for all users.

Accessibility wise, Spatial Pointers is an open-source web-based tool and is freely available to all users from across the globe.

To sum it all up, Spatial Pointers was created to address the lack of existing effective PPA oriented applications. We hope our application can be helpful for researchers to do PPA analysis.