IS415 Geospatial Analytics and Applications

User Guide for

Spatial Pointers:

A Dynamic and Interactive Shiny App for Point Patterns Analysis

Prepared By:

Teo Jun Peng

Yu Yiling

How to use Spatial Pointers: your quick start guide

Welcome to Spatial Pointers - A Dynamic and Interactive Shiny App for Point Patterns Analysis (PPA).

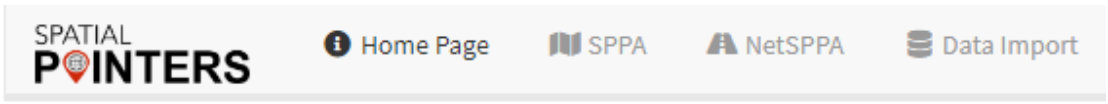
Our application will assist users with two kinds of Point Pattern Analysis: *Spatial Point Patterns Analysis and Network-Constrained Point Patterns Analysis*.

Application Link

SPATIAL POINTERS

https://yiling-yu.shinyapps.io/is415_project_shiny_app/

Navigation Tab Bar

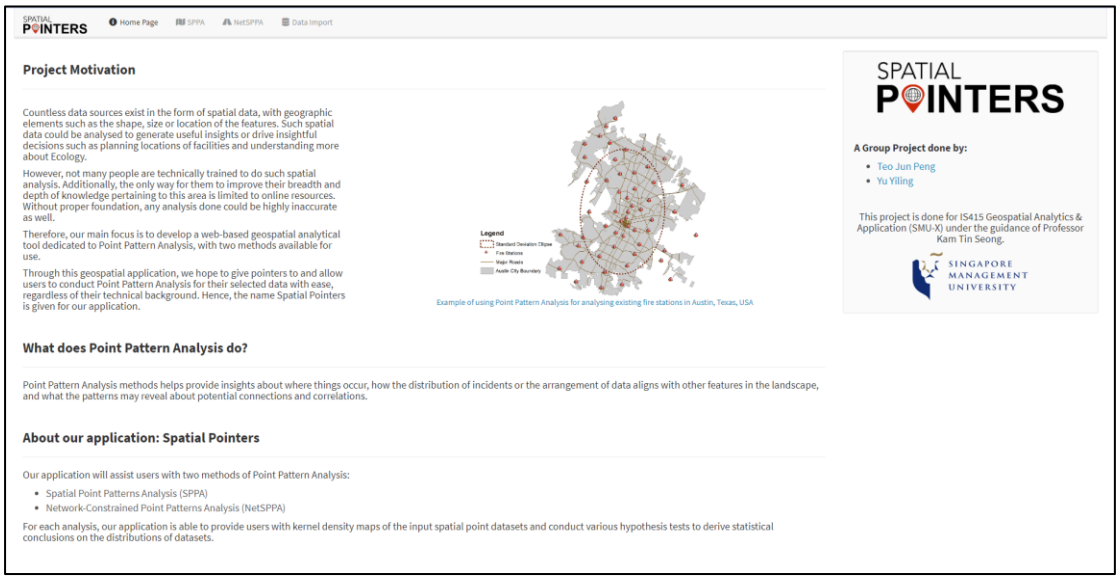


The Navigation Tab Bar is located at the top of the screen, which shows the different functionalities our application can provide for you.

By default, the tab bar is translucent: only when you click on a specific tab then it will distinguish itself as the current active tab through darkening.

However, to welcome you with an overview of our application the moment you access our application, the Home Page tab is set as the active tab by default.

1. Home Page

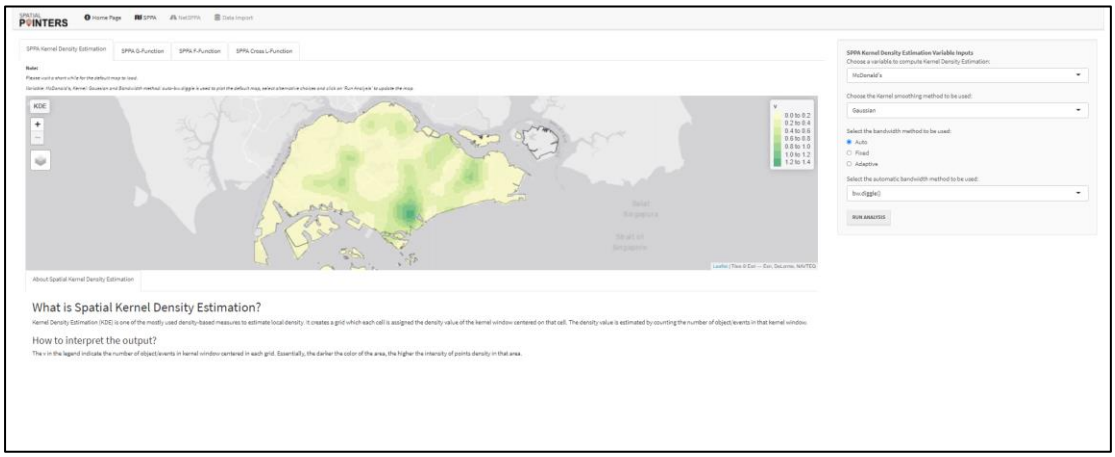


As mentioned above, the home page will be the first thing that greets you when you access our application.

From the 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.

On the side panel located at the right, you can also access the LinkedIn profiles of the creators of Spatial Pointers to find out more about them.

2. SPPA



The SPPA is the second page that you can access in our application.

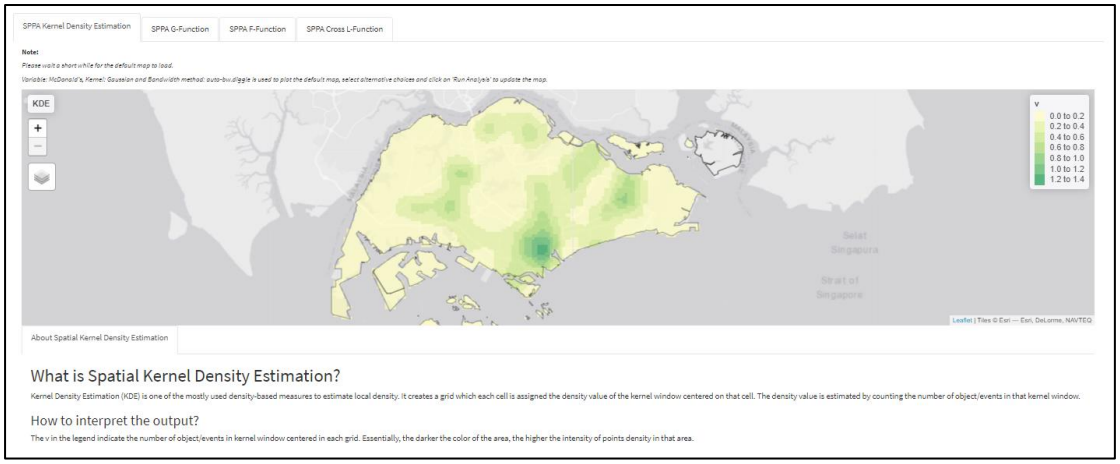
SPPA is short form for Spatial Point Patterns Analysis, the first of the two PPA analysis that our application provides you with.

Four sub tabs will be made available for use:

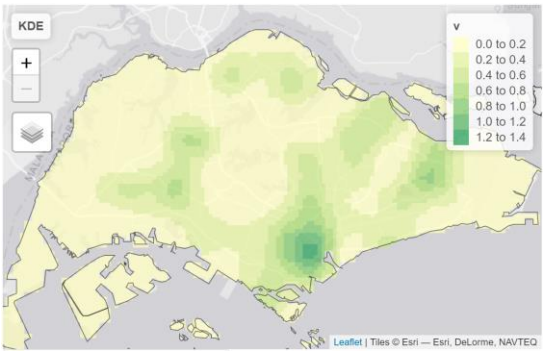
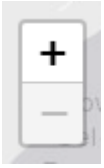
1) *SPPA Kernel Density Estimation*
2) *SPPA G-Function*
3) *SPPA F-Function*
4) *SPPA Cross L-Function*

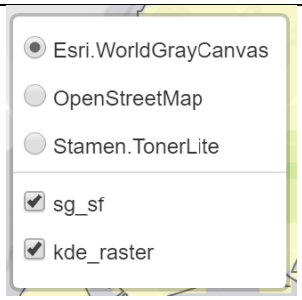
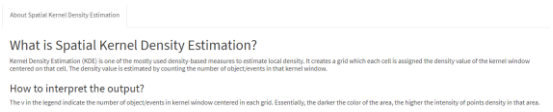
The layout of the sub tabs is similar in nature, with a main visualization panel on the left and a side panel for selection of inputs on the right.

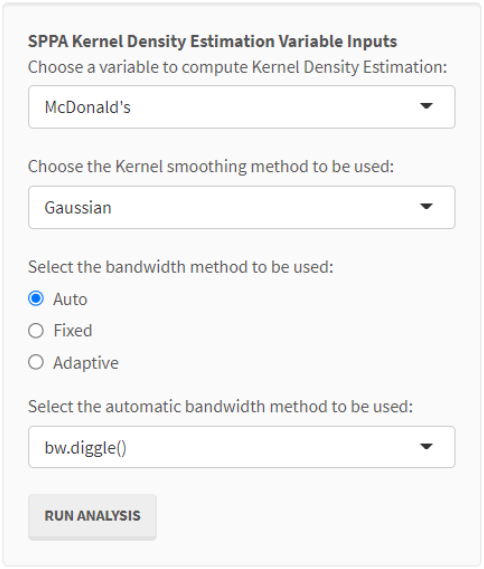
2.1 SPPA Kernel Density Estimation



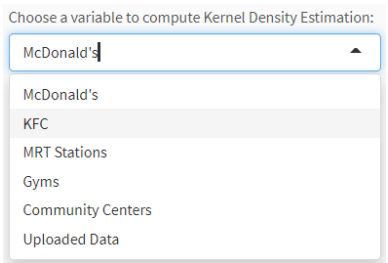
SPPA KDE Main Panel

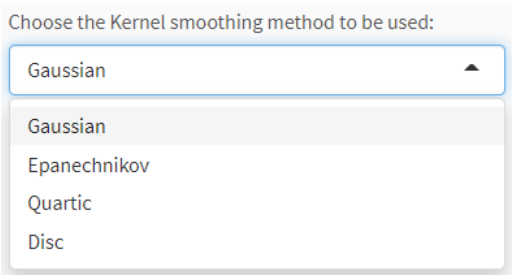
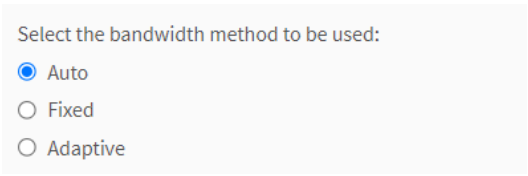
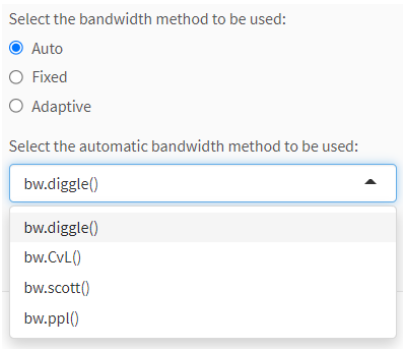
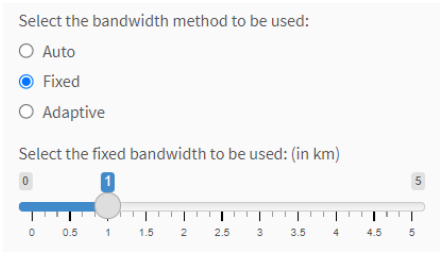
Feature	Functionality
 Map Visualization	This map is a visualization of the Spatial Kernel Density Estimation being computed. The v in the legend indicates the number of object/events in kernel window centered in each grid. Essentially, **the darker the color of the area, the higher the intensity of points density** in that area.
 Zoom Control	You can click on the '+' icon to zoom further into the map, and '-' to zoom further out. Alternatively, you can use your mouse scroll for zoom control too. The '-' icon is greyed out initially as a zoom limit has been set in the backend to ensure users are always seeing the best aspect ratio possible for the visualization.
	When you **hover your cursor over** this icon, the menu will appear, where you can **select your desired base map.**

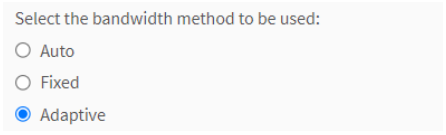
 Base Map Control	Our application offers **3 different base maps**, feel free to test them out to see which offers the best visualization for your use case. You also have the **option to select/de-select `sg_sf` and `kde_raster`**, which are the Singapore Costal Outline and the computed KDE raster layer respectively. Try de-selecting them to see what happens!
 About SPPA KDE Section	In this section, you can get a **quick understanding of what is Spatial Kernel Density Estimation** and **how to interpret the output in the map visualization.**



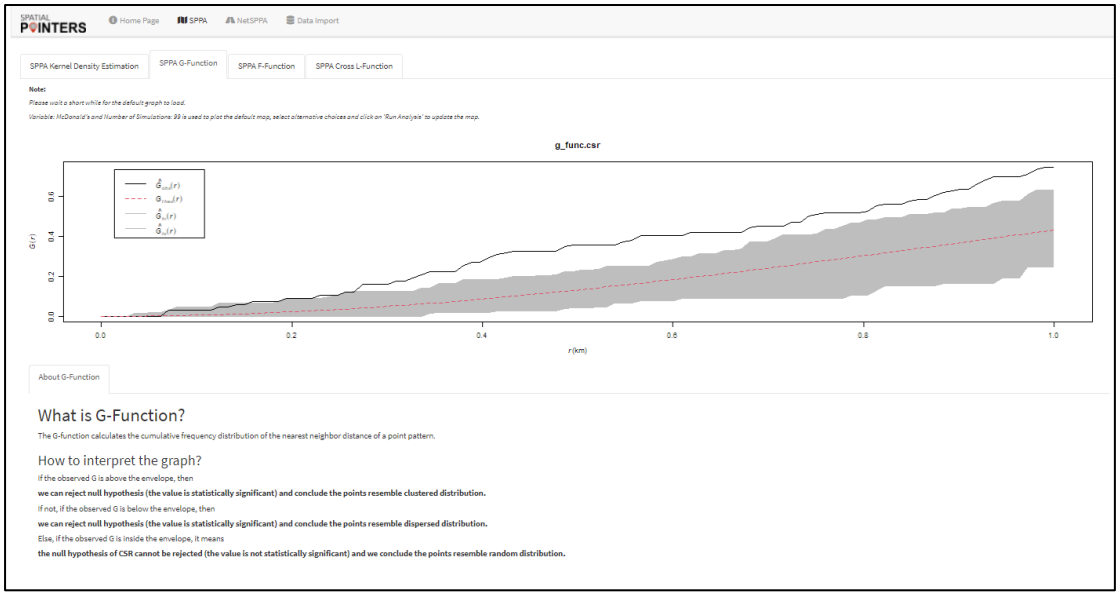
SPPA KDE Side Panel

Feature	Functionality
 Variable for SPPA KDE	From this **drop-down list, you can select the variable to compute SPPA KDE**. `McDonald's` is selected as the variable for computing the default map. Other options are `KFC`, `MRT Stations`, `Gyms`, `Community Centers` and your own custom uploaded data `Uploaded Data`.

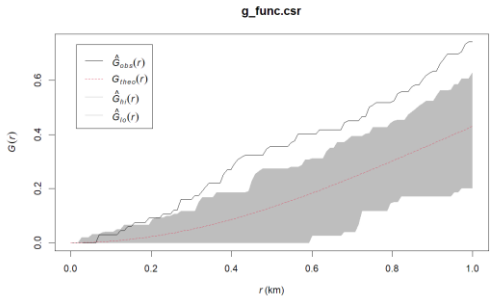
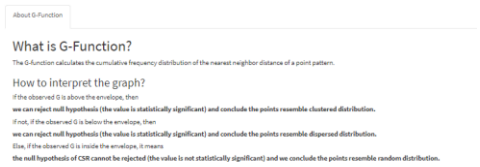
 SPPA KDE Kernel Selection	From this **drop-down list, you can select the kernel method to compute SPPA KDE.** `Gaussian` is selected as the kernel method for computing the default map. Other options are `Epanechnikov`, `Quartic` and `Disc`. Find out more about the differences between the various kernels here: https://en.wikipedia.org/wiki/Kernel_(statistics)
 SPPA KDE Bandwidth Method Selection	From these radio buttons**, you can select the bandwidth method compute SPPA KDE.** `Auto` is selected as the default bandwidth method. Other options are `Fixed` and `Adaptive`.
 Automatic Bandwidth Method Selection	For automatic bandwidth method, **you can select the specific functions to be used for computing the SPPA KDE bandwidth** from this dropdown list. `bw.diggle()` is selected as the default bandwidth function. Other options are `bw.CvL()`, `bw.scott()` and `bw.ppl()`. Find out more about the differences between the various functions here: https://search.r-project.org/CRAN/refmans/spatstat.core/html/density.ppp.html
 Fixed Bandwidth Method Selection	For fixed bandwidth method, **you can choose the specific bandwidth to perform the KDE** from this slider. `1(km)` is selected as the default kernel bandwidth, but you may choose any number between `0` and `5` (in km).

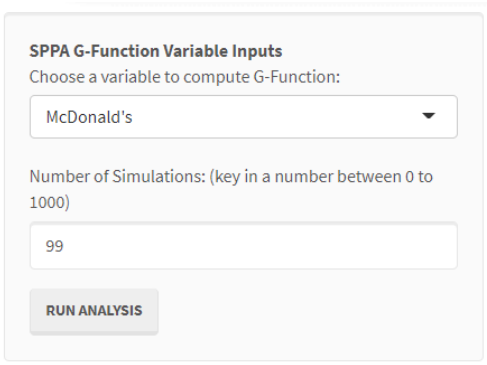
 Adaptive Bandwidth Method Selection	For adaptive bandwidth method, **once you choose it, the bandwidth will be automatically calculated for your KDE map**.
 Run Analysis Button	This feature is the most important out of the bunch, because **the map visualizations will only update after this button is clicked.** Therefore, do remember to **click on this `Run Analysis` button to see the updated changes** after selecting your desired variable, kernel, and bandwidth method.

2.2 SPPA G-Function

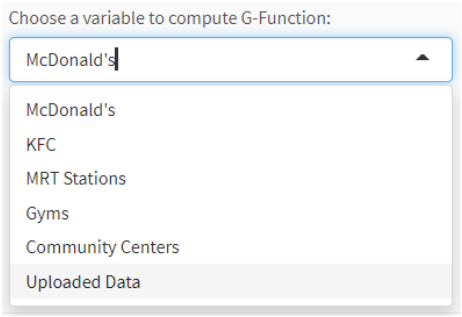
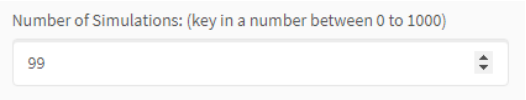


SPPA G-Function Main Panel

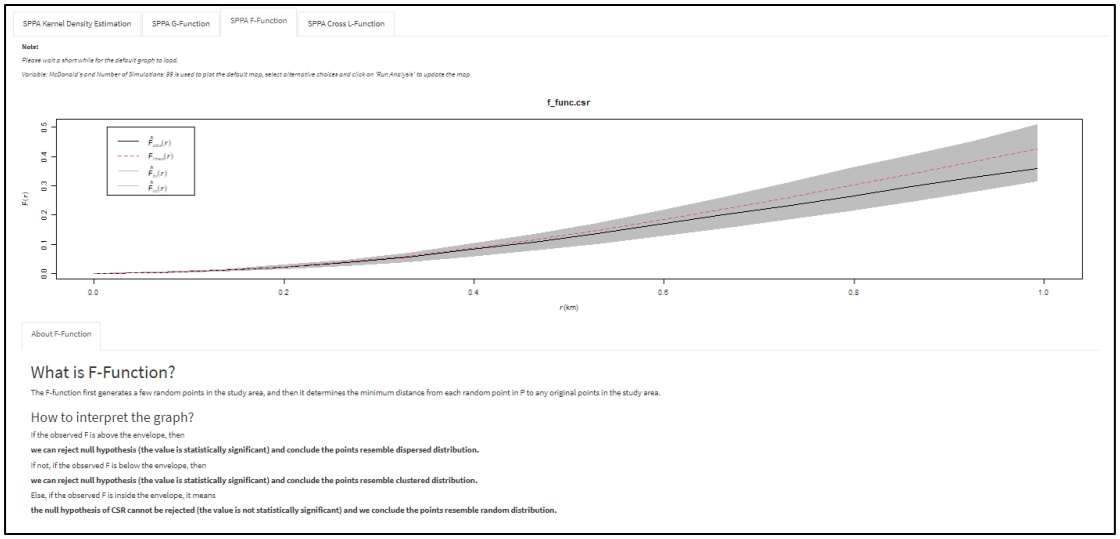
Feature	Functionality
 Monte Carlo simulation test of CSR on G-Function Visualization	This graph is the visualization of **Monte Carlo simulation test of CSR on G-Function for the selected variable**. The graph **illustrates the spatial distribution (clustering, dispersion, or randomness) of point features (which in this case, is our chosen variable from the side panel) over a wide range of scales.**
 About SPPA G-Function Section	In this section, you can get a **quick understanding of what is G-Function** and **how to interpret the graph output.**



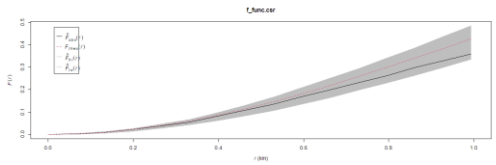
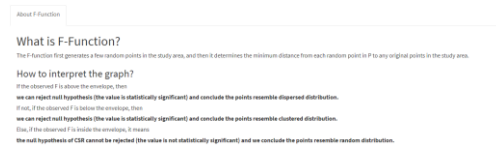
SPPA G-Function Side Panel

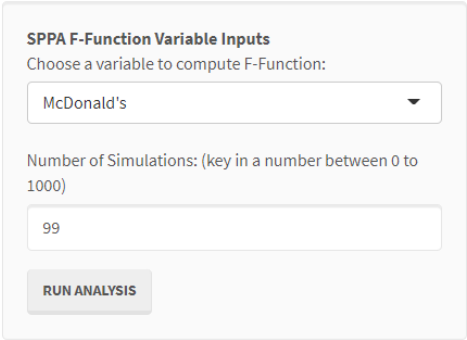
Feature	Functionality
 Variable for G-Function	From this **drop-down list, you can select the variable to compute G-Function**. `McDonald's` is selected as the variable for computing the default map. Other options are `KFC`, `MRT Stations`, `Gyms`, `Community Centers` and your own custom uploaded data `Uploaded Data`.
 No. of Simulations	Through this input box, you can **key in the number of Monte Carlo simulation test of CSR to run on the G-Function**. `99` is the default value for our graph, but you may input a number between `0` to `1000`. Find out more about Monte Carlo simulations here: https://www.ibm.com/sg-en/cloud/learn/monte-carlo-simulation
 Run Analysis Button	Same as other side panels, **the graph visualizations will only update after this button is clicked.** Therefore, do remember to **click on this `Run Analysis` button to see the updated changes** after selecting your desired variable and number of simulations.

2.3 SPPA F-Function

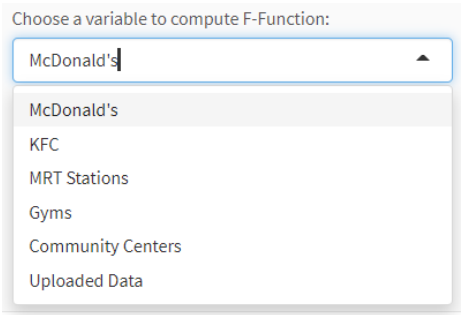
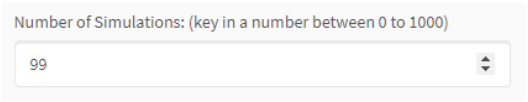


SPPA F-Function Main Panel

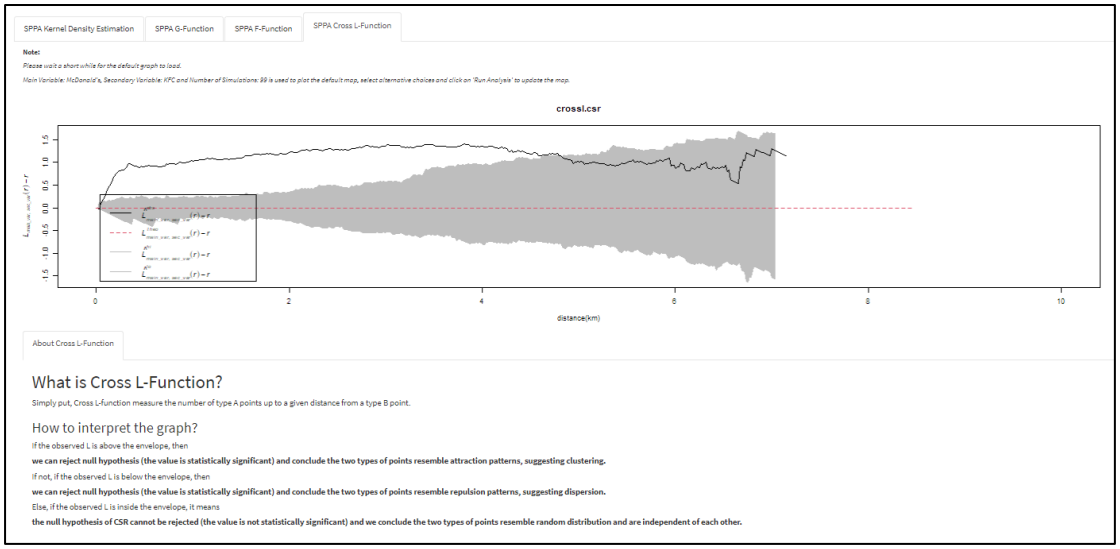
Feature	Functionality
 Monte Carlo simulation test of CSR on F-Function Visualization	This graph is the visualization of **Monte Carlo simulation test of CSR on F-Function for the selected variable**. The graph **illustrates the spatial distribution (clustering, dispersion, or randomness) of point features (which in this case, is our chosen variable from the side panel) over a wide range of scales.**
 About SPPA F-Function Section	In this section, you can get a **quick understanding of what is F-Function** and **how to interpret the graph output.**



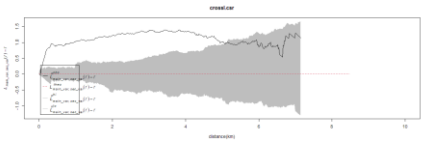
SPPA F-Function Side Panel

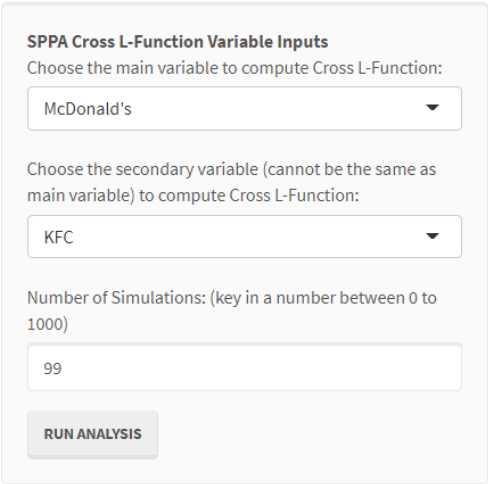
Feature	Functionality
 Variable for F-Function	From this **drop-down list, you can select the variable to compute F-Function**. `McDonald's` is selected as the variable for computing the default map. Other options are `KFC`, `MRT Stations`, `Gyms`, `Community Centers` and your own custom uploaded data `Uploaded Data`.
 No. of Simulations	Through this input box, you can **key in the number of Monte Carlo simulation test of CSR to run on the F-Function**. `99` is the default value for our graph, but you may input a number between `0` to `1000`. Find out more about Monte Carlo simulations here: https://www.ibm.com/sg-en/cloud/learn/monte-carlo-simulation
 Run Analysis Button	Same as other side panels, **the graph visualizations will only update after this button is clicked.** Therefore, do remember to **click on this `Run Analysis` button to see the updated changes** after selecting your desired variable and number of simulations.

2.4 SPPA Cross L-Function

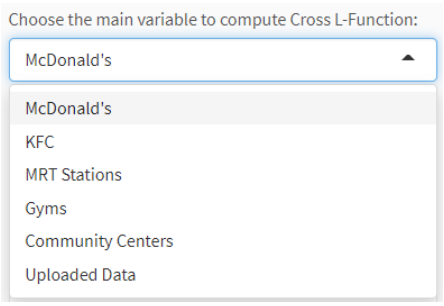
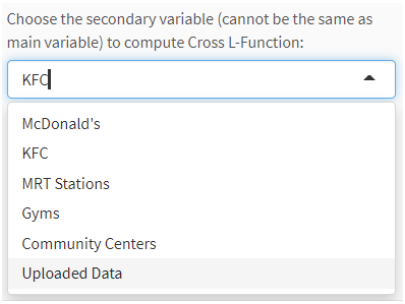
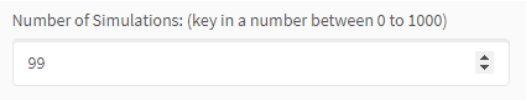


SPPA Cross L-Function Main Panel

Feature	Functionality
 Monte Carlo simulation test of CSR on Cross L-Function Visualization	This graph is the visualization of **Monte Carlo simulation test of CSR on Cross L-Function for the selected main (A) and secondary (B) variables**. The graph **illustrates the spatial dependence (clustering, dispersion, or randomness) between point A features and point B features over a wide range of scales.**
 About SPPA Cross L-Function Section	In this section, you can get a **quick understanding of what is Cross L-Function** and **how to interpret the graph output.**

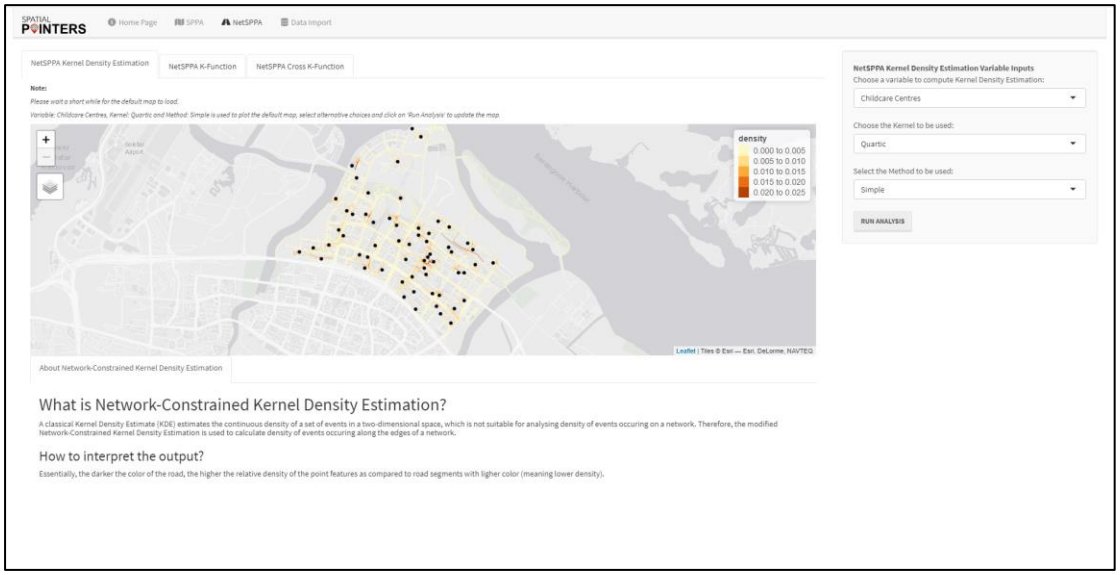


SPPA Cross L-Function Side Panel

Feature	Functionality
 Main Variable for Cross L-Function	From this **drop-down list, you can select the main variable to compute Cross L-Function**. `McDonald's` is selected as the main variable for computing the default map. Other options are `KFC`, `MRT Stations`, `Gyms`, `Community Centers` and your own custom uploaded data `Uploaded Data`.
 Secondary Variable for Cross L-Function	From this **drop-down list, you can select the secondary variable to compute Cross L-Function**. `KFC` is selected as the secondary variable for computing the default map. Other options are `McDonald's`, `MRT Stations`, `Gyms`, `Community Centers` and your own custom uploaded data `Uploaded Data`. **However, the chosen secondary variable cannot be the same as the main variable.**
 No. of Simulations	Through this input box, you can **key in the number of Monte Carlo simulation test of CSR to run on the Cross L-Function**. `99` is the default value for our graph, but you may input a number between `0` to `1000`.

	Find out more about Monte Carlo simulations here: https://www.ibm.com/sg-en/cloud/learn/monte-carlo-simulation
 Run Analysis Button	Same as other side panels, **the graph visualizations will only update after this button is clicked.** Therefore, do remember to **click on this `Run Analysis` button to see the updated changes** after selecting your desired variables and number of simulations.

3. NetSPPA



The NetSPPA is the third page that you can access in our application.

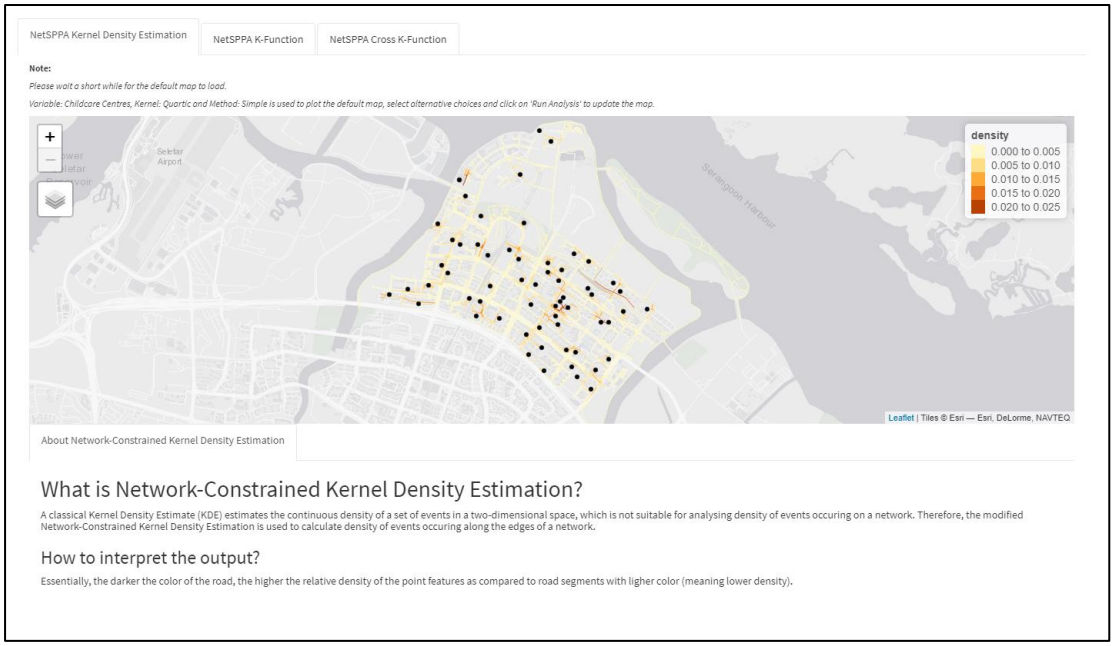
NetSPPA is short form for Network-Constrained Spatial Point Patterns Analysis, the second of the two PPA analysis that our application provides you with.

Three sub tabs will be made available for use:

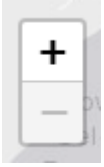
1) *NetSPPA Kernel Density Estimation*
2) *NetSPPA K-Function*
3) *NetSPPA Cross K-Function*

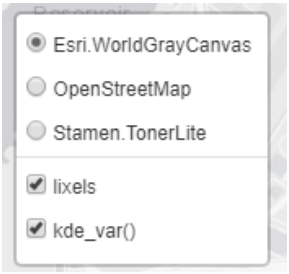
The layout of the sub tabs is similar in nature, with a main visualization panel on the left and a side panel for selection of inputs on the right.

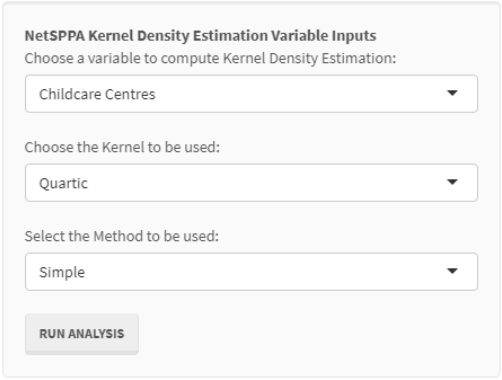
3.1 NetSPPA Kernel Density Estimation



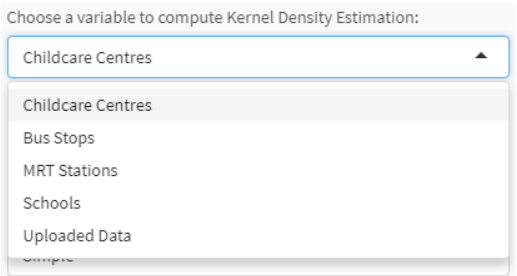
NetSPPA KDE Main Panel

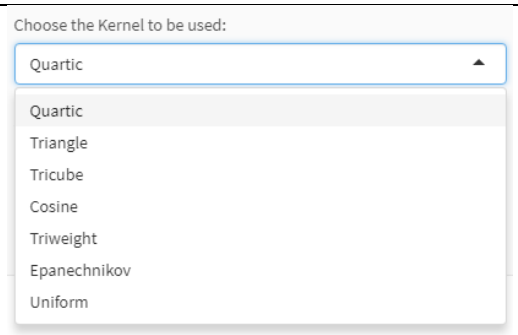
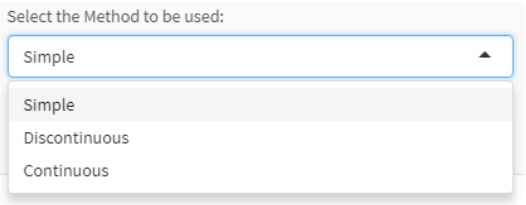
Feature	Functionality
 Map Visualization	This map is a visualization of the Network-Constrained Kernel Density Estimation being computed. The points are the variables, and the network is shown in the color range yellow-orange, with **the darker the color (darker orange), the higher the intensity of points density along the network.**
 Zoom Control	You can click on the '+' icon to zoom further into the map, and '-' to zoom further out. Alternatively, you can use your mouse scroll for zoom control too. The '-' icon is greyed out initially as a zoom limit has been set in the backend to ensure users are always seeing the best aspect ratio possible for the visualization.

  Base Map Control	When you **hover your cursor over** this icon, the menu will appear, where you can **select your desired base map.** Our application offers **3 different base maps**, feel free to test them out to see which offers the best visualization for your use case. You also have the **option to select/de-select `lixels` and `kde_var()`**, which are the network and the points respectively. Try de-selecting them to see what happens!
 About NetSPPA KDE Section	In this section, you can get a **quick understanding of what is Spatial Kernel Density Estimation** and **how to interpret the output in the map visualization.**

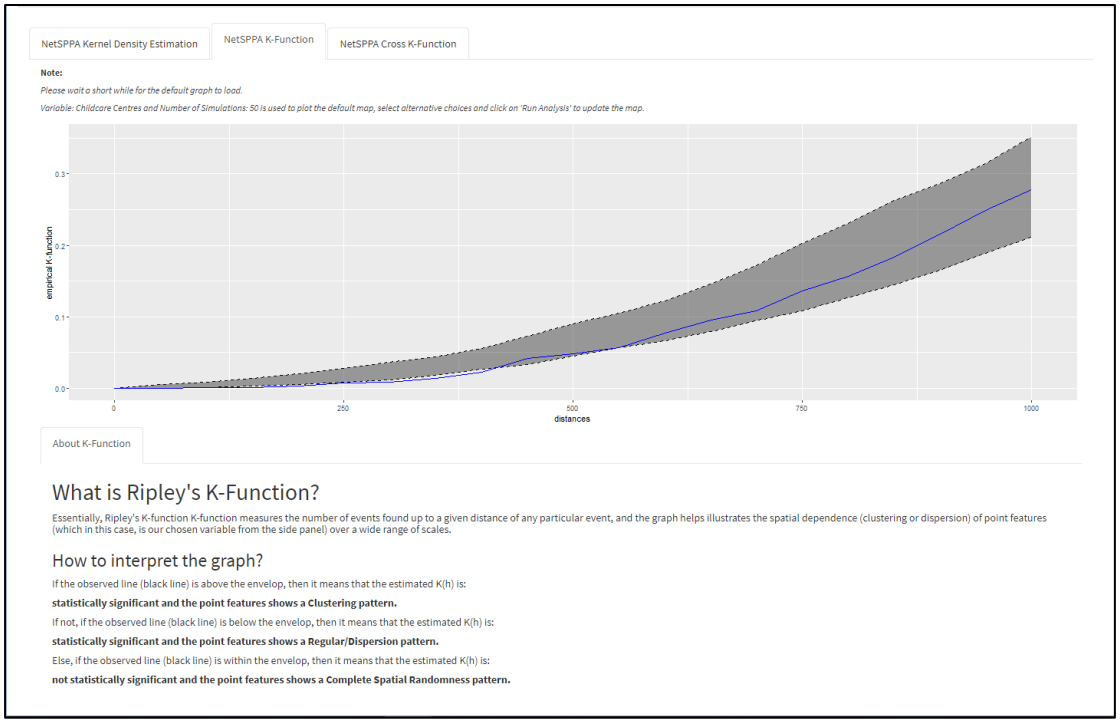


NetSPPA KDE Side Panel

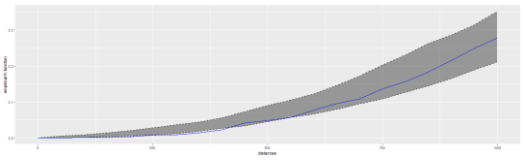
Feature	Functionality
 Variable for NetSPPA KDE	From this **drop-down list, you can select the variable to compute NetSPPA KDE**. `Childcare Centres` is selected as the variable for computing the default map. Other options are `Bus Stops`, `MRT Stations`, `Schools` and your own custom uploaded data `Uploaded Data`.

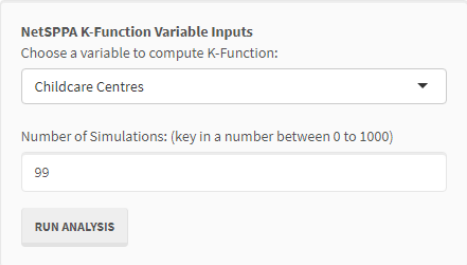
 NetSPPA KDE Kernel Selection	From this **drop-down list, you can select the kernel method to be used to compute NetSPPA KDE.** `Quartic` is selected as the kernel method for computing the default map.. Other options are `Triangle`, `Tricube`, `Cosine`, `Triweight`, `Epanechnikov` and `Uniform`. Find out more about the differences between the various kernels here: https://cran.r-project.org/web/packages/spNetwork/vignettes/NKDE.html
 NetSPPA KDE Method Selection	From this **drop-down list, you can select the method to compute NetSPPA KDE.** `Simple` is selected as the method for computing the default map. Other options are `Discontinuous` and `Continuous`. Find out more about the differences between the various methods here: https://cran.r-project.org/web/packages/spNetwork/vignettes/NKDE.html
 Run Analysis Button	This feature is the most important out of the bunch, because **the map visualisation will only update after this button is clicked.** Therefore, do remember to **click on this `Run Analysis` button to see the updated changes** after selecting your desired variable, kernel, and method.

3.2 NetSPPA K-Function

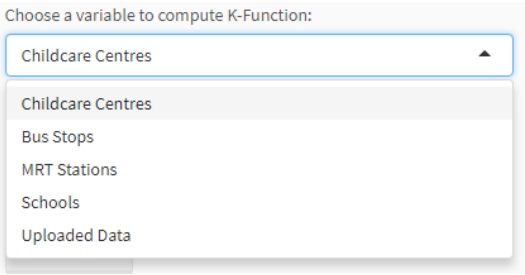
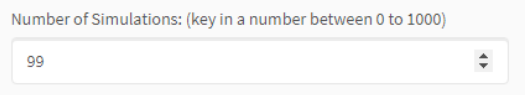


NetSPPA K-Function Main Panel

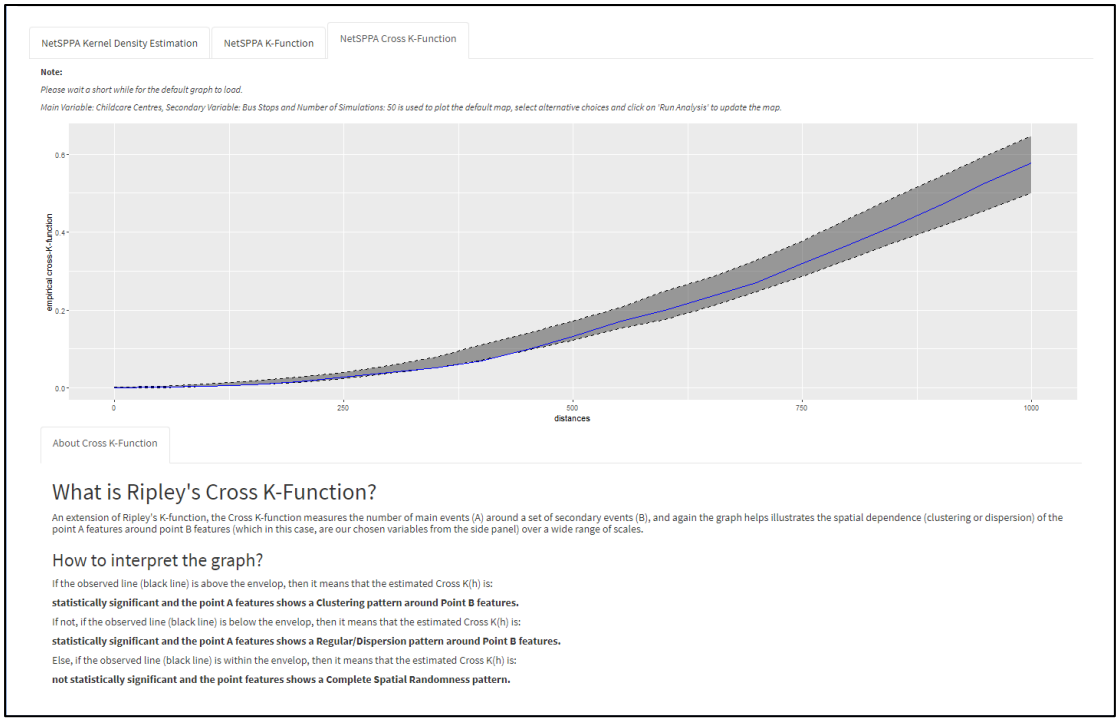
Feature	Functionality
 Monte Carlo simulation test of CSR on K-Function Visualization	This graph is the visualization of **Monte Carlo simulation test of CSR on K-Function for the selected variable**. The graph **illustrates the spatial distribution (clustering, dispersion, or randomness) of point features (which in this case, is our chosen variable from the side panel) over a wide range of scales.**
 About NetSPPA K-Function Section	In this section, you can get a **quick understanding of what is K-Function** and **how to interpret the graph output.**



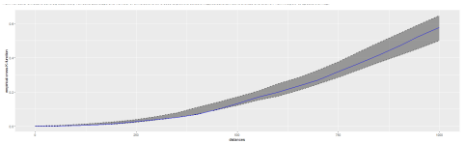
NetSPPA K-Function Side Panel

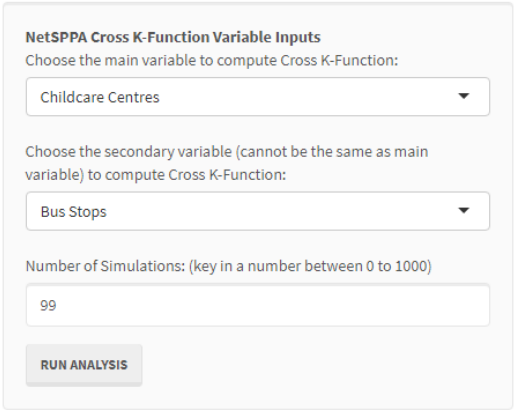
Feature	Functionality
 Variable for K-Function	From this **drop-down list, you can select the variable to compute K-Function**. `Childcare Centres` is selected as the variable for computing the default graph. Other options are ` Bus Stops`, `MRT Stations`, `Schools` and your own custom uploaded data `Uploaded Data`.
 No. of Simulations	Through this input box, you can **key in the number of Monte Carlo simulation test of CSR to run on the K-Function**. `99` is the default value for our graph, but you may input a number between `0` to `1000`. Find out more about Monte Carlo simulations here: https://www.ibm.com/sg-en/cloud/learn/monte-carlo-simulation
 Run Analysis Button	Same as other side panels, **the graph visualizations will only update after this button is clicked.** Therefore, do remember to **click on this `Run Analysis` button to see the updated changes** after selecting your desired variables and number of simulations.

3.3 NetSPPA Cross K-Function

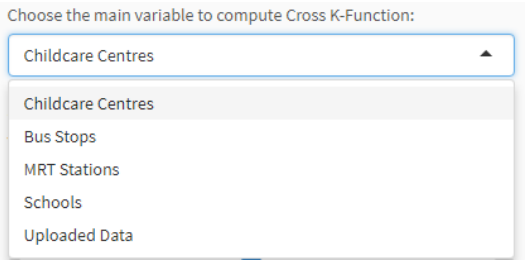
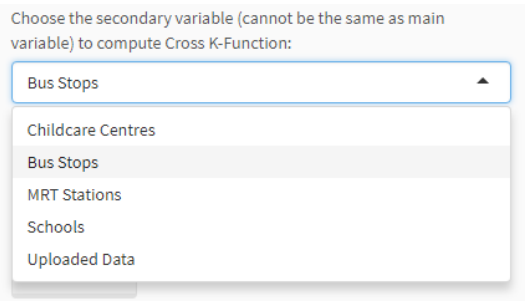
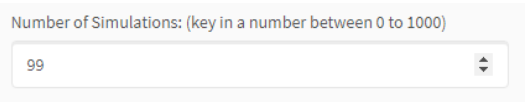


NetSPPA Cross K-Function Main Panel

Feature	Functionality
 Monte Carlo simulation test of CSR on Cross K-Function Visualization	This graph is the visualization of **Monte Carlo simulation test of CSR on Cross K-Function for the selected main (A) and secondary (B) variables**. The graph **illustrates the spatial dependence (clustering, dispersion, or randomness) between point A features and point B features over a wide range of scales.**
 About NetSPPA Cross K-Function Section	In this section, you can get a **quick understanding of what is Cross K-Function** and **how to interpret the graph output.**



NetSPPA Cross K-Function Side Panel

Feature	Functionality
 Main Variable for Cross K-Function	From this **drop-down list, you can select the main variable to compute Cross K-Function**. `Childcare Centres` is selected as the main variable for computing the default graph. Other options are `Bus Stops`, `MRT Stations`, `Schools` and your own custom uploaded data `Uploaded Data`.
 Secondary Variable for Cross K-Function	From this **drop-down list, you can select the secondary variable to compute Cross K-Function**. ` Bus Stops` is selected as the secondary variable for computing the default graph. Other options are `Childcare Centres`, `MRT Stations`, `Schools` and your own custom uploaded data `Uploaded Data`. **However, the chosen secondary variable cannot be the same as the main variable.**
 No. of Simulations	Through this input box, you can **key in the number of Monte Carlo simulation test of CSR to run on the Cross K-Function**. `99` is the default value for our graph, but you may input a number between `0` to `1000`. Find out more about Monte Carlo simulations here: https://www.ibm.com/sg-en/cloud/learn/monte-carlo-simulation

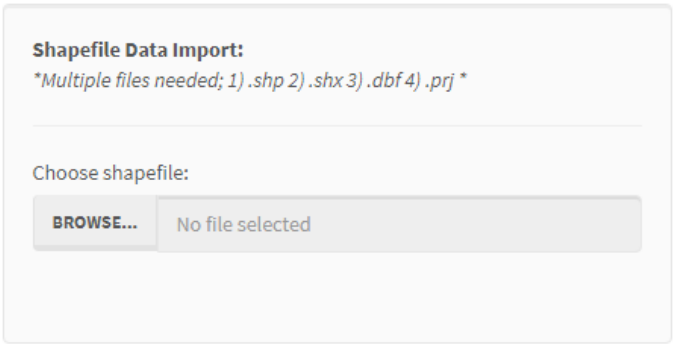
 Run Analysis Button	Same as other side panels, **the graph visualizations will only update after this button is clicked.** Therefore, do remember to **click on this `Run Analysis` button to see the updated changes** after selecting your desired variables and number of simulations.

4. Data Import

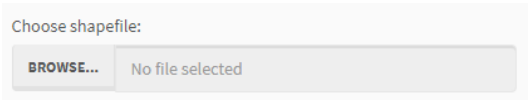
Data Import Main Panel

The Data Import is the fourth page that you can access in our application.

As the name suggests, this tab is catered for users to import their data in shapefile format.



Data Import Side Panel

Feature	Functionality
 Shapefile Upload Button	Once clicked, you can choose the various files to be uploaded (i.e. at least 4 needed: *1) .shp 2) .shx 3) .dbf 4) .prj*). **The minimum 4 types of files are needed to ensure the shapefile has the essential information that it needs.** P.S. *Our application is facing errors with this function at the backend server currently, but our intention behind this function is stated as above.*