



SMU

SINGAPORE MANAGEMENT
UNIVERSITY



IS415 Geospatial Analytics and Applications

R Shiny User Guide for

Hospital Playlist:

Spatial Point Pattern Analysis of Medical Facilities in Seoul, South Korea

Prepared By

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How to use: quick start guide

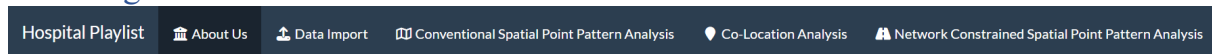
Welcome to Hospital Playlist - Spatial Point Pattern Analysis of Medical Facilities in Seoul, South Korea using R Shiny app.

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

Application Link

<https://hospitalplaylist.shinyapps.io/>

Navigation Tab Bar



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

When you click on a specific tab, it will distinguish itself as the active tab through darkening of that particular tab.

The “About Us” tab is displayed upon loading of the page as the introductory page.

1. Home Page

Hospital Playlist

About Us


Data Import

Conventional Spatial Point Pattern Analysis

Co-Location Analysis

Network Constrained Spatial Point Pattern Analysis

LightSwitch mode



Spatial Point Pattern Analysis by Team 10

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Guided by:

- Professor Kam Tin Seong (SMU IS415)

Problem Statement

The Korean National Statistical Office reports that the elderly population (aged 65 and over) in South Korea is expected to reach 14.9 million by 2067, which represents nearly one-third of the total population. This demographic shift is likely to increase demand for healthcare services, particularly in regions with higher proportions of elderly residents. Do South Korean residents have equal accessibility to healthcare services?

Project Objective

The objective of this project is to allow the end-user to use our model to identify areas with low healthcare accessibility. This app will also show the difference between the conventional and Network Constrained Spatial Point Analysis. Hence, the app will not only provide insights to healthcare accessibility but also serve as an educational tool on the different types of Spatial Point analysis.

App Functions

- Conventional Spatial Point Pattern Analysis:**
 - Visualisation of variable points
 - Kernel Density Plots
 - K & L Function plots and analysis
- Co-Location Analysis**
 - Visualisation of Local Co-Location Points
 - Co-Location Statistical Interpretation
- Network Constrained Spatial Point Analysis**
 - Visualisation of NetKDE
 - Network Constrained K Function Analysis
 - Network Constrained K-cross Function Analysis

Requirements

Do note that data wrangling should also be done before uploading the files into the application. Loading of .rds files are required in order to perform the analysis. More information is found under our User Guide.

[Access our User Guide Here](#)

This is the home page that will be first displayed once the application is loaded.

From the home page, you will be able to have a quick overview of the motivation behind our application, what our application is all about and also gain a quick understanding of what spatial point pattern analysis (SPPA) can do for you.

This was also where you found our User Guide for the Shiny application.

2. Data Import

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Data Import

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RDS Data Import (Healthcare):

Upload four RDS files

Upload rds file of healthcare points [POINT data]

Browse... No file selected

Upload rds file of another variable [POINT data]

Browse... No file selected

Upload rds file of transport networks [LINE data]

Browse... No file selected

Upload rds file of study area shapefile [POLYGON data]

Browse... No file selected

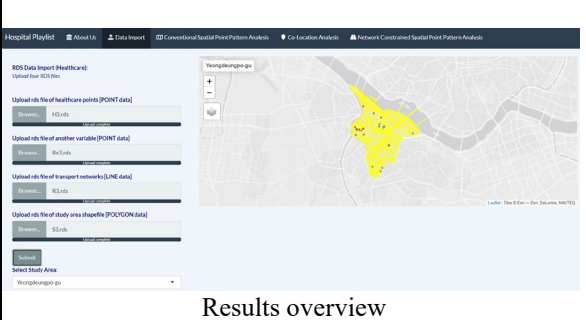
Submit

The second tab will be the page where you can import all your data. 4 sets of data are required, namely:

1. RDS file of first variable (medical facilities) in **POINT** feature
2. RDS file of second variable (residential buildings) in **POINT** feature
3. RDS file of road network in **LINE** feature
4. RDS file of administrative boundaries in **POLYGON** feature

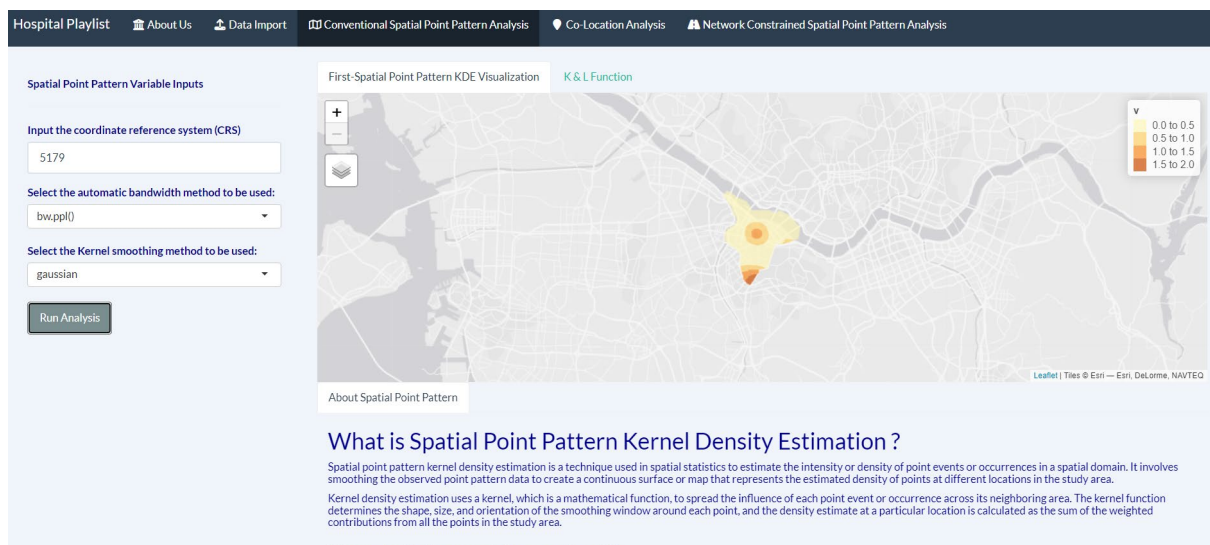
You will be able to find some sample data for the purpose of using this application in our [Github repository](#) for your convenience. Please use the files with .rds formats.

Feature	Functionality
<div><div>RDS Data Import (Healthcare):</div><div>Upload four RDS files</div></div> <div><div>Upload rds file of healthcare points [POINT data]</div><div>Browse... No file selected</div></div> <div><div>Upload rds file of another variable [POINT data]</div><div>Browse... No file selected</div></div> <div><div>Upload rds file of transport networks [LINE data]</div><div>Browse... No file selected</div></div> <div><div>Upload rds file of study area shapefile [POLYGON data]</div><div>Browse... No file selected</div></div> <div><div>Submit</div></div> <div>RDS Upload Feature</div>	<p>To upload files to perform visualisations and analysis, click on “Browse” and locate the file to upload from your computer, in the order as mentioned above.</p> <p>Once all 4 files are uploaded, click on the “Submit” button and a plot will be loaded on the right side of the page for basic EDA visualisation.</p>

	<p>After clicking the “Submit” button, a visualisation of all the files uploaded will be shown.</p>
<p>Select Study Area:</p> <div data-bbox="209 548 796 705"> <input type="text" value="Yeongdeungpo-gu"/> <ul style="list-style-type: none"> Yeongdeungpo-gu Gangnam-gu Eunpyeong-gu </div> <p>Study Area Selection</p>	<p>If you would like to, you will be able to select the study area you would like to focus on.</p> <p>After changing the study area, the map will be auto-loaded to the updated study area selected.</p>

3. Spatial Point Pattern Analysis

(Conventional First Spatial Point Pattern KDE Visualisation)



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

Two sub tabs will be made available for use:

- 1) *Spatial Point Pattern KDE Visualization*
- 2) *Spatial Point Pattern K-Function/L-Function*

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

3.1 Spatial Point Pattern KDE Visualization

Spatial Point Pattern Variable Inputs

Input the coordinate reference system (CRS)

5179

Select the automatic bandwidth method to be used:

bw.ppl()

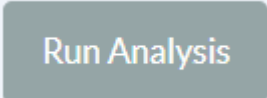
Select the Kernel smoothing method to be used:

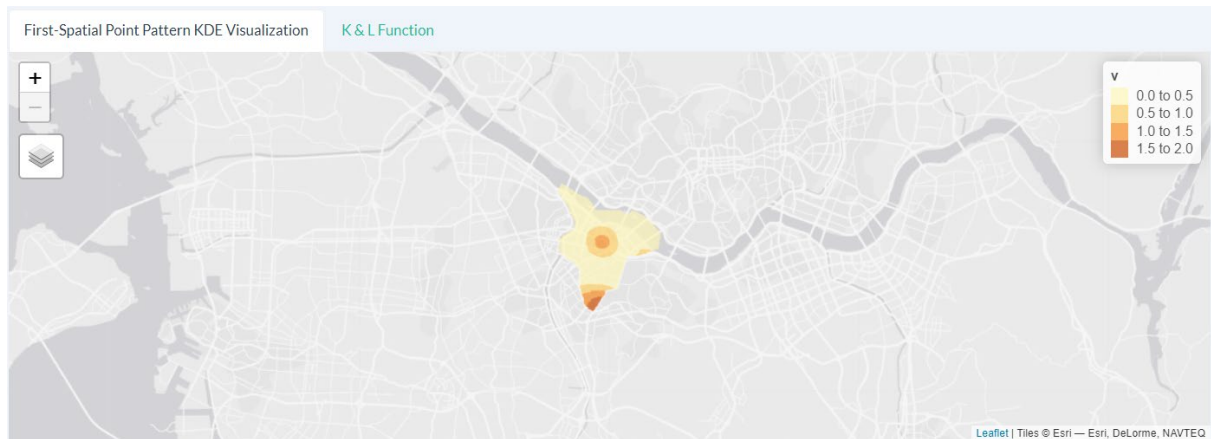
gaussian

Run Analysis

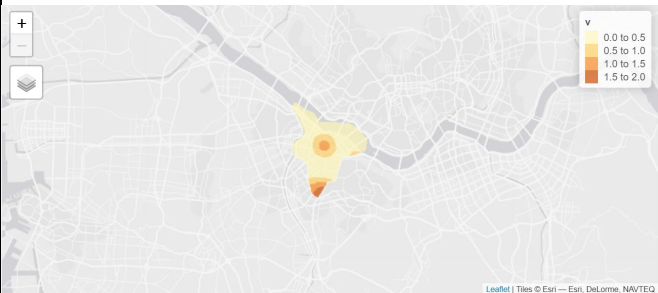


SPPA KDE Side Panel

Feature	Functionality
<div> <div>Input the coordinate reference system (CRS)</div> <div>5179</div> <div>Coordinate Reference System Input Field</div> </div>	<p>You will be able to input the Coordinate Reference System (CRS) of your data, based on the country the data is obtained from. From our example, we are looking at South Koreans' data so the CRS input would be 5179.</p>
<div> <div>Select the automatic bandwidth method to be used:</div> <div> <div>bw.ppl()</div> <div>bw.diggle()</div> <div>bw.CvL()</div> <div>bw.scott()</div> <div>bw.ppl()</div> </div> <div>Automatic Bandwidth Method Selection</div> </div>	<p>For the 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.</p> <p>Other options are 'bw.CvL()', 'bw.scott()' and 'bw.ppl()'.</p> <p>Find out more about the differences between the various functions here: https://search.r-project.org/CRAN/refmans/spatstat.core/html/density.ppp.html</p>
<div> <div>Select the Kernel smoothing method to be used:</div> <div> <div>gaussian</div> <div>gaussian</div> <div>epanechnikov</div> <div>quartic</div> <div>disc</div> </div> <div>SPPA KDE Kernel Selection</div> </div>	<p>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.</p> <p>Other options are 'Epanechnikov', 'Quartic' and 'Disc'.</p> <p>Find out more about the differences between the various kernels here: https://en.wikipedia.org/wiki/Kernel_(statistics)</p>

<div data-bbox="341 248 633 376">  <p>Run Analysis Button</p> </div>	<p>This feature is the most important out of the bunch, because the map visualizations will only be updated after this button is clicked.</p> <p>Therefore, do remember to click on this `Run Analysis` button to see the updated changes after inputting your CRS, selecting your kernel and bandwidth method.</p>
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SPPA KDE Main Panel

Feature	Functionality
<div data-bbox="134 1115 794 1406">  </div> <p>Map Visualization</p>	<p>Visualisation of the First-Spatial Point Pattern KDE is displayed.</p> <p>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.</p>
<div data-bbox="375 1532 475 1697">  </div> <p>Zoom Control</p>	<p>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.</p> <p>The '-' icon is grayed 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.</p>
<div data-bbox="362 1803 491 1912">  </div> <p>Map Control</p>	<p>When you hover your cursor over this icon, the menu will appear, where you can select your desired base map.</p>

<div> <div> <input checked="" type="radio"/> Esri.WorldGrayCanvas <input type="radio"/> OpenStreetMap <input type="radio"/> Stamen.TonerLite </div> <div> <input checked="" type="checkbox"/> kde_raster </div> </div> <div>Base Map Control</div>	<p>Our application offers 3 different base maps, feel free to test them out to see which offers the best visualization for your use case.</p>
<div>About Spatial Point Pattern</div> <div> <h3>What is Spatial Point Pattern Kernel Density Estimation ?</h3> <p>Spatial point pattern kernel density estimation is a technique used in spatial statistics to estimate the intensity or density of point events or occurrences in a spatial domain. It involves smoothing the observed point pattern data to create a continuous surface or map that represents the estimated density of points at different locations in the study area.</p> <p>Kernel density estimation uses a kernel, which is a mathematical function, to spread the influence of each point event or occurrence across its neighboring area. The kernel function determines the shape, size, and orientation of the smoothing window around each point, and the density estimate at a particular location is calculated as the sum of the weighted contributions from all the points in the study area.</p> <h3>How to interpret the output?</h3> <p>The darker the color, the higher the relative density of the point features as compared to lighter color (meaning lower density).</p> </div> <div>About SPPA KDE Section</div>	<p>In this section, you can get a quick understanding of what Spatial Point Pattern KDE Visualization is and how to interpret the output in the map visualization.</p>

3.2 SPPA K-Function/L-Function

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K & L Function Inputs

Choose the desired confidence interval (Significance Level)

5% (0.05 Significance Level)

Select the function to be used:

Kest

Run Analysis

First-Spatial Point Pattern KDE Visualization

K & L Function

About K and L function

What is K function?

k function calculates for a radius r the proportion of cells with a value below r in the distance matrix between all the points Did. The K function estimates 'the average number of neighbours of a typical random point'.

What is L function?

L Function is a summary statistic that provides information on the expected number of points within a certain distance of other points, which can help identify patterns of point

SPPA K-Function/L-Function Main Panel

Feature	Functionality
<div> <div>First-Spatial Point Pattern KDE Visualization</div> <div>K & L Function</div> </div> <div> </div> <div> <div>Monte Carlo simulation test of CSR on K-Function/L-Function Visualization</div> </div>	<p>This graph is the interactive visualization of a Monte Carlo simulation test of CSR on K-Function/L-Function for the selected variable.</p> <p>The interactive 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. You may also hover your mouse at the features and observe the popups.</p>

<p>About K and L function</p> <p>What is K function? k function calculates for a radius r the proportion of cells with a value below r in the distance matrix between all the points. The K function estimates 'the average number of neighbours of a typical random point'.</p> <p>What is L function? L Function is a summary statistic that provides information on the expected number of points within a certain distance of other points, which can help identify patterns of point interactions, repulsions, or regularity in the point pattern data.</p> <p>How to interpret the output? - Observed $K(r)$ or $L(r)$ values below the envelope indicate lower than expected density at radius r, i.e., significant sparseness. - Observed $K(r)$ or $L(r)$ values within the envelope indicate no significant deviation from sparseness. - Observed $K(r)$ or $L(r)$ values above the envelope indicate higher than expected density at radius r, i.e., significant clustering.</p> <p>About SPPA K-Function/L-Function Section</p>	<p>In this section, you can get a quick understanding of what K-Function/L-Function is and how to interpret the graph output.</p>
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K & L Function Inputs

Choose the desired confidence interval (Significance Level)

5% (0.05 Significance Level) ▼

Select the function to be used:

Kest ▼

Run Analysis

SPPA K-Function/L-Function Side Panel

Feature	Functionality
<p>Choose the desired confidence interval (Significance Level)</p> <div> <div>5% (0.05 Significance Level) ▲</div> <div>1% (0.01 Significance Level)</div> <div>5% (0.05 Significance Level)</div> <div>10% (0.10 Significance Level)</div> </div> <p>Confidence Level Selection</p>	<p>Through this input box, you can key in the desired confidence interval selection based on significance level to generate the K-Cross Function analysis.</p> <p>'5%' is the default confidence interval for our graph, and you can also select the two other options being 1% and 10%.</p> <p>Find out more about Monte Carlo simulations here: https://www.ibm.com/solution-provider/cloud/learn/monte-carlo-simulation</p>
<p>Select the function to be used:</p> <div> <div>Kest ▲</div> <div>Kest</div> <div>Lest</div> </div> <p>Function Selector</p>	<p>In this dropdown list, you will be able to choose the type of function to generate the graph on, with the 2 options being:</p> <ol style="list-style-type: none"> 1) Kest - Function 2) Lest - Function

<div data-bbox="309 248 644 383" data-label="Image"> </div> <div data-bbox="391 383 616 414" data-label="Caption"> <p>Run Analysis Button</p> </div>	<p>Same as other side panels, the graph visualizations will only be updated after this button is clicked.</p> <p>Therefore, do remember to click on this 'Run Analysis' button to see the updated changes after selecting your desired variable and number of simulations.</p>
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4. Co-Location Analysis

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Co-Location Analysis Variable Inputs

Choose the Kernel to be used:
Gaussian

Choose the desired confidence interval (Significance Level)
10% (0.10 Significance Level)

Number of neighbours
3

Visualisation Customisation
Select color palette:
Reds

Select dot size:
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1

Select significance level (for filtering)
0.10

Run Analysis

What is Co-Location?

Co-Location can be used to determine the spatial relationship between the location of point features (healthcare facility) and another variable of point features. In this case, residential buildings. Co-Location analysis can be used to locate the areas with highest accessibility to variables of concern in any situation where being within the vicinity brings great advantage.

How to interpret the plot generated?


Point-based approach is used. For each point of the first variable (healthcare facilities), you are as likely to have a point of the second variable as a neighbour. For points marked with the colour chosen, it indicates that the first variable (healthcare facility) is located as a nearest neighbour.

Those with no access or low access to the first variable (healthcare facility), the points are displayed in grey.

The points are also generated by the level of significance chosen.

Co-Location Main Panel

Feature	Functionality
<div data-bbox="213 1413 790 1666" data-label="Image"> </div> <div data-bbox="309 1666 695 1700" data-label="Caption"> <p>Co-Location Analysis Visualisation</p> </div>	<p>This map plot is the visualization of co-location for variable 1 (healthcare facilities) and variable 2 (residential buildings).</p> <p>The graph illustrates the points that are significantly co-located based on the two variables studied.</p>
<div data-bbox="448 1800 564 1989" data-label="Image"> </div> <div data-bbox="424 1989 579 2018" data-label="Caption"> <p>Zoom Control</p> </div>	<p>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.</p>

 <p>Map Control</p>	<p>When you hover your cursor over this icon, the menu will appear, where you can select your desired base map.</p>
<p>What is Co-Location?</p> <p>Co-Location can be used to determine the spatial relationship between the location of point features (healthcare facility) and another variable of point features, in this case, residential buildings.</p> <p>Co-Location analysis can be used to locate the areas with highest accessibility to variables of concern in any situation where being within the vicinity brings great advantage.</p> <p>How to interpret the plot generated?</p> <p>Point-based approach is used. For each point of the first variable (healthcare facilities), you are as likely to have a point of the second variable as a neighbour. For points marked with the colour chosen, it indicates that the first variable (healthcare facility) is located as a nearest neighbour.</p> <p>Those with no access or low access to the first variable (healthcare facility), the points are displayed in grey.</p> <p>The points are also generated by the level of significance chosen.</p> <p>About Co-Location Section</p>	<p>In this section, you can get a quick understanding of what Co-Location is and how to interpret the map output.</p>

Co-Location Analysis Variable Inputs

Choose the Kernel to be used:

Gaussian

Choose the desired confidence interval (Significance Level)

5% (0.05 Significance Level)

Number of neighbours

6

Visualisation Customisation

Select color palette:

Reds

Select dot size:

0.01

0.1

0.010.020.030.040.050.060.070.080.090.1

Select significance level (for filtering)

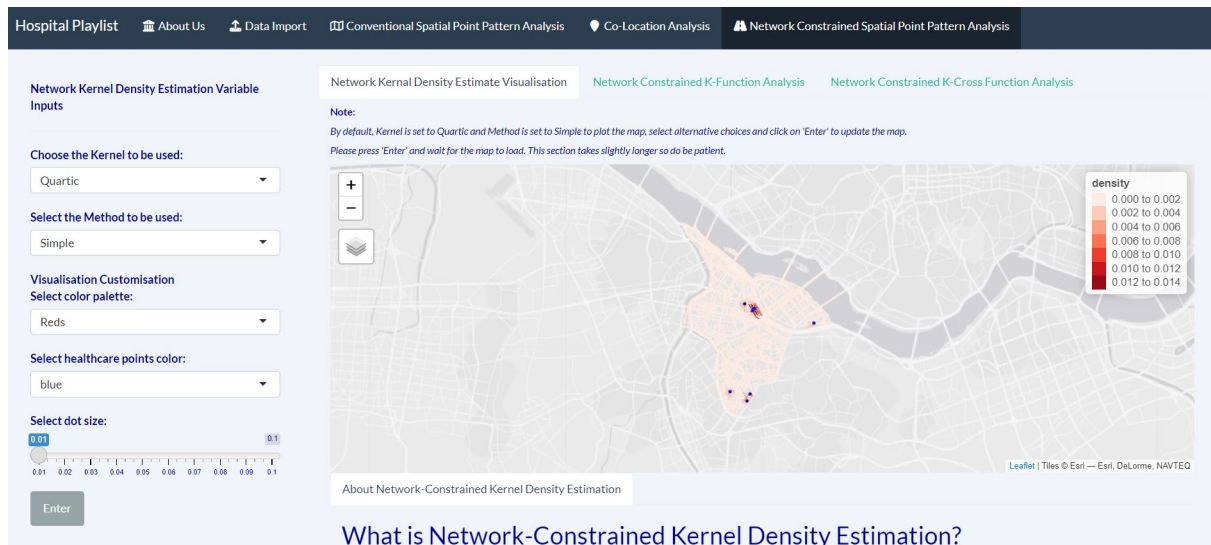
0.05

Run Analysis

Co-Location Side Panel

Feature	Functionality
<p>Choose the Kernel to be used:</p> <div> <div>Gaussian ▲</div> <div> Quartic Gaussian Triangular Epanechnikov Uniform </div> </div> <p>Kernel Selection</p>	<p>From this drop-down list, you can select the kernel method to compute co-location analysis. 'Gaussian' is selected as the kernel method for computing the default map.</p> <p>Other options are 'Epanechnikov', 'Quartic', 'Triangular' and 'Uniform'.</p> <p>Find out more about the differences between the various kernels here: https://en.wikipedia.org/wiki/Kernel_(statistics)</p>
<p>Number of neighbours</p> <div>6</div> <p>Neighbours Selection</p>	<p>Here, you may input the number of neighbours you require for the analysis, depending on the range of your analysis.</p> <p>'6' is the default value for our graph, but you may input a number between '0' to '10'.</p>
<p>Select color palette:</p> <div> <div>Reds ▲</div> <div> Reds Blues Magma Inferno Cividis </div> </div> <p>Colour Palette Selection</p>	<p>Here, you will be able to select your preferred colour of your choice for the visualisation of the map output.</p> <p>'Reds' is the default selection, but you may also change your selections to 'Blues', 'Magma', 'Inferno', and 'Cividis'.</p>
<p>Select dot size:</p> <div> <div>0.01</div> <div>0.1</div> <div> 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1 </div> </div> <p>Dot Size Selection</p>	<p>Also for the purpose of visualisation, you will be able to select the size of the dots displayed on the map output to your preference.</p> <p>Default value is set to '0.01' but you may also adjust the size to a maximum of '0.1'.</p>
<p>Select significance level (for filtering)</p> <div> <div>0.05 ▲</div> <div> 0.01 0.05 0.10 </div> </div> <p>Significance Level Selection</p>	<p>You will be able to choose your selection of significance level you would like to visualise to do the filtering.</p> <p>Points displayed on the map output will be filtered to the significance level selected.</p> <p>'0.05' significance level is selected by default, with two other options of '0.01' and '0.10' available.</p>
<div> <div>Run Analysis</div> <p>Run Analysis Button</p> </div>	<p>Same as other side panels, the graph visualizations will only be updated after this button is clicked.</p> <p>Therefore, do remember to click on this 'Run Analysis' button to see the updated changes after selecting your desired variables and number of simulations.</p>

5. Network Kernel Density Estimation



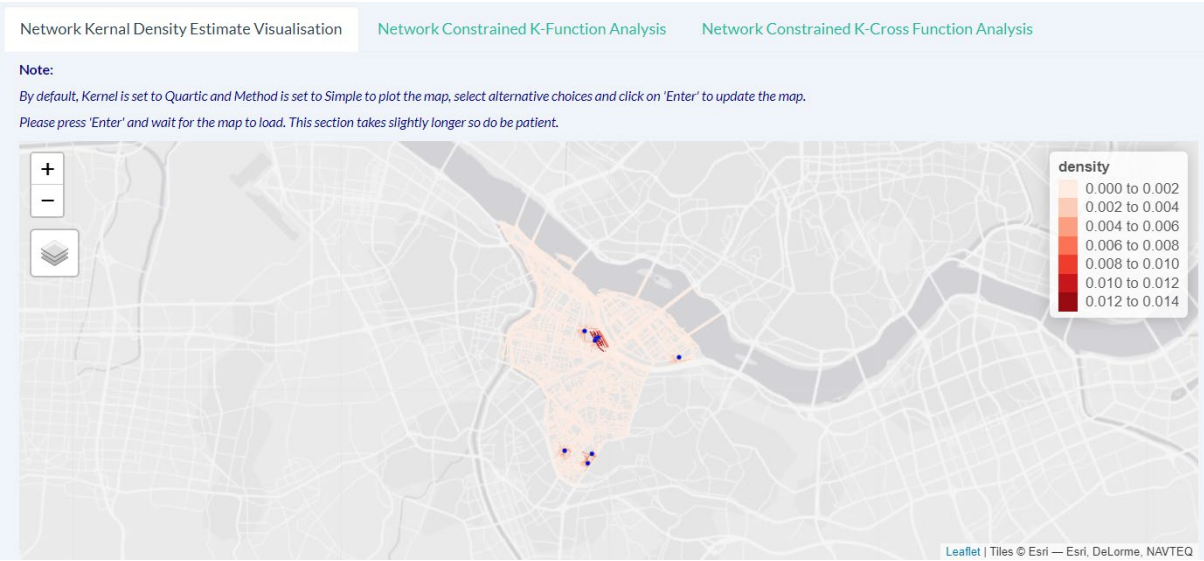
Network-Constrained Kernel Density Estimation (NetKDE) is the fifth and last page that you can access in our application.

Three sub tabs will be made available for use:

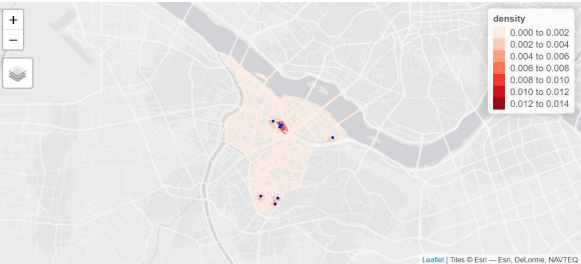
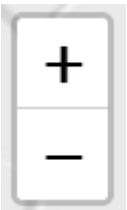
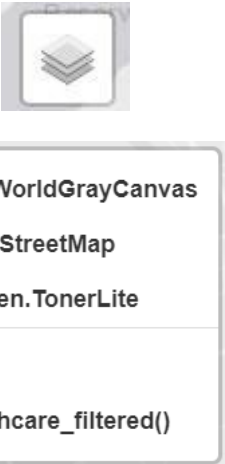
- 1) *NetKDE Visualisation*
- 2) *NetKDE K-Function*
- 3) *NetKDE K-Cross Function*

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

5.1 NetKDE Visualisation



NetKDE Main Panel

Feature	Functionality
 <p>Map Visualization</p>	<p>This map displays the visualization of the Network Kernel Density Estimation.</p> <p>The points are the variables, and the network is shown in the color range selected by you in the side panel, with the darker colour intensity being the areas with higher densities of points along the network.</p>
 <p>Zoom Control</p>	<p>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.</p>
 <p>Base Map Control</p>	<p>When you hover your cursor over this icon, the menu will appear, where you can select your desired base map.</p> <p>Our application offers 3 different base maps, feel free to test them out to see which offers the best visualization for your use case.</p> <p>You also have the option to select/de-select 'lixels' and your variable 'healthcare_filtered', which are the network and the points respectively.</p>

<p>About Network-Constrained Kernel Density Estimation</p> <p>What is Network-Constrained Kernel Density Estimation?</p> <p>A classical Kernel Density Estimate (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 along the edges of a network.</p> <p>How to interpret the output?</p> <p>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).</p> <p>About NetSPPA KDE Section</p>	<p>In this section, you can get a quick understanding of what Network-Constrained Kernel Density Estimation is and how to interpret the output in the map visualization.</p>
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Network Kernel Density Estimation

Variable Inputs

Choose the Kernel to be used:

Quartic

Select the Method to be used:

Simple

Visualisation Customisation

Select color palette:

Reds

Select healthcare points color:

blue

Select dot size:

0.01

0.1

0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1

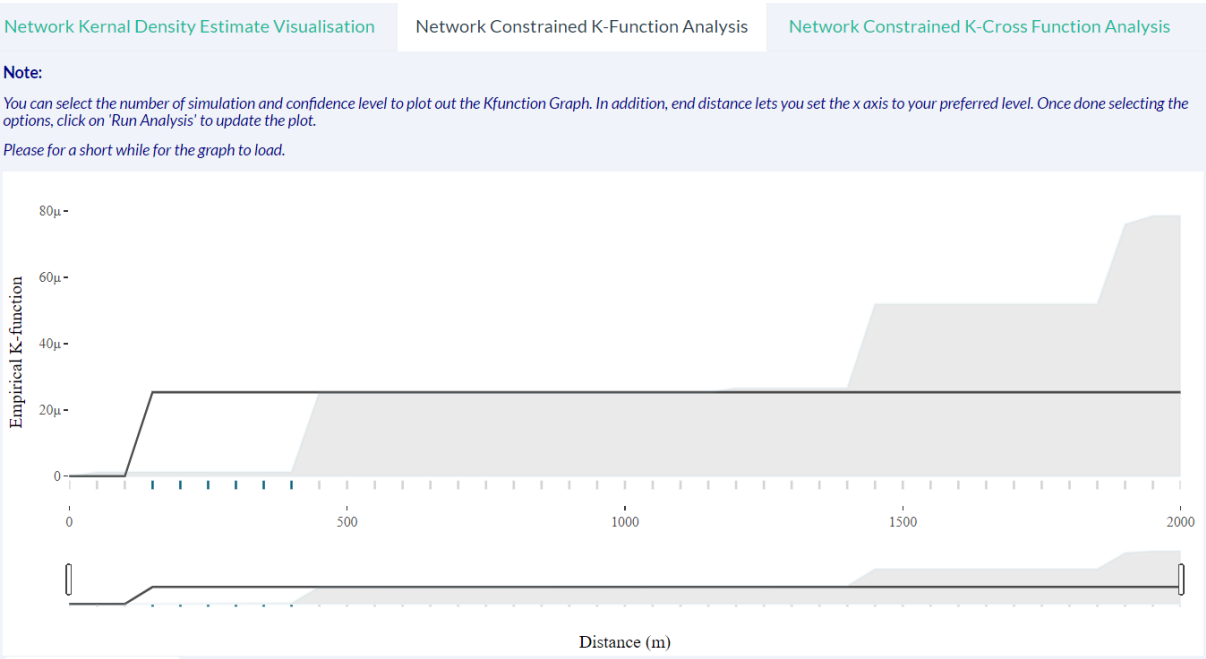
Enter

NetKDE Side Panel

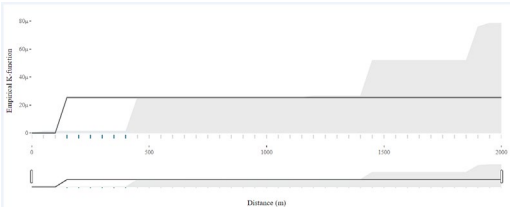
Feature	Functionality
<p>Choose the Kernel to be used:</p> <div> <div>Quartic</div> <div> <div>Quartic</div> <div>Triangle</div> <div>Tricube</div> <div>Cosine</div> <div>Triweight</div> <div>Epanechnikov</div> <div>Uniform</div> </div> </div> <p>NetKDE Kernel Selection</p>	<p>From this drop-down list, you can select the kernel method to be used to compute NetKDE. 'Quartic' is selected as the kernel method for computing the default map.</p> <p>Other options are 'Triangle', 'Tricube', 'Cosine', 'Triweight', 'Epanechnikov' and 'Uniform'.</p> <p>Find out more about the differences between the various kernels here: https://cran.r-project.org/web/packages/spNetwork/vignettes/NKDE.html</p>
	<p>From this drop-down list, you can select the method to compute NetKDE. 'Simple' is selected as the method for computing the default map.</p> <p>Other options are 'Discontinuous' and</p>

<p>Select the Method to be used:</p> <div> Simple </div> <div> Simple Discontinuous Continuous </div> <p>NetKDE Method Selection</p>	<p>`Continuous`.</p> <p>Find out more about the differences between the various methods here: https://cran.r-project.org/web/packages/spNetwork/vignettes/NKDE.html</p>
<p>Select color palette:</p> <div> Reds </div> <div> Reds Blues magma inferno cividis </div> <p>Colour Palette Selection</p>	<p>Here, you will be able to select your preferred colour of your choice for the visualisation of the map output.</p> <p>`Reds` is the default selection, but you may also change your selections to `Blues`, `Magma`, `Inferno`, and `Cividis`.</p>
<p>Select healthcare points color:</p> <div> blue </div> <div> red green blue yellow purple lightblue </div> <p>Colour Palette Selection for Variables</p>	<p>Here, you will be able to select your preferred colour of your choice for the visualisation of the healthcare variables for the map output.</p> <p>`Blue` is the default selection, but you may also change your selections to `Red`, `Green`, `Yellow`, `Purple` and `Lightblue`.</p>
<p>Select dot size:</p> <div> 0.01 0.1 </div> <p>Dot Size Selection</p>	<p>Also for the purpose of visualisation, you will be able to select the size of the dots displayed on the map output to your preference.</p> <p>Default value is set to `0.01` but you may also adjust the size to a maximum of `0.1`.</p>
<div> Enter </div> <p>“Enter” Button</p>	<p>This feature is the most important out of the bunch, because the map visualisation will only be updated after this button is clicked.</p> <p>Therefore, do remember to click on this `Enter` button to see the updated changes after selecting your desired kernel, method, colour palette and dot size.</p>

5.2 NetKDE K-Function



NetSPPA K-Function Main Panel

Feature	Functionality
<div><p>Monte Carlo simulation test of CSR on K-Function Visualization</p></div>	<p>This graph is the interactive visualization of Monte Carlo simulation test on K-Function for the selected variable. You may hover your mouse over the different areas of the graph to look into the details.</p> <p>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 - healthcare vs residential buildings) over a wide range of scales.</p>
<div><div>About K-Function</div><p>What is K-Function?</p><p>K-function measures the number of events found up to a given distance of any particular event, and the graph helps illustrates the spatial dependence (clustering or dispersion) of point features (healthcare facility) over a wide range of distances (m).</p><p>How to interpret the graph?</p><p>H0: The observed spatial point events (i.e distribution of healthcare facilities) are uniformly distributed over a street network in selected area</p><p>H1: The observed spatial point events (i.e distribution of healthcare facilities) are spatially dependent over a street network in selected Area.</p><p>If the observed K (blue line) is above the envelope, then</p><p>we can reject null hypothesis (the value is statistically significant) and conclude the points resemble clustered distribution.</p><p>If not, If the observed K is below the envelope, then</p><p>we can reject null hypothesis (the value is statistically significant) and conclude the points resemble dispersed distribution.</p><p>Else, If the observed K is inside the envelope, it means</p><p>the null hypothesis of CSR cannot be rejected (the value is not statistically significant) and we conclude the points resemble random distribution.</p><p>About NetSPPA K-Function Section</p></div>	<p>In this section, you can get a quick understanding of what K-Function is and how to interpret the graph output.</p>

**Choose the desired confidence interval
(Significance Level)**

5% (0.05 Significance Level) ▼

Select end distance

0 2,000 2,500

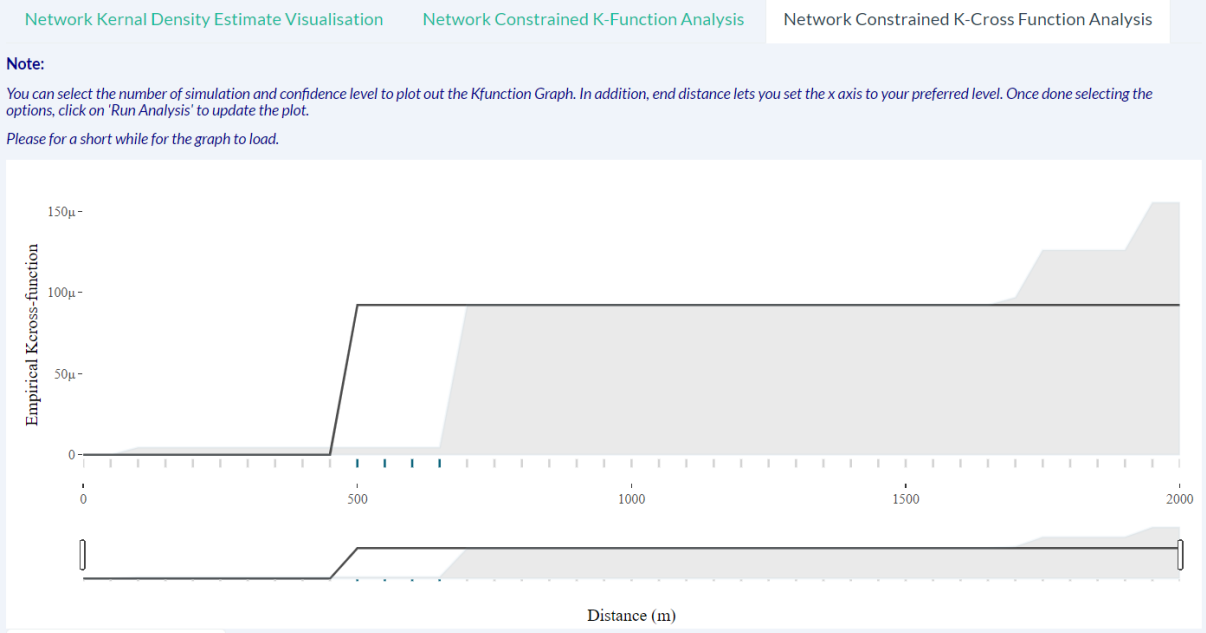
0 250 500 750 1,000 1,500 2,000 2,500

Run Analysis

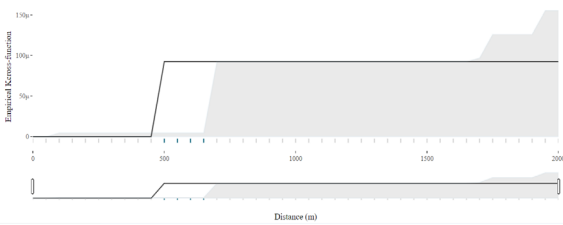
NetSPPA K-Function Side Panel

Feature	Functionality
<p>Choose the desired confidence interval (Significance Level)</p> <p>5% (0.05 Significance Level) ▲</p> <p>1% (0.01 Significance Level)</p> <p>5% (0.05 Significance Level)</p> <p>10% (0.10 Significance Level)</p> <p>Confidence Interval Selection</p>	<p>Through this input box, you can key in the desired confidence interval selection based on significance level to generate the K-Function analysis.</p> <p>`5%` is the default confidence interval for our graph, and you can also select the two other options being 1% and 10%.</p> <p>Find out more about Monte Carlo simulations here: https://www.ibm.com/sen/cloud/learn/monte-carlo-simulation</p>
<p>Select end distance</p> <p>0 2,000 2,500</p> <p>0 250 500 750 1,000 1,500 2,000 2,500</p> <p>Distance Selection</p>	<p>You may select the desired range of distance you are comfortable to run the analysis with. The default is 2000 (units in metres), and you may select up to a range of 2500 metres.</p>
<p>Run Analysis</p> <p>Run Analysis Button</p>	<p>Same as other side panels, the graph visualizations will only be updated after this button is clicked.</p> <p>Therefore, do remember to click on this `Run Analysis` button to see the updated changes after selecting your desired variables and number of simulations.</p>

5.3 NetKDE K-Cross Function



NetSPPA Cross K-Function Main Panel

Feature	Functionality
<div></div> <p>Monte Carlo simulation test of CSR on K-Cross Function Visualization</p>	<p>This graph is the interactive visualization of Monte Carlo simulation test on K-Function for the selected variable. You may hover your mouse over the different areas of the graph to look into the details.</p> <p>The graph illustrates the spatial dependence (clustering, dispersion, or randomness) between point A features (healthcare) and point B features (residential buildings) over a wide range of scales.</p>
<div><div>About Cross K-Function</div><div><p>What is Cross K-Function?</p><p>An extension of K-function, the Cross K-function measures the number of main point events (Healthcare facilities) around a set of secondary point events (Your chosen variable), and the graph illustrates the spatial dependence (clustering or dispersion) of the Healthcare points around point your chosen variable points over a wide range of distances (m).</p><p>How to interpret the graph?</p><p>H₀: The two types of points resemble random distribution and are independent of each other.</p><p>If the observed K (blue line) is above the envelope, then we can reject null hypothesis (the value is statistically significant) and conclude the two types of points resemble attraction patterns, suggesting clustering.</p><p>If not, if the observed K (blue line) is below the envelope, then we can reject null hypothesis (the value is statistically significant) and conclude the two types of points resemble repulsion patterns, suggesting dispersion.</p><p>Else, if the observed K (blue line) is inside the envelope, it means the null hypothesis of CSR cannot be rejected (the value is not statistically significant) and we conclude the two types of points resemble random distribution and are independent of each other.</p></div></div> <p>About NetKDE K-Cross Function Section</p>	<p>In this section, you can get a quick understanding of what K-Cross Function is and how to interpret the graph output.</p>

Choose the desired confidence interval (Significance Level)

5% (0.05 Significance Level) ▼

Confidence Interval: (Key in either, 0.01, 0.05, 0.10)

0.05

Select end distance

50 2,000 2,500

50 300 550 800 1,050 1,300 1,550 1,800 2,050 2,300 2,500

Run Analysis

NetSPPA Cross K-Function Side Panel

Feature	Functionality
<p>Choose the desired confidence interval (Significance Level)</p> <p>5% (0.05 Significance Level) ▲</p> <p>1% (0.01 Significance Level)</p> <p>5% (0.05 Significance Level)</p> <p>10% (0.10 Significance Level)</p> <p>Confidence Interval Selection</p>	<p>Through this input box, you can key in the desired confidence interval selection based on significance level to generate the K-Cross Function analysis.</p> <p>`5%` is the default confidence interval for our graph, and you can also select the two other options being 1% and 10%.</p> <p>Find out more about Monte Carlo simulations here: https://www.ibm.com/sen/cloud/learn/monte-carlo-simulation</p>
<p>Select end distance</p> <p>0 2,000 2,500</p> <p>0 250 500 750 1,000 1,500 2,000 2,500</p> <p>Distance Selection</p>	<p>You may select the desired range of distance you are comfortable to run the analysis with. The default is 2000 (units in metres), and you may select up to a range of 2500 metres (2.5km).</p>
<p>Run Analysis</p> <p>Run Analysis Button</p>	<p>Same as other side panels, the graph visualizations will only be updated after this button is clicked.</p> <p>Therefore, do remember to click on this `Run Analysis` button to see the updated changes after selecting your desired variables and number of simulations.</p>

6. References

We would like to thank Prof Kam Tin Seong for his guidance throughout this project, and seniors from the group [Spatial Pointers](#) for their help.