IS415 Geospatial Analytics and Applications

R Shiny User Guide for

Hospital Playlist:

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

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How Xinyee

How to use: quick start guide

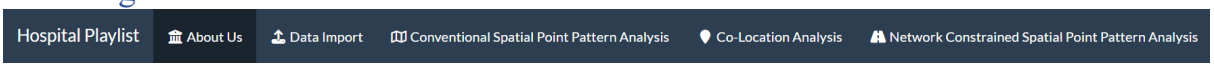
Welcome to Hospital Playlist - Spatial Point Pattern Analysis of Medical Facilities in Seoul, South Korea using R Shiny app.

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

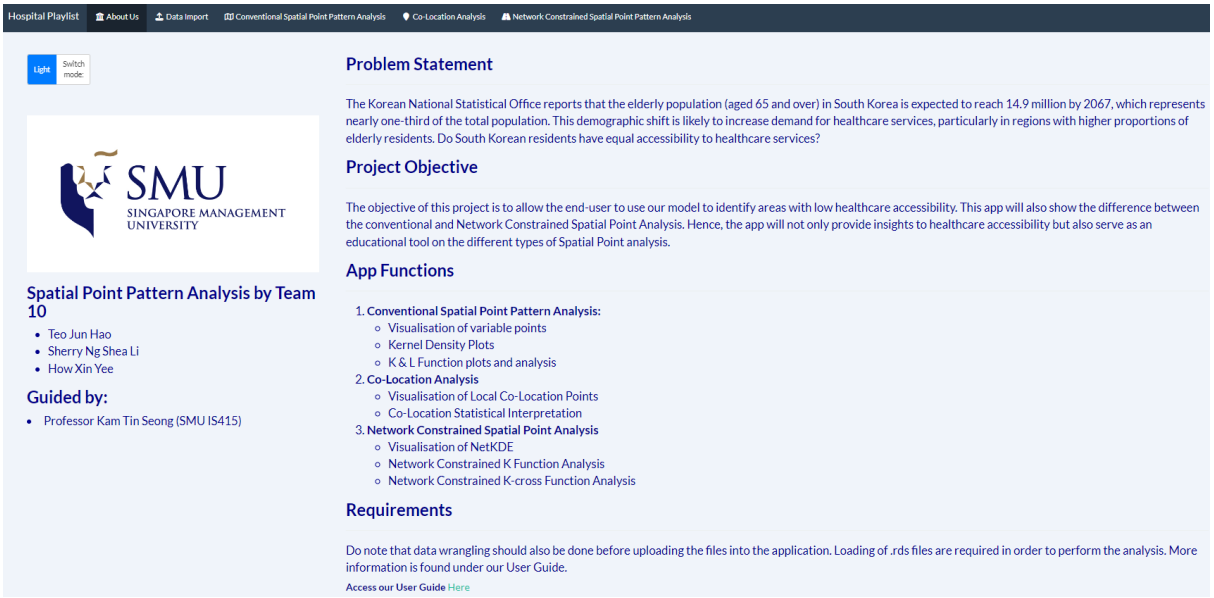


The Navigation Tab Bar is located at the top portion of the screen, which shows the different functionalities our application can provide for you.

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

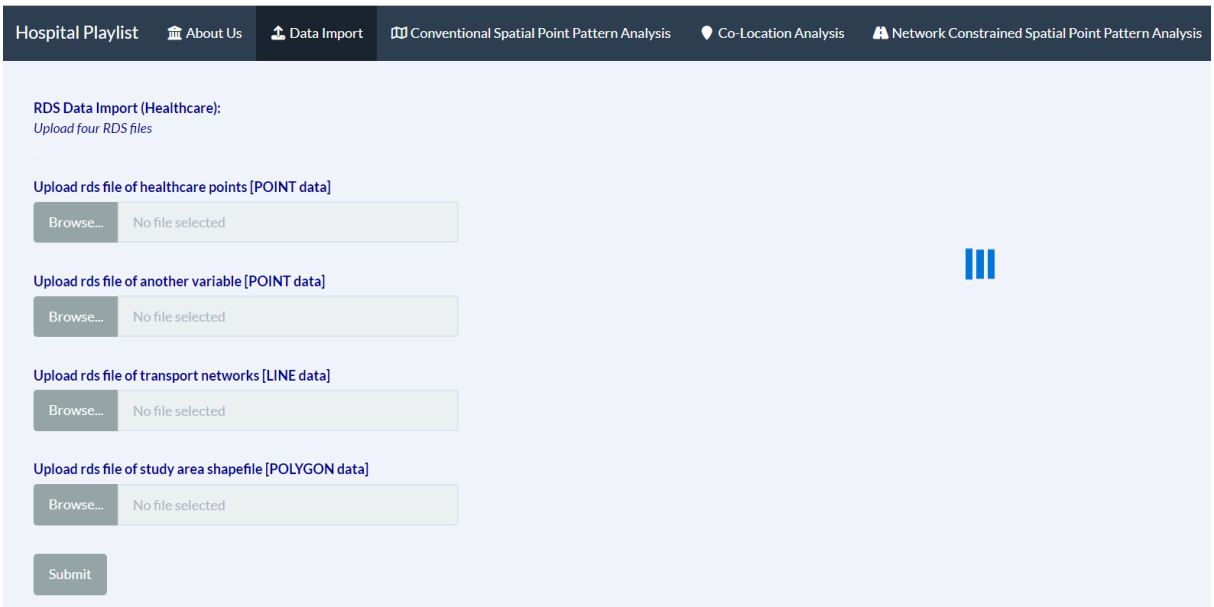


This is the home page that will be first displayed once the application is loaded.

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.

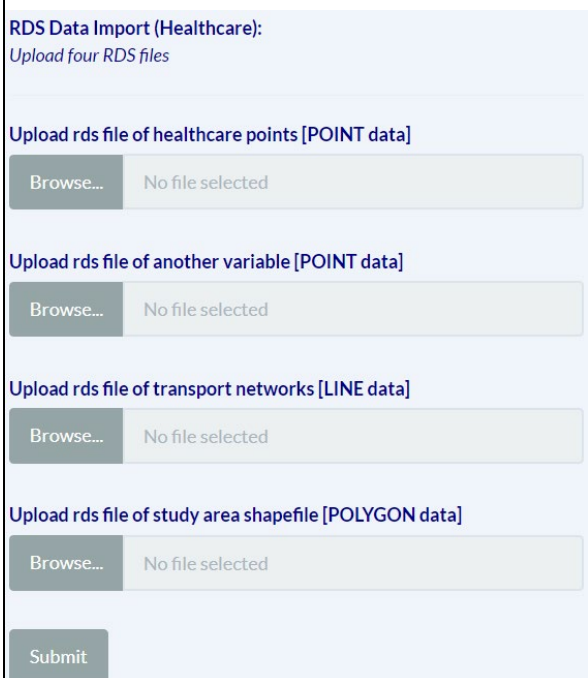
2. Data Import

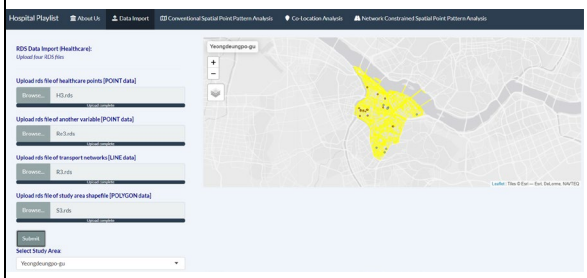
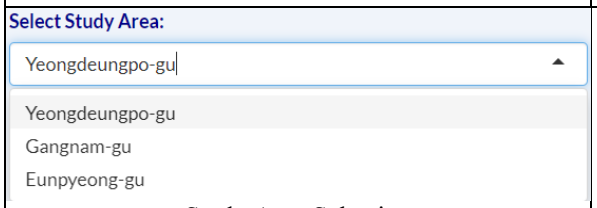


The second tab will be the page where you can import all your data. 4 sets of data are required, namely:

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

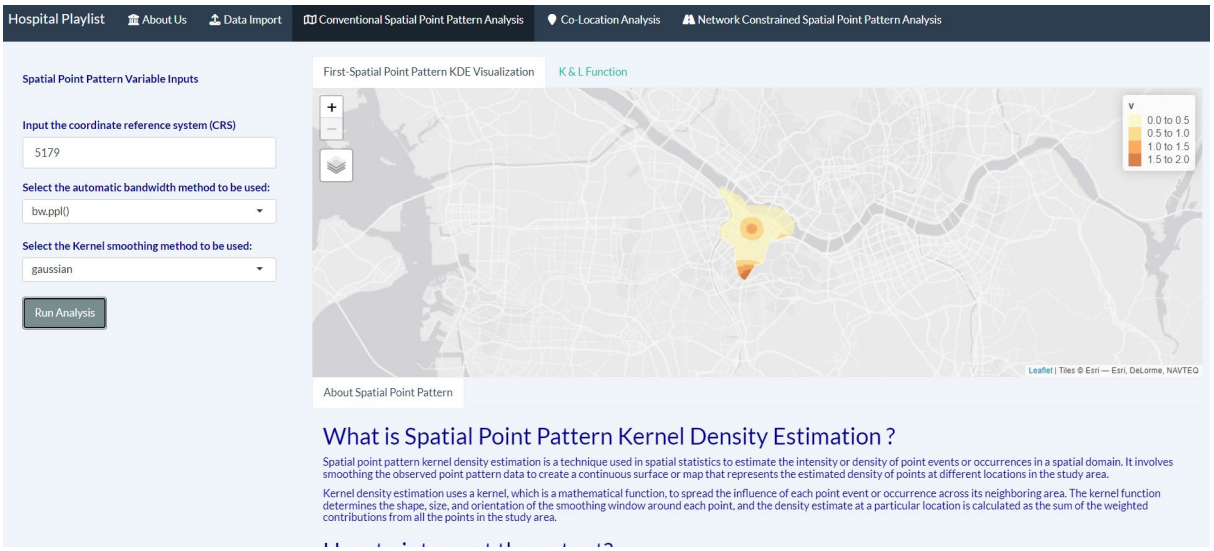
You will be able to find some sample data for the purpose of using this application in our Github repository for your convenience. Please use the files with `.rds` formats.

Feature	Functionality
 RDS Upload Feature	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. 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.

 Results overview	After clicking the “Submit” button, a visualisation of all the files uploaded will be shown.
 Study Area Selection	If you would like to, you will be able to select the study area you would like to focus on. After changing the study area, the map will be auto-loaded to the updated study area selected.

3. Spatial Point Pattern Analysis

(Conventional First Spatial Point Pattern KDE Visualisation)



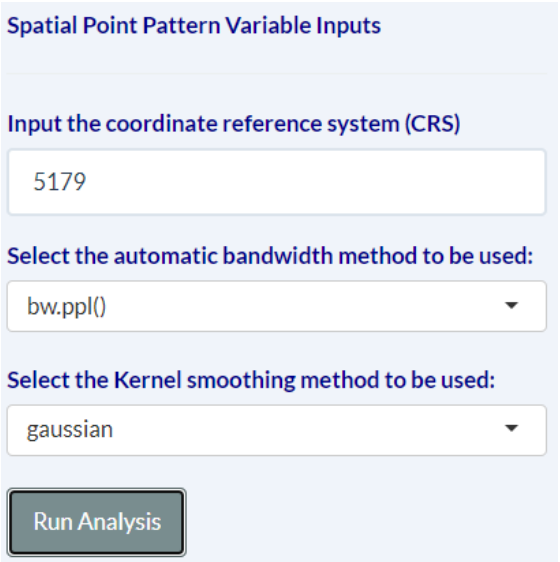
SPPA is the third page that you can access in our application.

Two sub tabs will be made available for use:

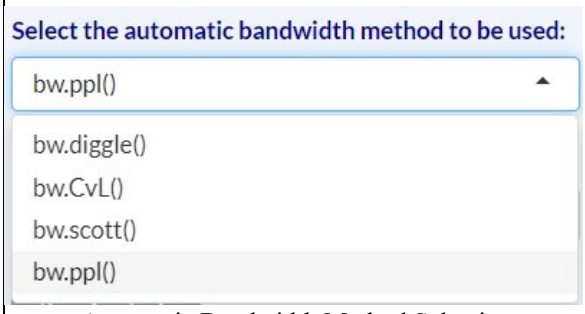
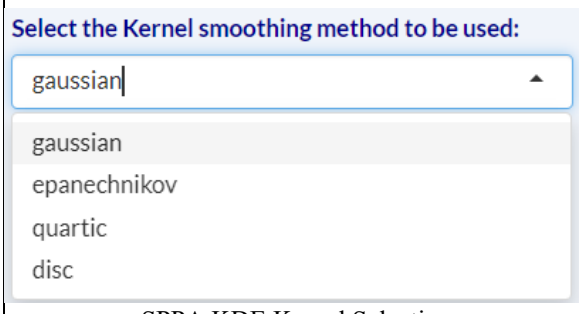
1) *Spatial Point Pattern KDE Visualization*
2) *Spatial Point Pattern K-Function/L-Function*

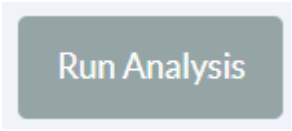
The layout of the sub tabs is similar in nature, with a main visualization panel on the right and a side panel for selection of inputs on the left.

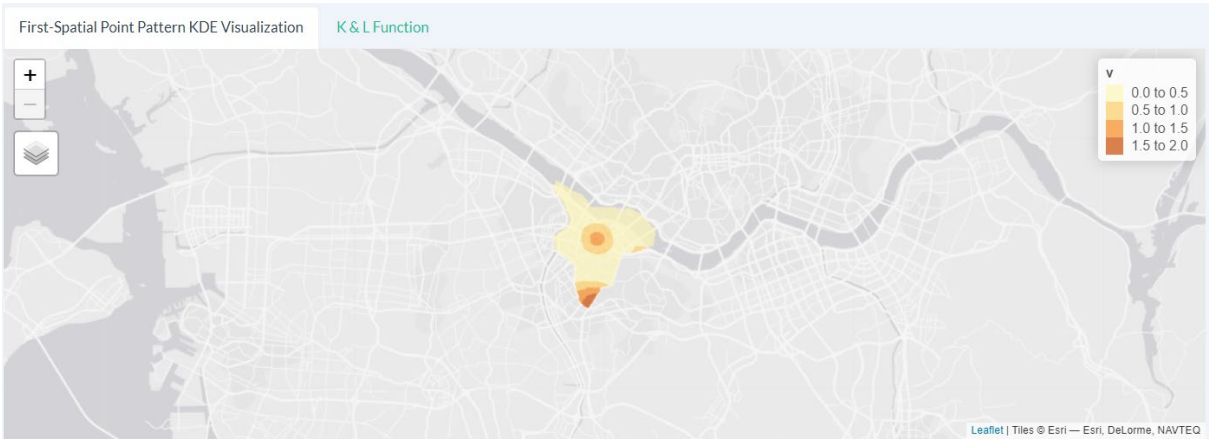
3.1 Spatial Point Pattern KDE Visualization



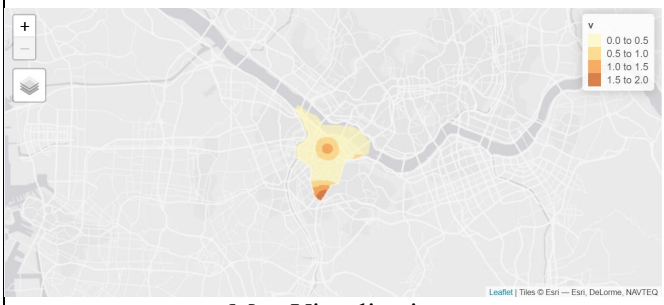
SPPA KDE Side Panel

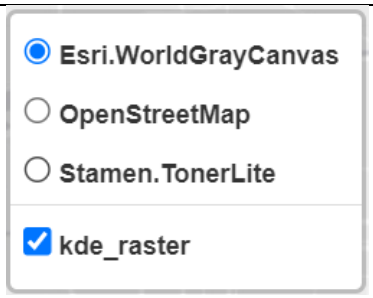
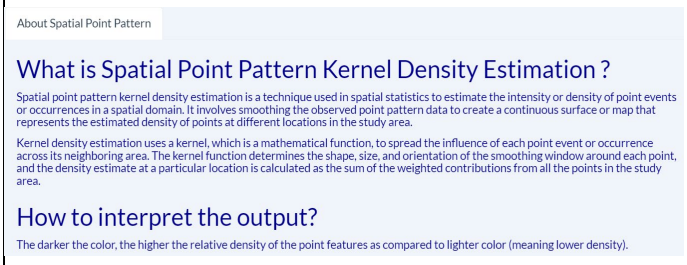
Feature	Functionality
 Coordinate Reference System Input Field	You will be able to input the Coordinate Reference System (CRS) of your data, based on the country the data is obtained from. From our example, we are looking at South Koreans' data so the CRS input would be 5179.
 Automatic Bandwidth Method Selection	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. 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
 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)

 Run Analysis Button	This feature is the most important out of the bunch, because **the map visualizations will only be updated after this button is clicked.** 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.

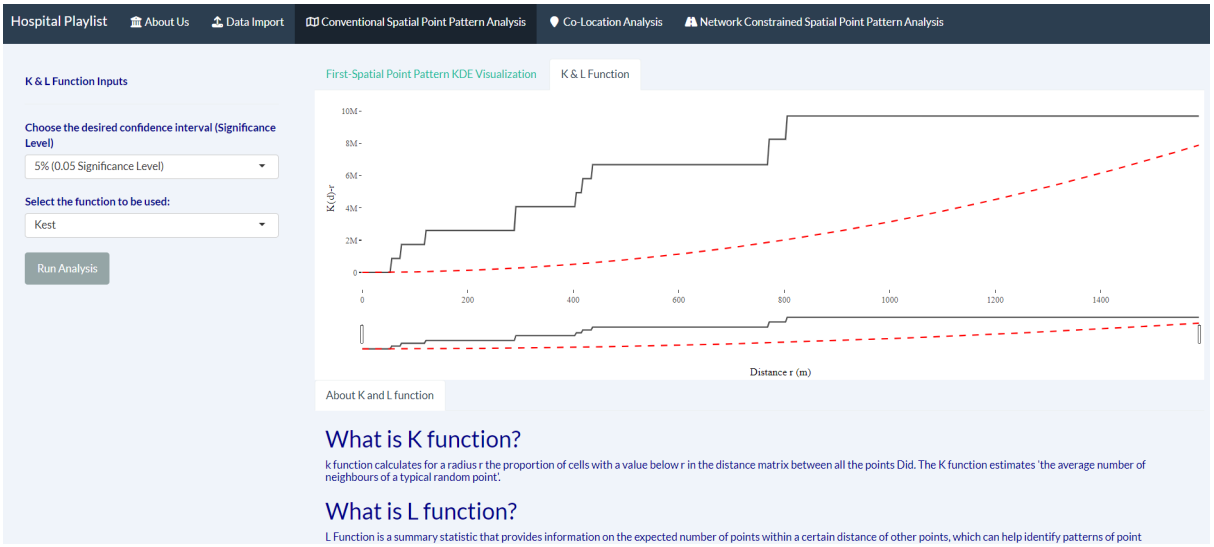


SPPA KDE Main Panel

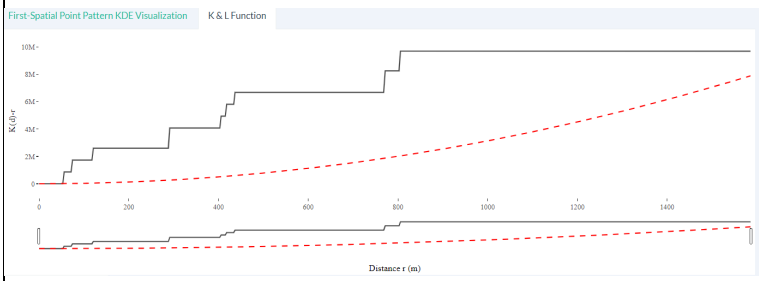
Feature	Functionality
 Map Visualization	Visualisation of the First-Spatial Point Pattern KDE is displayed. The v in the legend indicates the number of object/events in kernel window centered in each grid. Essentially, **the darker the color of the area, the higher the intensity of points density** in 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 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.
 Map Control	When you **hover your cursor over** this icon, the menu will appear, where you can **select your desired base map.**

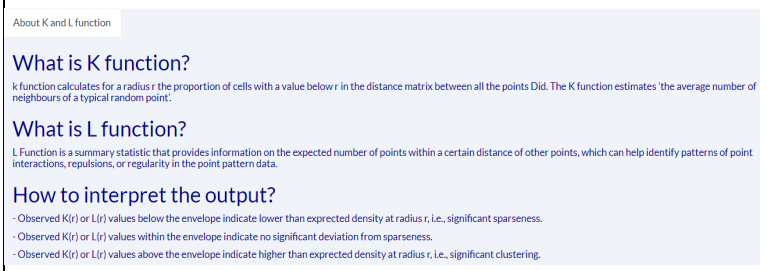
 Base Map Control	Our application offers **3 different base maps**, feel free to test them out to see which offers the best visualization for your use case.
 About SPPA KDE Section	In this section, you can get a **quick understanding of what Spatial Point Pattern KDE Visualization is** and **how to interpret the output in the map visualization.**

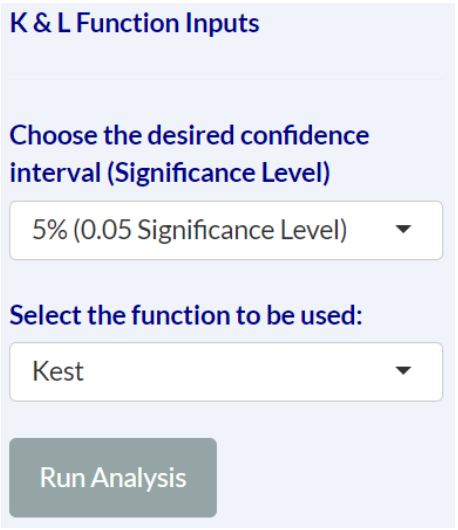
3.2 SPPA K-Function/L-Function



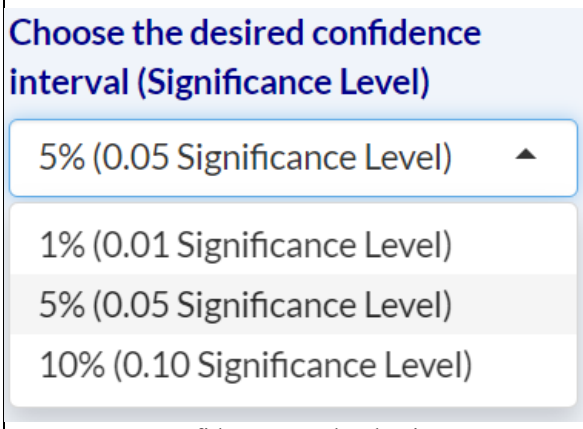
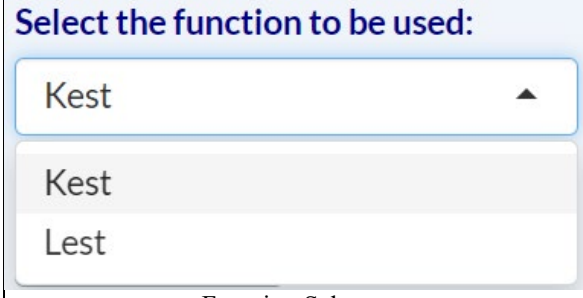
SPPA K-Function/L-Function Main Panel

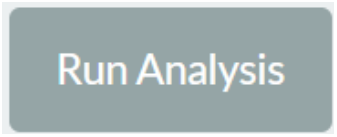
Feature	Functionality
 Monte Carlo simulation test of CSR on K-Function/L-Function Visualization	This graph is the **interactive** visualization of a **Monte Carlo simulation test of CSR on K-Function/L-Function for the selected variable**. The interactive graph **illustrates the spatial distribution (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.

 About SPPA K-Function/L-Function Section	In this section, you can get a **quick understanding of what K-Function/L-Function is** and **how to interpret the graph output.**

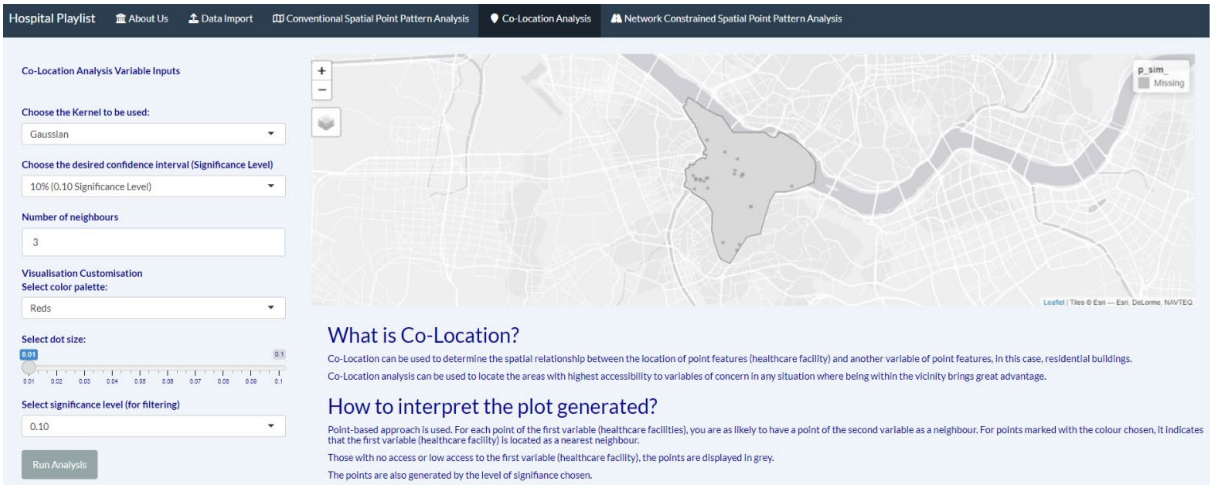


SPPA K-Function/L-Function Side Panel

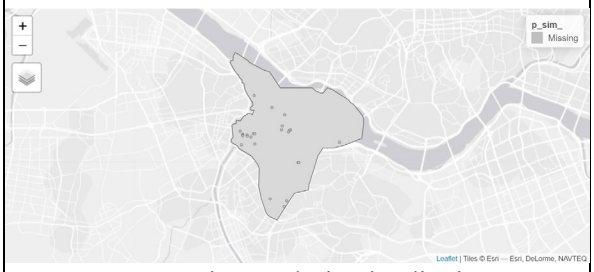
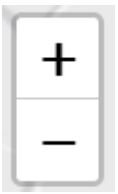
Feature	Functionality
 Confidence Level Selection	Through this input box, you can **key in the desired confidence interval selection based on significance level to generate the K-Cross Function analysis**. `5%` is the default confidence interval for our graph, and you can also select the two other options being 1% and 10%. Find out more about Monte Carlo simulations here: https://www.ibm.com/sg-en/cloud/learn/monte-carlo-simulation
 Function Selector	In this dropdown list, you will be able to choose the type of function to generate the graph on, with the 2 options being: 1) Kest - Function 2) Lest - Function

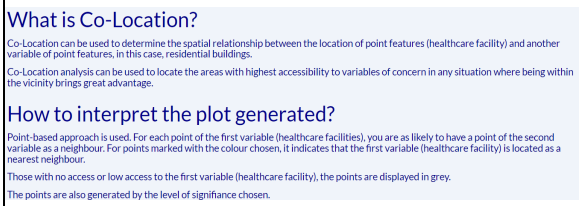
 Run Analysis Button	Same as other side panels, **the graph visualizations will only be updated after this button is clicked.** Therefore, do remember to **click on this `Run Analysis` button to see the updated changes** after selecting your desired variable and number of simulations.

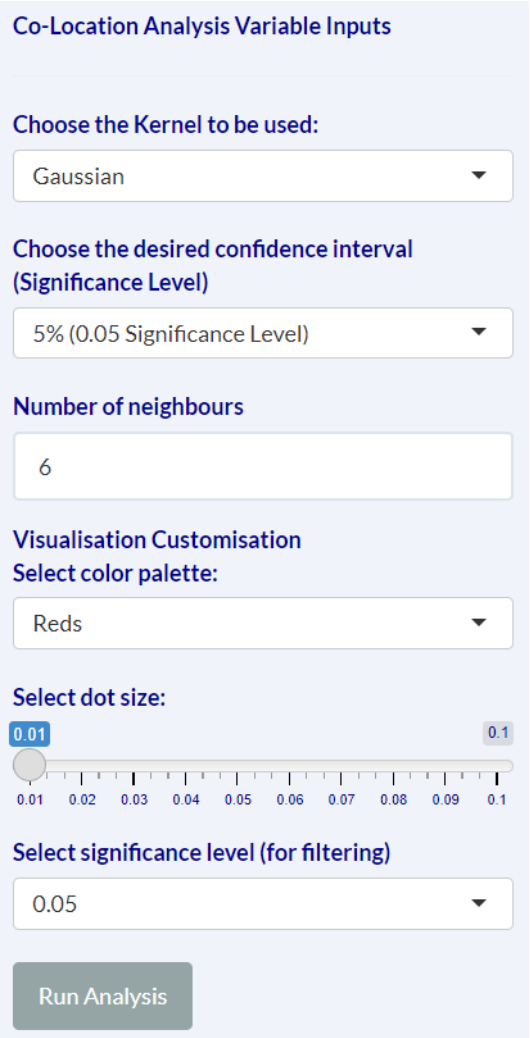
4. Co-Location Analysis



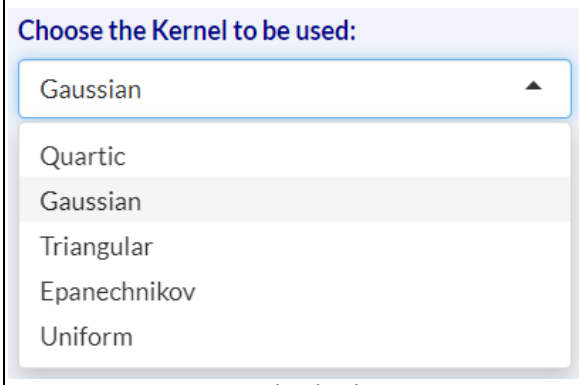
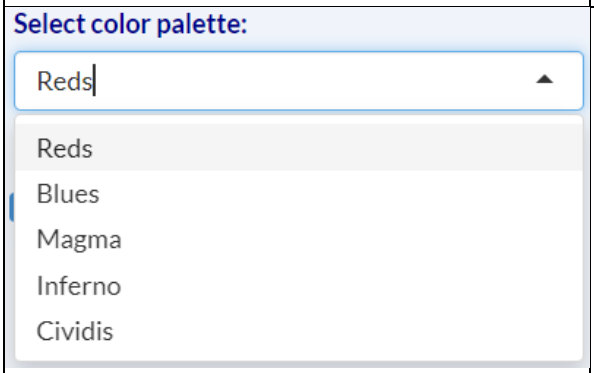
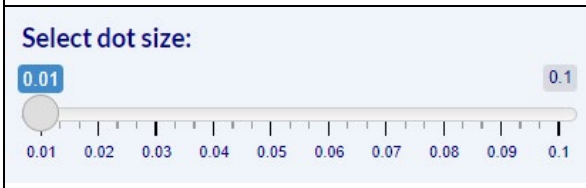
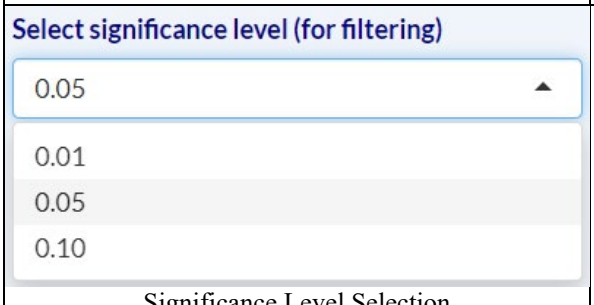
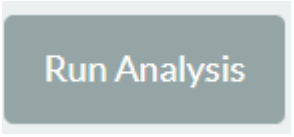
Co-Location Main Panel

Feature	Functionality
 Co-Location Analysis Visualisation	This map plot is the visualization of **co-location for variable 1 (healthcare facilities) and variable 2 (residential buildings)**. The graph **illustrates the points that are significantly co-located based on the two variables studied.**
 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.

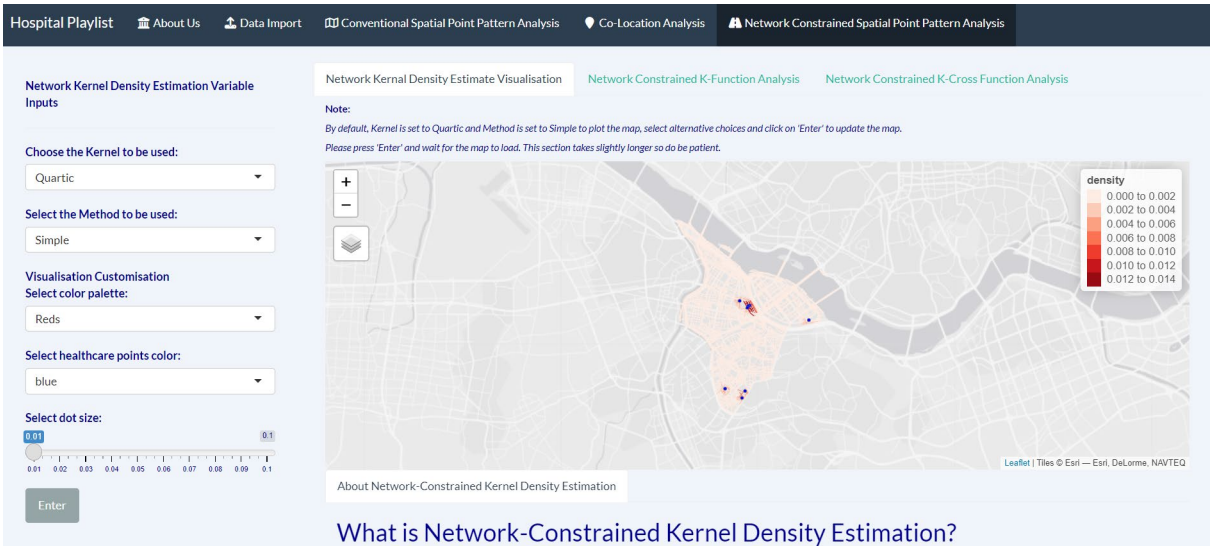
 Map Control	When you **hover your cursor over** this icon, the menu will appear, where you can **select your desired base map.**
 About Co-Location Section	In this section, you can get a **quick understanding of what Co-Location is** and **how to interpret the map output.**



Co-Location Side Panel

Feature	Functionality
 Kernel Selection	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. Other options are `Epanechnikov`, `Quartic`, `Triangular` and `Uniform`. Find out more about the differences between the various kernels here: https://en.wikipedia.org/wiki/Kernel_(statistics)
 Neighbours Selection	Here, you may input the number of neighbours you require for the analysis, depending on the range of your analysis. `6` is the default value for our graph, but you may input a number between `0` to `10`.
 Colour Palette Selection	Here, you will be able to select your preferred colour of your choice for the visualisation of the map output. `Reds` is the default selection, but you may also change your selections to `Blues`, `Magma`, `Inferno`, and `Cividis`.
 Dot Size Selection	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. Default value is set to `0.01` but you may also adjust the size to a maximum of `0.1`.
 Significance Level Selection	You will be able to choose your selection of significance level you would like to visualise to do the filtering. Points displayed on the map output will be filtered to the significance level selected. `0.05` significance level is selected by default, with two other options of `0.01` and `0.10` available.
 Run Analysis Button	Same as other side panels, **the graph visualizations will only be updated 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.

5. Network Kernel Density Estimation



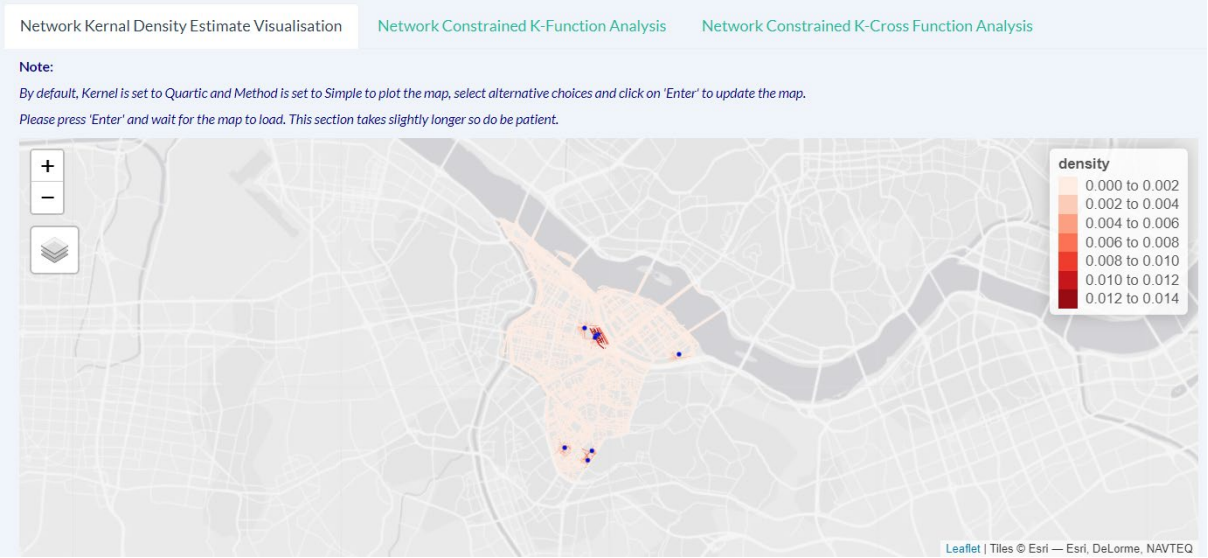
Network-Constrained Kernel Density Estimation (NetKDE) is the fifth and last page that you can access in our application.

Three sub tabs will be made available for use:

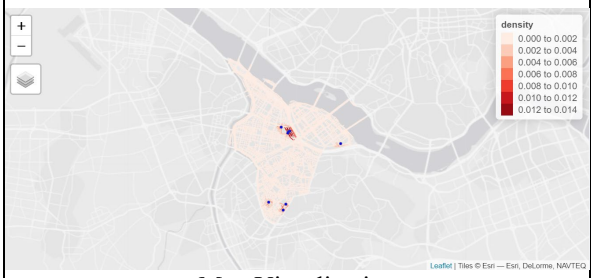
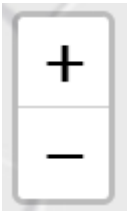
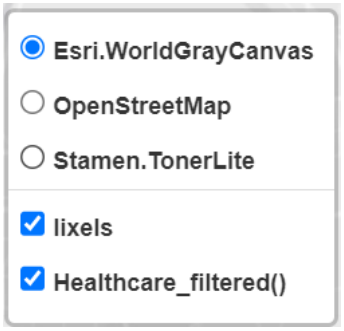
1) *NetKDE Visualisation*
2) *NetKDE K-Function*
3) *NetKDE K-Cross Function*

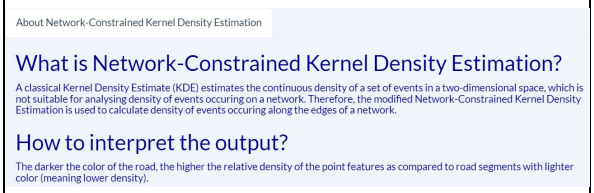
The layout of the sub tabs is similar in nature, with the side panel for selection of inputs on the left and the main visualization panel on the right.

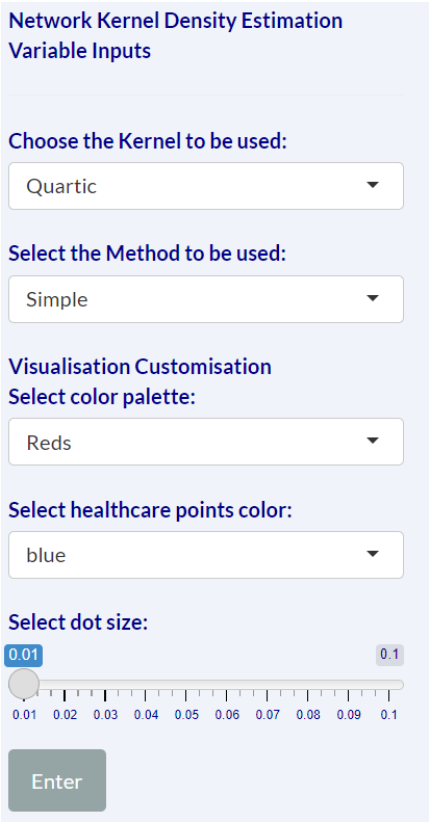
5.1 NetKDE Visualisation



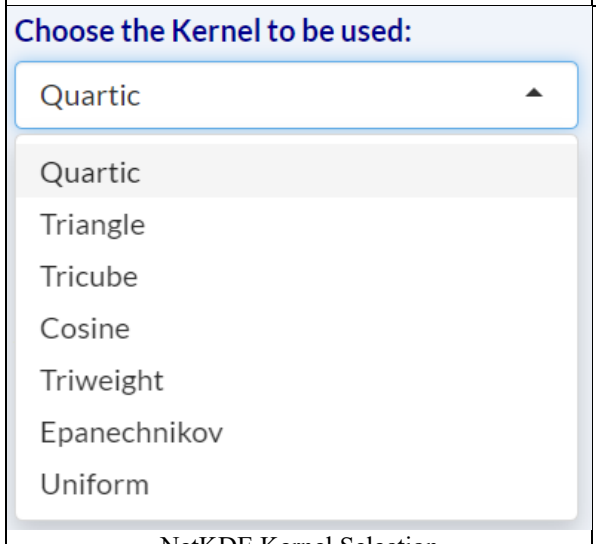
NetKDE Main Panel

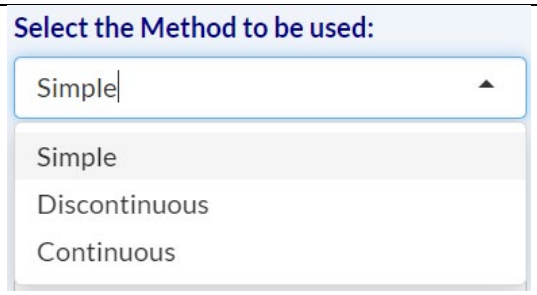
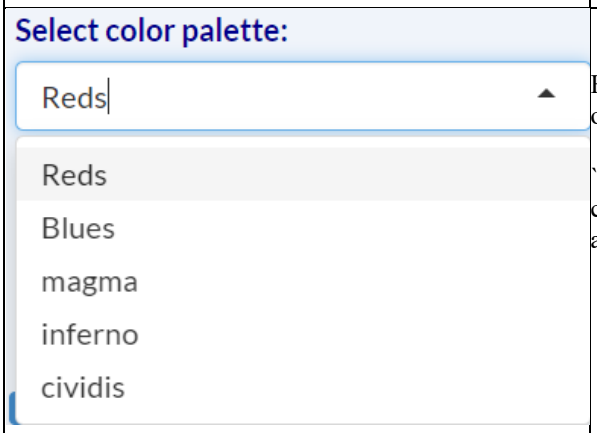
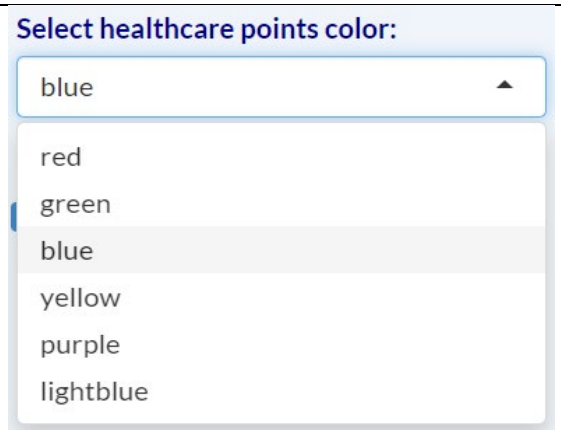
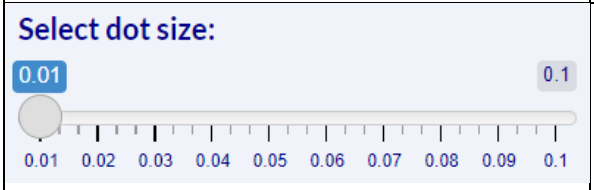
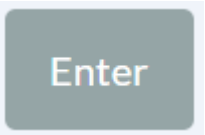
Feature	Functionality
 Map Visualization	This map displays the visualization of the Network Kernel Density Estimation. The points are the variables, and the network is shown in the color range selected by you in the side panel, with **the darker colour intensity being the areas with higher densities of points along the network.**
 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.
  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 your variable `healthcare_filtered`**, which are the network and the points respectively.

 About NetSPPA KDE Section	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.**

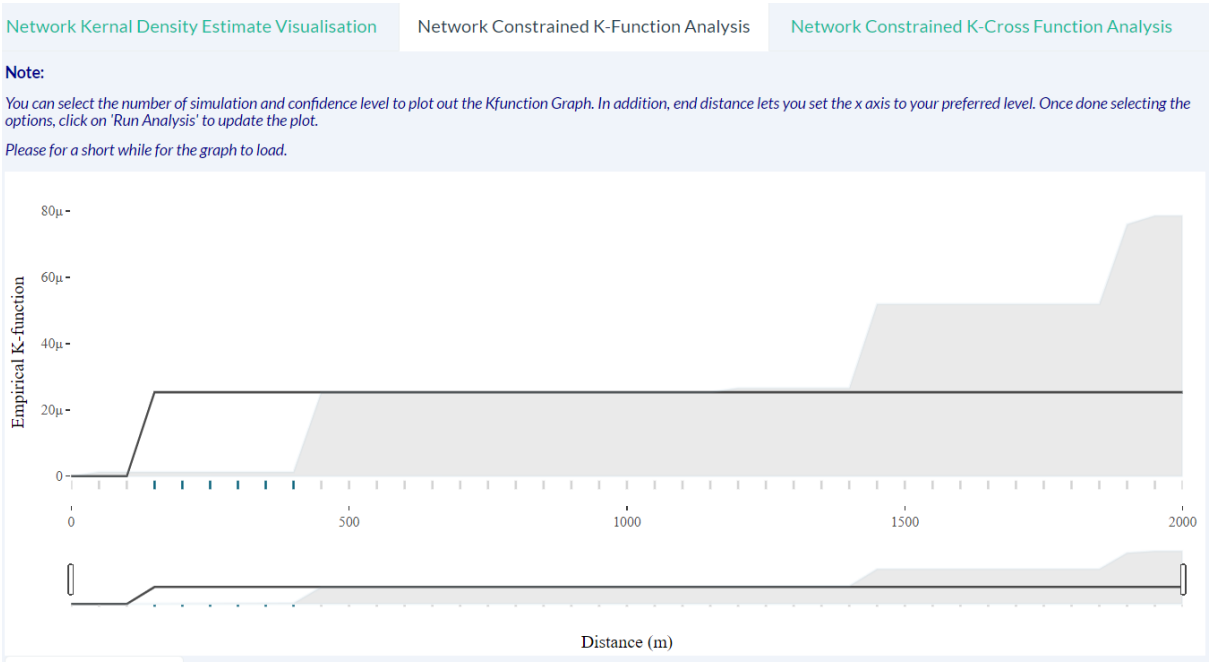


NetKDE Side Panel

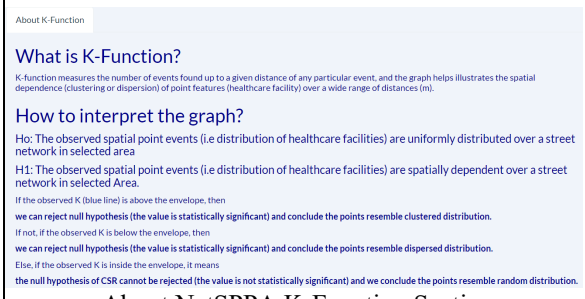
Feature	Functionality
 NetKDE Kernel Selection	From this **drop-down list, you can select the kernel method to be used to compute NetKDE.** `Quartic` is selected as the kernel method for computing the default map. Other options are `Triangle`, `Tricube`, `Cosine`, `Triweight`, `Epanechnikov` and `Uniform`.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

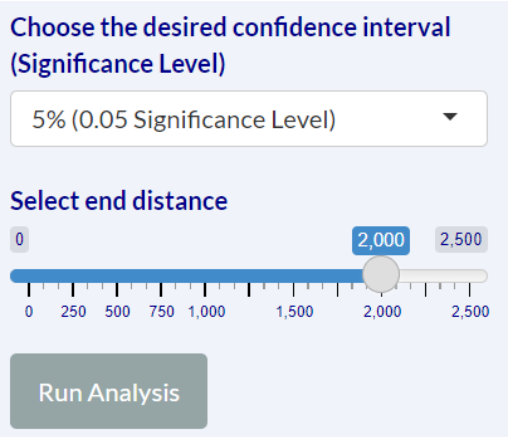
 NetKDE Method Selection	`Continuous`. Find out more about the differences between the various methods here: https://cran.r-project.org/web/packages/spNetwork/vignettes/NKDE.html
 Colour Palette Selection	Here, you will be able to select your preferred colour of your choice for the visualisation of the map output. `Reds` is the default selection, but you may also change your selections to `Blues`, `Magma`, `Inferno`, and `Cividis`.
 Colour Palette Selection for Variables	Here, you will be able to select your preferred colour of your choice for the visualisation of the healthcare variables for the map output. `Blue` is the default selection, but you may also change your selections to `Red`, `Green`, `Yellow`, `Purple` and `Lightblue`.
 Dot Size Selection	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. Default value is set to `0.01` but you may also adjust the size to a maximum of `0.1`.
 “Enter” Button	This feature is the most important out of the bunch, because **the map visualisation will only be updated after this button is clicked.** 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.

5.2 NetKDE K-Function

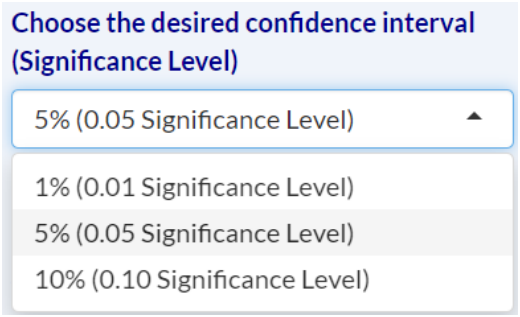
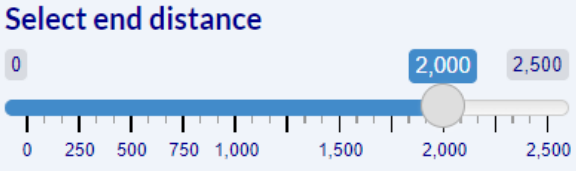
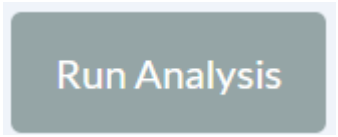


NetSPPA K-Function Main Panel

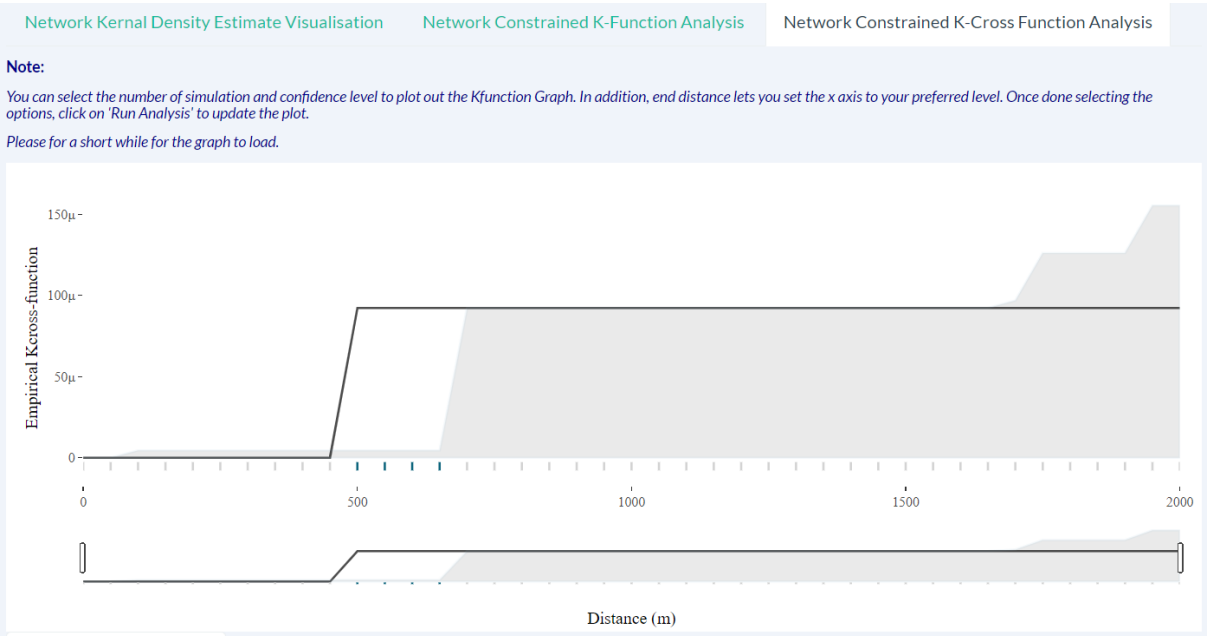
Feature	Functionality
 Monte Carlo simulation test of CSR on K-Function Visualization	This graph is the **interactive** visualization of **Monte Carlo simulation test on K-Function for the selected variable**. You may hover your mouse over the different areas of the graph to look into the details. The 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.**
 About NetSPPA K-Function Section	In this section, you can get a **quick understanding of what K-Function is** and **how to interpret the graph output.**



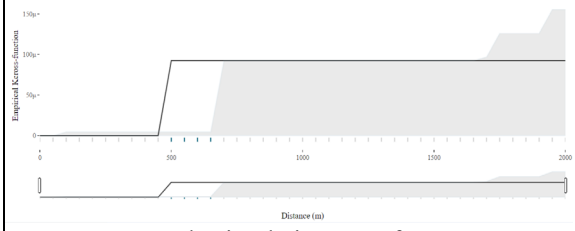
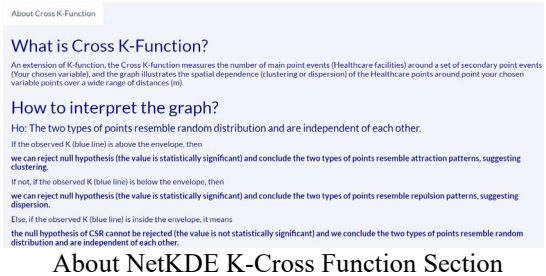
NetSPPA K-Function Side Panel

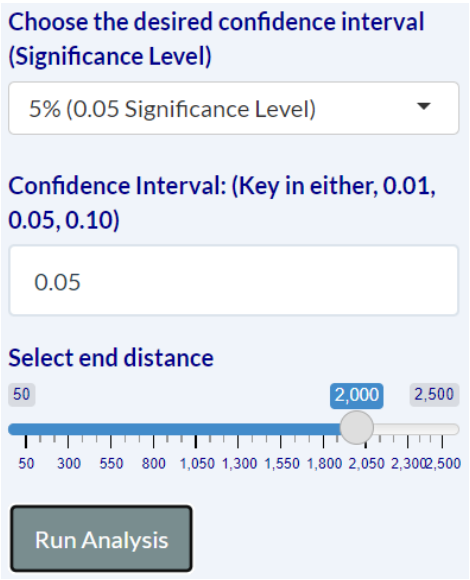
Feature	Functionality
 Confidence Interval Selection	Through this input box, you can **key in the desired confidence interval selection based on significance level to generate the K-Function analysis**. `5%` is the default confidence interval for our graph, and you can also select the two other options being 1% and 10%. Find out more about Monte Carlo simulations here: https://www.ibm.com/sg-en/cloud/learn/monte-carlo-simulation
 Distance Selection	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.
 Run Analysis Button	Same as other side panels, **the graph visualizations will only be updated 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.

5.3 NetKDE K-Cross Function

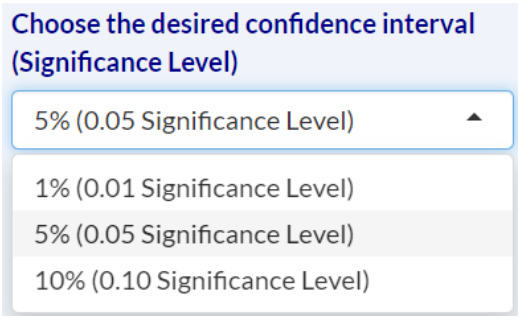
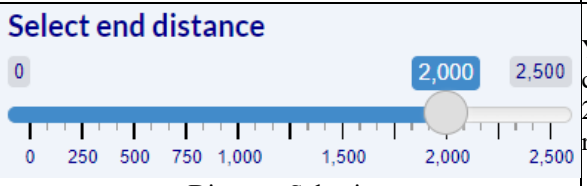
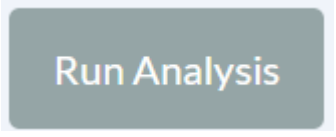


NetSPPA Cross K-Function Main Panel

Feature	Functionality
 Monte Carlo simulation test of CSR on K-Cross Function Visualization	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. 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.**
 About NetKDE K-Cross Function Section	In this section, you can get a **quick understanding of what K-Cross Function is** and **how to interpret the graph output.**



NetSPPA Cross K-Function Side Panel

Feature	Functionality
 Confidence Interval Selection	Through this input box, you can **key in the desired confidence interval selection based on significance level to generate the K-Cross Function analysis**. `5%` is the default confidence interval for our graph, and you can also select the two other options being 1% and 10%. Find out more about Monte Carlo simulations here: https://www.ibm.com/sg-en/cloud/learn/monte-carlo-simulation
 Distance Selection	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).
 Run Analysis Button	Same as other side panels, **the graph visualizations will only be updated 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.

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.