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SIGNAL

IS415 Geospatial Analysis and Application

User Guide for

**Network-constrained Spatio-temporal Analysis Tool for Traffic
Accidents in Leeds, United Kingdom**

Prepared By:

Ang JiaYing

Sheryl Chong Man Er

Tan Yan Lin

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Introduction

This document will guide you on how to use analysis tool.

Running the Application

If you have downloaded our application and plan to run our application on your computer. Please perform the following steps:

1. Unzip the file
2. Open app.R file in R studio
3. Click on Run at the top right-hand corner of R Studio
4. A window will appear with the functional application

Application

Overview

SIGNAL: Network-constrained Spatio-temporal Analysis Tool for Traffic Accidents in Leeds, United Kingdom

Ang JiaYing, Sheryl Chong Man Er, Tan Yan Lin | Supervised by Professor Kam Tin Seong
IS415: Geospatial Analytics and Applications

Introduction

This application was conceptualised to equip users with the necessary tools to visualise network-constrained spatial analyses of traffic accidents in Leeds, United Kingdom.

The application has the following features that enable users to obtain different types of insights and analyses:

- 1. Network-Constrained Kernel Density Estimation**
 - Objective: Visualise which segment(s) of the road have the highest intensity of traffic accident points or casualty points along the network. Two different kernel density maps are displayed separately for traffic accident points and casualty points respectively.
- 2. Network-Constrained K-Function**
 - Objective: Determine if there is spatial correlation between accident points on a linear network using geometrically corrected K-function. This helps the user to deduce if there is enough evidence to prove that spatial clustering is present on a network.
- 3. Network-Constrained Cross K-Function**
 - Objective: Determine if there is correlation between accident points and variables selected (pedestrian crossings, road junctions or schools), using multi-type K-function. Multi-type K-function contains contributions of all interpoint distances less than or equal to the radius of the variable selected.
- 4. Network-Constrained Cross Pair Correlation Function**
 - Objective: Determine if there is correlation between accident points and variables selected (pedestrian crossings, road junctions or schools), using pair correlation function. Pair correlation function only contains contributions of all interpoint distances that are equal to the radius of the variable selected, which makes interpretation easier than that of cross K-function.

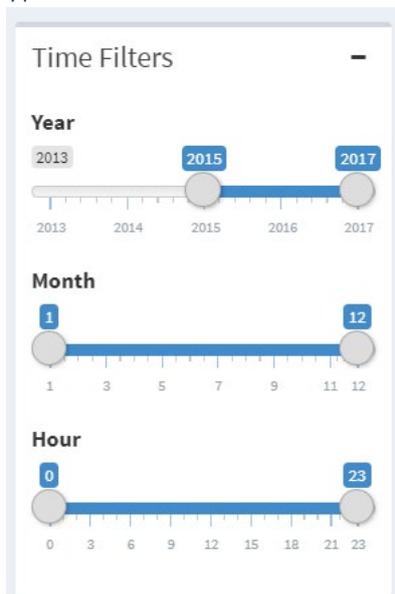
Data Used

The analyses derived from this application are based on datasets obtained from Leeds City Council and Ordnance Survey.

The overview page provides the user with an overview of the project and the list of features available in the application. At the left-hand side of the application is the side menu bar with 5 other tabs that will lead the user to 4 different analysis aspects of the visualization and the data set which is used for the application.

Network Constrained Kernel Density Estimation

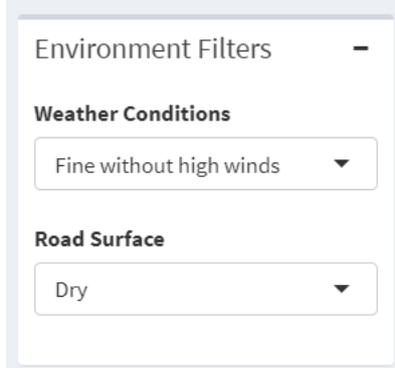
Type of filters



The screenshot shows the 'Time Filters' section of a user interface. It contains three horizontal sliders for selecting time ranges. The 'Year' slider is set from 2013 to 2017, with a blue bar indicating the selected range. The 'Month' slider is set from 1 to 12, also with a blue bar. The 'Hour' slider is set from 0 to 23, with a blue bar. Each slider has a central knob and tick marks along the axis.

Time Filters

The user will be able to filter the data by year, month and hours.

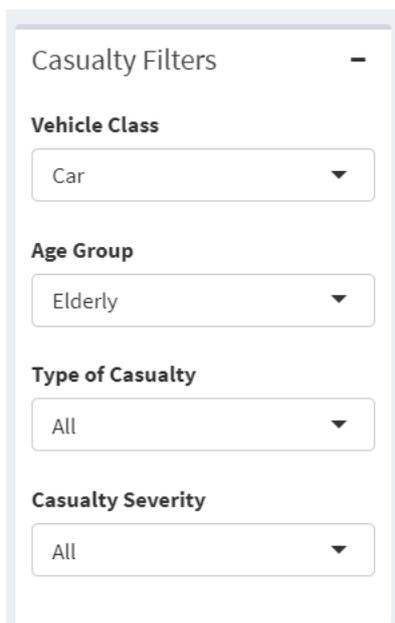


The screenshot shows the 'Environment Filters' section. It features two dropdown menus. The first is labeled 'Weather Conditions' and is currently set to 'Fine without high winds'. The second is labeled 'Road Surface' and is currently set to 'Dry'.

Environment Filters

The user will be able to filter the data by:

- **Weather conditions** – All, Fine without high winds, Fine with high winds, Snowing without high winds, Snowing with high winds, Raining without high winds, Raining with high winds, Fog or mist, unknown and others
- **Road Surface** – All, Dry, Frost / Ice, Wet / Damp, Snow, Others and Flood (surface water over 3cm deep)



The screenshot shows the 'Casualty Filters' section. It contains four dropdown menus. The first is 'Vehicle Class' set to 'Car'. The second is 'Age Group' set to 'Elderly'. The third is 'Type of Casualty' set to 'All'. The fourth is 'Casualty Severity' set to 'All'.

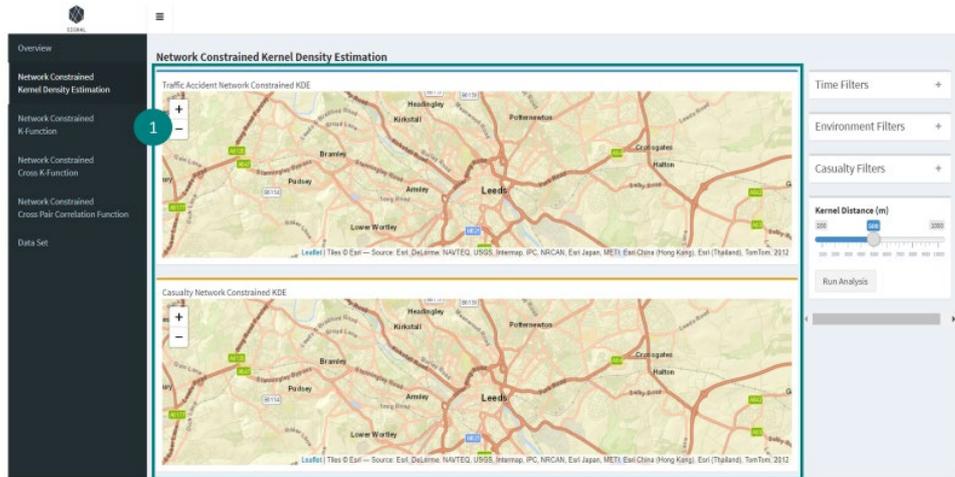
Casualty Filters

The user will be able to filter the data by:

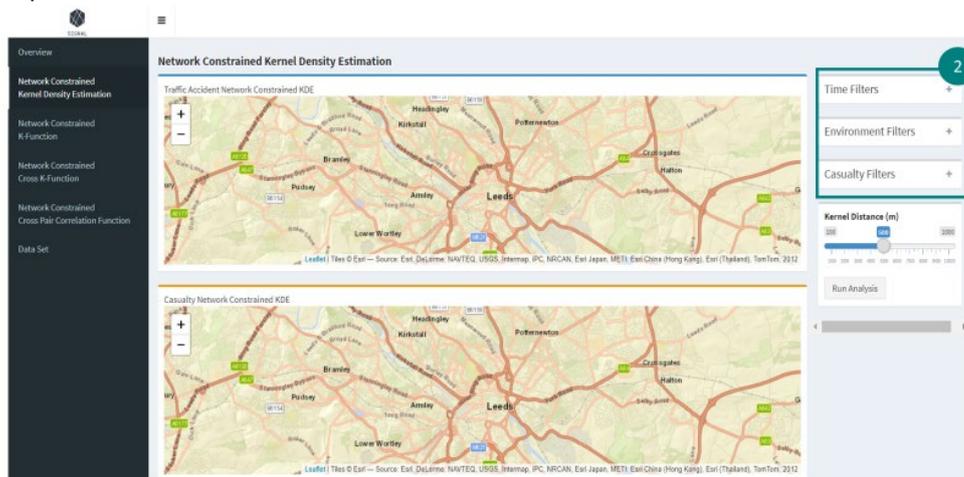
- **Vehicle Class** – All, Car, Motorcycle, Bus / Coach, Bicycle, Goods Vehicle, Taxi / Private Hire, Mini Bus, Agricultural Vehicle, Mobility Scooter, Horse and Tram
- **Age Group** – All, Adult, Elderly, Children and Young Adults
- **Type of Casualty** – All, Driver or rider, Passenger and Pedestrian
- **Casualty Severity** – All, Slight, Serious and Fatal

Instructions

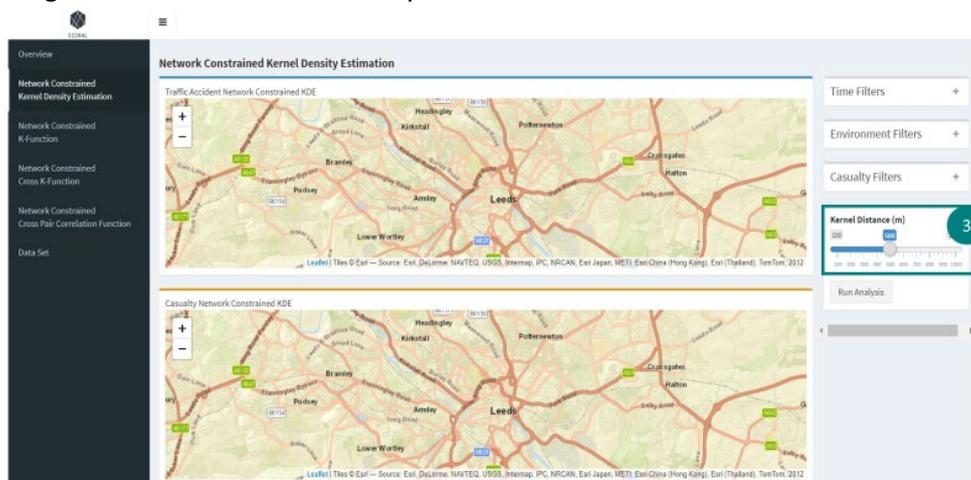
1. Zoom in using the map control button or move to the network constrained traffic accident KDE map (top map) to the area which you want to run the analysis. The network constrained casualty KDE map (bottom map) will be updated accordingly.



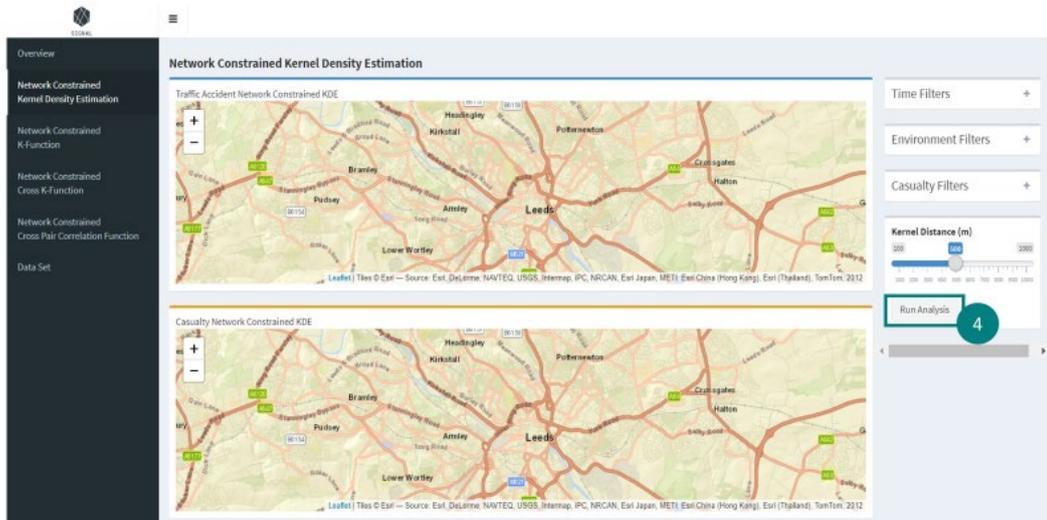
2. Expand the filters boxes and select the filters.



3. Drag the kernel distance slider to your desired distance.



- Click on the “Run Analysis” button to run network constrained kernel density estimation analysis.



- Wait for the application to calculate the network constrained kernel density estimation. There is a progress bar at the bottom right-hand side of the application to show you the progress of the calculation.

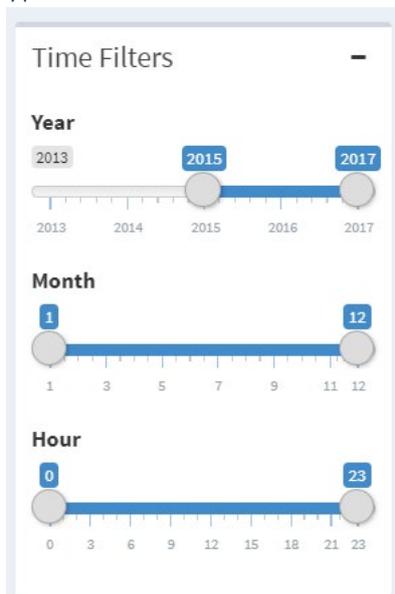


- The map will be updated with the network constrained kernel density estimation result.



Network Constrained K- Function

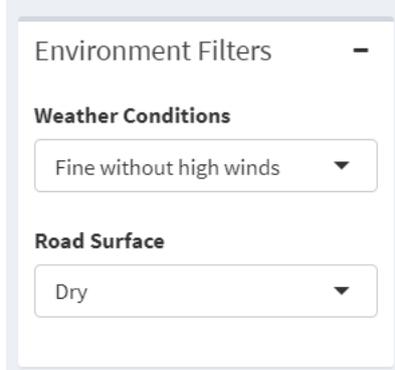
Type of Filters



The screenshot shows the 'Time Filters' section of a user interface. It contains three horizontal range sliders. The first slider is for 'Year', with a range from 2013 to 2017, and markers for 2013, 2015, and 2017. The second slider is for 'Month', with a range from 1 to 12, and markers for 1, 3, 5, 7, 9, 11, and 12. The third slider is for 'Hour', with a range from 0 to 23, and markers for 0, 3, 6, 9, 12, 15, 18, 21, and 23.

Time Filters

The user will be able to filter the data by year, month and hours.

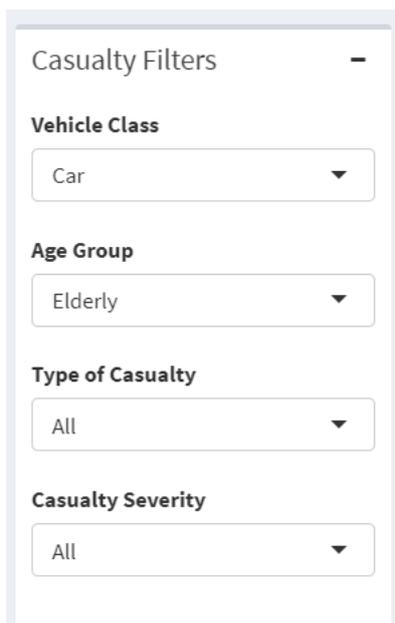


The screenshot shows the 'Environment Filters' section of a user interface. It contains two dropdown menus. The first is labeled 'Weather Conditions' and has 'Fine without high winds' selected. The second is labeled 'Road Surface' and has 'Dry' selected.

Environment Filters

The user will be able to filter the data by:

- **Weather conditions** – All, Fine without high winds, Fine with high winds, Snowing without high winds, Snowing with high winds, Raining without high winds, Raining with high winds, Fog or mist, unknown and others
- **Road Surface** – All, Dry, Frost / Ice, Wet / Damp, Snow, Others and Flood (surface water over 3cm deep)



The screenshot shows the 'Casualty Filters' section of a user interface. It contains four dropdown menus. The first is labeled 'Vehicle Class' and has 'Car' selected. The second is labeled 'Age Group' and has 'Elderly' selected. The third is labeled 'Type of Casualty' and has 'All' selected. The fourth is labeled 'Casualty Severity' and has 'All' selected.

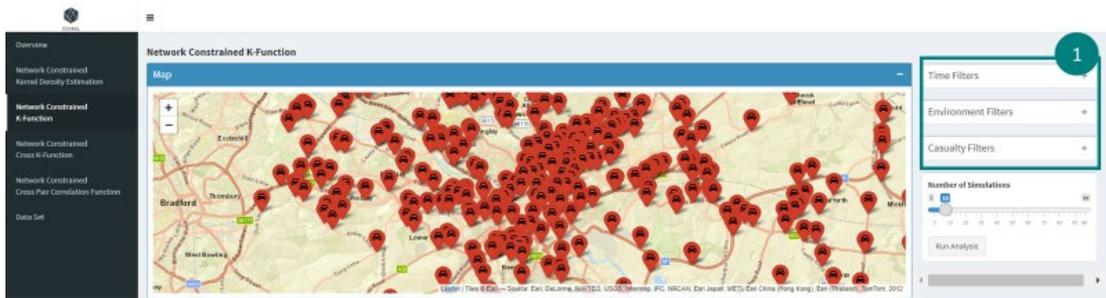
Casualty Filters

The user will be able to filter the data by:

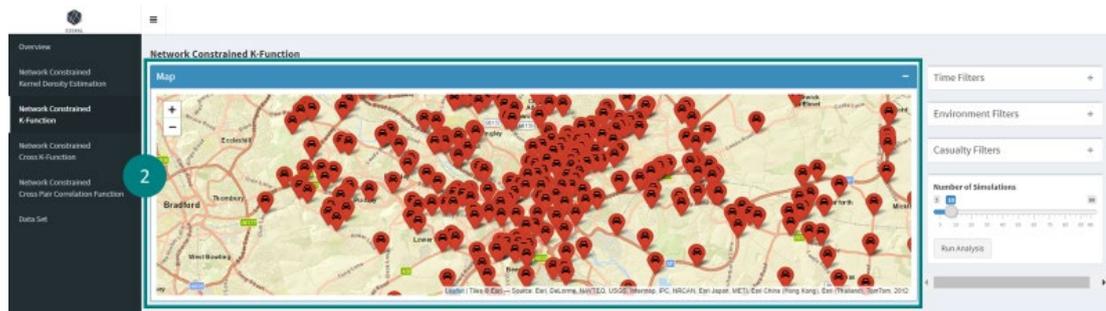
- **Vehicle Class** – All, Car, Motorcycle, Bus / Coach, Bicycle, Goods Vehicle, Taxi / Private Hire, Mini Bus, Agricultural Vehicle, Mobility Scooter, Horse and Tram
- **Age Group** – All, Adult, Elderly, Children and Young Adults
- **Type of Casualty** – All, Driver or rider, Passenger and Pedestrian
- **Casualty Severity** – All, Slight, Serious and Fatal

Instructions

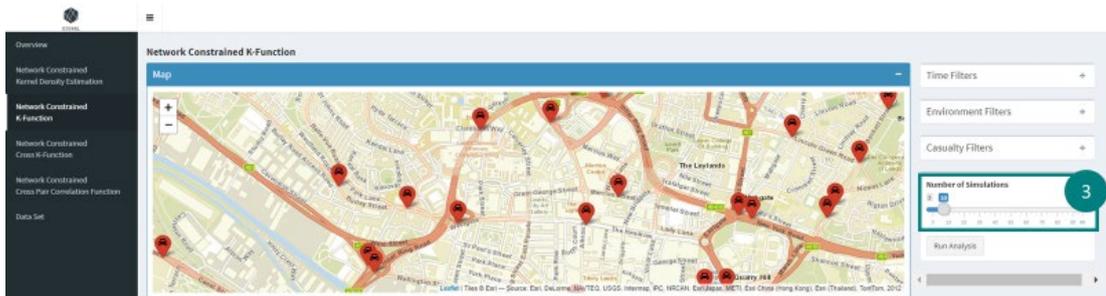
1. Expand the filters boxes and select the filters.



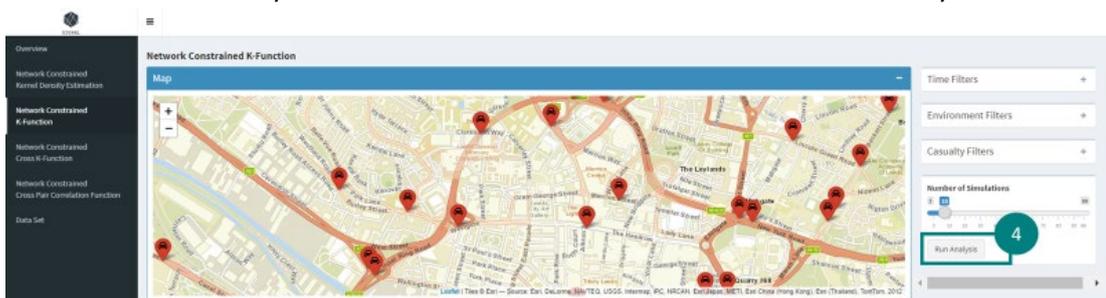
2. Zoom in using the map controls or move the map to the area which you want to analyse. Ensure that the map area has at least 1 accident point.



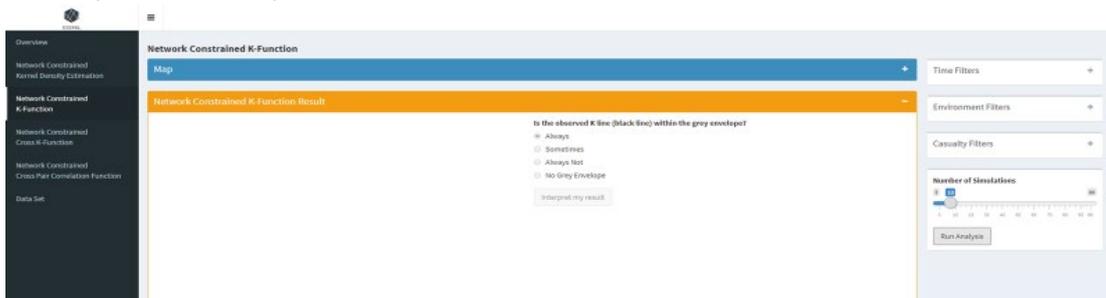
3. Drag the slider to state the number of simulations you want to run for the analysis.



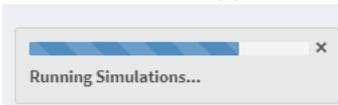
4. Click on the "Run Analysis" button to run network constrained k-function analysis.



5. The map box will collapse.



- Wait for the application to run the calculation. There is a progress bar at the bottom right-hand side of the application to show you the progress of the calculation.



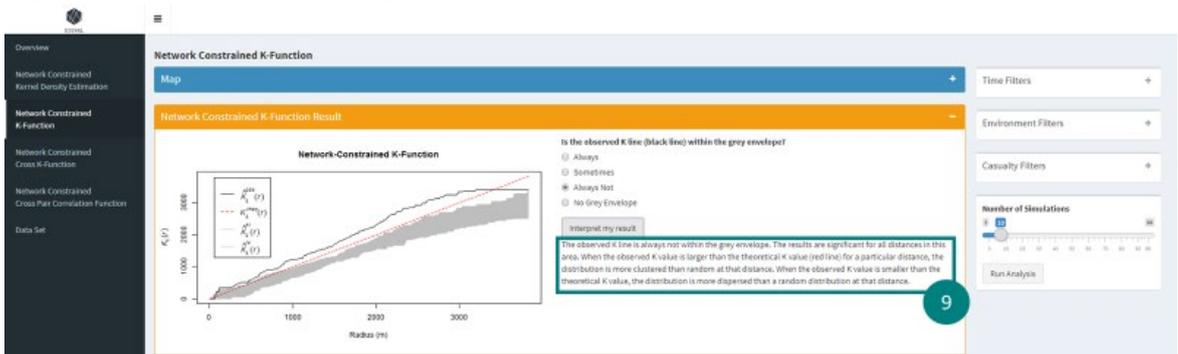
- A graph showing the result of the analysis will appear in the network constrained K-Function result box.



- Select the appropriate option according to the graph and click on “Interpret my result” button



- A general interpretation of the graph will be shown.



Network Constrained Cross K-Function

Types of Filters

Choose a variable:

Pedestrian Crossings ▼

Variable Filters

The user can choose which variable they want to run the analysis with the traffic accidents. They can choose either Pedestrian Crossings, Motorway Junctions or Schools.

Time Filters —

Year

2013 2015 2017

2013 2014 2015 2016 2017

Month

1 12

1 3 5 7 9 11 12

Hour

0 23

0 3 6 9 12 15 18 21 23

Time Filters

The user will be able to filter the data by year, month and hours.

Environment Filters —

Weather Conditions

Fine without high winds ▼

Road Surface

Dry ▼

Environment Filters

The user will be able to filter the data by:

- **Weather conditions** – All, Fine without high winds, Fine with high winds, Snowing without high winds, Snowing with high winds, Raining without high winds, Raining with high winds, Fog or mist, unknown and others
- **Road Surface** – All, Dry, Frost / Ice, Wet / Damp, Snow, Others and Flood (surface water over 3cm deep)

Casualty Filters —

Vehicle Class

Car ▼

Age Group

Elderly ▼

Type of Casualty

All ▼

Casualty Severity

All ▼

Casualty Filters

The user will be able to filter the data by:

- **Vehicle Class** – All, Car, Motorcycle, Bus / Coach, Bicycle, Goods Vehicle, Taxi / Private Hire, Mini Bus, Agricultural Vehicle, Mobility Scooter, Horse and Tram
- **Age Group** – All, Adult, Elderly, Children and Young Adults
- **Type of Casualty** – All, Driver or rider, Passenger and Pedestrian
- **Casualty Severity** – All, Slight, Serious and Fatal

Instructions

1. Choose which variable they want to run the analysis with the traffic accidents.

The screenshot shows the 'Network Constrained Cross K-Function' software interface. On the left is a navigation menu with options like 'Overview', 'Network Constrained Kernel Density Estimation', 'Network Constrained K-Function', 'Network Constrained Cross K-Function', 'Network Constrained Cross Pair Correlation Function', and 'Data Set'. The main area features a map of a city with red and green markers. A 'Marker Legend' indicates that red markers represent 'Car Accident' and green markers represent 'Pedestrian Crossing'. On the right, a control panel includes a 'Choose a variable' dropdown menu (highlighted with a red circle and the number 1), 'Time Filters', 'Environment Filters', 'Casualty Filters', and a 'Number of Simulations' slider. Below the map is a 'Cross K-Function Results' section with a question: 'Is the observed Cross-K line (black line) within the grey envelope?' and radio button options: 'Always', 'Sometimes', 'Always Not', and 'No Grey Envelope'. An 'Interpret my result' button is also present.

2. Expand the filters boxes and select the filters.

This screenshot shows the same software interface as the first image, but with the filter boxes on the right expanded. The 'Number of Simulations' slider is highlighted with a red circle and the number 2. The rest of the interface, including the map and the results panel, remains the same.

3. Zoom in using the map controls or move the map to the area which you want to analyse. Ensure that the map area has at least 1 accident point and chosen variable point.

This screenshot shows the software interface with the map zoomed in on a specific street area. The map controls (zoom in, zoom out, pan) are highlighted with a red circle and the number 3. The map now shows a detailed view of a street with several red and green markers. The rest of the interface, including the legend and the results panel, remains the same.

- Drag the slider to state the number of simulations you want to run for the analysis.



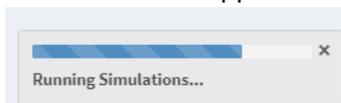
- Click on the “Run Analysis” button to run network network constrained cross k-function analysis.



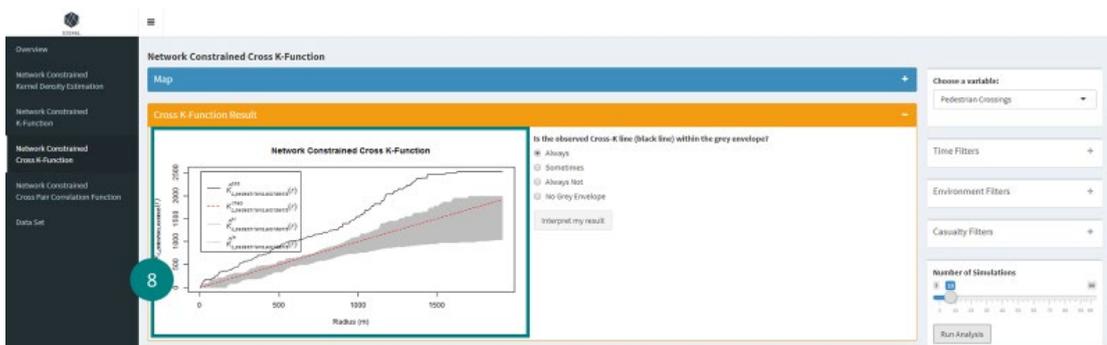
- The map box will collapse.



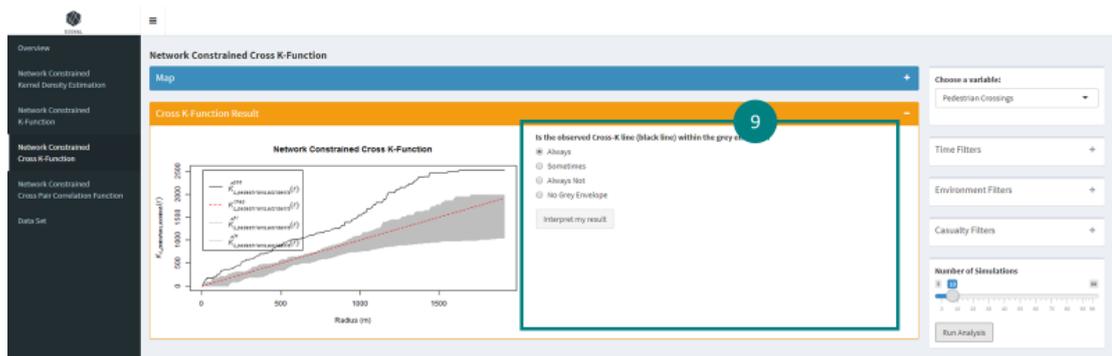
- Wait for the application to run the calculation. There is a progress bar at the bottom right-hand side of the application to show you the progress of the calculation.



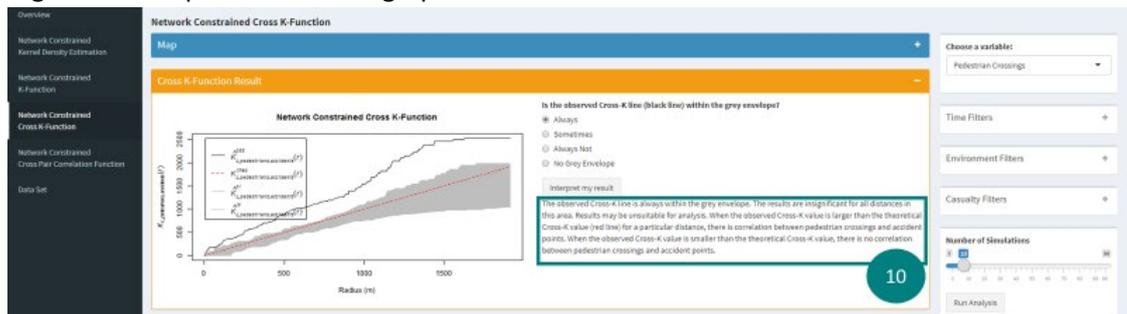
- A graph showing the result of the analysis will appear in the network constrained cross K-Function result box.



9. Select the appropriate option according to the graph and click on “Interpret my result” button



10. A general interpretation of the graph will be shown.



Network Constrained Cross Pair Correlation Function

Type of Filters

Choose a variable:

Pedestrian Crossings

Variable Filters

The user can choose which variable they want to run the analysis with the traffic accidents. They can choose either Pedestrian Crossings, Motorway Junctions or Schools.

Time Filters

Year

2013 2015 2017

2013 2014 2015 2016 2017

Month

1 12

1 3 5 7 9 11 12

Hour

0 23

0 3 6 9 12 15 18 21 23

Time Filters

The user will be able to filter the data by year, month and hours.

Environment Filters -

Weather Conditions

Fine without high winds ▼

Road Surface

Dry ▼

Environment Filters

The user will be able to filter the data by:

- **Weather conditions** – All, Fine without high winds, Fine with high winds, Snowing without high winds, Snowing with high winds, Raining without high winds, Raining with high winds, Fog or mist, unknown and others
- **Road Surface** – All, Dry, Frost / Ice, Wet / Damp, Snow, Others and Flood (surface water over 3cm deep)

Casualty Filters -

Vehicle Class

Car ▼

Age Group

Elderly ▼

Type of Casualty

All ▼

Casualty Severity

All ▼

Casualty Filters

The user will be able to filter the data by:

- **Vehicle Class** – All, Car, Motorcycle, Bus / Coach, Bicycle, Goods Vehicle, Taxi / Private Hire, Mini Bus, Agricultural Vehicle, Mobility Scooter, Horse and Tram
- **Age Group** – All, Adult, Elderly, Children and Young Adults
- **Type of Casualty** – All, Driver or rider, Passenger and Pedestrian
- **Casualty Severity** – All, Slight, Serious and Fatal

Instructions

1. Choose which variable they want to run the analysis with the traffic accidents.

The screenshot shows a software interface for a 'Network Constrained Cross Pair Correlation Function' analysis. On the left is a dark sidebar with menu items like 'Diagrams', 'Network Constrained Kernel Density Estimation', 'Network Constrained R-Function', 'Network Constrained Cross R-Function', and 'Network Constrained Cross Pair Correlation Function'. The main area features a map with numerous red and green circular markers representing accident locations. A 'Marker Legend' in the bottom-left of the map area identifies 'Car Accident' (red) and 'Pedestrian Crossing' (green). On the right, a control panel includes a 'Choose a variable:' dropdown menu (highlighted with a red circle and the number '1'), 'Time Filters', 'Environment Filters', 'Casualty Filters', and a 'Number of Simulations' slider. At the bottom, a status bar displays 'Cross Pair Correlation Function Result' and a question: 'Is the Cross Pair Correlation line (black line) within the grey envelope?'.

- Expand the filters boxes and select the filters.



- Zoom in using the map controls or move the map to the area which you want to analyse. Ensure that the map area has at least 1 accident point and chosen variable point.



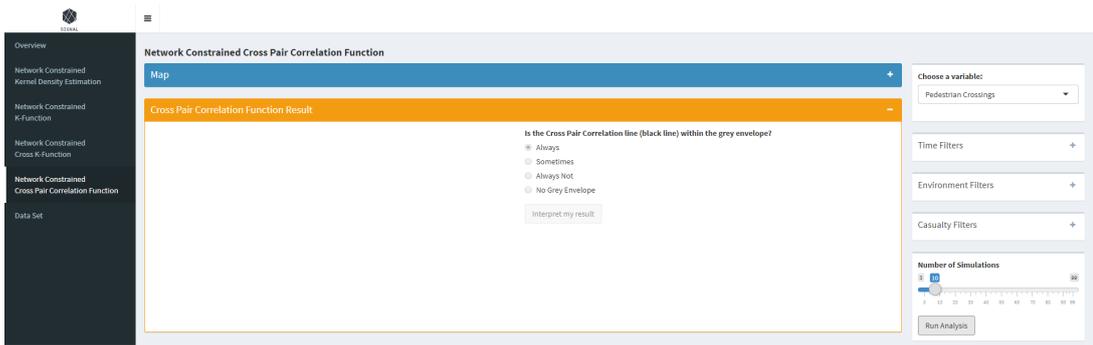
- Drag the slider to state the number of simulations you want to run for the analysis.



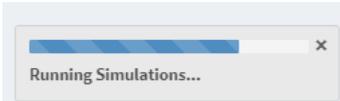
- Click on the "Run Analysis" button to run Network Constrained Cross Pair Correlation Function analysis.



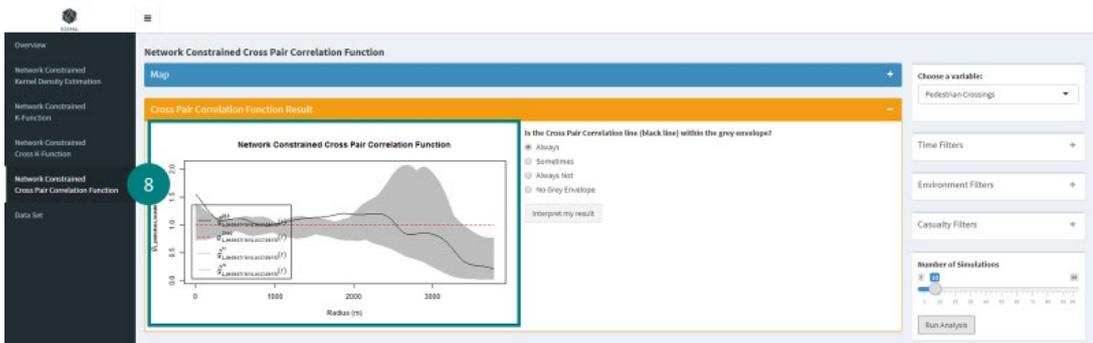
6. The map box will collapse.



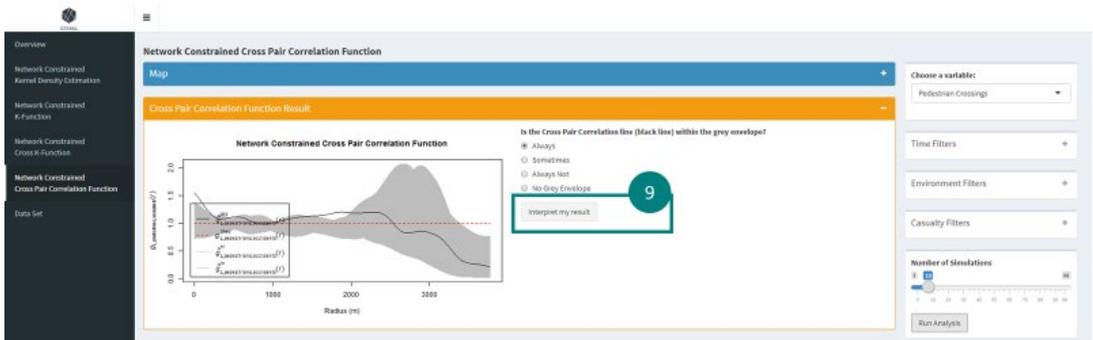
7. Wait for the application to run the calculation. There is a progress bar at the bottom right-hand side of the application to show you the progress of the calculation.



8. A graph showing the result of the analysis will appear in the Network Constrained Cross Pair Correlation Function result box.



9. Select the appropriate option according to the graph and click on "Interpret my result" button



10. A general interpretation of the graph will be shown.

