Network Analysis

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1_Introduction

1.1_Objectives

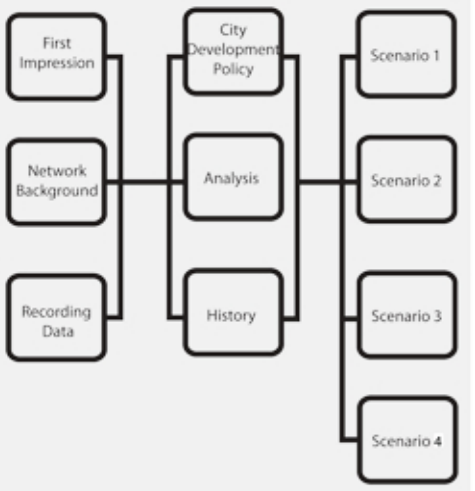
_To explain the general **concept of networks** and how they operate in a spatial context

_To **illustrate the concept of centrality** within networks, and describe how it is calculated with Multiple Centrality Assessment

_To **map the centrality** of the current city of Glasgow and interpret the results

_To **experiment with conceptual scenarios** for the layout of the city using the M8 motor way as a focal point, map the centrality of these scenarios, and observe how they affect the city's centrality

1.2_Progression Diagram



1.3_About Network

A Network can be used in many contexts to illustrate the **series of connections** a person or thing has between other related entities. The **subjects** in these connections are referred **as "nodes"** and the **connections between them as "edges"**. For example, in a social network (Facebook), the nodes would be people, while the edges would be the link connecting them (individuals knowing one another).

A spatial network is geographical and shaped by the built environment. This could include various connections such as railroads and train stations, or a system of water pipelines, however the **spatial network** we are focusing on is the urban street network, in which **nodes are intersections and edges are streets**.

_Centrality

In urban planning, **centrality** is key aspect in shaping urban space and urban growth which will allows an **extended visualization and characterization of the city structure**. Centrality valur of each node in a network is define depending on the value we intended to measure it. In spatial analysis, centrality measures the relations in topological space. Centrality of spatial networks can be visualized and analyzed through the maps created from MCA (Multiple Centrality Acessement).

In a **global network**, all the **nodes in a network are inputted to calculate centrality**. In a **local network**, **only the connections of nodes within a specified distance of each node are used to determine centrality**. For the local networks displayed in this presentation, the distance used to calculate local centrality was 800 meters.

MCA helps to shape the vision of the **potential development** of an existing network. By using MCA, the network is calculated into mathematical equations where the distance and connectivity between nodes are calculated and then graphically display the centrality of each node. Each of these defines centrality differently, and so provides its own unique set of information with relation to the urban framework.

_Closeness Centrality

Closeness centrality (Fig. 1) considers a node that is close to other nodes (via the shortest path) to be central. In other words, **a node that is central is able to connect with many places in a short distance**. This method is significant in the urban context in demonstrating the structural density of an urban layout. Therefore an area with high closeness centrality has high potential for commercial development since it is near many other points within the network, and accessed easily by a higher amount of people.

Fig. 1

Fig. 2

_Betweenness Centrality

Betweenness centrality (Fig. 2) is based on the idea that **a central node is located along paths that link other nodes with each other (via the shortest path)**. This is significant because it shows which routes people most likely to take, or must take, in order to get from one place to another. Places with high betweenness centrality will have higher volumes of traffic, as they are often places one must pass through to reach a destination. Due to the amount of people passing through these nodes, they often indicate places that can support services, landmarks, and public spaces.

1.4_First Impression

To begin our research, we went on a walk-through of the area of the city crossed by the M8. This gave us as observers a number of impressions of **how the motorway affects the way the city is navigated and experienced**.

We noticed that where the **fabric of the existing city is cut** through by the M8, the flow of life and movement b etween the centre and the city on the other side of the motorway is **separated**. While urban life continues in varying degrees to the areas beyond the M8, the motorway makes it **difficult for the city to operate as one cohesive unit**.

The presence of the M8 provides an **atmosphere that is uninviting and difficult for pedestrians to navigate**. Rather than cultivating a vibrant street life, it caters to the likes of boxy warehouses, auto malls, and massive storage units. With few crossings and little physical evidence to provide a **sense of continuity** across the gap carved out by the motorway, we observed that the city is effectively split.

With these feelings in mind, our next **goal** was to **view the city in terms of networks**, using our **initial observations as a starting point** for **conceptualizing hypothetical scenarios** that could provide insight into what may or may not work to improve the network of the city.

1.5_Network of Glasgow

_Glasgow City

M8 was constructed with the vision of transforming Glasgow into a service based economy city in the 60s. The motorway has been fucntioning well to served it purpose. M8 is **important to the economic contribution** to Glasgow as it brought in and distributing economic avtivities across the city and also to the urban regions. However, when it comes to the **neighbourhood scale**, the local configuration of the **street networks were not well taken care** of and has caused the city efficiently split into two parts and becoming more apparent over time.

In the network analysis, we focus on the city centre area where M8 is cutting through **to examine the impacts of the motorway** brought to the city locally and globally.

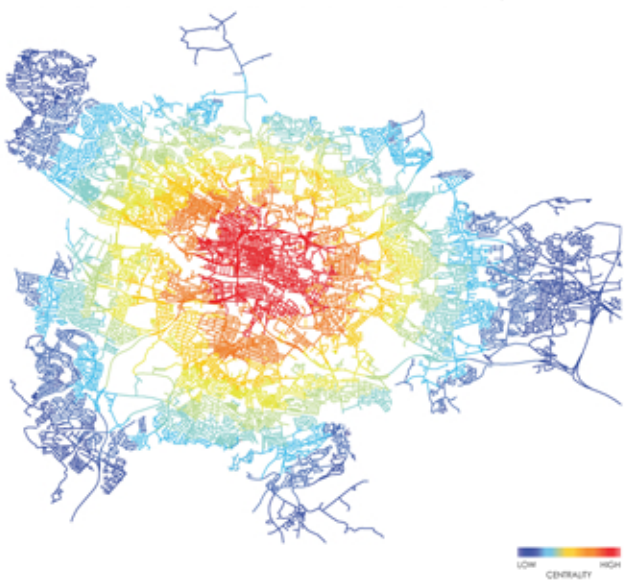
_Betweeness Centrality

The betweenness centrality for the city of Glasgow shows the M8 as a significant factor in the way the network is connected. A ring of high betweenness is visible around the city centre, from which many important paths of betweenness branch out. It also explains which roads will be access by large amount of vehiculars and how people commute within the city.

M8 is apparently having higher betweeness than other main roads as it connects many other nodes within the city centre by mostly connecting nodes to the west of the city centre. It also shows how M8 diverse traffic through the city centre.

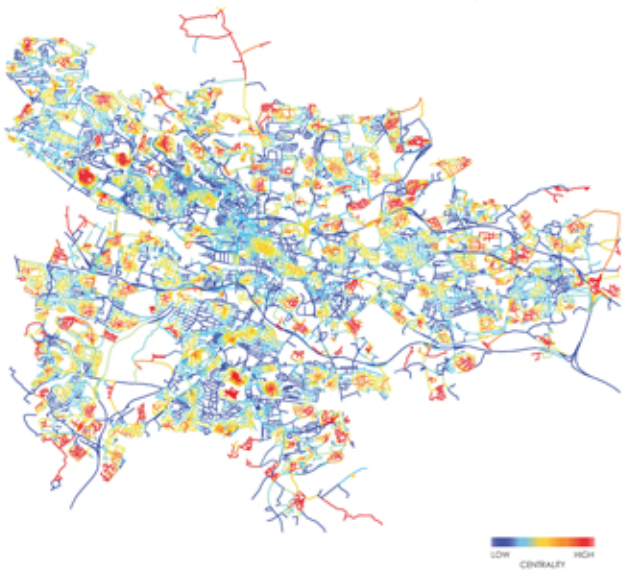
Red lines represent paths that link many nodes with each other, while blue lines represent paths that connect few nodes.

_Global Closeness Centrality



This map demonstrates the centrality of nodes in relation to the centre of the city. Nodes closely connected to the centre are red, while those that require more connections to reach the centre are blue. Paths located closest to the centre are naturally better connected, however the span of the network indicating high centrality indicates how well the network of streets serves the city and points out areas with patterns of nodes that work to either help or hurt the city's connectivity.

_Local Closeness Centrality



Red areas show nodes that are connected to a high number of other nodes locally. In this case those located within 800 meters. Areas with the highest local closeness centrality are located outside the center of the city, indicating that areas of the network connected best on a local level are separated from the city centre. The periphery of central Glasgow is occupied by a wide area of blue, indicating very low local closeness centrality.