**JOSEPH NORKPLIM ATTAH – 3974318**

**MORPHOLOGY OF STREET NETWORKS IN URBAN NEIGHBORHOODS IN GHANA**

**Introduction**

Street networks form the vessels through which the life blood of human settlements (people, services, goods and information) flow. They underlie commutes, discretionary trips and the location decisions of households and firms (Boeing, 2018a). More importantly, they help shape the urban structure and shape the way human interactions happen in space.

Understanding the composition, configuration and decisions underlying the way urban neighborhoods and cities are shaped will help shape future planning decisions and provide an avenue to scrutinize and better evaluate the effects of years of urban transportation planning in our cities in Ghana.

This study seeks to take the computational network and data science approach to examine the structural configuration of street networks in urban neighborhoods in Ghana, concentrating on the two neighborhoods each from the most developed and populated cities in Ghana, Accra and Kumasi which possess fine grained road networks comparable to cities on a global scale based on intersections and street densities (Dumedah & Garsonu, 2021)

**Problem Statement**

Rapid urbanization and its associated pressures on street networks and urban form have been widely studied and reported in Ghana. Coupled with the ad hoc approach to transportation planning that usually involves the expanding of street networks in cities to accommodate the increasing traffic with limited consideration for spatial configurations of street networks (Dumedah & Garsonu, 2021) the problem is becoming harder to ignore.

Even though there exists very little literature studying urban street networks in Ghana, many studies have been emerging all over the world studying topological relations, connectedness, resilience of street networks (Boeing, 2018a, 2018b; Zhao et al., 2019), using empirical methods that are open and reproducible and can be taken advantage of by urban planners, researchers and pedagogy to better understand street networks and how they affect and shape human interactions and settlement decisions in Ghana.

The lack of reproducible and open methods to street network analysis in Ghana makes it harder to understand how transportation and all urban planning in general is carried out. There exists little empirical studies on urban networks making it harder to break into the field especially for interested undergraduate students. Adopting a computational science approach to analyzing and understanding urban networks coupled with open data and tools, students at all levels can now take advantage of the numerous opportunities to produce research that seek to understand form, structure, configuration of urban networks.

**Research Questions**

1. Which source can be used to get replicable and accurate data on street networks in Ghana?
2. Which relevant tools can be used to accumulate data, model and visualize data to be able to tease out the metrics that help understand urban street networks.
3. Which metrics are to be measured and the relevance of the metrics to understanding topology and geometry of street networks in urban neighborhoods.
4. How can we effectively and sustainably operationalize the open and reproducible computational science approach to studying urban street networks and incorporate it into the transportation planning and urban planning to achieve desired results.

**Research Objectives**

1. The aim of this research is to seek out reproducible and open ways to download street network data from OpenStreetMap open data repositories and use free and Open Source tools for analysis.
2. The research aims to take modern computational data science approach by the use of portable computational notebooks to create replicable and verifiable analysis and comparisons of street networks across the study areas. There will also be the use of version control tools to share data.
3. The study aims to employ graph theoretic approach to analyzing street networks using the osmnx and networkx (Boeing, 2017, 2019) toolkits to tease out metrics from data. This tools together help to find the connectedness, compactness and resilience of street networks.
4. This study aims to assess the relevance of the approach to be used in this research in pedagogy, research and practice.

**Methodology**

The study is going to be conducted for several neighborhoods in two urban cities in Ghana, Accra and Kumasi. The density, patterns, topological and geometric differences across these neighborhoods are contrasted with each other and occasionally with others on a global scale.

The data for the study is to be downloaded from OpenStreetMap an open and collaborative project that provides spatial data for almost all places in the world. The credibility of data from this open repository is debatable but it has been used major research works in urban informatics over the years (Boeing, 2017, 2020, 2021; Dumedah & Garsonu, 2021)

The study will make heavy use of GIS tools; QGIS, the programming language Python and the computational notebook Jupyter Lab for downloading, aggregating, analyzing and visualizing spatial data.

**Conclusion**

The world is changing rapidly and technology has opened up new avenues for people in research, pedagogy to understanding our environments and our relations in space. Using these new ways it is possible to simulate future changes before rolling it out into physical space for human interaction. Street networks form the substrate for all human dynamics in space and understanding how they are shape and shape us will help us make the right decisions in our cities and neighborhoods.

The importance of research seeking to understanding street network form and morphology cannot be overstated in public health where walkable and bikeable communities are healthier (Marshall et al., 2014) , in disaster management where understanding street topologies are helping plan for better incident response (Zamanifar & Hartmann, 2021), in transportation planning where better choices will be made as to how to lay down street network understanding how they shape human interactions, in geography and urban studies where it provides more avenues for pedagogy to compare and contrast relevant variables to better understand the relationships that exist between form, shape and human interactions in physical space.

**References**

Boeing, G. (2017). OSMnx: New methods for acquiring, constructing, analyzing, and visualizing complex street networks. *Computers, Environment and Urban Systems*, *65*, 126–139. https://doi.org/10.1016/j.compenvurbsys.2017.05.004

Boeing, G. (2018a). The Morphology and Circuity of Walkable and Drivable Street Networks. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3119939

Boeing, G. (2018b). Urban Spatial Order: Street Network Orientation, Configuration, and Entropy. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3224723

Boeing, G. (2019). Urban street network analysis in a computational notebook. *Region*, *6*(3), 39–51. https://doi.org/10.18335/region.v6i3.278

Boeing, G. (2020). A multi-scale analysis of 27,000 urban street networks: Every US city, town, urbanized area, and Zillow neighborhood. *Environment and Planning B: Urban Analytics and City Science*, *47*(4), 590–608. https://doi.org/10.1177/2399808318784595

Boeing, G. (2021). Spatial information and the legibility of urban form: Big data in urban morphology. *International Journal of Information Management*, *56*. https://doi.org/10.1016/j.ijinfomgt.2019.09.009

Dumedah, G., & Garsonu, E. K. (2021). Characterising the structural pattern of urban road networks in Ghana using geometric and topological measures. *Geo: Geography and Environment*, *8*(1). https://doi.org/10.1002/geo2.95

Marshall, W. E., Piatkowski, D. P., & Garrick, N. W. (2014). Community design, street networks, and public health. *Journal of Transport & Health*, *1*(4), 326–340. https://doi.org/10.1016/J.JTH.2014.06.002

Zamanifar, M., & Hartmann, T. (2021). Decision attributes for disaster recovery planning of transportation networks; A case study. *Transportation Research Part D: Transport and Environment*, *93*, 102771. https://doi.org/10.1016/J.TRD.2021.102771

Zhao, P., Yen, Y., Bailey, E., & Sohail, M. T. (2019). Analysis of urban drivable and walkable street networks of the ASEAN smart cities network. *ISPRS International Journal of Geo-Information*, *8*(10). https://doi.org/10.3390/ijgi8100459