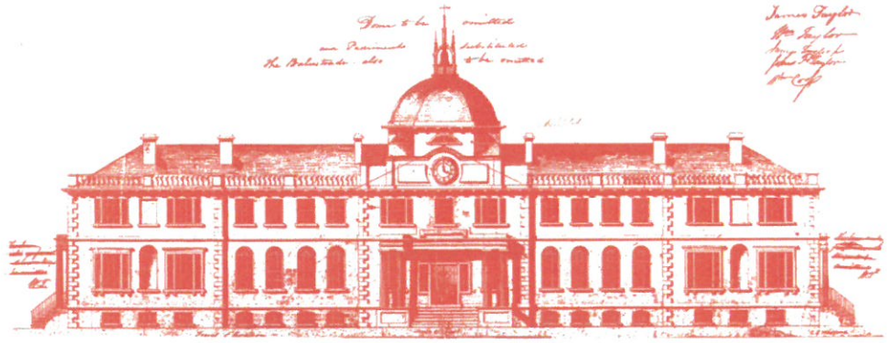
AN EVOLUTIONARY GRAPH FRAMEWORK FOR ANALYZING FAST-EVOLVING NETWORKS

Abstract

Fast-evolving networks by definition are real-world networks that change their structure, becoming denser over time since the number of edges and nodes grows faster, and their properties are also updated frequently. Due to the dynamic nature of these networks, many are too large to deal with and complex to generate new insights into their evolution process. One example includes the Internet of Things, which is expected to generate massive networks of billions of sensor nodes embedded into a smart city infrastructure. This PhD dissertation proposes a Space-Time Varying Graph (STVG) as a conceptual framework for modelling and analyzing fast-evolving networks. The STVG framework aims to model the evolution of a real-world network across varying temporal and spatial resolutions by integrating time-trees, subgraphs and projected graphs. The proposed STVG is developed to explore evolutionary patterns of fast-evolving networks using graph metrics, ad-hoc graph queries and a clustering algorithm. This framework also employs a Whole-graph approach to reduce high storage overhead and computational complexities associated with processing massive real-world networks. Two real-world networks have been used to evaluate the implementation of the STVG framework using a graph database. The overall results demonstrate the application of the STVG framework for capturing operational-level transit performance indicators such as schedule adherence, bus stop activity, and bus route activity ranking. Finally, another application of STVG reveals evolving communities of densely connected traffic accidents over different time resolutions.



Home of the School of Graduate Studies, Sir Howard Douglas Hall was designed by J.E. Woolford in 1825 and is the oldest university building in Canada still in use.

The University of New Brunswick recognizes that the university sits on traditional Wolastoqey territory. The river that runs right by our university – the St. John River – is also known as Wolastoq, along which live the Wolastoqiyik -- the people of the beautiful and bountiful river.

UNIVERSITY OF NEW BRUNSWICK

SCHOOL OF GRADUATE STUDIES

ORAL EXAMINATION

Ikechukwu Derek Maduako

IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

Ph.D. Candidate

Ikechukwu Derek Maduako

Graduate Academic Unit

Geodesy & Geomatics Engineering

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July 3, 2019

10:00 a.m.

Forestry/Geology Bldg.
Room 202

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Examining Board:
Dr. David Coleman, Retired Prof. (Geodesy & Geomatics Eng.)
Dr. Ian Church (Geodesy & Geomatics Eng.)
Dr. Trevor Hanson (Civil Eng.)
Dr. Monica Wachowicz (Geodesy & Geomatics Eng.) Supervisor

External Examiner:
Dr. Christopher Claramunt
Prof. Computer Science & Chair Naval Academy Research Institute
Lanvéoc-Poulmic, Brest Naval, France

The Oral Examination will be chaired by:
Dr. Kevin Englehart, Associate Dean of Graduate Studies

BIOGRAPHY

Universities attended (with dates & degrees obtained):

2015 – present	PhD candidate, University of New Brunswick
2012	MSc in Geospatial Technologies, jointly awarded by University of Muenster Germany; Universitt Jaume I, Spain and New University of Lisbon Portugal
2008	BSc in Geoinformatics and Surveying, University of Nigeria Nsukka

Publications: The following research publications are recorded by the author within the period of the PhD program.

Peer Reviewed Journal Papers:

1. Maduako, I. and Wachowicz, M. (2019). A Space-Time Varying Graph for Modelling Places and Events in a Network. *International Journal of Geographical Information Science.*
2. Maduako, I., Wachowicz, M., and Hanson, T. (2019). Transit Performance Assessment based on Graph Analytics. *Transportmetrica A: Transport Science.*
3. Maduako, I., Wachowicz, M., and Hanson, T. (2019). STVG: An Evolutionary Graph Framework for Analyzing Fast-evolving Networks. Journal of *Big Data.*

Conference Papers and Poster Abstracts:

1. Maduako, I., Cavalheri, E., & Wachowicz, M. (2017). Exploring the use of time-varying graphs for modelling transit networks. In *North American Regional Science Conference*. Vancouver Canada.
2. Maduako, I., Cao, H., Hernandez, L., & Wachowicz, M. (2017). Poster abstract: Combining edge and cloud computing for mobility analytics. In 2017 2nd *ACM/IEEE Symposium on Edge Computing*, SEC 2017. http://doi.org/10.1145/3132211.3132452
3. Cha, S., Ruiz, M. P., Wachowicz, M., Tran, L. H., Cao, H., & Maduako, I. (2016). The role of an IoT platform in the design of real-time recommender systems. In 2016 *IEEE 3rd World Forum on Internet of Things*, WF-IoT 2016. http://doi.org/10.1109/WF-IoT.2016.7845469
4. Maduako, I., Cao, H., & Wachowicz, M. (2016). The Role of Graph Databases in Geomatics. *In Geomatics Atlantic. Fredericton Canada.*
5. Maduako, I., Cao, H., Cavalheri, E., Brideau, R., & Wachowicz, M. (2016). How can graph databases improve transit systems? *In UNB Research Showcase. Fredericton Canada.*

Certifications:

1. *Neo4j Graph Data Analytics Developer*
2. *Session Chair, Advanced Transit Network Modelling, North American Regional Science Conference. Vancouver Canada.*