AIMS | African Institute for Mathematical Sciences SOUTH AFRICA

6 Melrose Road, Muizenberg
Cape Town 7945, South Africa
Tel: +27 (0)21 787 9320 Fax: +27 (0)21 7879321
Email: info@aims.ac.za Web: www.aims.ac.za

Postgraduate Report Form

Name of student: Alice Nanyanzi **Student number:** 20350201

Degree: Research masters in Mathematics **Full time / Part Time:** **Full time**

Supervisor: Dr. Franck Kalala Mutombo/ Dr. Simukai Utete

Co-supervisor:

Title of research project: **Dynamic processes on complex networks and applications**

Year of registration: 2017 **Expected submission date:** December , 2018

To be completed by the student

Research aims and plan for the past six months:

- Complete the implementation and documentation of accounting for long range interactions in diffusion over networks.

- Implement long range interactions in the random walker algorithm for image segmentation and ascertain whether a better image segmentation can be obtained by this method.

- Identify a centrality measure that can be used to identify the most important financial institution (too interconnected to fail) in a financial network. Possible idea is to introduce a new centrality measure based on the generalized degree (which accounts for long range interactions) and then apply it to the ranking of financial institutions based on this centrality measure.

- Extending the concept of Laplacian centrality of a node to Laplacian centrality of an edge. Ascertain whether the edge Laplacian centrality can aid in the partitioning of networks.

Progress over the last six months:

- Completed the implementation and documentation of long-range interactions in diffusion over networks which involved a simulation of heat diffusion over a lattice. Results were compared for direct interactions only as well as the inclusion of long-range interactions. It was observed that the accounting for long range interactions accelerated the rate of diffusion over the network.

- Possible extension of the concept of k-path Laplacian matrices to weighted networks, computed the number of k-hopped connected components. Work in progress.

- Implemented the random walker algorithm for image segmentation that involved long-range interactions. However, the analysis of results is underway to ascertain the impact of this method over the existing random walker based image segmentation methods.

- Additional Activities:

- Attended the Berlin Mathematical School summer school "Probabilistic and Statistical methods for networks" from 21 August – 03 September in Berlin, Germany. I gave a talk entitled " The Laplacian matrix of a network and Applications". I received constructive feedback for my current work. I was also able to interact with participants working in different fields of network theory, thus sharing knowledge, insights, and experiences in research.

- Participated in the Deep Learning Indaba, 10-15 September held at the University of the Witwatersrand. During the Indaba, I had the opportunity to understand the basics of machine learning, the applications, algorithms used as well as network with other participants, lecturers and sponsors.

- I was a trainer in the Africa code week held at the African Institute for Mathematical Sciences where we imparted coding skills to students from different schools from the western cape.

Reasons for unsatisfactory progress:

.....

.....

.....

Research aims and plan for the next six months:

- Studying robustness of a network on both random and targeted edge removal. In targeted edge removal, we consider the removal of edges in order of their Laplacian centrality rankings.

- Complete the analysis of results of long-range interactions in the random walker algorithm for image segmentation.

- Develop an algorithm for approximating the generalized degree for larger networks.

- Accounting for the effect of noise on consensus in networks. First, accounting for only direct interactions among agents. Second, account for both direct and long-range interactions among agents in reaching consensus.

- Impact of long range interactions on communicability in networks.

To be completed by the supervisor

Progress: Exceptional / Very good / Good / Satisfactory / Unsatisfactory

Comments by the supervisor:

Will the degree be completed in the time frame as originally planned? If not, furnish reasons:

Yes.

Signature of Student: [signature] **Date:** 01/12/17

Signature of Supervisor: [signature] **Date:** 01/12/17

3/