UNIVERSITY OF TECHNOLOGY SYDNEY
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Local Information and Structures in Analysis and Modelling of Complex Networks

by

Mingshan Jia

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Certificate of Authorship/Originality

I, Mingshan Jia, declare that this thesis, is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Faculty of Engineering and Information Technology at the University of Technology Sydney.

This thesis is wholly my work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

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Mingshan Jia

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ABSTRACT

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Abstracting entities and their interactions as nodes and links, networks are a general representation for modelling and studying complex systems. Modelling relational structures of the underlying data, rather than only a set of isolated entities, allows us to build more accurate models for various types of domain data, such as social relationships, molecular interactions, program executions, and many more. Despite being powerful and ubiquitous, networks are also difficult to process, mainly due to their complex topological structures. Therefore, the study of network structure, especially local structure, has been the core theme of studying complex networks. This dissertation aims to provide new understandings of how local structure information is extracted and utilised in studying different types of complex networks.

The dissertation includes three original works in the direction of local structure and information on top of a comprehensive survey. In the review, we propose new taxonomies for graph structures that bring together the notions of centrality measures, motifs, and other local-level metrics. For theoretical understanding, we propose new metrics to quantify the formation of 3-node and 4-node subgraphs and develop new motif patterns that are distinctive features in both network- and node-level analysis. For methodological approaches, we propose the framework to effectively encode edge attributes into the typed-edge graphlet degree vector, for both sociocentric and egocentric networks. Moreover, for practical applications, the proposed metrics and approaches are applied in many different types of complex net-

works and case studies. They are not only proven to be effective in multiple learning and analytical tasks but also lead to new insights and interesting discoveries.

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School of Computer Science, Data Science Institute, Complex Adaptive Systems Lab, UTS

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List of Publications

Journal Papers

J-1. **M. Jia**, B. Gabrys and K. Musial, ”Directed closure coefficient and its patterns,” in Plos one 16.6 (2021): e0253822.

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Conference Papers

C-1. **M. Jia**, B. Gabrys and K. Musial, ”Closure Coefficient in Complex Directed Networks.” International Conference on Complex Networks and Their Applications. Springer, Cham, 2020.

C-2. **M. Jia**, M. Van Alboom, L. Goubert, P. Bracke, B. Gabrys, K. Musial. ”Analysing Ego-Networks via Typed-Edge Graphlets: A Case Study of Chronic Pain Patients.” International Conference on Complex Networks and Their Applications. Springer, Cham, 2021.

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