Network and Agent-based Modeling for Complex System Studies

Leonard Petnga

University of Alabama in Huntsville

Follow this and additional works at: https://louis.uah.edu/rceu-proposals

Recommended Citation
https://louis.uah.edu/rceu-proposals/158

This Proposal is brought to you for free and open access by the Faculty Scholarship at LOUIS. It has been accepted for inclusion in RCEU Project Proposals by an authorized administrator of LOUIS.
Network and Agent-based Modeling for Complex Systems Studies
A Proposal for the Research or Creative Experience for Undergraduates (RCEU) Program
Summer 2019

Project Identifier: RCEU19-ISEEM-LP-02

Faculty Research Mentor: Leonard Petnga, Assistant Professor, Department of Industrial &
Systems Engineering and Engineering Management, Technology Hall N149. Phone: 6637
E-mail: leonard.petnga@uah.edu.

Project Description: Complex systems such as System of Systems (SoS) leverage capabilities
of existing and yet to be designed systems (as well as humans) to address the needs of
increasingly complex and evolving missions in uncertain environments. Model based systems
engineering (MBSE) has emerged as a valuable approach to manage the intrinsic complexity
in the design of such systems. However, state-of-the-art theoretical foundations do not provide
mechanisms nor path to directly leverage provided formalisms for effective engineering
modeling and analysis of such systems across a wide range of SoS domains. The overall goal
of this research project is to explore the use and integration of network and agent-based
modeling support to MBSE of complex systems such as SoS.

Unlike traditional modeling approaches, both network and agent-based modeling have shown
promising results in modeling large scale, and systems with complex dynamics in Biology and
social science. These capabilities and others make them of great interest for MBSE
applications of SoS. The research will leverage both the ability of (computational) agent-
based models to describe algorithmic behavior of numerous individual & independent agents,
combined with network models to capture and represent dynamics “on” and “of” network in
order to investigate adaptive behaviors in selected SoS.

Through this project, the student will gain hands-on experience in MBSE, system modeling,
software programing and development. He/she will get the opportunity to learn about
conceptual system modeling, network and agent-based modeling techniques and design of
complex systems. In turn, his/her work will greatly contribute to future research in MBSE of
complex systems.

Student duties, Contributions, and Outcomes

The student selected for this project will be responsible of the following:

1. Modeling: The student will create, evaluate and analyze network and agent-based
models of select engineering SoS of different types. The models will be used to evaluate above research ideas and see how well they help address identified MBSE challenges. An integration of both model types will be attempted and lessons learned from the effort will be documented.

2. **Programming:** The student will be responsible for developing and simulating software programs (in Python) implementing agent-based and network models of select SoS. Samples and examples of such models will be provided as starting point.

3. **Project plan:** the student will develop and submit a plan of work with reviews and milestones. The plan baseline will be used to evaluate his/her progress and performance.

4. **Manuscript Preparation:** Dr. Petnga encourages all undergraduate student researchers to write up their results in the form of a manuscript for publication. The RCEU participant will prepare the manuscript(s), which may include data from other sources.

**Faculty Requirement and Mentorship**

There are no systems engineering coursework or academic standing prerequisites. However, junior or senior level standing in the college of engineering or science is REQUIRED. This project involves writing programs for network and agent-based modeling. Thus, intermediary to advanced knowledge of Python is REQUIRED. Alternatively, advanced knowledge of Java coupled with beginner knowledge of Python will be considered. A good working ethic and a high motivation toward research are also expected from the qualified candidate.

The prospective RCEU student will receive close mentoring from Dr. Petnga. The student will meet and report to Dr. Petnga on a weekly basis (minimum) and is encouraged to seek advice whenever a problem is encountered. The performance of the student will be evaluated based on his working progress as well as the quality of the work. New student researchers are encouraged to engage their peer in Dr Petnga’s research group to exchange ideas, discuss issues and seek advices. Multiple venues and avenues will be offered to the student to that end including, weekly research meeting, presentation of research to the team, online group discussion and forums. An online and physical library containing hundreds of books, articles, magazines, software code and tutorials will be available to the student researcher to support his work.