Using canalization for the control of discrete networks

David Murrugarra[1,*]

[1] *Department of Mathematics, University of Kentucky, Lexington, KY 40506*

murrugarra@uky.edu

Many problems in biomedicine and other areas of the life sciences can be characterized as control problems, with the goal of finding strategies to change a disease or otherwise undesirable state of a biological system into another, more desirable, state through an intervention, such as a drug or other therapeutic treatment. The identification of such strategies is typically based on a mathematical model of the process to be altered through targeted control inputs. Multistate models, a generalization of the Boolean network framework, where the genes can attain more than two states have been proposed as appropriate models for capturing complex gene expression patterns, such as consideration of three states (low, medium, and high). This talk presents methods for the analysis and control of multistate networks. The results presented in this talk will use the algebraic representation of discrete functions as polynomials over a finite field. The first result to be discussed will be a stratification of the variables of multistate functions into layers of canalization. Canalization in the multistate setting provides a hierarchical structure of the inputs of a discrete function and has been studied in the context of network modeling where each layer of canalization adds a degree of stability to the dynamics of the network. One of our results will provide a partition of the inputs of any discrete function into canalizing and non-canalizing variables and within the canalizing ones, we can categorize the input variables into layers of canalization. Another result to be discussed will be a formula for counting the maximum number of transitions that will change in the state space upon an edge deletion in the wiring diagram. This formula relies on the stratification of the inputs of the target function where the number of changed transitions depends on the layer of canalization where the input to be deleted is located.