Constructing Biological Networks Using Fuzzy Models: A Case Study of the *Lac Operon Network*

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In this paper Petri net models are used as a formal framework for the specification and simulation of biological networks. Current approaches in modeling dynamic biological systems often lack comprehensibility, especially for users without mathematical background. In this paper, I propose a new approach to overcome such limitations by combining the graphical representation provided by the use of Petri nets with the modeling of dynamics by powerful yet intuitive fuzzy logic based systems. I construct a fuzzy reasoning Petri net model for the genetic regulatory network of the lac operon. The fuzzy Petri net formalism is a good alternative to differential equation models that require kinetic parameter values and superior to Boolean Formalism which automatically sets regulation as "on" or "off" rules. The *lac operon Escherichia coli* have been considered as a model system for understanding the molecular biology of gene expression and its regulation. I validate my formal model by automatic checking a series of properties that are known for the regulation of the lactose. Thus, I show the viability of using fuzzy reasoning Petri net to model and reason about biochemical networks.