
Hao Ying¹, Feng Lin¹ and Rodger D. MacArthur²
¹. Department of Electrical and Computer Engineering, Wayne State University
². Department of Medicine, Wayne State University

Abstract

A theory of fuzzy discrete event systems (DES) was recently originated to effectively represent deterministic uncertainties and vagueness as well as human subjective observation and judgment encountered in many real-world problems, especially those in medicine. Fuzzy states and fuzzy event transition and generalized conventional crisp DES were introduced to fuzzy DES. The largely graph-based framework of the crisp DES was unsuitable for the expansion and it was thus reformulated using state vectors and event transition matrices which could be extended to fuzzy vectors and matrices by allowing their elements to take values in [0, 1]. Optimal control of DES was extended to fuzzy DES. The new fuzzy DES theory is consistent with the existing theory, both at conceptual and computation levels, in that the former contains the latter as a special case when the membership grades are either 0 or 1. The FDES theory was further developed so that it possessed self-learning capability.

The fuzzy DES theory has been applied to develop an innovative software system for medical treatment, specifically for the first round of highly active antiretroviral therapy of HIV/AIDS patients. The objective is to build such a system whose treatment regimen choice for any given patient will match expert AIDS physician’s selection to produce the (anticipated) optimal treatment outcome. Preliminary retrospective evaluation of our prototype system using patients treated in the AIDS Clinical Center of Wayne State University demonstrates encouraging results when the system operated in either self-learning mode or non-learning mode. The approach has the capabilities of generalizing, learning, representing knowledge even in the face of weak consensus of domain experts, and being readily upgradeable to new medical knowledge. Future directions include investigating the role various epidemiologic, immunologic, and pro-inflammatory biochemical factors (i.e., biomarkers) play in facilitating or hindering full immunologic reconstitution in persons infected with HIV who have initiated antiretroviral therapy.

This research was supported in part by the National Institutes of Health under grant R21 EB001529-01A1, and by Wayne State University under a Research Enhancement Program grant.