

A Working Hypothesis on the Semantics/Accuracy Synergy

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Abstract

The main objective of this work is to assess the impact of the initial conditions regarding interpretability and accuracy on the optimizer's performance and present some guidelines in order to assist the designer. Automatic infusion of anesthesia is a task where both interpretability and accuracy of the controller are highly desirable features. Under this pretext, a description on how these goals can be measured is made and a set of evolutionary optimization schemes is set up. The results show that independently of the optimization process used, the introduction of a semantically valid individual in the initial population is a factor of success in the evolutionary optimization process.

Keywords: interpretability, accuracy, optimization, semantic integrity, fuzzy control

1 Introduction

In many domains of application the inherent expressive power of the fuzzy systems is a clear advantage that the designer can't afford to lose. This feature combined with the universal approximation property of such systems (subject to the assumption of an unbounded number of rules) makes them well suited for a wide range of applications in modelling, classification and control.

A paradigmatic application from the bio-medical field is the automatic infusion of anesthesia, more precisely the automatic neuromuscular blockade control of patients under surgery. For this kind of application the expressiveness or interpretability

of the deployed system plays a key role, in what concerns overcoming the reluctance of the anaesthetist to perform his task in a different manner, by delivering a control system which actions could be easily understood and validated.

Nevertheless, given the critical field of application, the accuracy of this controller has to be pursued by all possible means. Given a set of linguistic terms and a rule base provided by the anaesthetist which impose restrictions on the number of rules it's necessary to fine tuning the linguistic terms in order to attain maximum performance.

Immediately two questions arise: *(i)* To what extent can this optimization be performed without a heavy loss of interpretability? and *(ii)* Which are the ideal initial conditions of the optimization process in order to boost-up the accuracy of the optimized controller?

In respect to the former question, faced with the lack of theoretical results on the existence or absence of a trade-off between accuracy and semantics in fuzzy modelling and control, the authors started a few years ago, an empirical study on the subject. Some previous results were progressively presented elsewhere [?, ?, ?]. Moreover in the last decade many works have been reported on the preservation of semantics during fuzzy system optimization and on the relationship between accuracy and semantics of these systems, including a comprehensive compilation of some of these results on two edited volumes [?, ?].