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Evolving Fuzzy Models and Applications

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KEYNOTE SPEECH

***Abstract*—As shown in the classical papers on evolving fuzzy systems (EFSs), evolving Takagi-Sugeno or Takagi-Sugeno-Kang fuzzy models are characterized by continuous online rule base learning. These fuzzy models are developed in terms of the application of online identification algorithms. The online identification algorithms continuously evolve the parameters of the fuzzy models, which are built online by adding new or removing old local models. This process is referred to as the adding mechanism.**

According to the recent classification of online identification algorithms (Dovžan, Logar and Škrjanc, 2015), three categories of online identification algorithms are considered in EFSs, namely (1), (2) and (3): (1) adaptive algorithms – they start with the initial Takagi-Sugeno-Kang fuzzy model structure given by other algorithms or by user experience, the number of space partitions/clusters does not change over time, and these algorithms adapt just the parameters of the membership functions and the local models; (2) incremental algorithms – they implement only adding mechanisms; (3) evolving algorithms – these algorithm implement, besides the adding mechanism, also the removing and a part of them the merging and the splitting mechanisms. These specific features ensure a large area of applications.

This speech highlights a part of the results obtained by the Process Control Group of the Politehnica University of Timisoara, Romania. The presentation is focused on representative applications, implemented in our labs, with real-validated by experimental results. The results pointed out here include different lab equipment as pendulum-crane systems, twin rotor aerodynamic systems, magnetic levitation systems, anti-lock braking systems, and shape memory alloy systems.

The scope of the development of these models is the model-based and data-driven model-free design and tuning of fuzzy controllers by the Process Control Group.

Keywords—applications, evolving fuzzy models, lab equipment, Takagi-Sugeno-Kang fuzzy models

SHORT BIO

Radu-Emil Precup (M'03–SM'07) received the Dipl.Ing. (with honors) degree in automation and computers from the "Traian Vuia" Polytechnic Institute of Timisoara, Timisoara, Romania, the Dipl. degree in mathematics from the West University of Timisoara, Timisoara, and the Ph.D. degree in automatic systems from the Politehnica University of Timisoara (UPT), Timisoara, Romania, in 1987, 1993, and 1996, respectively.

He is currently with UPT, Timisoara, Romania, where he became a Professor with the Department of Automation and Applied Informatics in 2000. He is also an Adjunct Professor within the School of Engineering, Edith Cowan University, Joondalup, WA, Australia, and an Honorary Professor with the Óbuda University, Budapest, Hungary. He is the author or coauthor of more than 300 papers. His current research interests include intelligent control systems and data-driven control.

Prof. Precup is a corresponding member of The Romanian Academy, a member of several Technical Committees (TCs) including IEEE ones, the IFAC TC on Computational Intelligence in Control and the TC12 on Artificial Intelligence of IFIP. He was the recipient of the Elsevier Scopus Award for Excellence in Global Contribution (2017), the "Grigore Moisil" Prize from the Romanian Academy, two times, in 2005 and 2016, for his contribution on fuzzy control and the optimization of fuzzy systems, the "Tudor Tănăsescu" Prize from the Romanian Academy in 2020 for his contribution on data-driven controller tuning techniques, and several best paper awards (2004–2021).

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