University of Coimbra

Doctoral Program in Information Science and Technology

Real Time Learning in Intelligent Systems

Assignment #4 - Process Modelling with Neuro-Fuzzy Systems

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1 Introduction

Dynamic systems are often described and modelled by different equations, where the outputs in a given time instant (say k) are conditioned by previous outputs (in instants $k-1$, $k-2$, ...) and inputs (in instants k, $k-1$, $k-2$, ...). A system is also said to have *inertia* when the inputs in a given instant only affect its outputs in posterior instants (that is, input at instant k can only influence the output at instants $k+1$, $k+2$, ...).

The current assignment proposes the development of a Sugeno-type Neuro-Fuzzy System (NFS) to model the dynamics of a given process or system with inertia. NFSs of this nature are characterised by mapping their input space to an output space using a series of fuzzy *if-then* rules. In the particular case of Sugeno NFSs the output of each rule is written as a linear combination of the input variables. In simpler Sugeno systems, this linear combination consists in a constant value.

By collecting data containing pairs of the system's input and corresponding output values the rules that define the NFS can be learned in such a way that they describe the system's behaviour.

In other words, exploring collected data from the system the mentioned fuzzy rules can be learned, resulting in the development of a Sugeno NFS that models the dynamics of the desired process or system, as it is the objective of this assignment.

The remainder of this document is organised as follows: Section 2 presents the system to be modelled in this work; Section 3 describes the methodology followed throughout the project; Sections 4 and 5 cover the main steps of the work, presented in the Methodology section. Finally, Section 6 concludes the document.

2 Modelled System

Dizer que o sistema é de 3ª ordem (3 pólos)e uma vez que tem mais pólos (3) do que zeros (0) é um sistema com inércia.

O sistema a ser considerado neste trabalho é descrito pela seguinte função de transferência:

$$G(s) = \frac{2}{s^3 + 5s^2 + 6.75s + 2.25}$$

Pode-se demonstrar que este sistema tem memória na saída e na entrada até ao instante 3, ou seja:

$$y(k) = f(y(k-1), y(k-2), y(k-3), u(k-1), u(k-2), u(k-3))$$

onde $y(k)$ representa a saída do sistema no instante k e $u(k)$ a entrada do sistema no instante k.

3 Methodology

Apresentar resumidamente as diferentes etapas que compõem este trabalho: as duas fases e detalhar cada uma delas.

4 Fase A

Melhorar título e detalhar o que se fez

Não esquecer das funções de pertença!!

5 Fase B

Melhorar título e detalhar a segunda fase

6 Conclusion