COM2536 – Ders 4

Fuzzy Rules, Fuzzy Reasoning, Fuzzy Logic Controllers, Fuzzy Inference

Dr. Metehan GÜZEL
Expert

Metehan GÜZEL, Ph.D. , e-mail: metehanguzel@kafkas.edu.tr, web: https://metehanguzel.github.io

Fuzzy Inference and Control

* Fuzzy Inference Engine
* Fuzzy Controller
* Fuzzy Rules

Let’s think of an example ^_^

Metehan GÜZEL, Ph.D. , e-mail: metehanguzel@kafkas.edu.tr, web: https://metehanguzel.github.io

Fuzzy Inference Systems

Metehan GÜZEL, Ph.D. , e-mail: metehanguzel@kafkas.edu.tr, web: https://metehanguzel.github.io

Fuzzy Rules

Fuzzy rules imitate human thought process and causality.

* IF A THEN B
    * A -> Antecedent (öncül)
    * B -> Consequent (sonuç)

Antecedent may contain multiple terms, such as

* **IF a** is **X AND b** is **Y THEN c** is **Z**
* **IF a** is **X OR b** is **Y THEN c** is **Z**

Metehan GÜZEL, Ph.D. , e-mail: metehanguzel@kafkas.edu.tr, web: https://metehanguzel.github.io

Fuzzy Inference Systems

Basically 4 steps

* Fuzzification (Bulandırım)
* Rule Evaluation (Kural Geçerlemesi)
* Output Aggregation (Çıktı Birleştirimi)
* DeFuzzification (Berraklaştırma)

Metehan GÜZEL, Ph.D. , e-mail: metehanguzel@kafkas.edu.tr, web: https://metehanguzel.github.io

Mamdani method

RULE : **IF a** is **X AND b** is **Y THEN c** is **Z**

* High Interpretability

* Low Accuracy

An Experiment in Linguistic Synthesis with a Fuzzy Logic Controller

E. H. MAMDANI AND S. ASSILIAN
Queen Mary College, London University, U.K.

(*Received 2 November 1973*)

This paper describes an experiment on the "linguistic" synthesis of a controller for a model industrial plant (a steam engine). Fuzzy logic is used to convert heuristic control rules stated by a human operator into an automatic control strategy. The experiment was initiated to investigate the possibility of human interaction with a learning controller. However, the control strategy set up linguistically proved to be far better than expected in its own right, and the basic experiment of linguistic control synthesis in a non-learning controller is reported here.

Metehan GÜZEL, Ph.D. , e-mail: metehanguzel@kafkas.edu.tr web: http://metehanguzel.github.io

Sugeno method

RULE : IF a is X AND b is Y THEN c is f(x,y)

$f(x,y) = \alpha a + \beta b + \gamma$

* Low Interpretability

* High Accuracy

Fuzzy Identification of Systems and Its Applications to Modeling and Control

TOMOHIRO TAKAGI AND MICHIO SUGENO

Abstract—A mathematical tool to build a fuzzy model of a system where fuzzy implications and reasoning are used is presented in this paper. The premise of an implication is the description of fuzzy subspace of inputs and its consequence is a linear input–output relation. The method of identification of a system using its input–output data is then shown. Two applications of the method to industrial processes are also discussed: a water cleaning process and a converter in a steel-making process.

reasoning is given by the aggregation of the values inferred by some implications that were applied to an input.

This paper also shows the method of identification of a system using its input–output data. As is well-known, identification is divided into two parts: structure identification and parameter identification.

Metehan GÜZEL, Ph.D. , e-mail: metehanguzel@kafkas.edu.tr, web: https://metehanguzel.github.io

Next Lecture

Can we eliminate domain experts?

Metehan GÜZEL, Ph.D. , e-mail: metehanguzel@kafkas.edu.tr, web: https://metehanguzel.github.io

Suggested Reading

IEEE TRANSACTIONS ON SYSTEMS, MAN, AND CYBERNETICS, VOL. 23, NO. 3, MAY/JUNE 1993

ANFIS: Adaptive-Network-Based Fuzzy Inference System

Jyh-Shing Roger Jang

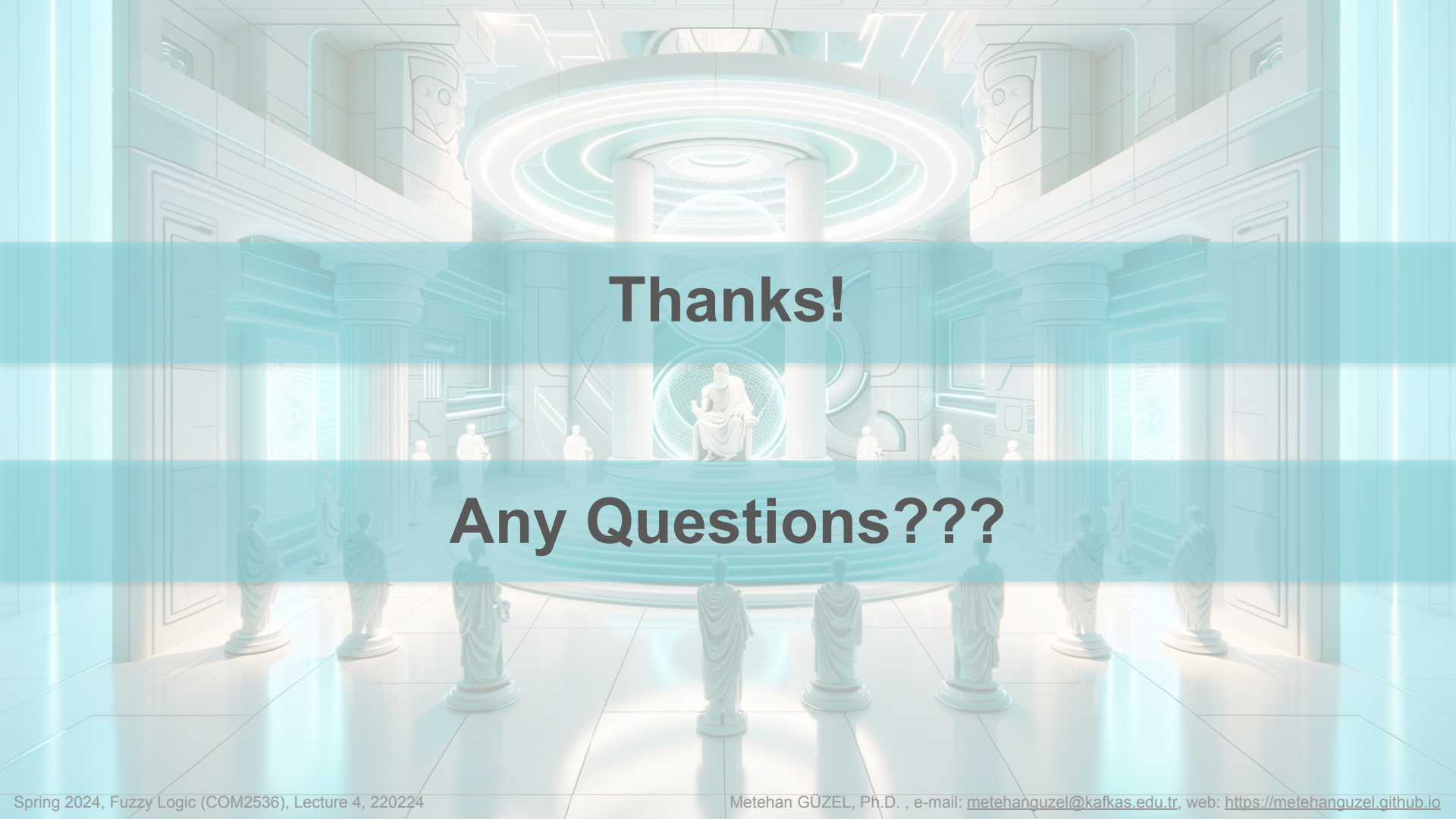
***Abstract*—The architecture and learning procedure underlying ANFIS (adaptive-network-based fuzzy inference system) is presented, which is a fuzzy inference system implemented in the framework of adaptive networks. By using a hybrid learning procedure, the proposed ANFIS can construct an input–output mapping based on both human knowledge (in the form of fuzzy if–then rules) and stipulated input–output data pairs. In the simulation, the ANFIS architecture is employed to model nonlinear functions, identify nonlinear components on-linely in a control system, and predict a chaotic time series, all yielding remarkable results. Comparisons with artificial neural networks and earlier work on fuzzy modeling are listed and discussed. Other extensions of the proposed ANFIS and promising applications to automatic control and signal processing are also suggested.**

adaptive networks, we obtain the ANFIS architecture which is the backbone of this paper and it is covered in Section IV. Application examples such as nonlinear function modeling and chaotic time series prediction are given in Section V. Section VI concludes this paper by giving important extensions and future directions of this work.

II. Fuzzy If-Then Rules and Fuzzy Inference Systems

A. Fuzzy If–Then Rules

Fuzzy if-then rules or *fuzzy conditional statements* are ex-



Metehan GÜZEL, Ph.D. , e-mail: metehanguzel@kafkas.edu.tr, web: https://metehanguzel.github.io