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ANFIS Report

Intelligent and Adaptive Systems

MSc in Robotics

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1 Introduction

For the application of the fuzzy inference system the Takagi-Sugeno system is widely used for ANFIS models, and is indeed the implementation used within the MATLAB functions *anfis* and *genfis*.

Due to some weakness in the backpropagation algorithm, the learning algorithm used for the adaptive network is a hybrid learning algorithm.

[1]

2 Tasks

2.1 ANFIS Implentation for 3D Planar Arm

2.1.1 Method

The first step was to generate the data from which the ANFIS networks could be trained. This was done using the forward kinematics equations for a planar three revolute joint manipulator that can be seen in equations 1a and 1b below.

$$x_p = l_1 \cos\theta_1 + l_2 \cos(\theta_1 + \theta_2) + l_3 \cos(\theta_1 + \theta_2 + \theta_3) \tag{1a}$$

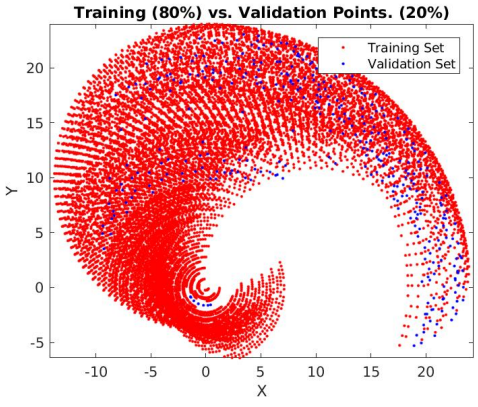
$$y_p = l_1 \sin\theta_1 + l_2 \sin(\theta_1 + \theta_2) + l_3 \sin(\theta_1 + \theta_2 + \theta_3) \tag{1b}$$

Where θ_n is the angle of joint n and l_n the length of link n. The range of θ was suitably defined and then turned into a discrete data set by sampling at different intervals. The equation for the total angle of the robot, which can also be considered as the orientation of the manipulator with respect to the end-effector position (x_p, y_p) is shown below in equation 2.

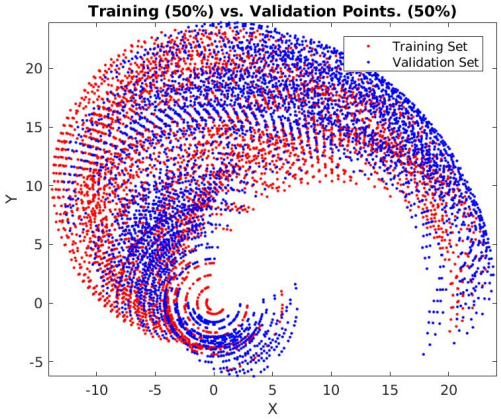
$$\phi = \theta_1 + \theta_2 + \theta_3 \tag{2}$$

After the data was generated it was compiled into a array that could be passed to MATLAB functions for training. For the training of the networks, I chose to train one for each arm. In the data, the end-effector position, the total angle ϕ and the angle for which the network was to be trained θ_n were passed into the MATLAB *genfis* function to generate the initial fuzzy inference system. This data was also broken up into two sets, one for validation and one for training. This was done in a pseudo-random way by randomising the order of the θ angles after the generation of the discrete angle array. The data was then broken down according to a certain split, initially a 80:20 split was chosen (training:validation).

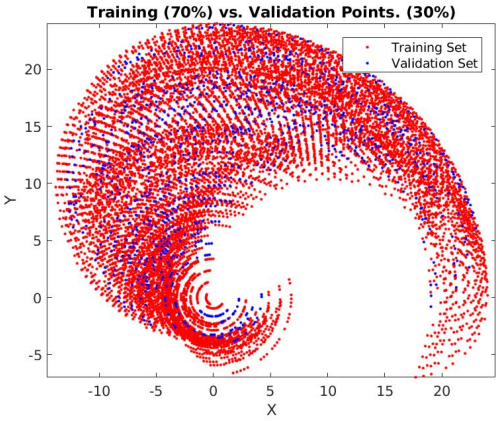
2.1.2 Results and Discussion



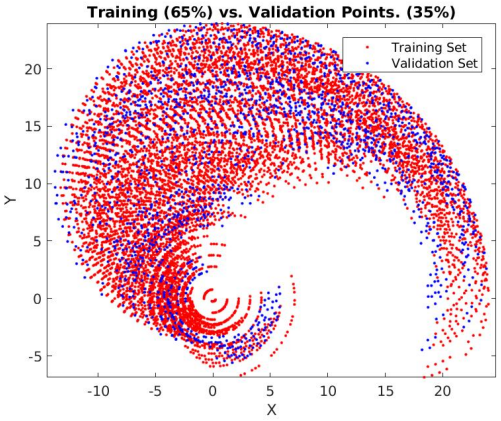
(a) 80:20 split.



(b) 50:50 split.



(c) 70:30 split.



(d) 65:35 split.

Figure 1: Workspace plots for different training and validation dataset splits.

2.2 ANFIS vs. Neural Network

2.2.1 Method

2.2.2 Results and Discussion

2.3 Singularity Considerations

2.3.1 Method

2.3.2 Results and Discussion

2.4 Search Algorithm for Parameters

2.4.1 Method

2.4.2 Results and Discussion

Appendix

References

[1] Jyh Shing Roger Jang. ANFIS: Adaptive-Network-Based Fuzzy Inference System. *IEEE Transactions on Systems, Man and Cybernetics*, 23(3):665–685, 1993.