Matlab Assignment for Knowledge-Based Control Systems (SC4081)

Frequently Asked Questions

1 Questions on Problem 1

1.1 What are the functions expected from us in this problem?

The first function expected is one that takes in the value x and, based on the given antecedents A and consequents C, gives the output y. Thus it can be a function of the form $y = g(x)$ or $y = g(x; A, C)$.

The second function expected is one that takes in the values of inputs x and outputs y (generated using $y = f(x)$, f being a function of your choice), and based on the antecedents, estimates the consequents.

For the second function, singleton consequent estimation is sufficient. If affine consequents are estimated, this will be reflected positively in the grade.

1.2 What antecedents do I use for this problem?

You can try out various kinds of antecedents for solving this problem. You could also use any techniques you like for formulating the antecedents, including clustering algorithms.

1.3 For estimation of the singleton model, should we optimise the parameters locally or over the entire range of x?

Since the fuzzy approximation of the nonlinear model is to be valid over the entire range of x, the parameters should be optimised accordingly.

1.4 The dimensions in my estimation equation don't match. Am I doing something wrong?

Please take into account that $X_e = 1$ means that X_e is a column vector with all elements equal to 1. It is not an identity matrix.

1.5 Are we allowed to use the function trapmf() of the Fuzzy Toolbox?

No, you are not allowed to use toolboxes for this problem. However, you can use the Matlab documentation if you need help in writing your own functions.

2 Questions on Problem 2

2.1 Should we use only the error signal as input to our fuzzy supervisory controller?

No, you may use any other signal (for instance reference, control input) as input to your fuzzy supervisor. In fact, for some models it may not even be possible to achieve the control requirements using one single input to the fuzzy supervisor.

2.2 Is there a scientific way to tune my supervisory controller, or is it all trial and error?

In principle, you can linearise your plant at different operating points and use the Bode (or Nyquist or root locus) to tune the PID controller for that operating point, which can then be embedded in the supervisory controller. However, since your plant is inherently nonlinear, this approach will not give an optimal solution, and some degree of tuning is required for a good supervisory controller.

2.3 What amount of overshoot and/or settling time is allowed?

This is the choice of the control designer. Please choose your time domain specifications explicitly, and include a reference to a standard control textbook where you obtained these specifications from.

2.4 We have used fuzzy clustering to design the supervisory controller, but the number of clusters makes supervisory control design very complex. What can we do?

Fuzzy clustering can give you an idea of the general design of your controller. However, since there is no unique solution for a PID controller that satisfies your requirements, an exact solution cannot be achieved. If you use fuzzy clustering, you need to visually approximate the results to simplify supervisory control design.

2.5 Is it sufficient to meet the requirements only for the reference signal given to us, or should we design the supervisor that can handle any random reference sequence?

It is sufficient that your supervisory controller is able to satisfy your control requirements for the given reference signal. However, if you are in fact able to synthesise a supervisory controller that shows good performance for any arbitrary reference signal, and you are able to demonstrate this in your assignment document, this will reflect positively in your Matlab assignment grade.

2.6 Can we use the fuzzy inference block given in the example?

Yes, for this problem, you can use the fuzzy inference block given in the example or any other Simulink block available in the standard (or non-standard) blocksets. You can also use any Matlab toolbox to solve this question.

2.7 Can I use a PI/PID/PD controller?

You can use any controller you like, the focus of this question is on the eventual fuzzy supervisory controller.

2.8 How do I change the P, I or D parameters at runtime?

You can simply delete the PID block and make your own P, I and D blocks, multiplying their individual outputs with the corresponding outputs of your supervisory controller.

3 Questions on Problem 3

3.1 Matlab divides my dataset into two and uses one part for training and another for validation. However, we already have two datasets: one for training and one for validation. Should we combine it into one dataset?

No. The neural network that you are supposed to develop should be trained using only 'iddata'. While training the neural network, Matlab will divide this set into two and use a part of the data to validate the neural network and ensure that it does not overfit the data. You are then expected to confirm this by using the other dataset, 'valdata' to see whether the neural network training was indeed able to avoid overfitting.

3.2 Where can we find the simulation RMS error?

This can be directly calculated if you know the true output and the output predicted by the neural network.

3.3 The RMS error changes drastically with every run. Is this normal?

Neural network training involves non-convex optimisation and hence the result depends on the (random) initial conditions. As such, you will not get the same result even when you run the same code multiple times. However, if you see very large differences in the results you get across multiple runs, you may need to check your code for errors.

3.4 What is the difference between one-step-ahead and simulation?

Please refer to Lecture 3, Slide 12.

3.5 Are we allowed to use ntstool and estimate a NARX model to solve this question?

Yes, you can use any standard (or non-standard) tools or toolboxes in Matlab to solve this question. Further, be aware that some Matlab functions require you to work with cell arrays, and not numerical arrays.

3.6 The valdata fit is not as good as the iddata fit. What can we do?

By definition, the fit with valdata will never be as good as that with iddata. You can make recommendations about how to improve iddata so that the generalisation capabilities of the trained neural network improve.

3.7 Should we train a second neural network in the simulation configuration?

No, you are expected to synthesise one single neural network and test it in both the simulation as well as the one-step-ahead configuration.

3.8 We tried training a feedforward neural network and it gives us absurd results. What is wrong?

The system that you are modelling is a dynamic system. Hence, the current value of output does not depend only on the current value of input, but also on the past values of input and output. You could either adjust a feedforward neural network to reflect this dependency, or you could use one of the built-in dynamic neural networks in the Matlab toolbox. In case you use the feedforward neural network, you need to run it one step at a time to obtain the simulation output.

4 Practical Questions

4.1 How do I get the various toolboxes from Matlab?

You need to go to the Matlab website and login with your student account. From there, you can download the toolboxes by choosing the correct version of Matlab that you have installed on your computer, and selecting (only the) toolboxes your require.

4.2 My assignment partner decided to stop working on the Matlab assignment OR I am unable to find an assignment partner. What do I do?

The Matlab assignment is intended to be completed in pairs of two or by one person alone. In case your assignment partner decides to discontinue the course and/or you cannot find an assignment partner, you are required to work on the assignment by yourself. Single-author assignments will be given due consideration while grading.

4.3 We were unable to submit a printed copy of the assignment on time. Will this affect our grade?

The soft copy of the assignment needs to be submitted strictly before the deadline mentioned in the Matlab assignment document, failure to do so will adversely affect the grade you receive for your assignment. Since it is logistically more difficult to deliver a printed copy of the assignment, slight delays in its submission will not affect your grade. For students enrolled in TU Eindhoven or UTwente, it is not necessary to submit a printed copy.

4.4 Is it possible to get an extension on the deadline for the submission of the Matlab assignment?

In principle, a deadline extension of upto three weeks can be asked for, however this will negatively affect the grade that you receive for the assignment, in order to be fair to the students who are able to make the deadline mentioned in the Matlab assignment document.