AEEM 5197/6097 "Soft Computing Based AI" or AEEM 7010: Prof. Kelly Cohen - Fall 2019

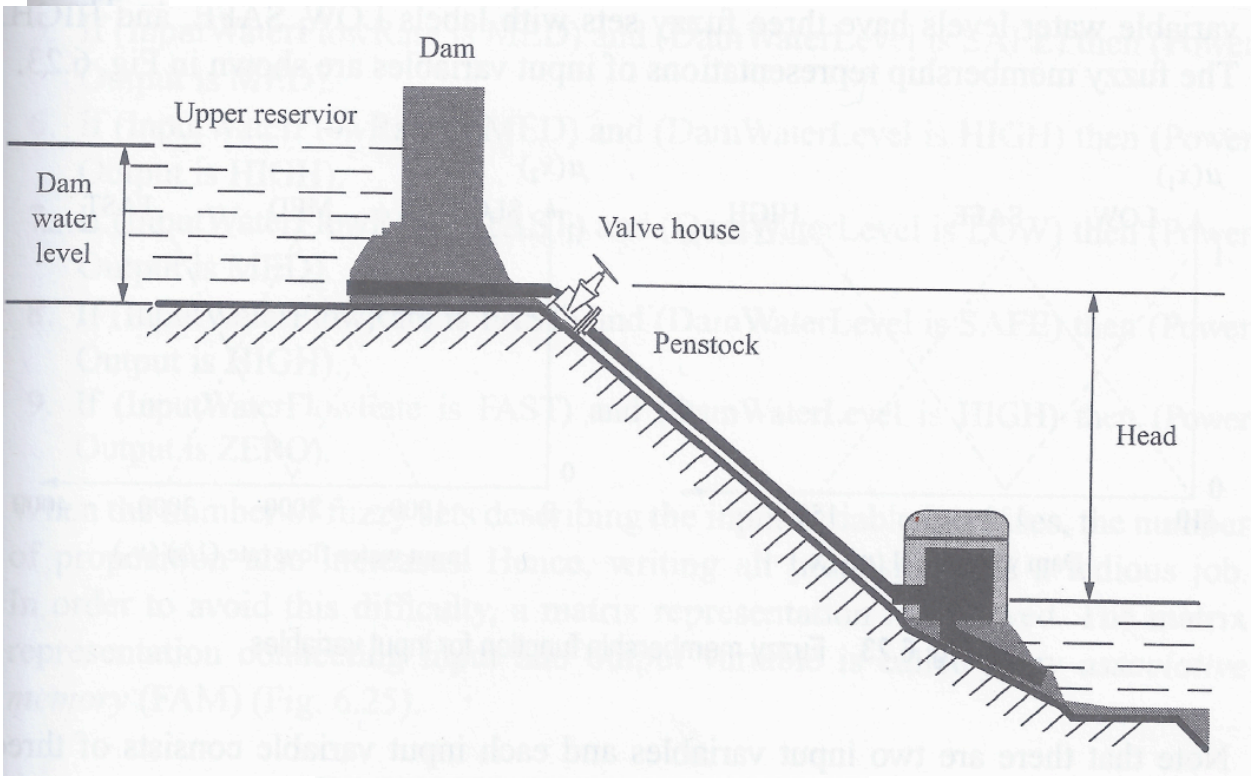
Take Home Test T#1

This is an Individual Test and comprises 5% of your Final Grade

Instructions:

Please read/review Lessons L#5 – L#8. Then develop a two input one, output fuzzy logic decision making system (using **ONLY YOUR OWN CODE WHICH NEEDS TO BE ATTACHED**) for the following Hydel Power Plant problem addressing all of the deliverables requested:

In a hydel power plant, water is collected in huge amount by constructing a dam across the river. The collected water in the dam stores energy as potential energy. The water from the dam is fed into a powerhouse situated below the dam. Due to the difference in the level of the head, between the dam and powerhouse, the potential energy in water is converted into kinetic energy as the water moves towards the powerhouse from the dam. The powerhouse consists of turbine and generator. The amount of power produced by the powerhouse can be controlled by varying the water flow rate. The water flow rate can be governed by a valve situated in the penstock



Sketch of a hydel power plant

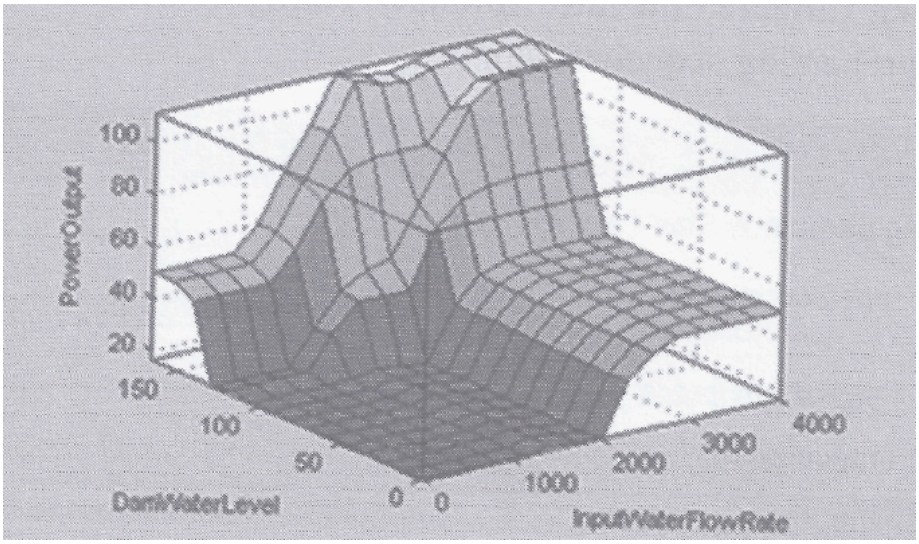
Consider a hydel power plant with a dam of height 165 m. The dam is connected to an upstream that has a flow rate ranging from 0 to 3000 l/s. The safe water level of the dam is 130 m. An increase in water level will affect the stability of the dam. Decrease in water level will affect future water requirement. In order to maintain the water level within safe limits, the amount of water flowing out of the dam is regulated. The water flowing out of the dam is fed into the powerhouse. This variation in water flow rate in turn varies the power output of powerhouse.

Let us consider power output as the output variable, and the input variables influencing the power output are water flow rate entering into the dam and water level of the dam.

If the input water flow rate is slow and water level of dam is below a certain limit, the amount of water released from the dam is low. As the amount of water entering the powerhouse is low, the power generated from the plant is also low.

If the input water flow rate is slow and water level of dam is within the limits, then the power output of the plant is low. Similarly, if the input water flow rate is high and the water level in the dam is within the limits, then the power output of the plant is high. If the input water flow rate is high and water level of the dam is maximum, then the amount of water released from the dam is very high. At this very high water flow rate, the powerhouse should be bypassed in order to safeguard the equipments placed in the powerhouse. The power generated by the powerhouse at this condition is zero. From the aforementioned operations, we can infer that the hydel power plant is non-linear.

The objective is to develop a 2 input, one output control surface, which looks as follows:



1. Develop a fuzzification system using five membership functions (MF) for each of your two inputs, **Water Flow Rate** & **Dam Water Level** as well as for your single output termed as **Power Output**. Describe your rationale (**plot all MF**, **20 points**)

2. Develop a Rule Base comprised of Relevant IF…..THEN …Rules. Describe your rationale. (provide **Rule Base Matrix**, **20 points**)

3. Plot your control surface using the same scale and then compare the plot you obtained with the one provided above. What are your observations? **(plot + ~ 0.5 page**, **20 points**)

4. What are the lessons learned in this exercise concerning your ability to develop simple fuzzy systems. (~ **1 page, 15 points**)

5. Explain the main challenges if you need to scale your solution for a multiple input-multiple output system (16 inputs and 3 outputs). (~ **1 page, 15 points**)

6. Attach a complete set of all software developed for this test. Please add detailed comments (**10 points**)

Best of Luck!