Artificial Neural Networks

In class activities

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# 1. Activities

## 1.1 Single-layer perceptron neural network

In a chemical processing plant, a critical valve is controlled based on three parameters: temperature, pressure, and reactant concentration, all within normalized ranges. Each parameter is represented as a binary input: 1 if the parameter is within the desired range, indicating favorable conditions for opening the valve, and 0 if it is outside the range, indicating unfavorable conditions. The decision to open the valve depends on these inputs to ensure safe and efficient operation.

* Scenario 1: Low temperature, low pressure, optimal concentration.
* Scenario 2: Optimal temperature, optimal pressure, optimal concentration.
* Scenario 3: Optimal temperature, low pressure, optimal concentration.
* Scenario 4: Low temperature, optimal pressure, optimal concentration.

Expected valve position

| Temperature | Pressure | Concentration | Valve Opens |
| --- | --- | --- | --- |
| 0 | 0 | 1 | 0 |
| 1 | 1 | 1 | 1 |
| 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 |

Design a simple single-layer perceptron using MATLAB to learn this decision-making process based on the input parameters.

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| Solution |
| The code for single layer perceptron is in [ann\_single\_layer\_perceptron.mlx](./ann_single_layer_perceptron.mlx). |

## 1.2 ANN modeling of Crystallization

To control the average crystal size in a crystallization process, it is essential to account for its dependence on two measurable variables:

1. Mother liquor temperature
2. Mother liquor density

Since average crystal size cannot be directly measured and requires offline laboratory analysis, there are inherent delays in controlling the crystallizer.

To predict crystal size using temperature and density , consider the following:

1. Input transfer functions
   1. Feed flow rate (U1)

* 1. Stirrer Speed (U2)

1. Process Transfer functions
   1. Temperature (X1) is influenced by U1

* 1. Density (X2) is influenced by U2

1. Dependency of average crystal size davg (Y) on temperature and density is given by

Develop an Artificial Neural Network (ANN) model to predict the average crystal size in a crystallization process based on measured temperature and density, which are influenced by feed flow rate and stirrer speed.

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| Solution |
| * [Crystallizer model for training](./ann_crystallizer_model_for_training.slx) * [Crystallizer model control](./ann_crystallizer_model_control.slx) |