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Autonomous Fault Detection Using Artificial Intelligence Applied to CLAS12 Drift Chamber Data

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2.1 Artificial Neural Networks

Artificial neural networks (ANNs) are a class of machine learning algorithms that are loosely inspired by the structure of biological nervous systems. To be precise, each ANN consists of a collection of artificial neurons that are connected with each other. The neurons are able to exchange information along their connections. A common way to arrange artificial neurons within a network is to organize them in layers as depicted in figure 2.1.

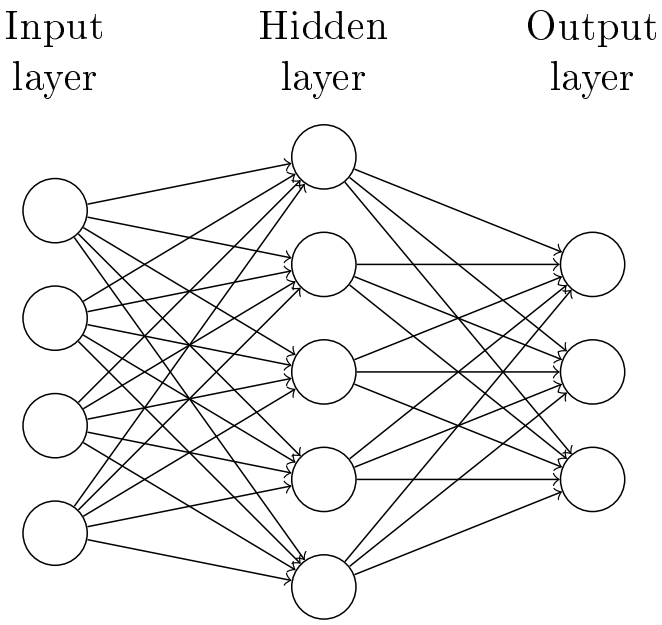

Figure 2.1: The structure of a simple ANN. The nodes represent the neurons, the edges represent their connections, also indicating the flow of information.

When an artificial neuron receives a signal on some of its incoming connections, it may elect to become active.[1] In this state it also influences all neurons it has an outgoing

[1] The details of this process are further illustrated in section 2.1.1 on the next page.

connection to by passing a signal along their channel. Those other neurons in turn may also elect to become activated - this way a signal can propagate through the network along the connecting edges.

Usually, each ANN consists of at least one layer of neurons that is responsible for receiving signals from the environment - we call this an *input layer* (see figure 2.1 on the preceding page). When these neurons receive a signal from the environment, they propagate it to their connected neighbors in the next layer. This process repeats until the *output layer* is reached. The neurons in this layer represent the output of the whole network. Each layer in between is called a *hidden layer* because there is no direct communication between the neurons in this layer and the environment.

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