**Neuroid Parameter Definitions and Examples**

**What is a neuroid?**

A neuroid is a ‘novel computational neuron-model’ which is comprised of ‘three basic operations’ relating to operations that a traditional neuron uses to ‘process incoming information’. These three operations are:

1. Comparison – incoming inputs are compared to an action potential
2. Frequency Modulation – in response to the comparison, if an input reaches the action potential threshold, the axon signal yields a 1, if not, a 0
3. Frequency Demodulation – taking the series of 1’s and 0’s produced as the axon signal, the series is translated from dialog to analog, producing a continuous output of a de-modulated output plotted as a time versus frequency graph

This diagram shows each of these operations as part of the neuroid:

A picture containing text, clock

Description automatically generated

Our neuroid simulation follows these steps and produces these charts:

Chart

Description automatically generated

In addition to these operations, neuroids are customizable with 4 key parameters. Changing these parameters allows a great deal of computational power with very few computational units.

**Parameters Explained**

Beta – originally defined as a ‘proportionality constant’, the Beta parameter can be shown to have the following impact when varied:

Chart, histogram

Description automatically generatedHere, increasing the magnitude of Beta decreases the height and width of the output pyramid. This translates less time between occurrences of the activation potential being reached.

Additionally, looking at the axon signal prior to the output along with the output for two different Beta values will help depict this impact.

Axon Signal Output

Chart, shape

Description automatically generatedChart, histogram

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Here, the Beta parameter is set at 1 The Axon Signal is oscillating back and forth between 0 and 1, with small but noticeable gaps between the first 100 timed or so outputs, meaning that the time between 0 and 1 outputs is decreasing. After 200ms passes, the time between the 0 and 1 outputs becomes unnoticeable until near the 1750ms mark. From there, a few small gaps can be seen, and then the signal remains at 0 to the end of the time window. This mirrors the shape of the output on the right, where the increase in output magnitude happens after 100ms and the decrease after 1750ms.

Looking at the same graphs when Beta is set to 2.5, we notice different things.

Axon Signal Output

Chart

Description automatically generatedChart

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Now, there is a much more noticeable pattern of spacing between the 1 and 0 outputs well past 200ms and starting again around 1600ms. This again is mirrored on the output graph where we see the increase and decrease in output magnitude occurring around the same timestamps. We also notice that the output depicts a lower overall magnitude and less time within each output level. This is because the time between the axon signal reaching 1 is greater.

Umbr – originally defined as an ‘activation threshold’, Umbr represents the value at which the axon signal will be 1 rather than 0, meaning the activation potential has been reached. The effects of changing the value of Umbr can be seen below:

Chart, histogram

Description automatically generated

Here, changing Umbr shows a pyramid that maintains space between inputs but lowers the overall frequency of hitting or surpassing the activation threshold, since the activation threshold is becoming greater.

Kr – originally defined as a ‘regeneration constant’, Kr serves as a bound on the shape of the output pyramid, dictating how to scale the frequency-modulated signal into a de-modulated signal.

Chart, histogram

Description automatically generated

Here, viewing various values of Kr shows that the shape of the output pyramid changes greatly. For small values of Kr, the pyramid becomes flatter, meaning there is less variation in the output signal. For a larger value of Kr, there is a greater variation in the outputs of the neuroid.

MaxCount – originally defined as a ‘maximum value’ for the total signal of a neuroid, MaxCount works to avoid a situation where the ouput signal would be ‘extended indefinitely’. Once the MaxCount value is reached, the output returns to 0.

Chart, histogram

Description automatically generatedHere, changing the values of MaxCount does not have much of an impact. We can see a slight change in how the end of the output stream looks with greater values of MaxCount. It is worth noting that the impact of MaxCount is greater when there are multiple neuroids in a system.