Fully recurrent networks feed back the hidden layer to itself. Partially recurrent networks start with a fully recurrent net and add a feedforward connection that bypasses the recurrency, effectively treating the recurrent part as a state memory. These recurrent networks can have an infinite memory depth and thus find relationships through time as well as through the instantaneous input space. Most real-world data contains information in its time structure. Recurrent networks are the state of the art in nonlinear time series prediction, system identification, and temporal pattern classification.

There are two recurrent structures to choose from. The fully recurrent structure connects the first hidden layer to itself through a recurrent synapse connection. The partially recurrent structure adds a feedforward connection, through a synapse, from the input axon to the layer after the 1st hidden layer. In this case, the recurrent structure acts as a state for the feedforward structure.

General recurrent networks (GRN’s) are to temporal data as multi-layer perceptrons (MLP’s) are to static data. They are categorized by a layer that feeds back upon itself using adaptable weights. If all of the layer’s axon’s feed back their output, then the network is fully recurrent, otherwise it is called partially recurrent.

Advantages

The main advantage of GRN’s is that they have a potentially unlimited memory depth and thus, as previously stated, can actually capture the dynamics of the system that produced a temporal signal. This distinguishes them from [Time Lagged Recurrent Networks](mk:@MSITStore:C:\Program%20Files%20(x86)\NeuroSolutions%205\Wizards\NeuralBuilder\NeuralBuilder.chm::/NeuralWizard/Time_Lagged_Recurrent_Networks.htm), where the memory depth is also adaptable, but has an effective upper limit due to loss of resolution.

Disadvantages

The primary disadvantage of GRN’s is that they can become unstable during training. This is because their feedback is adaptable, and they can evolve to an unstable non-linear pole. This distinguishes them from [Jordan and Elman Networks](mk:@MSITStore:C:\Program%20Files%20(x86)\NeuroSolutions%205\Wizards\NeuralBuilder\NeuralBuilder.chm::/NeuralWizard/Jordan_and_Elman_Networks.htm), where the feedback is fixed. Also, Bengio showed that GRN’s have trouble learning long term relationships because the gradient over time in the back propagation through time (BPTT) algorithm decays exponentially. The BPTT algorithm is also quite complex and requires a lot of memory. NeuroSolutions hides most of the complexity from the user and provides an efficient implementation of this algorithm.