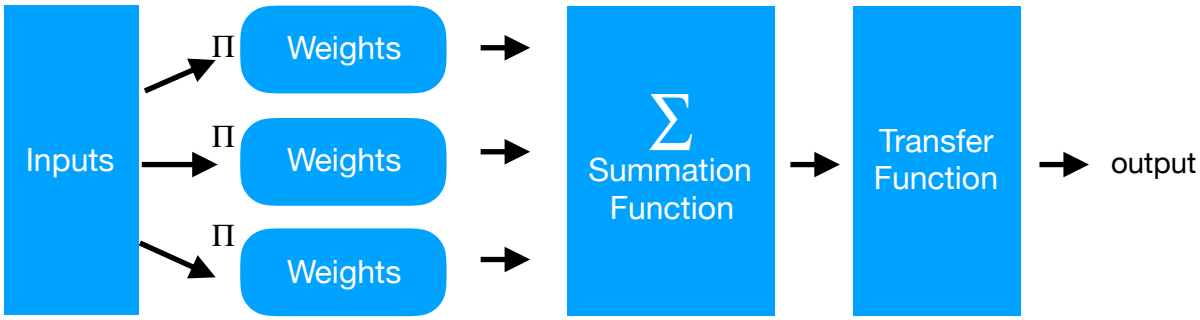
Wednesday, September 4, 2019

Field Notes

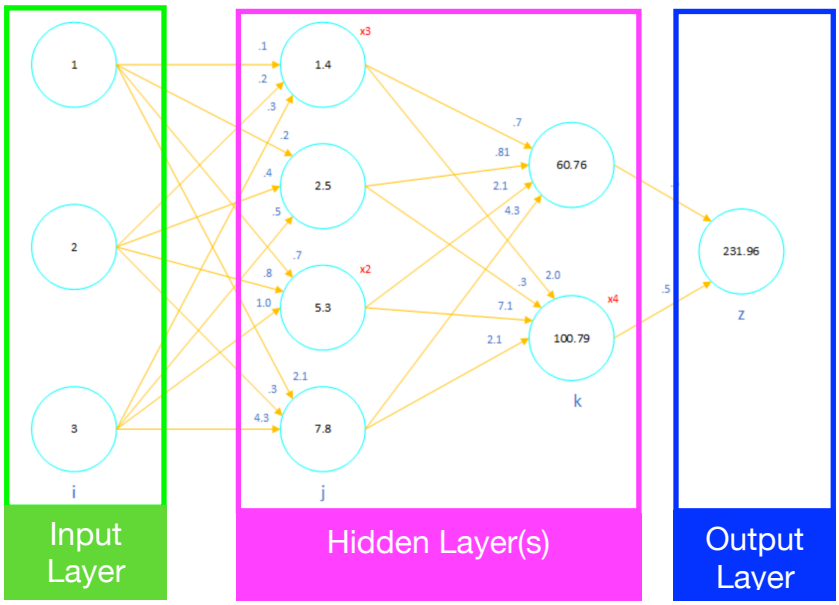
http://www2.psych.utoronto.ca/users/reingold/courses/ai/cache/neural1.html

Artificial Neural Networks

- Inputs enter Processing Element (depicted below), multiplied by weights, input into a summing function, and finally sent into a transfer function. The transfer function uses an algorithm to convert the summation's output to a real number, outputs to the rest of the system.



- Example algorithms used in the Summation function: Sum, Max, Min, Avg., OR, AND.
- Example algorithms used in the Transfer function: Hyperbolic tangent, Linear, Sigmoid, Sine.
- This is the basic building block of almost all ANNs (Artificial Neural Networks). This building block tries to emulate a primitive artificial neural. The clustering of these basic building blocks compose 'layers' which are connected to one-another in stages. The connection between layers is an art which allows us to solve real problems.
- There are USEFUL ANNs which consist of 1 layer, 1 element — but most application require a network of 3 layers: Input Layer, Hidden Layer, Output Layer.



- Most networks contain hidden layers which are fed signals from the layers before them, commonly the input layer. After the neurons inside the hidden layers complete their function, they pass an output to the layers after them.
- The connection between neurons provides an important mechanism in neural networks. Some connections add (EXCITE) the signal from one neuron to the next, some subtract (INHIBIT) the signal between two neurons. Connections can also FEEDBACK signals into prior layers.
- There are cases where a neurons in the SAME LAYER inhibit neighbours. This is LATERAL INHIBITION. This is commonly implemented in the output layer.
    - Example: in text recognition, if the probability of a character being “P” is 0.85 and the probability of a character being “F” is 0.65, your network wants to choose the highest probability and INHIBIT all others. This is done by lateral inhibition. This particular concept is called COMPETITION.
- The interconnect between neurons has a significant impact on network operation. Professional ANN development tools parametrize these connections to allow users to add, delete, control their behaviour by exciting or inhibiting.

Training ANNs

- Initial weights are chosen randomly. Training can be supervised or unsupervised.
- UNSUPERVISED training, requires the network to make its own decisions about the inputs.
- SUPERVISED training reviews the networks output by: grading the network’s performance, or providing the desired outputs when giving inputs. This is the PREFERRED method of network training.
    - When the network processes the inputs, the trainer compares the result to the desired outcome, and the errors are BACK-PROPAGATED through the system, adjusting weights controlling the network. This process is repeated until the weights are refined to the trainer’s satisfaction.
    - Some networks may never learn. Maybe: input data does not contain enough specific information required to achieve the desired output, or if there is not enough input data. It is possible to have a network MEMORIZE the specific inputs used in the training set, this is undesirable.
        - Supervised training must hold back some training data to confirm the network did not memorize training data. THIS IS AVOIDED BY not having too many processing elements.
- Artificial intelligence also is hostage to the speed of the processor that it runs on. Ultimately, it is restricted to the theoretical limit of a single processor. Artificial intelligence is also burdened by the fact that experts don't always speak in rules (algorithms).

- **ANNs are not a solution for all computing problems:**

CHARACTERISTICS	TRADITIONAL COMPUTING (including Expert Systems)	ARTIFICIAL NEURAL NETWORKS
Processing style Functions	Sequential Logically (left brained) via Rules Concepts Calculations	Parallel Gestault (right brained) via Images Pictures Controls
Learning Method Applications	by rules (didactically) Accounting word processing math inventory digital communications	by example (Socratically) Sensor processing speech recognition pattern recognition text recognition

- **Expert Systems vs. ANN system differences:**

Characteristics	Von Neumann Architecture Used for Expert Systems	Artificial Neural Networks
Processors	VLSI (traditional processors)	Artificial Neural Networks; variety of technologies; hardware development is on going
Processing Approach	Separate	The same
Processing Approach	Processes problem rule at a one time; sequential	Multiple, simultaneously
Connections	Externally programmable	Dynamically self programming
Self learning	Only algorithmic parameters modified	Continuously adaptable
Fault tolerance	None without special processors	Significant in the very nature of the interconnected neurons
Neurobiology in design	None	Moderate
Programming	Through a rule based complicated	Self-programming; but network must be set up properly
Ability to be fast	Requires big processors	Requires multiple custom-built chips