

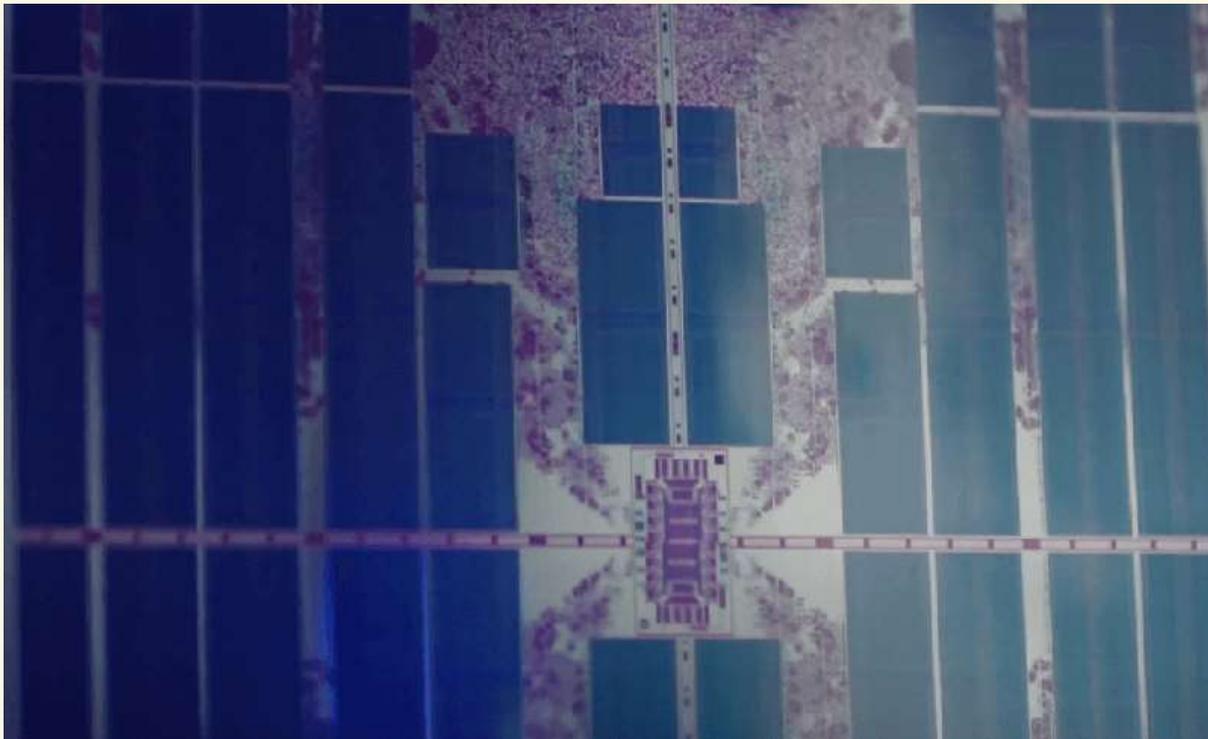
# Neuromorphic Computing The Cutting Edge of AI 2020

Neuromorphic Computing is one of the subjects that engineers are looking forward to in the computing regime where AI is going to be the next evolution in the world of us. So we will discuss about all the facts and features of Neuromorphic Computing here, how it was started, and what scientific advancements have been done on this subject and where are we standing on this.

## What is Neuromorphic Computing

In a nutshell, this is the process where the computers try to replicate how our brain works. Our brain is comprised of tiny neurons, and they create an entire network of response system.

The engineers are trying to use this technology to build a different kind of processor that is more smart, more human and thinks how our brain intercepts different kinds of signals and respond with different kinds of outputs based on the type of incoming signals.



## Problems with Neuromorphic Computing

The first and foremost challenge with traditional computing is that rule of processing it follows is known as Von Neumann Architecture. In this Architecture, there are three parts, one is input-output, second is the combination of Control Unit and Logarithmic Unit, called Central Processing Unit, and the third is memory.

### Architecture Problem

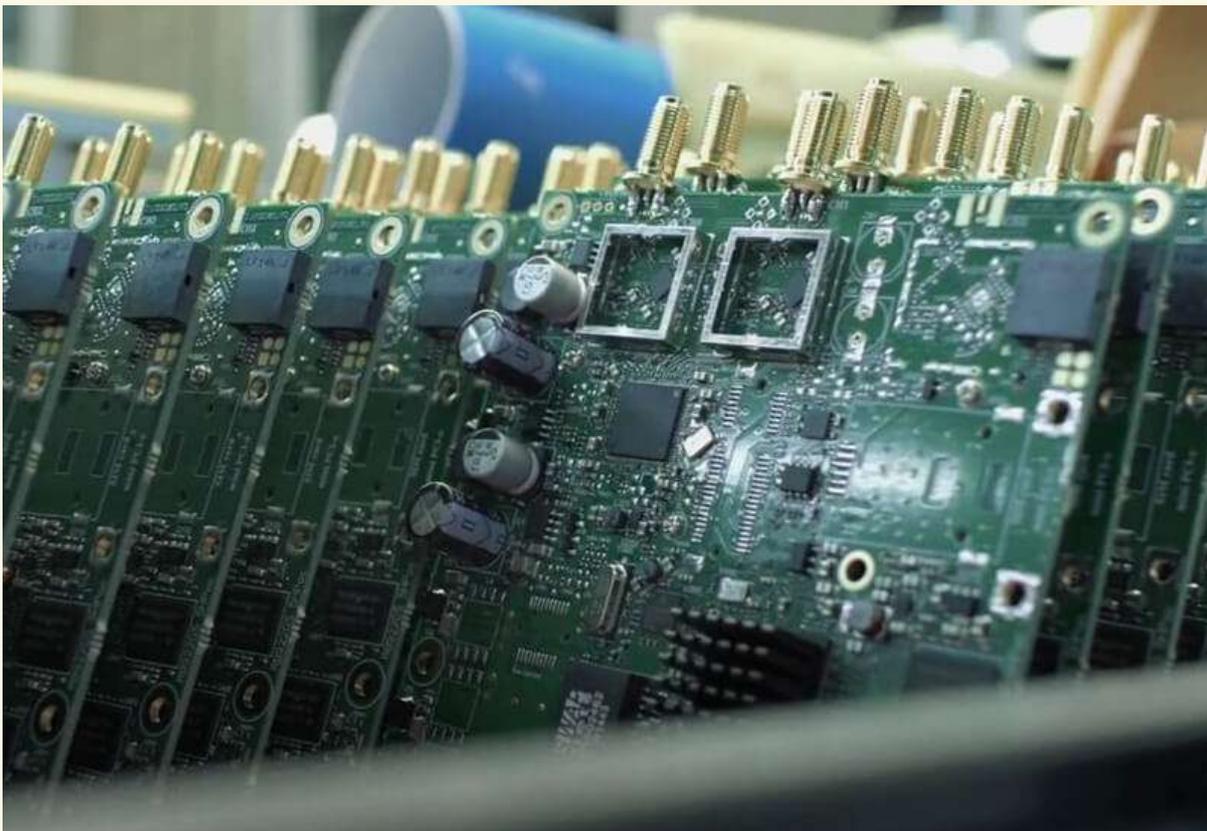
Now as CPU and memory resides separately, the time to travel of inputs and signals to and fro between memory and processor is the main burden in the system. This separate structure is the bottleneck of the Von Neumann Architecture as well as modern day computers built on this Architecture.

## Simultaneous Connections Problem

Our brain or our central nervous system is dependent on neurons, the micro cells that receives signals and convey the signals to its next unit. Now one end of neuron is attached to 1000+ other neurons and signals travels in a speed that has never been achieved by any processing system yet.

The Neuromorphic System on the other hand, works with chips that has thousands of simultaneous processing power, so this bottleneck is easily nullified. Both the chips, Intel's Loihi and IBM's Truenorth Chip work with specifically this advantage over all the traditional chips out there.

Traditional modern day computers, except specially made supercomputing chips, has only 3 simultaneous connections, so the ration of 3:1000 is self explanatory why speed can not be achieved without Neuromorphic System.

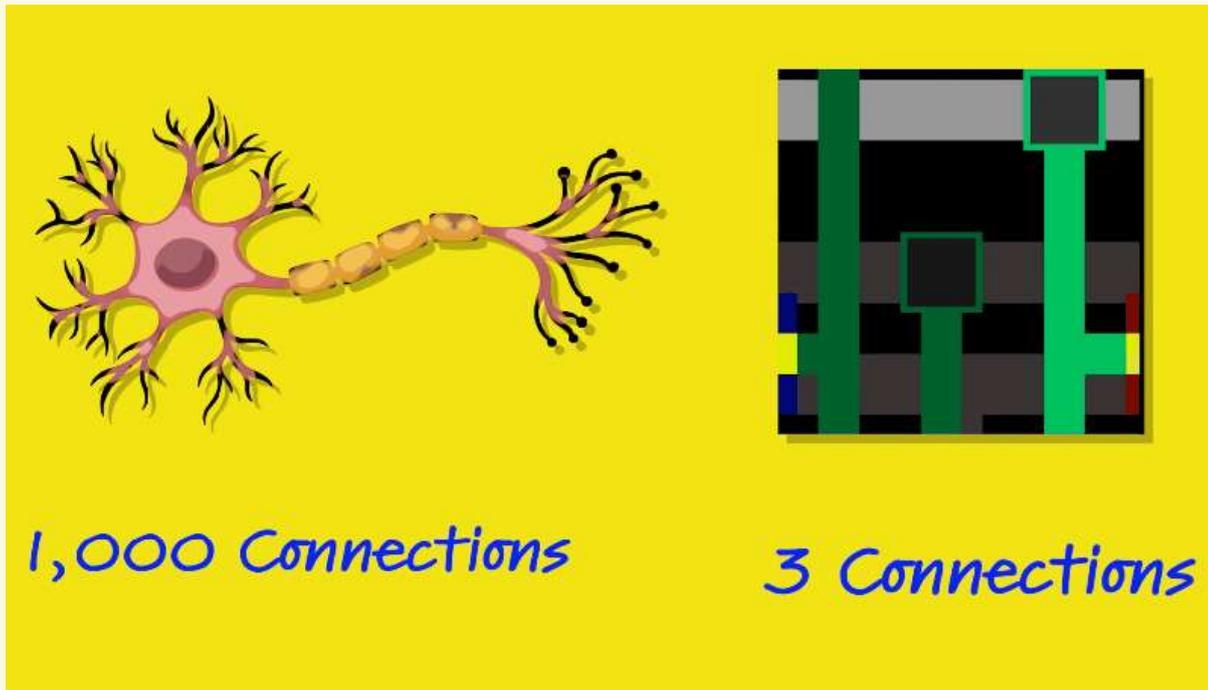


## Neuromorphic Computing Language

Now this is another hurdle in the evolving technology, all the programming languages so far like C or C++ has been made to work in Von Neumann Architecture. Programming languages pre-concur that the data needs to travel between memory and cpu for the processing system to work, which is not the case for Neuromorphic Computing Systems.

## How Neuromorphic Computing Works

As we have explained before, Neuromorphic Computing is the system that tries to clone the response system of our brain. And chips built for the system has two distinct advantages over all other chips - one is that the memory and central processing unit is embedded in one single system - and second is that in the whole system chips are interconnected with one another.



So for a process in Neuromorphic Computing System, if one chip is busy for any signal to process, the signal is relayed to next chip which process the signal for a proper response and thus achieve simultaneous signal processing.

### Neuromorphic computing IBM

IBM got a contract from Defense Advanced Research Projects Agency (Darpa) in 2008 to develop a cognitive computing system that works similar to the works of a brain. in 2011, they developed 2 prototype chips called 'Golden Gate' and 'Sanfrancisco' which has system similar to a nervous system of 256 neurons.

The chip Golden gate was then selected as pilot for the Neuromorphic computing system and was further developed in to 15 times smaller footprint and 100 times efficiency of its predecessor chip in 2013. This chip had 4096 Neurosynaptic Core converging into a processing system much like our neuron based system capable of simultaneous parallel processing.



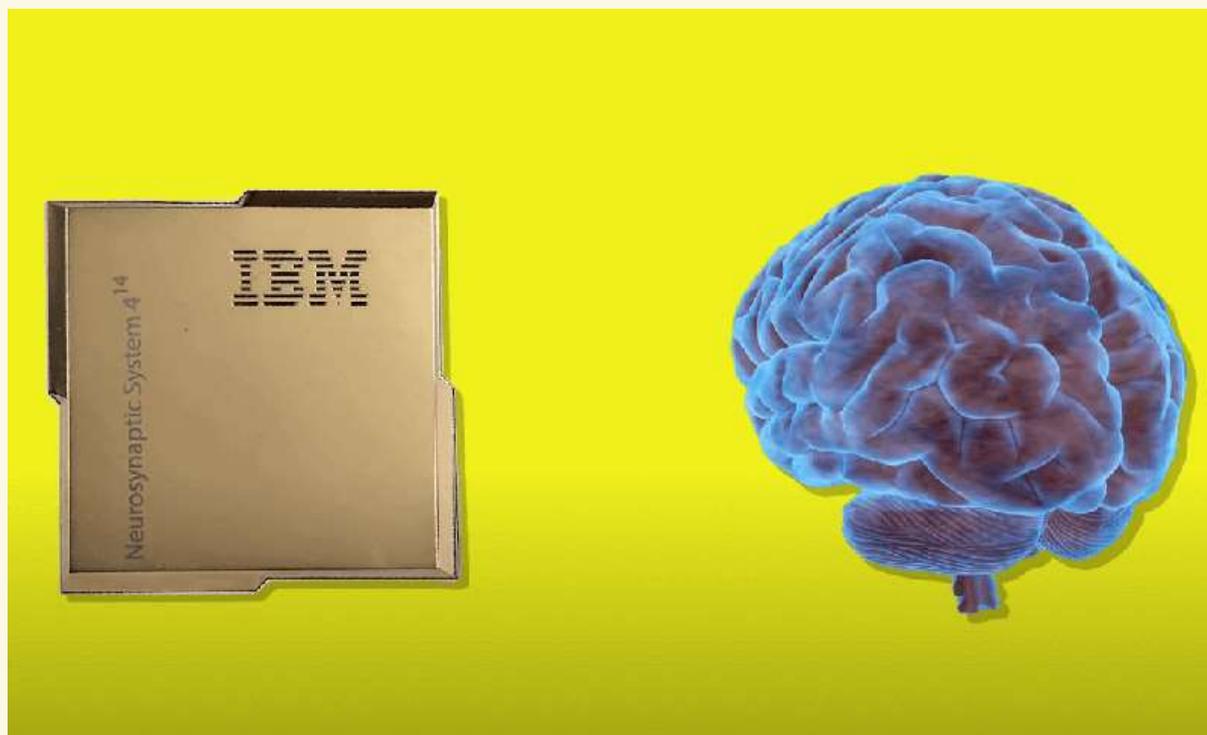
This chip was further developed into the legendary "Truenorth Chip" of IBM which had 1 million neuron and 256 million synapses. These Truenorth Chips again could communicate with each other in speed never been seen before.

The fastest supercomputer of the world, 'Summit' aka "ORNL-4" was built on this chip by Oak Ridge National Laboratory in joint venture with United States Energy Department which works 10,000 times faster than the most power desktop money can buy in the market. But still it is 5 times slower than any 5 year child's brain processing power.

## Neuromorphic computing Intel

Intel started working to build processors to use Neuromorphic computing process as well, being the top position holder in commercial processor industry. In 2017, they developed the Intel Loihi System on their proprietary processors with Spiking Neural Networks (SNN).

Jon Tse from Intel Engineering Department made a demonstration in March 2nd, 2018 on how the Loihi system can use image recognition to identify any unknown object in just a matter of few seconds.



## Neuromorphic Chips

The Chips that use this Neuromorphic system has two basic differences from others, the memory and the processor is built together and number of connection is around 16 with one another. Apart from Intel's 'Loihi' and IBM's 'Truenorth' chip, there are few chips that successfully integrated the Neuromorphic engineering.

## Neuromorphic vs quantum computing

Quantum Computing is the system that use quantum phenomenons like superposition and entanglement to process any signal and give outputs. Whereas Neuromorphic computing is the system that replicates the Neuro-Biological Architecture of the brain. Later system is more advanced and key factor in developing AI technology.

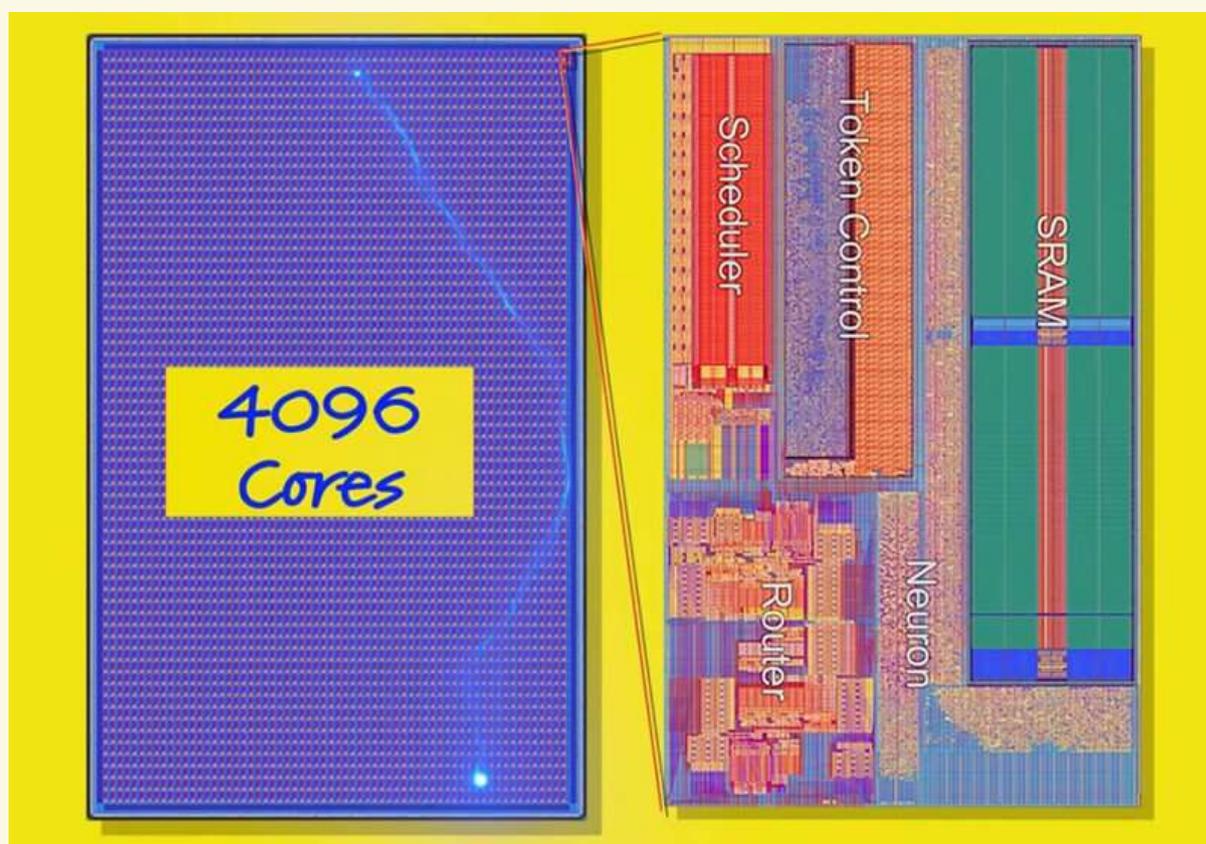
## Neuromorphic computing course

The scope of using Neuromorphic computing is being broadened day by day in many areas like image recognition, video recognition, self driven cars, automated system and anything that has a glimpse of Artificial Intelligence.

While there is no full course yet on this matter, few universities and engineering colleges have started to teach this subject as a part of their study, Carnegie Mellon University can be named as one of them.

## Neuromorphic computing companies

There are companies that are just building their technology on facial recognition or self driving system, and Neuromorphic computing may be solution for them to get maximum processing power with best efficiency possible. A Neuromorphic computing Engineer will be very valuable to them.



## Neuromorphic Computing Applications

The applications of this system is vast and new, there are many areas in engineering that can be revolutionized with Neuromorphic System processing, field are ranging from physics to engineering to modern day commercial systems.

## Neuromorphic Computing ppt

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## Neuromorphic Computing Infographics

For better understanding of the topic in question, we have tried to make Infographics on the Neuromorphic Computing System which may help the enthusiasts. You can use the file as per your requirement, but you need to take permission before modifying the content and republishing anywhere.

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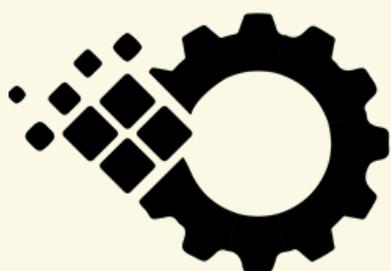
### Conclusion

We have discussed here the history, the details and the architecture about Neuromorphic Computing system. If you want to more here, or point out mistake in the above content, please feel free to leave a comment here.

### Footnotes :

M. Davies *et al.*, "[Loihi: A Neuromorphic Manycore Processor with On-Chip Learning.](#)" in *IEEE Micro*, January/February 2018.

Intel, [Beyond Today's AI](#), Intel Blogs



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