Readings in Neuroinformatics

[redacted]

Mead, Carver. "Neuromorphic electronic systems." Proceedings of the IEEE 78.10 (1990): 1629-1636.

Abstract

In today's electronic systems the commonly used building methods exclusively make us of digital computational primitives. The trend in optimizing their efficacy has been to diminish the consumption of energy per computational unit which is achieved by a reduction of the ~~chip~~ transistor size. Inevitably, we will meet the physical limits of minimization and be faced with a bottleneck in terms of further optimization. Neuromorphic systems inspired by the computations carried out in the brain are a promising alternative to traditional systems. By nature these systems combine digital and analog signals and, by making use of adaptive techniques they effectively reduce energy consumption by several orders of magnitudes and are by far more efficient in the use of silicon~~s~~. Until now we have built systems that successfully process visual as well as auditory signals in the fashion of their biological counterparts. Although the vast majority of computations carried out in the brain are still poorly understood the potential in neuromorphic systems will still increase as we proceed in discovering more basic principles of neural computation. In the future we expect refinements of sensory systems implemented by now as well as the implementations of other sensory systems. (195)

1 Not exactly the right background

2 Not exactly the right problem

3 Not posed as a "solution"

4

5 More details would help

1) 0.5
2) 0.5
3) 0.5
4) 0.5
5) 1
6) 0.5

3.5

1. Intro + background
2. Problem definition
3. Proposed solution
4. Methods
5. Results + impact
6. Overall work (word count, understanding, ...)

Readings in Neroinformatics

[redacted]

10-931-798

Mead, Carver. 1990. Neuromorphic electronic systems. *Proceedings of the IEEE* 78(10). 1629–1636.

Abstract

1) 0.5
2) —
3) 0.5
4) 0.5
5) —
6) 0.5

2

No background on electronic computing systems & energy costs

Even the simplest animal brains are awesome computational instruments. Their elementary operations provide a rich set of powerful computational primitives. We can build devices that implement these primitives by the use of wafer-scale silicon fabrication, enabling us to build entire systems based on the organizing principles of the nervous system, many orders of magnitude more effective than what could be implemented up to the present time. To this end, we have to find a natural way to integrate computational primitives into an overall system-design strategy. (2) Here I propose the term *neuromorphic systems* to generically refer to such systems and give an outline of the prerequisites and important principles as well as the currently available approaches. (3) I argue that adaptive techniques are needed to correct for differences between nominally identical components, and that this adaptive capability leads naturally to systems that learn about their environment. (2? 6?) I show that the representation of information by the relative values of analog signals creates the principle advantage and I maintain that the basic two-dimensional limitation of silicon technology is not a serious limitation in exploiting the potential of neuromorphic systems. (2? 5?) With these notions I show the next steps in this development and indicate where it may lead in the long run. (5?)

206 words.

Readings in Neuroinformatics

[redacted]

Carver Mead, Neuromorphic Electronic Systems, Proceedings of the IEEE, Vol. 78, No. 10, 1990.

1 Abstract

1) 1
2) 0.5
3) 0.5
4) 0.5
5) 1
6) 0.5

4

Neural information-processing systems operate on completely different principles from computers. While computers rely on precise and carefully controlled digital operations, biological computation is analogue and adaptive. Biological systems solve many problems that computers cannot, and are much more energy efficient and robust. Despite these advantages, biologically inspired electronic systems have hardly been used. We introduce the notion of neuromorphic electronic systems and argue for their advantages over computers used today. We use the Mahowald retina as an example of an implementable neuromorphic system, and argue that the adaptiveness of neuromorphic systems makes them immensely powerful as it enables learning and self-organization. Furthermore, we hypothesize that wafer-scale neuromorphic systems would be highly robust and energy efficient, and show that neural computation also relies mostly on local wiring strategies. Neuromorphic systems provide an opportunity to rethink engineering and improve our understanding of neural computation. Indeed, neuromorphic engineering has the potential to enable truly intelligent technology and surpass the inevitable physical limitations of our current computers.

Word count: 163

Readings in Neuroinformatics

[redacted]

Carver Mead, *Neuromorphic Electronic Systems*, Proceedings of the IEEE, Vol.78, No.10, 1629-1636, 1990

Abstract

1) 1

2) 0.5 1 Biological information-processing systems, such as brains, outperform current digital ones with regards to power efficiency, adaptability and robustness to individual component failure. This is not due to the wetware used by biology, but rather the nature of its analog computation. This analog computation can also be implemented in silicon by using elementary physical phenomena as

3) 0.5 computational primitives rather than absolute digital signals. Systems inspired by biological

4) 0.5 systems in this way are called neuromorphic systems. These systems do face the problem that variations in individual components affect computation in undesired ways, but the system could be Wrong problem

5) 0.5 2 designed to adapt to these variations. This also has the added benefit of making the system adapt to

6) 0.5 3 its environment. It also makes it more robust, because if a transistor breaks, the system adapts to Not only "solution"

4 compensate for it. We have designed, fabricated and tested hundreds of neuromorphic chips that perform various functions. They use 10 000 times less power than digital systems made with the same technology. They aren't quite as efficient as the brain yet, but this is an emerging technology and they could one day be. The impact of widespread adoption of neuromorphic systems would be Too vague promises..

3.5 5 very positive. Firstly, systems would be so efficient that much less cooling would be needed, and in many cases, the ambient airflow at room temperature would be more than enough. Chip manufacturing would also be simplified, because the systems would be robust to faulty components.

Words: 238