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Static and Dynamic Connectionism

Artificial neural nets typically use simple units modelled on the McCulloch-Pitts neuron, with static connectivity defined by physical synaptic links, and synapse-based learning. Real neurons may have much greater computational capability. Processes of neuron growth and maintance use complex chemical signalling between cell bodies and synapses, ferrying chemical messengers over microtubules and actin fibres. These processes could support computation which, while slower than neural electrical signalling, allows any neuron to act as a complex Finite State Machine (FSM), changing state over intervals of seconds. The FSM can selectively de-activate synapses, allowing network connectivity to change dynamically, sculpting a dynamic neural net from the static neural connections. The dynamic net can do fast electrical computation. The dynamic neural net has the potential to (a) represent dynamic data structures, such as trees and graphs of unlimited depth; (b) use slowly changing metadata to define the meaning offast-changing electrical signals; (c) use alternative models of memory and learning, whose speed comes closer to animal learning, unlike the glacial learning rates of static neural nets. It may also support the more efficient evolution of animal brains. These proposals are illustrated by simulations. They can be applied to artificial neural nets, opening up new capabilities – such as learning at biologically realistic speeds.

Keywords

dynamic neural net; intra-neural computation; dynamic data structures; Finite State Machine; metadata; memory; learning.

Biography

Dr. Robert Worden did research in high energy physics at Cambridge, CalTech and CERN, before working in commercial computer software. He ran a corporate research center in Cambridge , researching software engineering, AI and human-computer interfaces. He has published papers on AI, evolution, neuroscience, and cognitive science including language and consciousness.

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