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Evolution of Mathematical Neuroscience

The precursors of mathematical neuroscience can be found in the work of Boole, Poincaré, and van der Pol. Hodgkin and Huxley built on their work, using nonlinear dynamics to show that their experimental data could explain the action potential. This line of research has continued to the present day as newly discovered ion currents are added to the equations.

A parallel line that emerged from this was network dynamics, which evolved as computer power increased. In 1972-3 Jack Cowan and I developed equations that described spatially distributed networks with excitatory and inhibitory neurons. This approach has been extended to include additional currents and multiple neuron types, and it has contributed to the development of artificial intelligence. I have recently explored chaos in the Wilson-Cowan equations, and I believe that this suggests an explanation of “free will”.

Jack Cowan, my late mentor, was a key to much of this work. With other collaborators he developed mathematical theories of geometrical hallucinations and stochastic versions of the Wilson-Cowan equations. In addition, he pioneered the Department of Theoretical Biology at The University of Chicago. Jack Cowan was a major creator of mathematical neuroscience.