Mathematical Neuroscience: An Introduction

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Abstract

The use of mathematics has many historical successes, especially in the fields of physics and engineering, where mathematical concepts have been put to good use to address challenges far beyond the context in which they were originally developed. More recently, mathematics has been employed to further our understanding of biological systems, such as the human brain. Despite the immense complexity of the brain, mathematical modelling has allowed for major advances to be made towards understanding behaviour, conciousness and disease. Assuming no specific neuroscience knowledge, this talk introduces the general ideas behind mathematically modelling the human brain. I will briefly review seminal work in the field, such as the Hodgkin-Huxley [1] and Wilson-Cowan [2] models, before discussing more recent work investigating the role of neural synchronisation in diseases such a epilepsy and Parkinson's disease [3].

References

[1] A. L. Hodgkin; A. F. Huxley, *A Quantitative Description of Membrane Current and its Application to Conduction and Excitation in Nerve*, The Journal of Physiology, 117(4):500–544, 1952

[2] H. R. Wilson; J. D. Cowan, *Excitatory and inhibitory interactions in localized populations of model neurons*, Biophysical Journal, 12(1):1–24, 1972.

[3] Á Byrne; R.O. Dea; M. Forrester; J. Ross; S. Coombes, *Next generation neural mass and field modelling*, Journal of Neurophysiology. 123, 726–742, 2020.

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