On the Capacity of an Axon Tract With Random Demyelination

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Abstract

In this experimental note, the authors demyelinate an axon tract in-silico with ($N = 2$) two coupled axons at random locations and study its conduction properties.

In the context of [1, 2, 3, 4] it is found that the capacity of a size two axon tract is 0.6359 bits per channel use using the Blahut-Arimoto algorithm and the capacity achieving distribution is [0.3049 0.3049 0.3902] for the three input types: '01', '10', '11'. The channel transition matrix was determined to be: p = [0.1667 0 0.3333 0 0.1667 0 0 0.1667 0.1667; 0 0.1667 0.3333 0 0.1667 0 0.1667 0.1667 0; 0 0 0.4000 0.3000 0.2000 0.1000 0 0 0]. The axon ratio parameter was 0.5. Symmetry was assumed between the two axons in the tract. The nodal capacitance was 3.14e-9 F/cm and at the demyelinated units it was 3.17e-9 F/cm. The demyelinated units were distributed randomly amongst the Ranvier nodal positions; these were fixed. Future work will determine this capacity under further parameter variations.

References

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[4] Aman Chawla, Salvatore D. Morgera, and Arthur D. Snider. Fields, geometry, and their impact on axon interaction. *Journal of Applied Mathematics and Physics*, 9(4):751–778, 2021.

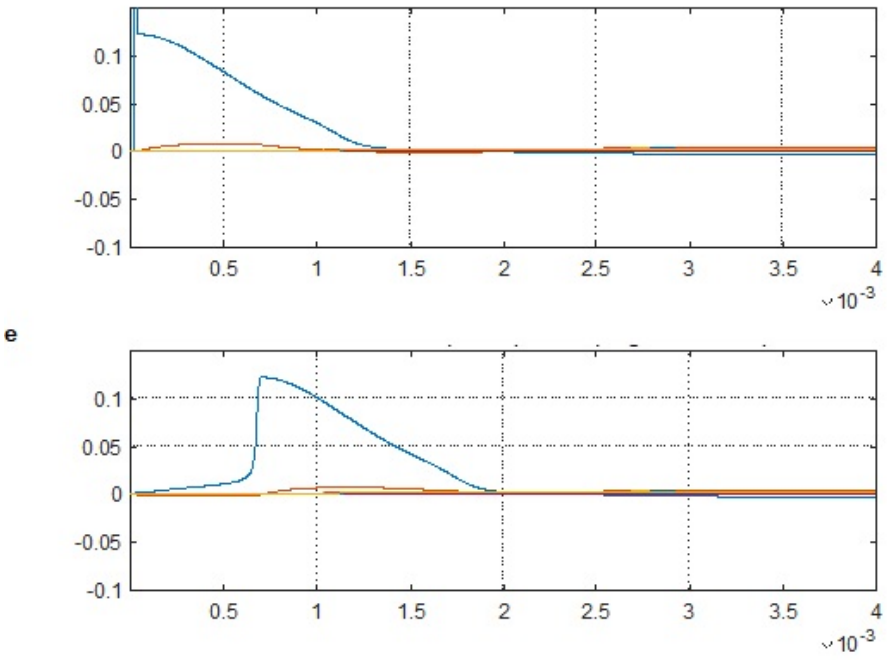

Figure 1: Axon 1 (top) and axon 2 (bottom) are investigated. The top one is stimulated which results in nearly two hop propagation which stops due to the conditions of demyelination prevailing. The bottom one is sympathetically activated. The x-axes are time in seconds and the y-axes are voltage in Volts.