NOISE-INDUCED FIRING IN TYPE I NEURONS: A CASE FOR THE UNIVERSALITY OF INTEGRATE-AND-FIRE DYNAMICS

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Type I excitable systems are characterized by a zero firing rate at the onset of firing. This property is a consequence of the saddle-node bifurcation that occurs as the current bias increases past a critical value. The presence of noise on such an excitable system causes the cell to fire for biases below this critical value, and perturbs the periodic firing (limit cycle) that exists for supracritical currents. It is also known that many models of noisy neurons can be simplified by using noise-driven leaky integrate-and-fire dynamics. Here we show theoretically and numerically that the noise-driven saddle-node dynamics can be accurately analyzed in terms of noise-driven integrate and fire dynamics in the vicinity of the bifurcation point, i.e. for peri-threshold stimuli.
This analysis justifies the usefulness and universality of noisy-integrate-and-fire dynamics for type I membranes with noisy inputs.