Inverse First Passage Time methods and their applications to neuronal modeling

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One of the most popular neuronal models to describe the generation of the Interspikes Intervals (ISIs) distribution is the Leaky Integrate-and-Fire (LIF) concept. In absence of external inputs, the membrane potential evolution is described by an Ornstein-Uhlenbeck (OU) stochastic process $X = \{X_t, t \geq 0\}$. The distribution of the first passage time (FPT) T of this process through a constant boundary S is commonly used to model the ISI distribution. After each spike the membrane potential is reset to zero making the ISIs identically distributed and independent random variables.

Generally one investigates the distribution features of the FPT

$$\tau_b = \inf \{ \, t > 0 \mid W_t \geq b(t) \, \} \tag{1}$$

of X_t over S. This is the direct FPT problem. However there are also instances when the underlying stochastic process is assigned, one knows or estimates the FPT distribution F_b and wishes to determine the corresponding boundary shape. This is the inverse first passage time (IFPT) problem.

Here we apply the IFPT problem to several instances that can be of interest in neuroscience.

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