Statistical Analysis of SST-Pyramidal Post-synaptic Amplitude Distributions

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Outline

Outline

Biology of Post-synaptic Amplitudes

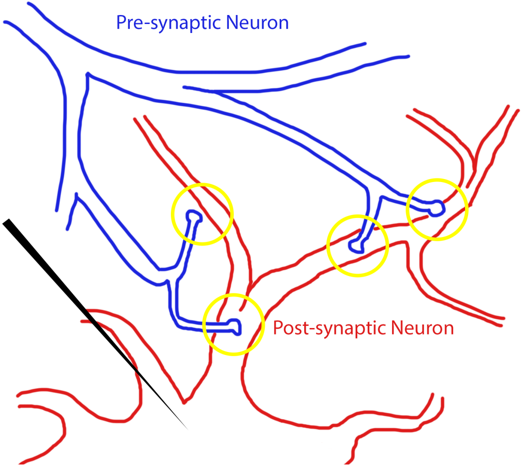

Figure: Biology of post-synaptic amplitudes

Outline

Experimental Measurements

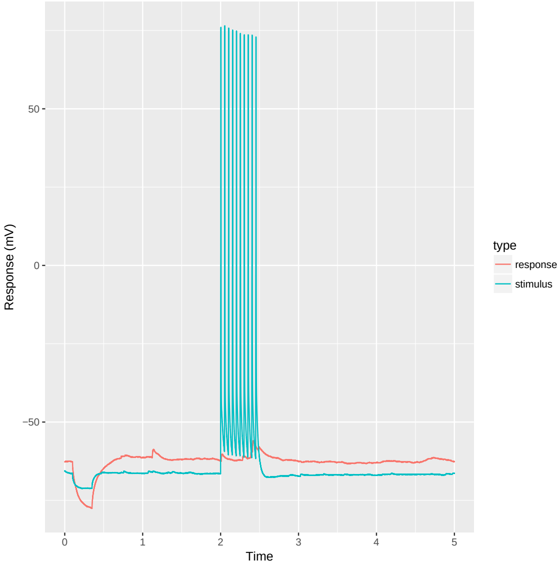

Figure: Wave files of the stimulus and response

Extracting Post-synaptic Response Amplitudes

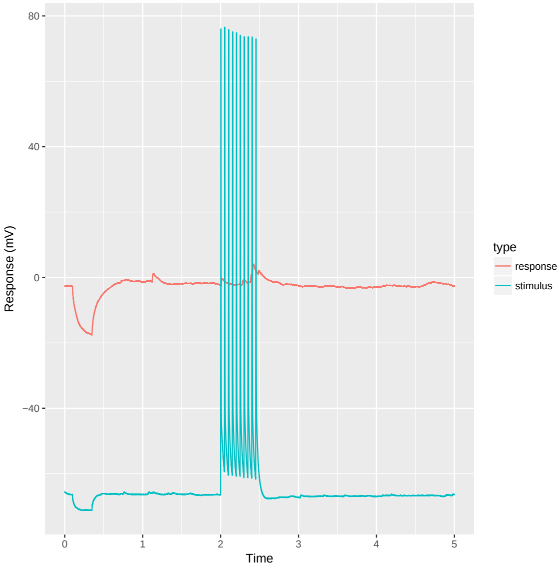

Figure: Moving the responses next to the stimuli

Extracting Post-synaptic Response Amplitudes

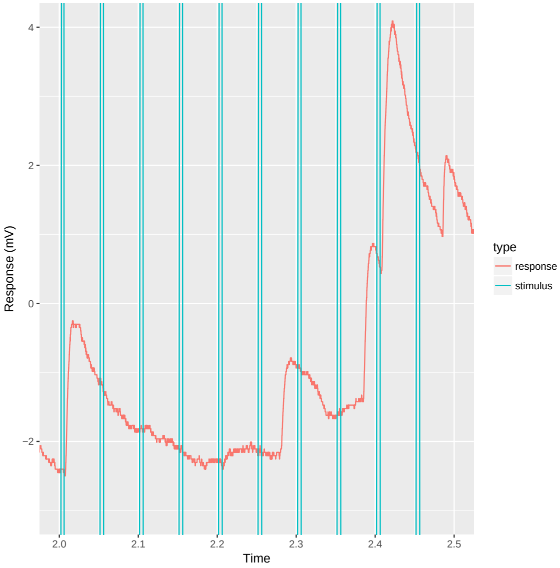

Figure: Zooming in on the stimuli and responses

Extracting Post-synaptic Response Amplitudes

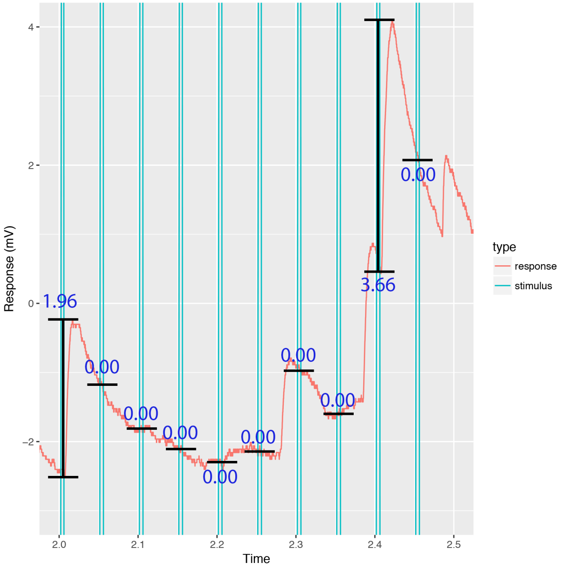

Figure: Extracting the response amplitudes

A More Typical Wave Response

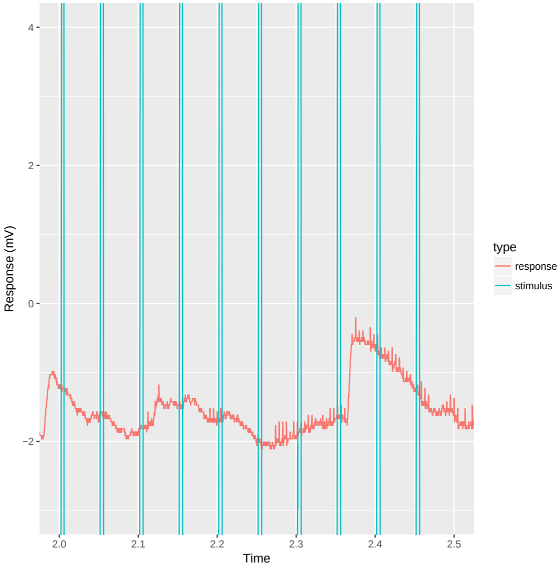

Figure: A sweep with more failures

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Compound Binomial Distribution Model

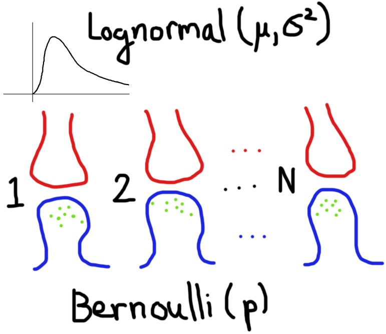

Figure: Compound binomial distribution model

Mathematical Description

$$X = \sum_{j=1}^{N} X_j,\ Y_j \sim \text{Bernoulli}(p), \begin{cases} (X_j \mid Y_j = 1) \sim \text{Lognormal}(\mu, \sigma^2) \\ (X_j \mid Y_j = 0) \sim 0 \end{cases}$$

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Post-synaptic Amplitude Distribution Over Trials

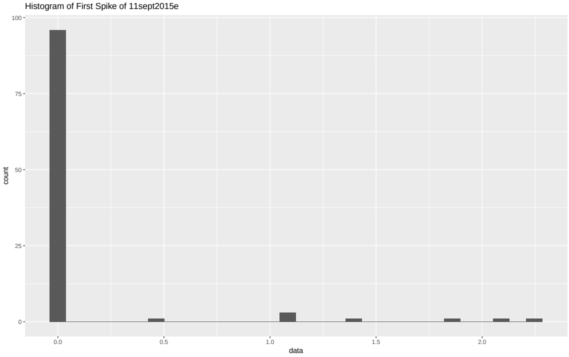

Figure: Example of observed distribution

Inference of Parameters Assuming the Binomial Model

- Method of Moments guesses the parameters μ, σ^2, p by matching sample properties to the theoretical values of the properties.
- In our case, we match the failure rate, mean value, and variance.
- If p_f is the failure rate, $\overline{X}$ is the sample mean, and S^2 is the sample variance, then

$$p = 1 - \sqrt[N]{p_f}$$

$$\begin{pmatrix} \mu \\ \sigma \end{pmatrix} = \begin{pmatrix} -1 & 1 \\ 2 & -1 \end{pmatrix} \begin{pmatrix} \frac{1}{2} \log \left(\frac{S^2}{Np} + \left(\frac{\overline{X}}{Np} \right)^2 \right) \\ 2 \log \left(\frac{\overline{X}}{Np} \right) \end{pmatrix}.$$

Inference of Parameters on Simulated Data

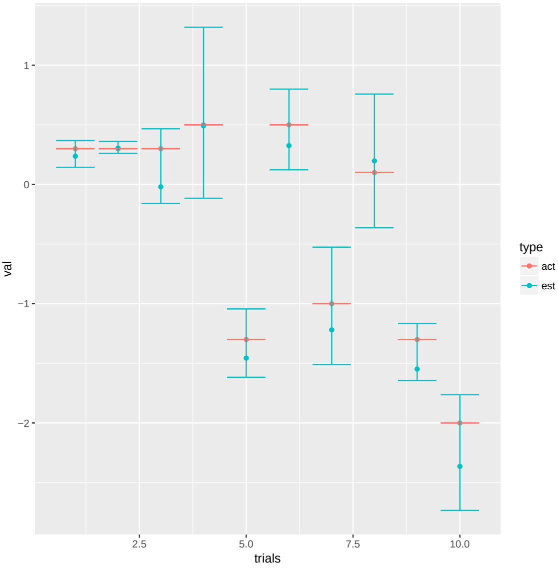

Figure: Inferring μ

Inference of Parameters on Simulated Data

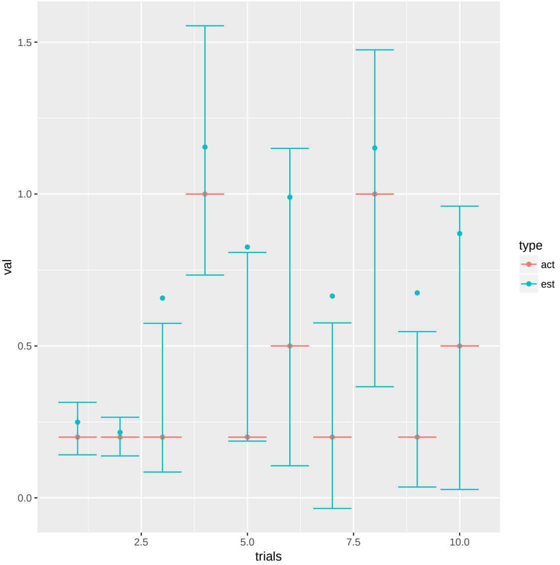

Figure: Inferring σ

Inference of Parameters on Simulated Data

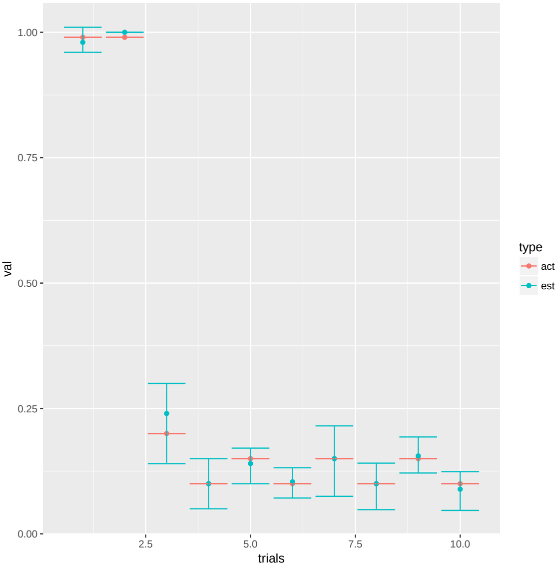

Figure: Inferring p

Comparison of Simulated Model Against the Data

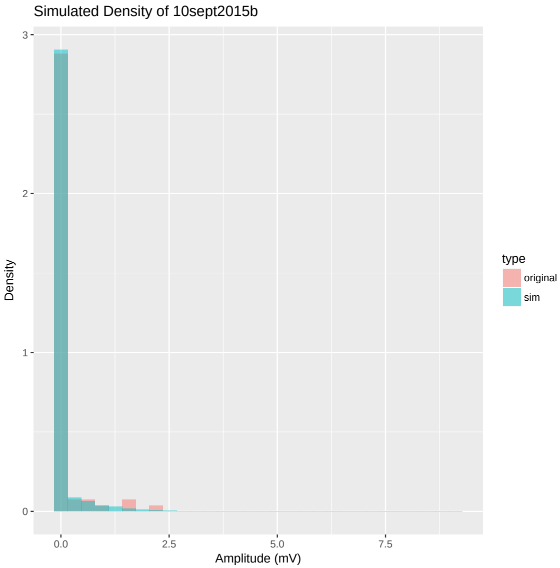

Figure: Simulating from the inferred model

Comparison of Simulated Model Against the Data

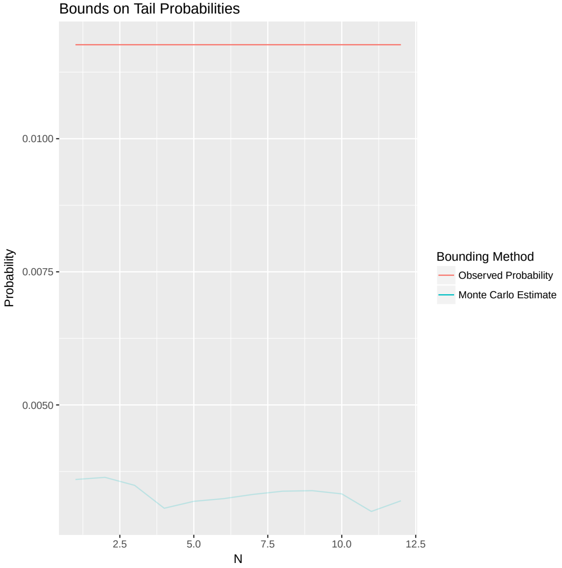

Figure: Monte Carlo estimate of tail probabilities