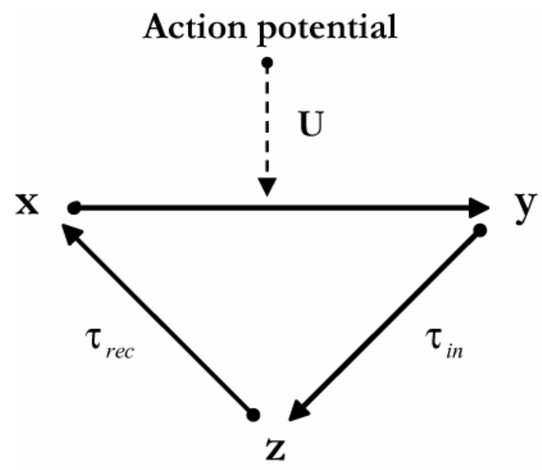
Short-term synaptic depression

$$\tau_{\text{in}} << \tau_{\text{rec}}$$

$$\dot{x} = \frac{1-x}{\tau_{\text{rec}}} - Ux\delta(t - \vec{t}_{\text{sp}})$$

$$\dot{y} = -\frac{y}{\tau_{\text{in}}} + Ux\delta(t - \vec{t}_{\text{sp}})$$

$$\tau_{\text{mem}}\dot{V} = -V + Ay$$



The spike timings:

$$\vec{\boldsymbol{t}}_{\boldsymbol{sp}} = \{\boldsymbol{t}_{\boldsymbol{sp}}^{1}, \boldsymbol{t}_{\boldsymbol{sp}}^{2}, \ldots, \boldsymbol{t}_{\boldsymbol{sp}}^{9}\}$$

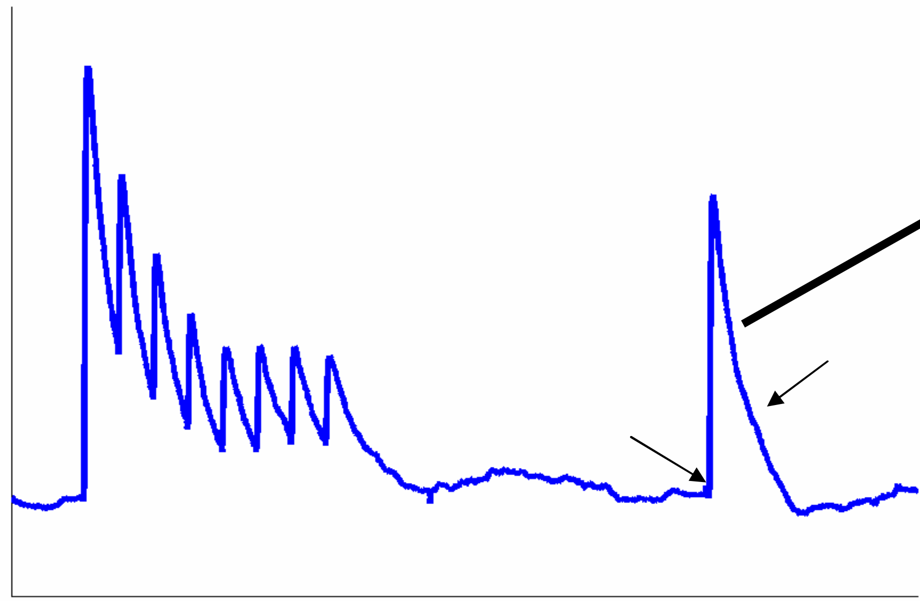
The synaptic parameters:

$$\boldsymbol{A}, \boldsymbol{U}, \boldsymbol{\tau}_{\boldsymbol{rec}}, \boldsymbol{\tau}_{\boldsymbol{in}}$$

The cell parameter:

$$\boldsymbol{\tau}_{\boldsymbol{mem}}$$

The fitting process



$$\tau_{mem}, \tau_{in}$$

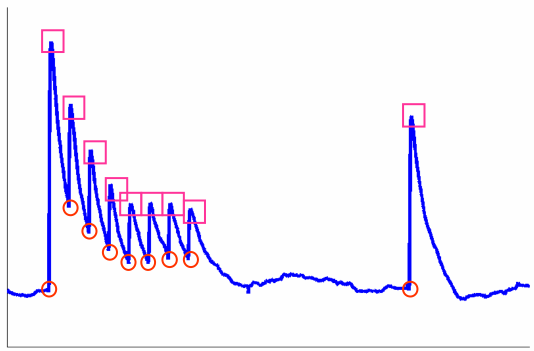
$$\dot{y} = -\frac{y}{\tau_{in}} + Ux\delta(t - \vec{t}_{sp})$$

$$\tau_{mem}\dot{V} = -V + Ay(t)$$

$$y(t) = y(0) \cdot e^{-\frac{t}{\tau_{in}}}, \quad y(0) = 1$$

$$V(t) = \frac{B \cdot \tau_{in}}{\tau_{in} - \tau_{mem}} \cdot (e^{-\frac{t}{\tau_{in}}} - e^{-\frac{t}{\tau_{mem}}})$$

The fitting process



$$\dot{x} = \frac{1-x}{\tau_{rec}} - Ux\delta(t - \vec{t}_{sp}) \longrightarrow$$

$$\dot{y} = -\frac{y}{\tau_{in}} + Ux\delta(t - \vec{t}_{sp})$$

$$\tau_{mem}\dot{V} = -V + Ay$$

$$x_1 = 1$$

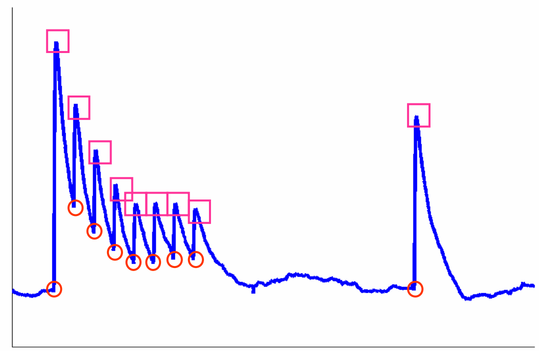
for $n = 2:8$

$$x_n = x_{n-1} \cdot (1-U) \cdot e^{-\frac{\Delta T_1}{\tau_{rec}}} + 1 - e^{-\frac{\Delta T_1}{\tau_{rec}}}$$

for $n = 9$

$$x_n = x_{n-1} \cdot (1-U) \cdot e^{-\frac{\Delta T_2}{\tau_{rec}}} + 1 - e^{-\frac{\Delta T_2}{\tau_{rec}}}$$

The fitting process



$$\alpha_n = A \cdot U \cdot x_n$$

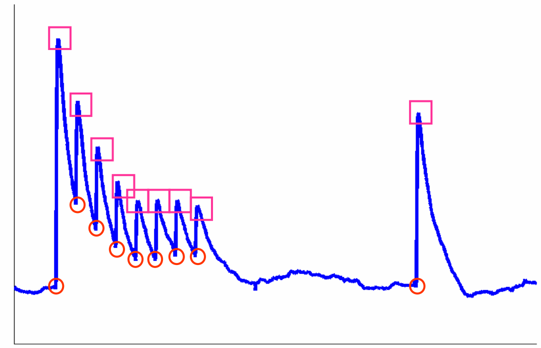
$$V0_1 = 0$$

for $n = 2:8$

$$VMax_{n-1} = \alpha_{n-1} \cdot \left(\frac{\alpha_{n-1} \cdot \tau_{mem}}{\alpha_{n-1} \cdot \tau_{in} - V0_{n-1} \cdot (\tau_{in} - \tau_{mem})}\right)^{\frac{\tau_{mem}}{\tau_{in} - \tau_{mem}}}$$

$$V0_n = V0_{n-1} \cdot e^{-\frac{\Delta T_1}{\tau_{mem}}} + \frac{\alpha_{n-1} \cdot \tau_{in}}{(\tau_{in} - \tau_{mem})} \cdot \left(e^{-\frac{\Delta T_1}{\tau_{in}}} - e^{-\frac{\Delta T_1}{\tau_{mem}}}\right)$$

The fitting process



$$VMax_8 = \alpha_8 \cdot \left(\frac{\alpha_8 \cdot \tau_{mem}}{\alpha_8 \cdot \tau_{in} - V0_8 \cdot (\tau_{in} - \tau_{mem})}\right)^{\frac{\tau_{mem}}{\tau_{in} - \tau_{mem}}}$$

$$V0_9 = V0_8 \cdot e^{-\frac{\Delta T_2}{\tau_{mem}}} + \frac{\alpha_8 \cdot \tau_{in}}{(\tau_{in} - \tau_{mem})} \cdot \left(e^{-\frac{\Delta T_2}{\tau_{in}}} - e^{-\frac{\Delta T_2}{\tau_{mem}}}\right)$$

$$VMax_9 = \alpha_9 \cdot \left(\frac{\alpha_9 \cdot \tau_{mem}}{\alpha_9 \cdot \tau_{in} - V0_9 \cdot (\tau_{in} - \tau_{mem})}\right)^{\frac{\tau_{mem}}{\tau_{in} - \tau_{mem}}}$$

$$Amp = VMax - V0$$

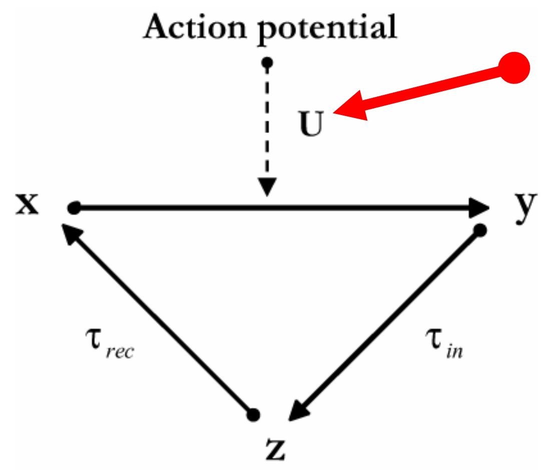
The Jackknife measures

$$\mathrm{Std} = \sqrt{\frac{\boxed{J-1}}{J}\sum_{i=1}^{J}\left(\mathrm{Par}_i - <\mathrm{Par}>\right)^2}$$

$$<\mathrm{Par}> = \frac{1}{J}\sum_{i=1}^{J}\mathrm{Par}_i$$

$$\mathrm{CV} = \frac{\mathrm{Std}}{<\mathrm{Par}>}$$

Short-term synaptic facilitation



$$\dot{x} = \frac{z}{\tau_{rec}} - \boxed{u(t)} \cdot x\delta(t - \vec{t}_{sp})$$

$$\dot{y} = -\frac{y}{\tau_{in}} + \boxed{u(t)} \cdot x\delta(t - \vec{t}_{sp})$$

$$\dot{z} = \frac{y}{\tau_{in}} - \frac{z}{\tau_{rec}}$$

$$\dot{u} = -\frac{u}{\boxed{\tau_{facil}}} + U \cdot (1 - u)\delta(t - \vec{t}_{sp})$$