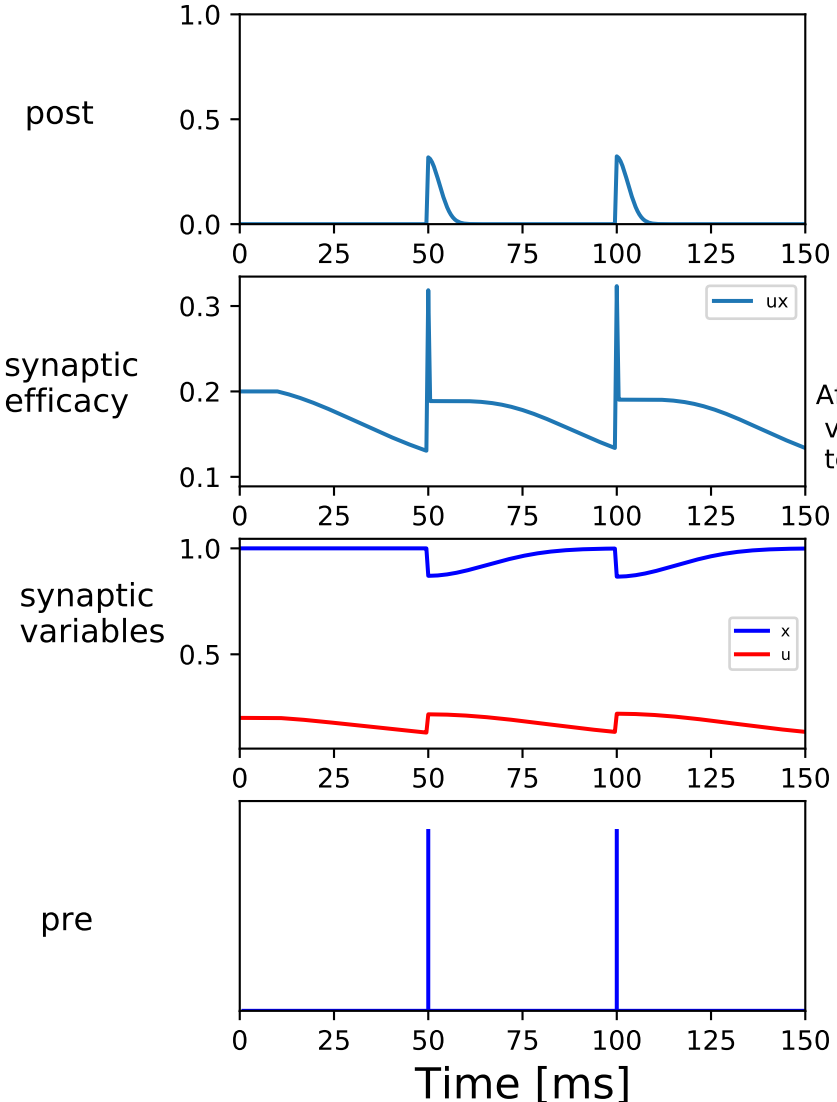
Tsodyks-Uziel-Markram model for short term synaptic plasticity



Short-term synaptic plasticity model

$$\frac{dx}{dt} = \frac{1-x}{\tau_D} - ux\delta(t-t_{sp}) \quad \text{(Depre)}$$

$$\frac{du}{dt} = \frac{U-u}{\tau_F} + U(1-u)x\delta(t-t_{sp}) \quad \text{(Facil)}$$

Synaptic input current

$$\frac{dI_{syn}}{dt} = -\frac{I_{syn}}{\tau_{syn}} + ux\delta(t-t_{sp})$$

After neuronal spiking: (u returns to its basline value U with a time constant τ_F, and x recovers to its maximum value $x = 1$ with a time constant τ_D)

$$u = U + (u-U) * \exp(-(t-\text{lastupdate})/\tau_F)$$
$$x = 1 + (x-1) * \exp(-(t-\text{lastupdate})/\tau_D)$$
$$I_{syn} = I_{syn} * \exp(-(t-\text{lastupdate})/\tau_{syn})$$

Upon arrival of a spike (each presynaptic spike triggers modifications of the variables)

$$x \leftarrow x * (1-u)$$
$$u \leftarrow u + U * (1-u)$$
$$I_{syn} \leftarrow I_{syn} + ux$$

Depressing ($\tau_D > \tau_F$) and facilitating ($\tau_F > \tau_D$).

References:
Tsodyks et al.,J.Neurosci. 20, RC50(2000).
Mongillo et al.,Science,319(2008).
Mi et al., Neuron, 93(2017).