УНИВЕРСИТЕТ ЛОБАЧЕВСКОГО
НИЖЕГОРОДСКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ

# Using two interconnected reservoirs to predict mouse hippocampal fEPSP

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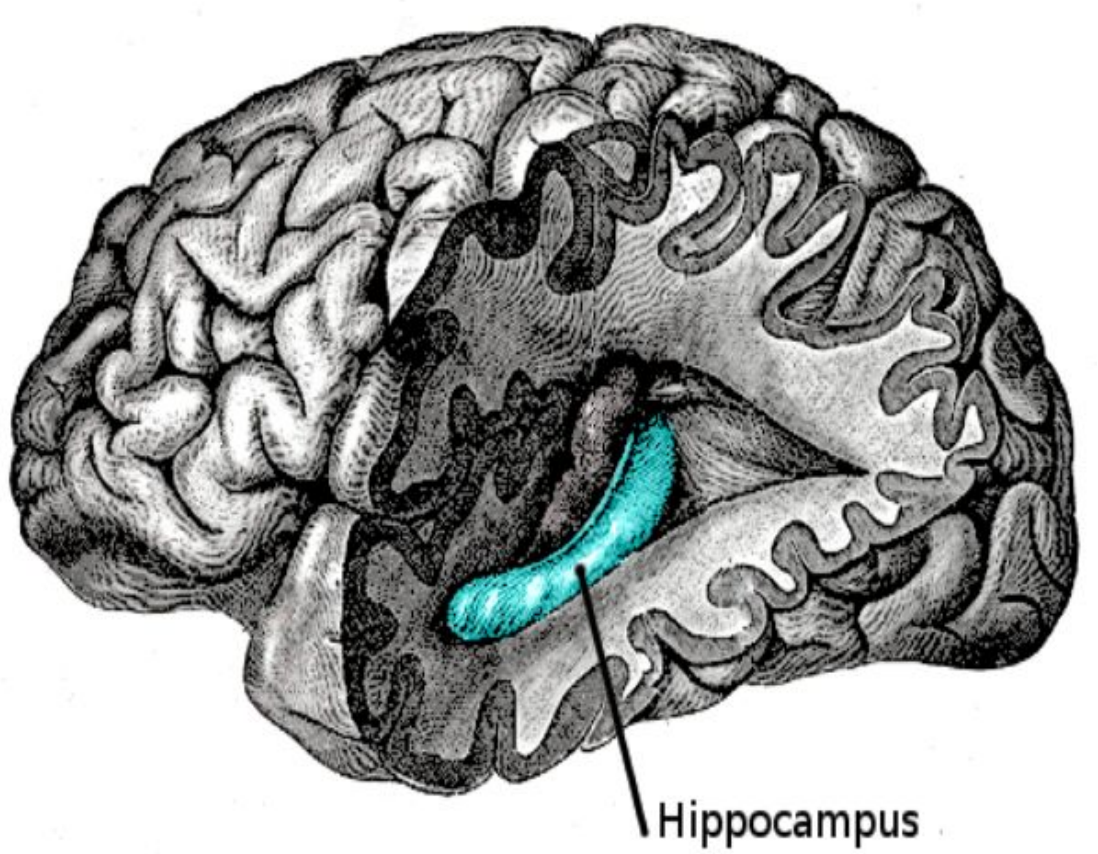
# Biological background

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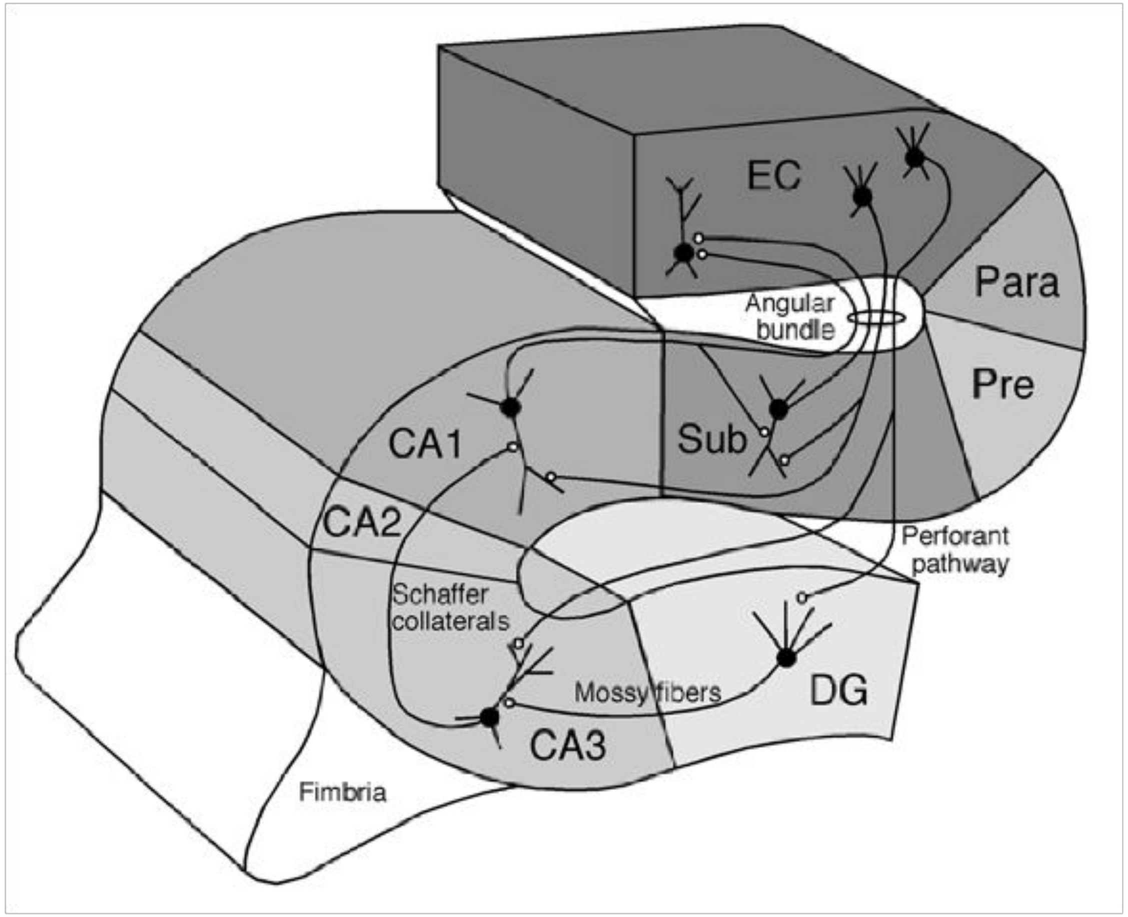
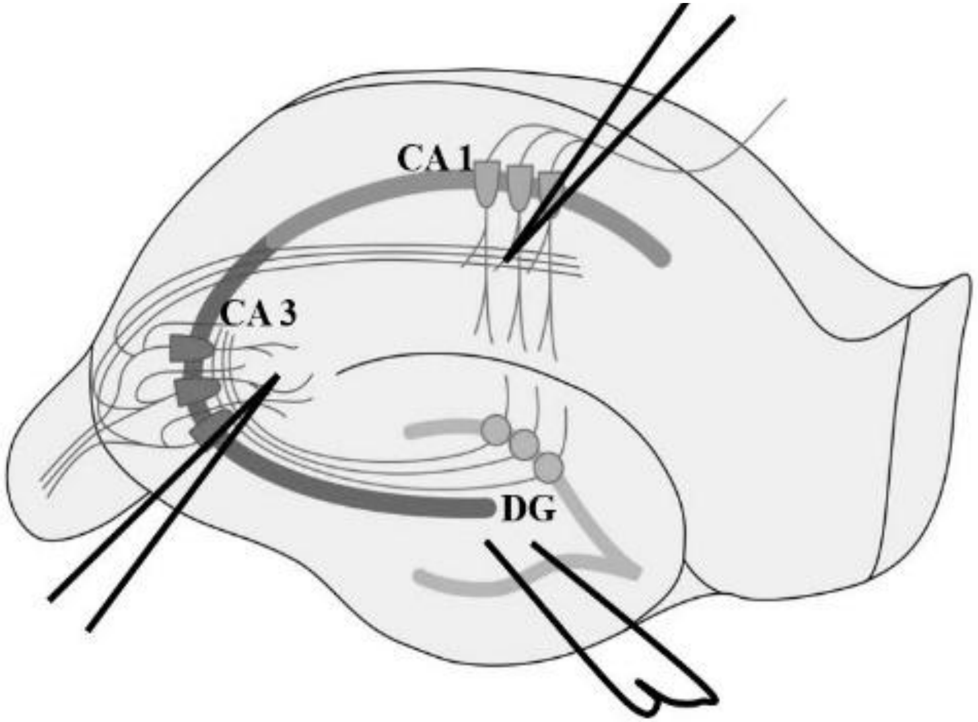
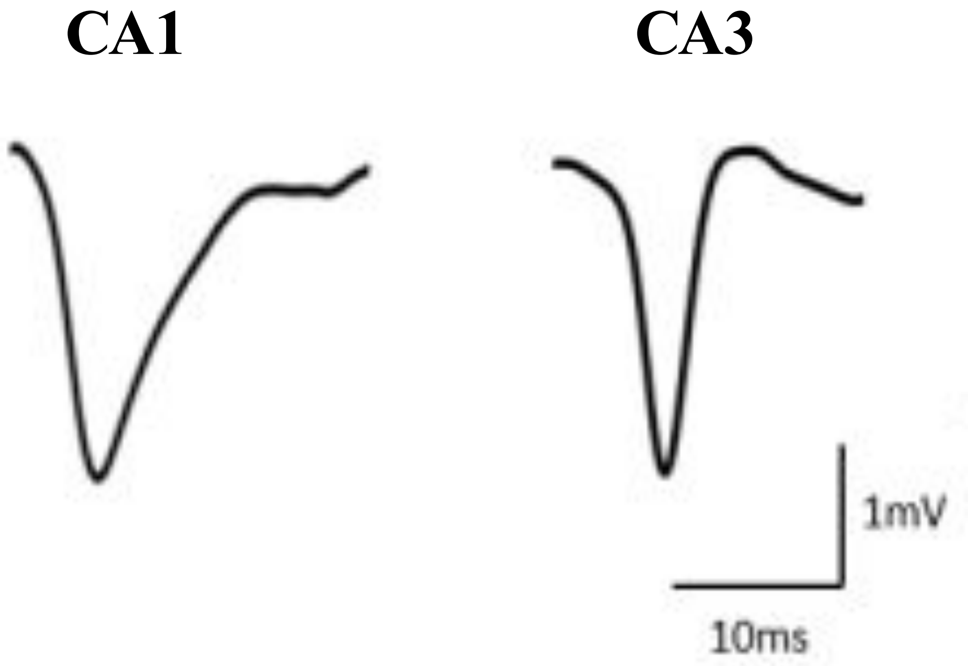


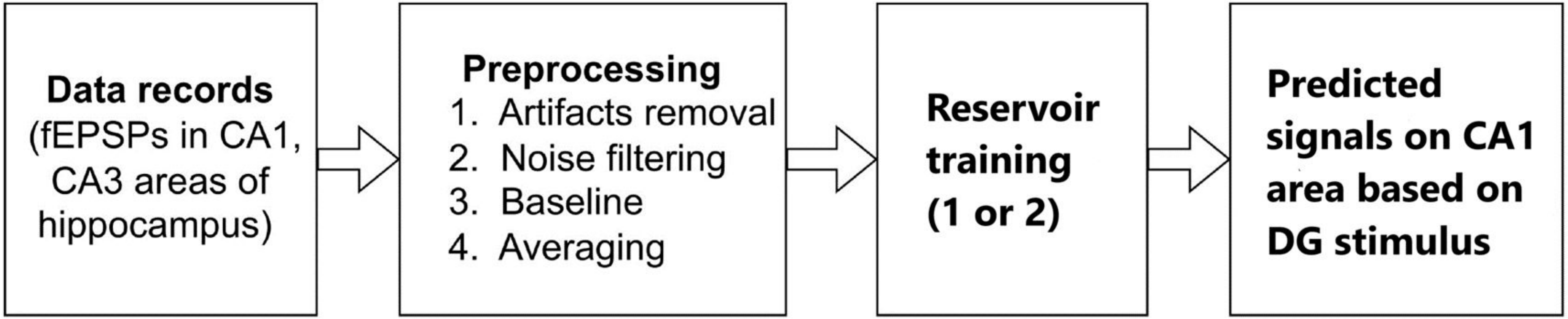

(Per Andersen et. al., 2007)

# Experiment on a hippocampal slice

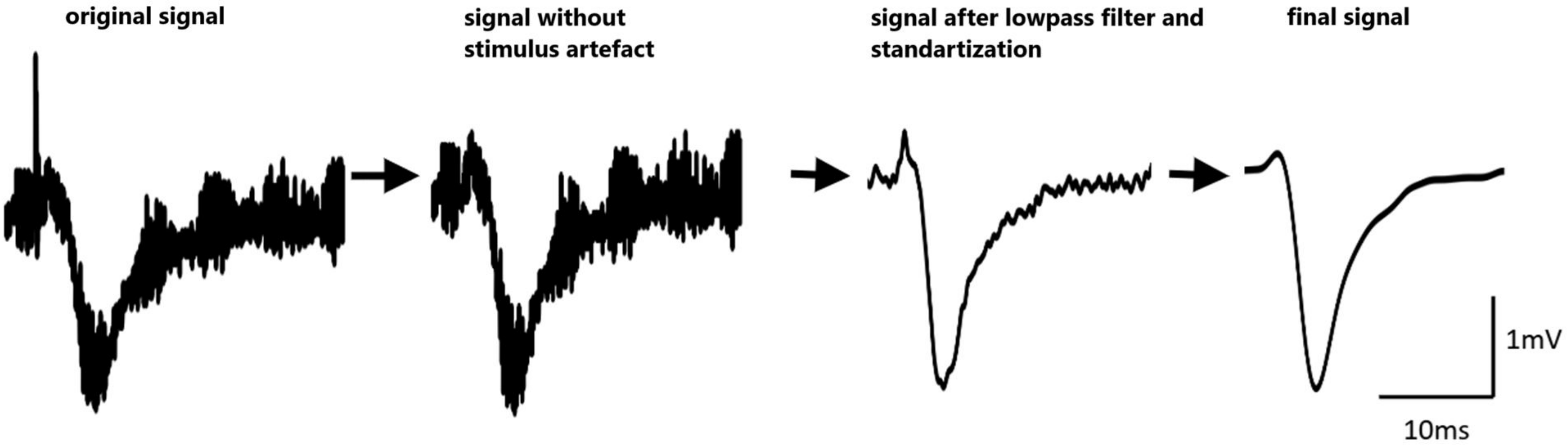


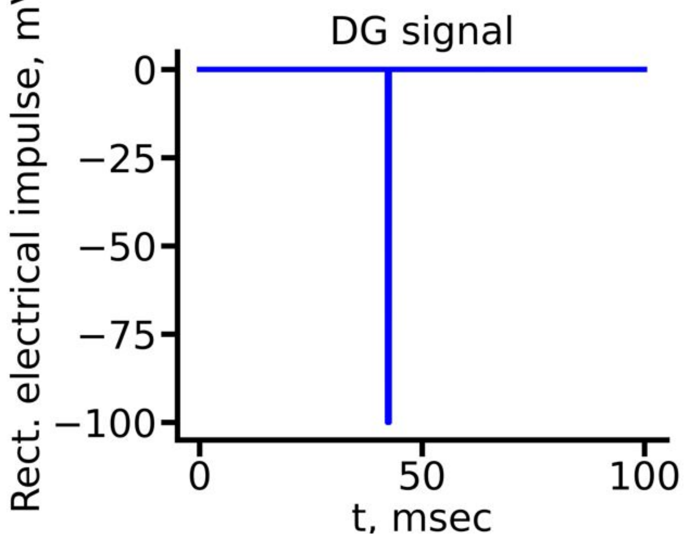
# Pipeline for data processing



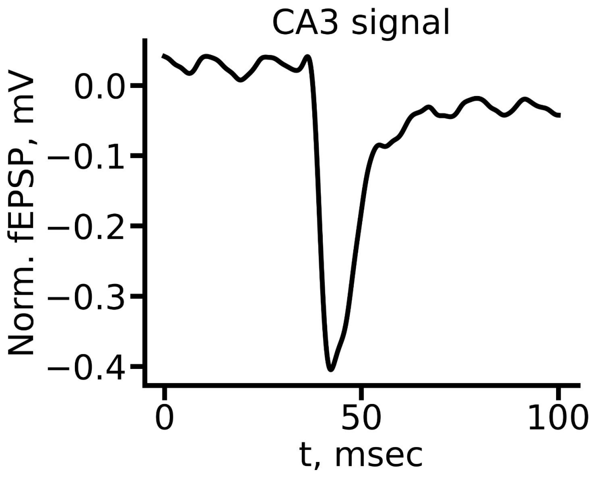
# Data preprocessing

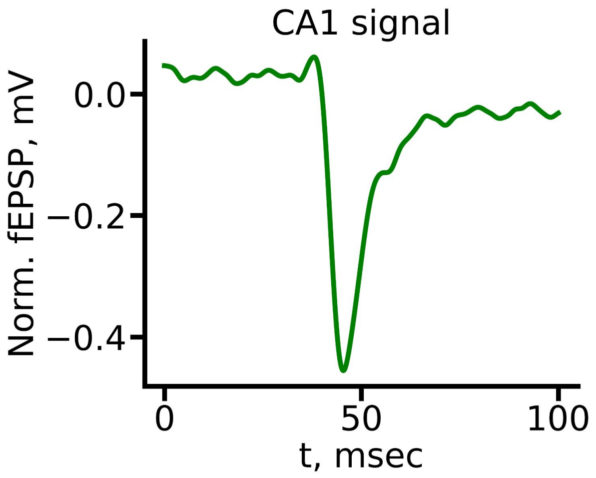


# Three signals on the conducting pathway




Input signal

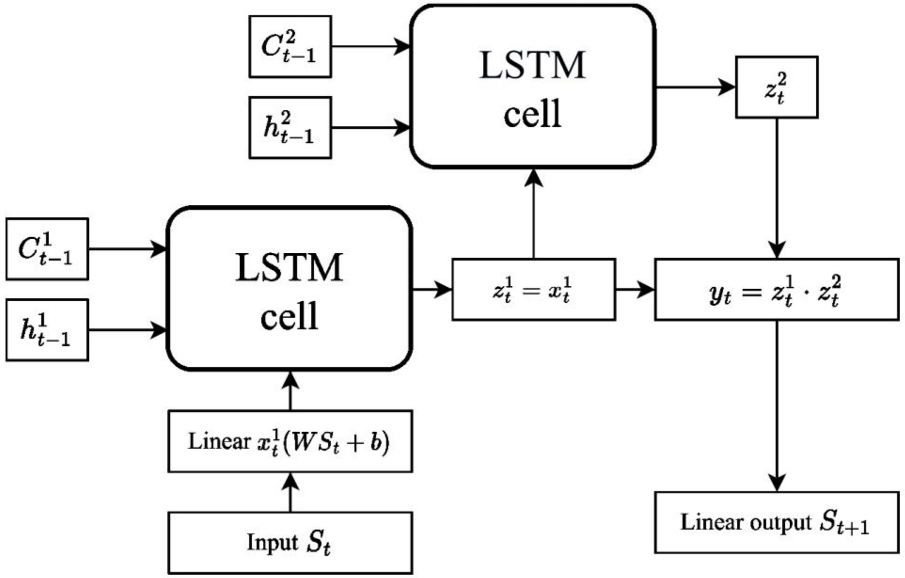


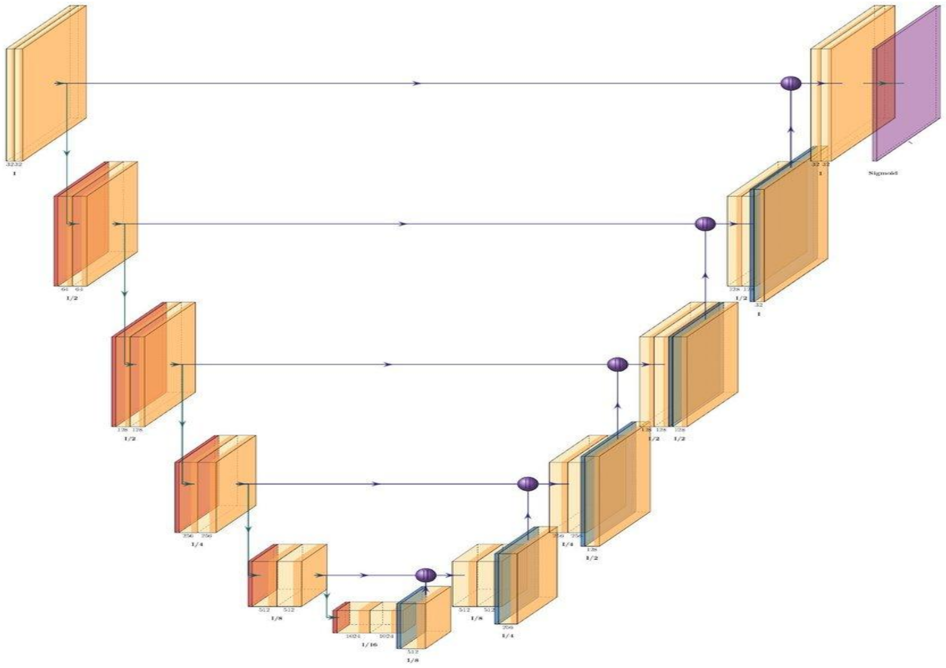

Output signals

# Another neural network approaches

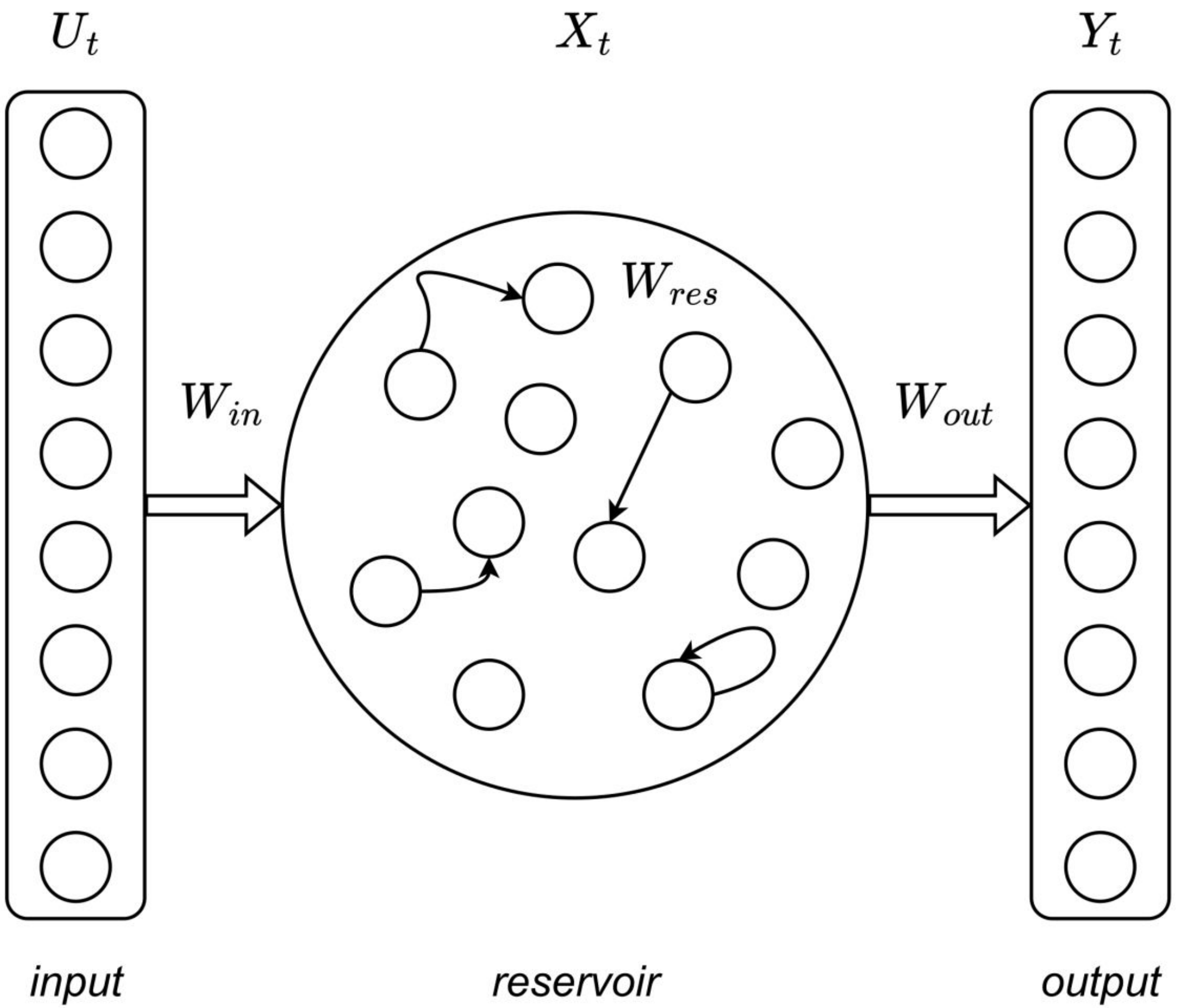
## LSTM




## Convolutional NN



# Reservoir architecture




Final pipeline

$$x(t) = f(W_{in}u(t) + W_{res}x(t-1))$$
$$y(t) = W_{out}x(t)$$

Reservoir

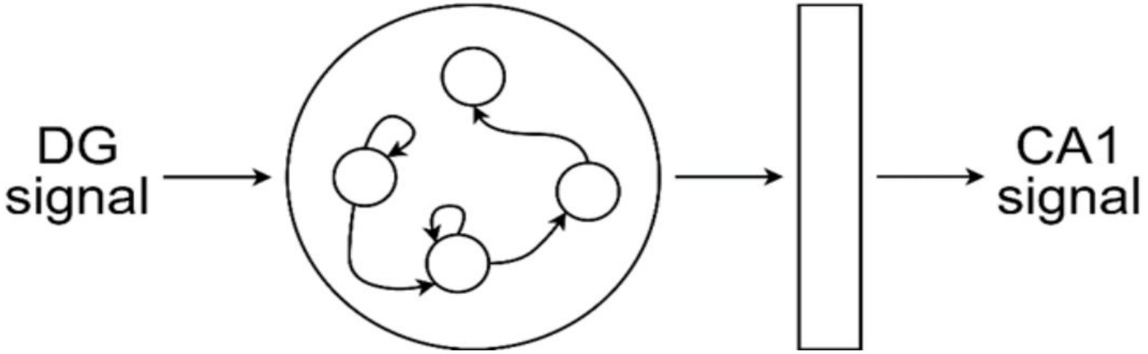
$$s[n+1] = (1 - lr) \cdot s[t] + \alpha \cdot f(W_{in} \cdot x[n] + W \cdot s[t])$$

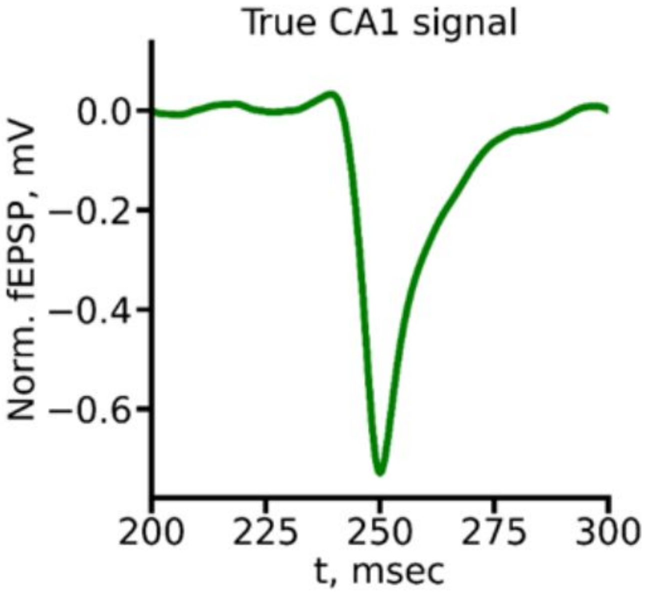
Ridge

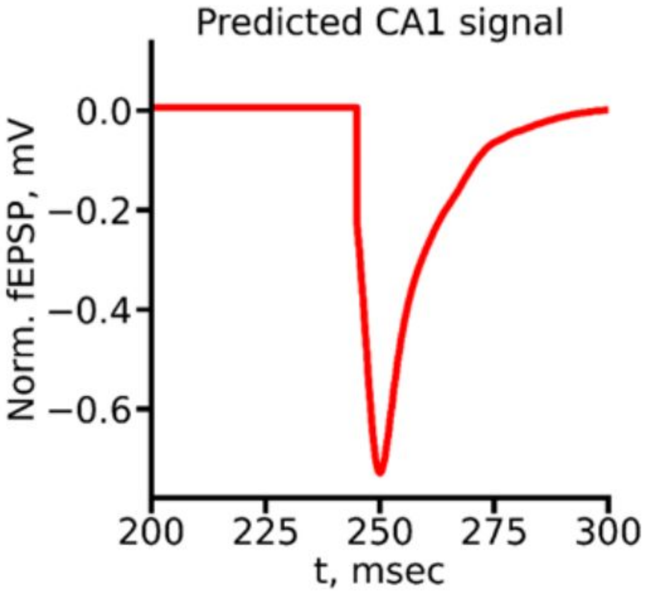
$$\min_{W_{out}} ||W_{out}X - Y||_2^2$$

$$W_{out} = Y \cdot X^{-1}$$

# One reservoir



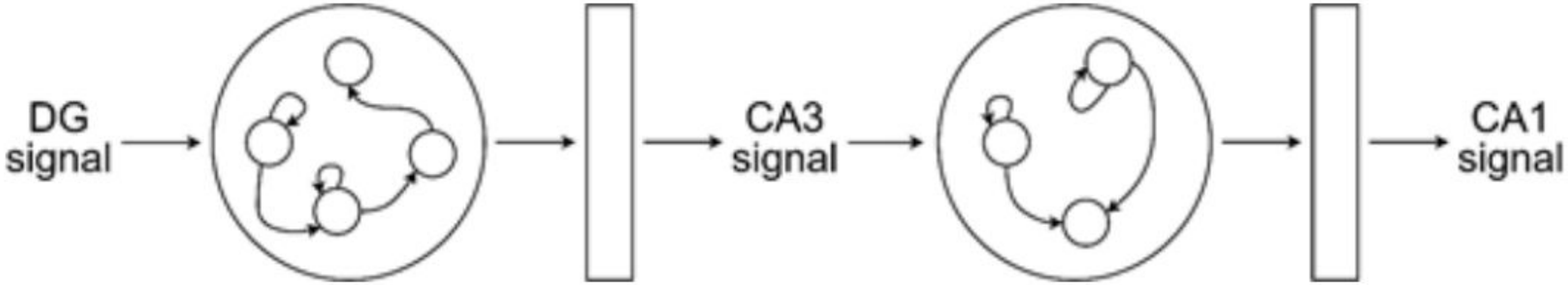



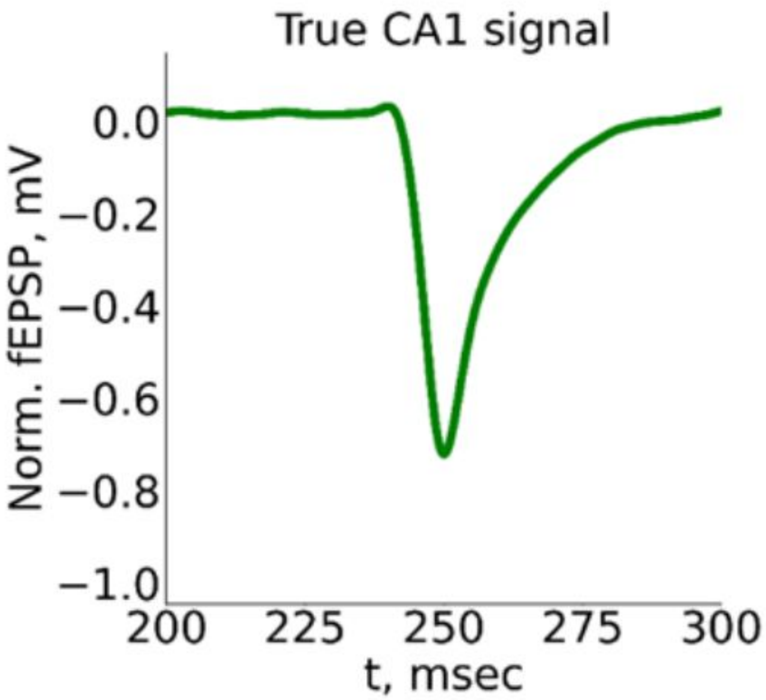



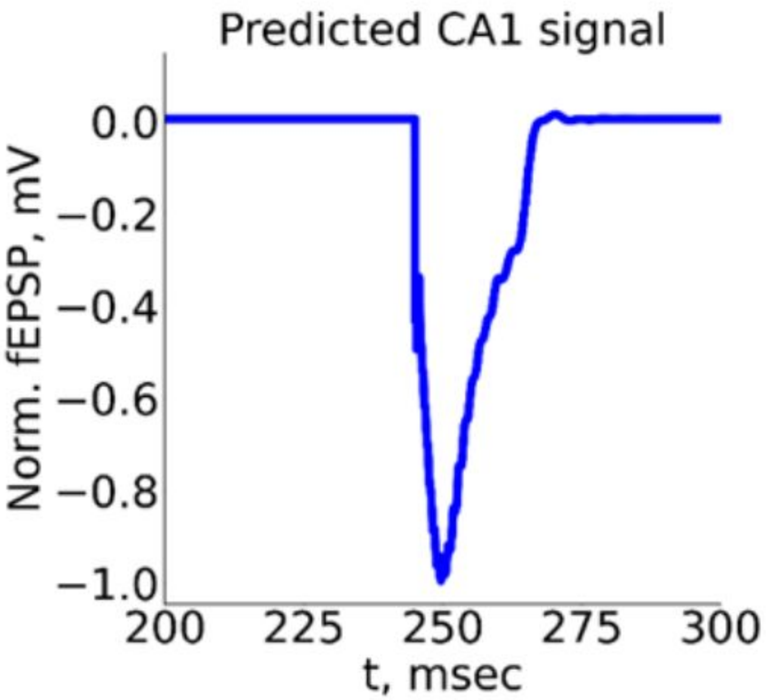

Best parameters:

Size: **290 neurons**
Connectivity: 0.5
Spectral radius: 1.5
Leakage: 0.25

# Two interconnected reservoirs



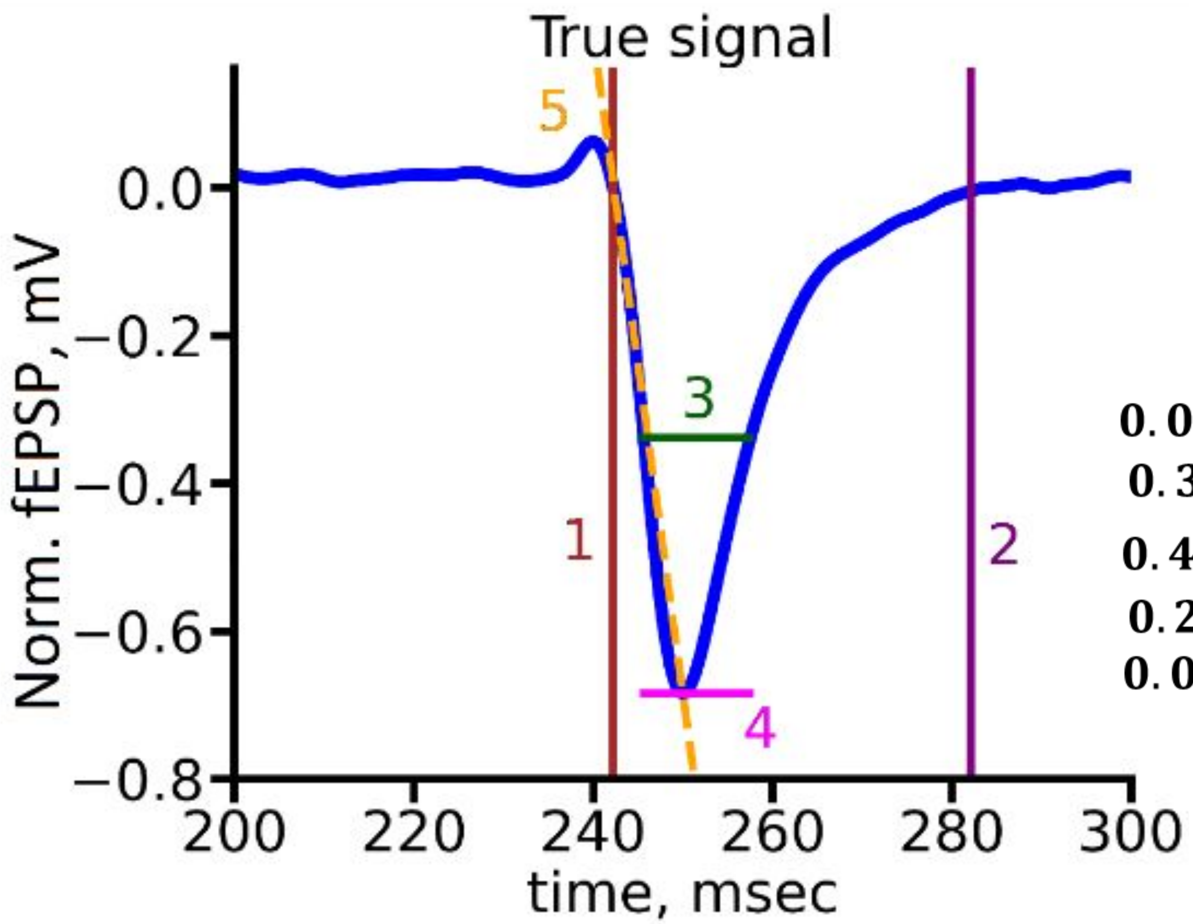




Best parameters:

Reservoir 1:
Size: **290 neurons**
Connectivity: 0.5
Spectral radius: 1.5
Leakage: 0.25

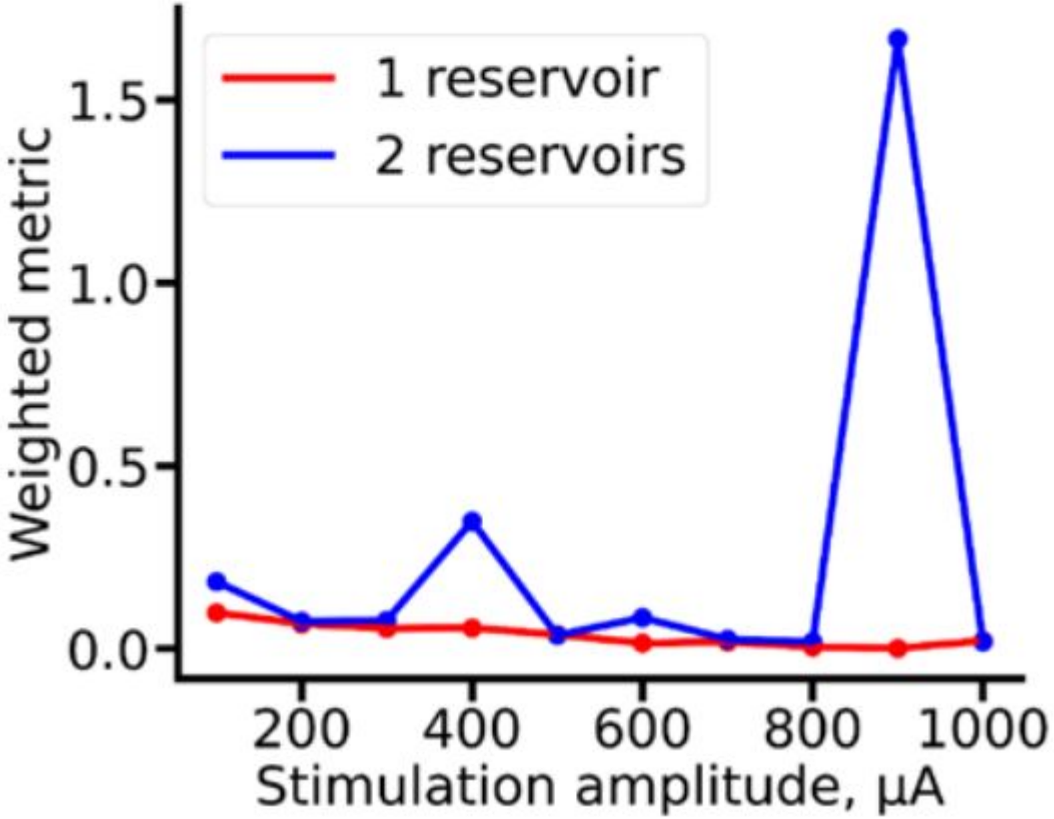
Reservoir 2:
Size: **10 neurons**
Connectivity: 0.6
Spectral radius: 1.2
Leakage: 0.4

# Biology-based metric




$$metric(y, y^*) =$$
$$\mathbf{0.05} * \left(rise\ time(y) - rise\ time(y^*)\right)^2 +$$
$$\mathbf{0.3} * (decay\ time(y) - decay\ time(y^*)^2 +$$
$$\mathbf{0.4} * \left(response\ halfwidth(y) - responce\ halfwith(y^*)\right)^2 +$$
$$\mathbf{0.2} * (amplitude(y) - amplitude(y^*)^2 +$$
$$\mathbf{0.05} * (slope(y) - slope(y^*))$$

# Metric values for different stimulus amplitudes




Results obtained with 1 reservoir are more stable

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**Papers**


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