Spodbujevano učenje na impulznih nevronskih mrežah

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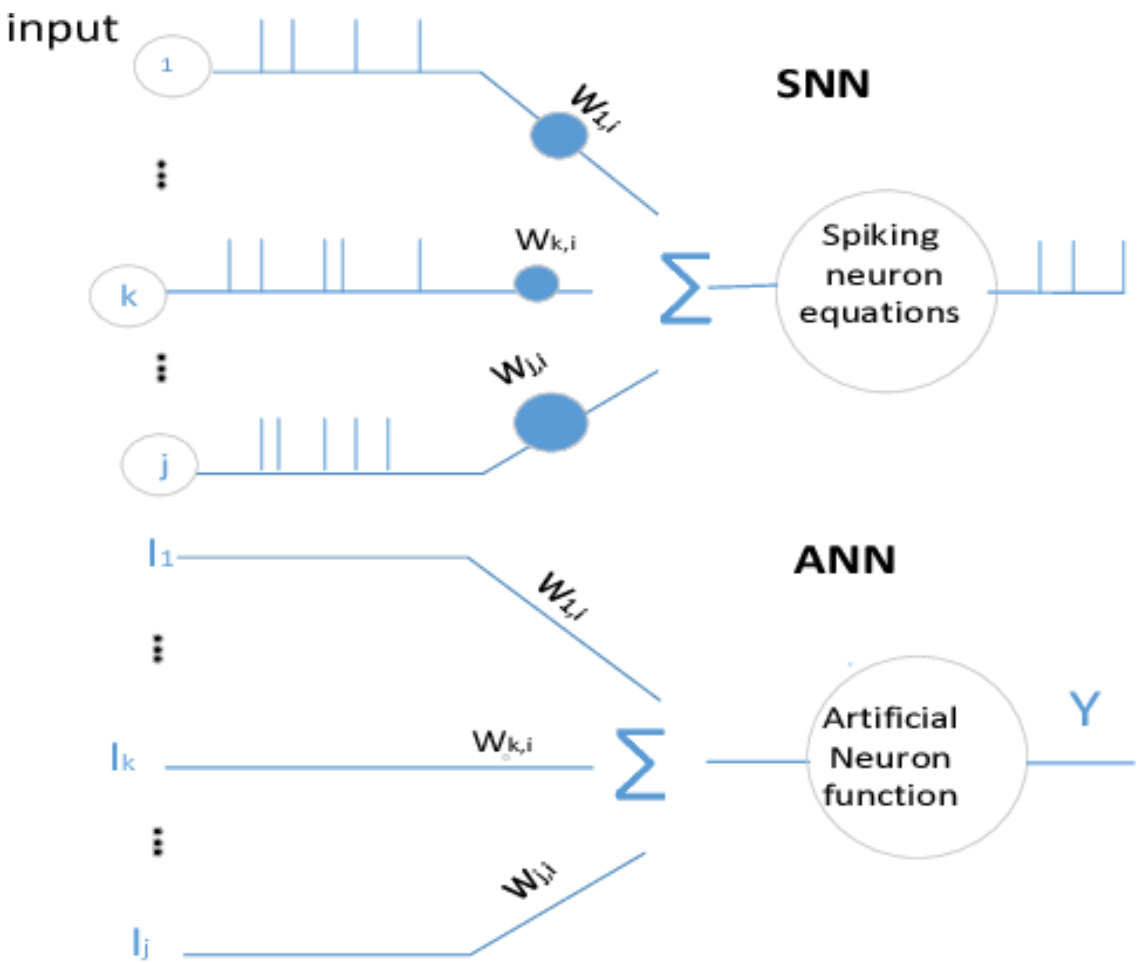
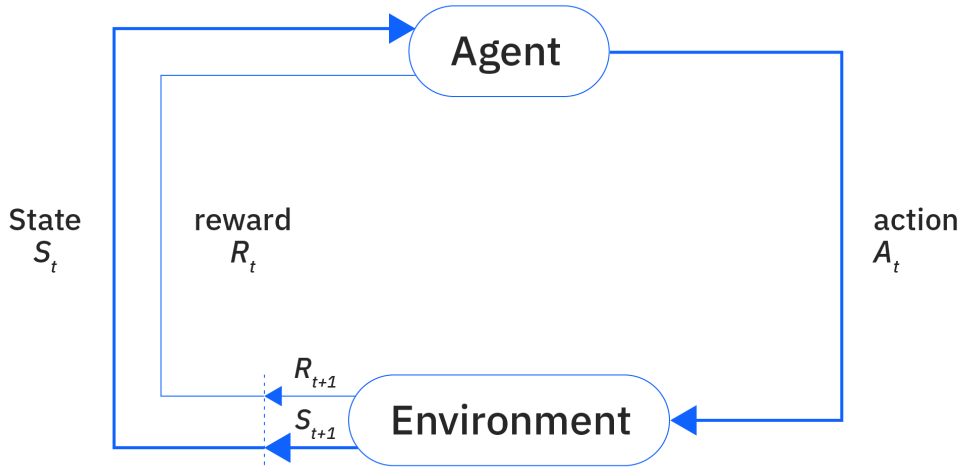
Overview

Impulzna vs umetna nevronska mreža



Source: [Gündüz, 2021]

Spodbujevano učenje



Source: [IBM, 2023]

Modeliranje nevronov in sinaps

$$w_{ij}^{new} = w_{ij}^{old} + \alpha\, f_i(a_{iq}) g_j(p_{jq})$$

Presynaptic Signal

Postsynaptic Signal

Simplified Form:

$$w_{ij}^{new} = w_{ij}^{old} + \alpha a_{iq} p_{jq}$$

Supervised Form:

$$w_{ij}^{new} = w_{ij}^{old} + t_{iq} p_{jq}$$

Matrix Form:

$$\mathbf{W}^{new} = \mathbf{W}^{old} + \mathbf{t}_q \mathbf{p}_q^T$$

Source: [SlidePlayer, n.d.]

Modeliranje nevronov in sinaps

Basic Rule: $\mathbf{W}^{new} = \mathbf{W}^{old} + \mathbf{t}_q \mathbf{p}_q^T$

Learning Rate: $\mathbf{W}^{new} = \mathbf{W}^{old} + \alpha \mathbf{t}_q \mathbf{p}_q^T$

Smoothing: $\mathbf{W}^{new} = \mathbf{W}^{old} + \alpha \mathbf{t}_q \mathbf{p}_q^T - \gamma \mathbf{W}^{old} = (1-\gamma)\mathbf{W}^{old} + \alpha$

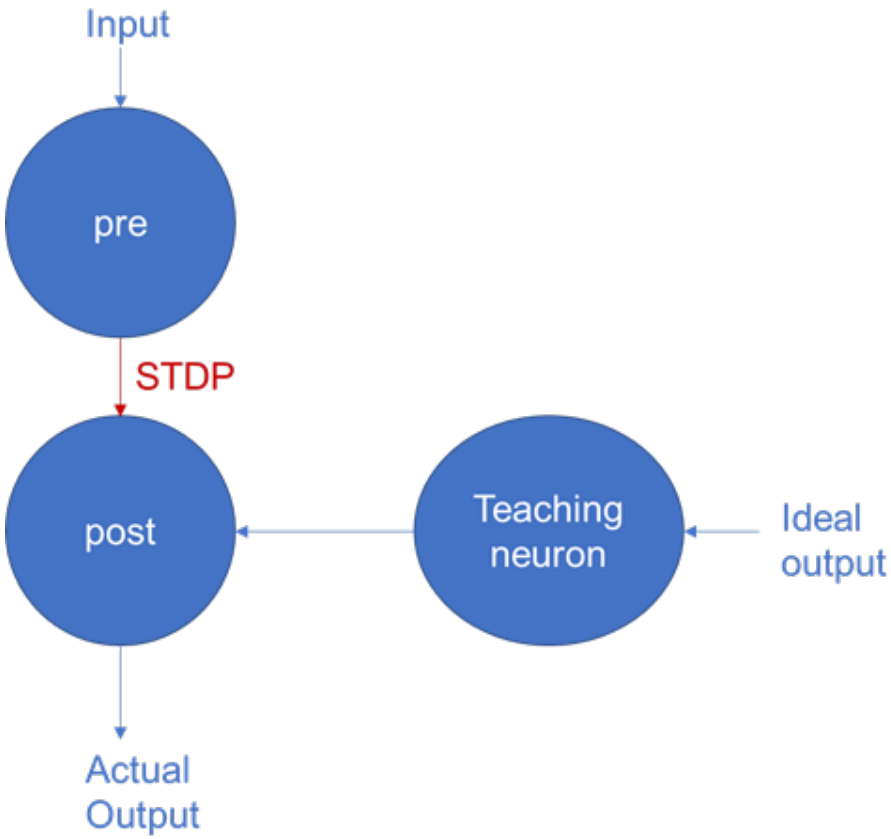
Delta Rule: $\mathbf{W}^{new} = \mathbf{W}^{old} + \alpha(\mathbf{t}_q - \mathbf{a}_q)\mathbf{p}_q^T$

Unsupervised: $\mathbf{W}^{new} = \mathbf{W}^{old} + \alpha \mathbf{a}_q \mathbf{p}_q^T$

Source: [SlidePlayer, n.d.]

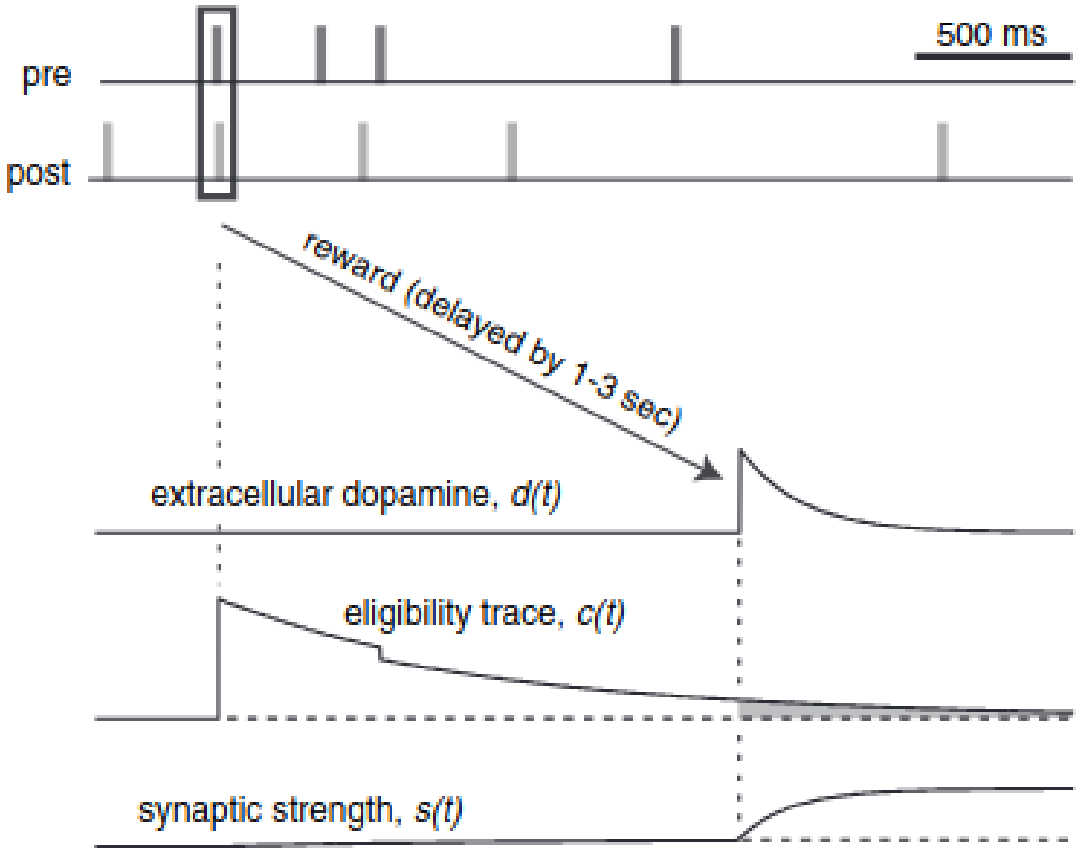
Sinaptična plastičnost odvisna od nagrajevanja in časovne razporeditve impulzov

- angl. *Reward modulated spike timing dependent plasticity - R-STDP*



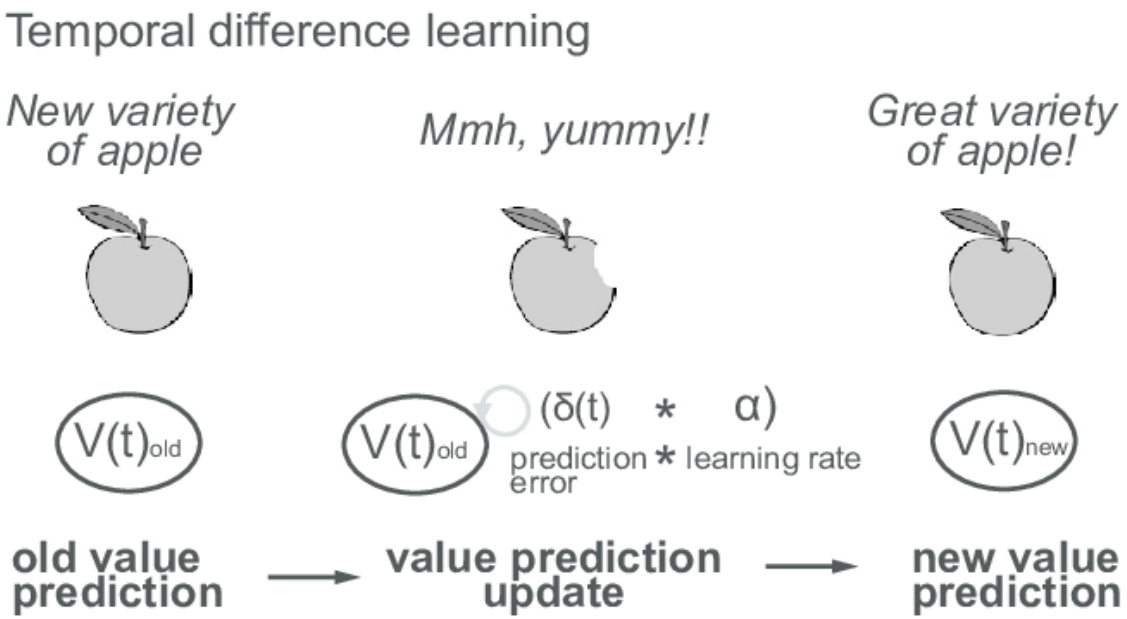
Source: [Nengo Forum, 2020]

Problem oddaljene nagrade in pripisovanja odgovornosti



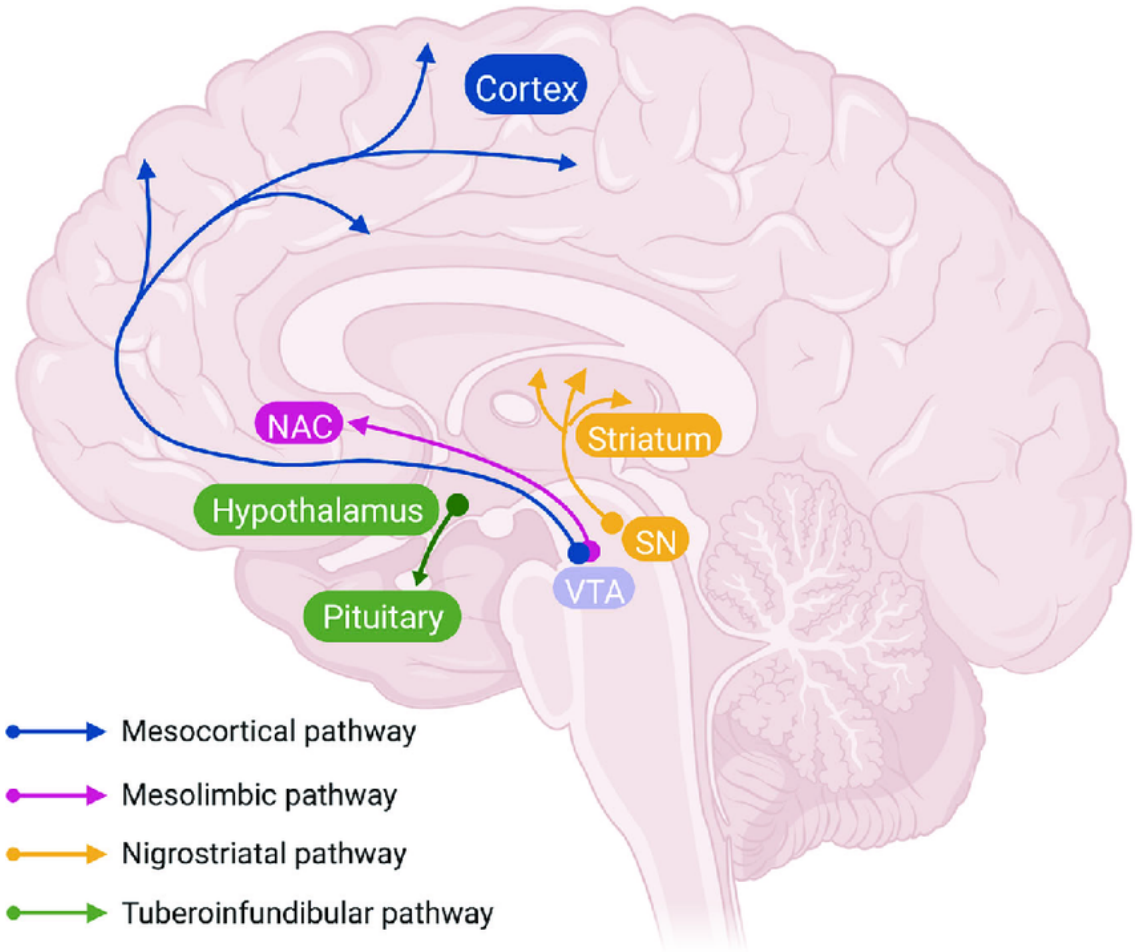
Source: [Izhikevich, 2007]

TD učenje (angl. *Temporal difference learning*)



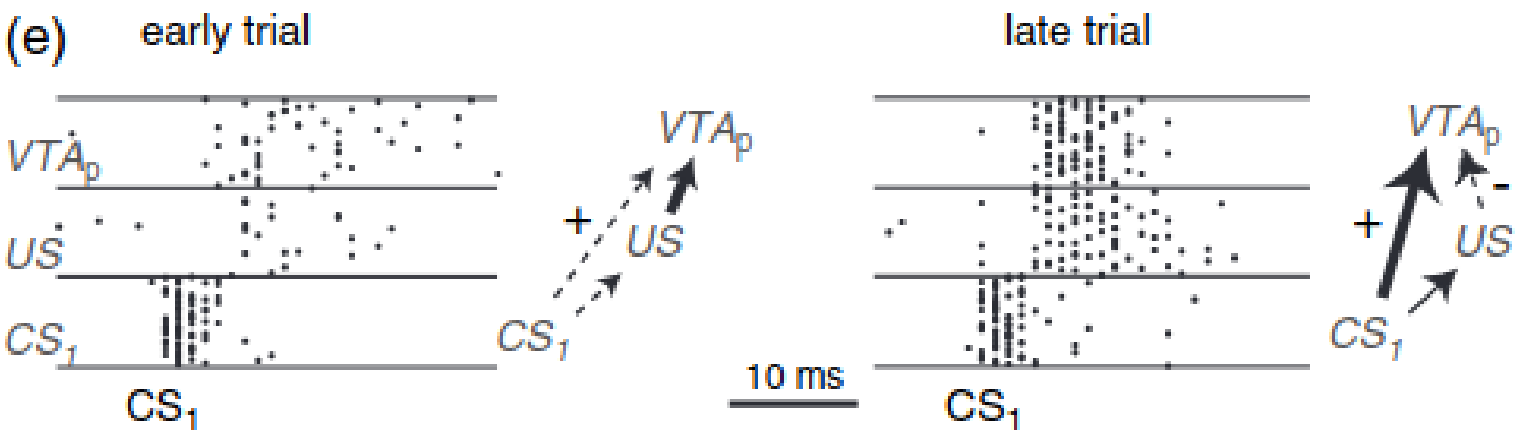
Source: [BotPenguin, 2024]

Človeški dopaminski sistem



Source: [Xu Yang, 2022]

Simulacija dopaminskega sistema



Source:

[Izhikevich, 2007]

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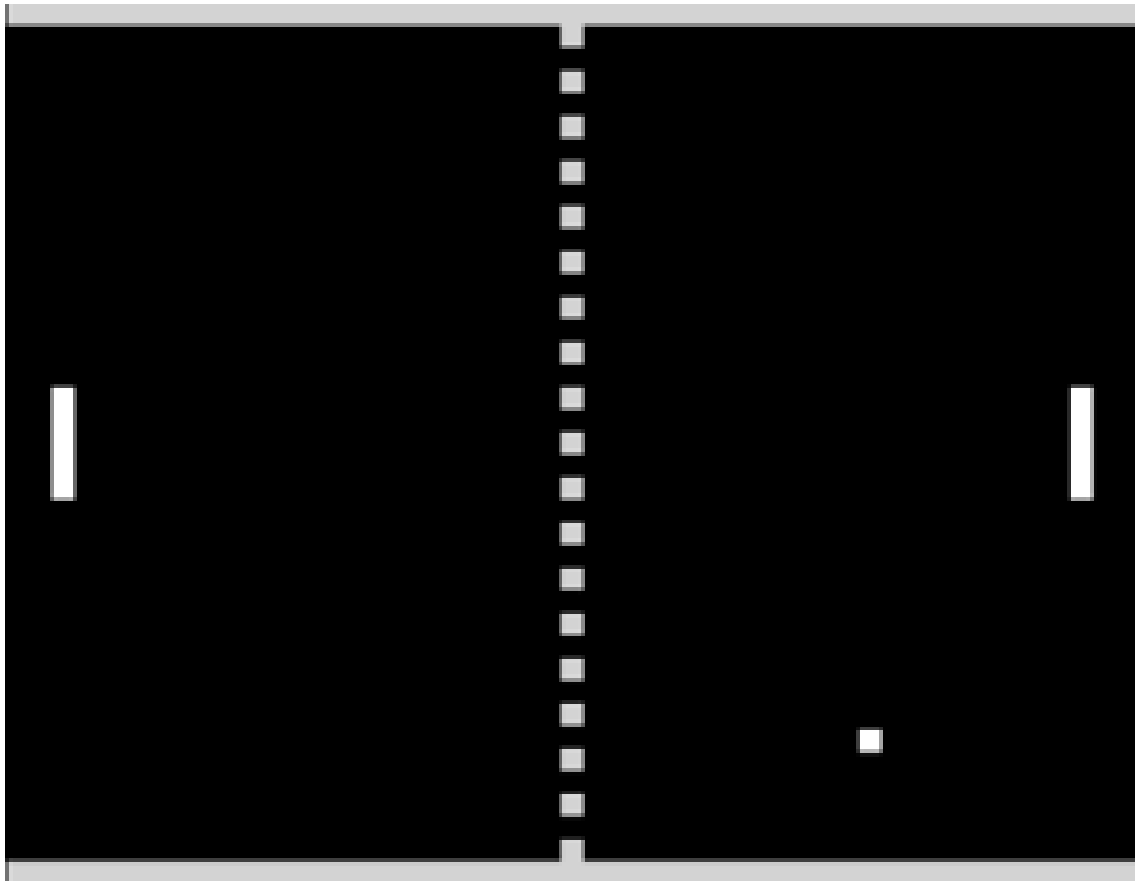

Source: [Straker, n.d.]

Zaključek

Predstavitev in komentar rezultatov

Reference (1/2)

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The End