Week 7 answers

1 Video 1

The weights are initialized at $w_1(0) = 0, w_1(0) = 0$*, with a learning rate of* 0.1*. Compute the final weights,* $w_1(2)$ *and* $w_2(2)$ *if we have* $x(1) = (1, 0)$*,* $y^*(1) = 2$*, followed by* $x(2) = (1, 1)$*,* $y^*(2) = -2$*. (The* (0)*,* (1) *and* (2) *are time indices).*

For the first update,

$$\hat{y}(1) = w_1(0)x_1(1) + w_2(0)x_2(1) = 0 \tag{1}$$
$$\delta(1) = y^*(1) - \hat{y}(1) = 2 \tag{2}$$
$$w_1(1) = w_1(0) + 0.1x_1(1)\delta(1) = 0.2 \tag{3}$$
$$w_2(1) = w_2(0) + 0.1x_2(1)\delta(1) = 0 \tag{4}$$

For the second update,

$$\hat{y}(2) = w_1(1)x_1(2) + w_2(1)x_2(2) = 0.2 \tag{5}$$
$$\delta(2) = y^*(2) - \hat{y}(2) = -2 - (0.4) = -2.2 \tag{6}$$
$$w_1(1) = w_1(0) + 0.1\delta(1) = 0.2 - 0.22 = -0.02 \tag{7}$$
$$w_2(1) = w_2(0) + 0.1\delta(1) = 0 - 0.22 = -0.22 \tag{8}$$

2 Video 2

Describe the main cerebellar pathway (cells + fibres), including interesting features of each part of the pathway

The primary pathway is external signals → granule cells → parallel fibres → Purkinje cells. And Purkinje cells also receive a climbing-fibre error signal.

Granule cells are extremely numerous, with around 70 billion cells (compared to around 25 million in cortex).

Purkinje cells are very large, with around 100,000 incoming synapses, and fast firing (around 50 Hz).

Climbing fibre error signals are lower frequency (1 Hz) and unique in that there is only one climbing fibre associated with each cell.

3 Video 3

For each conditioning paradigm, draw a sketch a plot showing how the weights over time.

(See slides for a description.)

4 Video 4

Describe the differences between Rescorla-Wagner and TD learning.

Temporal difference learning and Rescorla Wagner are attempting to learn totally different quantities. Rescorla Wagner is try to learn targets, y^* that are available immediately. In contrast, temporal difference learning is trying to learn the sum of future rewards. These future rewards are by definition not available immediately, and we need a much more sophisticated strategy to estimate the prediction error, δ (in Rescola Wagner, we just use the difference between the target and the estimate, $\delta = y^* - \hat{y}$. Because As such, temporal difference learning needs a much more sophisticated strategy to find its error signal (see slides).