Backpropagation: 2-2-1 Network

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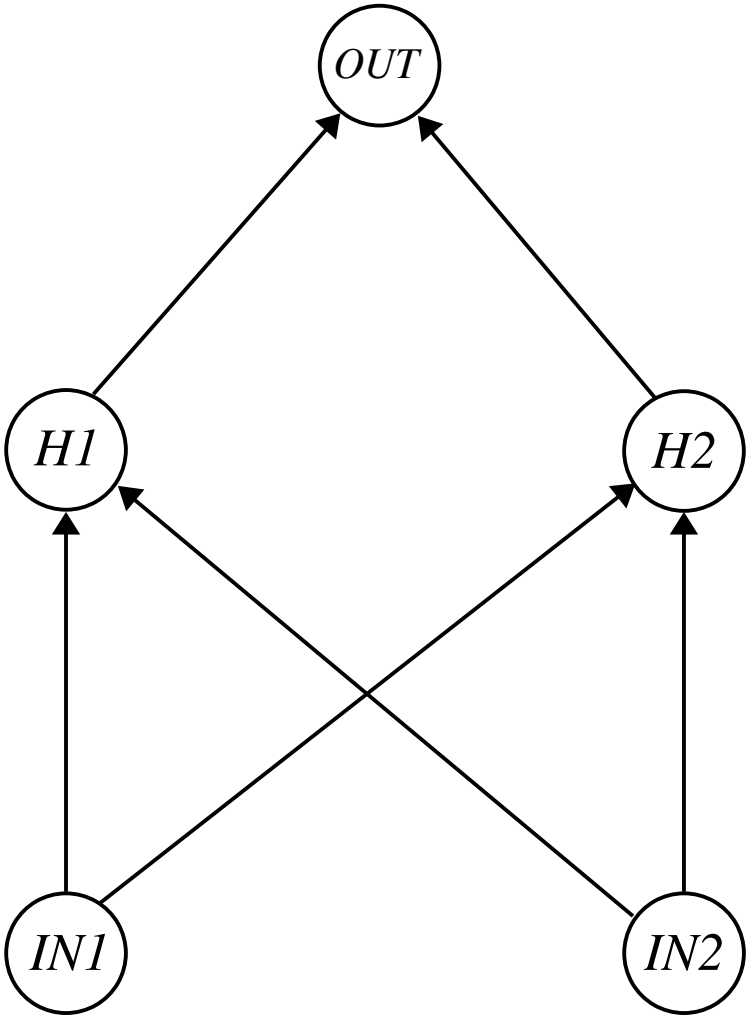
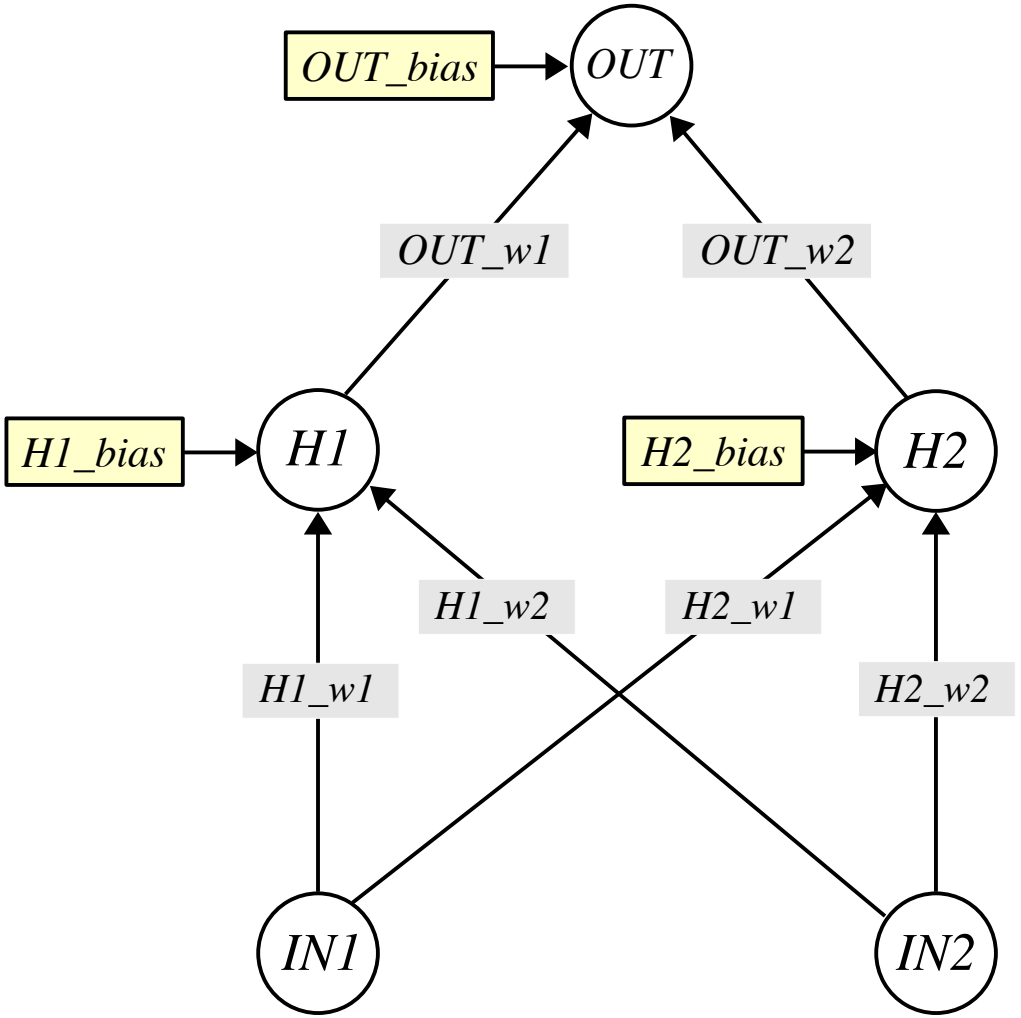
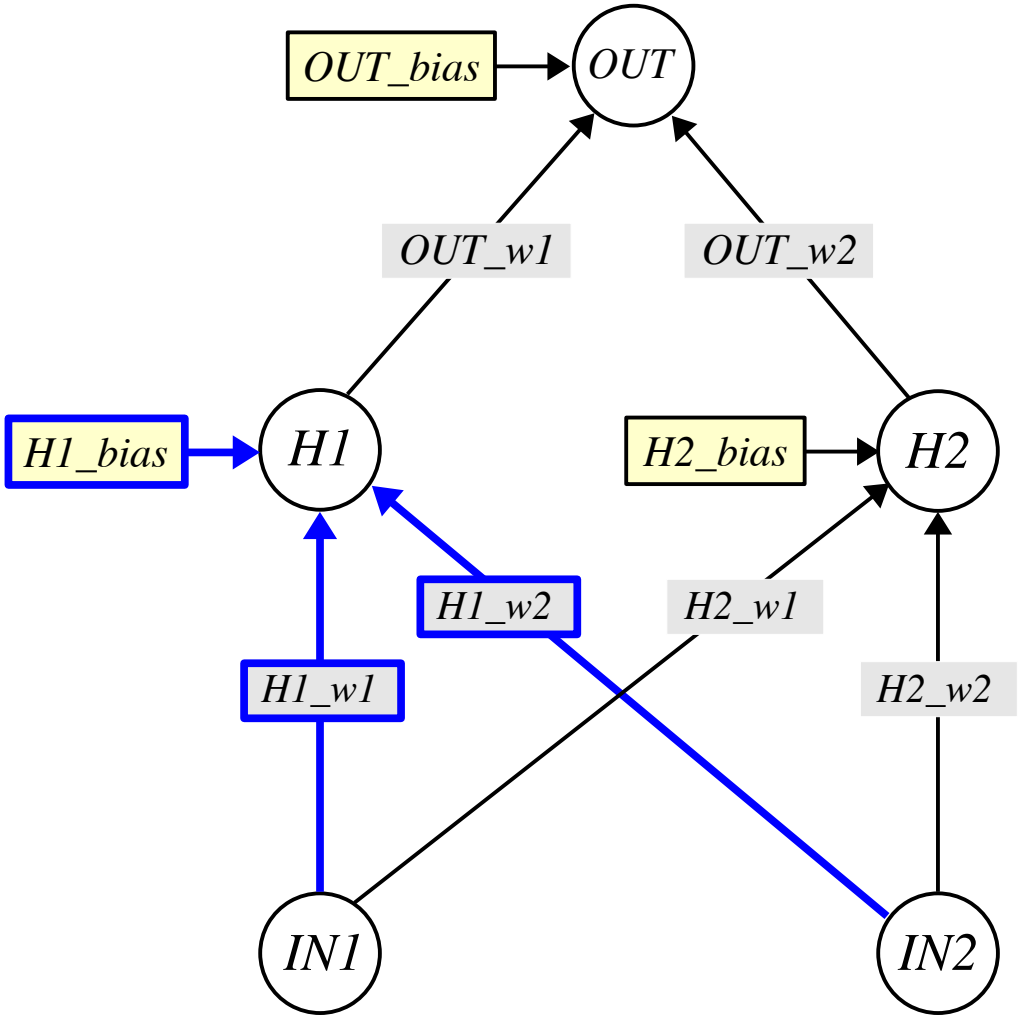


Backpropagation: 2-2-1 Network



Backpropagation: 2-2-1 Network

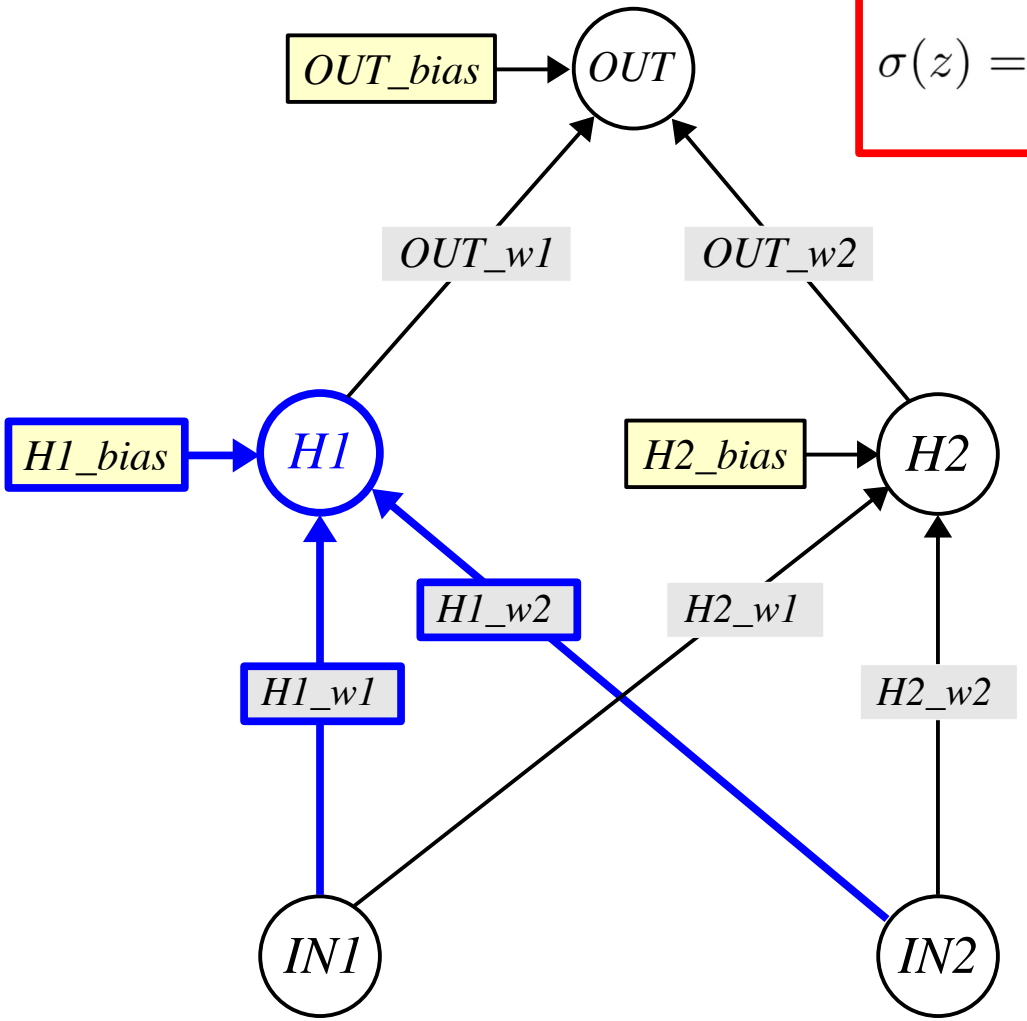
$$IN1 \times H1\_w1 \; + \; IN2 \times H1\_w2 \; + \; H1\_bias$$



Backpropagation: 2-2-1 Network

$$H1 = \sigma(IN1 \times H1\_w1 + IN2 \times H1\_w2 + H1\_bias)$$

$$\sigma(z) = \frac{1}{1 + e^{-z}}$$

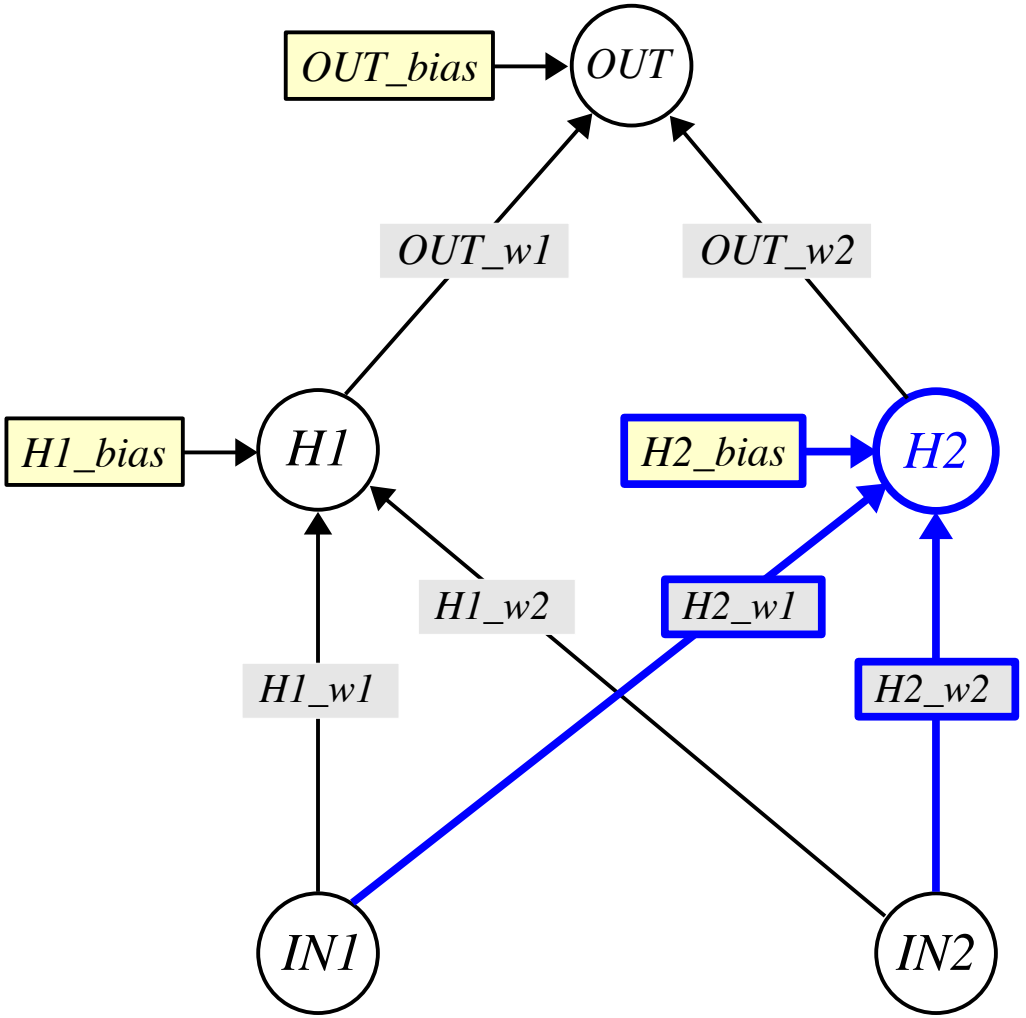


Backpropagation: 2-2-1 Network

$$\sigma(z) = \frac{1}{1 + e^{-z}}$$

$$H1 = \sigma(IN1 \times H1\_w1 + IN2 \times H1\_w2 + H1\_bias)$$

$$H2 = \sigma(IN1 \times H2\_w1 + IN2 \times H2\_w2 + H2\_bias)$$



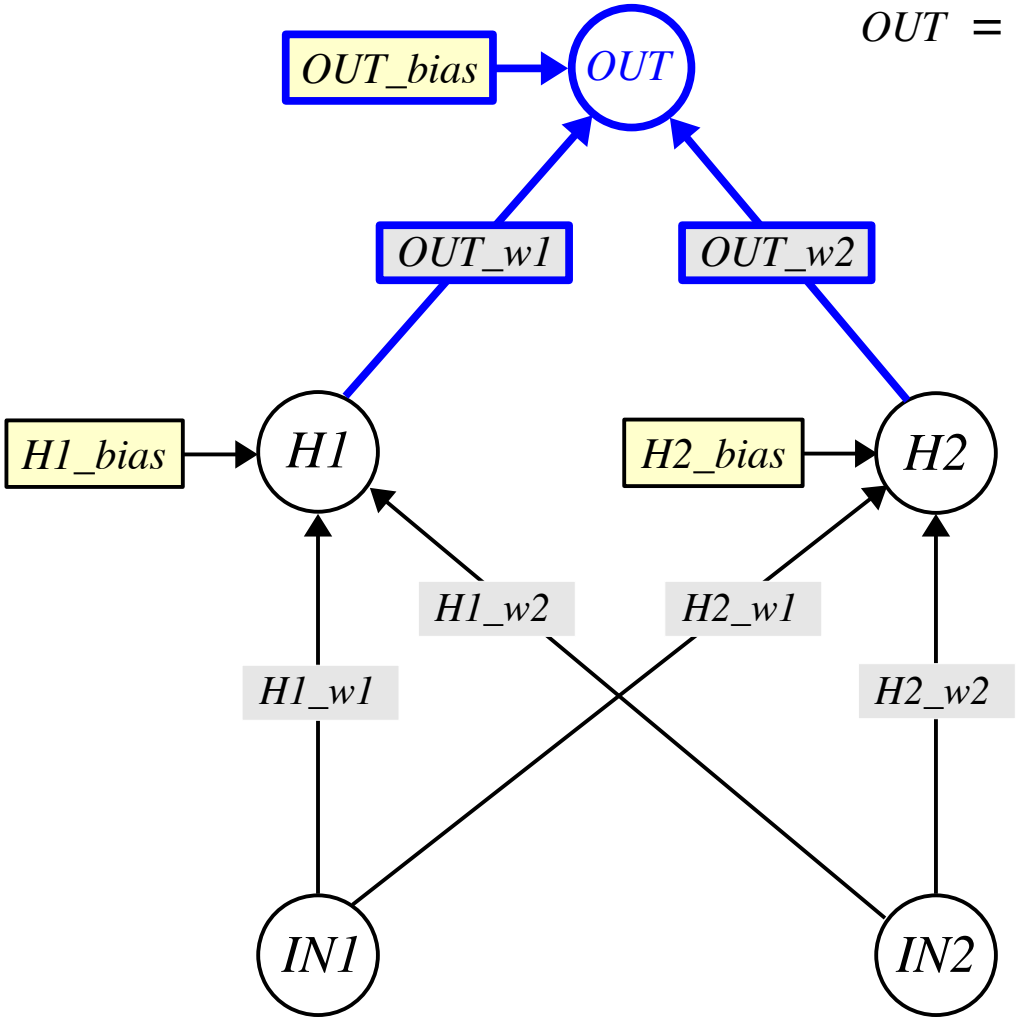
Backpropagation: 2-2-1 Network

$$\sigma(z) = \frac{1}{1 + e^{-z}}$$

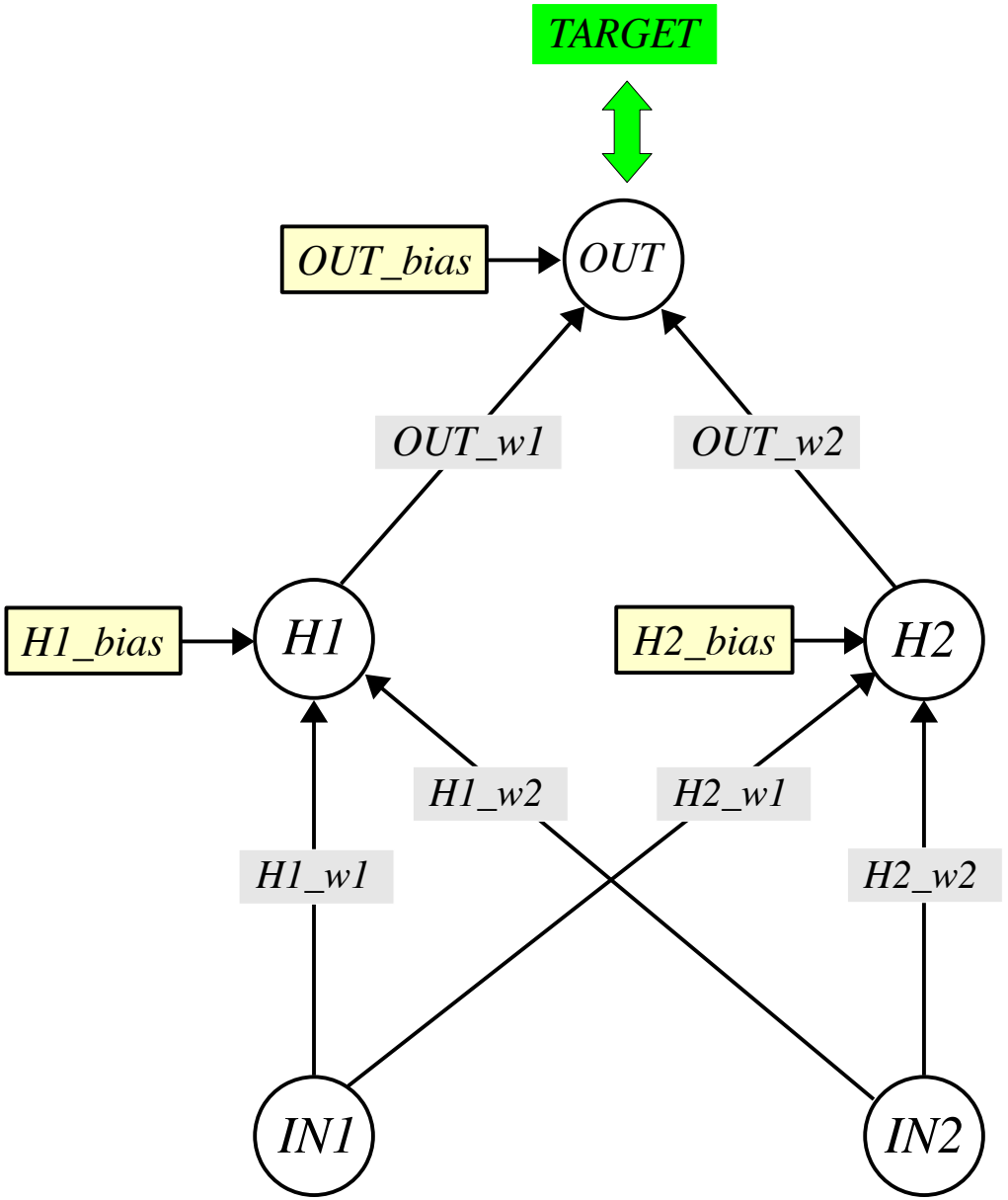
$$H1 = \sigma(IN1 \times H1\_w1 + IN2 \times H1\_w2 + H1\_bias)$$

$$H2 = \sigma(IN1 \times H2\_w1 + IN2 \times H2\_w2 + H2\_bias)$$

$$OUT = \sigma(H1 \times OUT\_w1 + H2 \times OUT\_w2 + OUT\_bias)$$

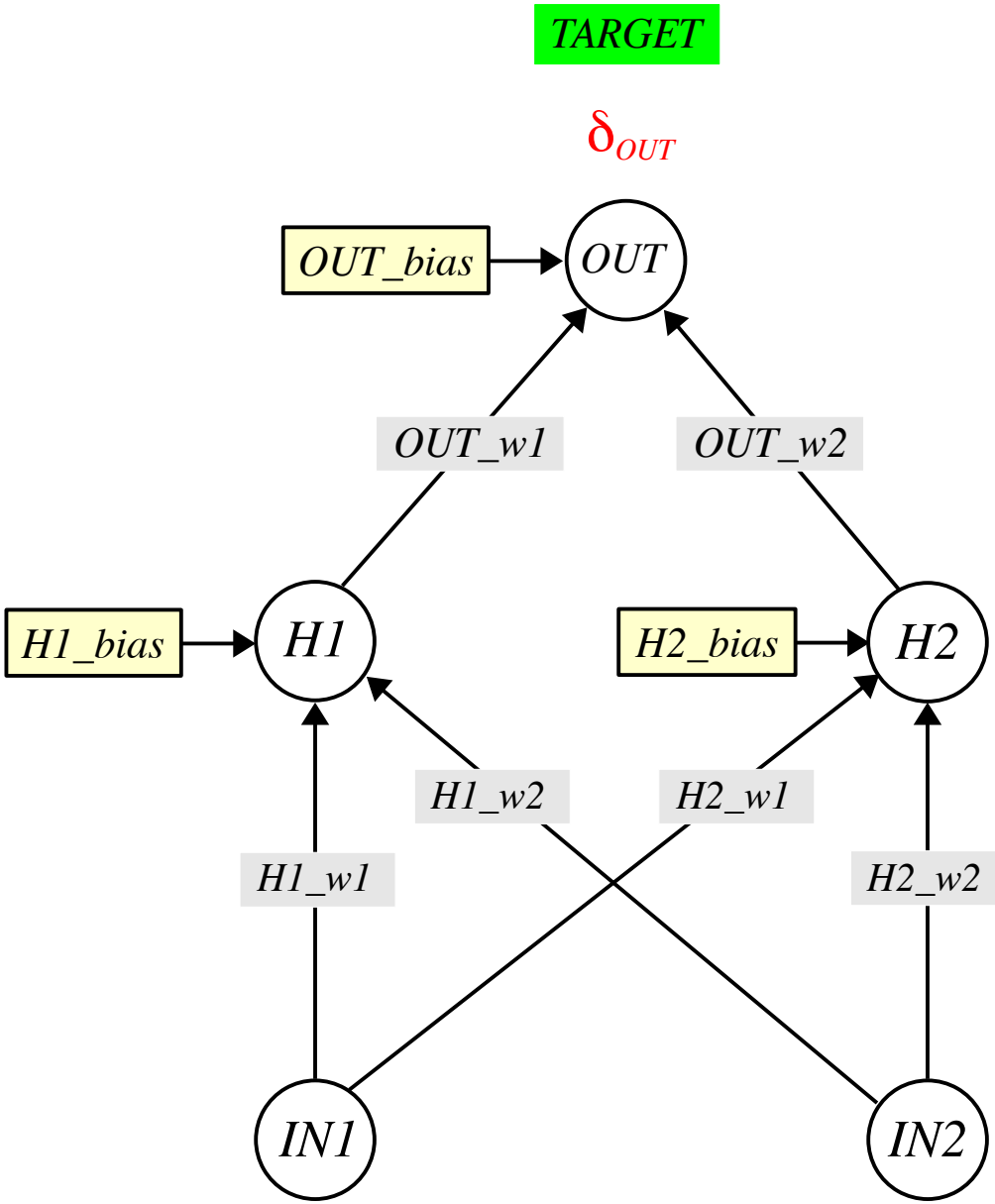


Backpropagation: 2-2-1 Network



Backpropagation: 2-2-1 Network

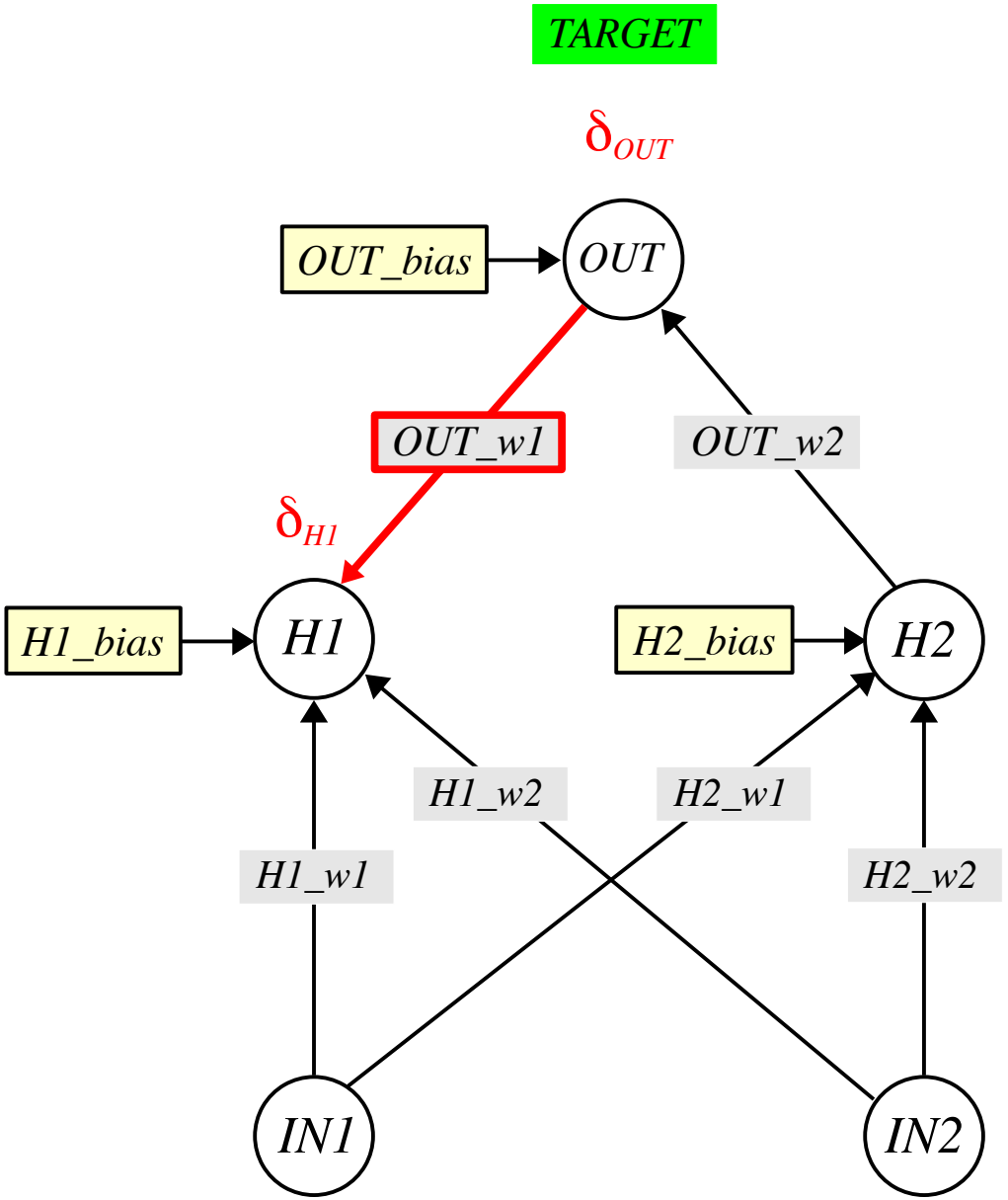
$$\delta_{OUT} = (OUT - TARGET) \times OUT \times (1 - OUT)$$



Backpropagation: 2-2-1 Network

$$\delta_{OUT} = (OUT - TARGET) \times OUT \times (1 - OUT)$$

$$\delta_{H1} = (\delta_{OUT} \times OUT\_w1) \times H1 \times (1 - H1)$$

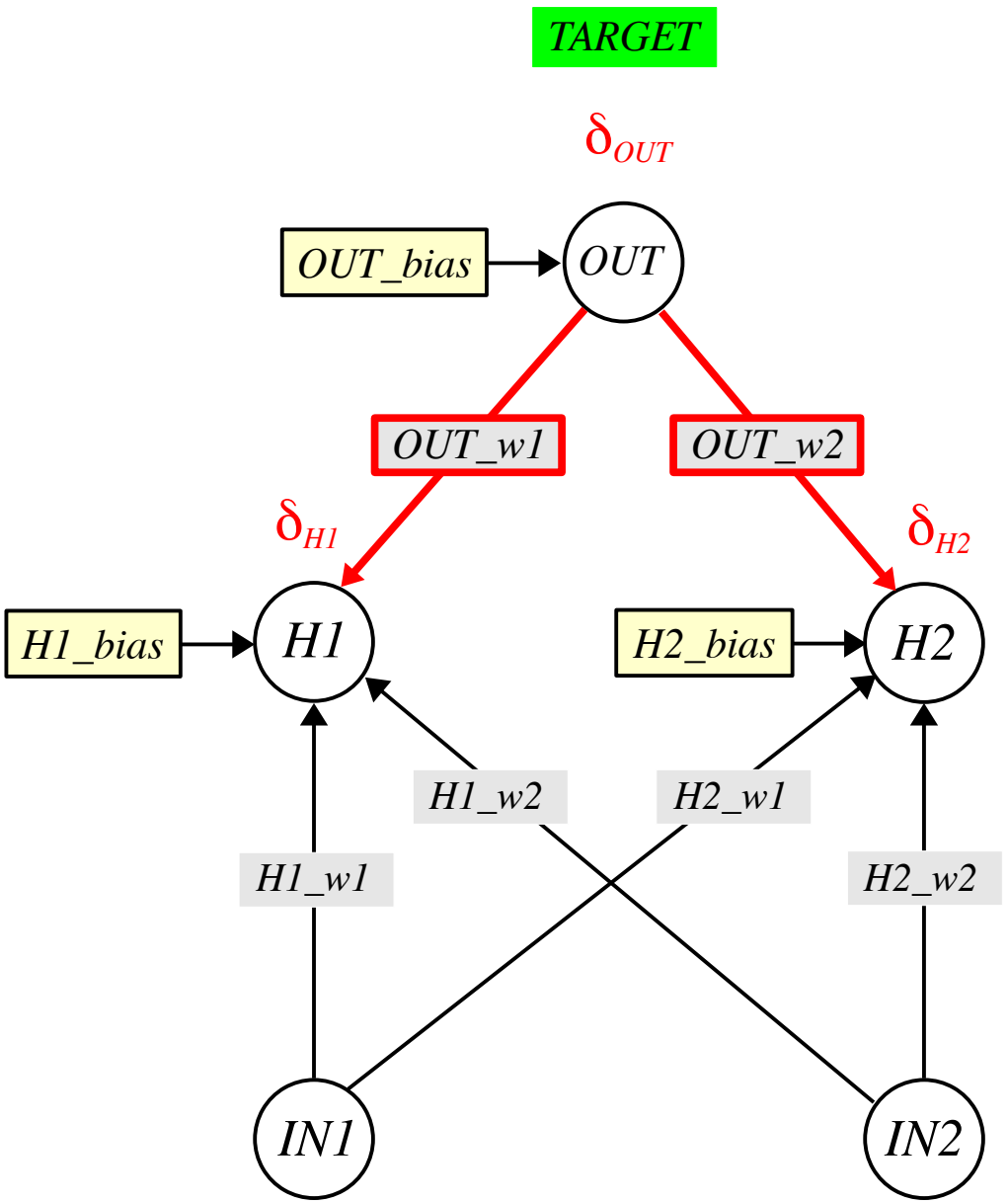


Backpropagation: 2-2-1 Network

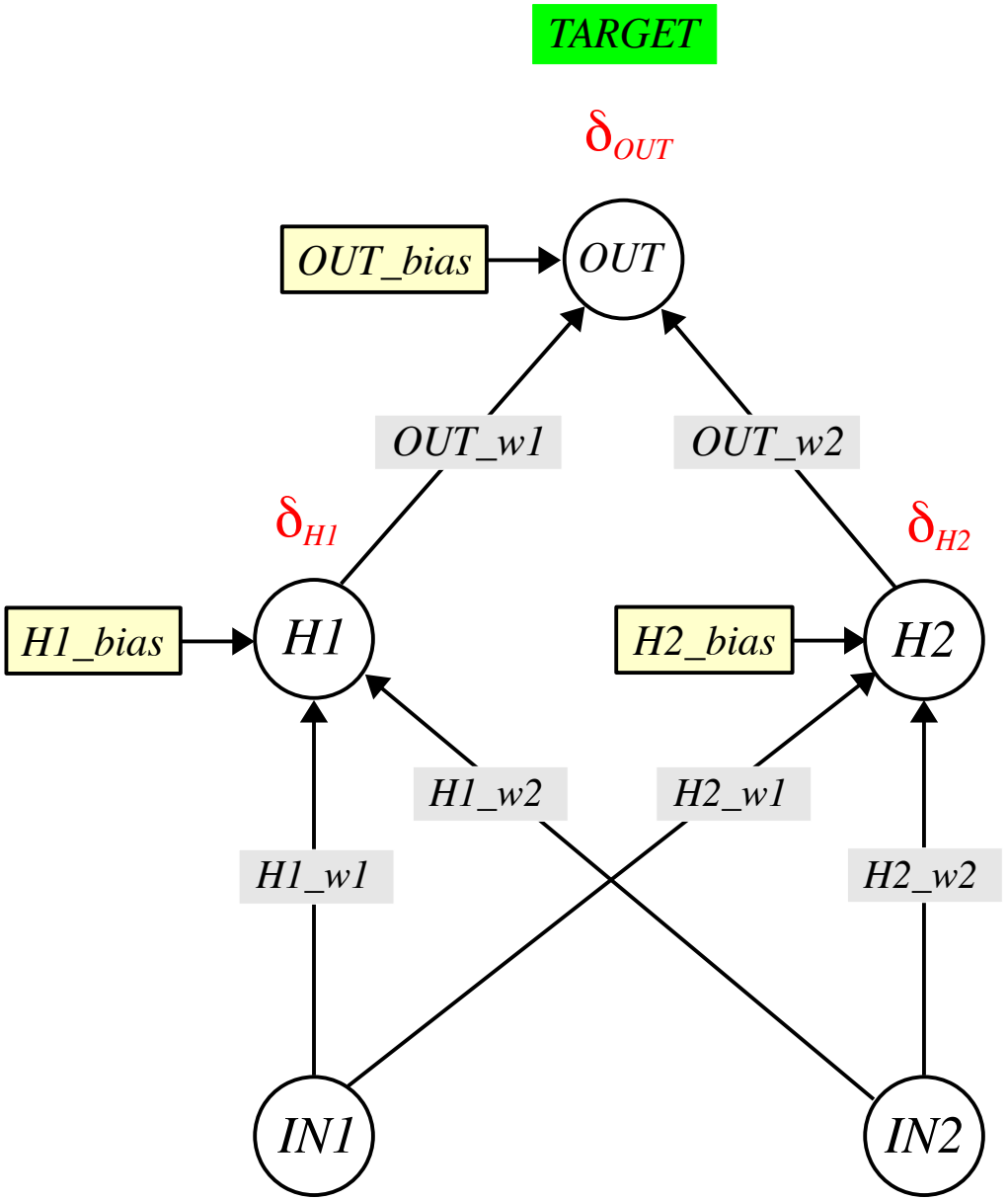
$$\delta_{OUT} = (OUT - TARGET) \times OUT \times (1 - OUT)$$

$$\delta_{H1} = (\delta_{OUT} \times OUT\_w1) \times H1 \times (1 - H1)$$

$$\delta_{H2} = (\delta_{OUT} \times OUT\_w2) \times H2 \times (1 - H2)$$



Backpropagation: 2-2-1 Network



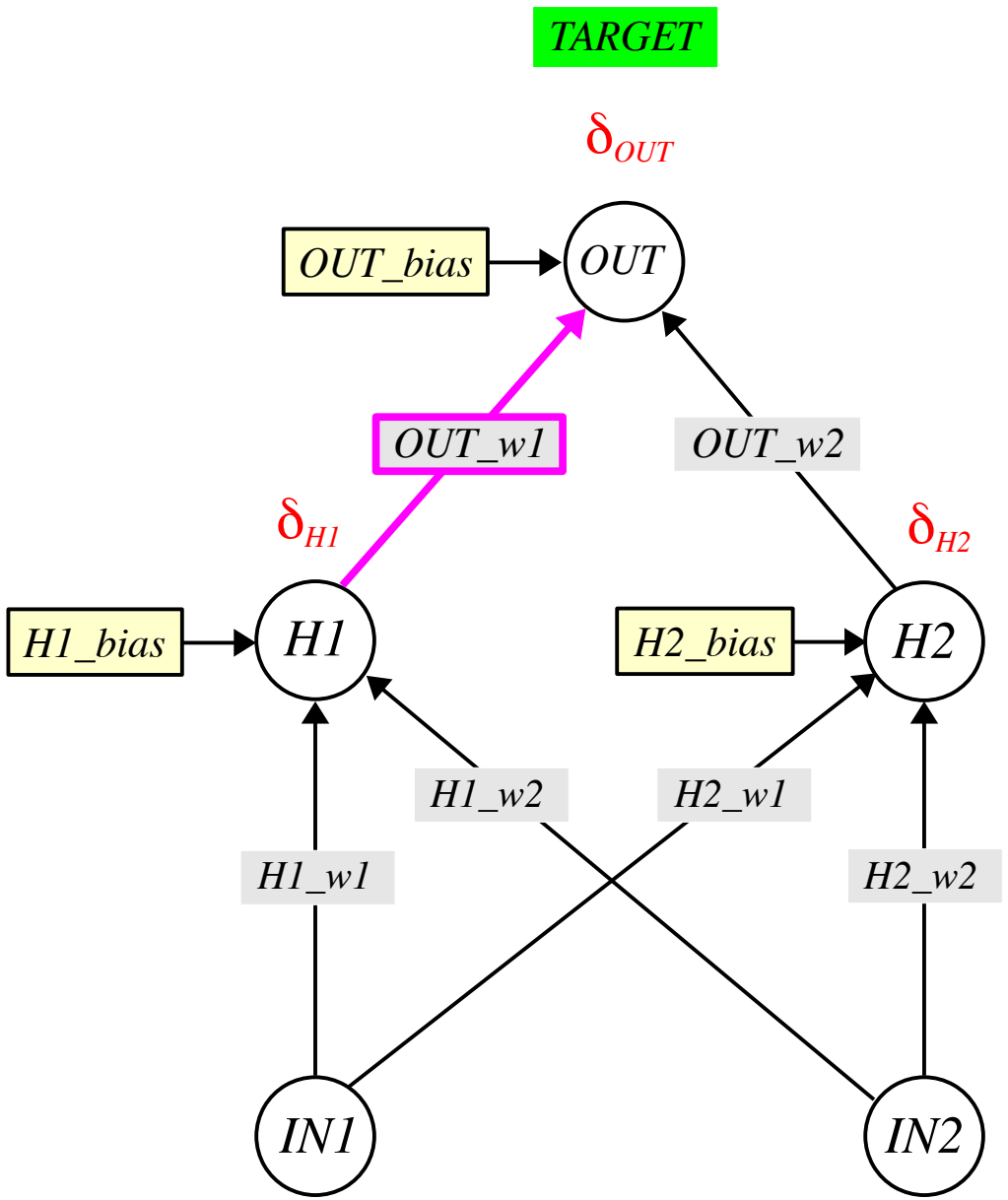
$$\delta_{OUT} = (OUT - TARGET) \times OUT \times (1 - OUT)$$

$$\delta_{H1} = (\delta_{OUT} \times OUT\_w1) \times H1 \times (1 - H1)$$

$$\delta_{H2} = (\delta_{OUT} \times OUT\_w2) \times H2 \times (1 - H2)$$

Now we are ready to update the weights and biases

Backpropagation: 2-2-1 Network



$$\delta_{OUT} = (OUT - TARGET) \times OUT \times (1 - OUT)$$

$$\delta_{H1} = (\delta_{OUT} \times OUT\_w1) \times H1 \times (1 - H1)$$

$$\delta_{H2} = (\delta_{OUT} \times OUT\_w2) \times H2 \times (1 - H2)$$

$$\Delta OUT\_w1 = -\eta \times \delta_{OUT} \times H1$$

Learning rate

$0 < \eta < 1$

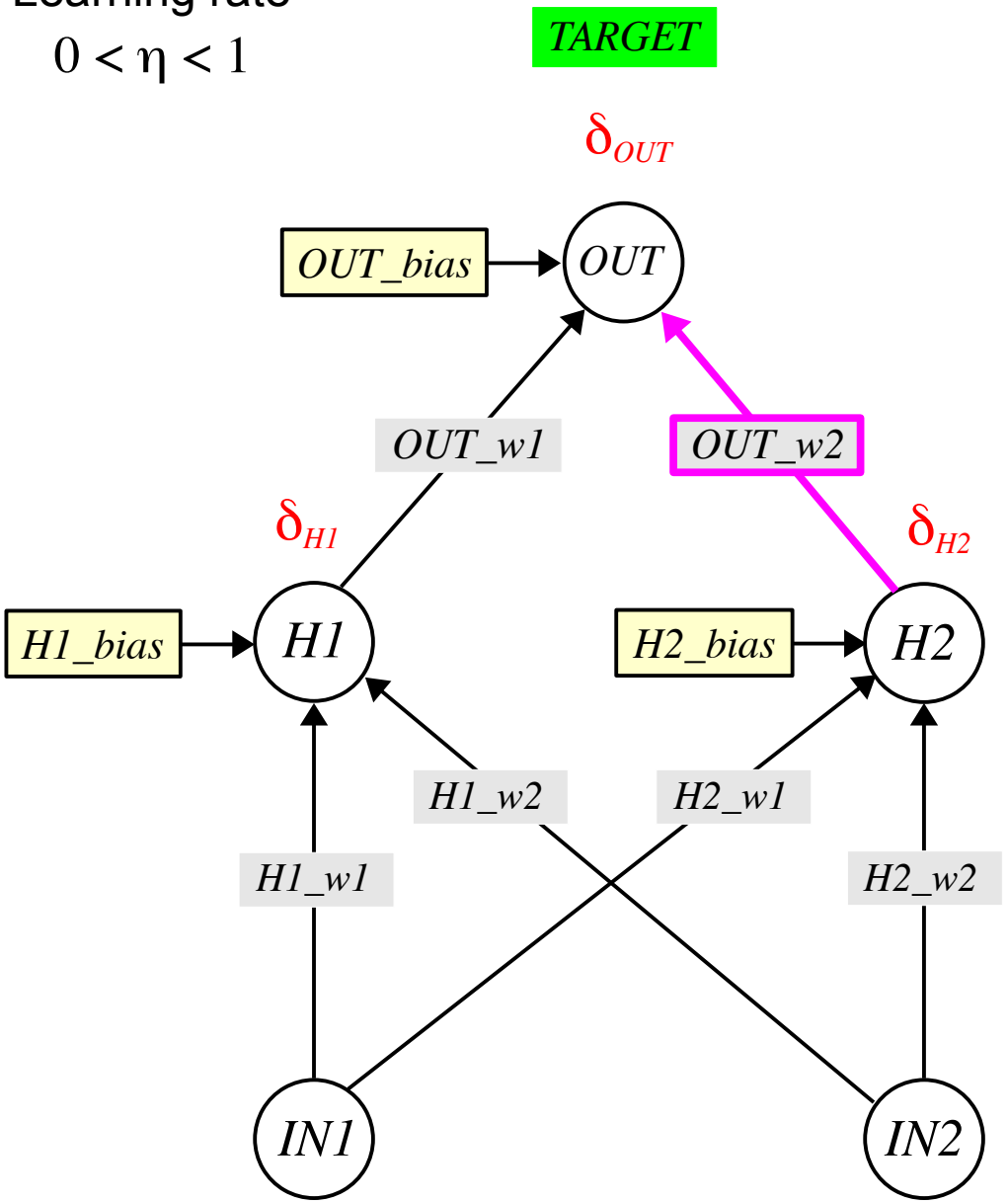
Amount to **change** *OUT_w1*

$$OUT\_w1 = OUT\_w1 + \Delta OUT\_w1$$

Backpropagation: 2-2-1 Network

Learning rate

$0 < \eta < 1$



$$\delta_{OUT} = (OUT - TARGET) \times OUT \times (1 - OUT)$$

$$\delta_{H1} = (\delta_{OUT} \times OUT\_w1) \times H1 \times (1 - H1)$$

$$\delta_{H2} = (\delta_{OUT} \times OUT\_w2) \times H2 \times (1 - H2)$$

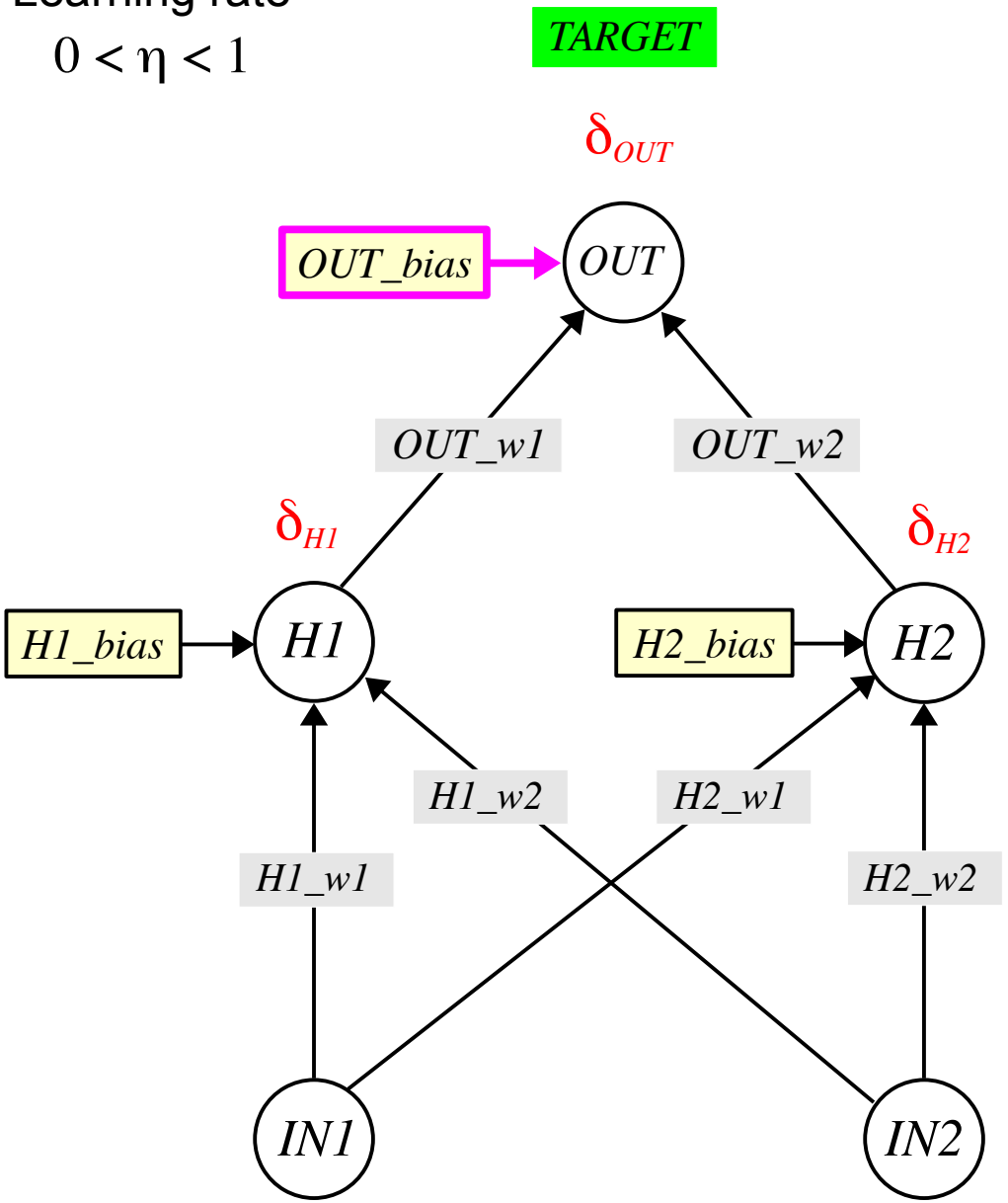
$$\Delta OUT\_w1 = -\eta \times \delta_{OUT} \times H1$$

$$\Delta OUT\_w2 = -\eta \times \delta_{OUT} \times H2$$

Backpropagation: 2-2-1 Network

Learning rate

$0 < \eta < 1$



$$\delta_{OUT} = (OUT - TARGET) \times OUT \times (1 - OUT)$$

$$\delta_{H1} = (\delta_{OUT} \times OUT\_w1) \times H1 \times (1 - H1)$$

$$\delta_{H2} = (\delta_{OUT} \times OUT\_w2) \times H2 \times (1 - H2)$$

$$\Delta OUT\_w1 = -\eta \times \delta_{OUT} \times H1$$

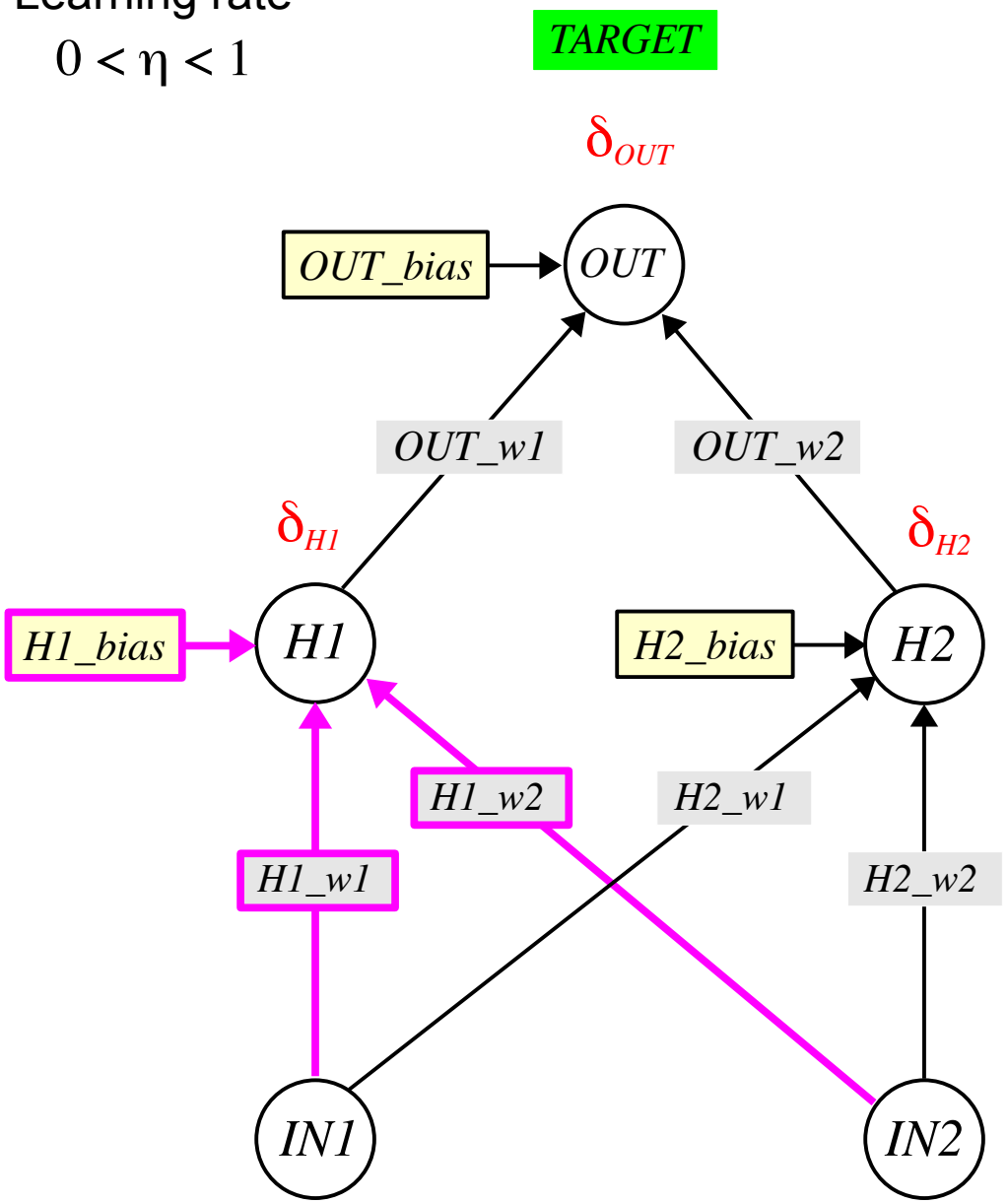
$$\Delta OUT\_w2 = -\eta \times \delta_{OUT} \times H2$$

$$\Delta OUT\_bias = -\eta \times \delta_{OUT}$$

Backpropagation: 2-2-1 Network

Learning rate

$0 < \eta < 1$



$$\delta_{OUT} = (OUT - TARGET) \times OUT \times (1 - OUT)$$

$$\delta_{H1} = (\delta_{OUT} \times OUT\_w1) \times H1 \times (1 - H1)$$

$$\delta_{H2} = (\delta_{OUT} \times OUT\_w2) \times H2 \times (1 - H2)$$

$$\Delta OUT\_w1 = -\eta \times \delta_{OUT} \times H1$$

$$\Delta OUT\_w2 = -\eta \times \delta_{OUT} \times H2$$

$$\Delta OUT\_bias = -\eta \times \delta_{OUT}$$

$$\Delta H1\_w1 = -\eta \times \delta_{H1} \times IN1$$

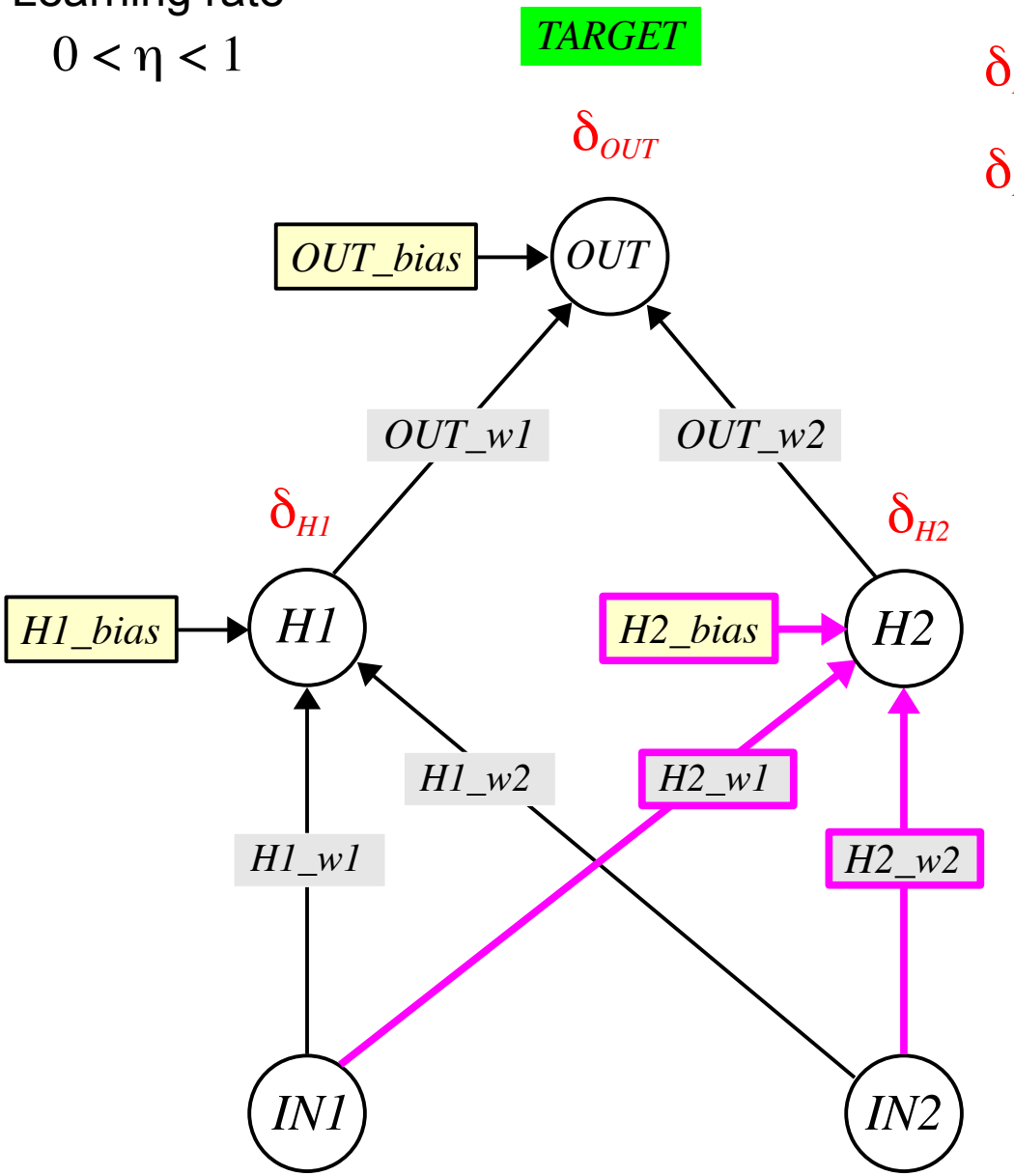
$$\Delta H1\_w2 = -\eta \times \delta_{H1} \times IN2$$

$$\Delta H1\_bias = -\eta \times \delta_{H1}$$

Backpropagation: 2-2-1 Network

Learning rate

$0 < \eta < 1$



$$\delta_{OUT} = (OUT - TARGET) \times OUT \times (1 - OUT)$$

$$\delta_{H1} = (\delta_{OUT} \times OUT\_w1) \times H1 \times (1 - H1)$$

$$\delta_{H2} = (\delta_{OUT} \times OUT\_w2) \times H2 \times (1 - H2)$$

$$\Delta OUT\_w1 = -\eta \times \delta_{OUT} \times H1$$

$$\Delta OUT\_w2 = -\eta \times \delta_{OUT} \times H2$$

$$\Delta OUT\_bias = -\eta \times \delta_{OUT}$$

$$\Delta H1\_w1 = -\eta \times \delta_{H1} \times IN1$$

$$\Delta H1\_w2 = -\eta \times \delta_{H1} \times IN2$$

$$\Delta H1\_bias = -\eta \times \delta_{H1}$$

$$\Delta H2\_w1 = -\eta \times \delta_{H2} \times IN1$$

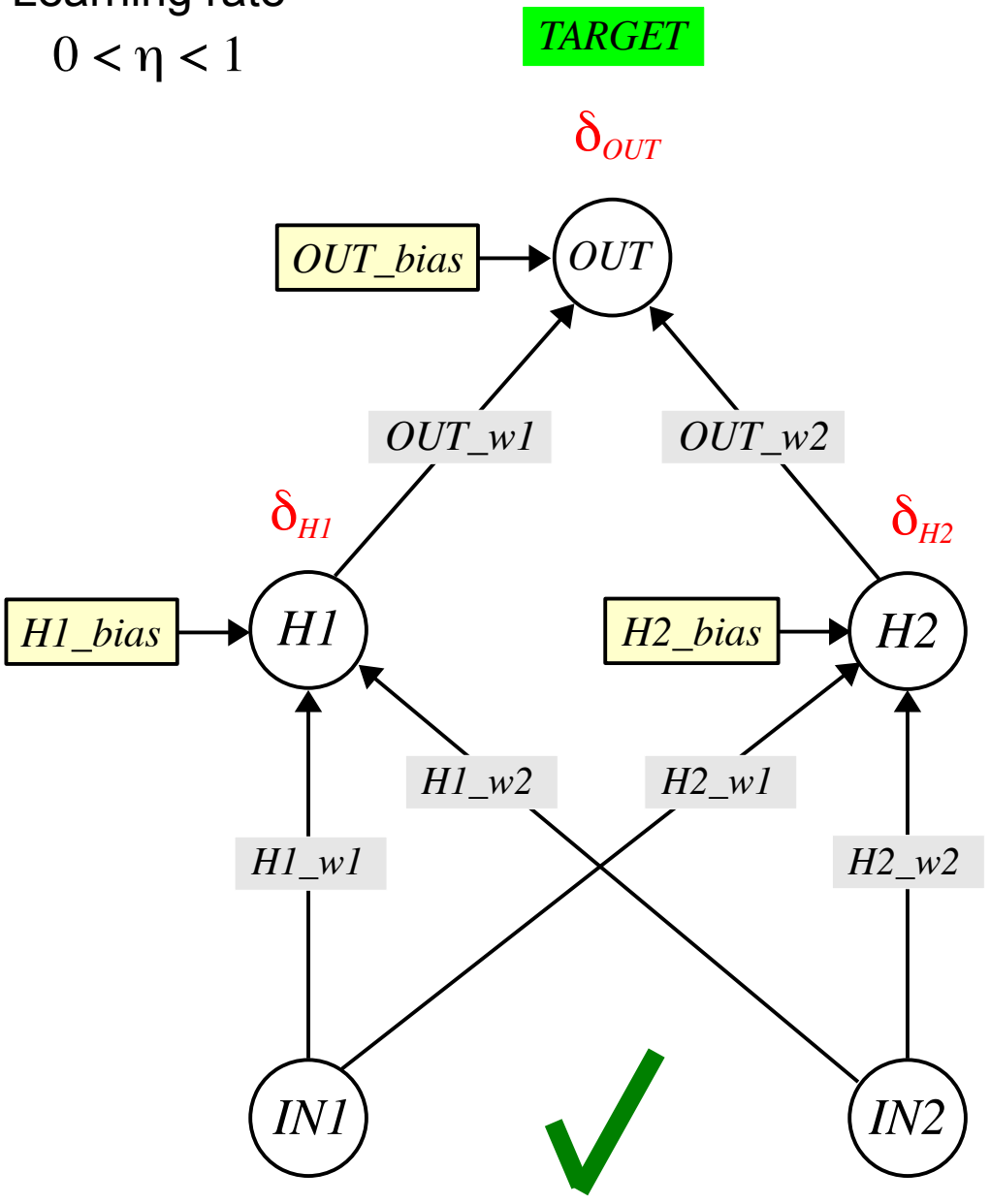
$$\Delta H2\_w2 = -\eta \times \delta_{H2} \times IN2$$

$$\Delta H2\_bias = -\eta \times \delta_{H2}$$

Backpropagation: 2-2-1 Network

Learning rate

$0 < \eta < 1$



$$\delta_{OUT} = (OUT - TARGET) \times OUT \times (1 - OUT)$$

$$\delta_{H1} = (\delta_{OUT} \times OUT\_w1) \times H1 \times (1 - H1)$$

$$\delta_{H2} = (\delta_{OUT} \times OUT\_w2) \times H2 \times (1 - H2)$$

$$\Delta OUT\_w1 = -\eta \times \delta_{OUT} \times H1$$

$$\Delta OUT\_w2 = -\eta \times \delta_{OUT} \times H2$$

$$\Delta OUT\_bias = -\eta \times \delta_{OUT}$$

$$\Delta H1\_w1 = -\eta \times \delta_{H1} \times IN1$$

$$\Delta H1\_w2 = -\eta \times \delta_{H1} \times IN2$$

$$\Delta H1\_bias = -\eta \times \delta_{H1}$$

$$\Delta H2\_w1 = -\eta \times \delta_{H2} \times IN1$$

$$\Delta H2\_w2 = -\eta \times \delta_{H2} \times IN2$$

$$\Delta H2\_bias = -\eta \times \delta_{H2}$$