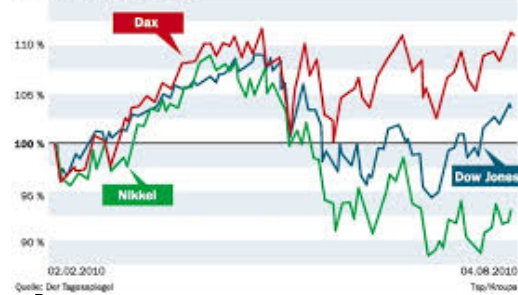


Machine Learning today

Schaukelbörsen weltweit

Werte indiziert, 02.02.2010 = 100 %



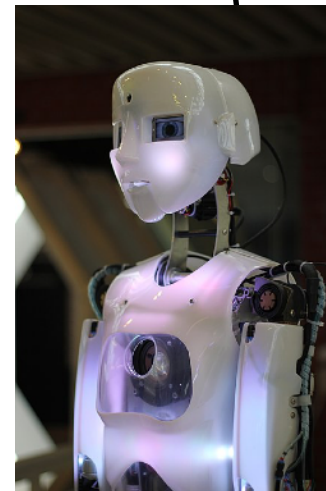
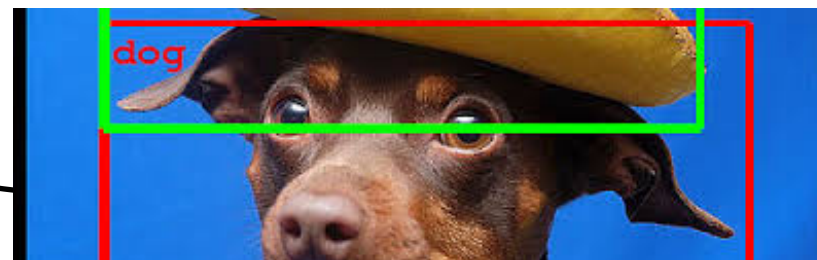
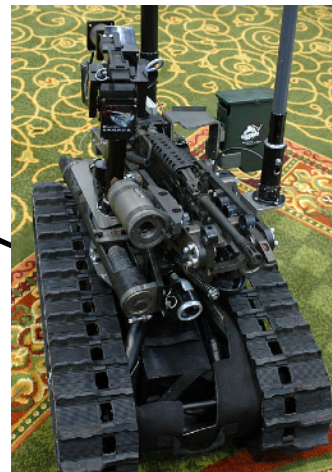
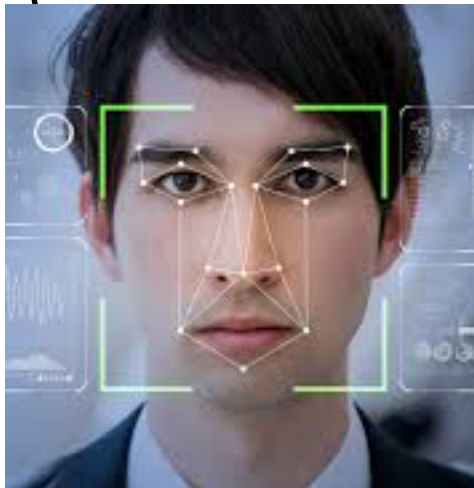
Google

Wir gehen schnell, um die Küh
wohl, daß wir an der hellen Sc
hellen Sonne ...
Wir gehen schnell, um die Küh
wohl, daß wir an der hellen Sc
hellen Sonne ...
Wir gehen schrigJL, um die Küh
wohl, daß wir an der hellen Son
hellen Sonne ...

Artificial Intelligence
Machine Learning
Deep Learning
Artificial neural networks
Classification

...

is everywhere



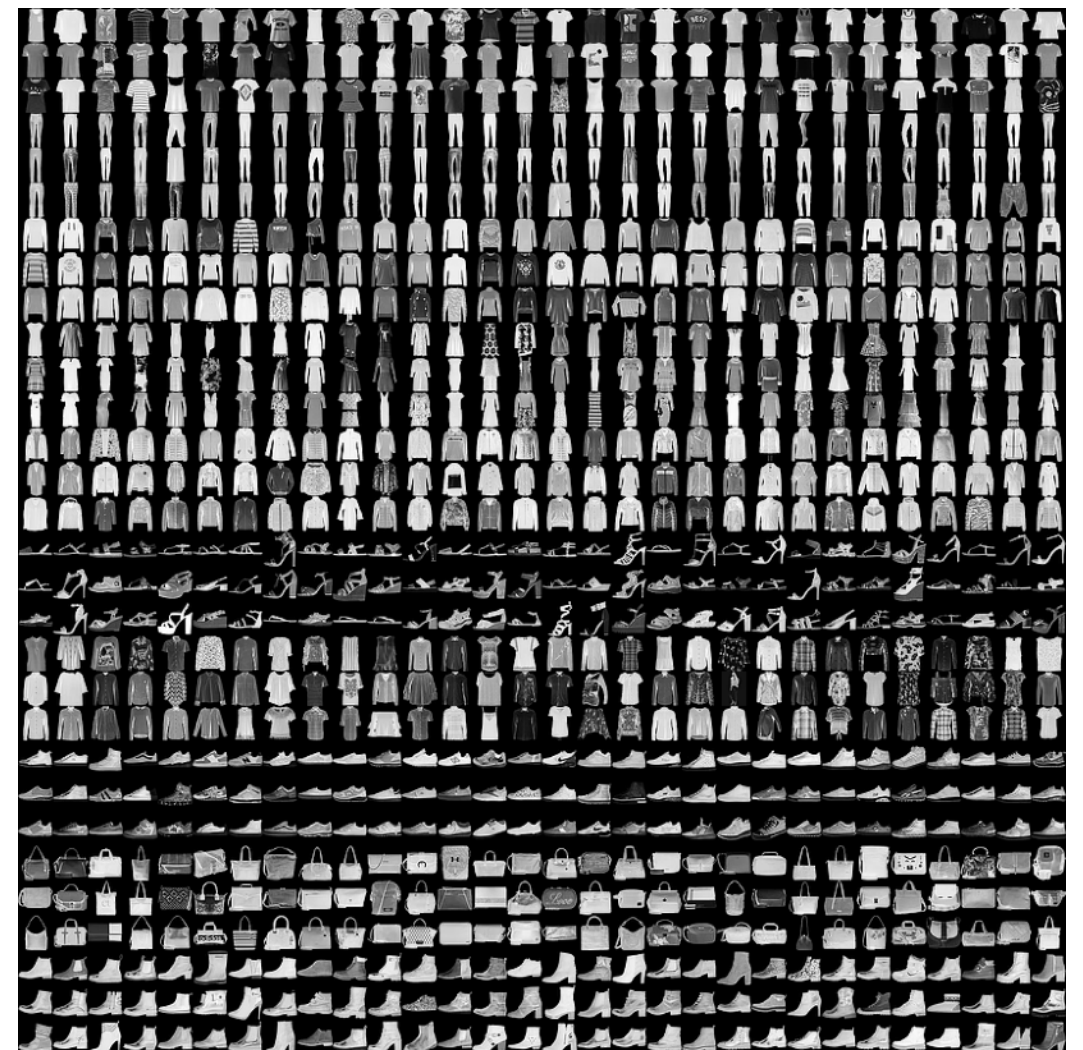
Tensorflow and Co. - FRIGHTENING (!)

Machine Learning is so powerful nowadays

**With these few lines you can
classify 70.000 images from 10 classes
with 98% correctly**

```
mnist = tf.keras.datasets.mnist
(x_train, y_train), (x_test, y_test) = mnist.load_data()
x_train, x_test = x_train / 255.0, x_test / 255.0
model = tf.keras.models.Sequential([
    tf.keras.layers.Flatten(input_shape=(28, 28)),
    tf.keras.layers.Dense(128, activation='relu'),
    tf.keras.layers.Dropout(0.2),
    tf.keras.layers.Dense(10, activation='softmax')
])
model.compile(optimizer='adam',
              loss='sparse_categorical_crossentropy',
              metrics=['accuracy'])
model.fit(x_train, y_train, epochs=5)

model.evaluate(x_test, y_test, verbose=2)
```

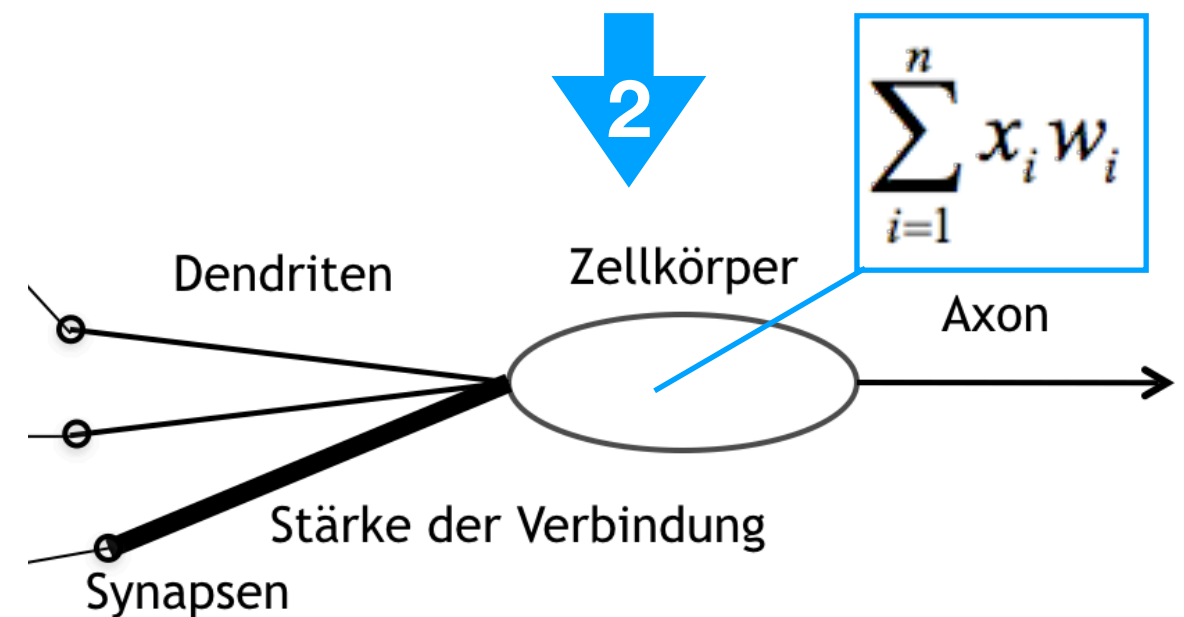
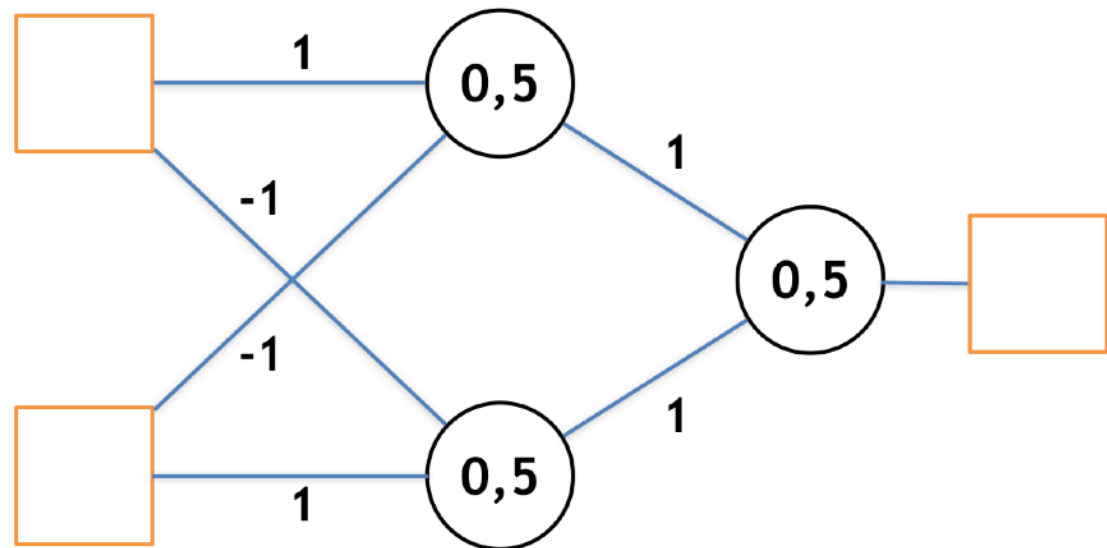
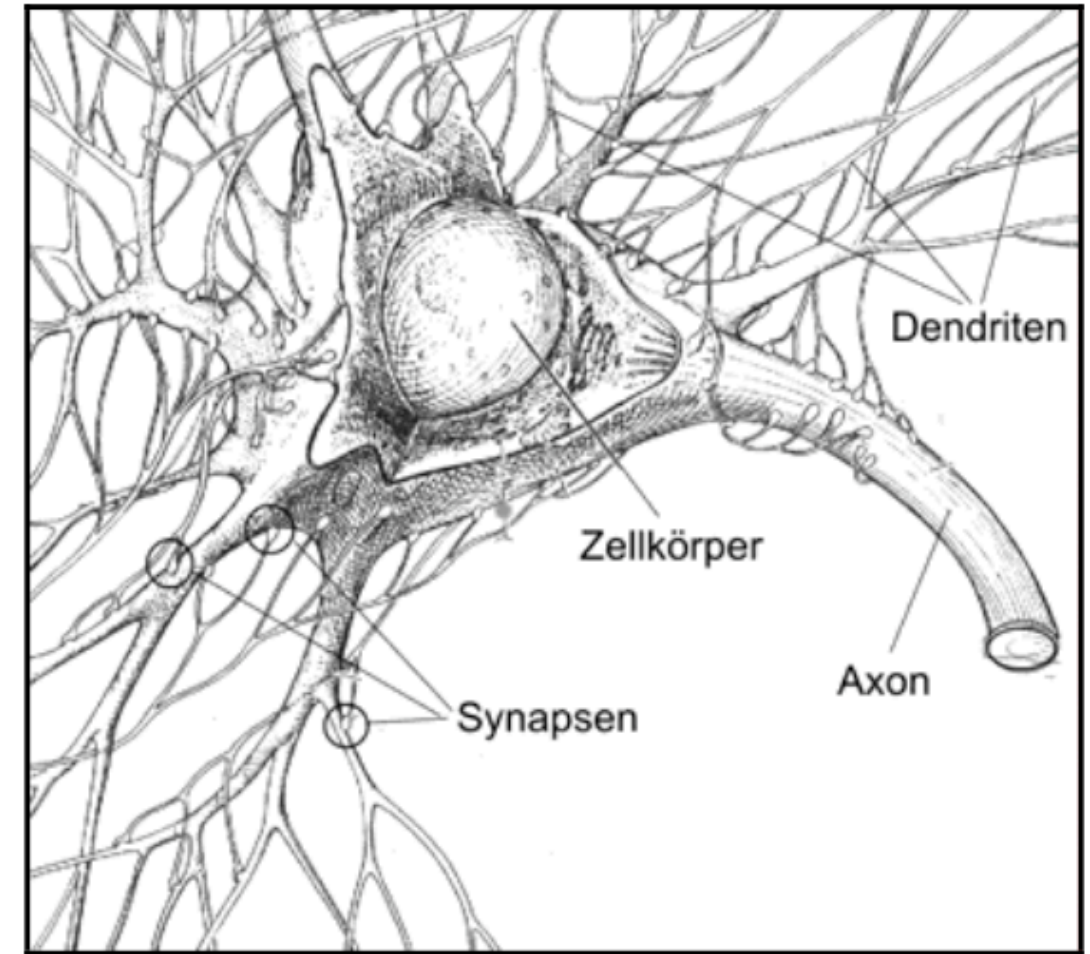
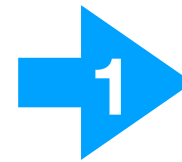
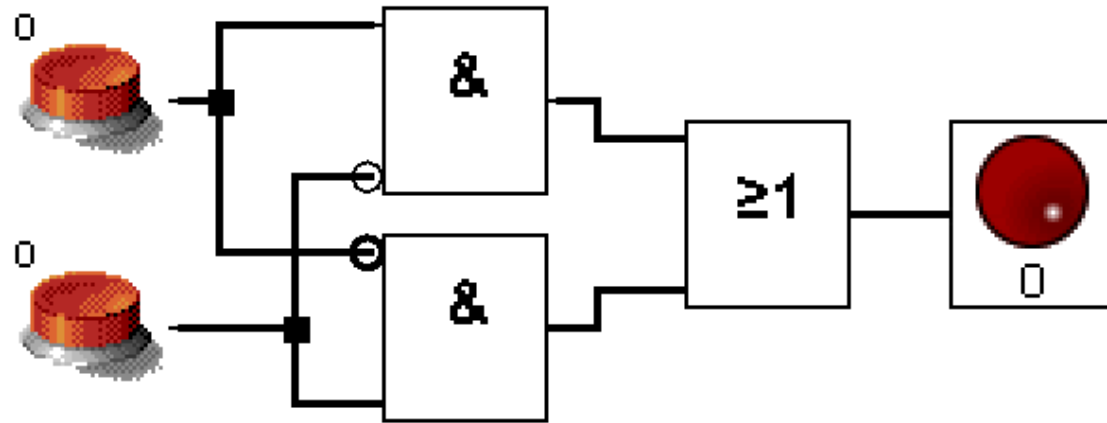


Tensorflow and Co. - FRIGHTENING (!)

But...
do you ...
do we ...
do they ...

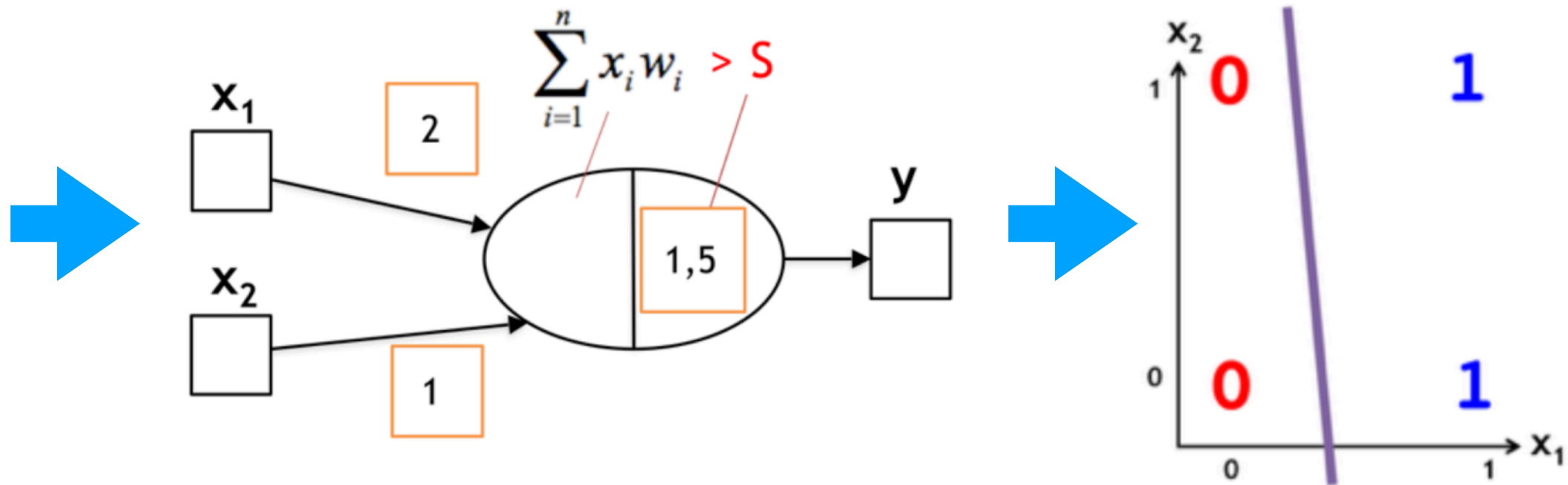
... KNOW AND UNDERSTAND
WHAT IS GOING ON INSIDE ??????

From digital circuits to neural networks



Learning in neural networks

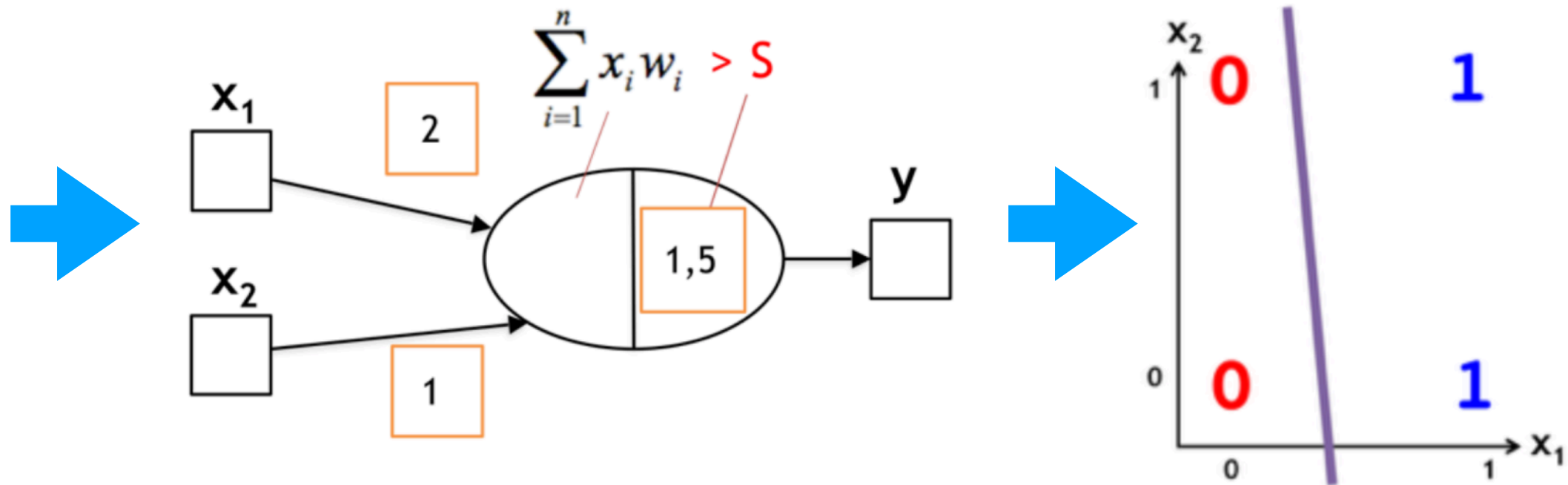
X1	X2	Y
0	0	0
0	1	0
1	0	1
1	1	1



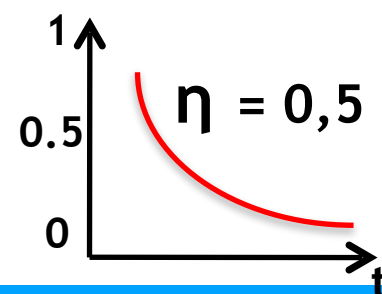
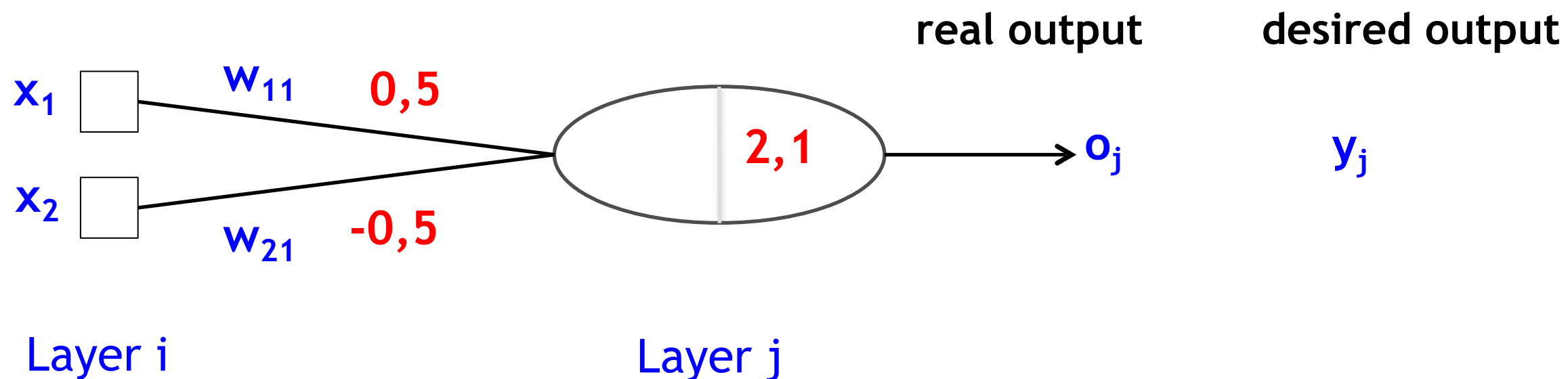
How do neural networks learn ???

Learning in neural networks

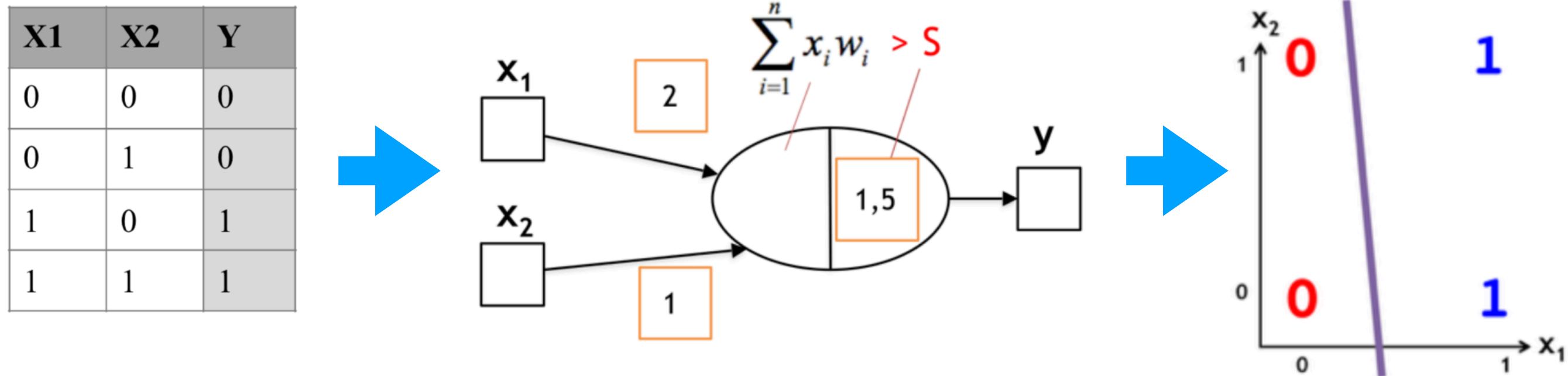
X1	X2	Y
0	0	0
0	1	0
1	0	1
1	1	1



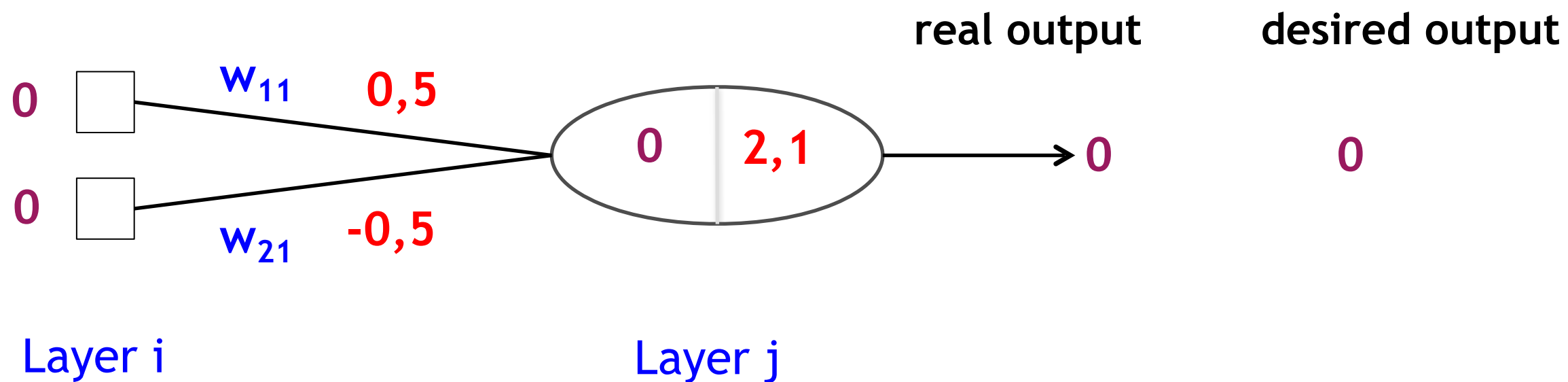
with this **Learning rule:** $w_{ij}(t+1) = w_{ij}(t) + \eta \cdot (y_j - o_i) \cdot x_i$



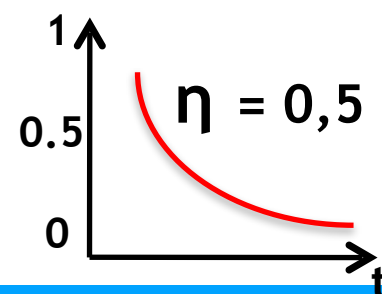
Learning in neural networks



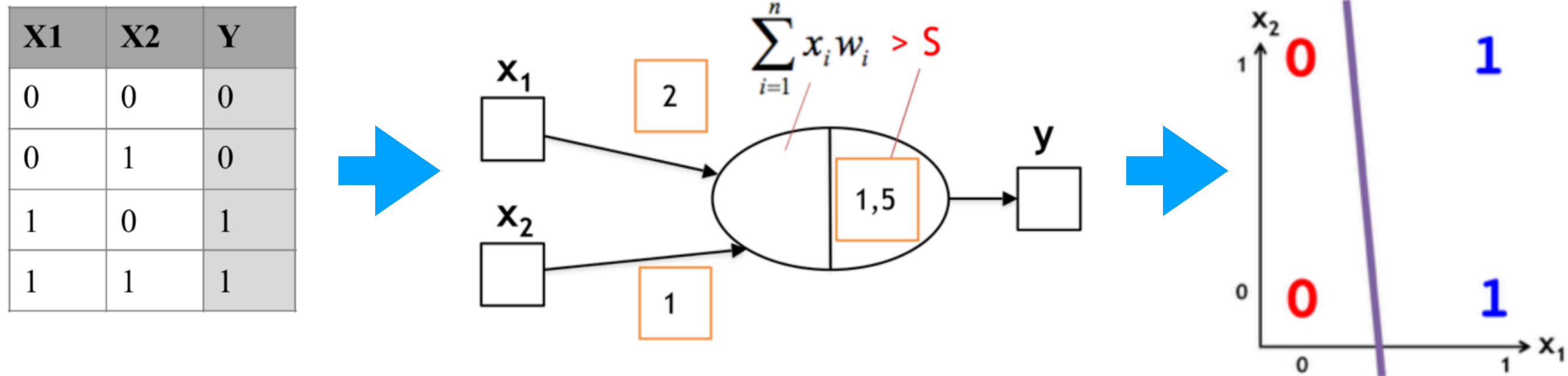
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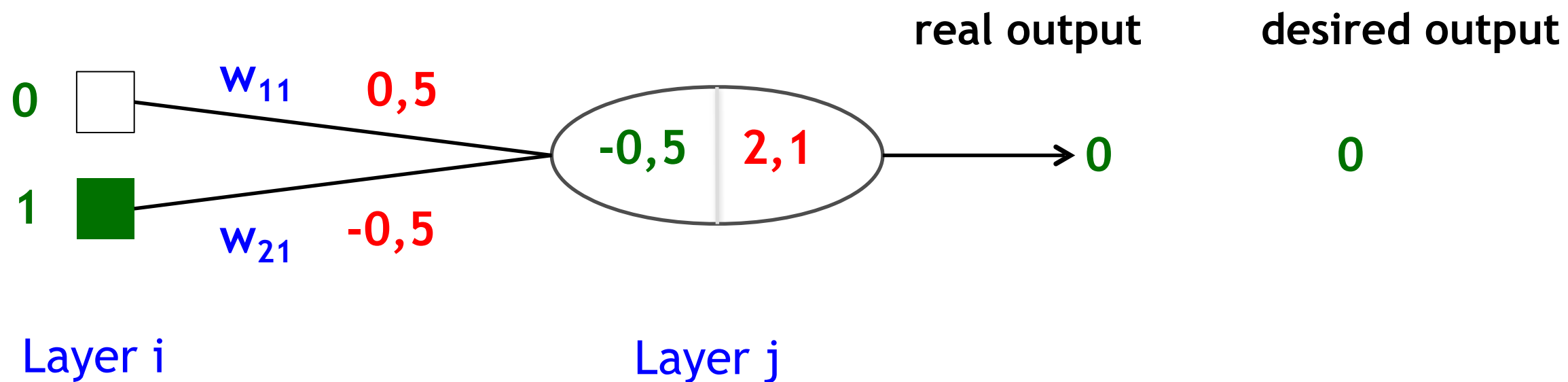
x ₁	x ₂	y
0	0	0
0	1	0
1	0	1
1	1	1



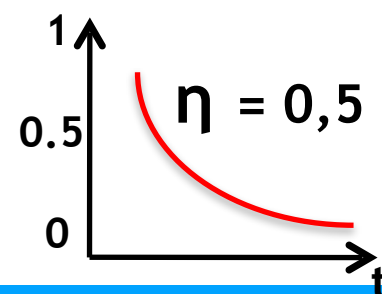
Learning in neural networks



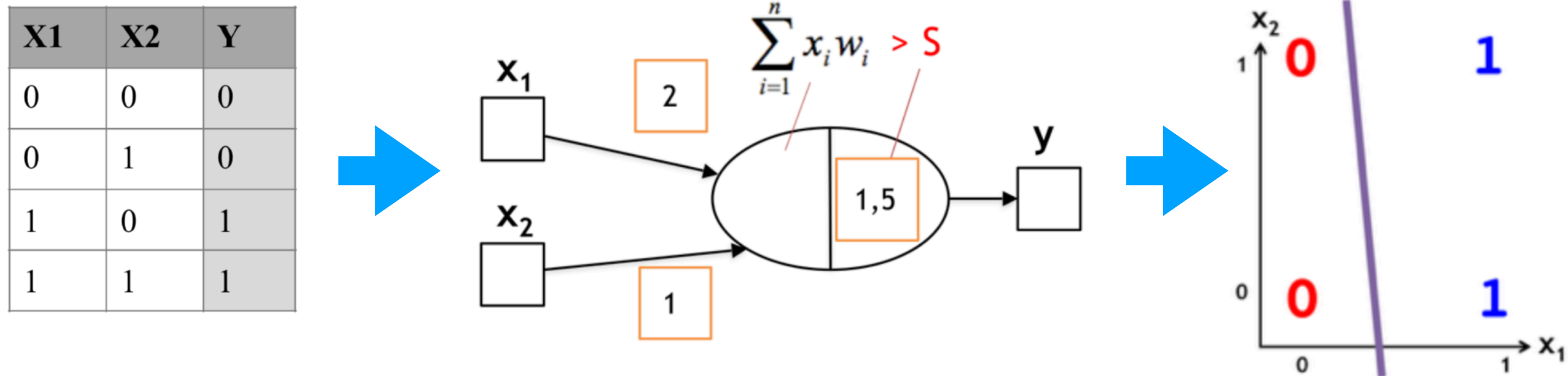
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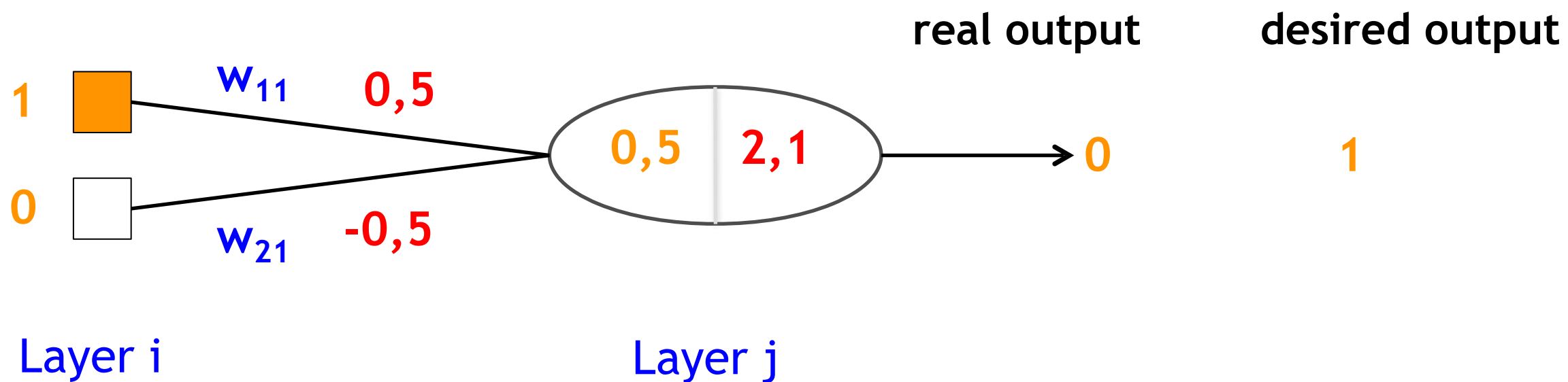
x ₁	x ₂	y
0	0	0
0	1	0
1	0	1
1	1	1



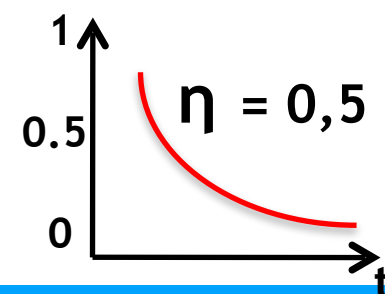
Learning in neural networks



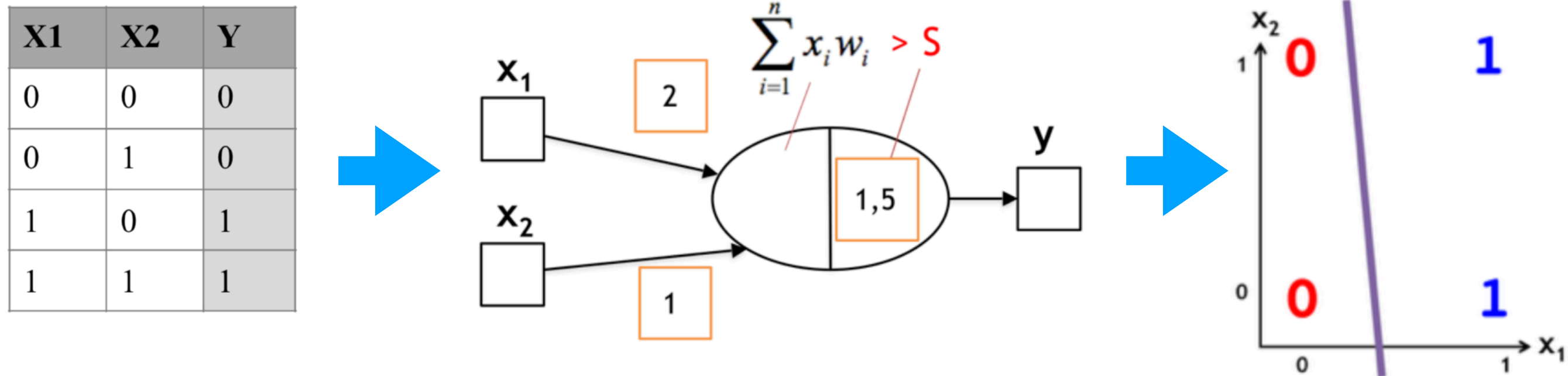
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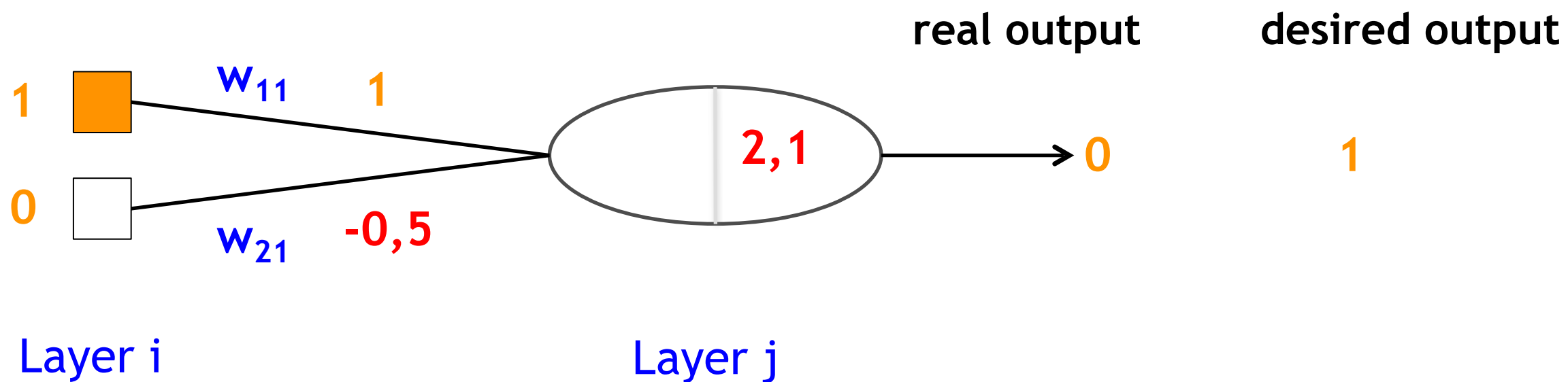
x_1	x_2	y
0	0	0
0	1	0
1	0	1
1	1	1



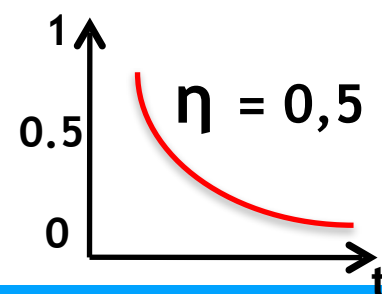
Learning in neural networks



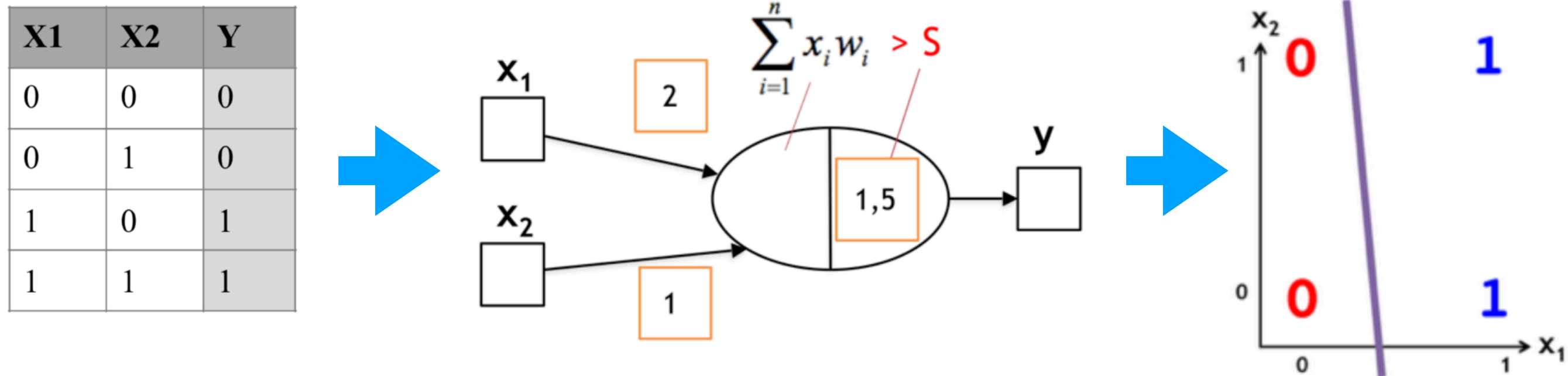
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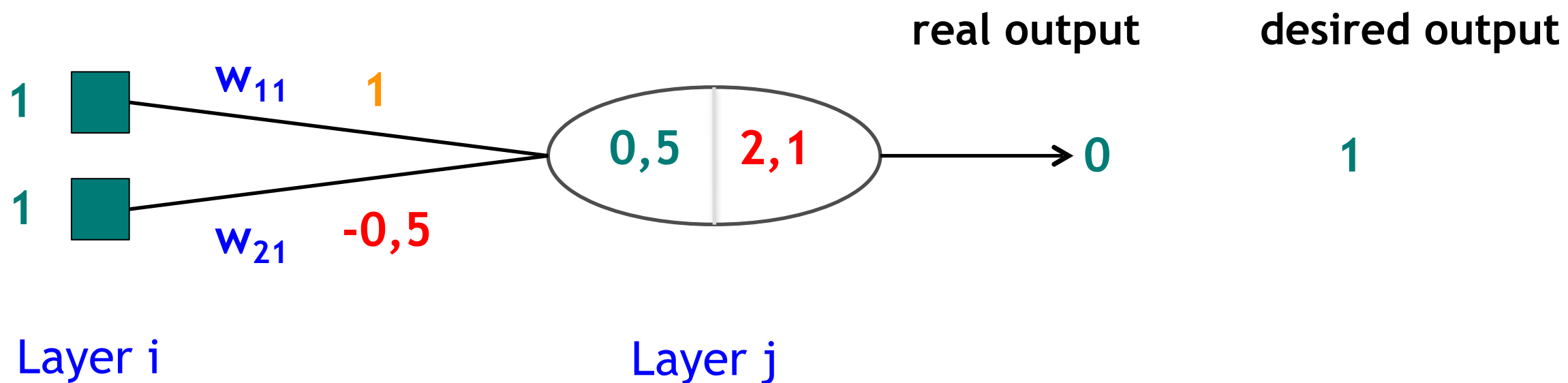
x ₁	x ₂	y
0	0	0
0	1	0
1	0	1
1	1	1



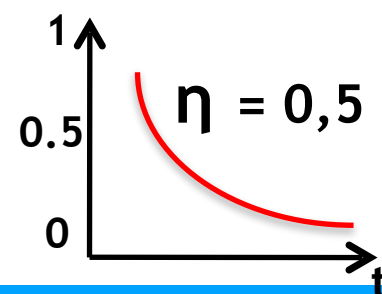
Learning in neural networks



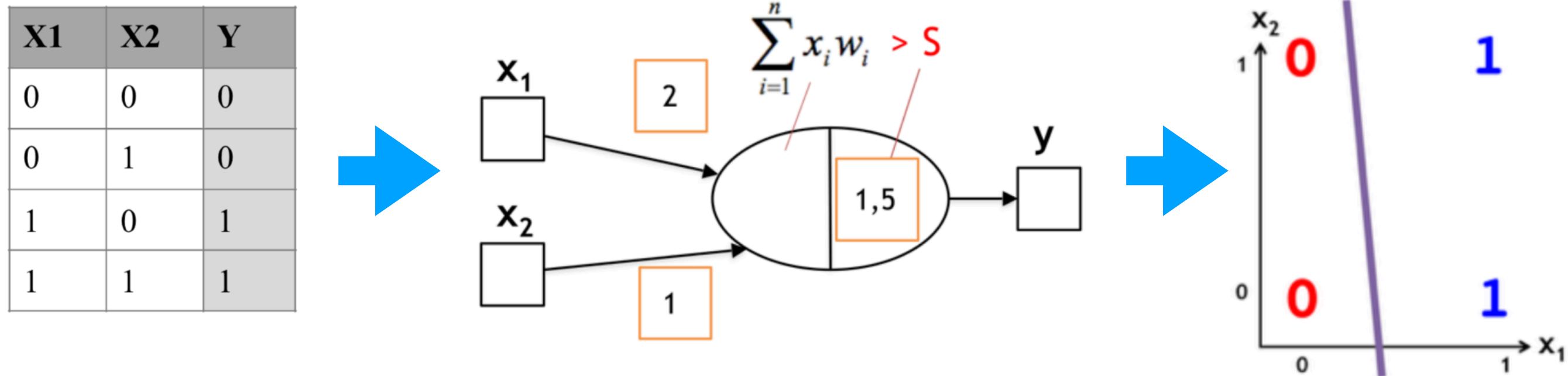
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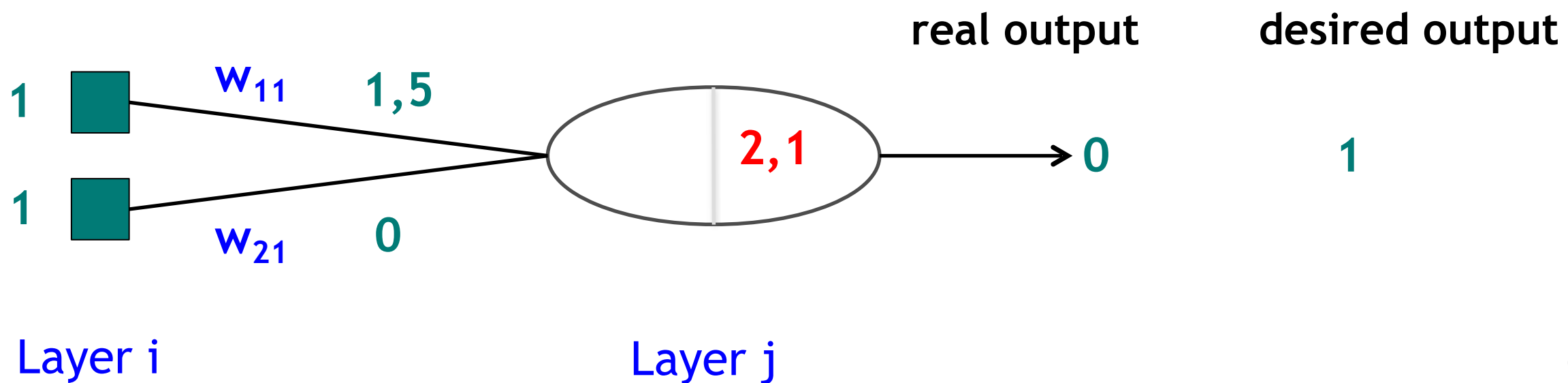
x ₁	x ₂	y
0	0	0
0	1	0
1	0	1
1	1	1



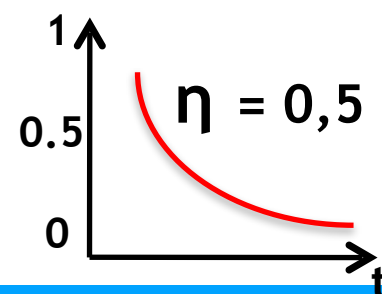
Learning in neural networks



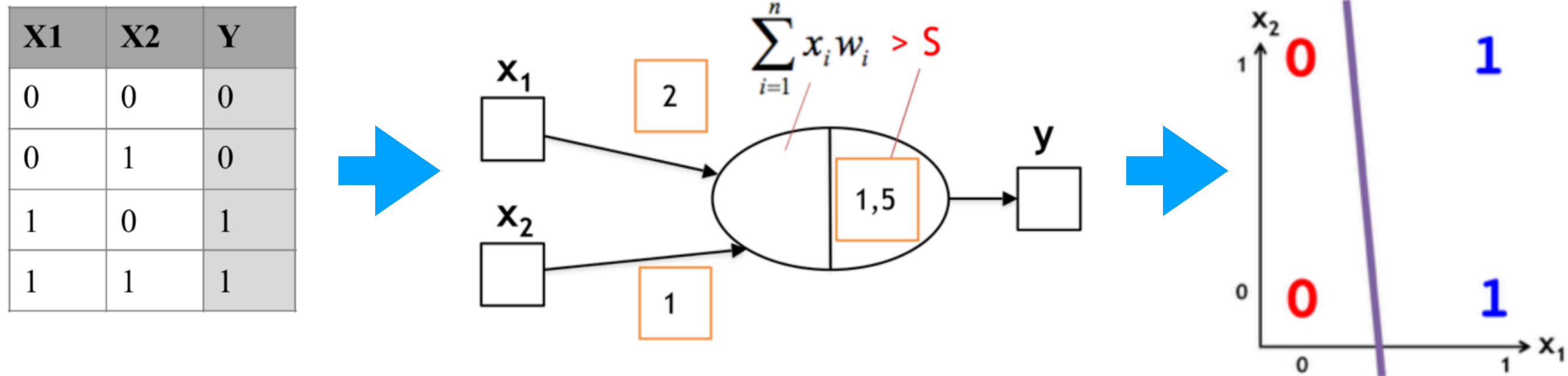
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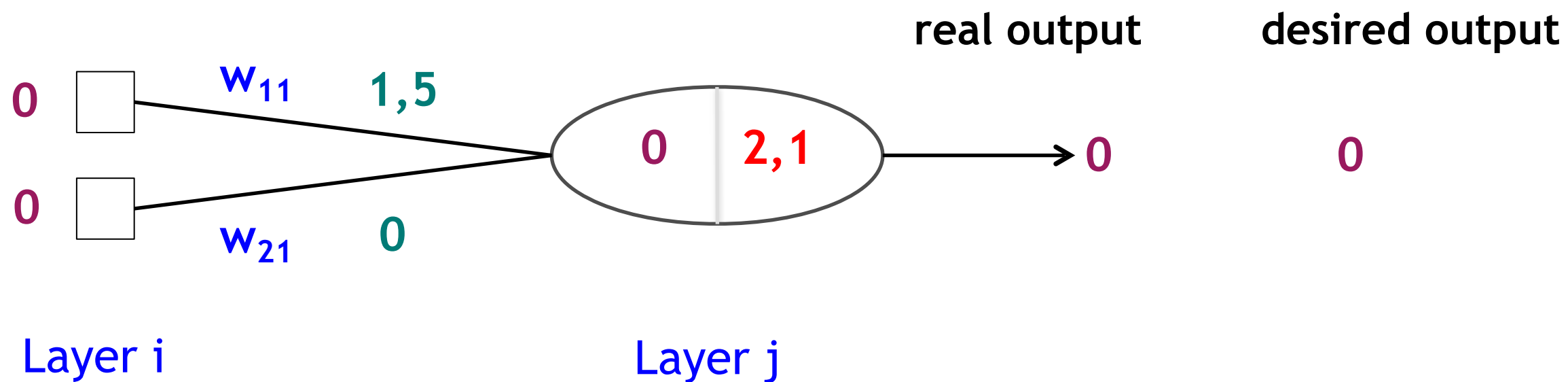
x ₁	x ₂	y
0	0	0
0	1	0
1	0	1
1	1	1



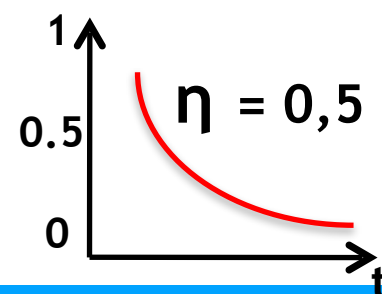
Learning in neural networks



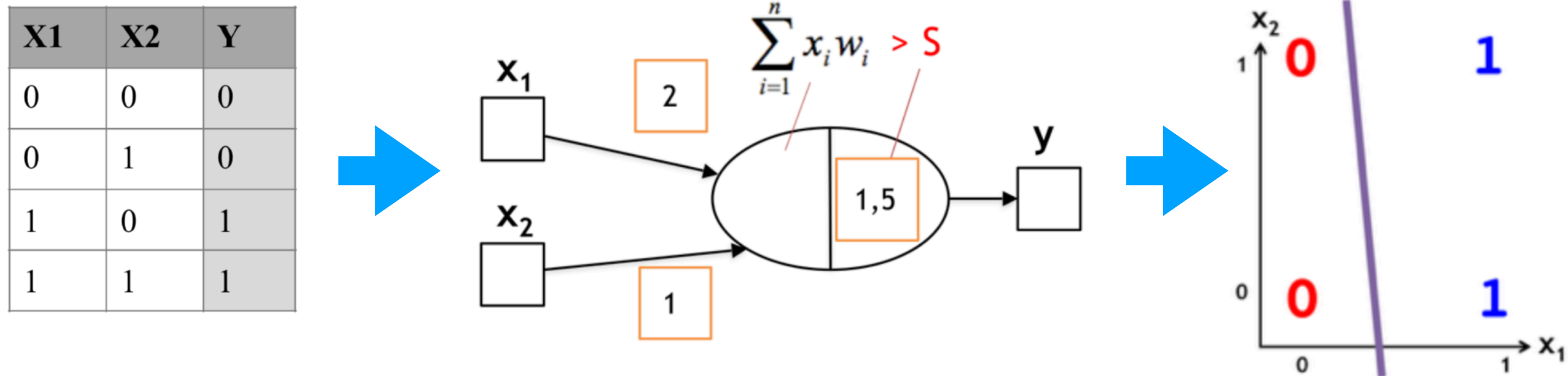
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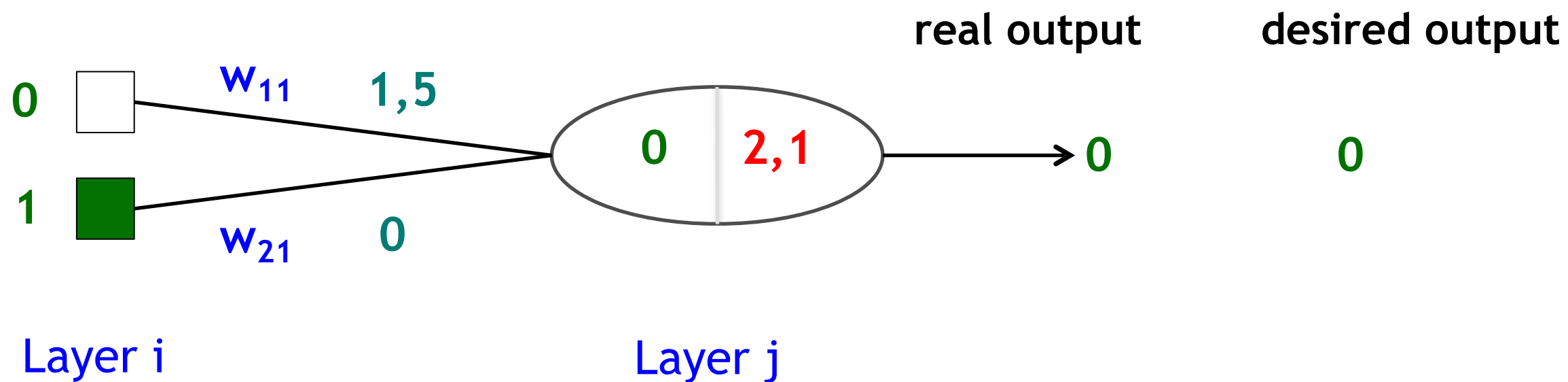
x ₁	x ₂	y
0	0	0
0	1	0
1	0	1
1	1	1



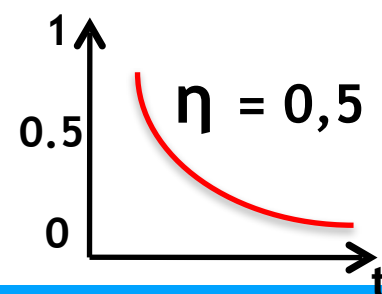
Learning in neural networks



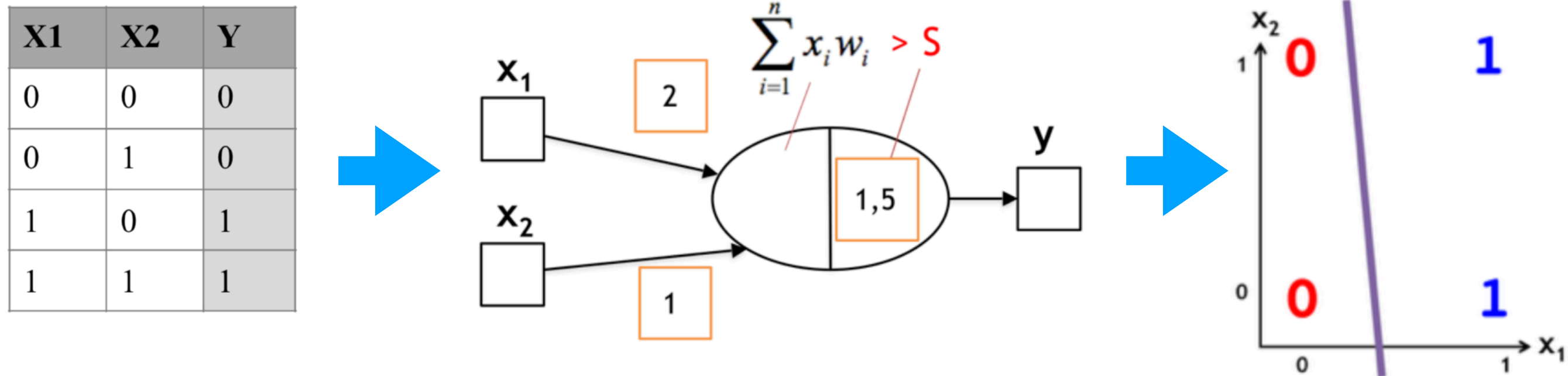
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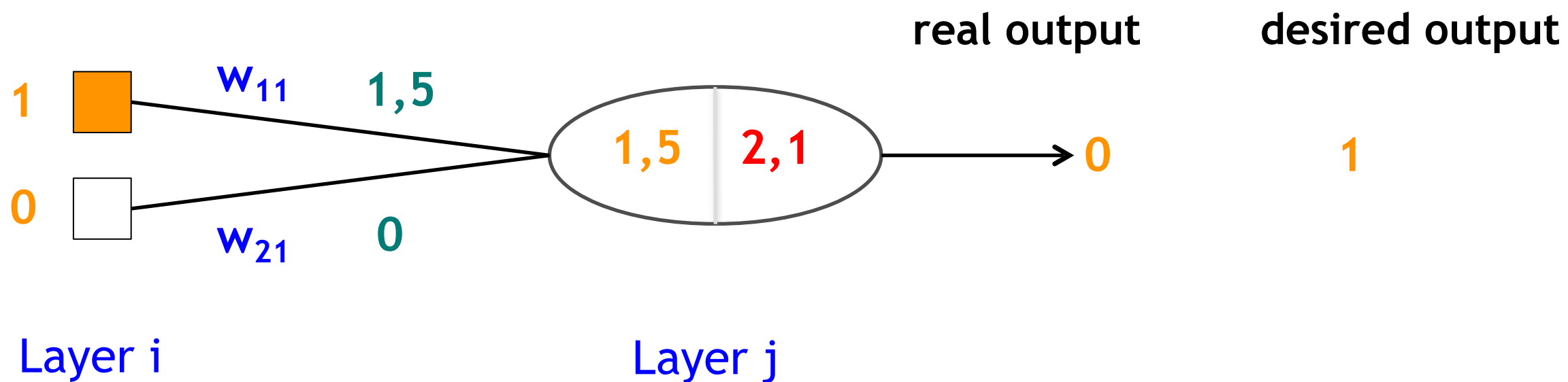
x ₁	x ₂	y
0	0	0
0	1	0
1	0	1
1	1	1



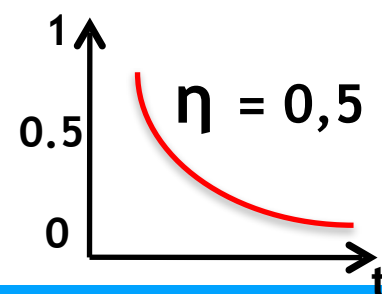
Learning in neural networks



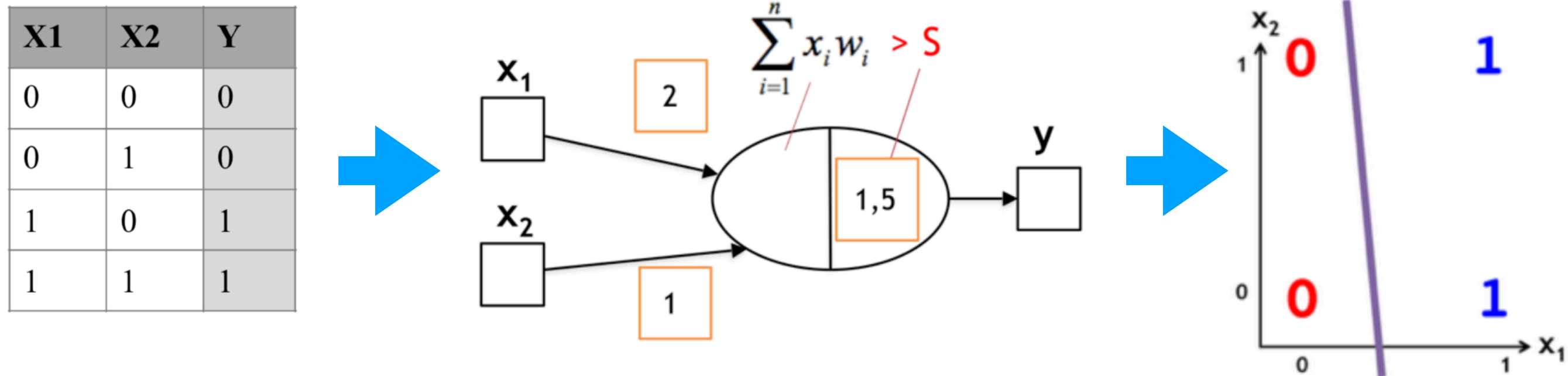
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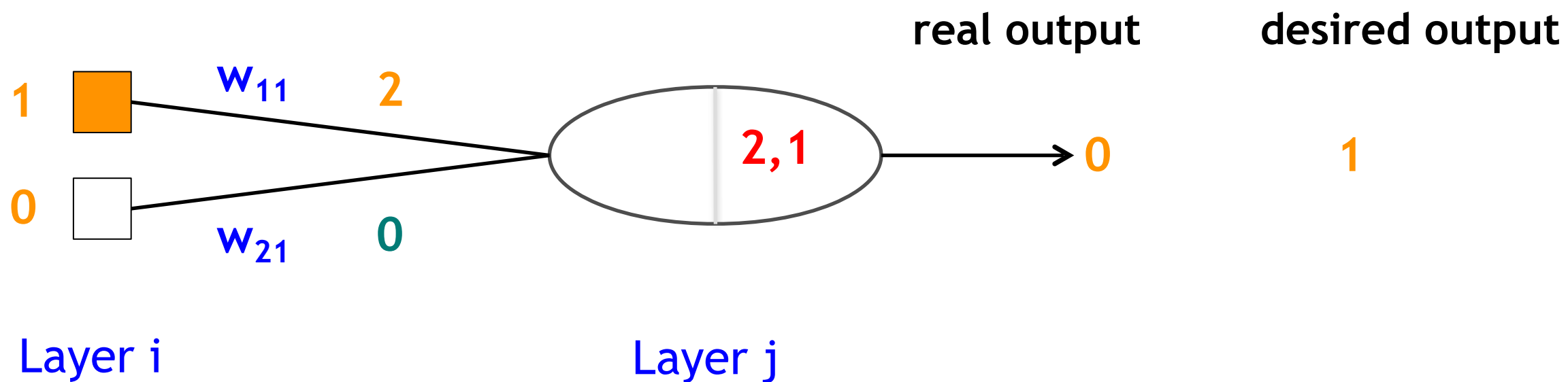
x_1	x_2	y
0	0	0
0	1	0
1	0	1
1	1	1



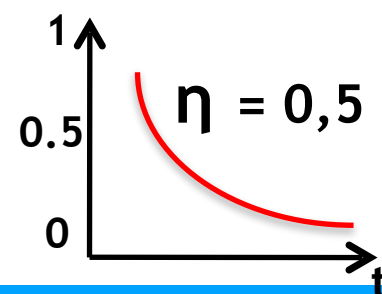
Learning in neural networks



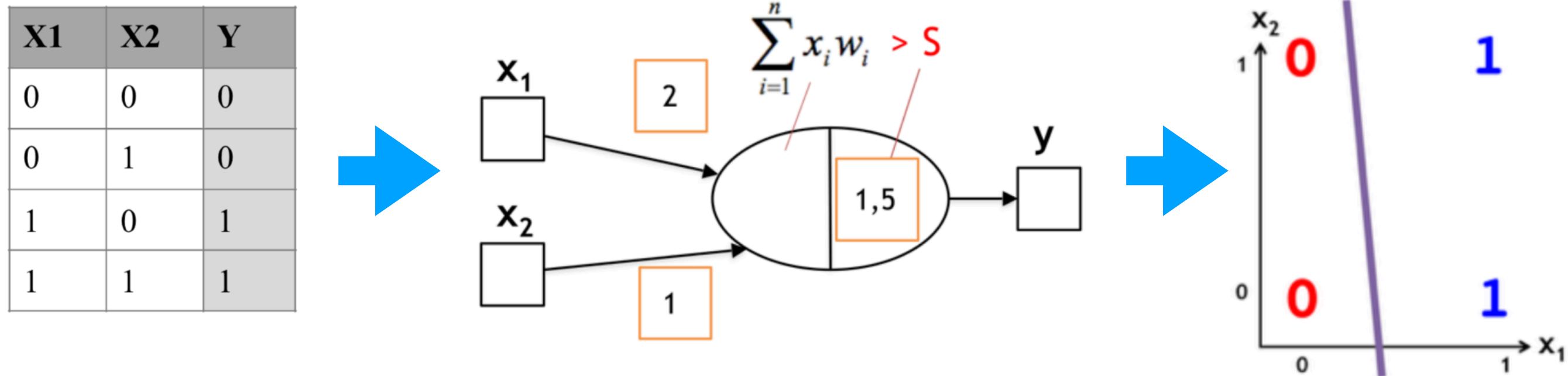
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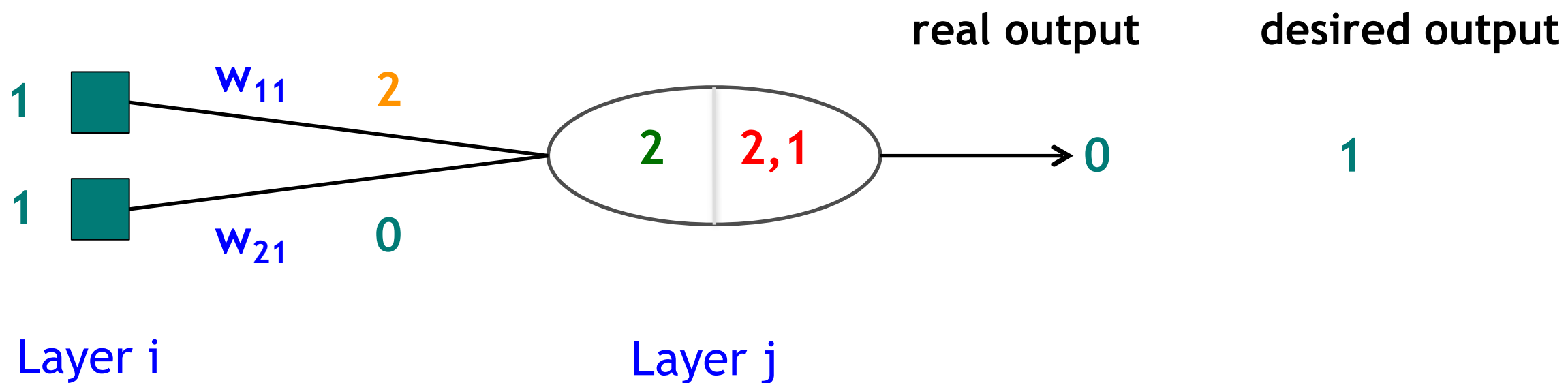
x ₁	x ₂	y
0	0	0
0	1	0
1	0	1
1	1	1



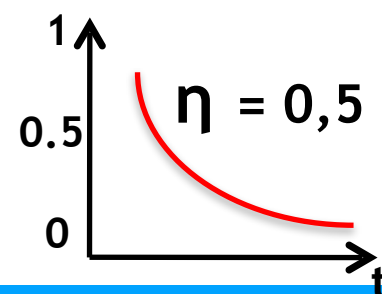
Learning in neural networks



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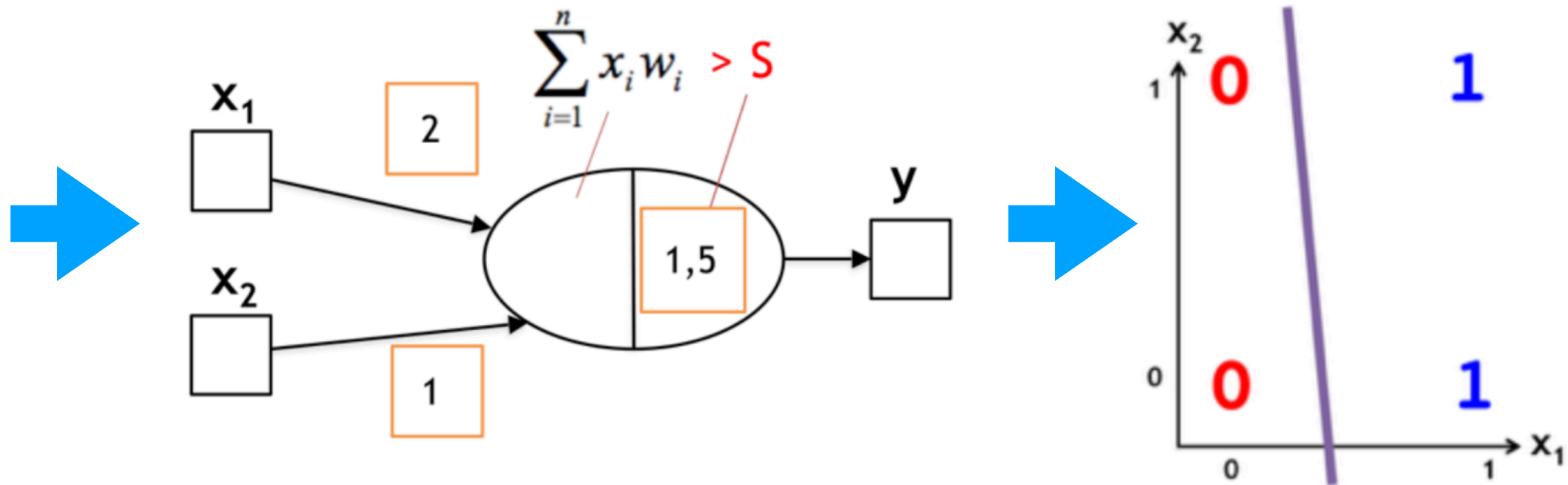


x ₁	x ₂	y
0	0	0
0	1	0
1	0	1
1	1	1

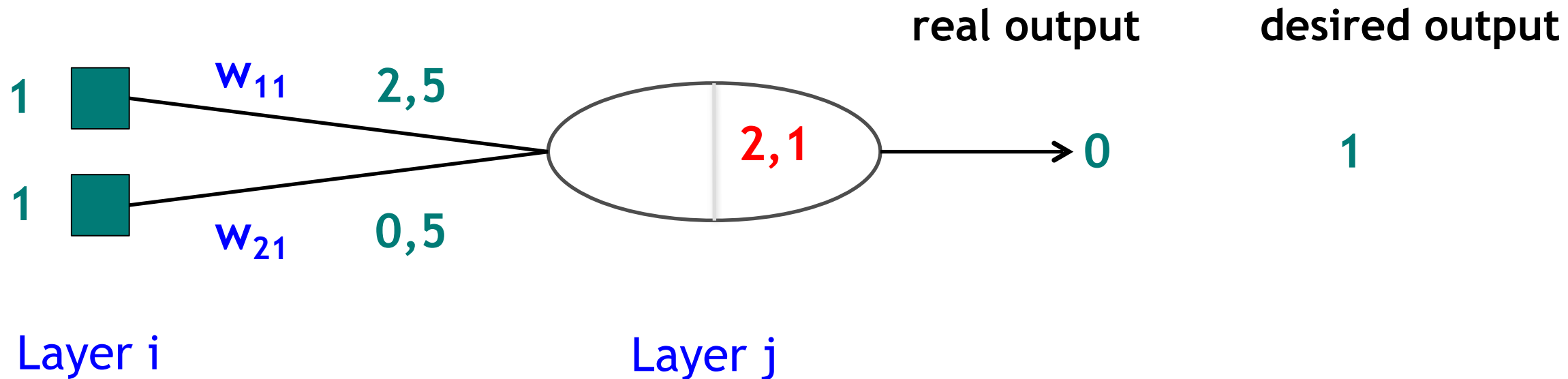


Learning in neural networks

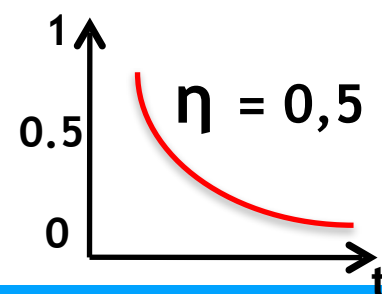
X1	X2	Y
0	0	0
0	1	0
1	0	1
1	1	1



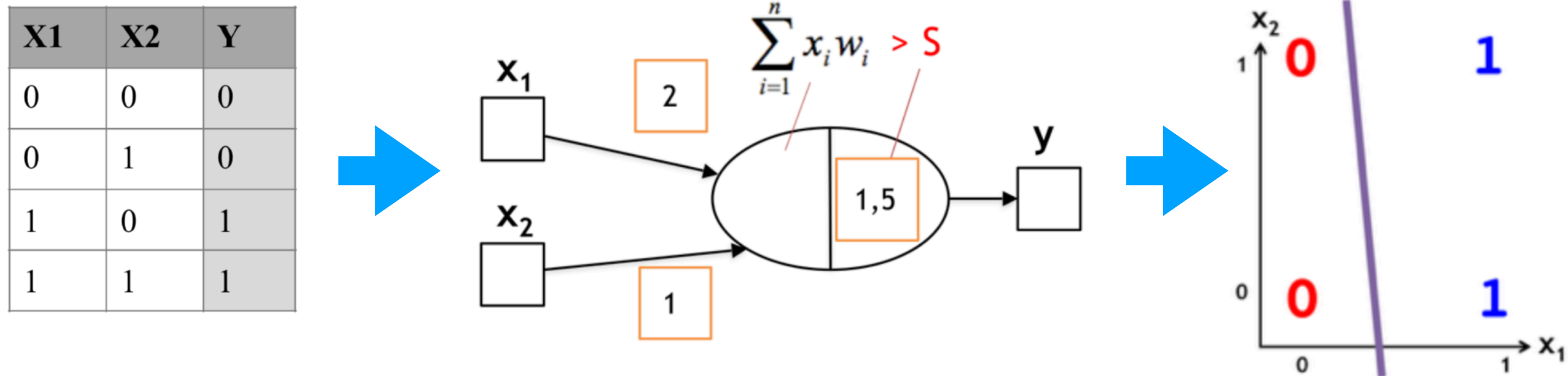
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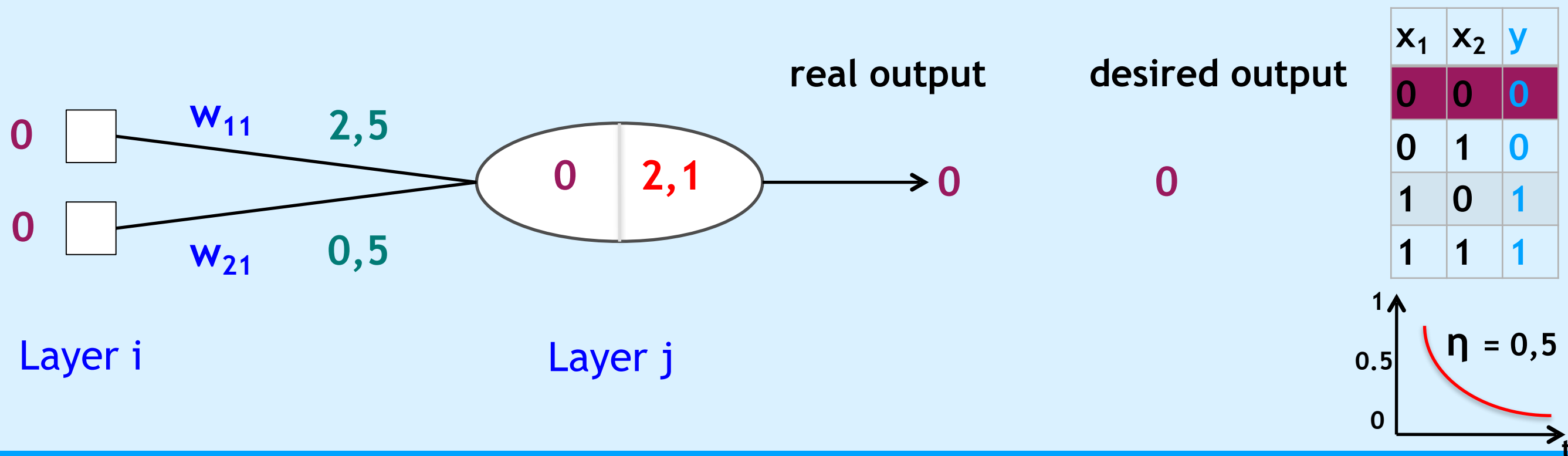
x_1	x_2	y
0	0	0
0	1	0
1	0	1
1	1	1



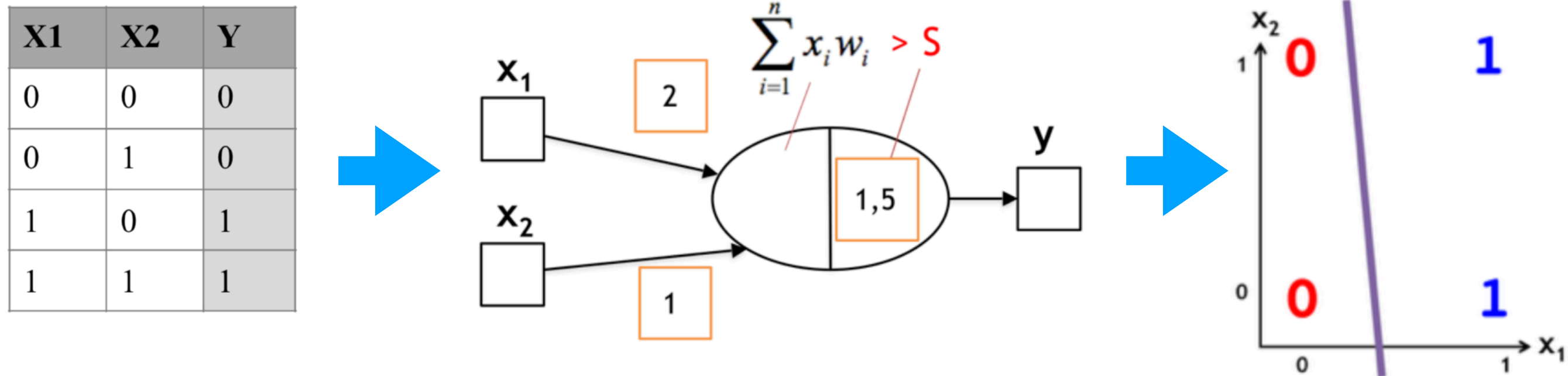
Learning in neural networks



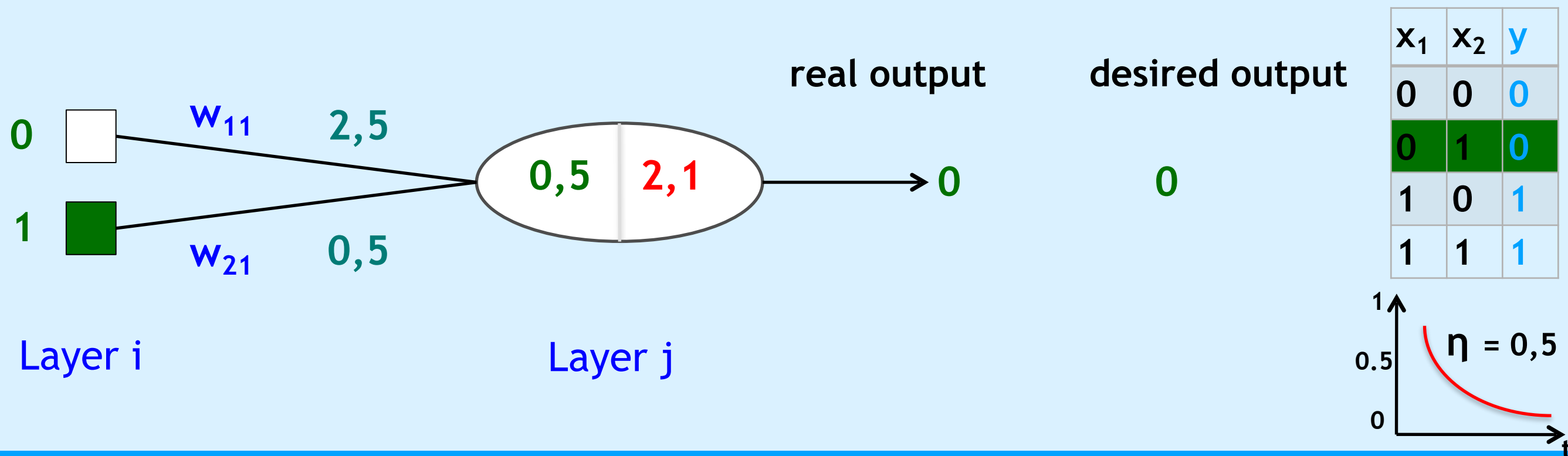
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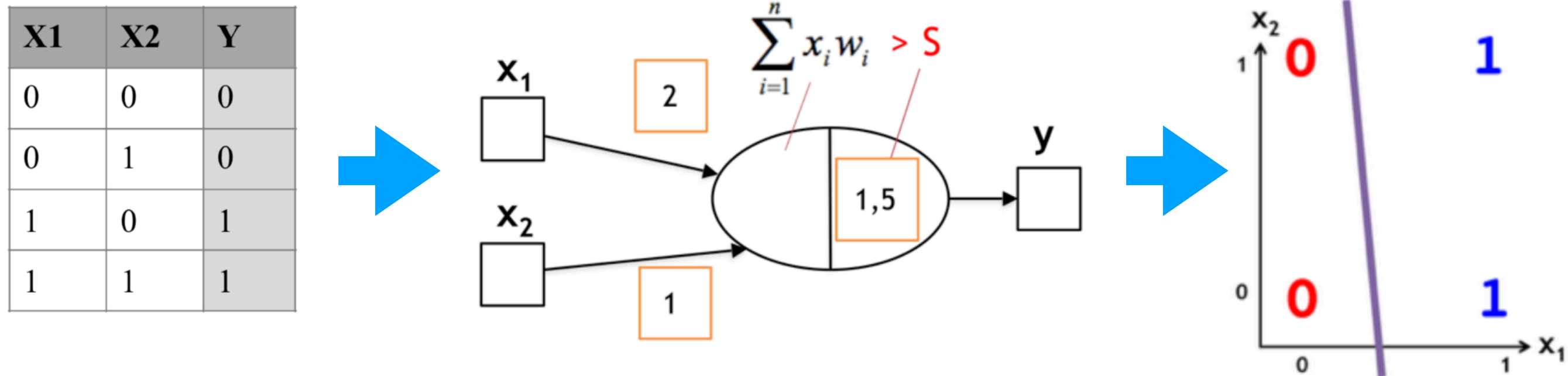
Learning in neural networks



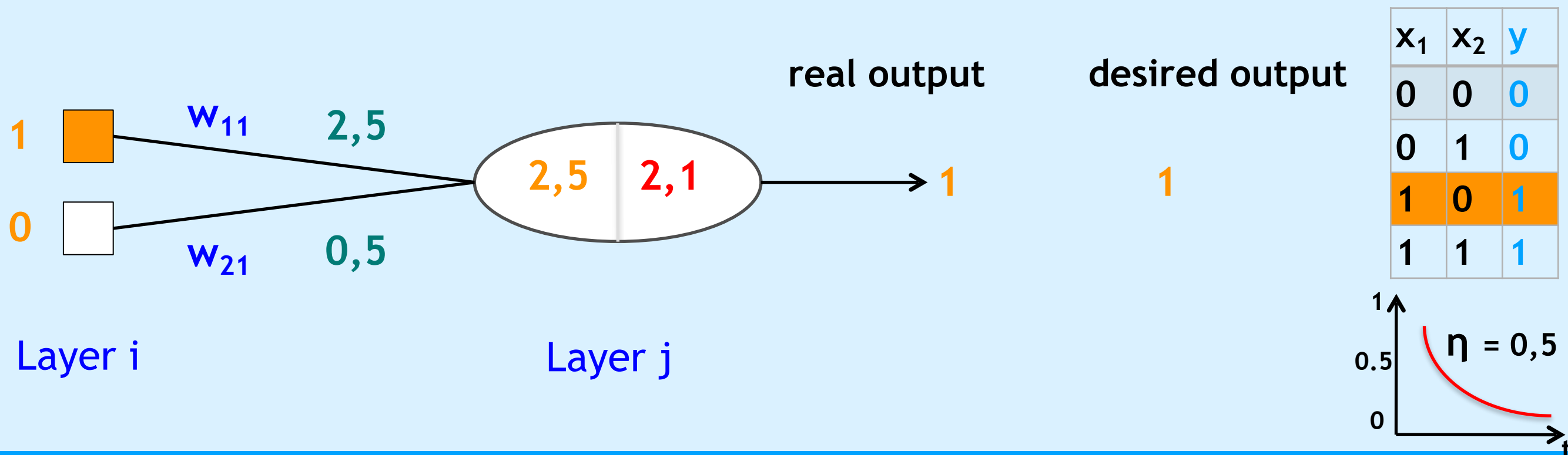
with this **Learning rule**: $w_{ij}(t+1) = w_{ij}(t) + \eta \cdot (y_j - o_i) \cdot x_i$



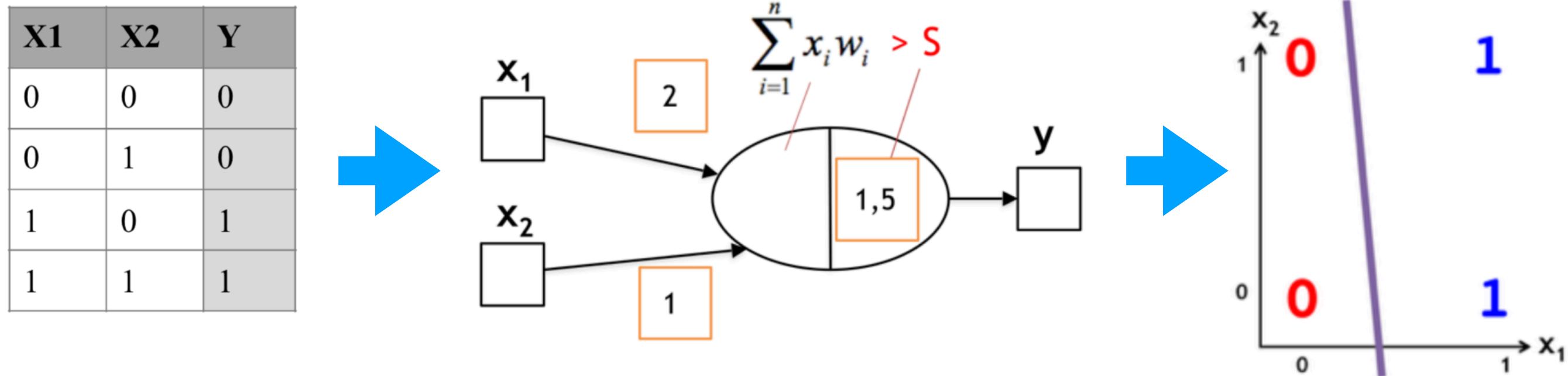
Learning in neural networks



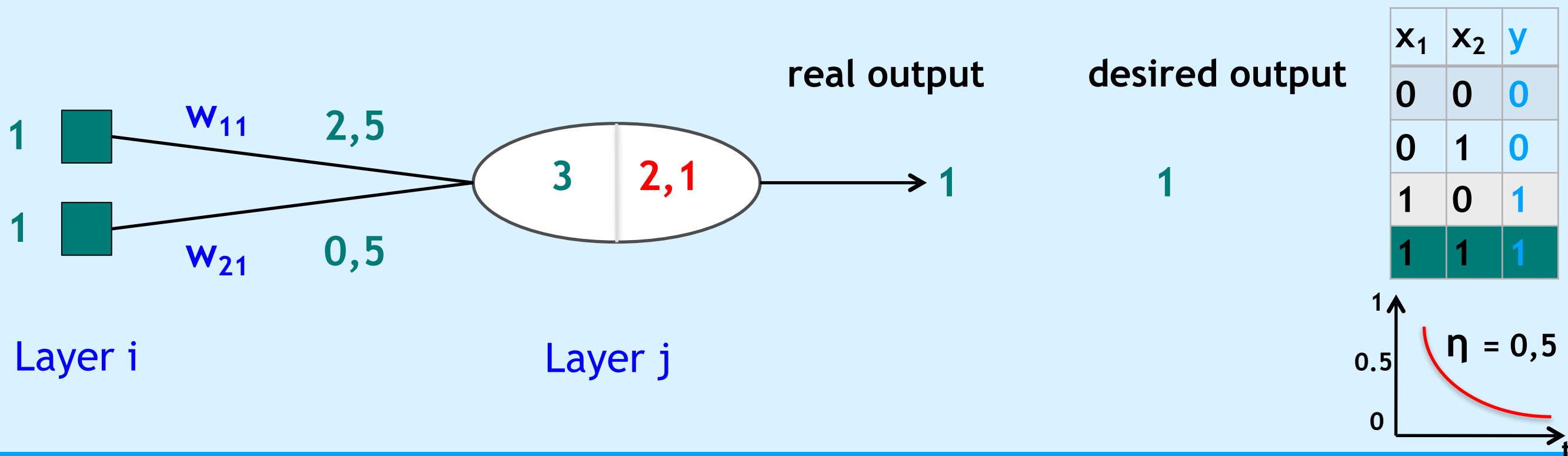
with this **Learning rule**: $w_{ij}(t+1) = w_{ij}(t) + \eta \cdot (y_j - o_i) \cdot x_i$

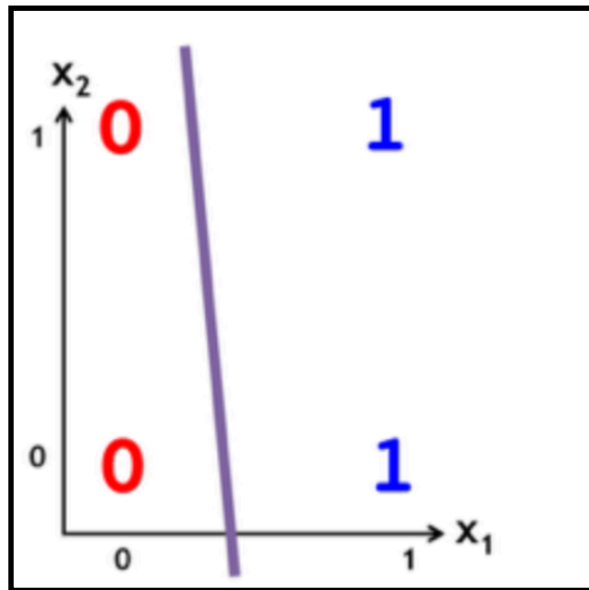
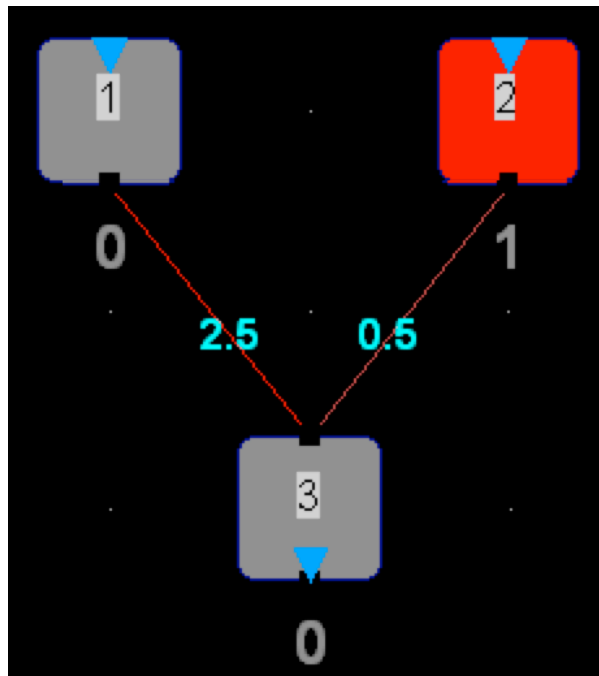


Learning in neural networks



with this **Learning rule**: $w_{ij}(t+1) = w_{ij}(t) + \eta \cdot (y_j - o_i) \cdot x_i$

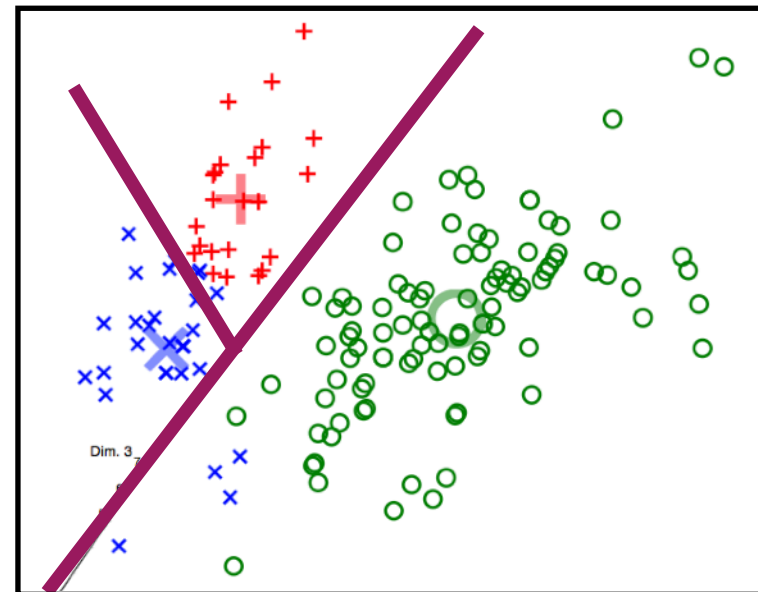
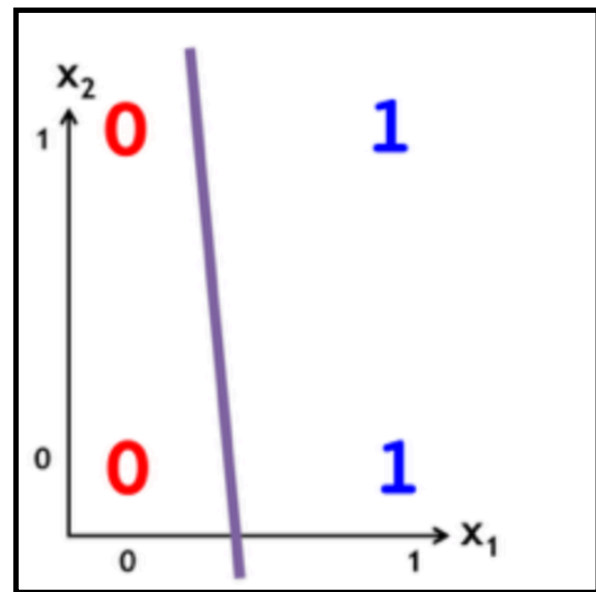
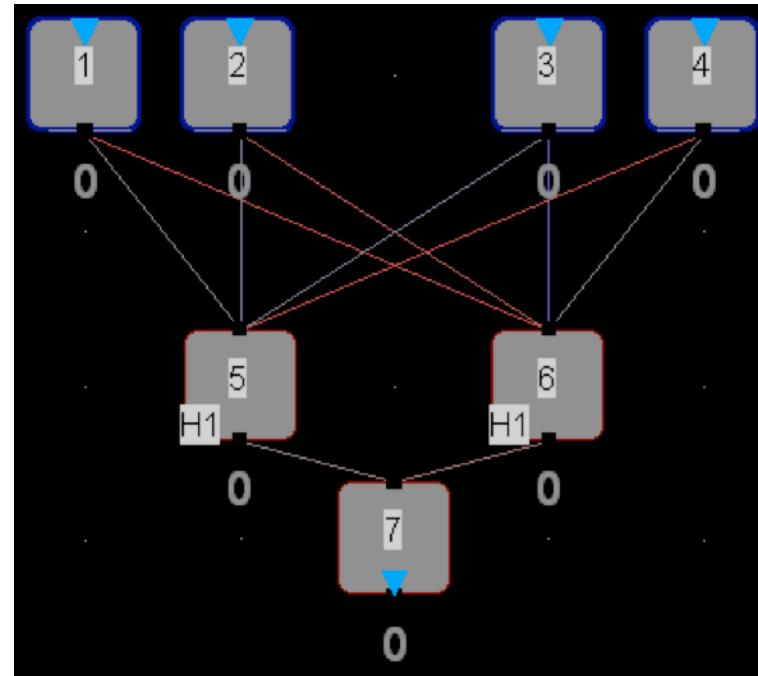
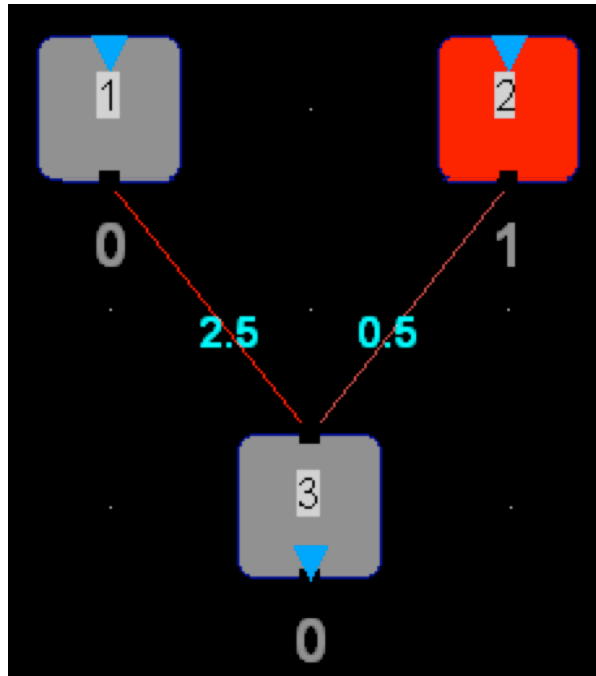




x_1	x_2	y
0	0	0
0	1	0
1	0	1
1	1	1

Binary functions

Neural networks in MemBrain www.membrain-nn.de

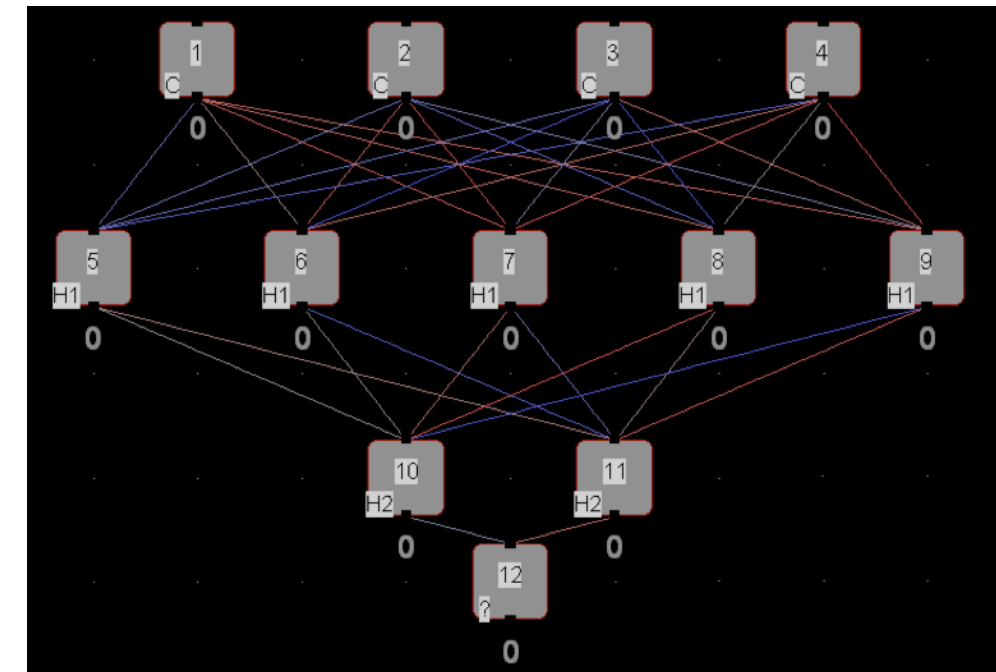
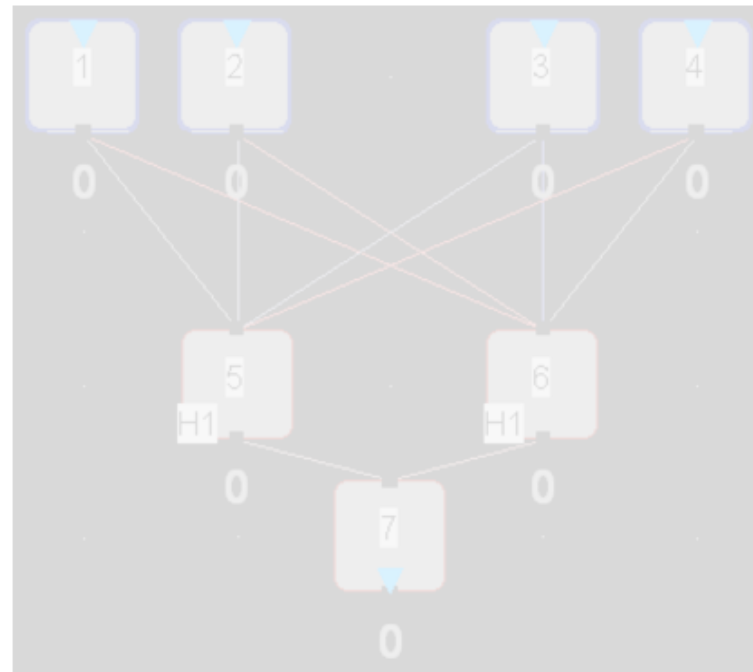
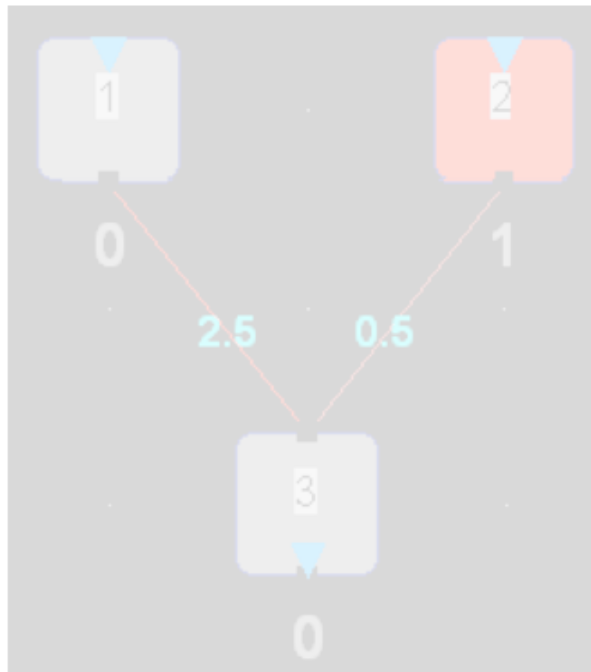


**real world data
(IRIS dataset)**

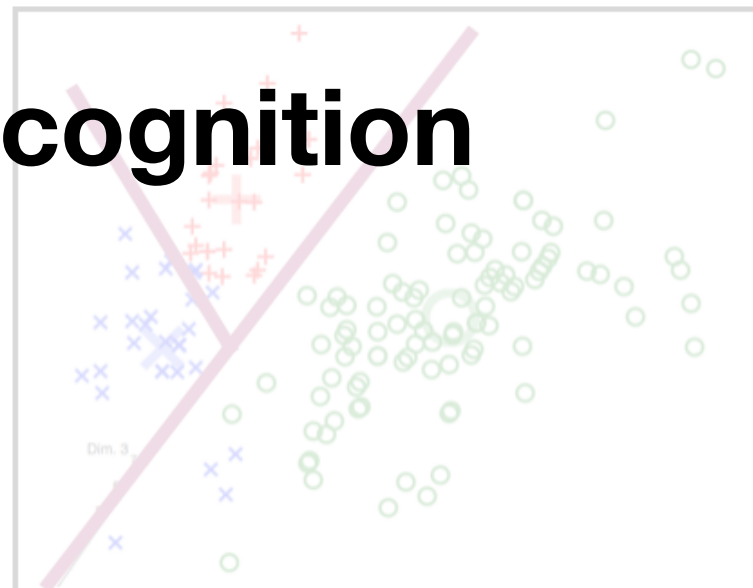
x1	x2	y
0	0	0
0	1	0
1	0	1
1	1	1

KeL	KeB	KrL	KrB	Y
5.1	3.8	1.4	0.2	0
5.8	2.6	4.0	1.2	0.5
6.3	3.3	4.1	1.3	0.5
6.2	2.8	4.8	1.8	1

Neural networks in MemBrain (www.membrain-nn.de)



face recognition



...



x1	x2	y
0	0	0
0	1	0
1	0	1
1	1	1

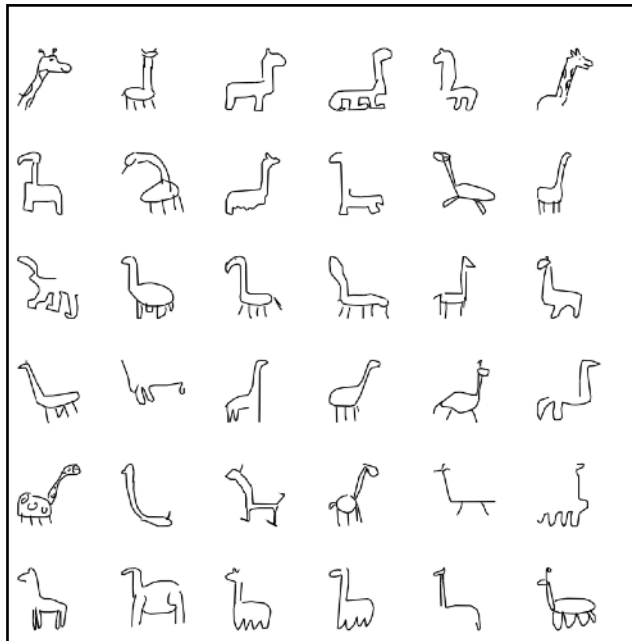
KeL	KeB	KrL	KrB	Y
5.1	3.8	1.4	0.2	0
5.8	2.6	4.0	1.2	0.5
6.3	3.3	4.1	1.3	0.5
6.2	2.8	4.8	1.8	1

M1	M2	M3	M4	Y
0.56	0.23	0.57	0.23	0
0.67	0.34	0.60	0.44	0.5
0.70	0.32	0.55	0.47	0.5
0.45	0.30	0.54	0.65	1

Further information



$$f(X) = Y$$



quickdraw.withgoogle.com



deepdreamgenerator.com

$$f(X) = Y$$

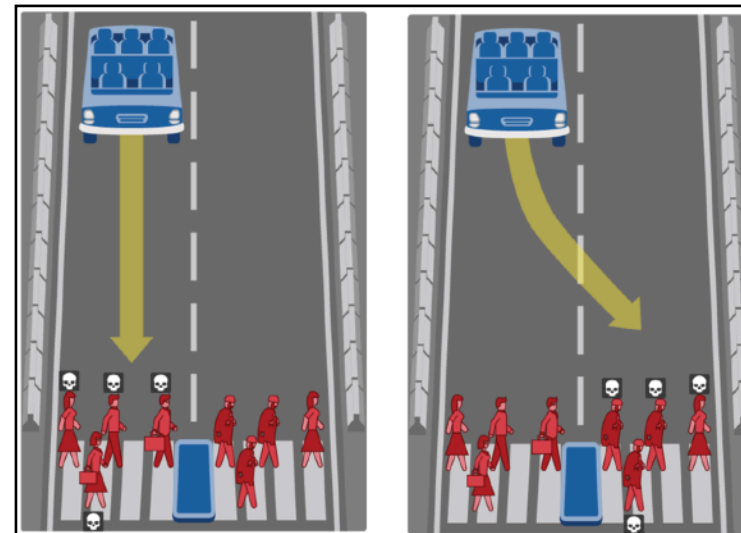


Deep Fakes
youtu.be/cQ54GDm1eL0



cs.stanford.edu/people/karpathy/convnetjs

moralmachine.mit.edu



autonomousweapons.org