

SZTUCZNY UMYSŁ - CZYLI JAK DZIAŁAJĄ SIECI NEURONOWE

Aleksander Obuchowski

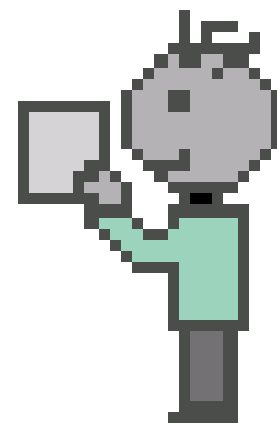
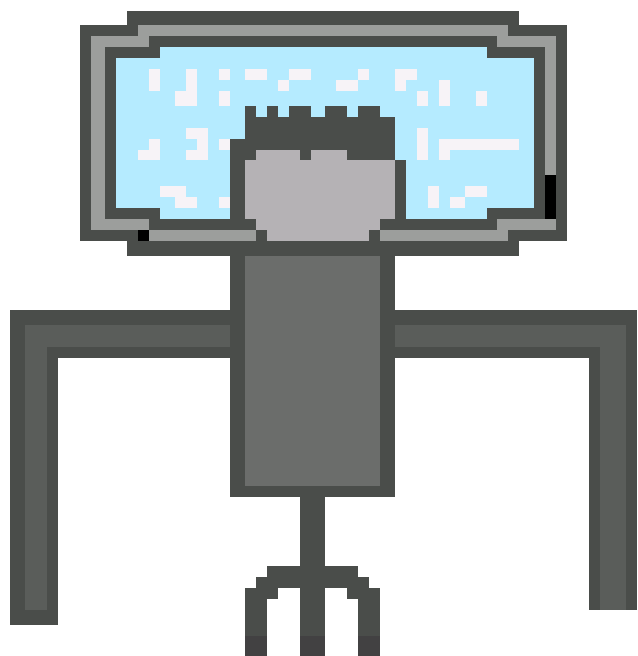
Pojedynczy neuron:

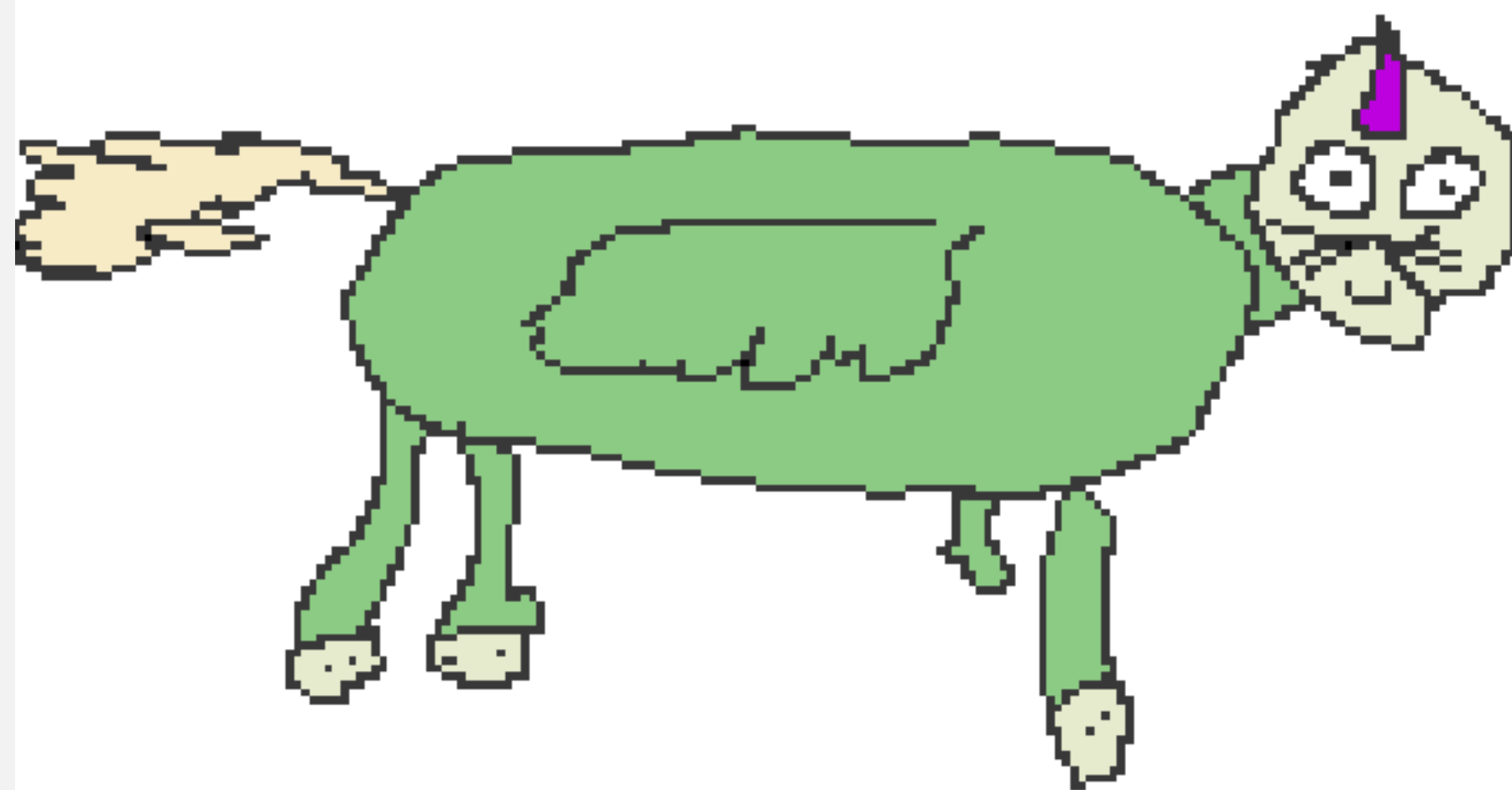
- Koncept
- Opis matematyczny

Sieć neuronowa:

- Feed forward
- Propagacja błędu
- Nauka nadzorowana
- Funkcje aktywacji
- Przykłady

KONCEPT







Oczy

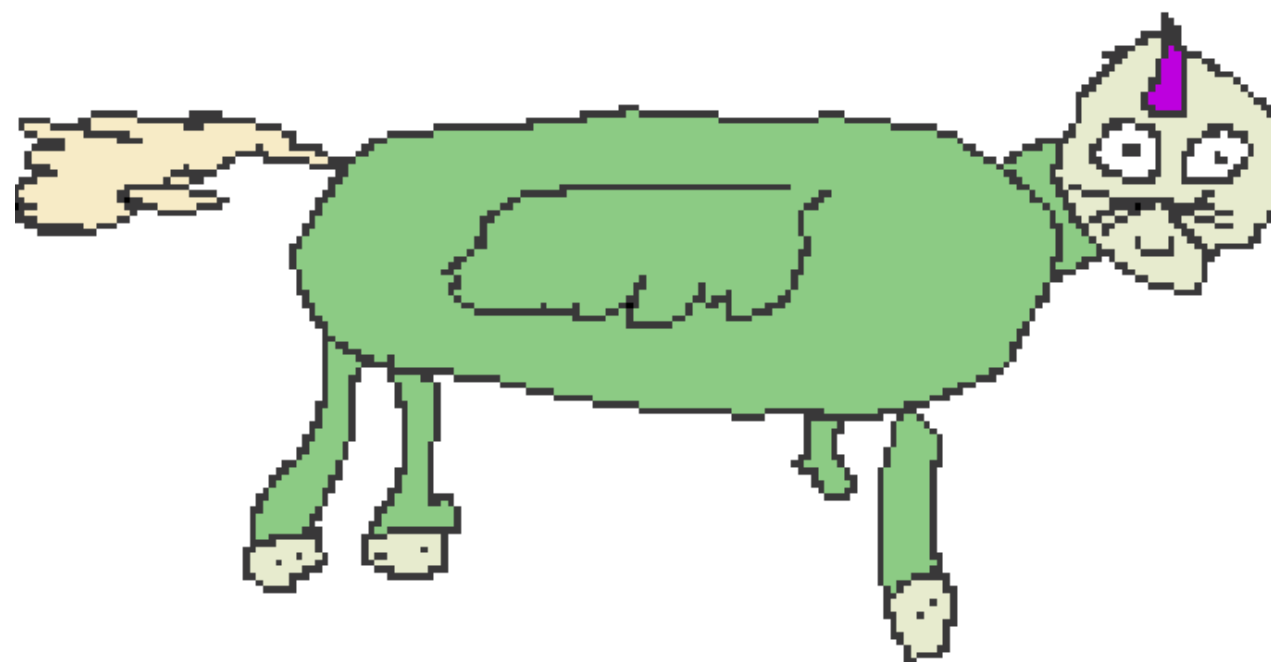
4 łapy

Wąsy

Skrzydła

Ogon

Róg



Oczy 0.89

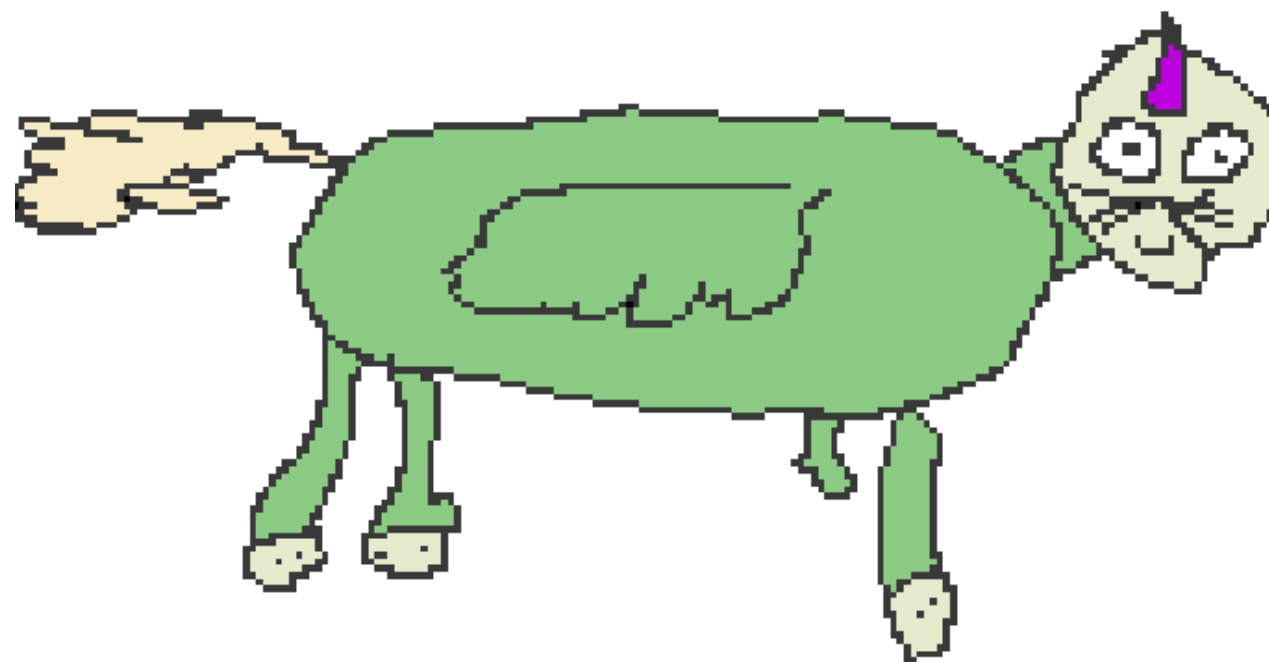
4 łapy 0.63

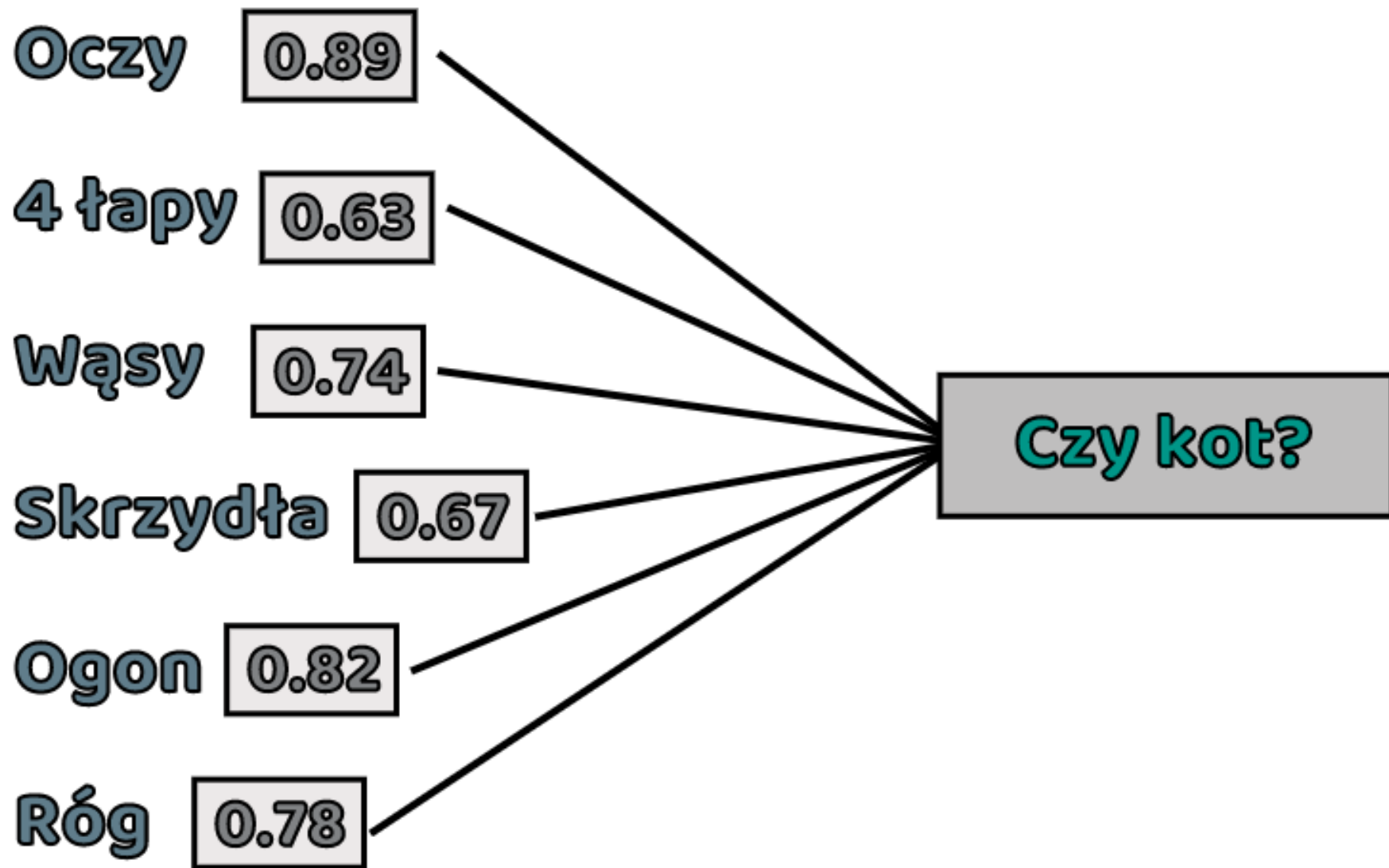
Wąsy 0.74

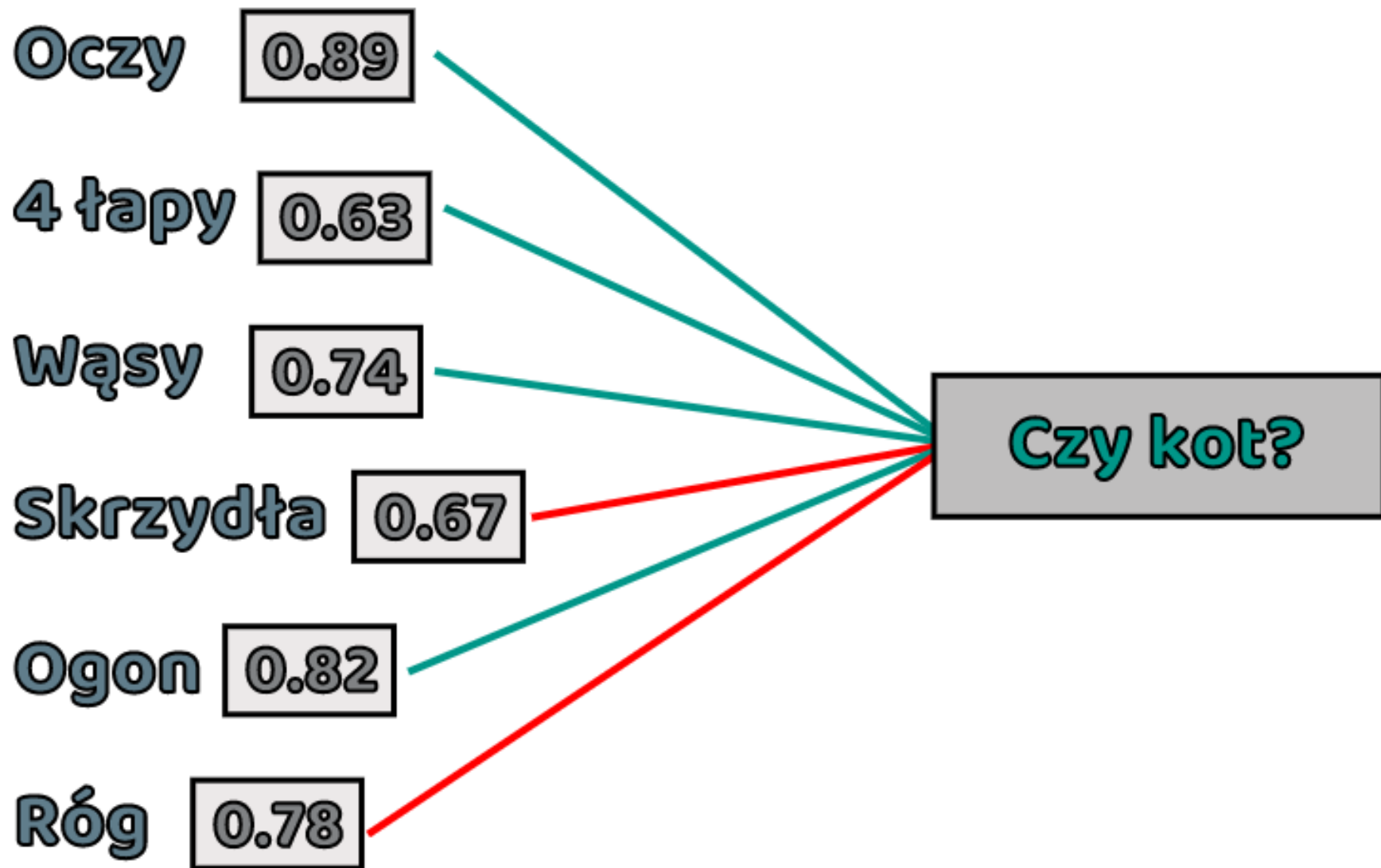
Skrzydła 0.67

Ogon 0.82

Róg 0.78







Oczy 0.89×0.93

4 łapy 0.63×0.71

Wąsy 0.74×0.23

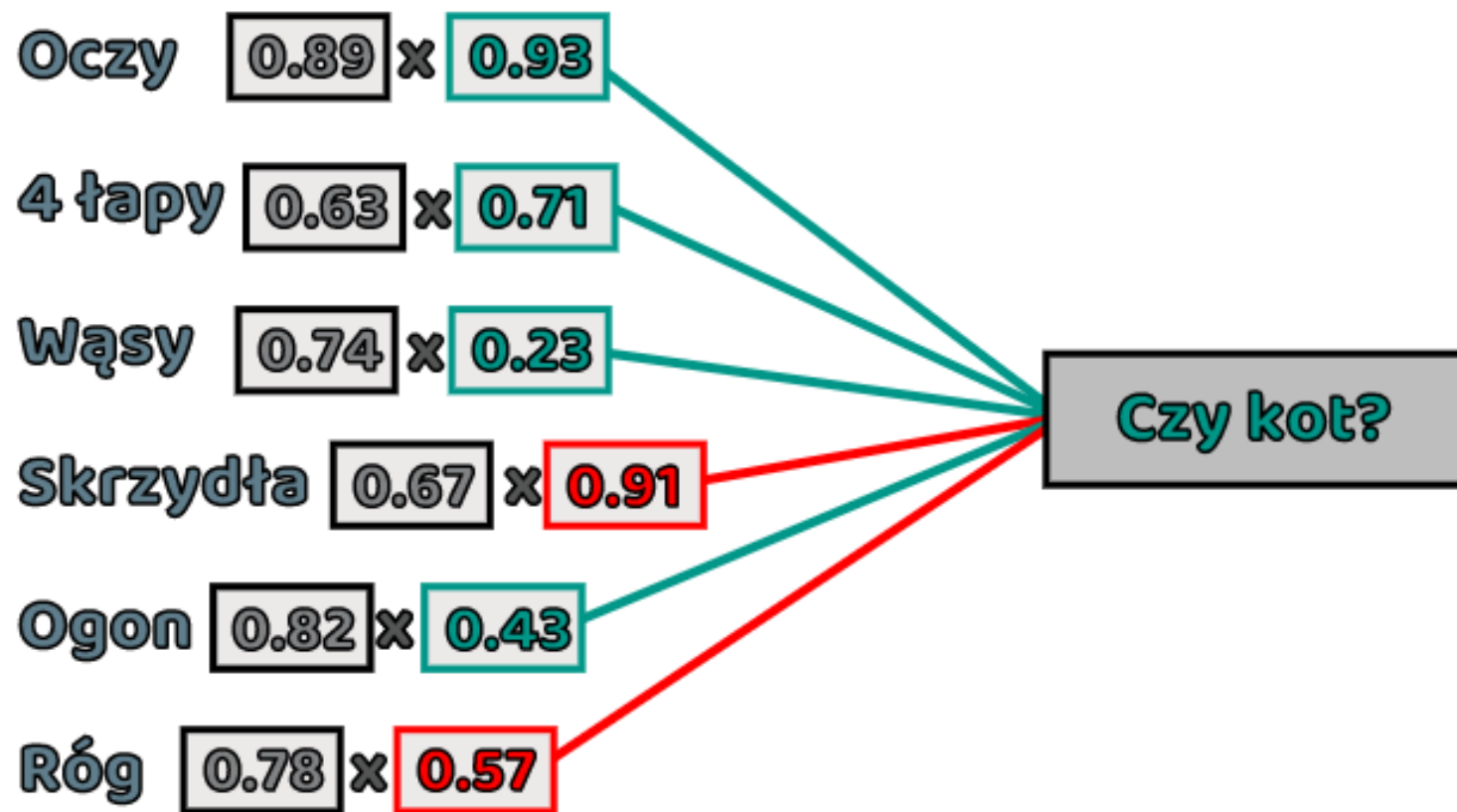
Skrzydła 0.67×0.91

Ogon 0.82×0.43

Róg 0.78×0.57

Czy kot?

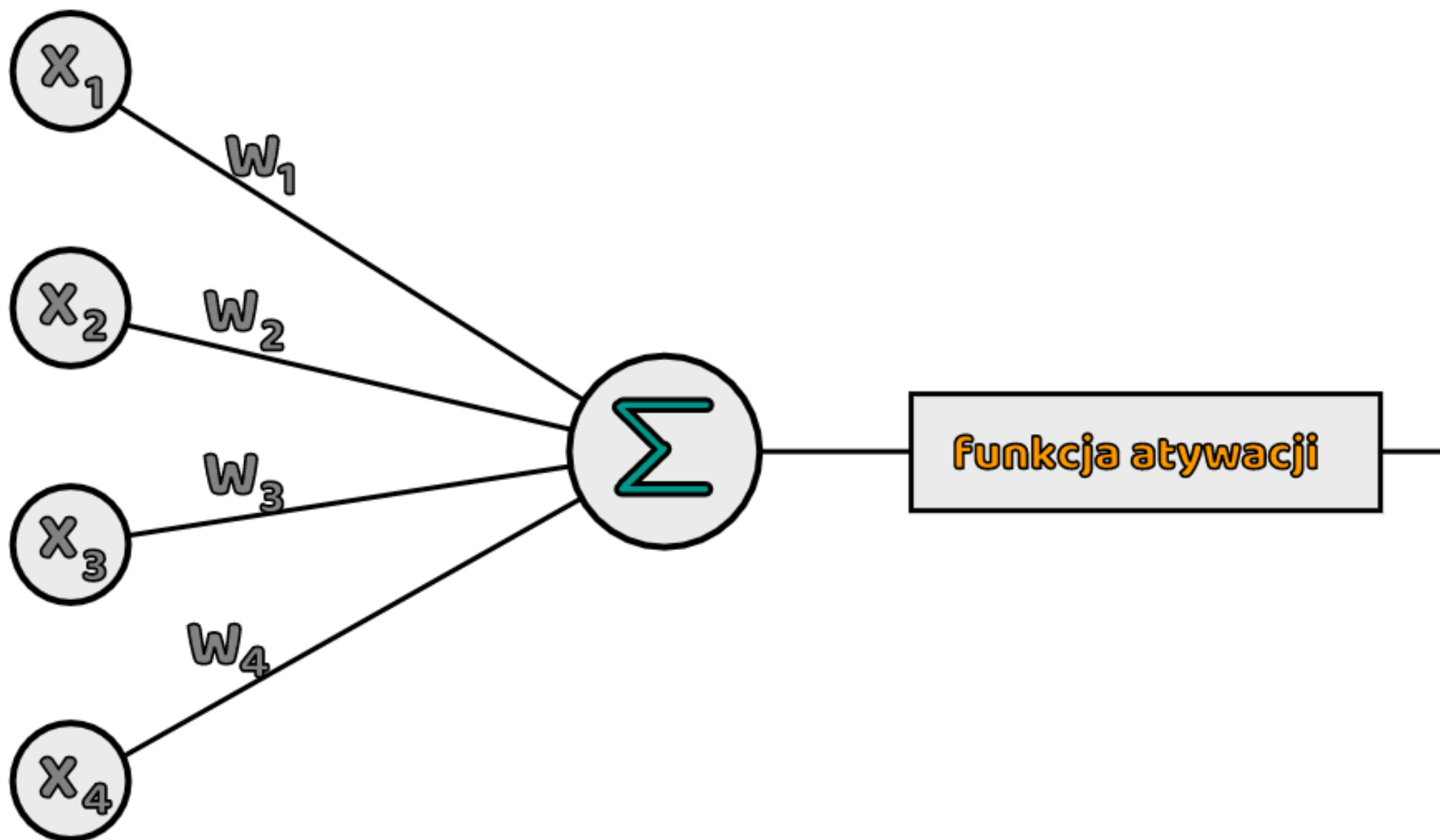
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graph LR; A["Oczy 0.89 x 0.93"] -- teal --> F["Czy kot?"]; B["4 łapy 0.63 x 0.71"] -- teal --> F; C["Wąsy 0.74 x 0.23"] -- teal --> F; D["Skrzydła 0.67 x 0.91"] -- red --> F; E["Ogon 0.82 x 0.43"] -- teal --> F; F2["Róg 0.78 x 0.57"] -- red --> F;
```

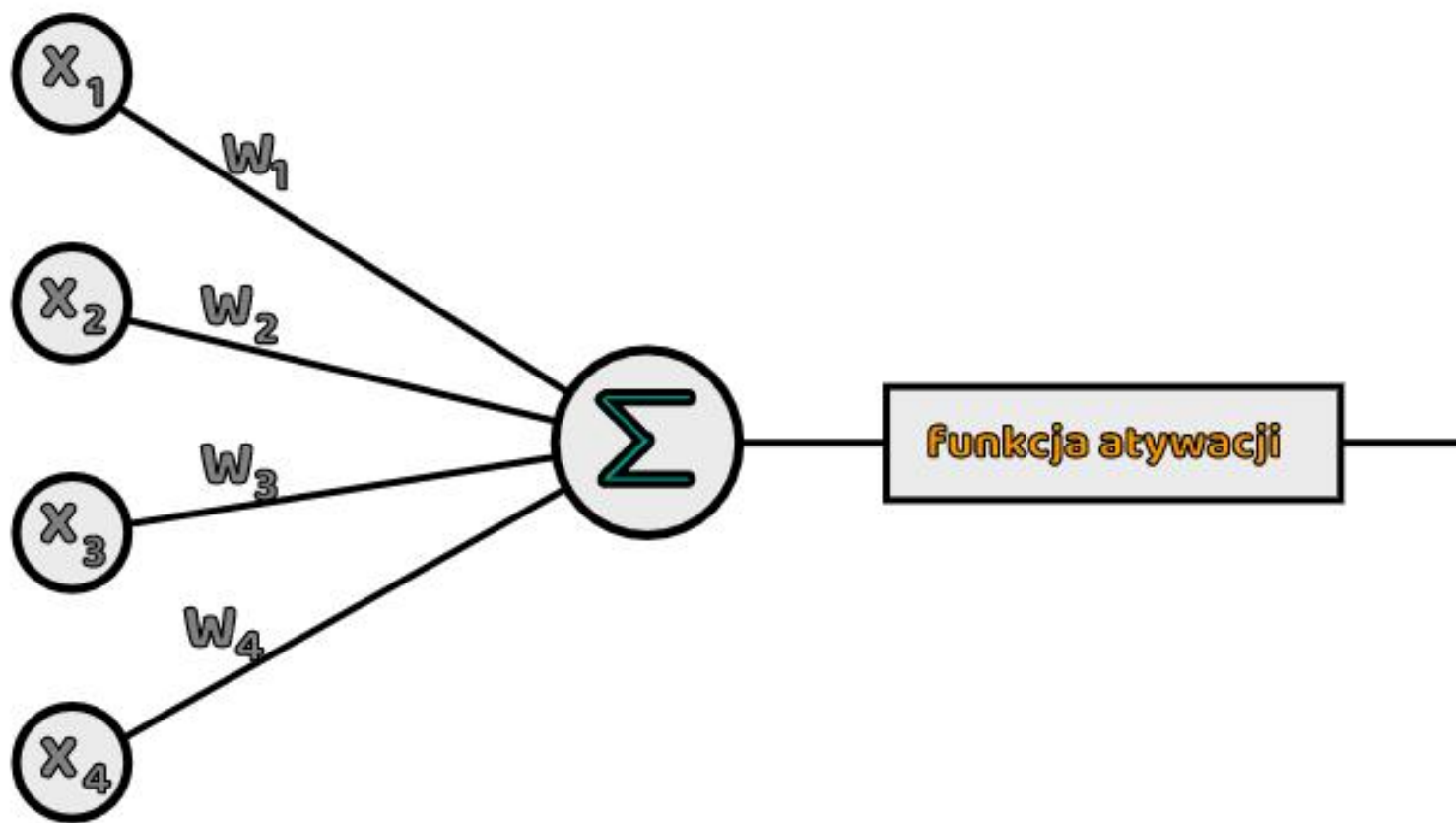


$$0.89 \times 0.93 + 0.63 \times 0.71 + 0.74 \times 0.23 +$$

$$0.67 \times 0.91 + 0.82 \times 0.43 + 0.78 \times 0.57 = 2.85$$

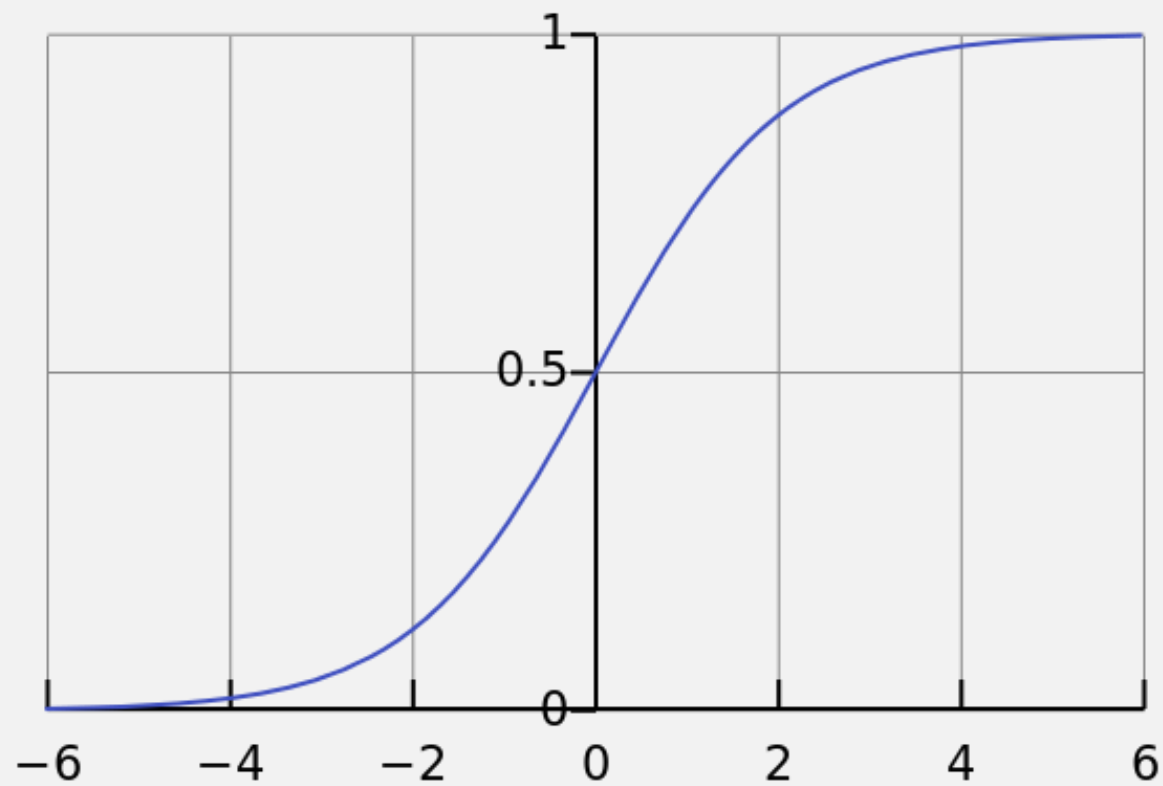
OPIS MATEMATYCZNY





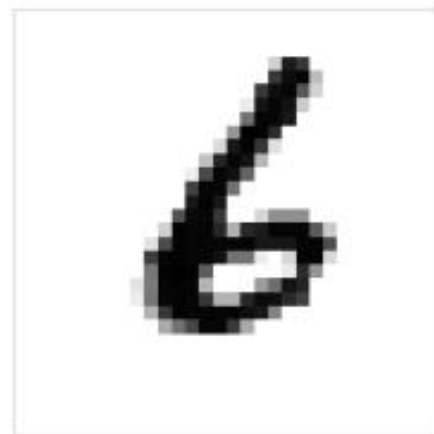
Wyjście = $\text{funkcja aktywacji}(x_1 * w_1 + x_2 * w_2 + x_3 * w_3 + x_4 * w_4)$

FUNKCJA SIGMOID

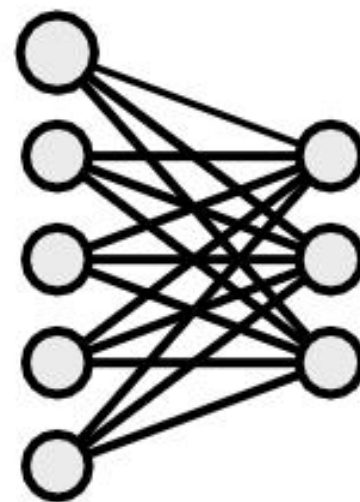


$$A = \frac{1}{1+e^{-x}}$$

SIEĆ NEURONOWA



000	001	002	003	...	026	027
028	029	030	031	...	054	055
056	057	058	059	...	082	083
				...		
728	729	730	731	...	754	755
756	757	758	759	...	782	783

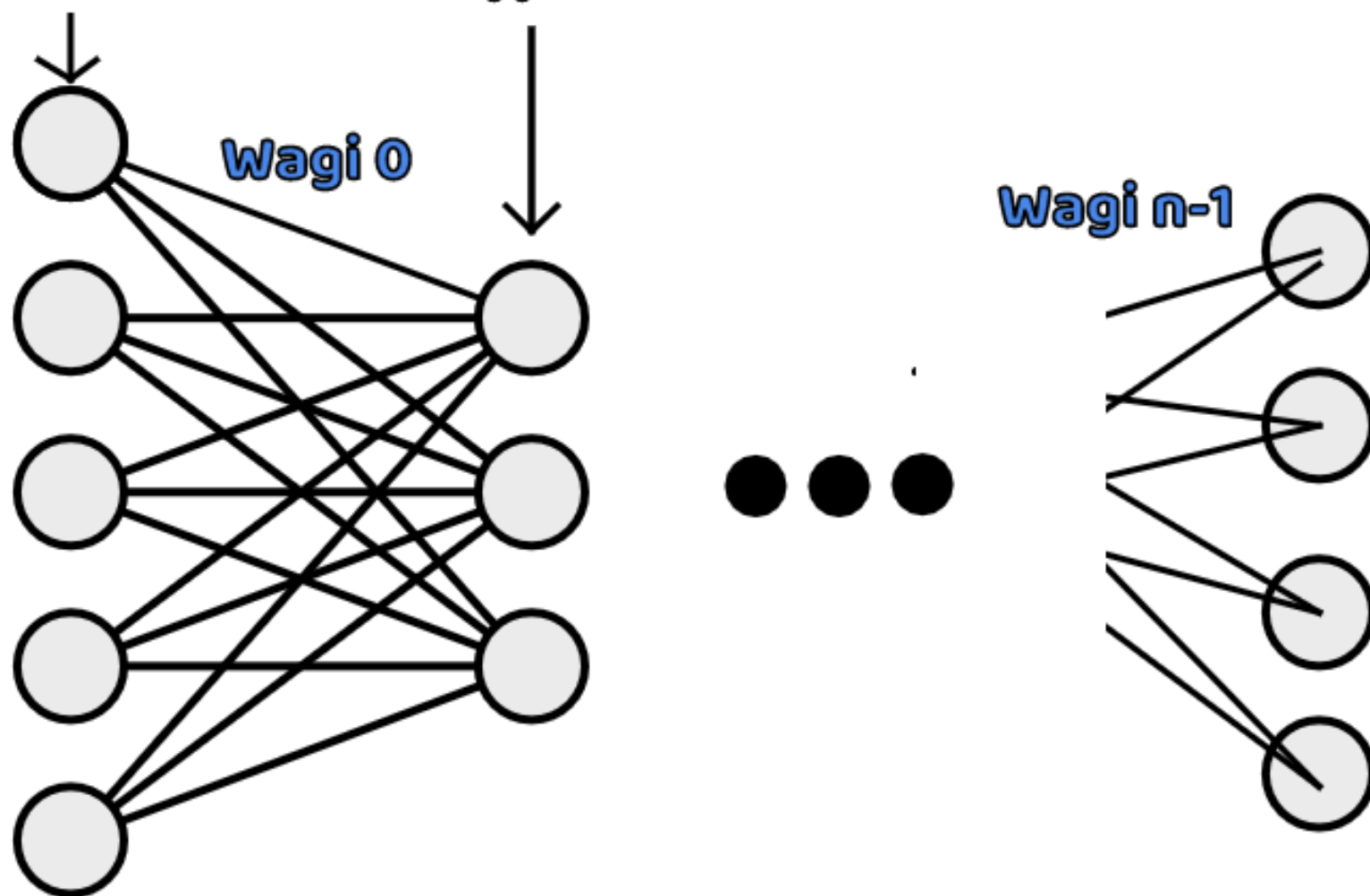


- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 0

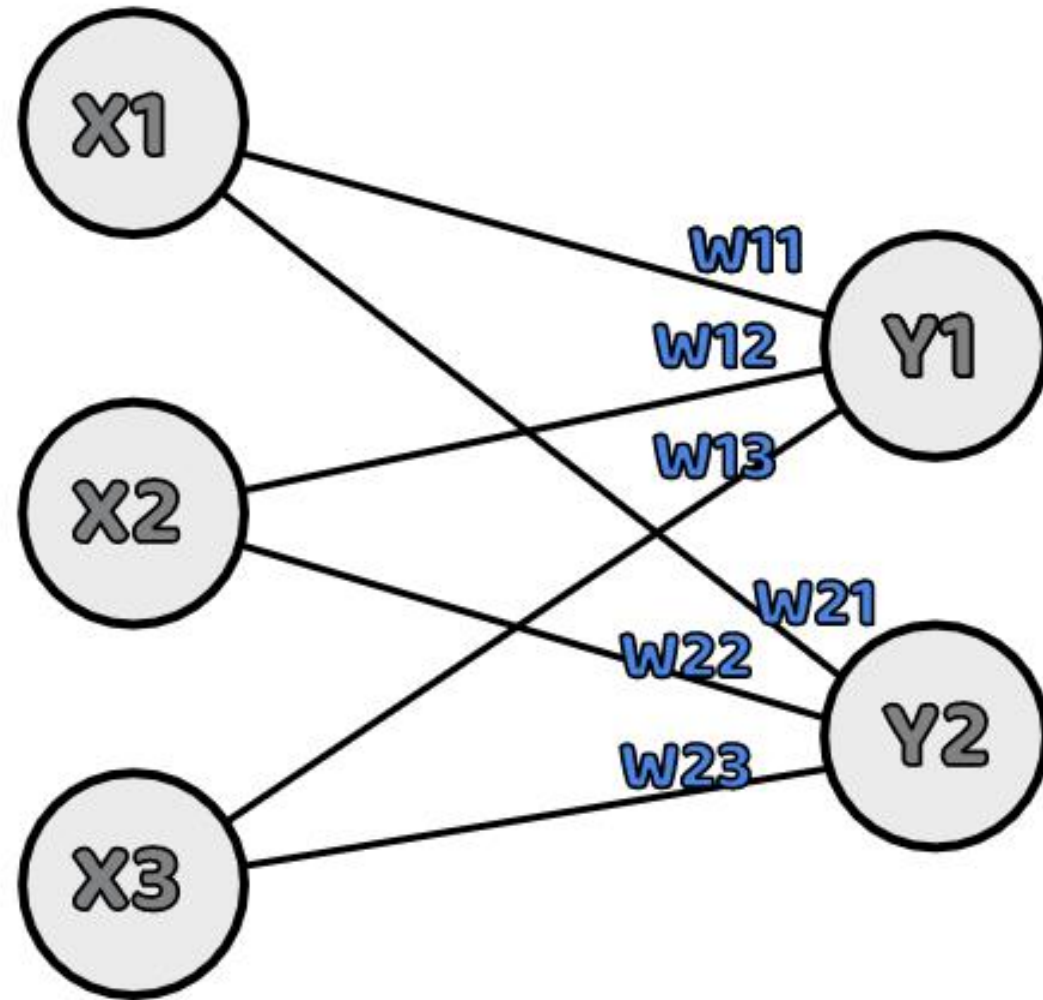
Warstwa 0
Wyjście 0

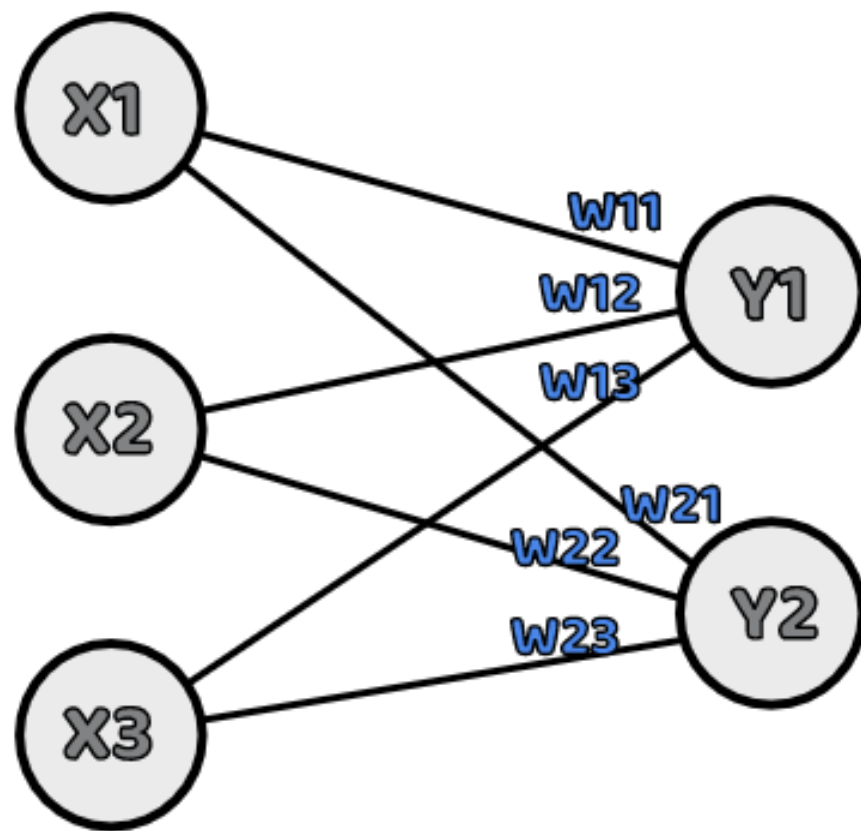
Warstwa 1
Wyjście 1

Warstwa n
Wyjście n



FEED FORWARD





Wejście Y1 = $X1 * W11 + X2 * \underline{W12} + X3 * W13$

Wejście Y2 = $X1 * W21 + X2 * W22 + X3 * W23$

$$\text{Wejście } Y1 = X1 * W11 + X2 * W12 + X3 * W13$$

$$\text{Wejście } Y2 = X1 * W21 + X2 * W22 + X3 * W23$$

$$\begin{bmatrix} W11 & W12 & W13 \\ W21 & W22 & W23 \end{bmatrix} \times \begin{bmatrix} X1 \\ X2 \\ X3 \end{bmatrix} = \begin{bmatrix} X1 * W11 + X2 * W12 + X3 * W13 \\ X1 * W21 + X2 * W22 + X3 * W23 \end{bmatrix}$$

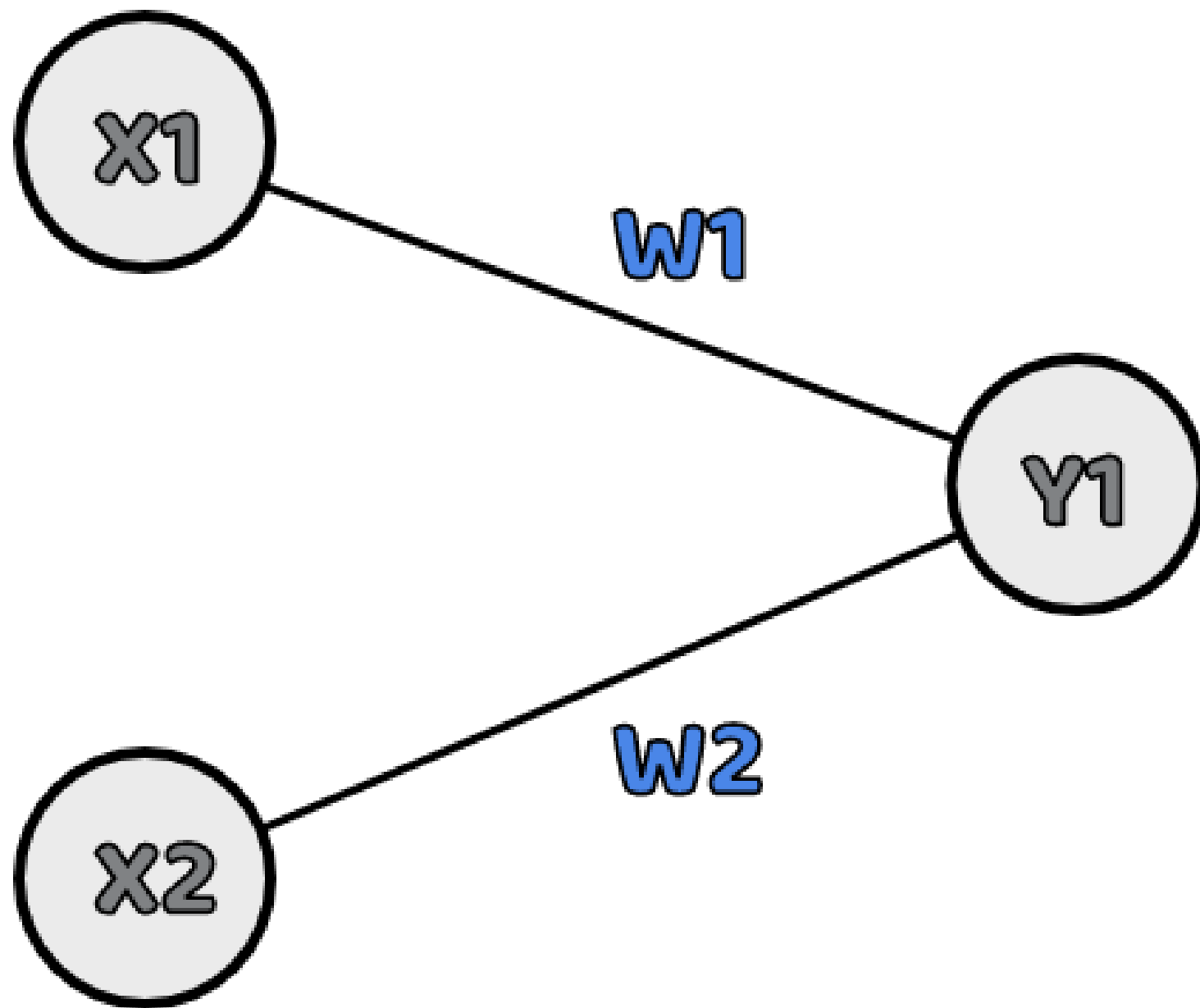
Wejście $Y1 = X1 * W11 + X2 * W12 + X3 * W13$

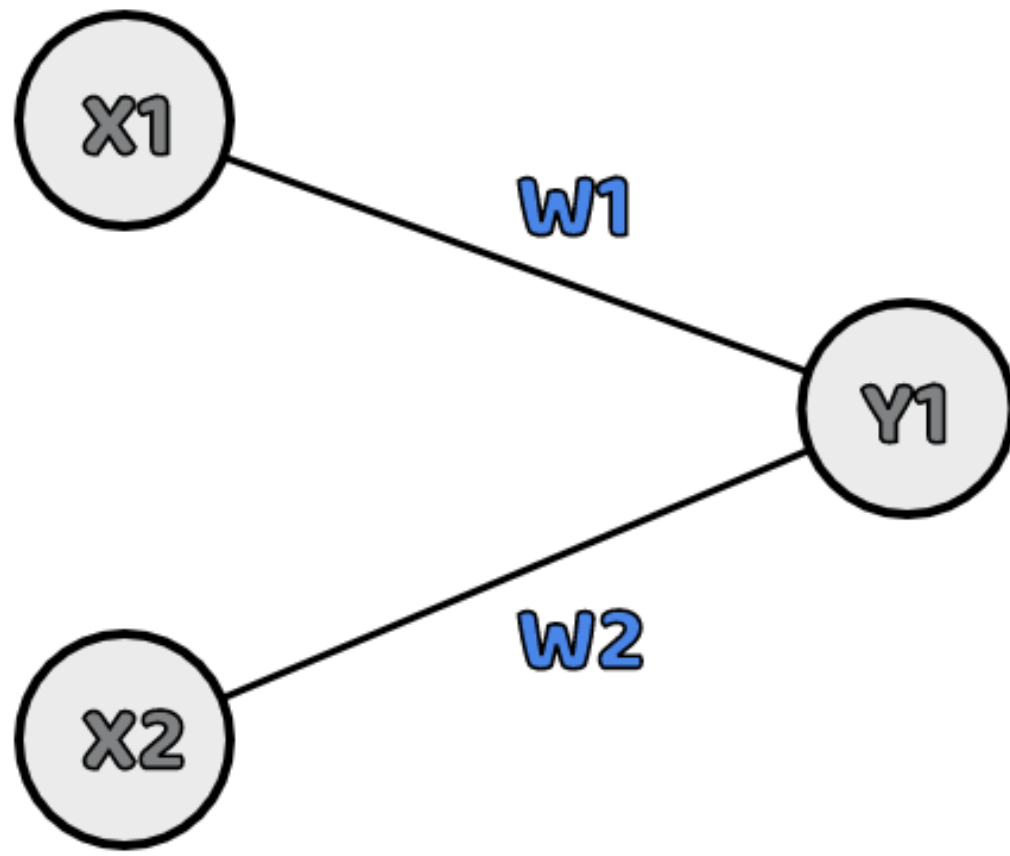
Wejście $Y2 = X1 * W21 + X2 * W22 + X3 * W23$

$$\begin{bmatrix} w11 & w12 & w13 \\ w21 & w22 & w23 \end{bmatrix} \times \begin{bmatrix} x1 \\ x2 \\ x3 \end{bmatrix} = \begin{bmatrix} y1 \\ y2 \end{bmatrix}$$

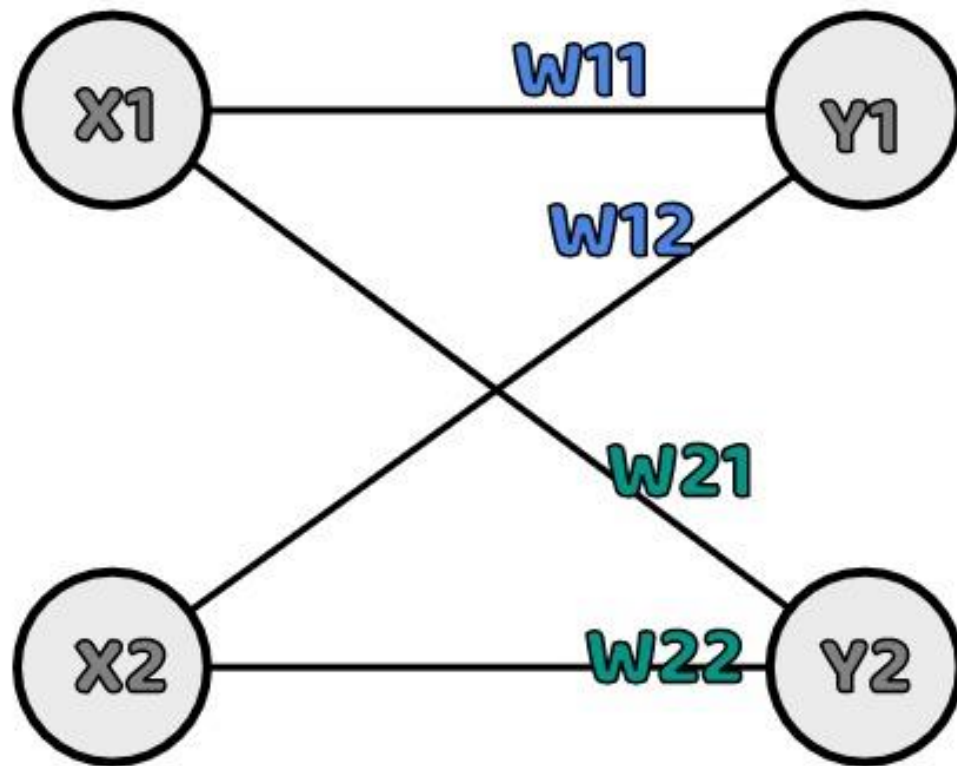
Wyjście n = funkcja aktywacji(Wagi $n-1$ x Wyjście $n-1$)

PROPAGACJA BŁĘDU





$$\text{Bt\`ad } X1 = \frac{w1}{w1 + w2} * Y1 \quad \text{Bt\`ad } X2 = \frac{w2}{w1 + w2} * Y1$$



$$\text{Btad } X1 = \frac{w_{11}}{w_{11} + w_{12}} * Y1 + \frac{w_{21}}{w_{21} + w_{22}} * Y2$$

$$\text{Btad } X2 = \frac{w_{12}}{w_{11} + w_{12}} * Y1 + \frac{w_{22}}{w_{21} + w_{22}} * Y2$$

$$\text{Btad } X1 = \frac{W11}{W11 + W12} * Y1 + \frac{W21}{W21 + W22} * Y2$$

$$\text{Btad } X2 = \frac{W12}{W11 + W12} * Y1 + \frac{W22}{W21 + W22} * Y2$$

$$\text{Btad } X = \begin{bmatrix} \frac{W11}{W11 + W12} & \frac{W21}{W21 + W22} \\ \frac{W12}{W11 + W12} & \frac{W22}{W21 + W22} \end{bmatrix} \times \begin{bmatrix} \text{Btad } Y1 \\ \text{Btad } Y2 \end{bmatrix}$$

$$\text{Bt\`ad X} = \begin{bmatrix} \frac{w_{11}}{w_{11} + w_{12}} & \frac{w_{21}}{w_{21} + w_{22}} \\ \frac{w_{12}}{w_{11} + w_{12}} & \frac{w_{22}}{w_{21} + w_{22}} \end{bmatrix} \times \begin{bmatrix} \text{Bt\`ad Y1} \\ \text{Bt\`ad Y2} \end{bmatrix}$$

$$\text{Bt\`ad X} = \begin{bmatrix} w_{11} & w_{21} \\ w_{12} & w_{22} \end{bmatrix} \times \begin{bmatrix} \text{Bt\`ad Y1} \\ \text{Bt\`ad Y2} \end{bmatrix}$$

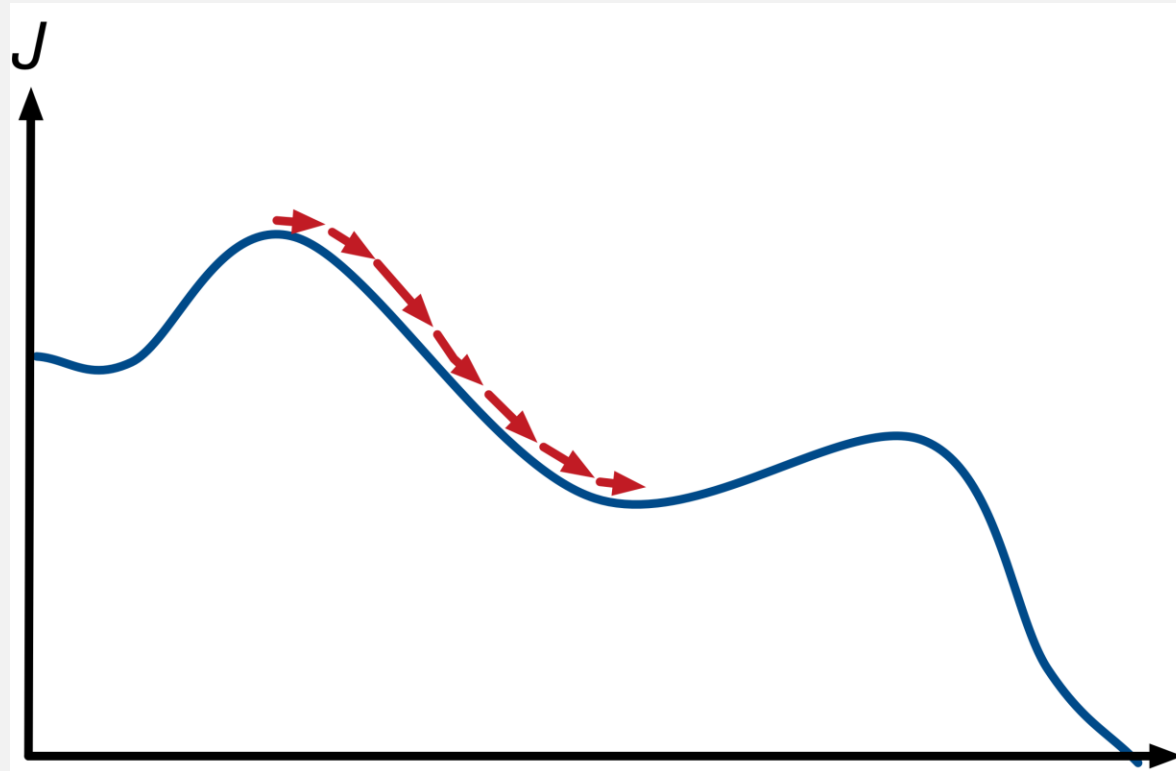
$$\text{Bt\`ad X} = \begin{bmatrix} w_{11} & w_{21} \\ w_{12} & w_{22} \end{bmatrix} \times \begin{bmatrix} \text{Bt\`ad Y1} \\ \text{Bt\`ad Y2} \end{bmatrix}$$

$$\begin{bmatrix} w_{11} & w_{21} \\ w_{12} & w_{22} \end{bmatrix} = \begin{bmatrix} w_{11} & w_{12} \\ w_{21} & w_{22} \end{bmatrix}^T$$

$$\text{Btad } n = \text{Wagi } n^T \times \text{Btad } n+1$$

NAUKA NADZOROWANA

METODA GRADIENTU PROSTEGO



$$\frac{\partial E}{\partial W} = \frac{\partial}{\partial W} \times (A - O)^2$$

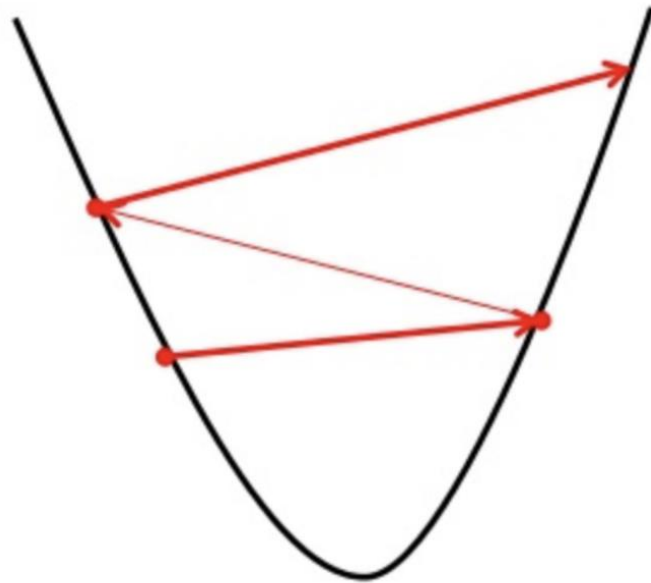
$$\frac{\partial E}{\partial W} = \frac{\partial E}{\partial O} \times \frac{\partial O}{\partial W}$$

$$\frac{\partial E}{\partial W} = -2(A - O) \times \frac{\partial O}{\partial W}$$

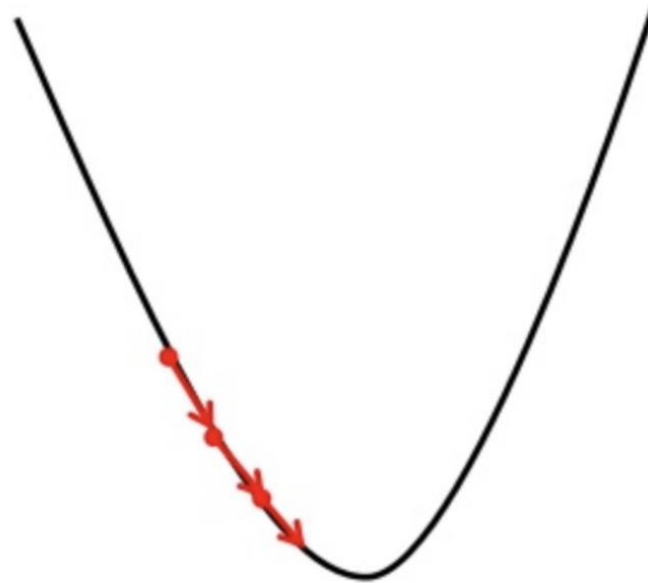
$$\Delta W_n = E_n \times O_n \times O_n' \times (O_{n-1})^T$$

WSKAŚNIK UCZENIA

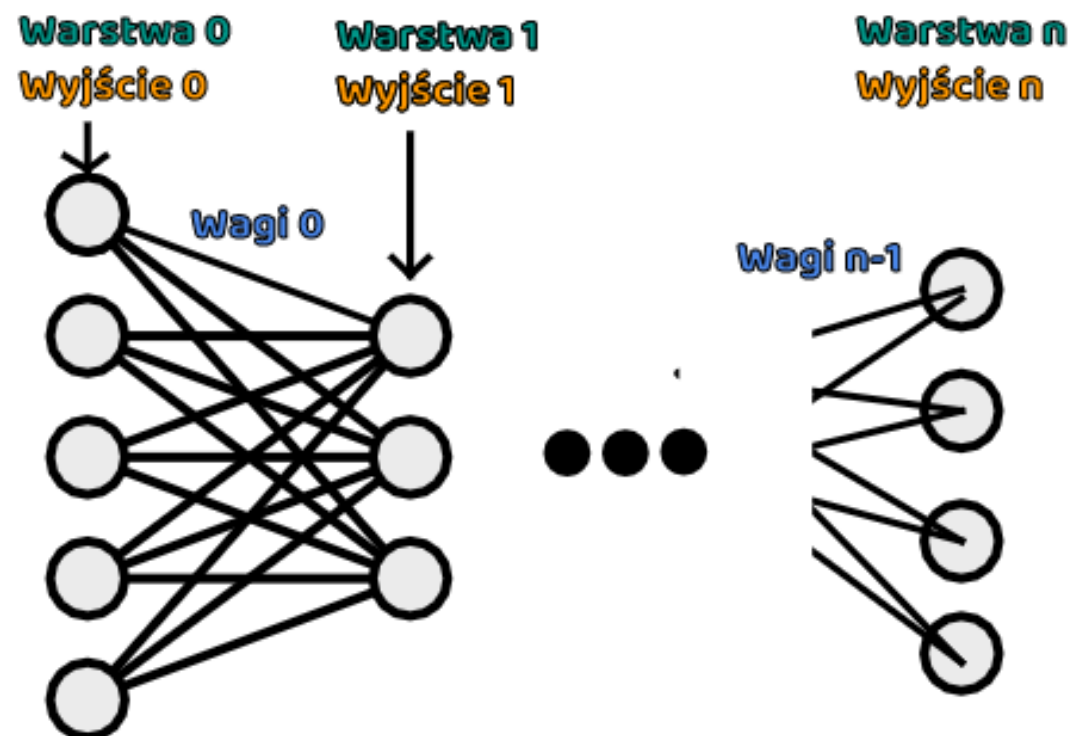
Big learning rate



Small learning rate



$Wagi_n += Lr \times Błąd_n \times Wyjście_n \times Wyjście_{n'} \times Wyjście_{n-1}^T$



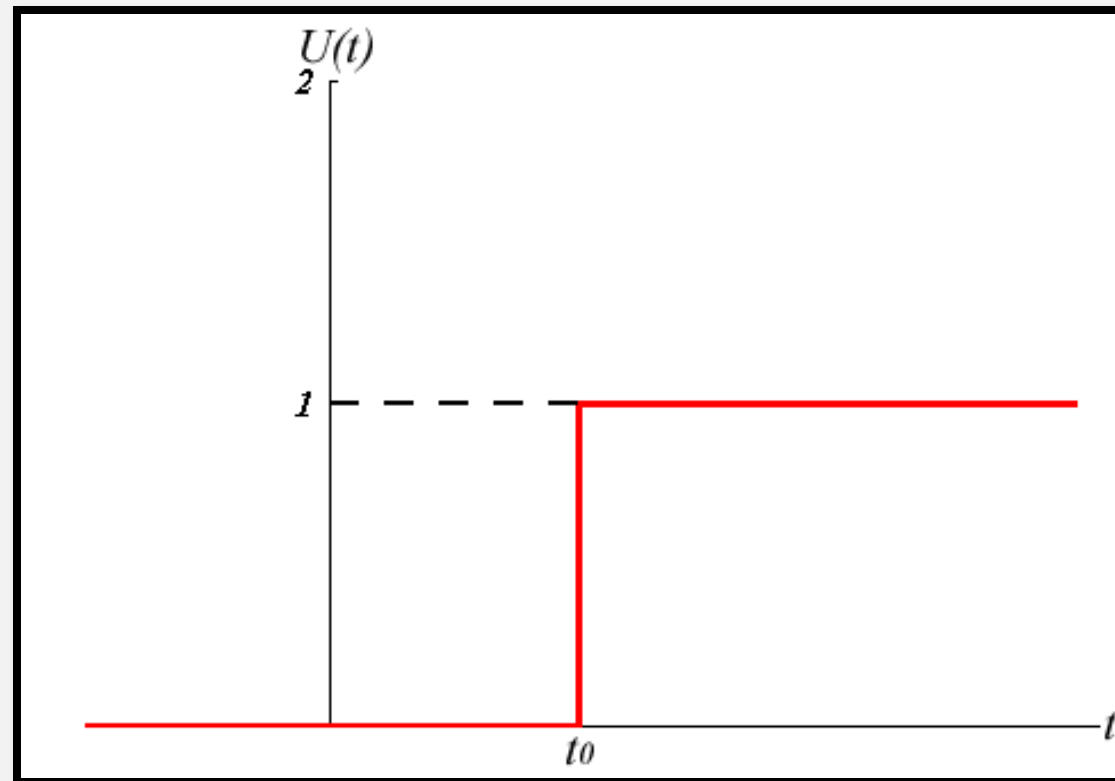
$\text{Wyjście } n = \text{Funkcja aktywacji}(\text{Wagi } n-1 \times \text{Wyjście } n-1)$

$$\text{Błąd } n = \text{Wagi } n^T \times \text{Błąd } n+1$$

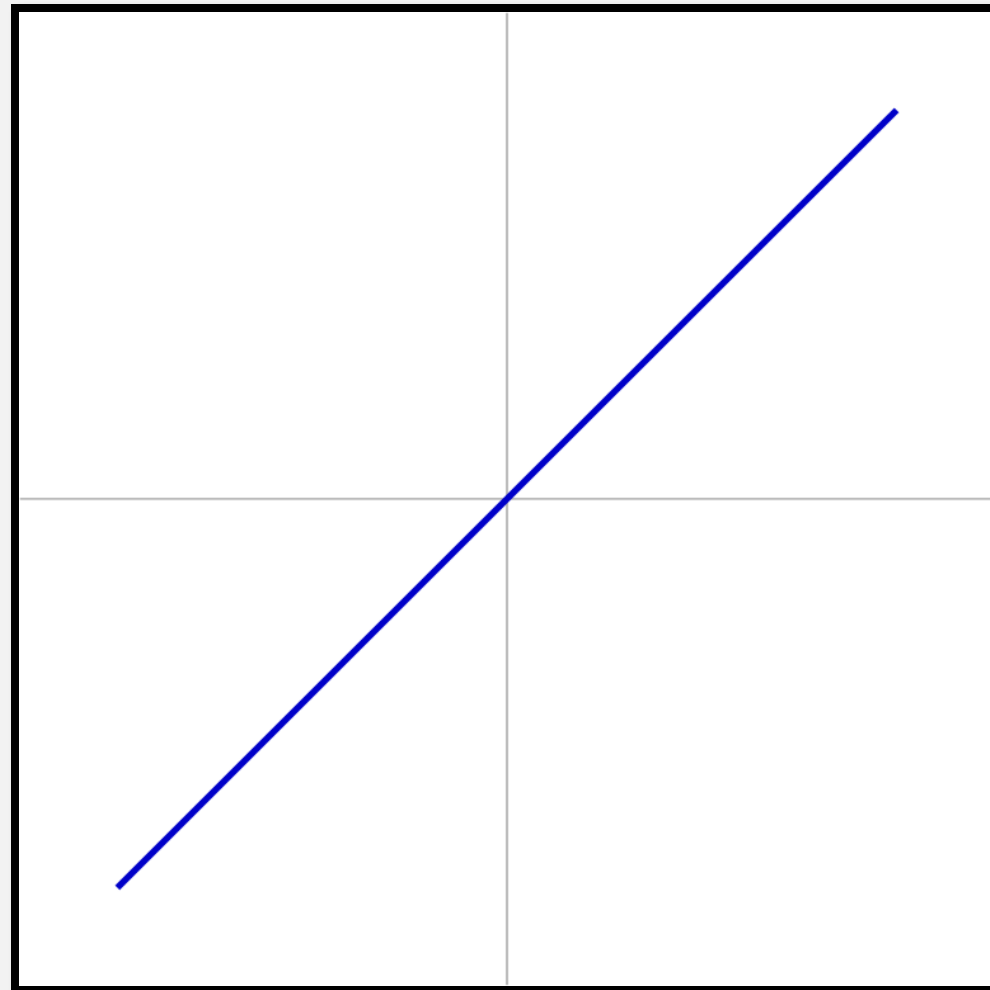
$$\text{Wagi } n += \text{Lr} \times \text{Błąd } n \times \text{Wyjście } n \times \text{Wyjście } n' \times \text{Wyjście } n-1^T$$

FUNKCJE AKTYWACJI

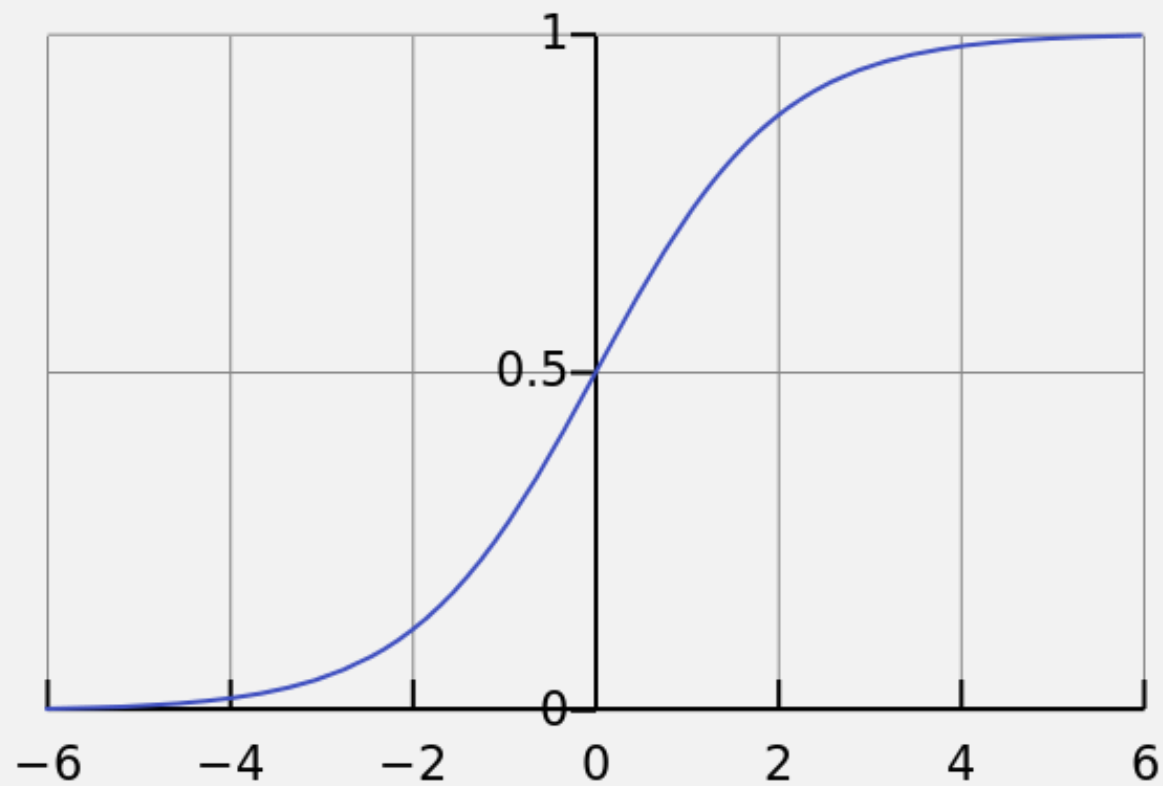
FUNKCJA PROGOWA



FUNKCJA LINIOWA

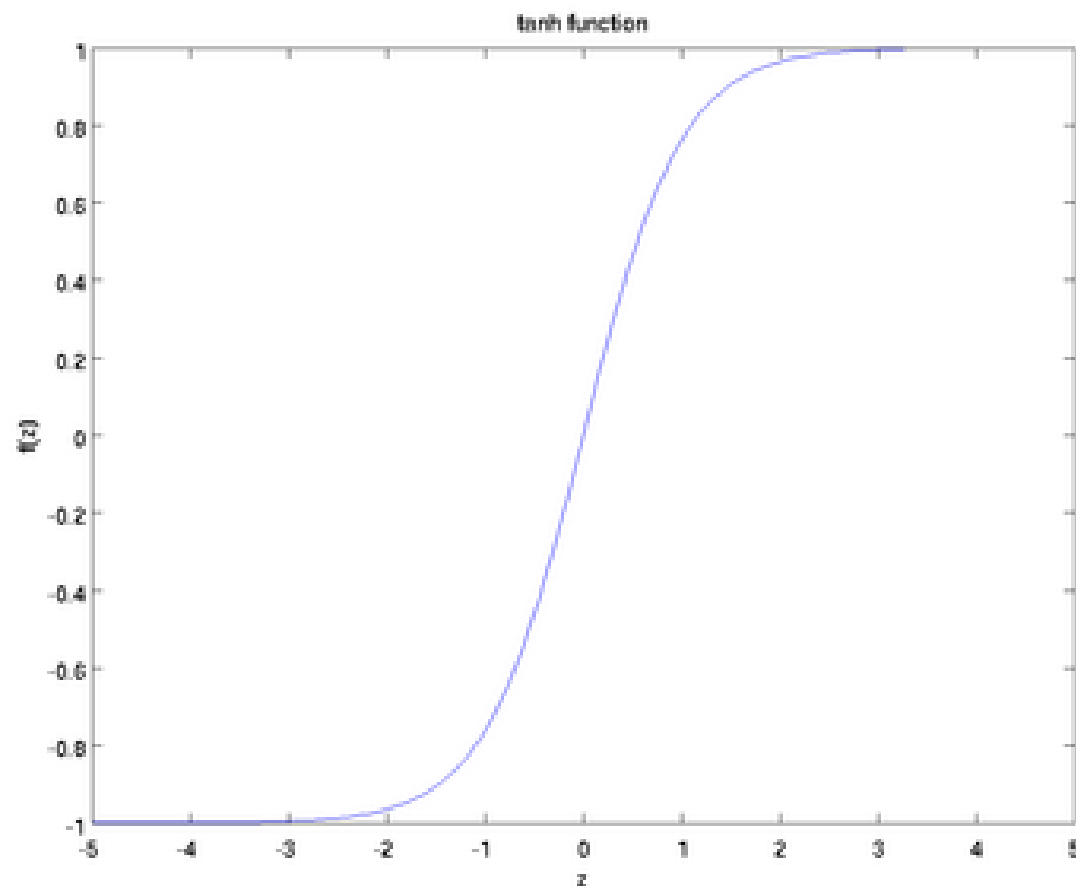


FUNKCJA SIGMOID



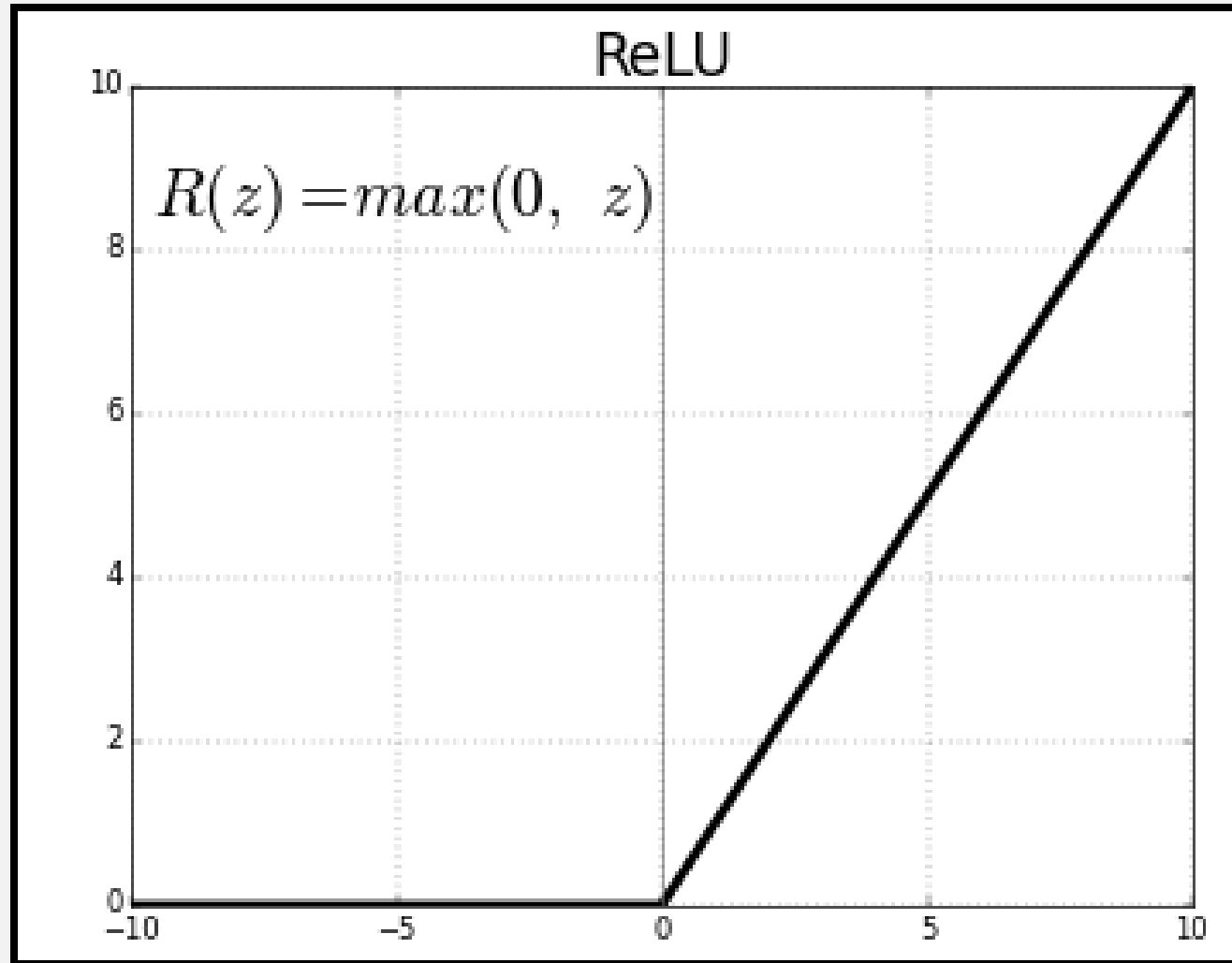
$$A = \frac{1}{1+e^{-x}}$$

TANGENS HIPERBOLICZNY

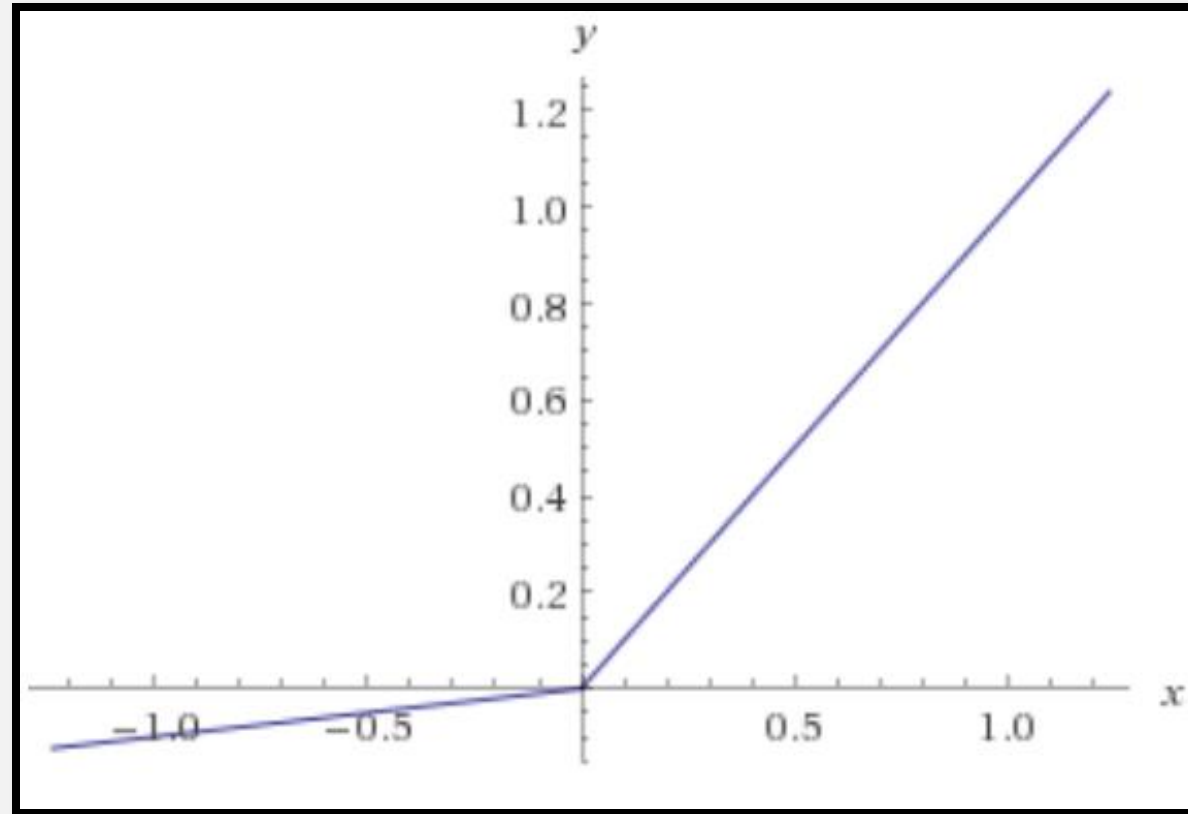


$$f(x) = \tanh(x) = \frac{2}{1+e^{-2x}} - 1$$

ReLU

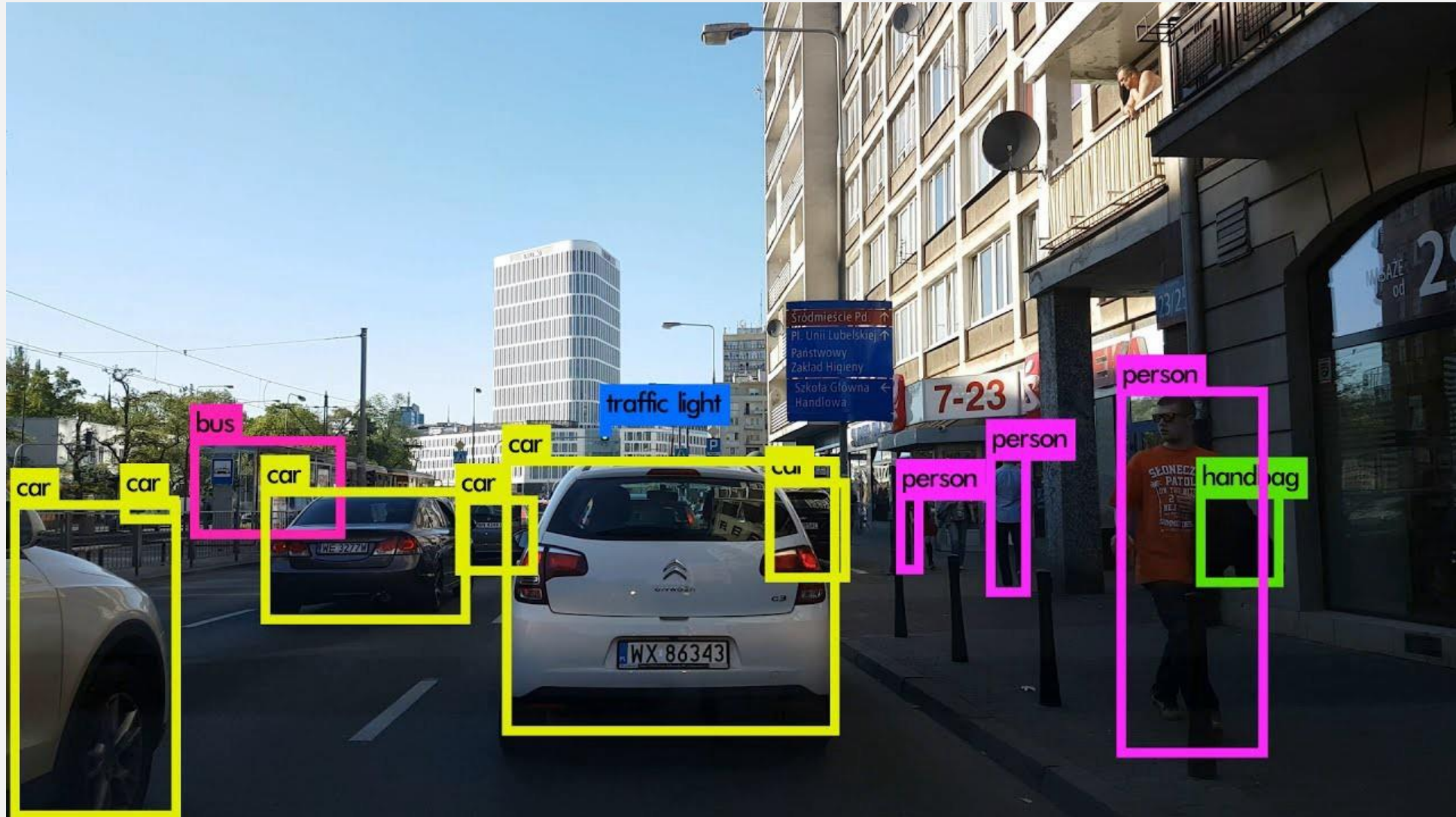


LEAKY RELU



ZASTOSOWANIA

ROZPOZNAWANIE OBRAZU



DIAGNOSTYKA



REKLAMA



DZIĘKUJĘ ZA UWAGĘ

```
import natural from "natural"
```

"I work with a deep neural network to develop a powerful natural language processing algorithm"

hackmd.io/s/SyjLVEArX