

NEURONALE NETZE

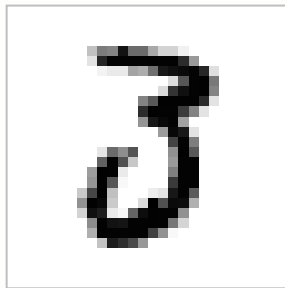
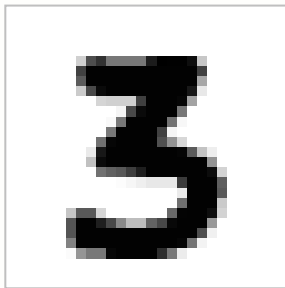
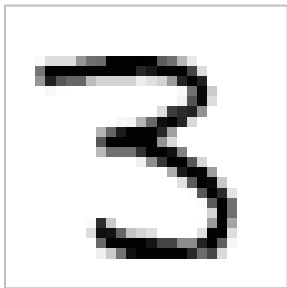
Handschriftliche Zahlen erkennen

Jasper Gude

28. November 2023
Carl-Friedrich-Gauß-Gymnasium

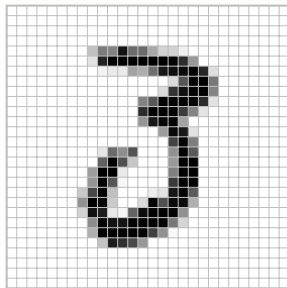
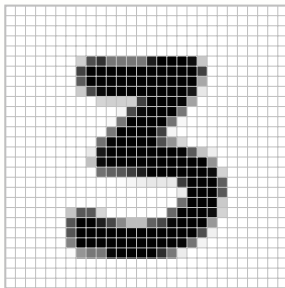
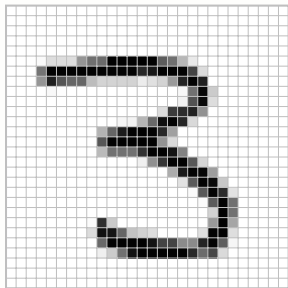
2.1

Modellierung des Problems



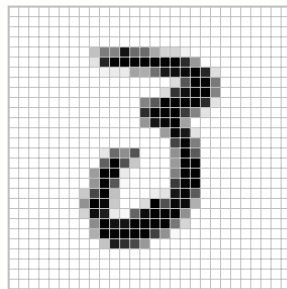
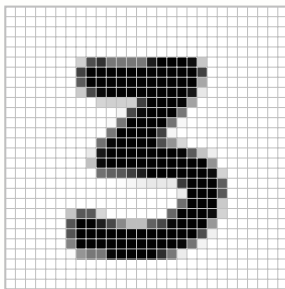
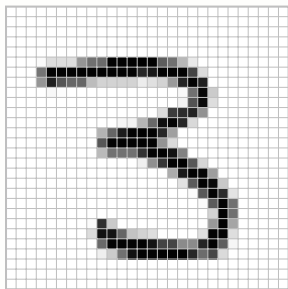
2.2

Modellierung des Problems



2.3

Modellierung des Problems



0,00

0,25

0,50

0,75

1,00



Modellierung

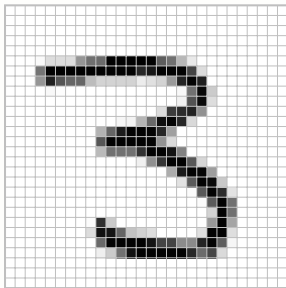


Künstliche Neuronen



3.1

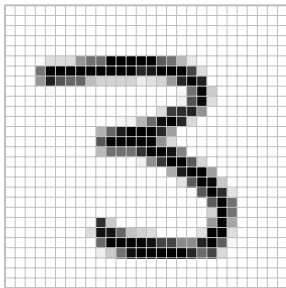
Überführung auf eine Netzstruktur



28px × 28px

3.2

Überführung auf eine Netzstruktur

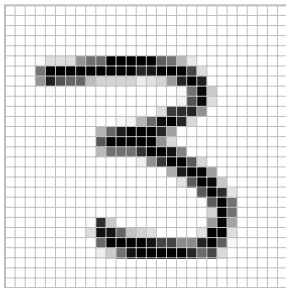


28px x 28px



3.3

Überführung auf eine Netzstruktur



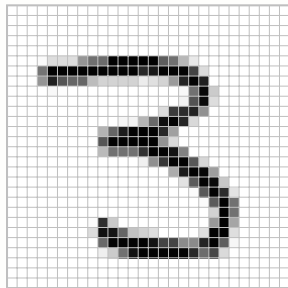
28px x 28px



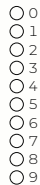
- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9

3.4

Überführung auf eine Netzstruktur

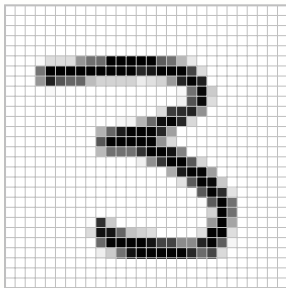


28px x 28px

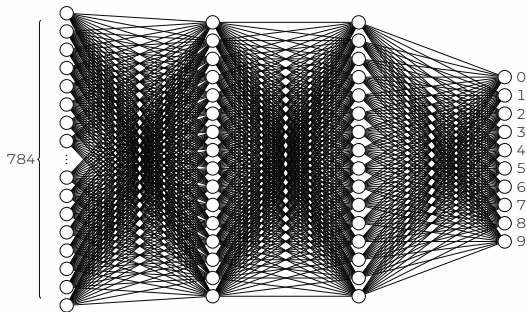


3.5

Überführung auf eine Netzstruktur

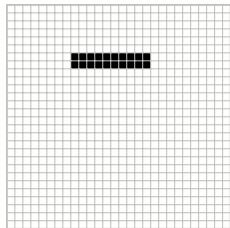


28px x 28px

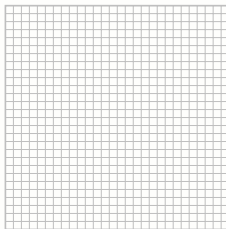


4.1

Gewichtungen setzen



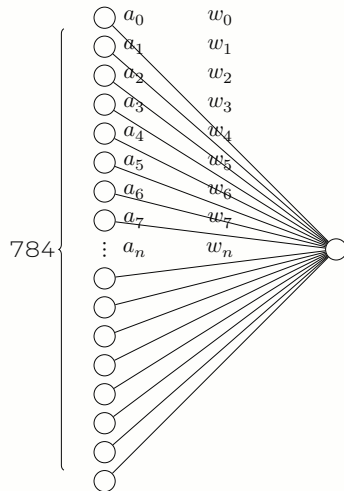
Inputs



Gewichte

Linearkombination

$$w_0x_0 + w_1x_1 + \dots + w_nx_n$$

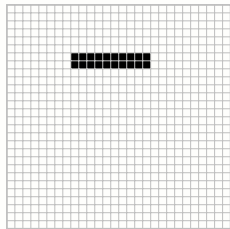


Künstliche Neuronen

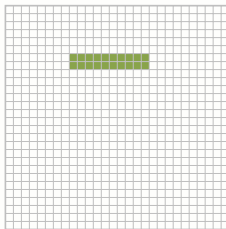


4.2

Gewichtungen setzen



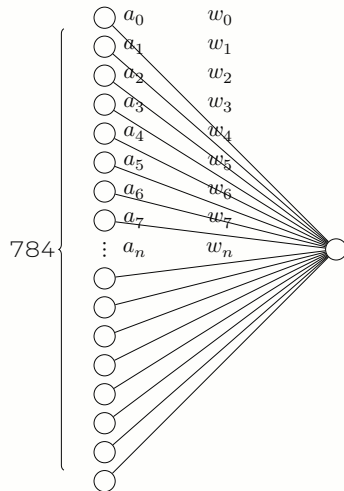
Inputs



Gewichte

Linearkombination

$$w_0x_0 + w_1x_1 + \dots + w_nx_n$$

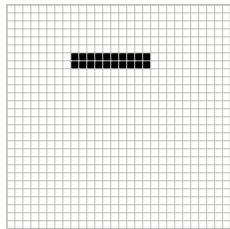


Künstliche Neuronen

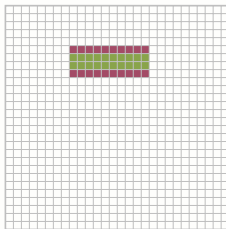


4.3

Gewichtungen setzen



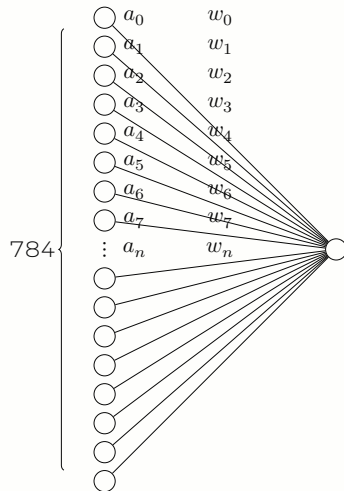
Inputs



Gewichte

Linearkombination

$$w_0x_0 + w_1x_1 + \dots + w_nx_n$$

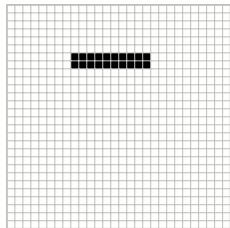


Künstliche Neuronen

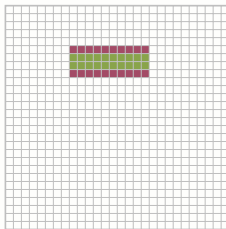


4.4

Gewichtungen setzen



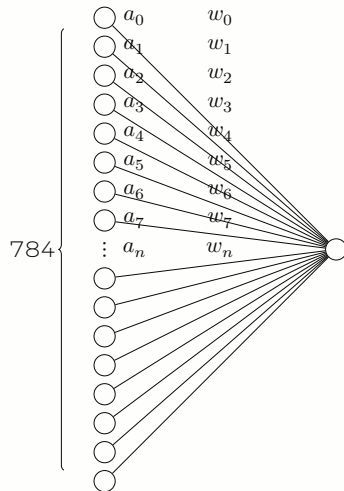
Inputs



Gewichte

Linearkombination

$$w_0x_0 + w_1x_1 + \dots + w_nx_n - b$$



Künstliche Neuronen

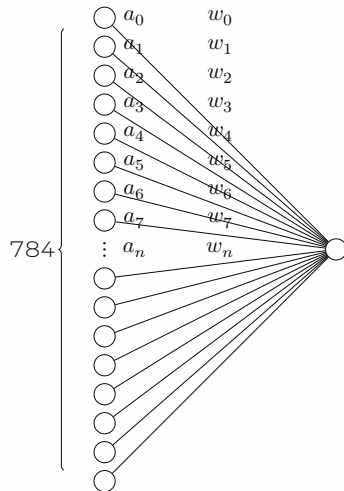
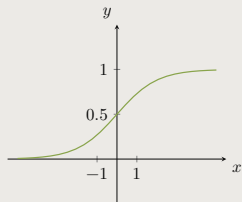


5

Zahlenbereich begrenzen

Sigmoidfunktion

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

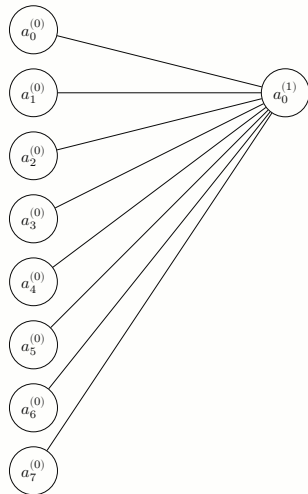


6.1

Alles zusammen setzen

Aktivierungsfunktion

$$a_0^{(1)} = \sigma(w_0^{(0)} a_0 + w_1^{(0)} a_1 + \dots + w_n^{(0)} a_n - b)$$



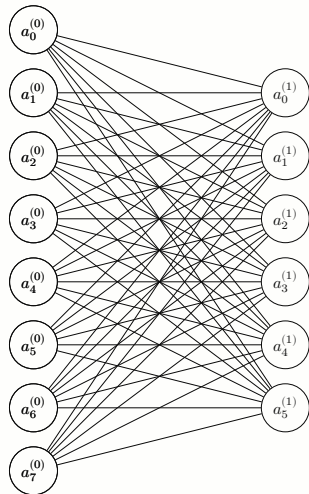
6.2

Alles zusammen setzen

Aktivierungsfunktion

$$a_0^{(1)} = \sigma(w_0^{(0)} a_0 + w_1^{(0)} a_1 + \dots + w_n^{(0)} a_n - b)$$

$$\begin{bmatrix} a_0^{(1)} \\ a_1^{(1)} \\ \vdots \\ a_n^{(1)} \end{bmatrix} = \sigma \left(\begin{bmatrix} w_{0,0} & w_{0,1} & \dots & w_{0,n} \\ w_{1,0} & w_{1,1} & \dots & w_{1,n} \\ \vdots & \vdots & \ddots & \vdots \\ w_{k,0} & w_{k,1} & \dots & w_{k,n} \end{bmatrix} \begin{bmatrix} a_0^{(0)} \\ a_1^{(0)} \\ \vdots \\ a_n^{(0)} \end{bmatrix} + \begin{bmatrix} b_0 \\ b_1 \\ \vdots \\ b_k \end{bmatrix} \right)$$



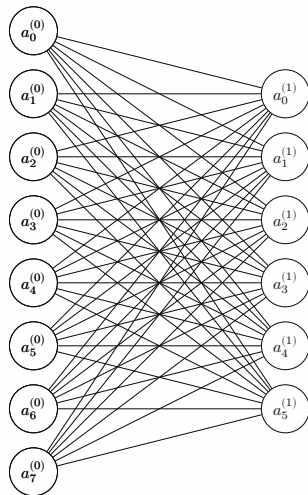
6.3

Alles zusammen setzen

Aktivierungsfunktion

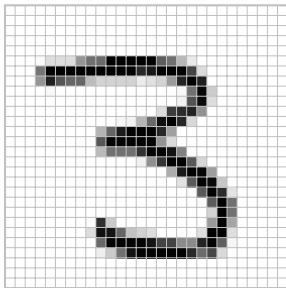
$$a^{(1)} = \sigma(Wa^{(0)} + \vec{b})$$

$$\begin{bmatrix} a_0^{(1)} \\ a_1^{(1)} \\ \vdots \\ a_n^{(1)} \end{bmatrix} = \sigma \left(\begin{bmatrix} w_{0,0} & w_{0,1} & \cdots & w_{0,n} \\ w_{1,0} & w_{1,1} & \cdots & w_{1,n} \\ \vdots & \vdots & \ddots & \vdots \\ w_{k,0} & w_{k,1} & \cdots & w_{k,n} \end{bmatrix} \begin{bmatrix} a_0^{(0)} \\ a_1^{(0)} \\ \vdots \\ a_n^{(0)} \end{bmatrix} + \begin{bmatrix} b_0 \\ b_1 \\ \vdots \\ b_k \end{bmatrix} \right)$$

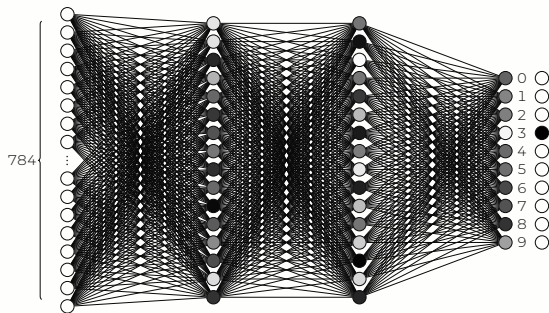


7.1

Fehler bestimmen

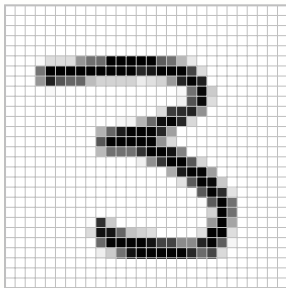


28px x 28px



7.2

Fehler bestimmen



28px × 28px

$$\frac{1}{n} \sum \left\{ \begin{array}{ccc} \left(\begin{array}{c} 0.48 \\ 0 \end{array} \right) & - & \left(\begin{array}{c} 0.00 \\ 0 \end{array} \right)^2 \\ \left(\begin{array}{c} 0.69 \\ 1 \end{array} \right) & - & \left(\begin{array}{c} 0.00 \\ 1 \end{array} \right)^2 \\ \left(\begin{array}{c} 0.52 \\ 2 \end{array} \right) & - & \left(\begin{array}{c} 0.00 \\ 2 \end{array} \right)^2 \\ \left(\begin{array}{c} 0.82 \\ 3 \end{array} \right) & - & \left(\begin{array}{c} 1.00 \\ 3 \end{array} \right)^2 \\ \left(\begin{array}{c} 0.59 \\ 4 \end{array} \right) & - & \left(\begin{array}{c} 0.00 \\ 4 \end{array} \right)^2 \\ \left(\begin{array}{c} 0.85 \\ 5 \end{array} \right) & - & \left(\begin{array}{c} 0.00 \\ 5 \end{array} \right)^2 \\ \left(\begin{array}{c} 1.00 \\ 6 \end{array} \right) & - & \left(\begin{array}{c} 0.00 \\ 6 \end{array} \right)^2 \\ \left(\begin{array}{c} 0.86 \\ 7 \end{array} \right) & - & \left(\begin{array}{c} 0.00 \\ 7 \end{array} \right)^2 \\ \left(\begin{array}{c} 0.80 \\ 8 \end{array} \right) & - & \left(\begin{array}{c} 0.00 \\ 8 \end{array} \right)^2 \\ \left(\begin{array}{c} 0.62 \\ 9 \end{array} \right) & - & \left(\begin{array}{c} 0.00 \\ 9 \end{array} \right)^2 \end{array} \right.$$



Jasper Gude

Hockenheim, 28. November
2023