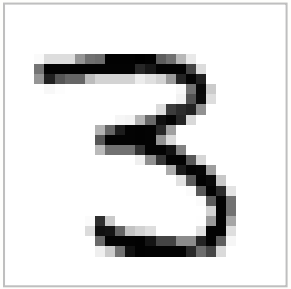
NEURONALE NETZE

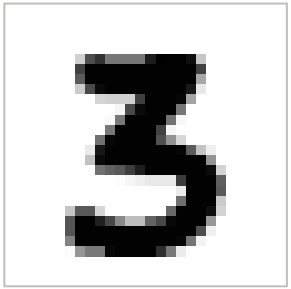
Handschriftliche Zahlen erkennen

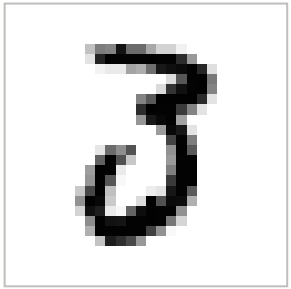
Jasper Gude

28. November 2023
Carl-Friedrich-Gauß-Gymnasium

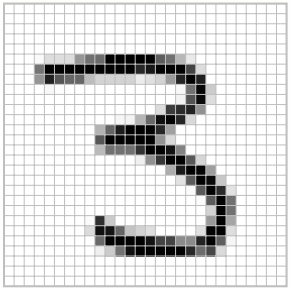
2.1 Modellierung des Problems

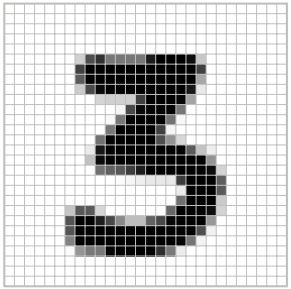


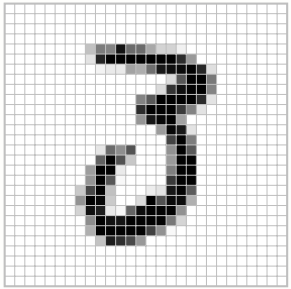




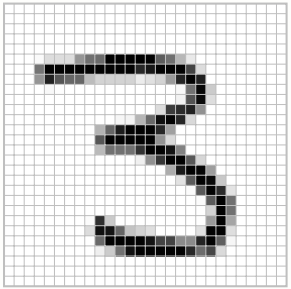
2.2 Modellierung des Problems

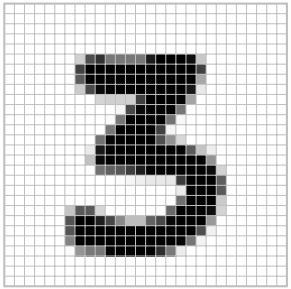


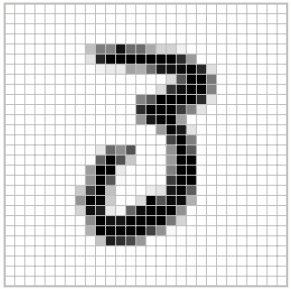




2.3 Modellierung des Problems

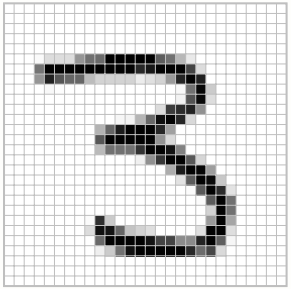






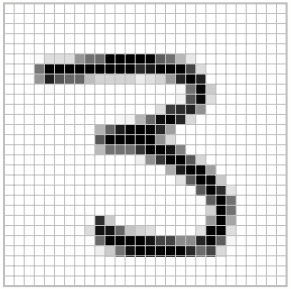
0,00	0,25	0,50	0,75	1,00

3.1 Überführung auf eine Netzstruktur

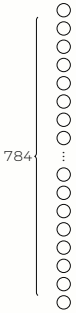


28px × 28px

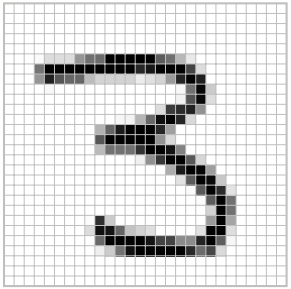
3.2 Überführung auf eine Netzstruktur



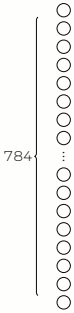
28px × 28px



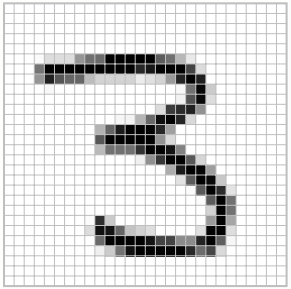
3.3 Überführung auf eine Netzstruktur



28px × 28px



3.4 Überführung auf eine Netzstruktur



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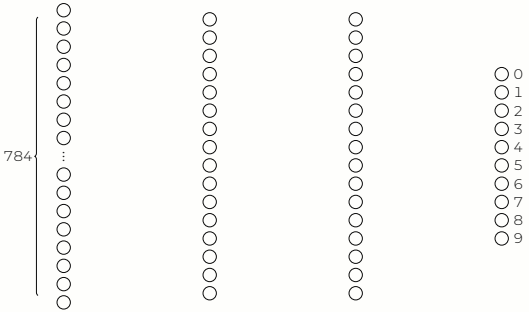
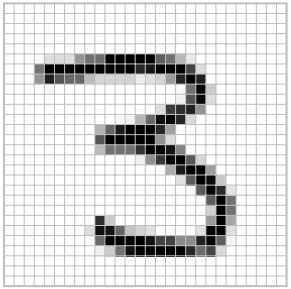
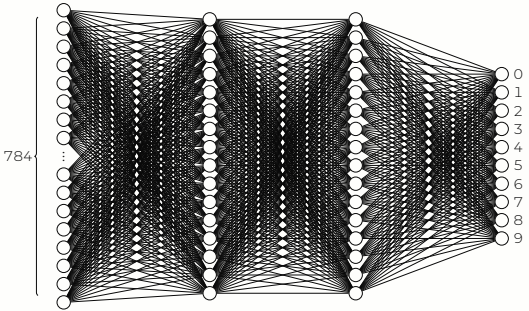


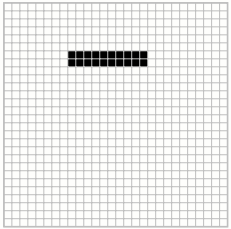
3.5 Überführung auf eine Netzstruktur



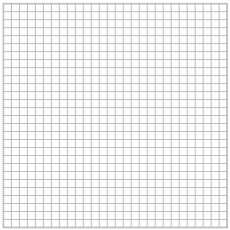
28px × 28px



4.1 Gewichtungen setzen



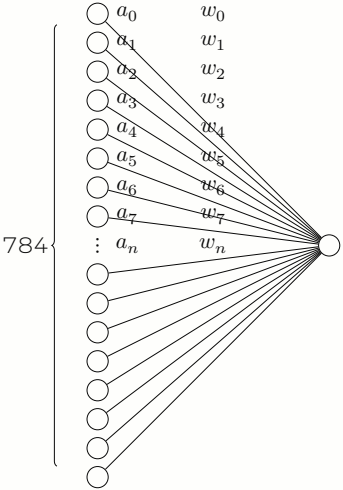
Inputs



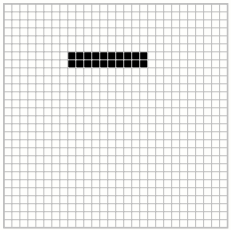
Gewichte

Linearkombination

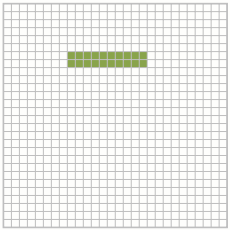
$$w_0x_0 + w_1x_1 + \cdots + w_nx_n$$



4.2 Gewichtungen setzen



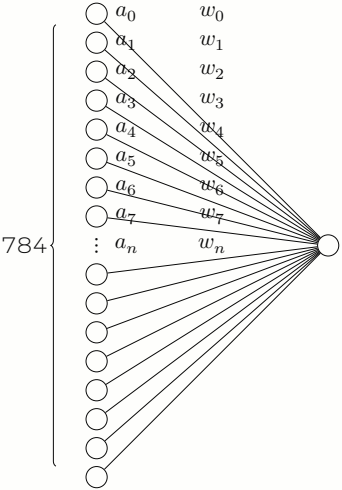
Inputs



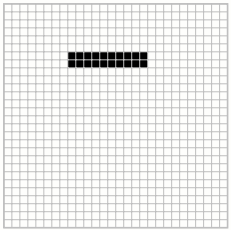
Gewichte

Linearkombination

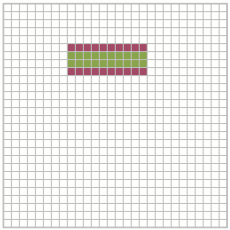
$$w_0x_0 + w_1x_1 + \cdots + w_nx_n$$



4.3 Gewichtungen setzen



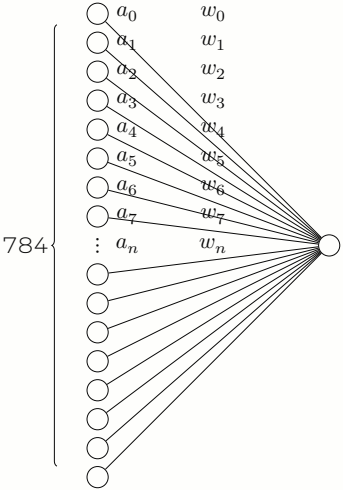
Inputs



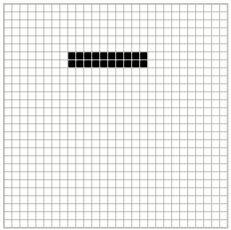
Gewichte

Linearkombination

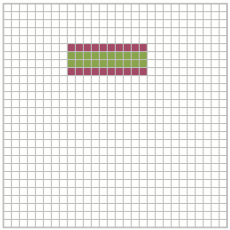
$$w_0x_0 + w_1x_1 + \cdots + w_nx_n$$



Gewichtungen setzen



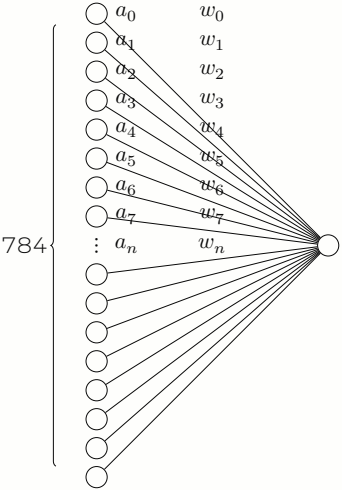
Inputs



Gewichte

Linearkombination

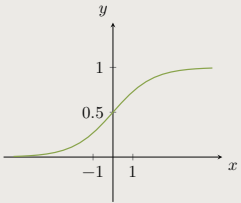
$$w_0x_0 + w_1x_1 + \cdots + w_nx_n - b$$

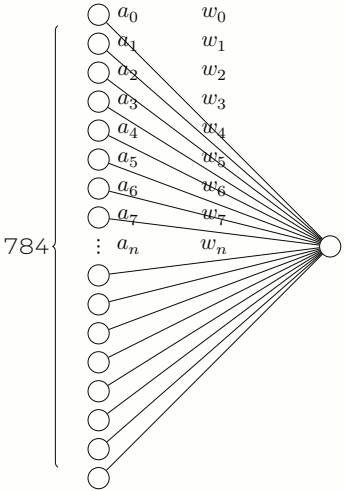


5 Zahlenbereich begrenzen

Sigmoidfunktion

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

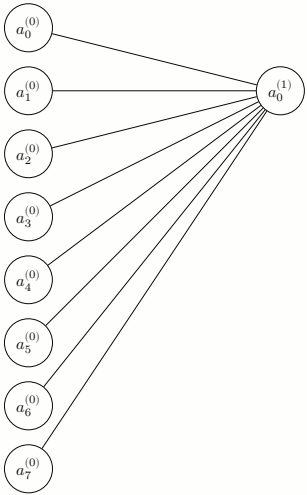




Alles zusammen setzen

Aktivierungsfunktion

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

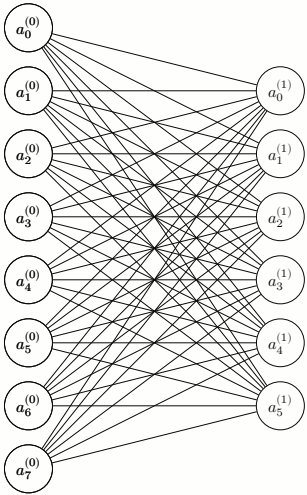


6.2 Alles zusammen setzen

Aktivierungsfunktion

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

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

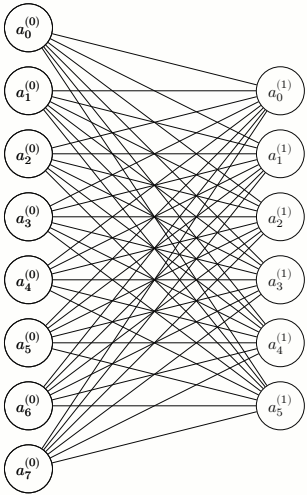


6.3 Alles zusammen setzen

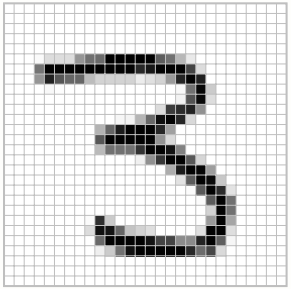
Aktivierungsfunktion

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

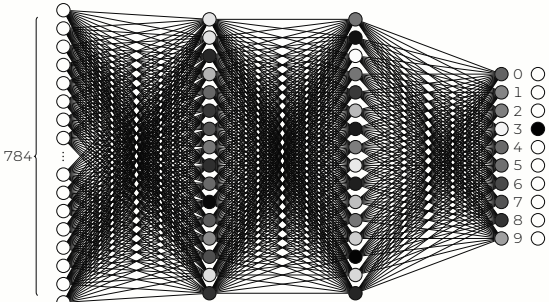
$$\begin{bmatrix} a_0^{(1)} \\ a_1^{(1)} \\ \vdots \\ a_n^{(1)} \end{bmatrix} = \sigma \left(\begin{bmatrix} w_{0,0} & w_{0,1} & \cdots & w_{0,n} \\ w_{1,0} & w_{1,1} & \cdots & w_{1,n} \\ \vdots & \vdots & \ddots & \vdots \\ w_{k,0} & w_{k,1} & \cdots & w_{k,n} \end{bmatrix} \begin{bmatrix} a_0^{(0)}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



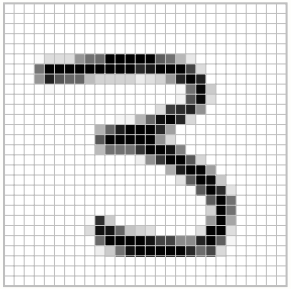
7.1 Fehler bestimmen



28px × 28px



7.2 Fehler bestimmen



28px × 28px

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

Jasper Gude

Hockenheim, 28. November 2023