Künstliche Intelligenz, Machine and Deep Learning

4. Künstliche Neuronale Netze & Deep Learning

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Mykola Dobrochynskyy
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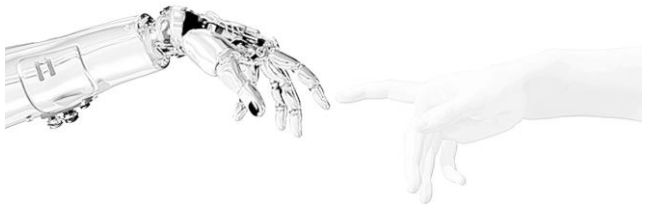

Agenda

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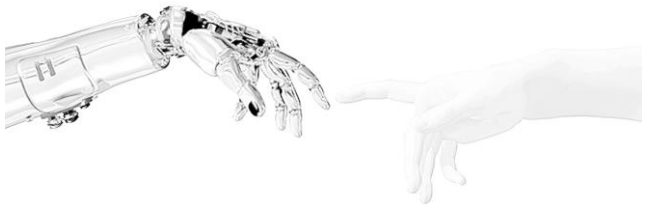
Agenda

1. Künstliche Intelligenz - Einführung
2. Machine Learning - Grundlagen
3. Machine Learning - klassische Methoden
4. **Künstliche Neuronale Netze**
5. Deep Learning für Computer Vision
6. Deep Learning für Texte und Sequenzen
7. Generatives Deep Learning, Reinforcement Learning, Adversarial und Quantum Machine Learning und andere Forschung- und Zukunftsthemen
8. KI Infrastruktur - Ressourcen und Dokumentation, Hardware, Bibliotheken, KI Cloud-Dienste
9. Demo Lab-1 - Azure Machine Learning Studio und Cognitive Services
10. Demo Lab-2 - Machine Learning Services von Amazon AWS
11. Demo Lab-3 - Machine Learning Services von Google Cloud
12. Demo Lab-4 – Bild-Klassifizierung mit CNN in Python



4. Künstliche Neuronale Netze & Deep Learning

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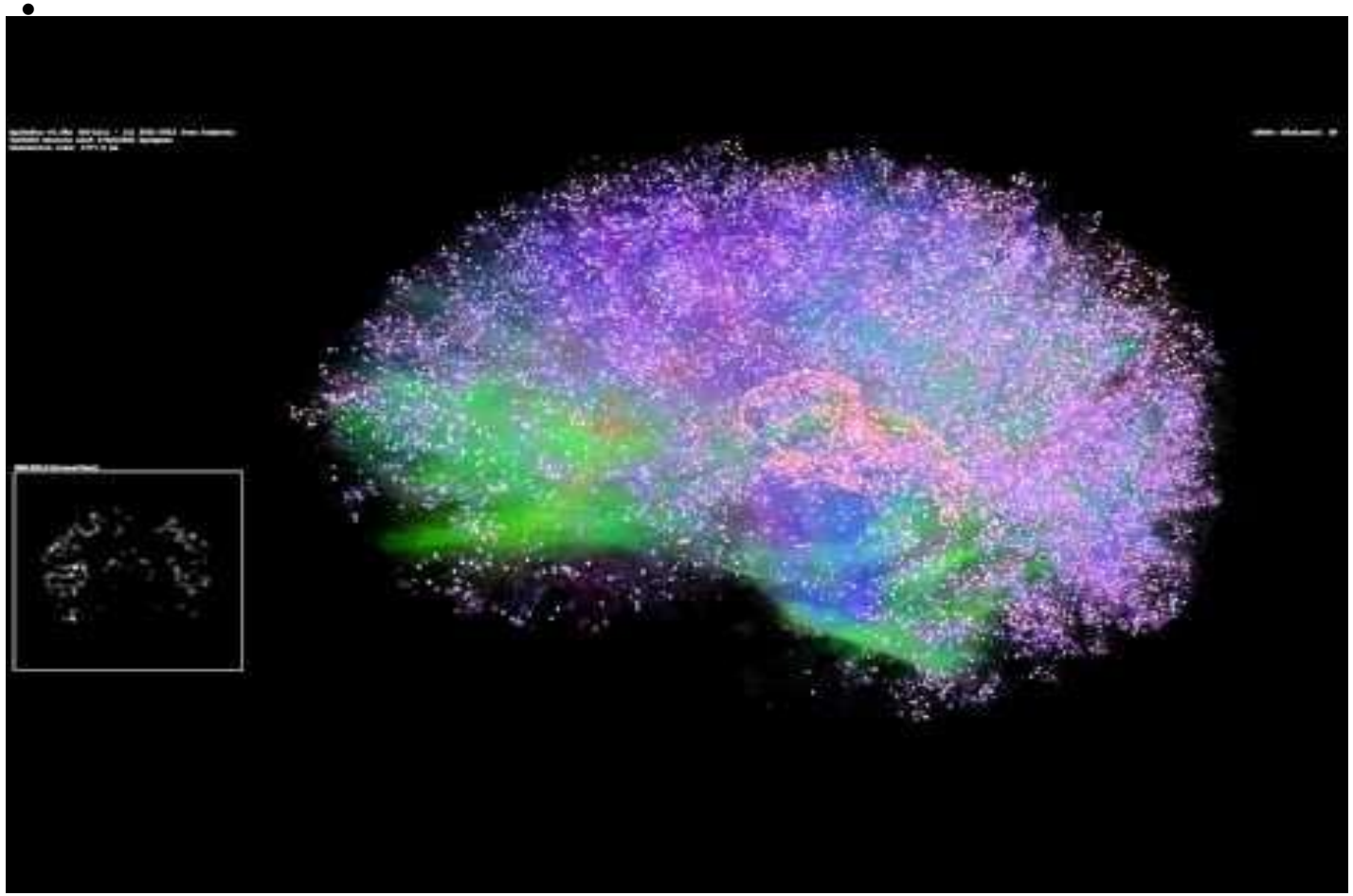
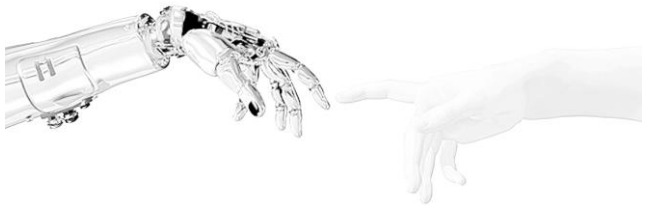
Biologisches Neuonales Netz

- **Thalamocortical brain network** (Simulationsvideo unten):
  3 Millionen Neuronen, 476 Millionen Synapsen
- **Ganzes menschliches Gehirn**:
  100 Milliarden Neuronen, 1.000 Billionen Synapsen
-





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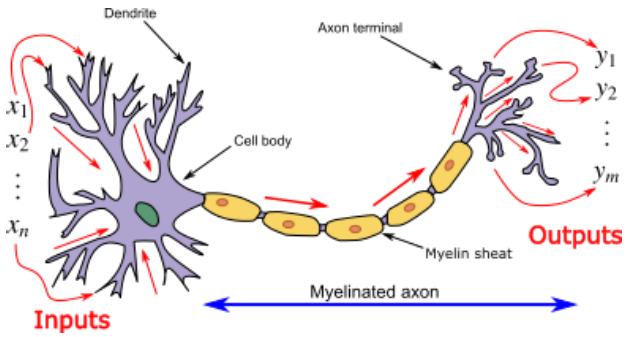
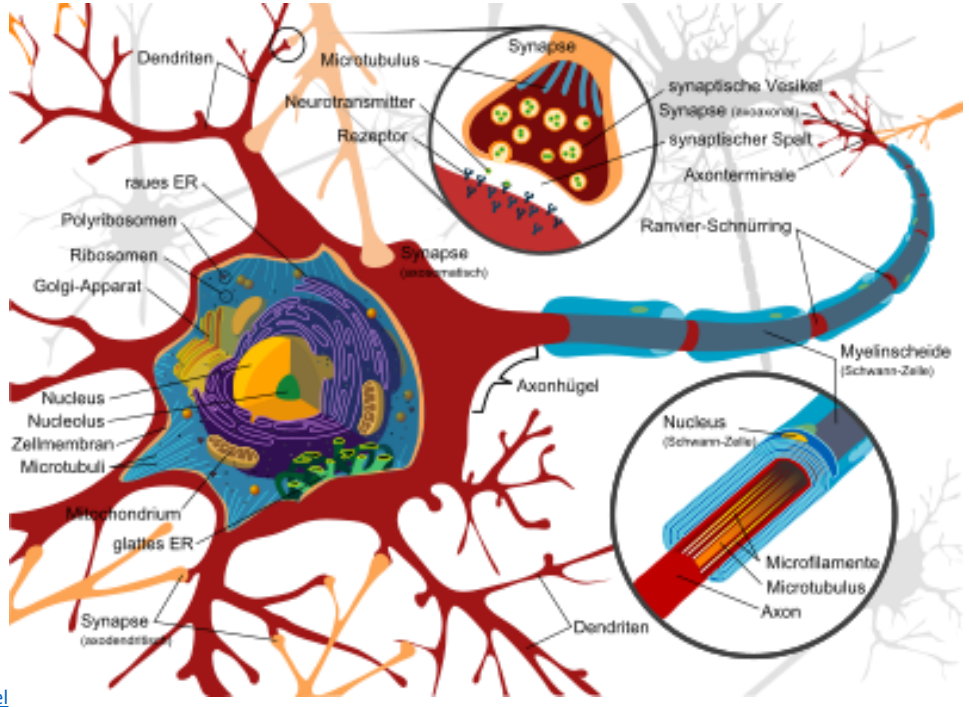
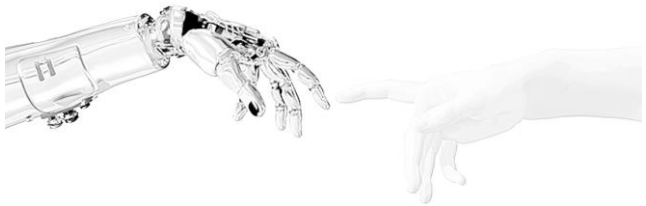
Biologisches Neuron





Source:
https://en.wikipedia.org/wiki/Biological_neuron_model
https://de.wikipedia.org/wiki/Nervenzelle



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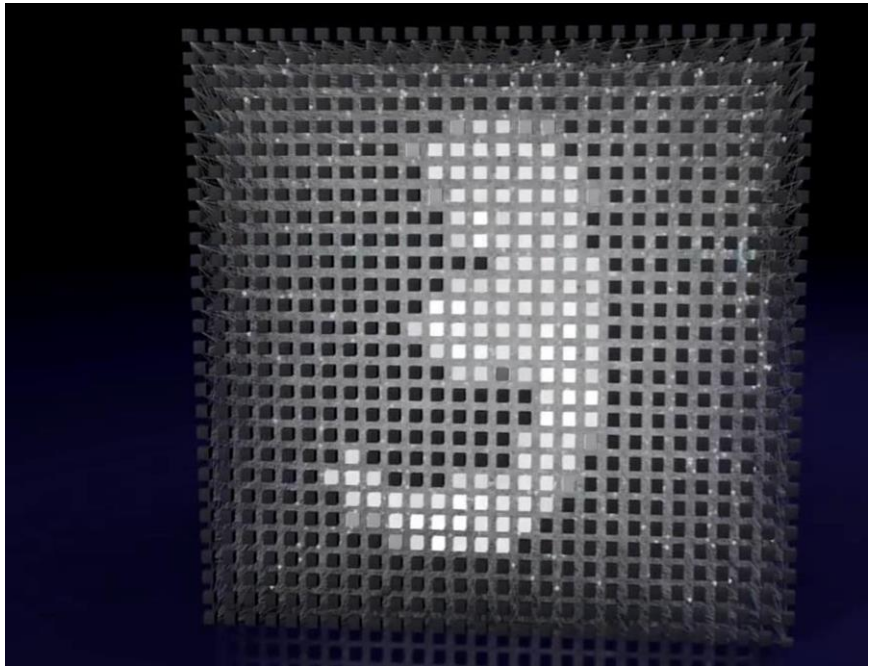
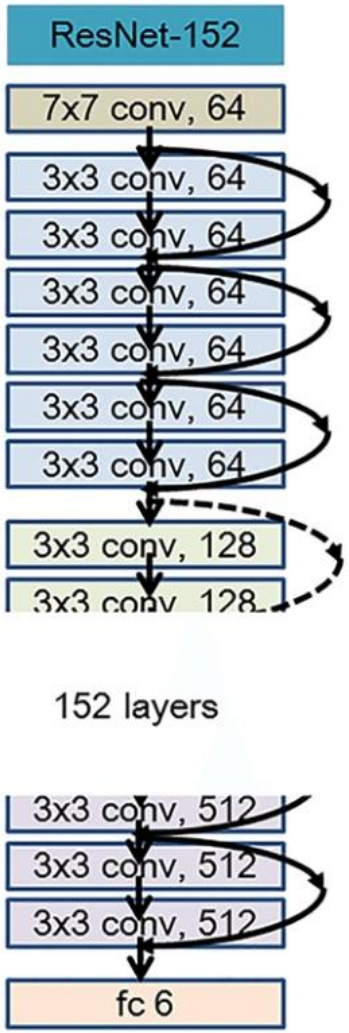
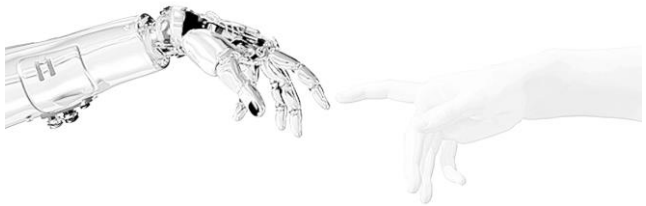
Künstliches Neuronales Netz

- **ResNet -152**: ca. 10.000 Künstlicher Neuronen und 60 Millionen Synapsen (Parameter)
- **Ganzes menschliches Gehirn**:
  100 Milliarden Neuronen
  1.000 Trillionen Synapsen







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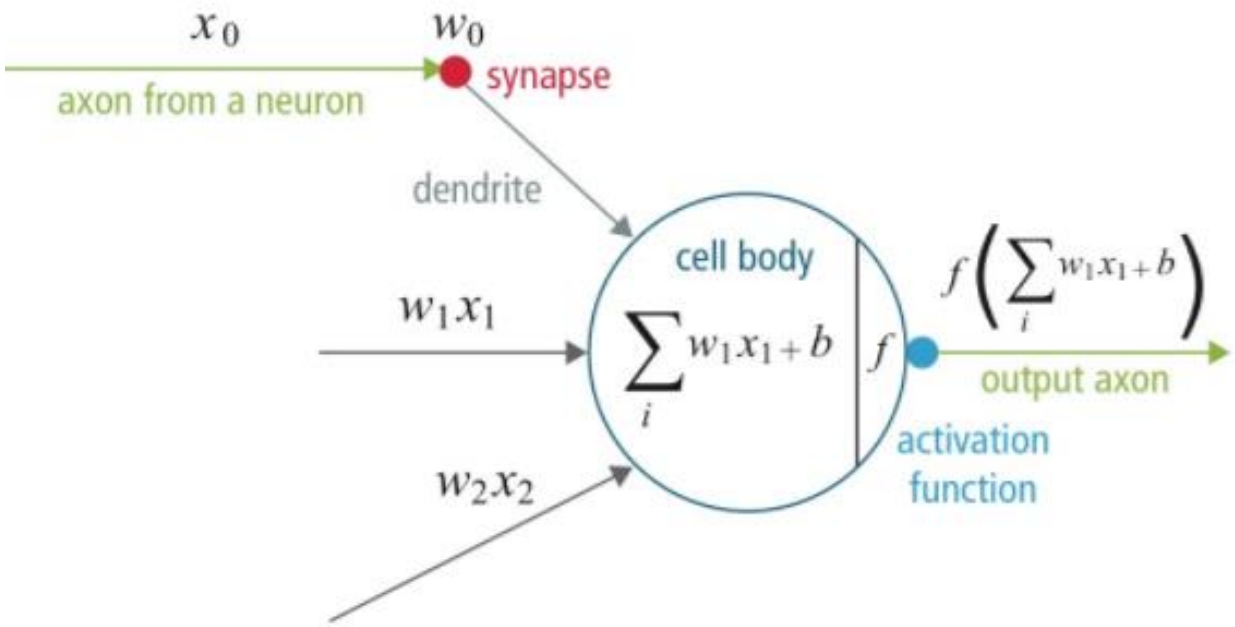
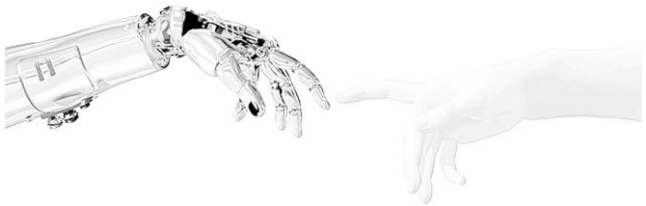
Neuron - Mathematisches Modell



Source: https://www.embedded-vision.com



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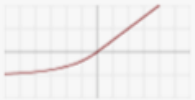
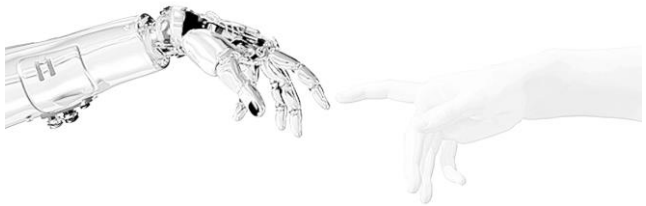
Aktivierung Funktionen

Name	Plot	Equation	Derivative
Identity		$f(x) = x$	$f'(x) = 1$
Binary step		$f(x) = \begin{cases} 0 & \text{for} \quad x < 0 \\ 1 & \text{for} \quad x \geq 0 \end{cases}$	$f'(x) = \begin{cases} 0 & \text{for} \quad x \neq 0 \\ ? & \text{for} \quad x = 0 \end{cases}$
Logistic (a.k.a Soft step)		$f(x) = \frac{1}{1+e^{-x}}$	$f'(x) = f(x)(1 - f(x))$
TanH		$f(x) = \tanh(x) = \frac{2}{1+e^{-2x}} - 1$	$f'(x) = 1 - f(x)^2$
ArcTan		$f(x) = \tan^{-1}(x)$	$f'(x) = \frac{1}{x^2+1}$
Rectified Linear Unit (ReLU)		$f(x) = \begin{cases} 0 & \text{for} \quad x < 0 \\ x & \text{for} \quad x \geq 0 \end{cases}$	$f'(x) = \begin{cases} 0 & \text{for} \quad x < 0 \\ 1 & \text{for} \quad x \geq 0 \end{cases}$
Parameteric Rectified Linear Unit (PReLU) [2]		$f(x) = \begin{cases} \alpha x & \text{for} \quad x < 0 \\ x & \text{for} \quad x \geq 0 \end{cases}$	$f'(x) = \begin{cases} \alpha & \text{for} \quad x < 0 \\ 1 & \text{for} \quad x \geq 0 \end{cases}$
Exponential Linear Unit (ELU) [3]		$f(x) = \begin{cases} \alpha(e^x - 1) & \text{for} \quad x < 0 \\ x & \text{for} \quad x \geq 0 \end{cases}$	$f'(x) = \begin{cases} f(x) + \alpha & \text{for} \quad x < 0 \\ 1 & \text{for} \quad x \geq 0 \end{cases}$
SoftPlus		$f(x) = \log_e(1 + e^x)$	$f'(x) = \frac{1}{1+e^{-x}}$



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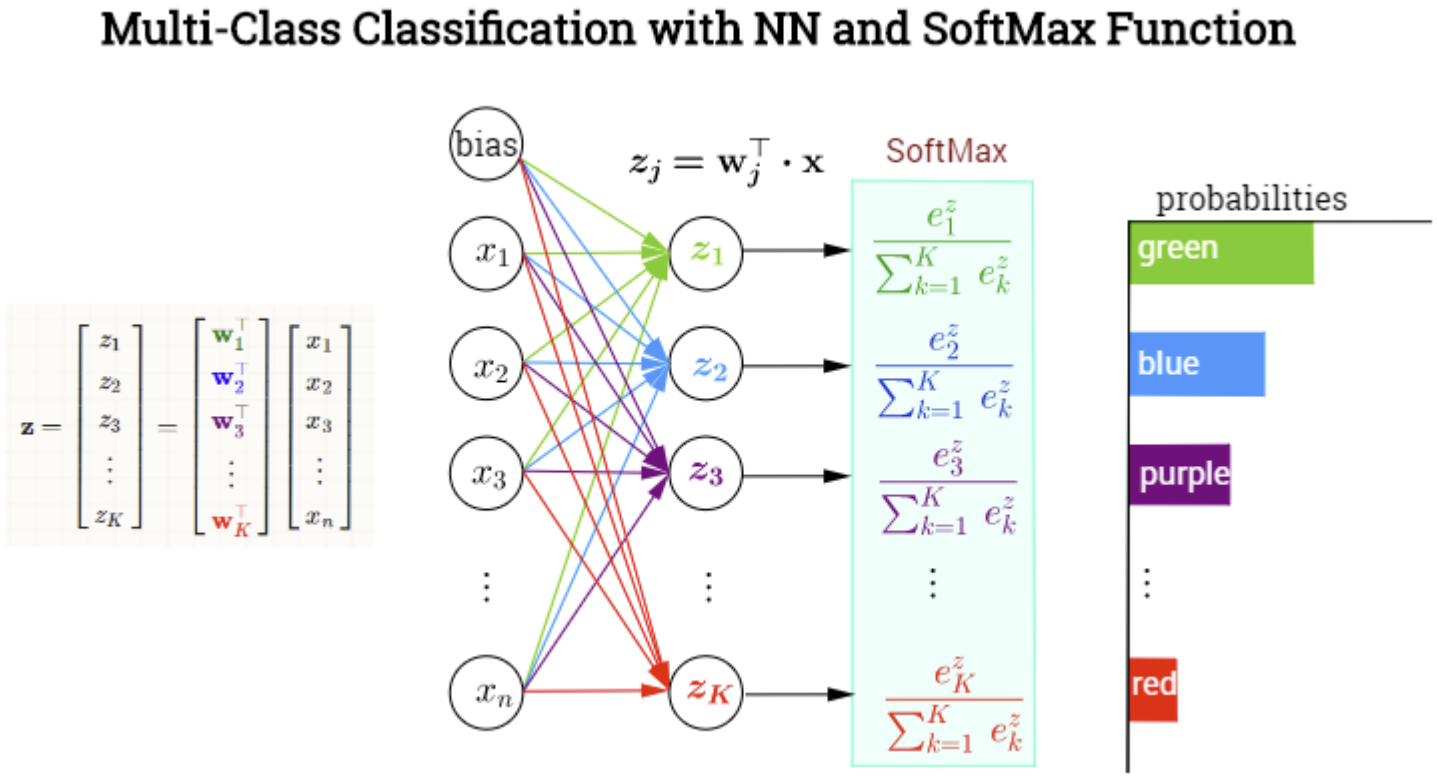
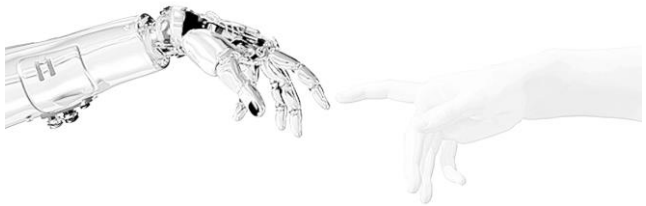
Aktivierung Funktionen. Softmax.





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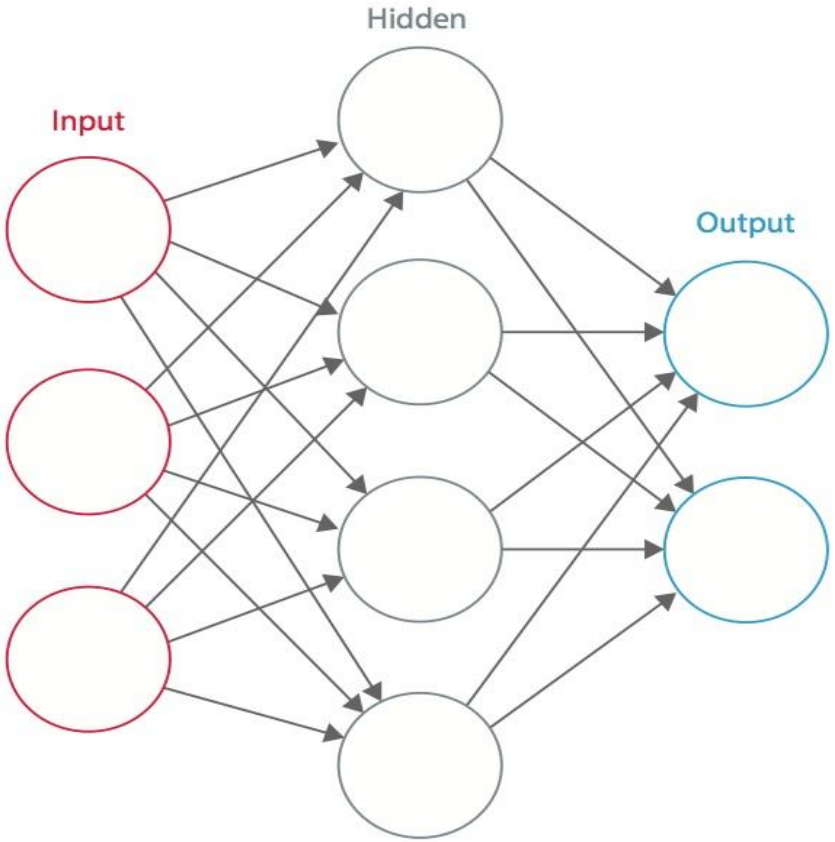
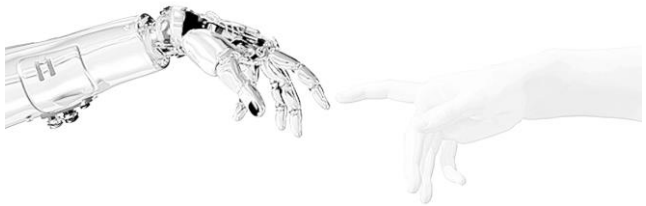
Künstliches neuronales Netzwerk MLP – Multi-Layer Perceptron



Important Deep Learning Architectures see here

Source: https://www.embedded-vision.com



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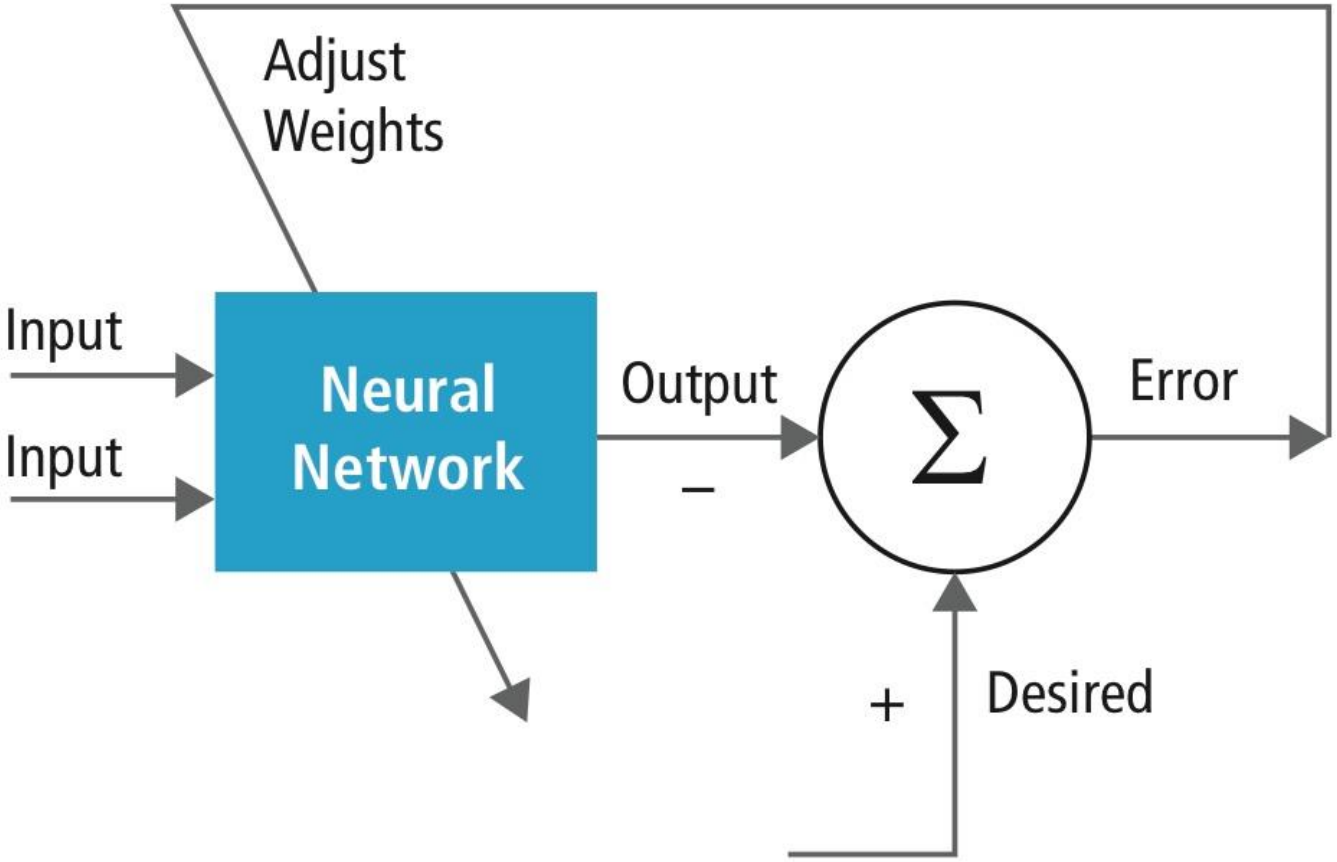
Training eines neuronalen Netzwerks



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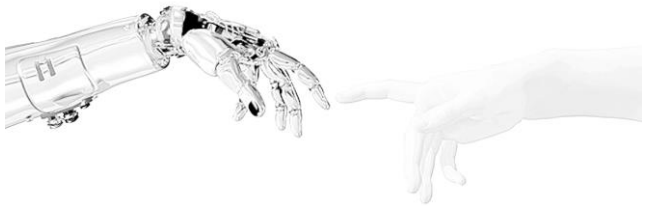

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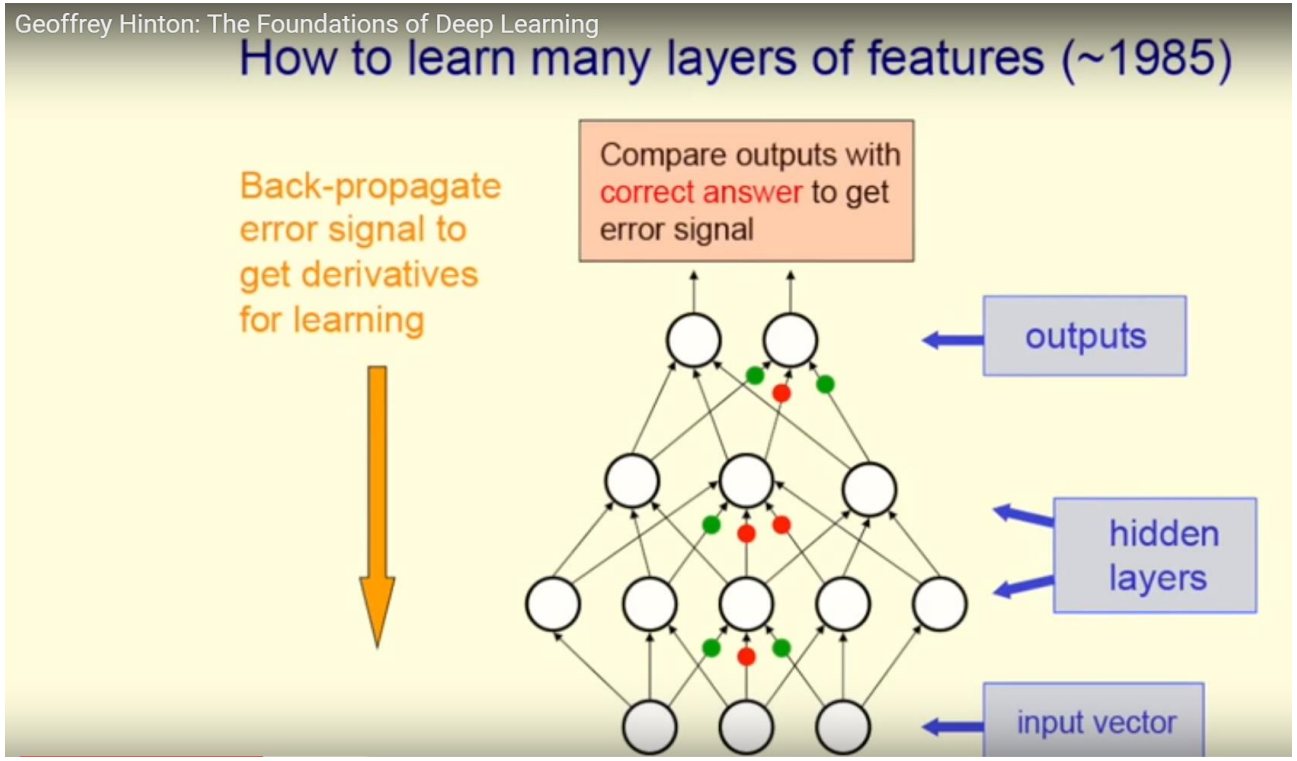
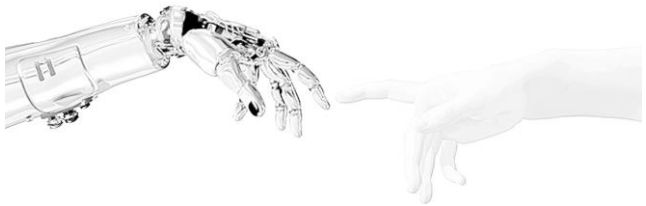
Backpropagation – Gewichte durch “Gradient Descent” anpassen



[Source - Geoffrey Hinton: The Foundations of Deep Learning]



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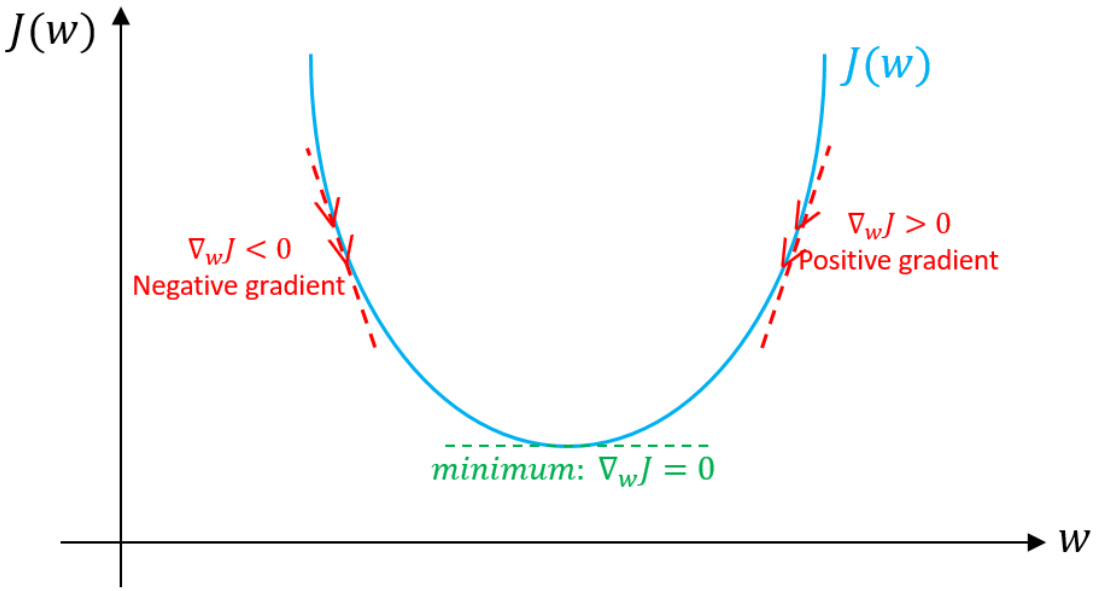
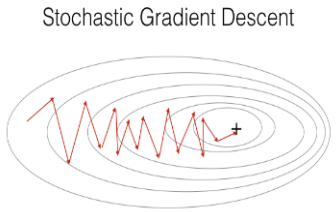
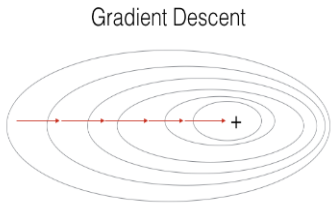
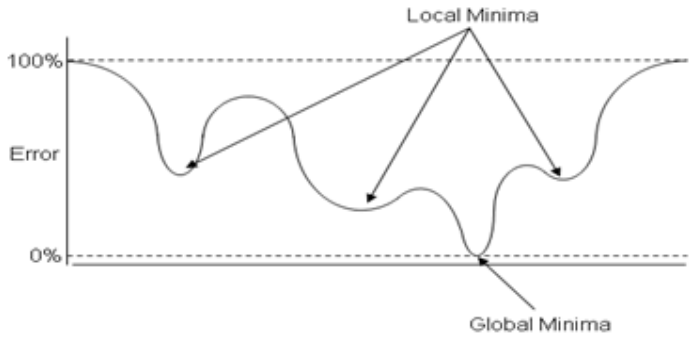
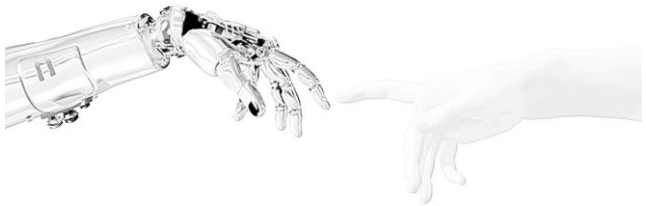
Gradient descent / stochastic Gradient Descent und globales Extremum











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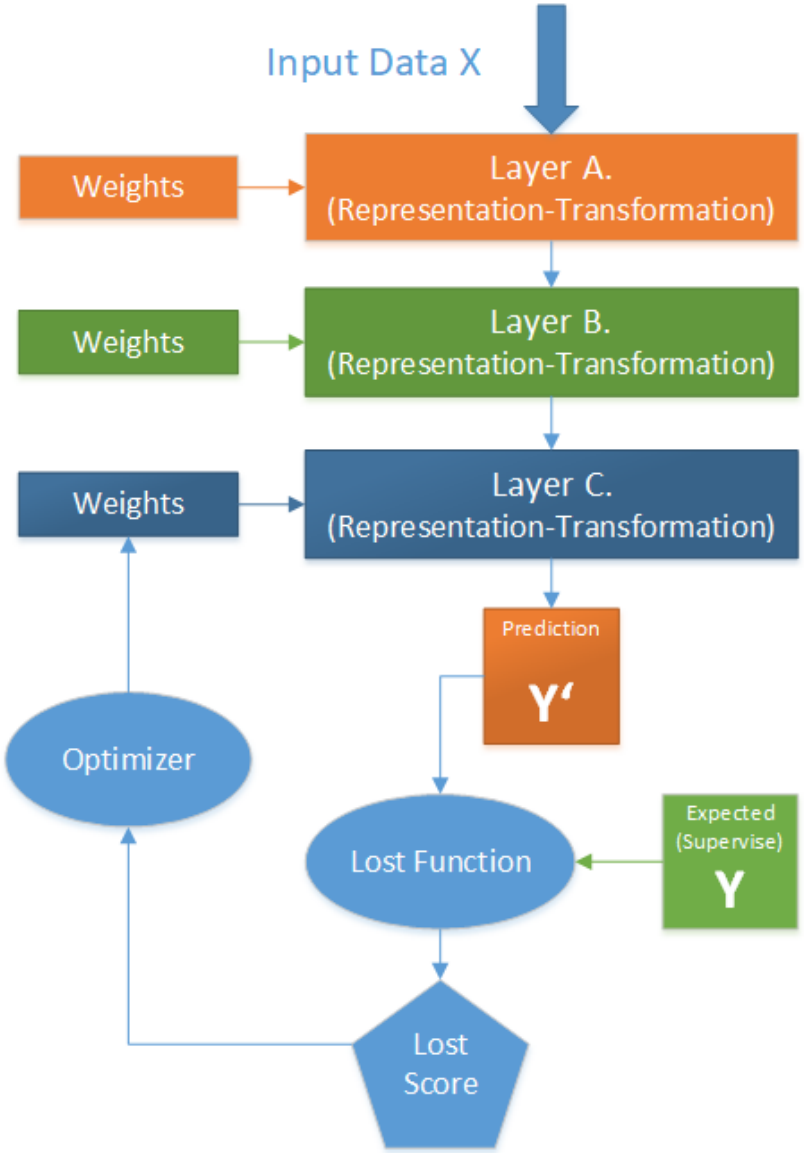
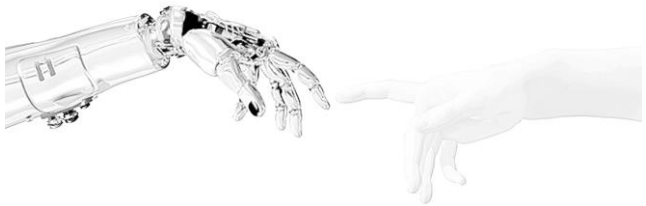
Wie ein Deep Learning Model trainiert wird





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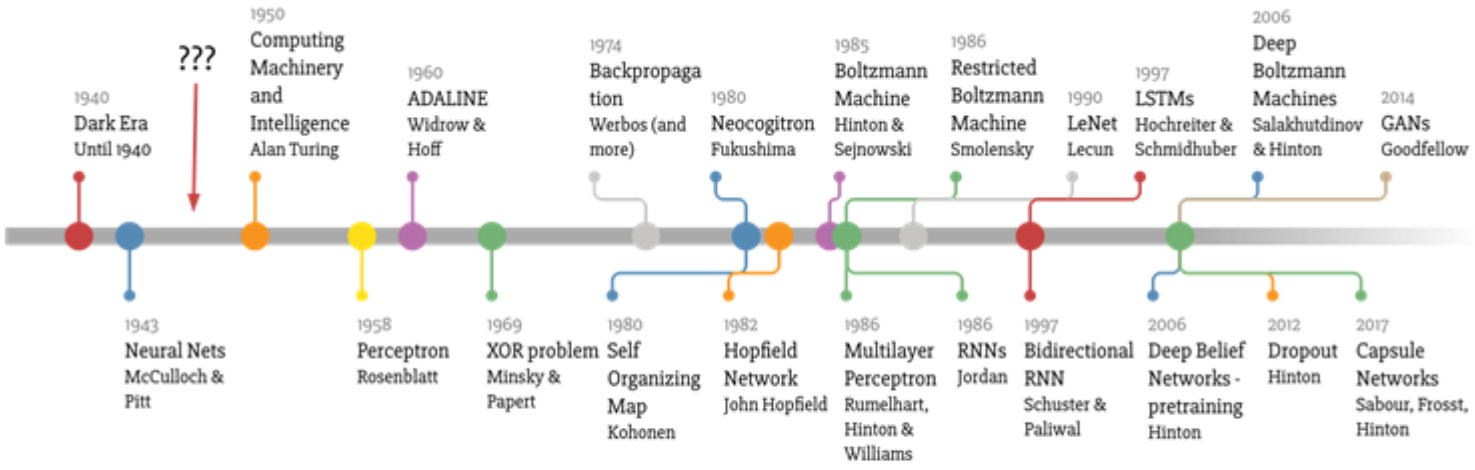
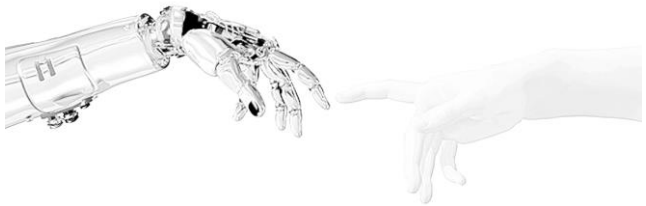
Deep Learning – Timeline



Made by Favio Vázquez

Quelle: [Favio Vazquez]



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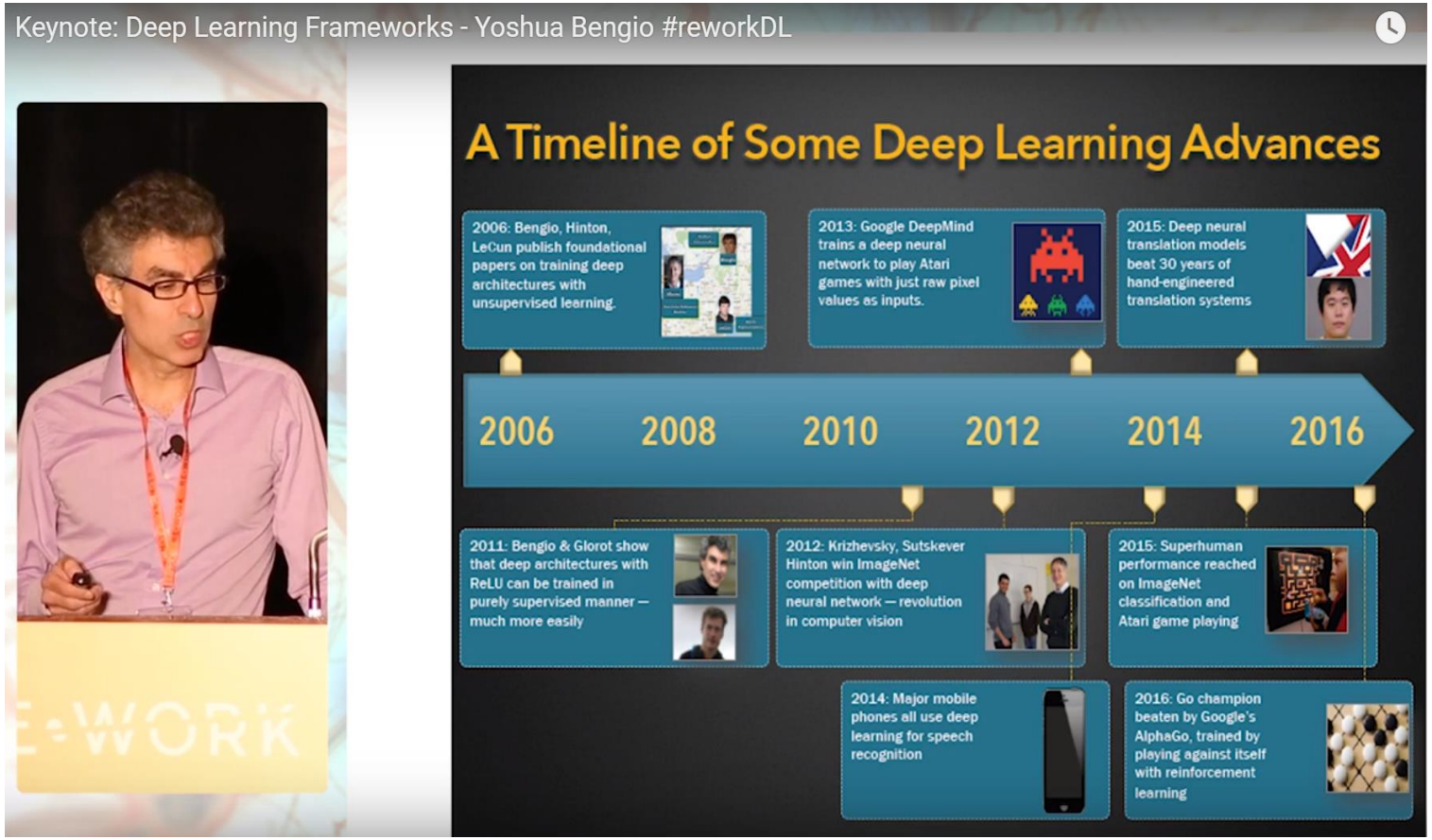
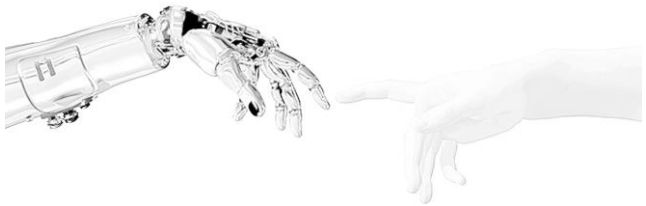
Deep Learning – Schüssel-Technologie in moderner KI



Source - Keynote: Deep Learning Frameworks - Yoshua Bengio #reworkDL



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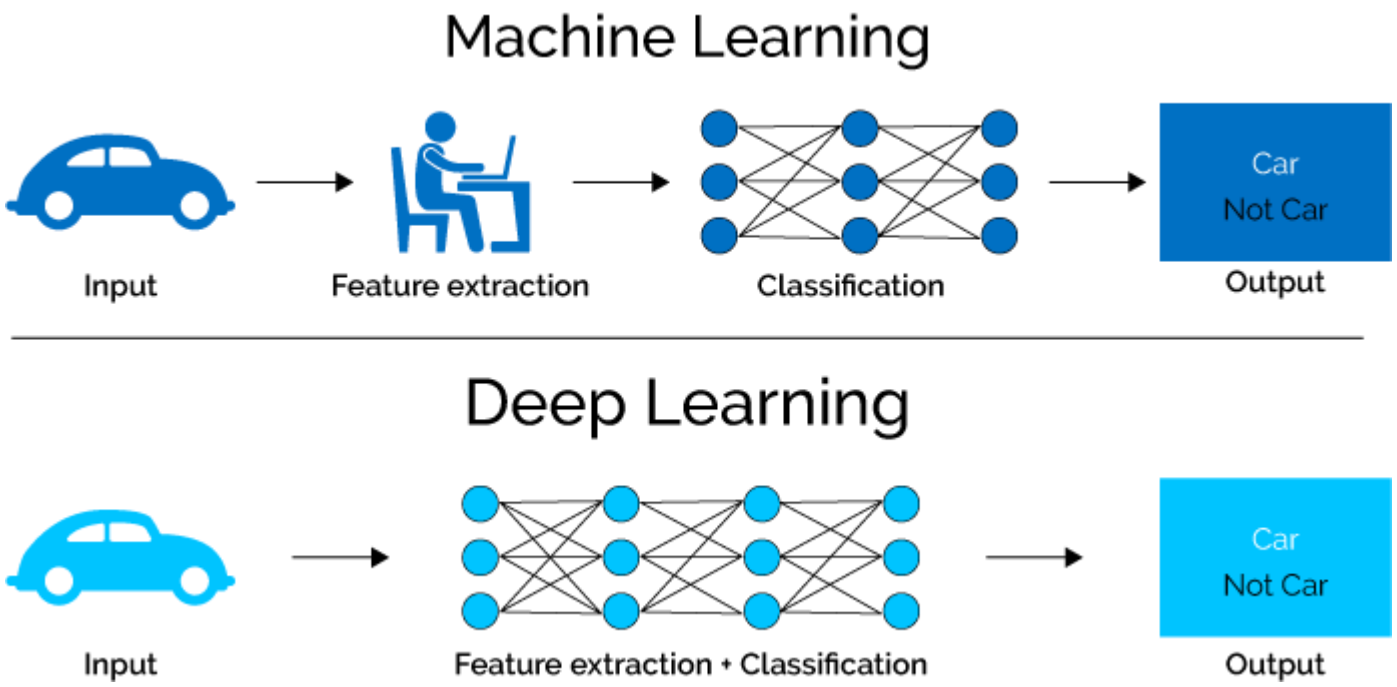
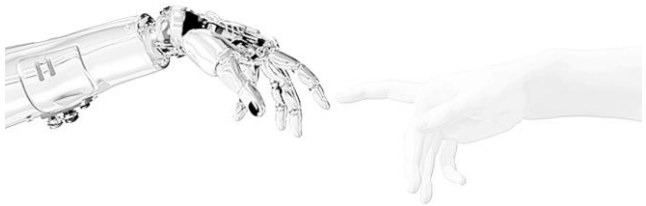
Deep Learning – automatic feature extraction





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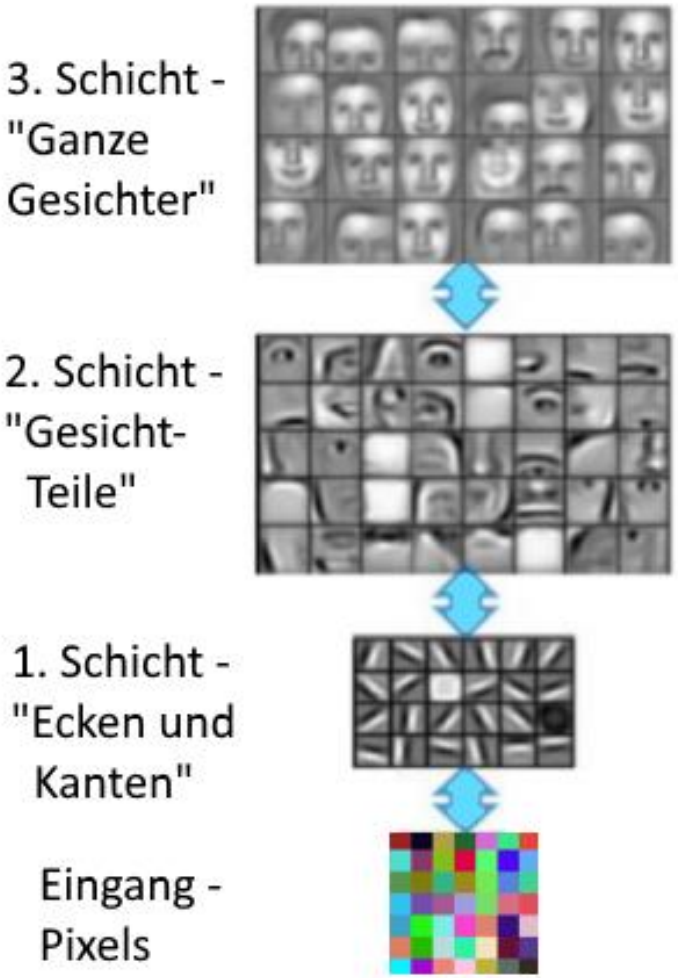

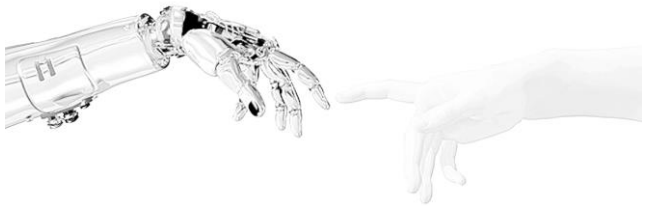

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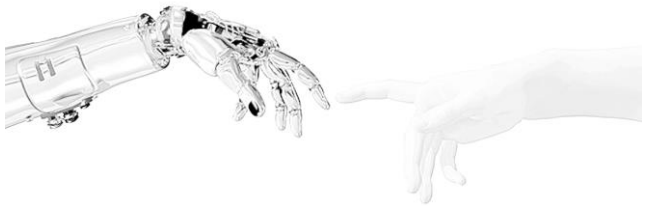
Deep Learning Erfolgsfaktoren

- Viele-viele Daten
- Sehr flexible ML-Modelle
- Steigende Rechenleistung
- Rechnerisch effiziente Schlussfolgerung
- Mächtige Vorläufer, die die Dimensionalität-Problematik durch Kompositionen (wie menschliche Abstraktionen) lösen können
- Tiefe ML-Architekturen mit mehreren Ebenen



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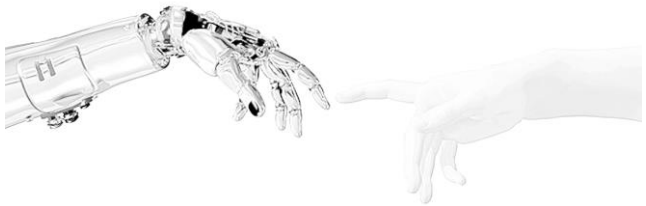
Fortschritte in DeepLearning

- Spracherkennung
- Computer Vision
- Maschinelle Übersetzung
- Argumentation, Aufmerksamkeit und Erinnerung
- Bestärkendes Lernen (Spiele, Go etc.)
- Roboter und Autonome Fahrzeuge
- Langzeitige Abhängigkeiten, sehr tiefe Netze



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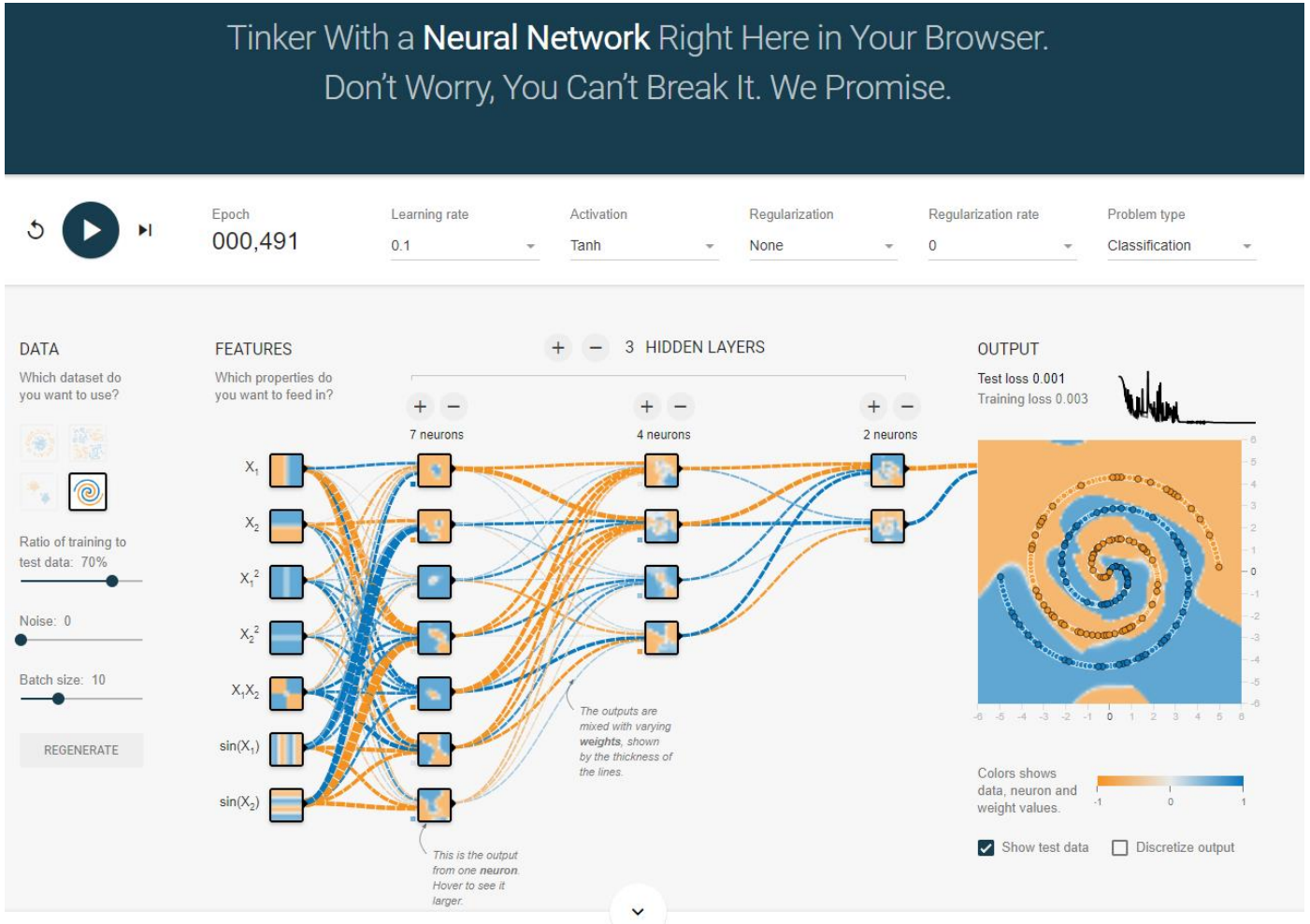
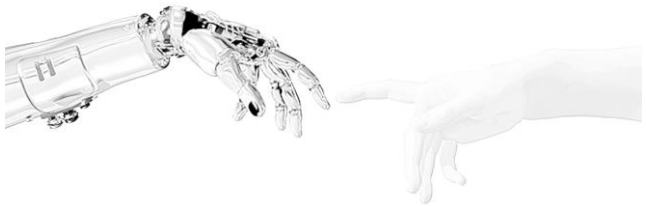
Classification-Demo

playground.tensorflow.org





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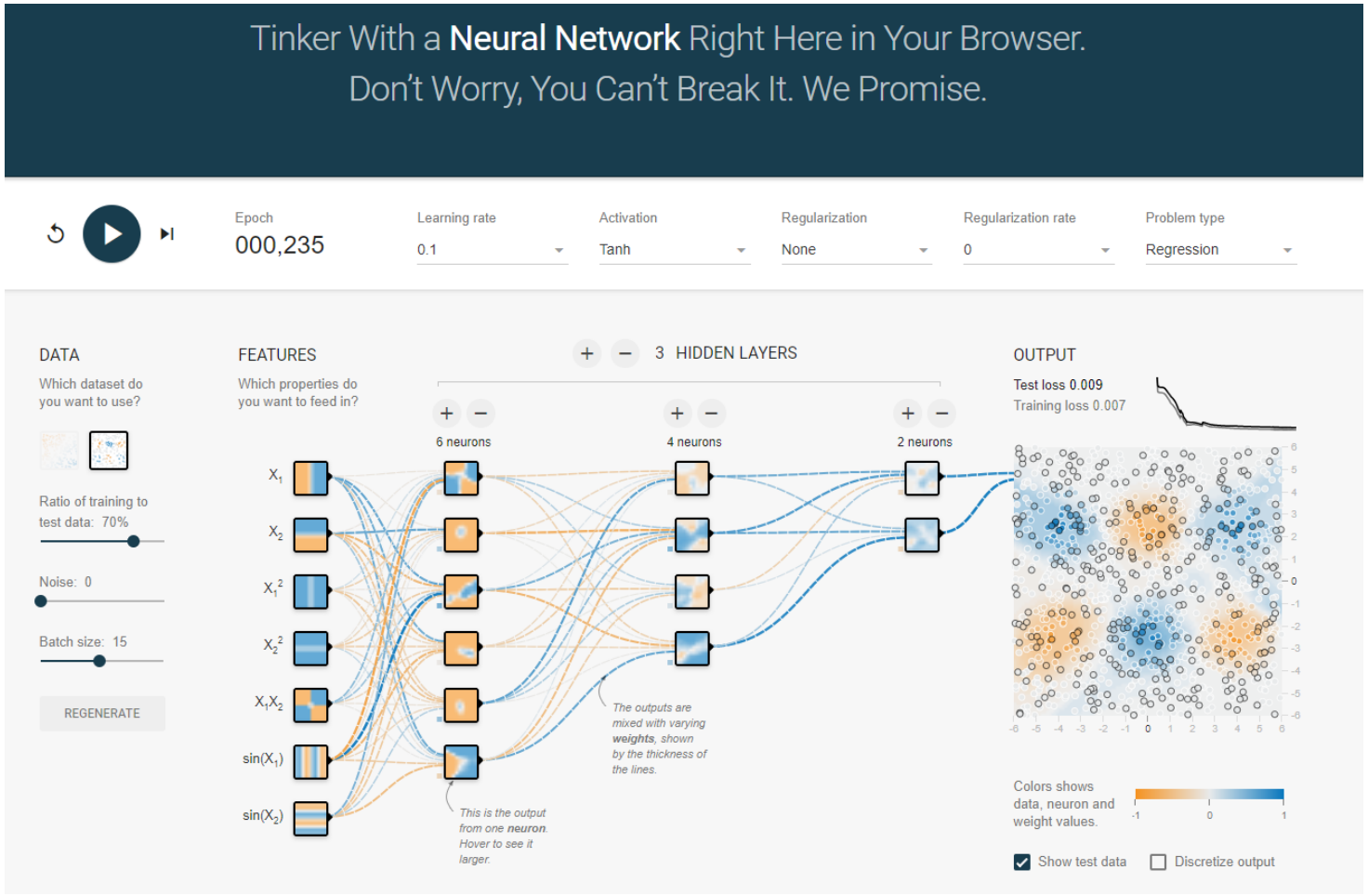
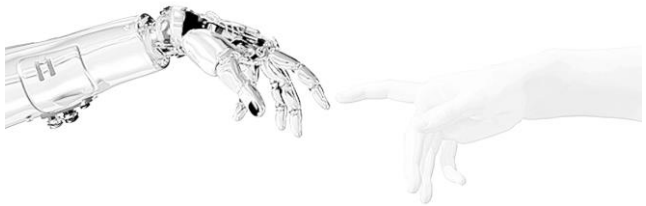
Regression-Demo

playground.tensorflow.org





4. Künstliche Neuronale Netze & Deep Learning

Software Factories
makes software that works

Danke!

Mykola Dobrochynskyy ist Geschäftsführer von Software Factories. Sein Fokus und seine Interessen sind Modellgetriebene Softwareentwicklung, Code Generierung, künstliche Intelligenz, Machine und Deep Learning sowie Cloud und Service orientierte Software-Architekturen.

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