

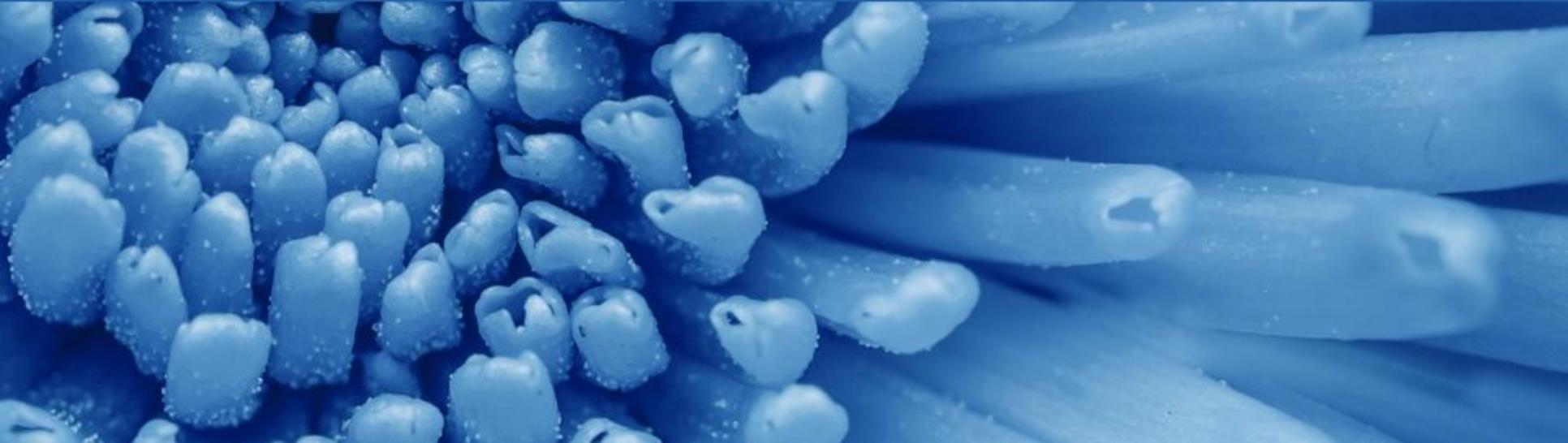
Ich sehe was, was Du nicht siehst...

Aktuelle Möglichkeiten und Grenzen der Künstlichen
Intelligenz

Prof. Dr. Harald Sack
DGI Praxistage 2018, Frankfurt
09. Nov. 2018

**“Jede hinreichend fortgeschrittene Technologie ist von
Magie nicht mehr zu unterscheiden.”**

Arthur C. Clarke, Profiles of the Future (1973)



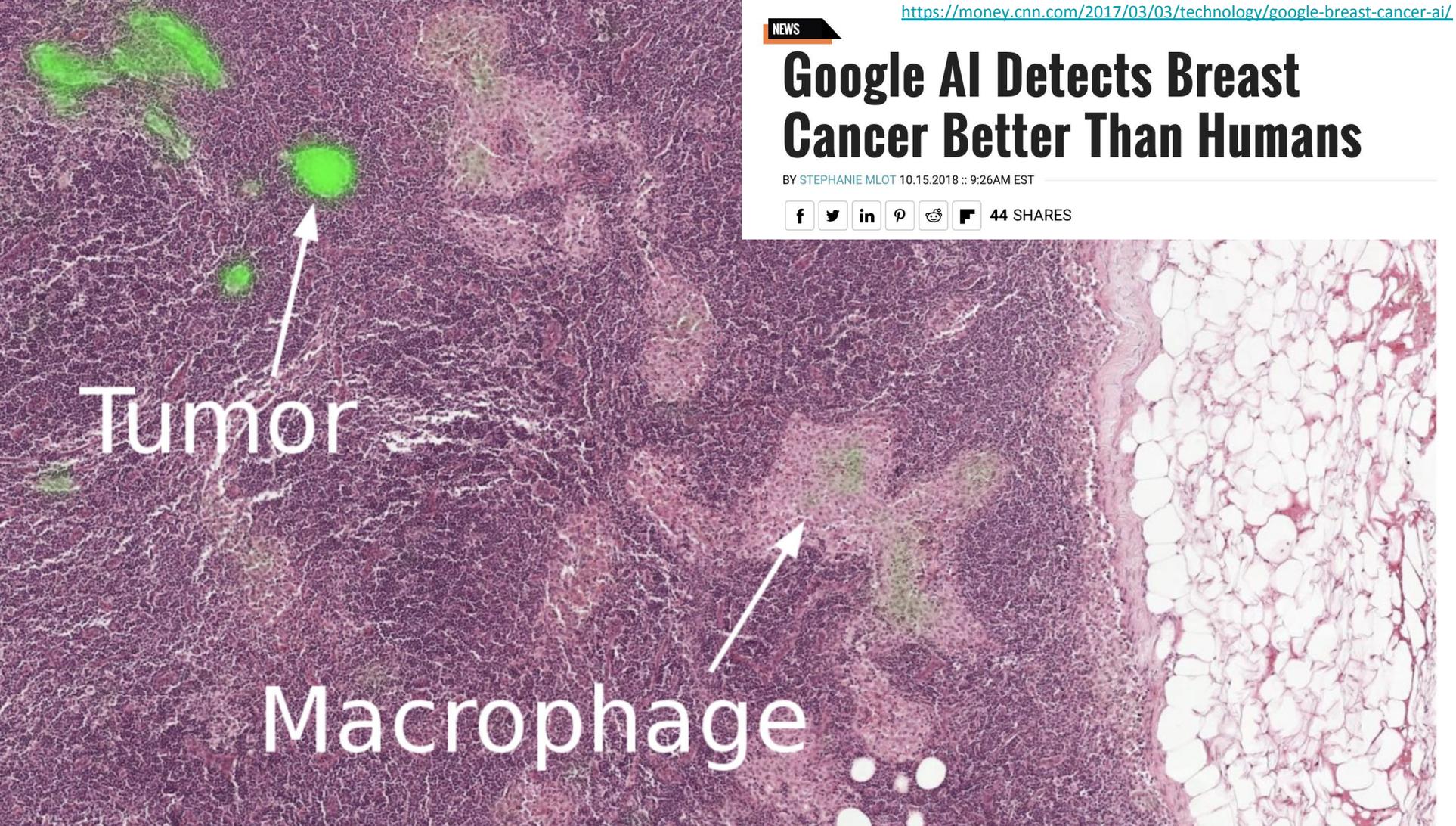
Can you find the cancer?

NEWS

Google AI Detects Breast Cancer Better Than Humans

BY STEPHANIE MLOT 10.15.2018 :: 9:26AM EST

      44 SHARES



Tumor

Macrophage

AlphaGo Zero: Google DeepMind supercomputer learns 3,000 years of human knowledge in 40 days



17



AlphaGo



<http://www.telegraph.co.uk/science/2017/10/18/alphago-zero-google-deepmind-supercomputer-learns-3000-years/>



<https://www.christies.com/features/A-collaboration-between-two-artists-one-human-one-a-machine-9332-1.aspx>

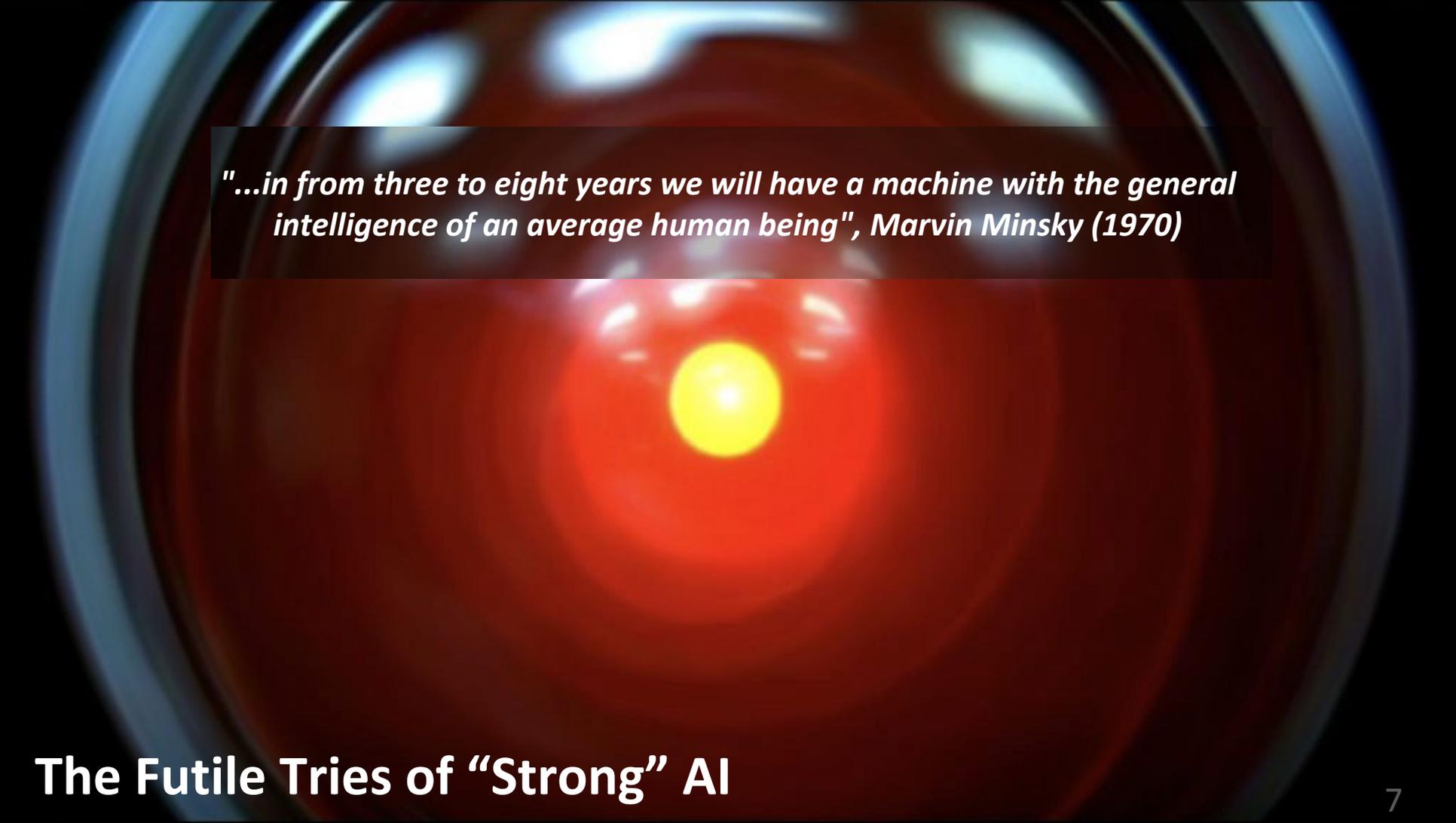


Is artificial intelligence set to become art's next medium?

16 October 2018

PHOTOGRAPHS & PRINTS |

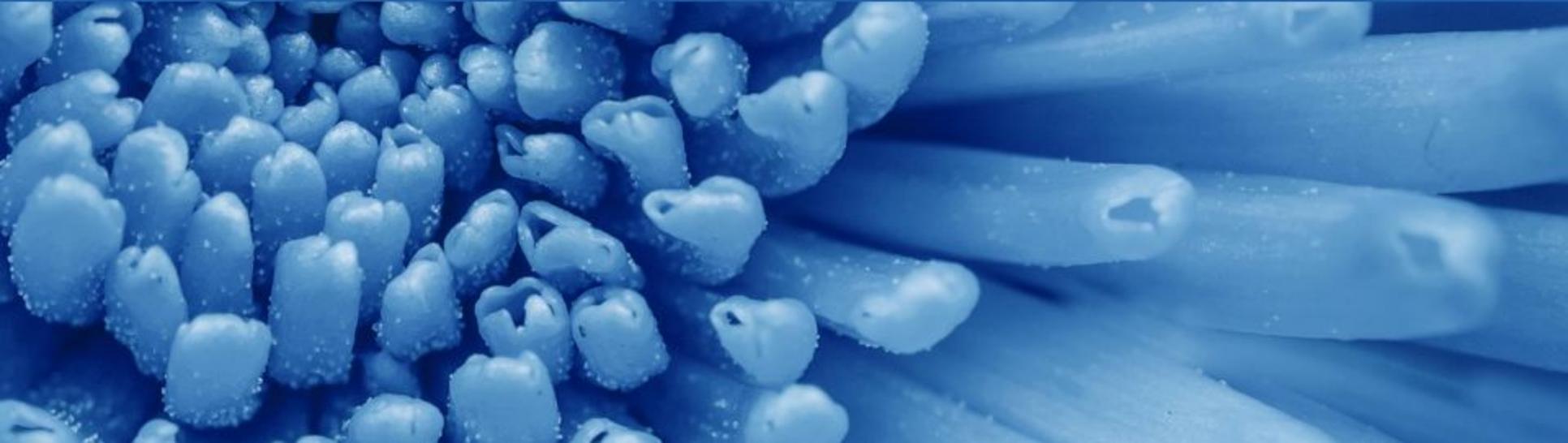
AI artwork sells for \$432,500 — nearly 45 times its high estimate — as Christie's becomes the first auction house to offer

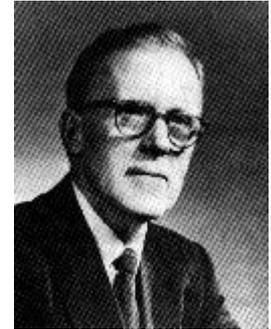
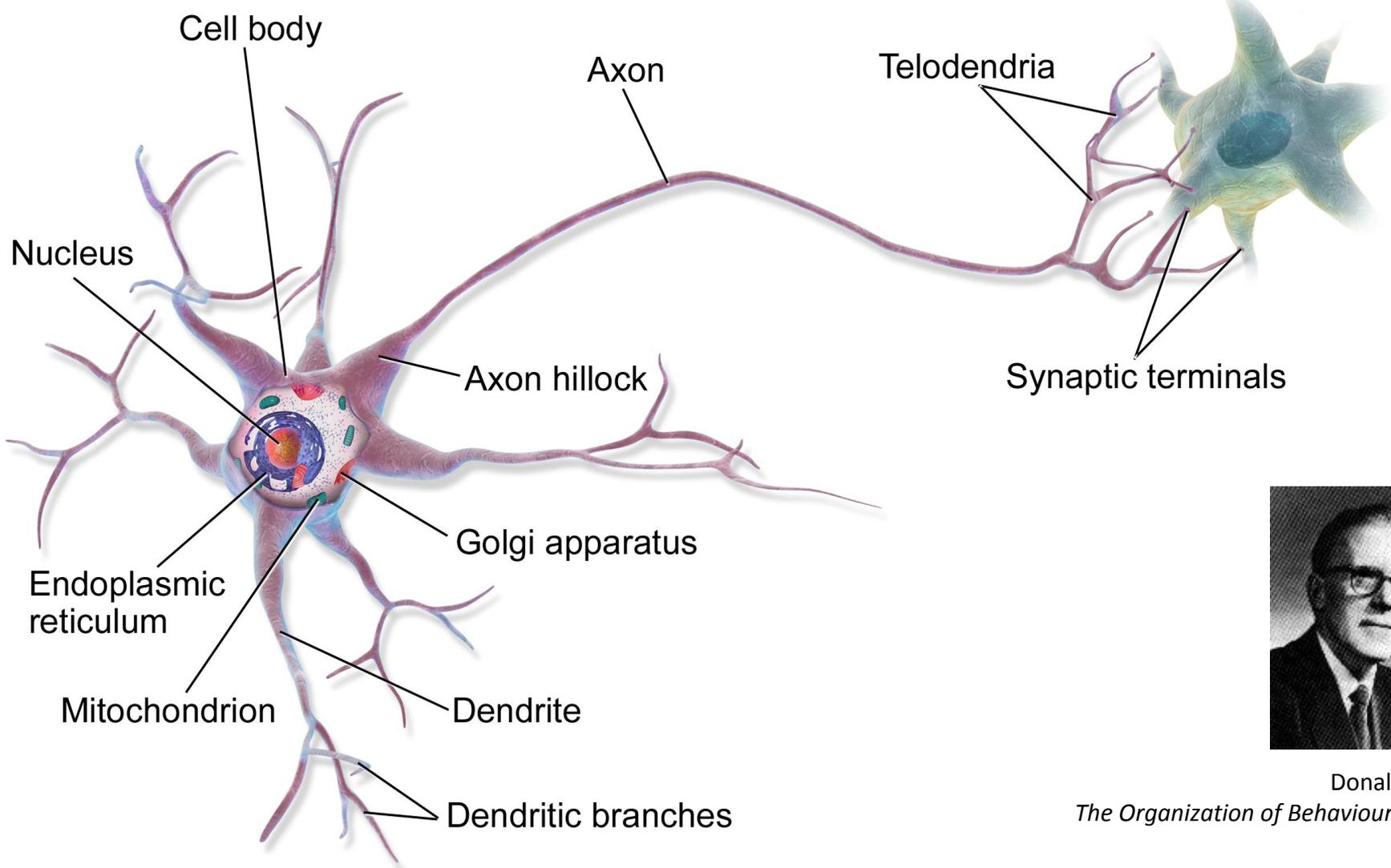


"...in from three to eight years we will have a machine with the general intelligence of an average human being", Marvin Minsky (1970)

The Futile Tries of “Strong” AI

Aber woher kommt nun die “Magie”...?





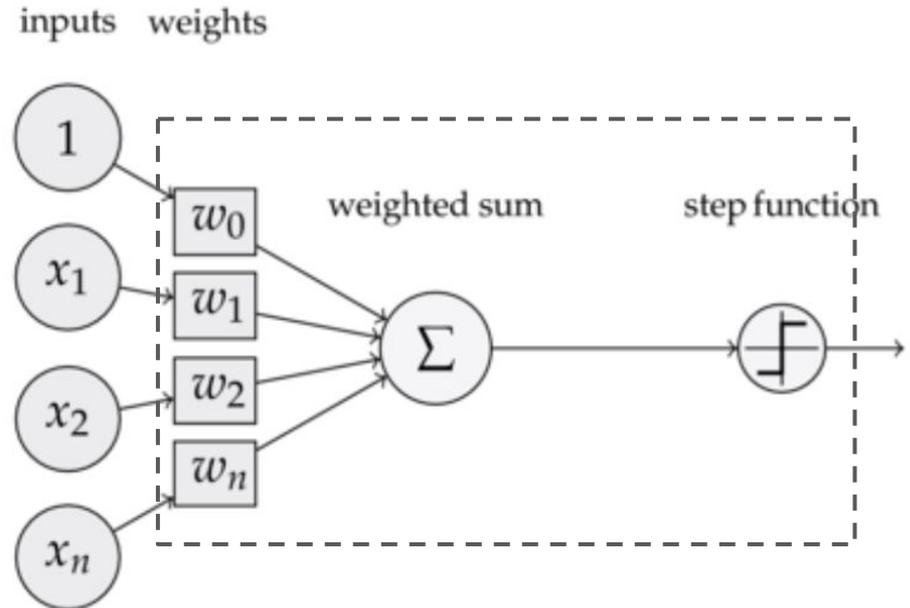
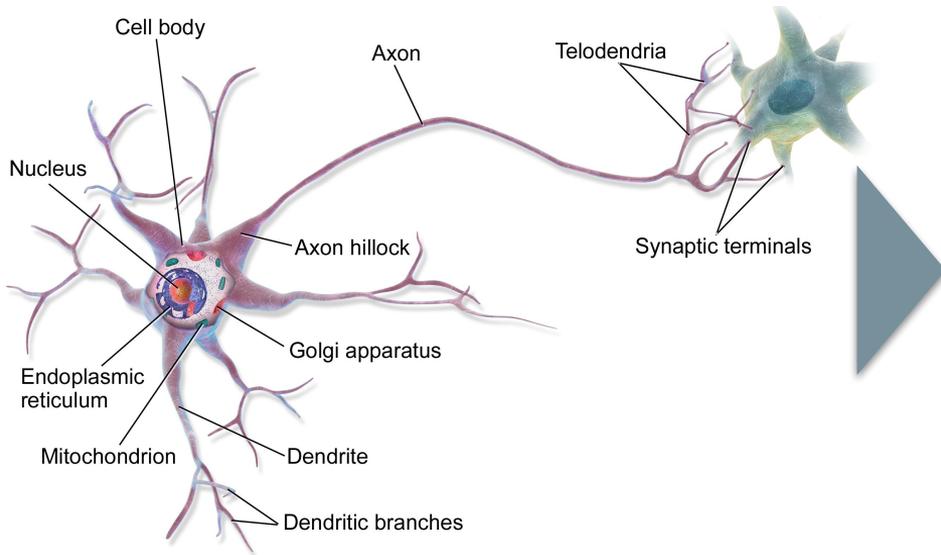
Donald Hebb

The Organization of Behaviour (1949)

Von der Biologie zum Mathematischen Modell



Warren Sturgis McCulloch & Walter Pitts
A Logical Calculus of the Ideas Immanent in Nervous Activity (1943)

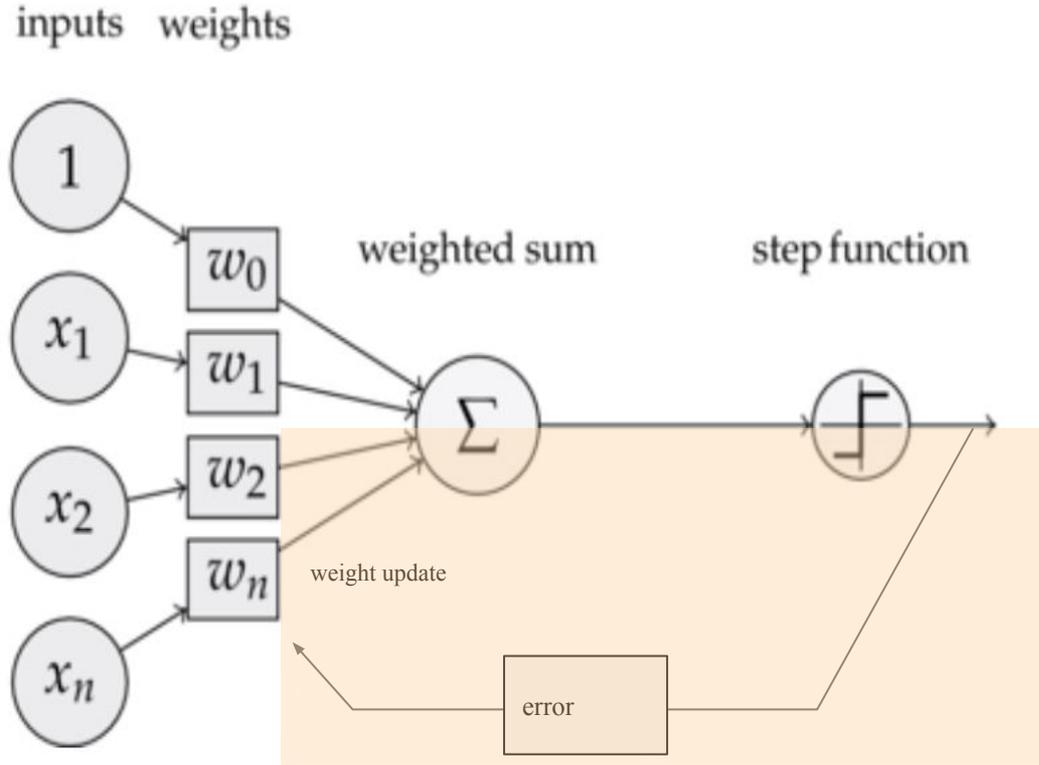


Perceptron Algorithmus



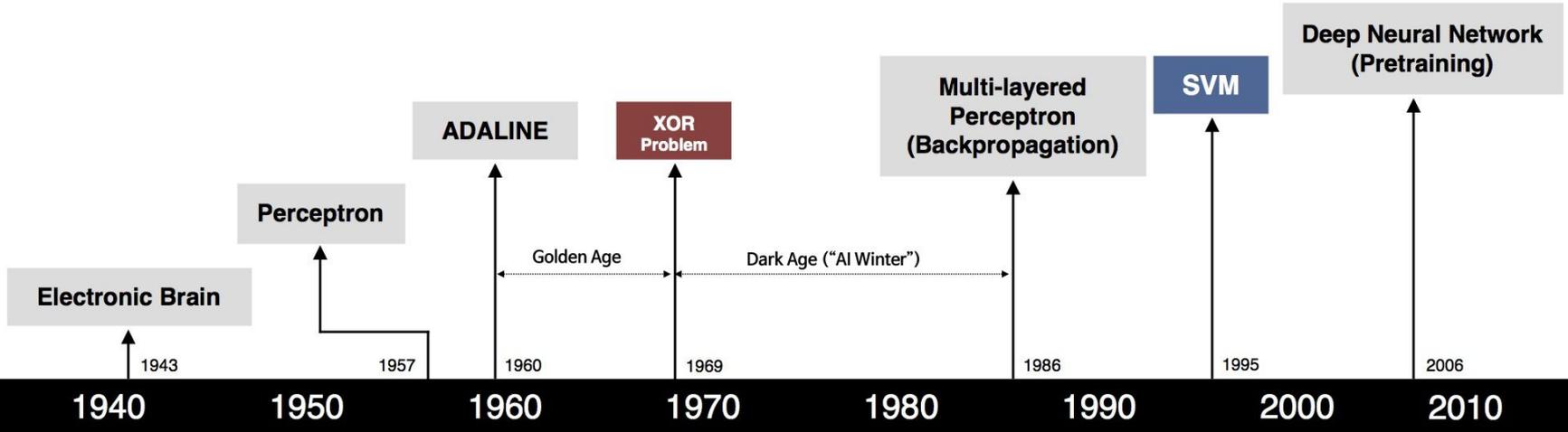
Frank Rosenblatt

The perceptron: a probabilistic model for information storage and organization in the brain. (1958)

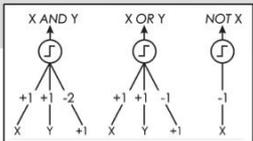


$$w_{ij}^{\text{neu}} = w_{ij}^{\text{alt}} + \Delta w_{ij},$$
$$\Delta w_{ij} = \alpha \cdot (t_j - o_j) \cdot x_i.$$

Der Siegeszug des konnektionistischen Paradigmas



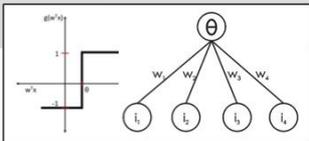
S. McCulloch – W. Pitts



- Adjustable Weights
- Weights are not Learned



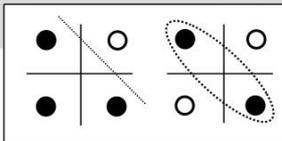
F. Rosenblatt B. Widrow – M. Hoff



- Learnable Weights and Threshold



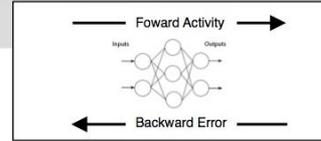
M. Minsky – S. Papert



- XOR Problem



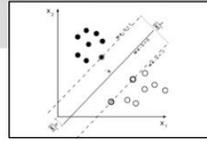
D. Rumelhart – G. Hinton – R. Williams



- Solution to nonlinearly separable problems
- Big computation, local optima and overfitting



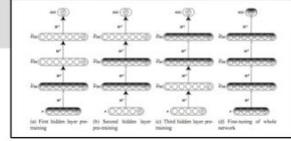
V. Vapnik – C. Cortes



- Limitations of learning prior knowledge
- Kernel function: Human Intervention

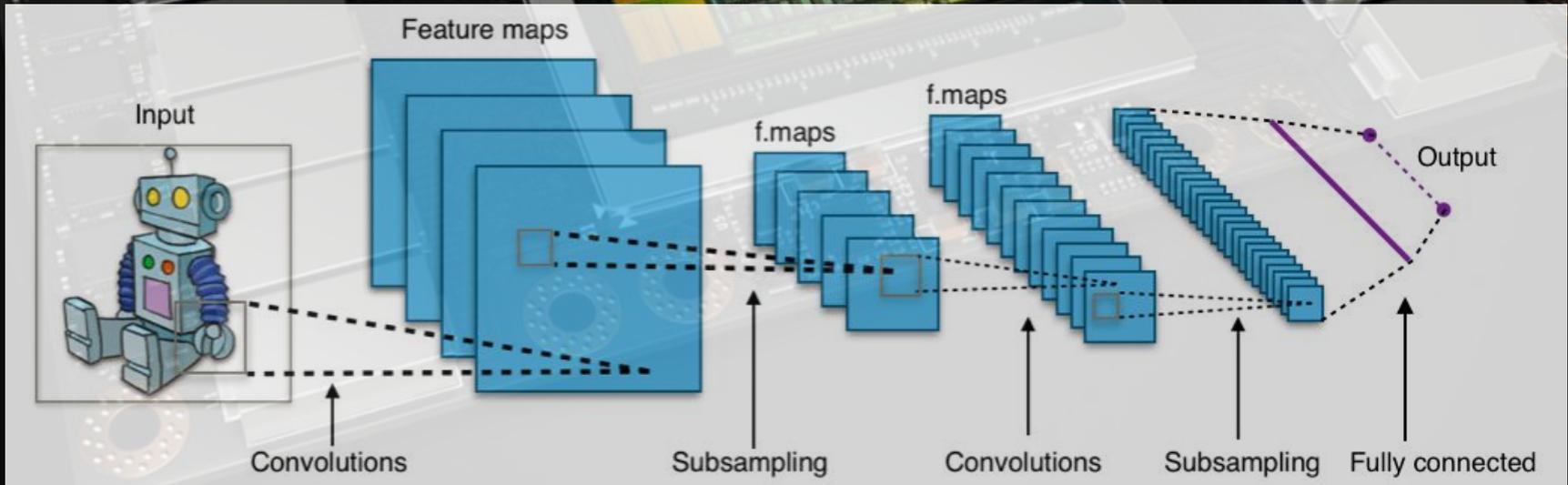


G. Hinton – S. Ruslan



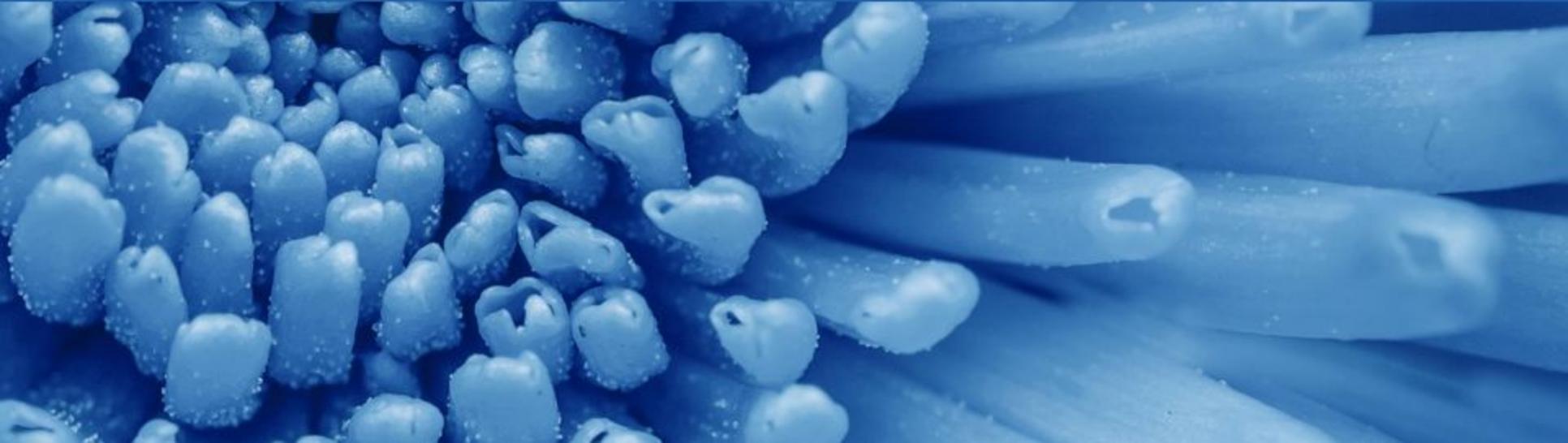
- Hierarchical feature Learning

Convolutional Deep Neural Networks und GPU Supercomputer

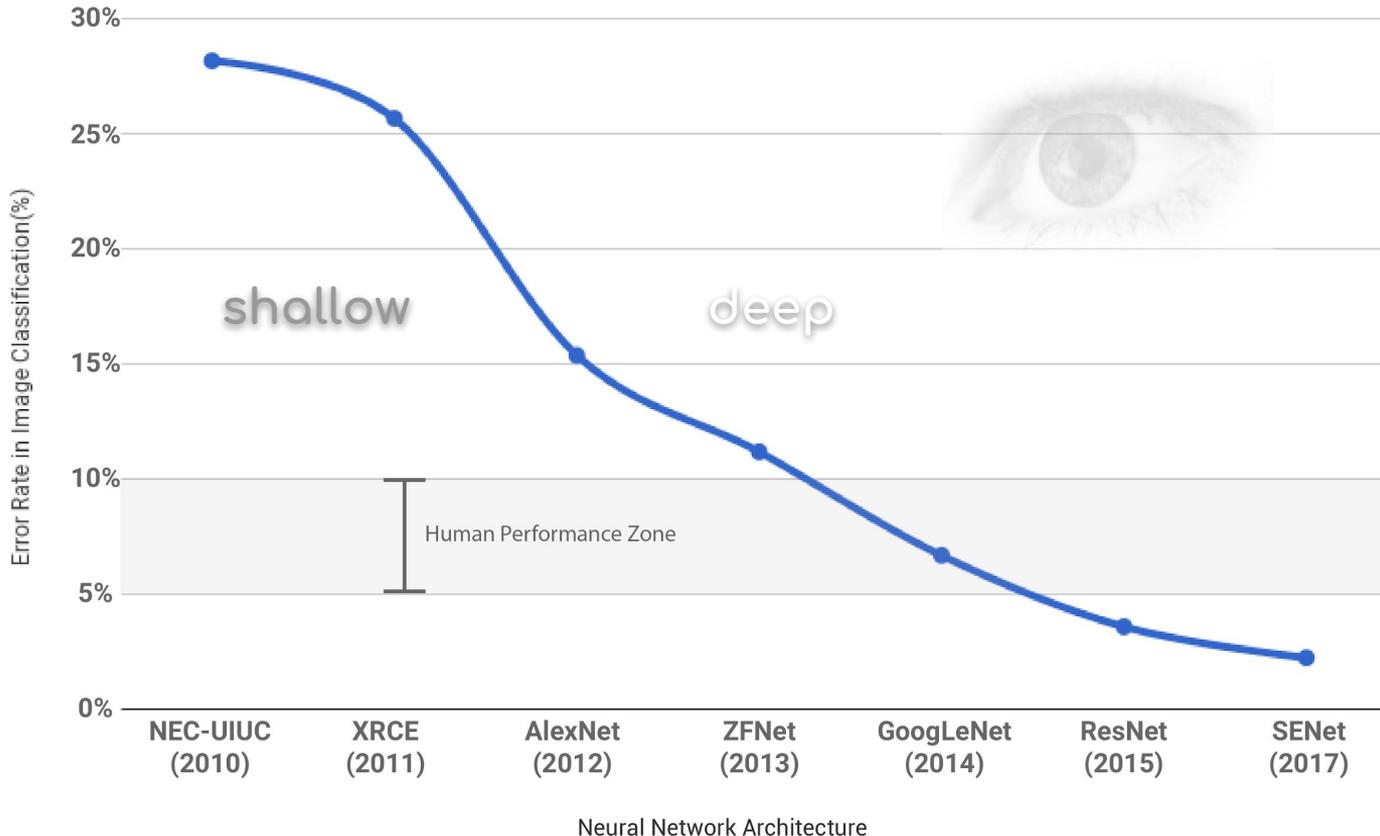


**“Jede hinreichend fortgeschrittene Technologie ist von
Magie nicht mehr zu unterscheiden.”**

Arthur C. Clarke, Profiles of the Future (1973)



Deep Learning für die visuelle Analyse



IMAGENET

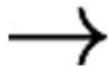
Large Scale Visual Recognition
Challenge (ILSVRC)

<http://image-net.org/challenges/LSVRC/>

Vom Klassifizieren zum Generieren



Photograph



Monet



Van Gogh



Cezanne



Ukiyo-e

Vom Klassifizieren zum Generieren

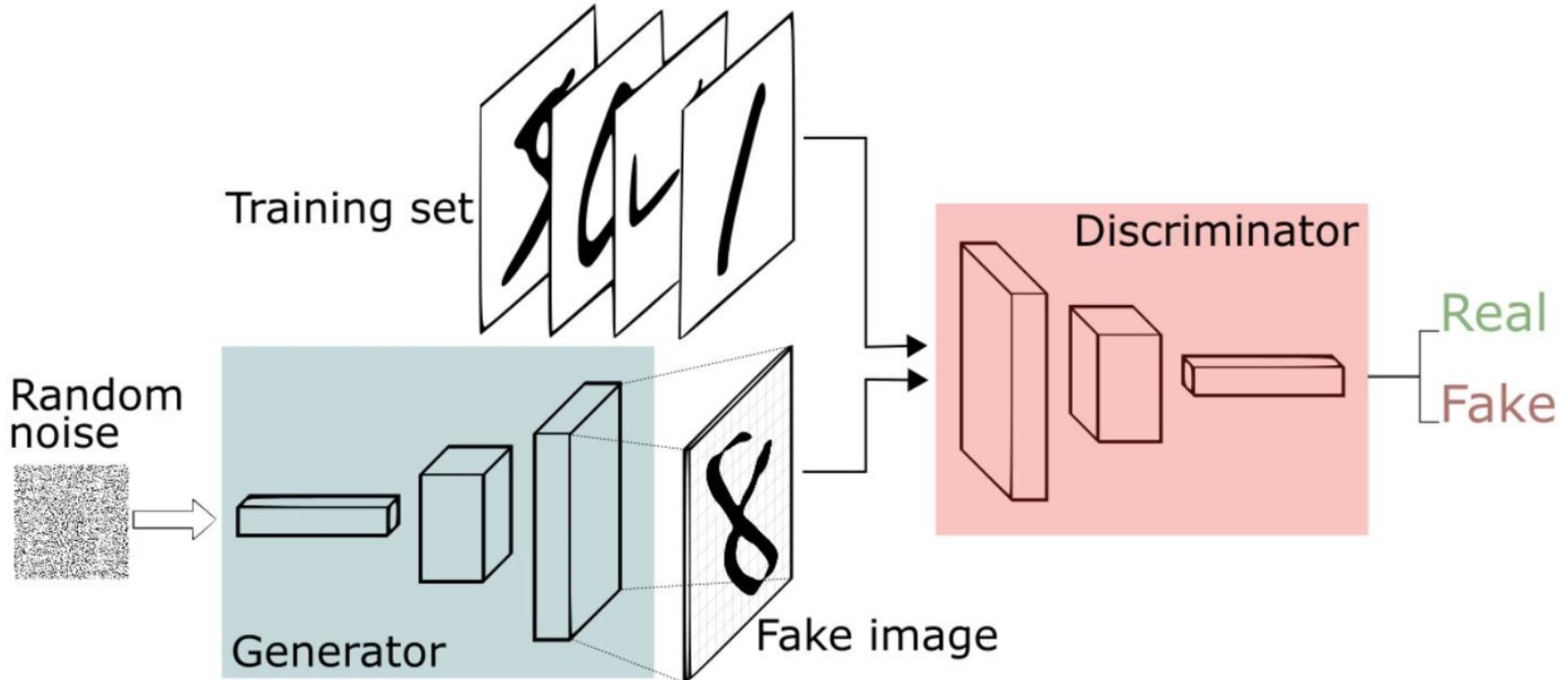
Monet



Photograph



Comparatives Lernen - Generative Adversarial Networks





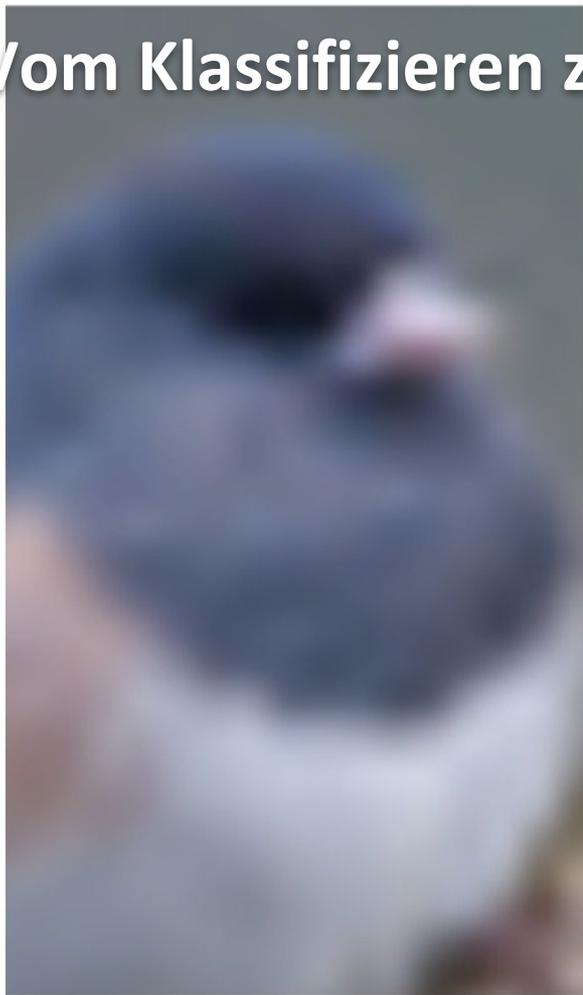
Vom Klassifizieren zum Generieren

Vom Klassifizieren zum Generieren

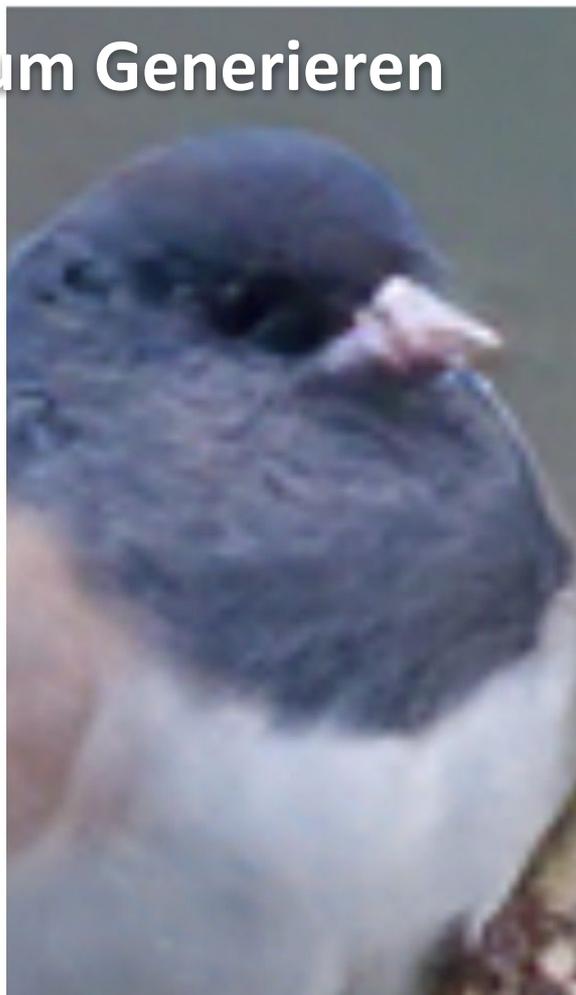


<https://iunvanz.github.io/CycleGAN/>

Vom Klassifizieren zum Generieren



Low-resolution input



Our result



Original image

Input



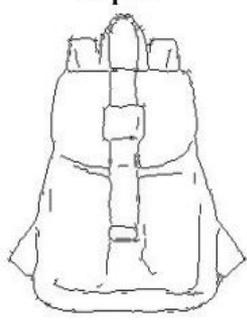
Ground truth



Output



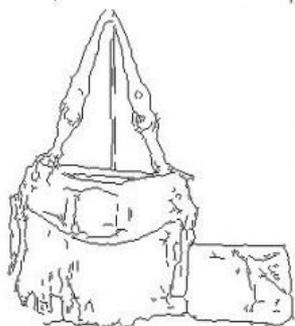
Input



Ground truth



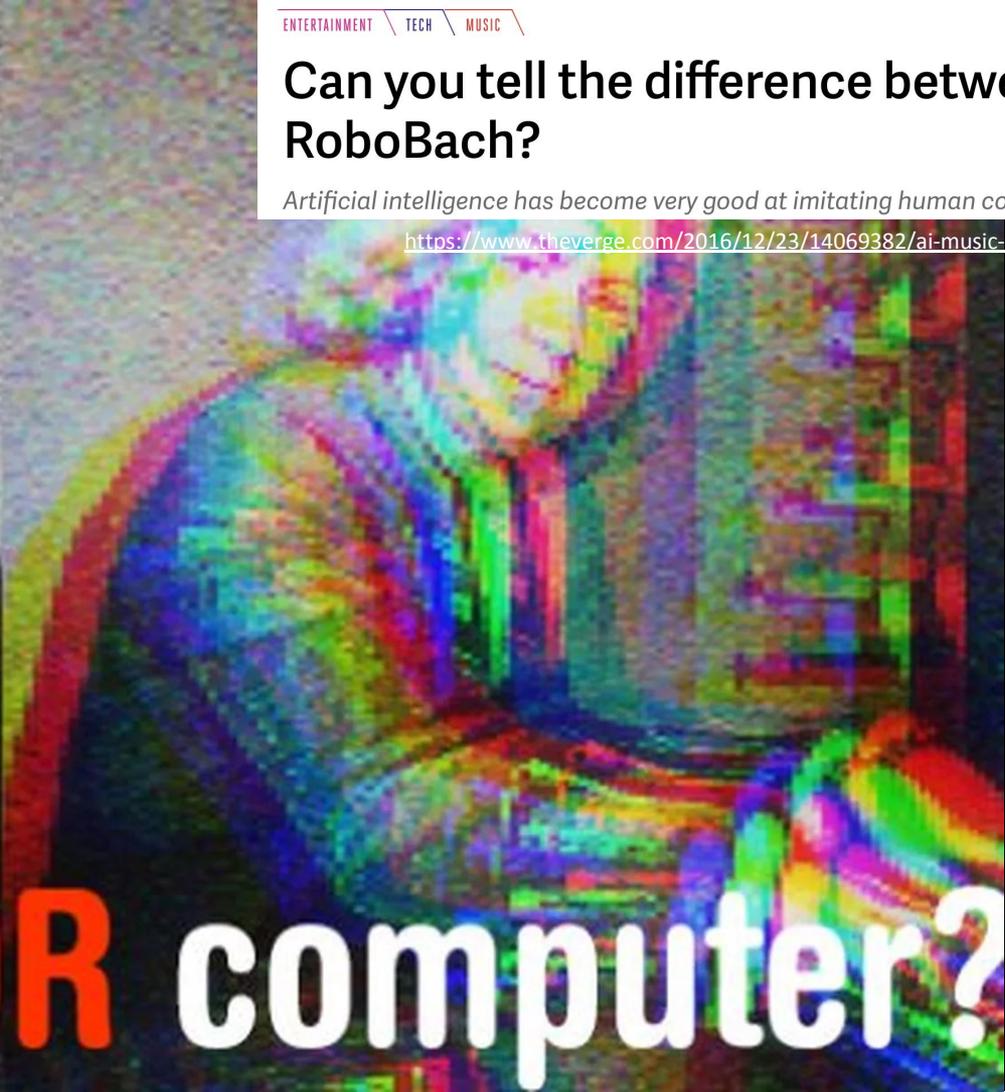
Output



Can you tell the difference between Bach and RoboBach?

Artificial intelligence has become very good at imitating human composers

<https://www.theverge.com/2016/12/23/14069382/ai-music-creativity-bach-deepbach-csl>



Bach **OR** computer?

Visuelle Analyse in Kombination mit Linguistik

Rose Hork

Corcanitol Orange

Suffer

Snowbonk

Golder Craam

Sindis Poop

Navel Tan

Burf Pink

Stargoos

Clear Paste

Burple Simp

Horble Gray

Turdly

Stanky Bean

Dry Custard

Clardic Fug

Burnt Bit Curry

Dondarf

Sink

Grass Bat

Snader Brown

Sudden Pine

Very Barrel

Sane Green

Homestar Brown

Testing

Colona

Dorkwood

Burfream

Violet Ook

GAMING & CULTURE —

Movie written by algorithm turns out to be hilarious and intense



WATCH

Sunspring | A Sci-Fi Short Film Starring Thomas Middleditch

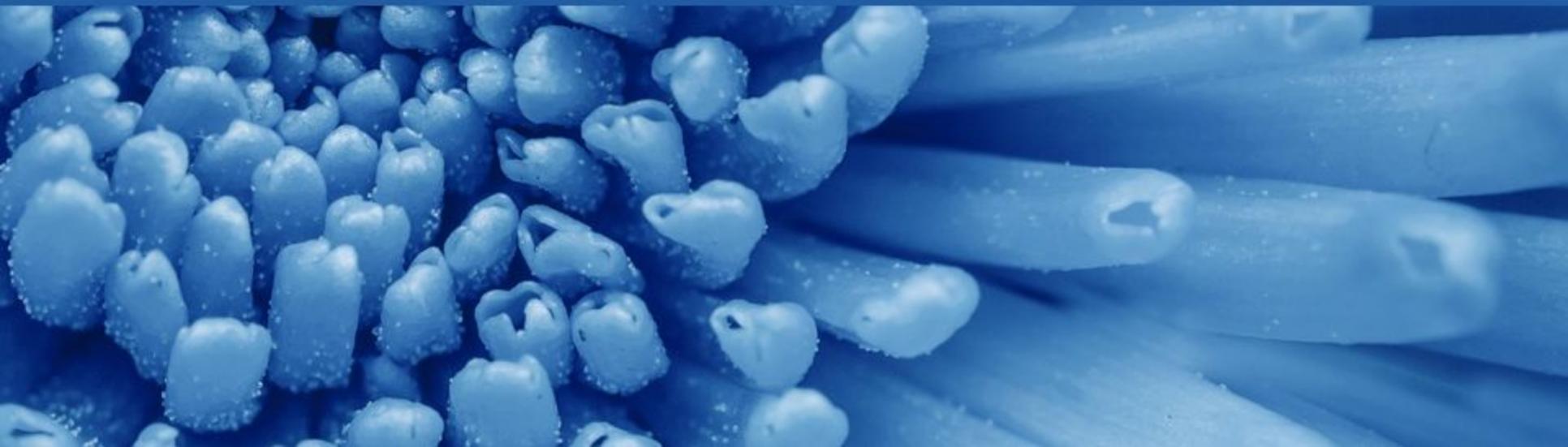
<https://arstechnica.com/gaming/2016/06/an-ai-wrote-this-movie-and-its-strangely-moving/>

Was Neuronale Netzwerke bislang erreicht haben...

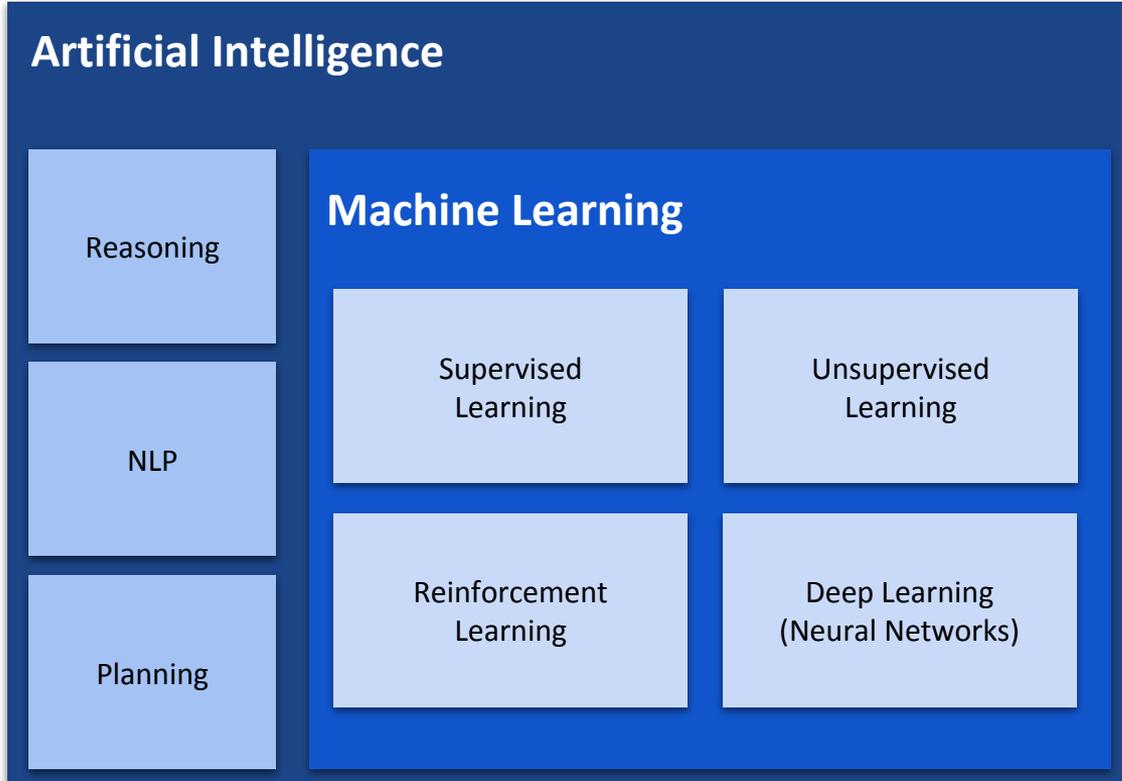
- **Bildklassifikation** - fast so gut und z.T. sogar besser als der Mensch
- **Bildmanipulation** - besser als der Mensch
- **Spracherkennung** - fast so gut wie der Mensch
- **Handschrifterkennung** - fast so gut wie der Mensch
- **Maschinelle Übersetzungen** - signifikante Verbesserungen
- **Spracherzeugung** - signifikante Verbesserungen
- **Digitale Assistenten**, wie z.B. Google Now oder Amazon Alexa
- **Autonomes Fahren** - fast so gut wie der Mensch
- **Go spielen** - viel besser als der Mensch

**“Erste Regel der Magie:
Niemand darf Deinen wahren Namen kennen...”**

Neil Gaiman, The invisible Labyrinth (1990)



Künstliche Intelligenz und Maschinelles Lernen



“Das Ziel der KI ist es, Maschinen zu entwickeln, die sich so verhalten, als wären sie intelligent.”

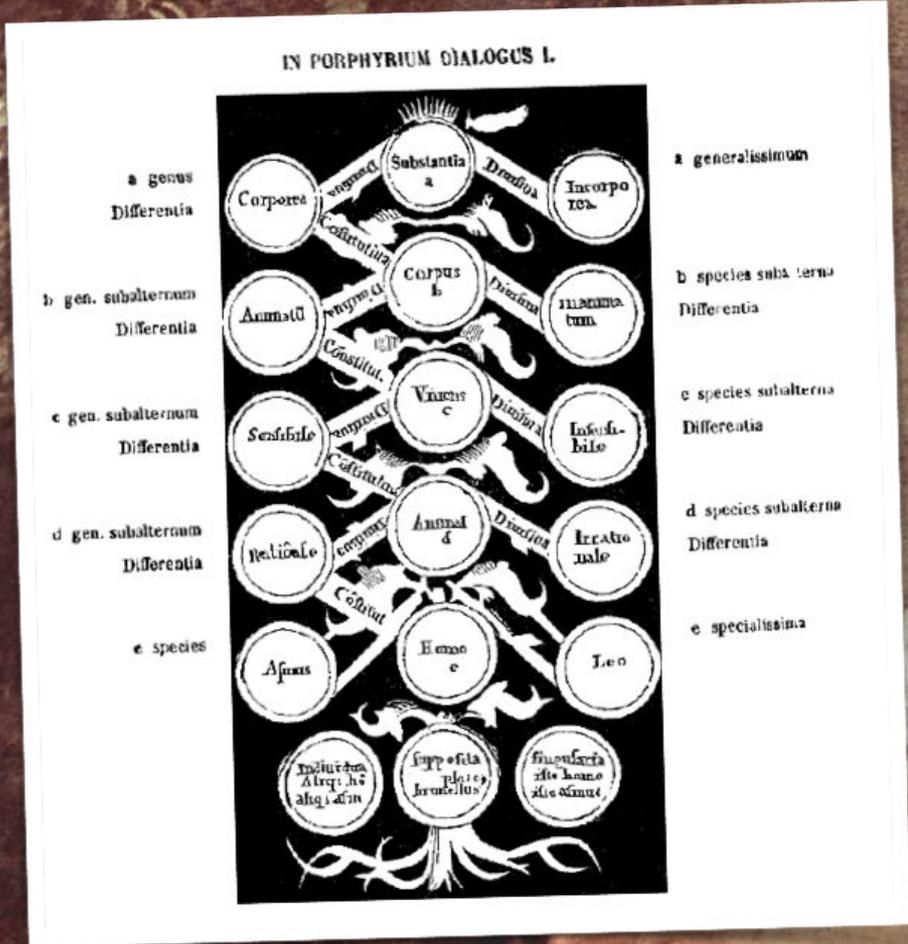
- John McCarthy (1955)

P A R E N T A L

ADVISORY

EXPLICIT SEMANTICS

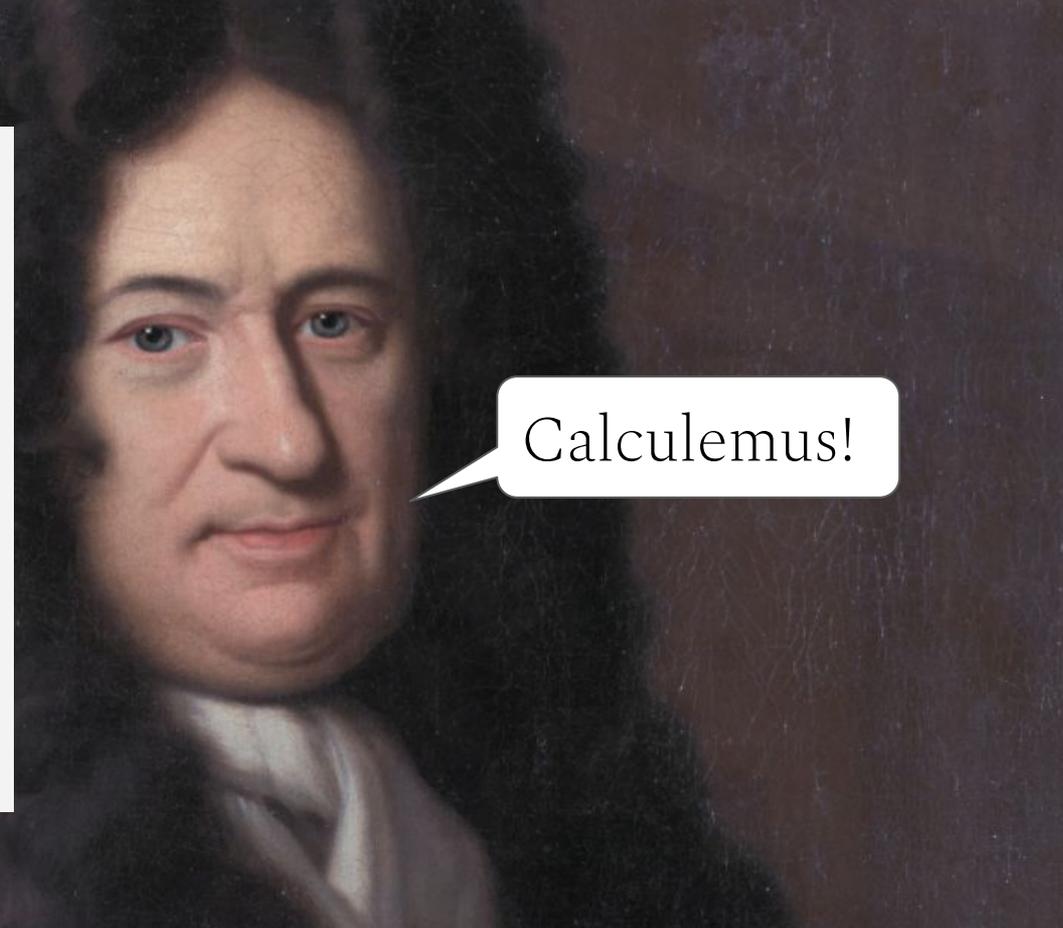
Die Kategorien - Aristoteles (384–322 v. Chr.)



Calculus Ratiocinator - Gottfried Wilhelm Leibniz (1646-1716)

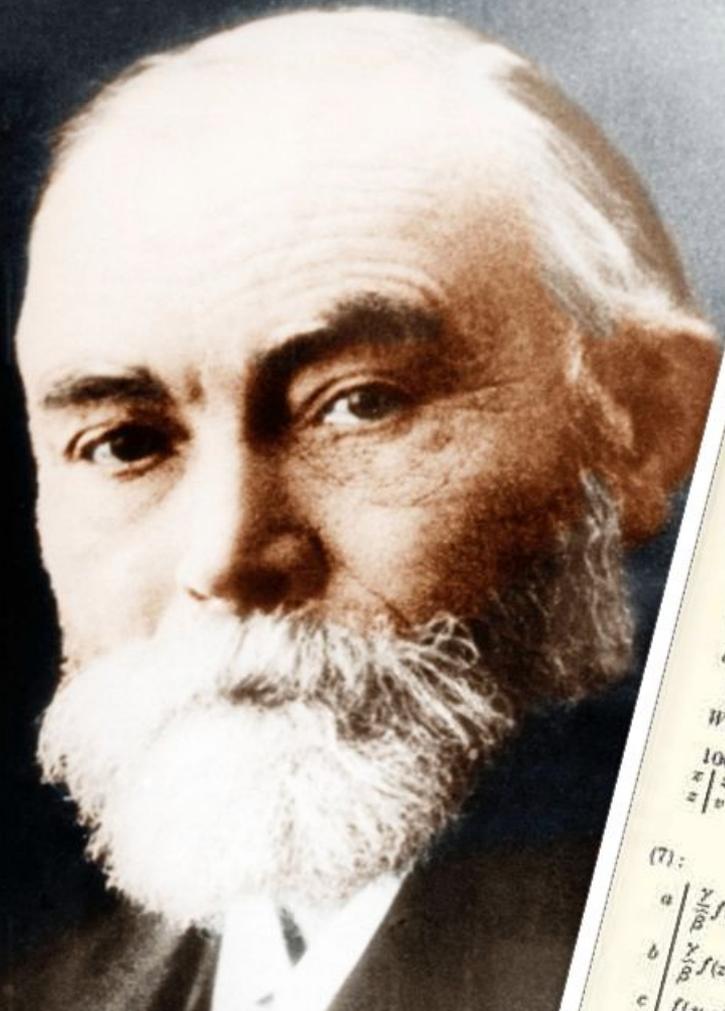
*„...alle menschlichen Schlussfolgerungen müssten auf irgendeine mit Zeichen arbeitende Rechnungsart zurückgeführt werden, wie es sie in der Algebra und Kombinatorik und mit den Zahlen gibt, wodurch nicht nur mit einer unzweifelhaften Kunst die menschliche Erfindungsgabe gefördert werden könnte, sondern auch viele Streitigkeiten beendet werden könnten, das Sichere vom Unsicheren unterschieden und selbst die Grade der Wahrscheinlichkeiten abgeschätzt werden könnten, da ja der eine der im Disput Streitenden zum anderen sagen könnte: **Lasst uns doch nachrechnen!***

Leibniz in einem BRef an Ph. J. Spener, Juli 1687

A portrait of Gottfried Wilhelm Leibniz, a German philosopher, mathematician, and scientist. He is shown from the chest up, wearing a dark coat and a white cravat. He has long, dark, wavy hair and is looking slightly to the right of the viewer with a neutral expression.

Calculemus!

Begriffsschrift - Gottlob Frege (1848-1925)



71

BEGRIFFSSCHRIFT

(55) ::

$$\begin{array}{l} d \\ \hline c \end{array} \left| \begin{array}{l} x \\ z \end{array} \right.$$

$$\begin{array}{l} \hline \left[\begin{array}{l} (x \equiv z) \\ \gamma \\ \beta \end{array} \right] f(x, z) \\ \hline \gamma \\ \beta \end{array} \right] f(x, z)$$

§ 30. 99

(52):

$$\begin{array}{l} f(I) \\ \hline c \end{array} \left| \begin{array}{l} \Gamma \\ \left[\begin{array}{l} (z \equiv x) \\ \gamma \\ \beta \end{array} \right] f(x, z) \\ \gamma \\ \beta \end{array} \right. \right.$$

$$\left[\left[\begin{array}{l} (z \equiv x) \\ \gamma \\ \beta \end{array} \right] f(x, z) \right] \equiv \frac{\gamma}{\beta} f(x, z)$$

(37):

$$\begin{array}{l} a \\ \hline b \\ \hline c \end{array} \left| \begin{array}{l} \frac{\gamma}{\beta} f(x, z) \\ (z \equiv x) \\ \frac{\gamma}{\beta} f(x, z) \end{array} \right.$$

$$\begin{array}{l} \hline \left[\begin{array}{l} \gamma \\ \beta \end{array} \right] f(x, z) \\ \hline (z \equiv x) \\ \gamma \\ \beta \end{array} \right] f(x, z)$$

(104).

$$\begin{array}{l} \hline \left[\begin{array}{l} \gamma \\ \beta \end{array} \right] f(x, z) \\ \hline \left[\begin{array}{l} \gamma \\ \beta \end{array} \right] f(x, z) \end{array}$$

(105).

Whatever follows x in the f -sequence belongs to the f -sequence beginning with x .

$$\begin{array}{l} 106 \\ x \\ \hline z \\ \hline v \end{array}$$

$$\begin{array}{l} \hline \left[\begin{array}{l} \gamma \\ \beta \end{array} \right] f(z, v) \\ \hline \left[\begin{array}{l} \gamma \\ \beta \end{array} \right] f(z, v) \end{array}$$

(7):

$$\begin{array}{l} a \\ \hline b \\ \hline c \end{array} \left| \begin{array}{l} \frac{\gamma}{\beta} f(z, v) \\ \frac{\gamma}{\beta} f(z, v) \\ f(z, v) \end{array} \right.$$

$$\begin{array}{l} \hline \left[\begin{array}{l} \gamma \\ \beta \end{array} \right] f(z, v) \\ \hline \left[\begin{array}{l} \gamma \\ \beta \end{array} \right] f(z, v) \end{array}$$

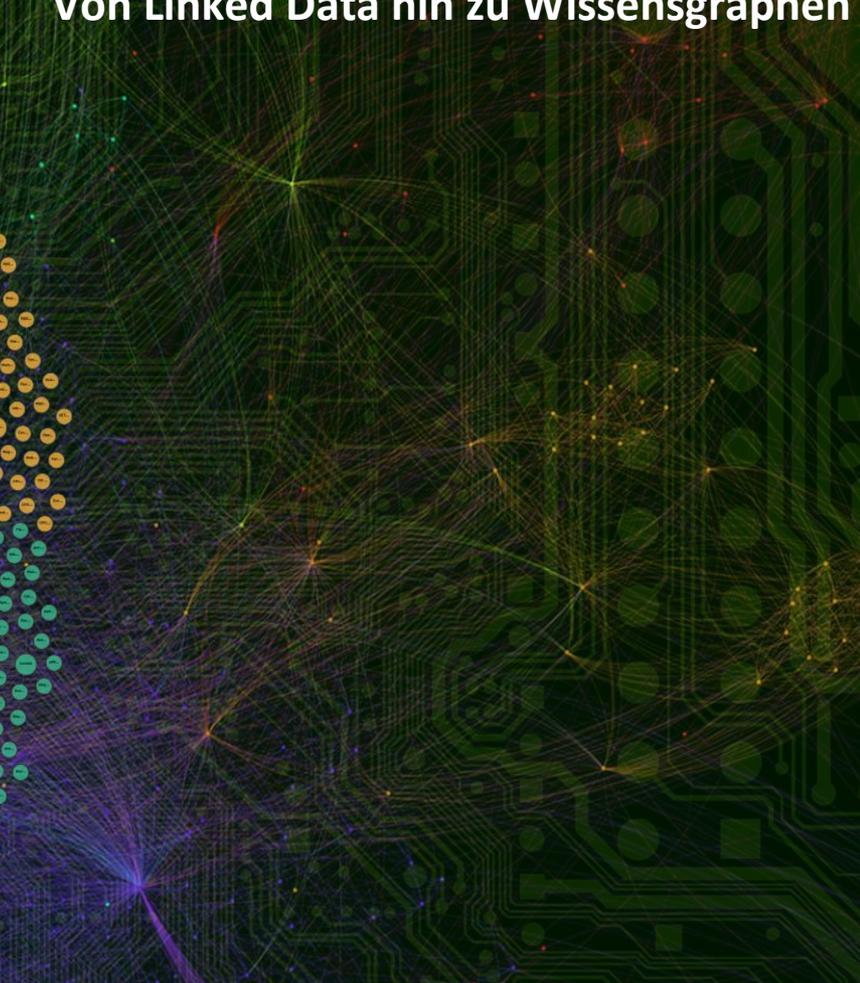
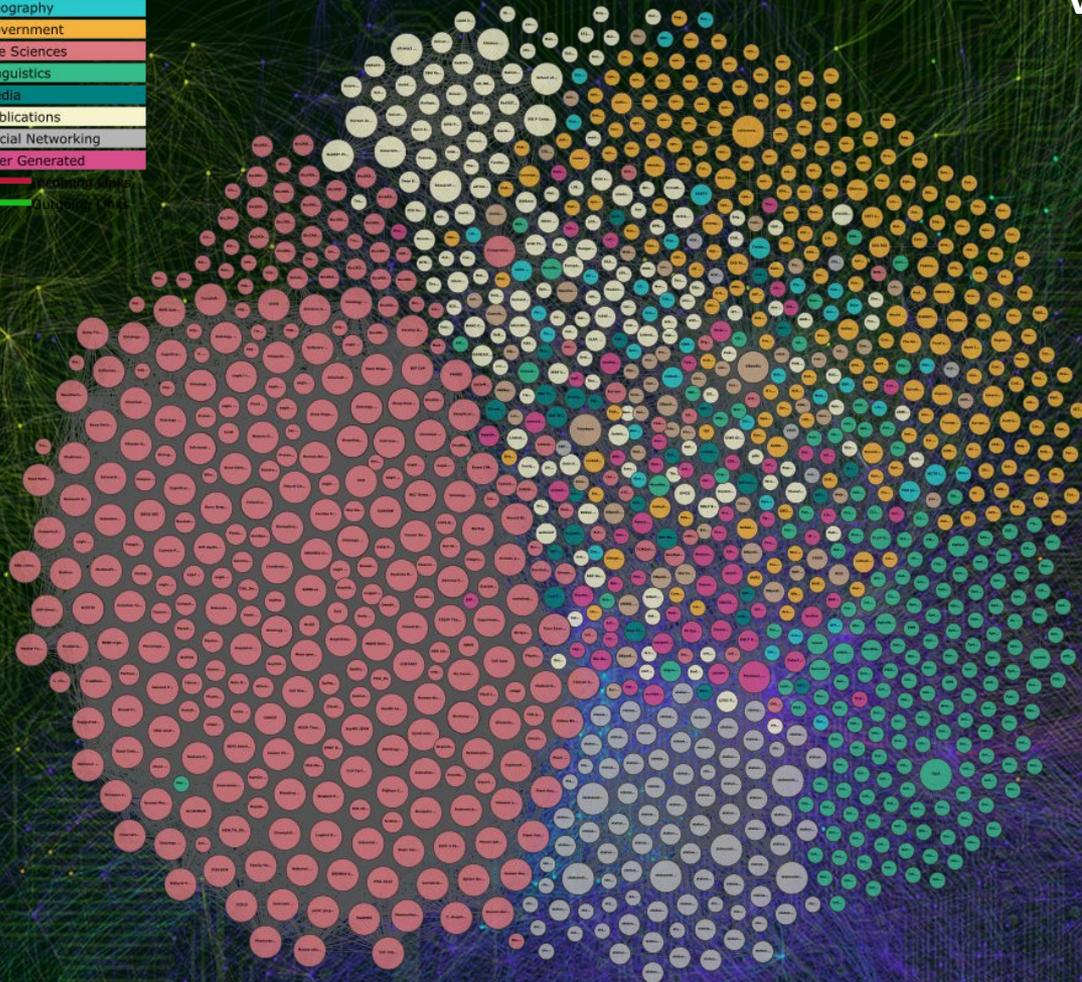
(106).

Wissensrepräsentation mit Frames - Marvin Minsky (1974)



Von Linked Data hin zu Wissensgraphen

- Cross Domain
- Geography
- Government
- Life Sciences
- Linguistics
- Media
- Publications
- Social Networking
- User Generated
- Education
- Healthcare

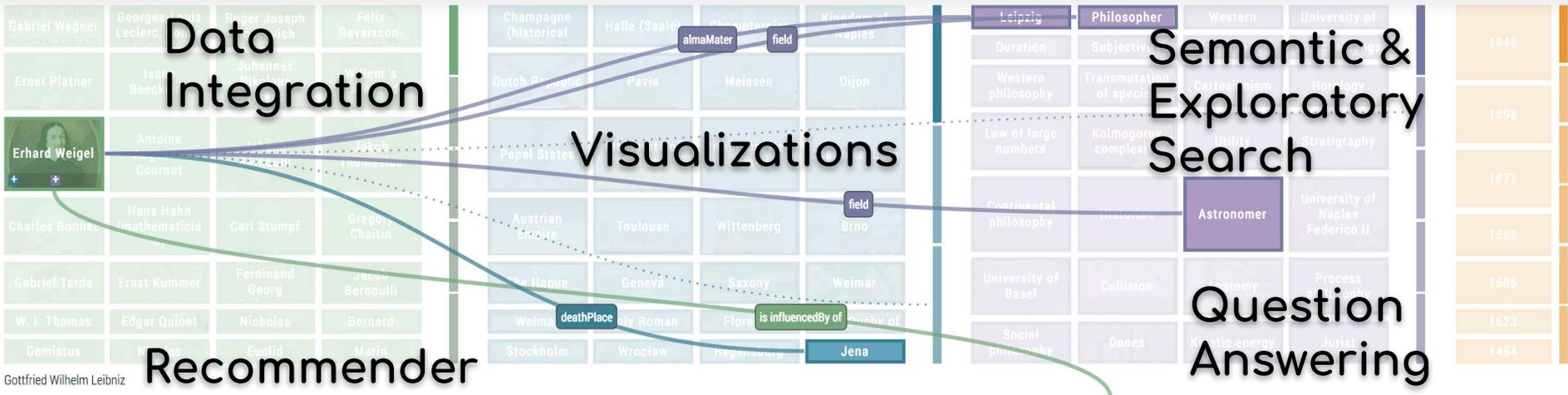


Wissensgraph basierte Anwendungen



T. Tietz, J. Jäger, J. Waitelonis, H. Sack, *Semantic Annotation and Information Visualization for Blogposts with refer*, (VOILA 2016)

Relation Browser Timeline



Recommender Systems

15 Recommended Articles

- #1 The Case of J. Robert Oppenheimer
- #2 Wilhelm Pfeffer and Plant Physiology
- #3 Karl Pearson and Mathematical Statistics
- #4 Raphael and the School of Athens
- #5 Jerzy Neyman – Architect of Modern Theoretical Statistics
- #6 Christian Gottfried Ehrenberg – Father of Microzoology

Gottfried Wilhelm Leibniz

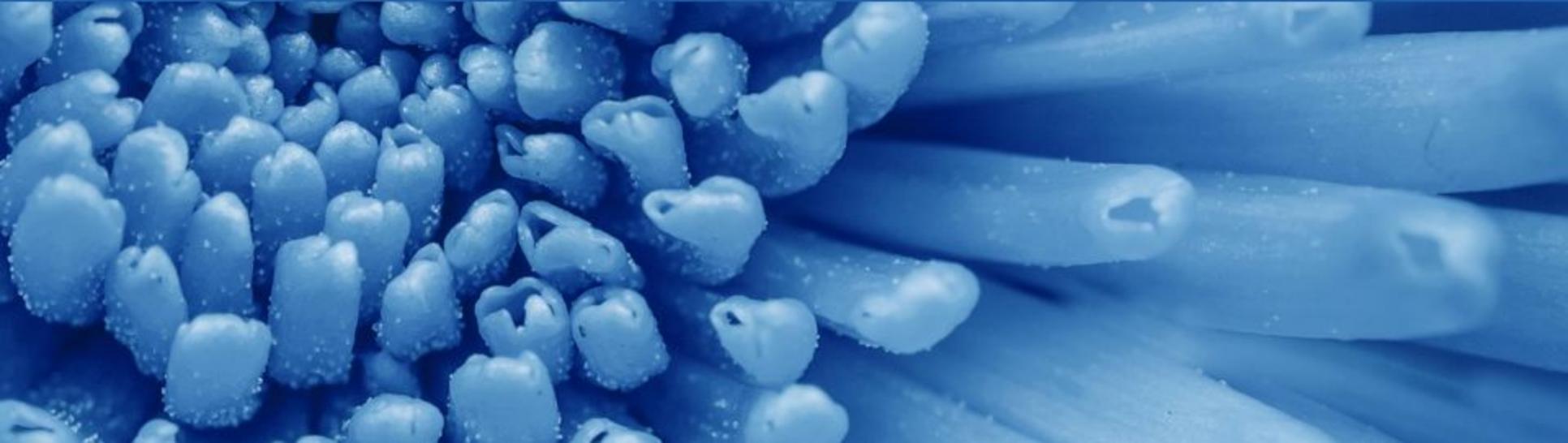


Gottfried Wilhelm von Leibniz (German: [ˈɡɔʦfʁiːt ˈvɪlhɛlm fɔn ˈlaɪbnɪtʃ] or [ˈlaɪpnɪtʃ]) (July 1, 1646 – November 14, 1716) was a German mathematician and philosopher. He occupies a prominent place in the history of mathematics and the history of philosophy. Leibniz developed the infinitesimal calculus independently of Isaac Newton, and Leibniz's mathematical notation has been widely used ever since it was published. It was only in the 20th century that his Law of Continuity and Transcendental Law of Homogeneity found mathematical implementation (by means of non-standard analysis). He became one of the most prolific inventors in the field of mechanical calculators. While working on adding automatic multiplication and division to Pascal's calculator, he was the first to describe a pinwheel calculator in 1685 and invented the Leibniz wheel, used

DBpedia: Gottfried Wilhelm Leibniz

“There ain’t no such thing as a free Lunch.”

Robert A. Heinlein, The Moon is a Harsh Mistress (1966)

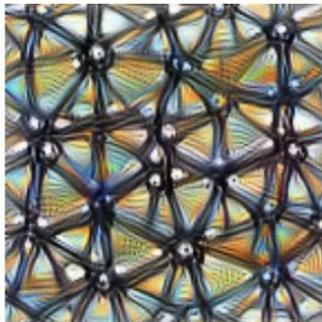


Was sehen Neuronale Netze tatsächlich?



Neuron

`layern[x,y,z]`



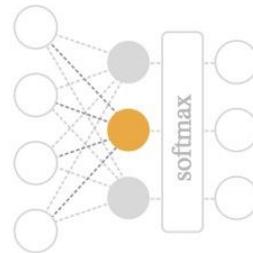
Channel

`layern[:, :, z]`



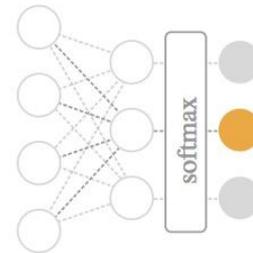
Layer/DeepDream

`layern[:, :, :]2`



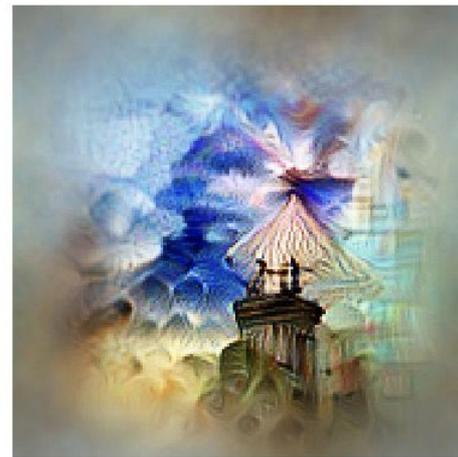
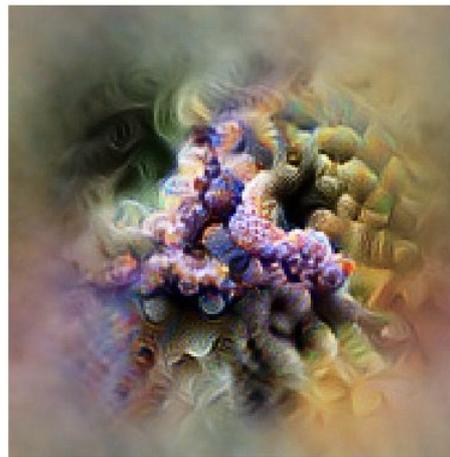
Class Logits

`pre_softmax[k]`



Class Probability

`softmax[k]`



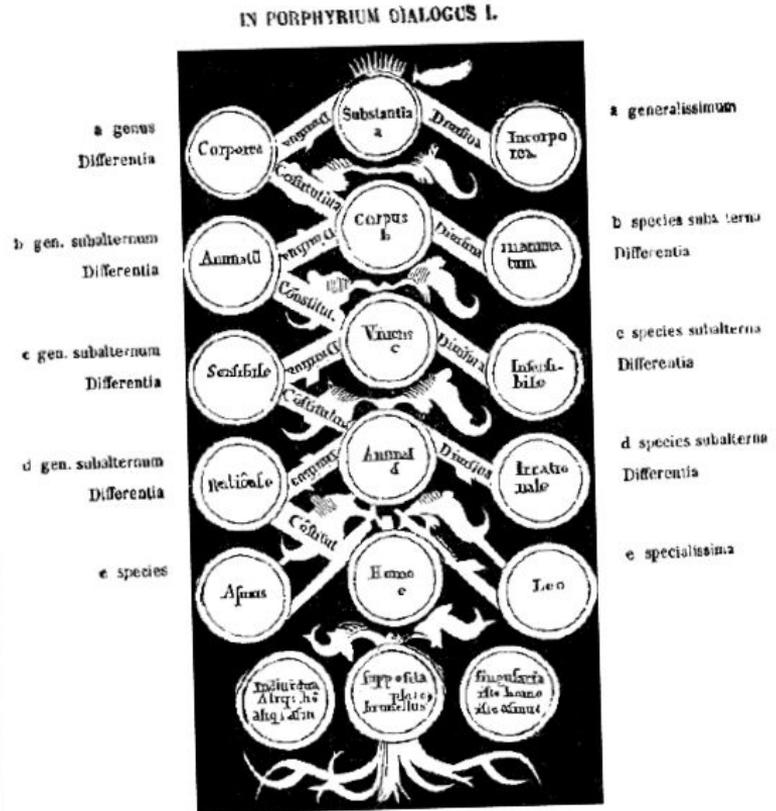
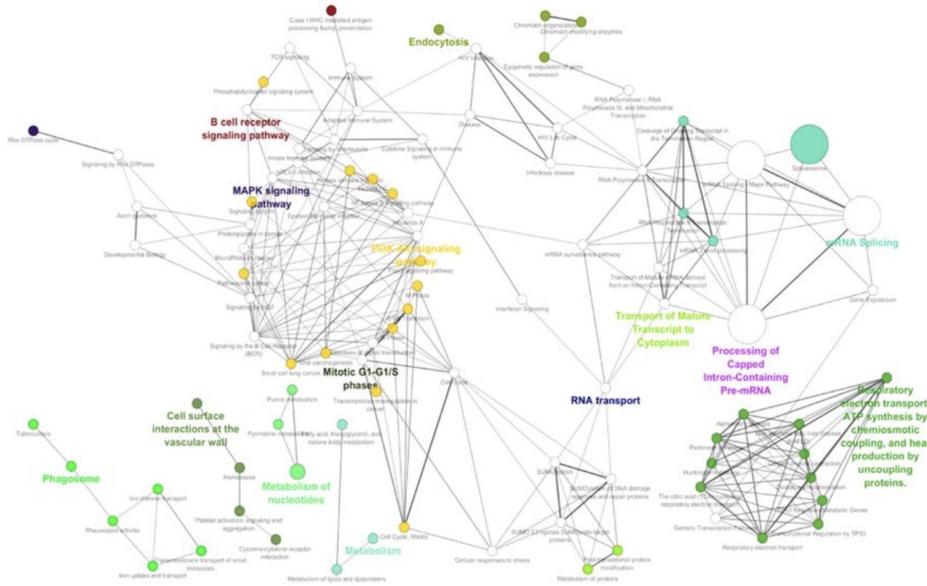
Baseball—or stripes?

Animal faces—or snouts?

Clouds—or fluffiness?

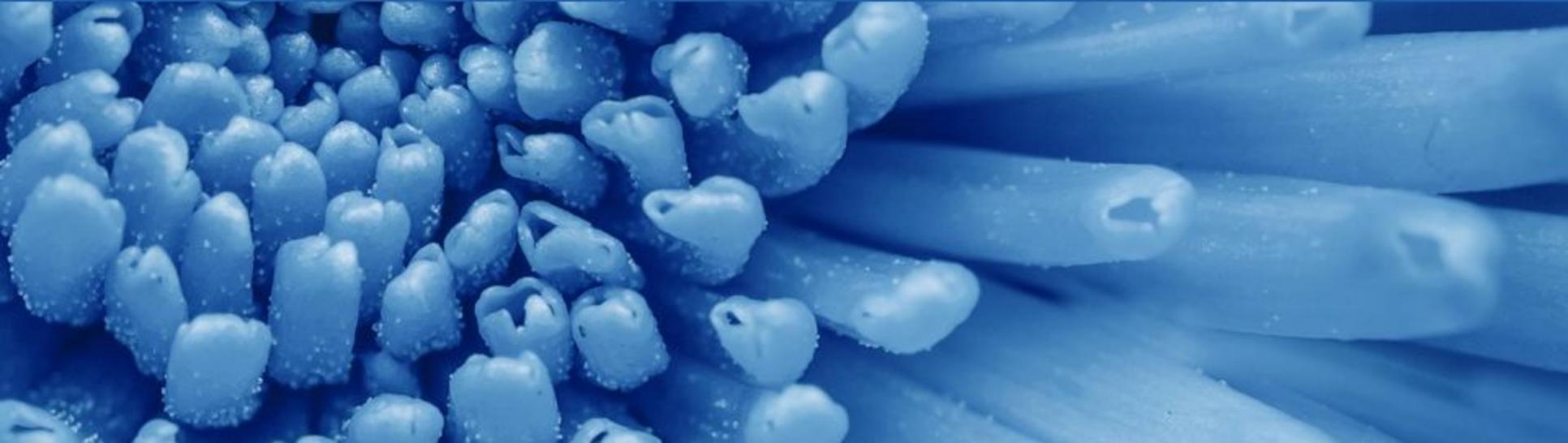
Buildings—or sky?

Wissensgraphen: Lokale Details vs. Globale Abdeckung



**“90% aller Magie besteht lediglich darin,
einen einzigen zusätzlichen Fakt mehr zu kennen.”**

Terry Pratchett, Night Watch (2002)



Generative Adversarial Networks - Beispiel

Text description

This bird is blue with white and has a very short beak

This bird has wings that are brown and has a yellow belly

A white bird with a black crown and yellow beak

This bird is white, black, and brown in color, with a brown beak

The bird has small beak, with reddish brown crown and gray belly

This is a small, black bird with a white breast and white on the wingbars.

This bird is white black and yellow in color, with a short black beak

Stage-I images



Stage-II images



Han Zhang, Tao Xu, Hongsheng Li, Shaoting Zhang, Xiaogang Wang, Xiaolei Huang, Dimitris N. Metaxas:

[StackGAN++: Realistic Image Synthesis with Stacked Generative Adversarial Networks.](#)

CoRR abs/1710.10916 (2017)

Generative Adversarial Networks - Beispiel

This is a small light gray bird with a small head and green crown nape and some green coloring on its wings



Han Zhang, Tao Xu, Hongsheng Li, Shaoting Zhang, Xiaogang Wang, Xiaolei Huang, Dimitris N. Metaxas:

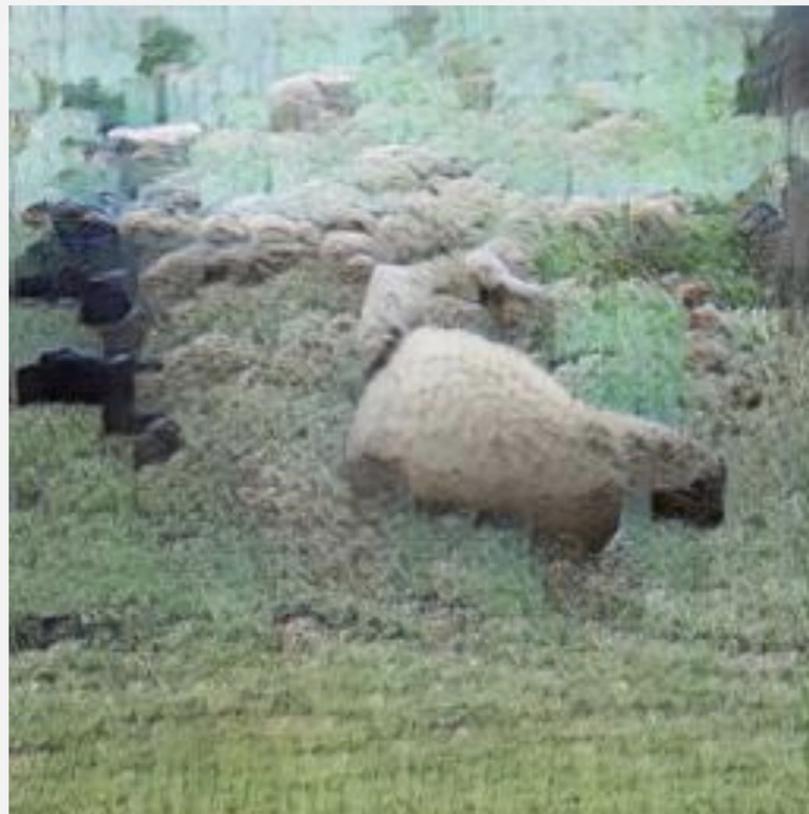
[StackGAN++: Realistic Image Synthesis with Stacked Generative Adversarial Networks.](#)

CoRR abs/1710.10916 (2017)

Versuchen wir einmal etwas Allgemeineres ...



A flock of sheep on green meadows



<http://t2i.cvalenzuelab.com/>

Concerto for a rainy day



<http://t2i.cvalenzuelab.com/>

a girl watching tv



<http://t2i.cvalenzuelab.com/>

a girl with
two blue eyes,
one upturned
nose, and a
red mouth

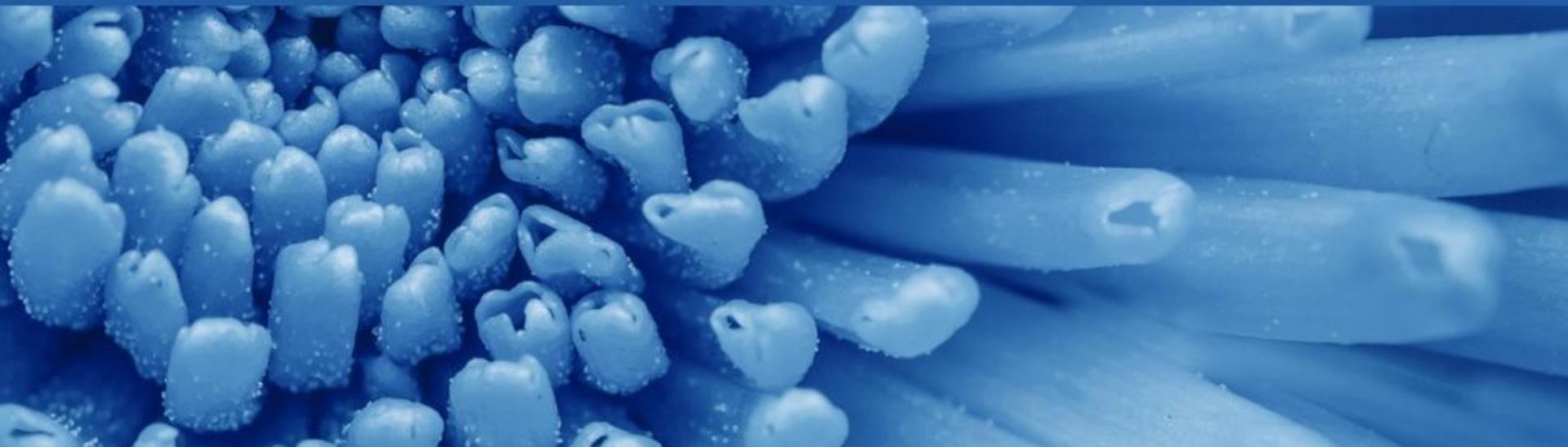


<http://t2i.cvalenzuelab.com/>

melting clocks over the dessert



Quo vadis KI?



Quo vadis KI?

- **Langfristige Ziele:**
 - Effiziente Kombination von **Semantik** (symbolische Logik) mit **Neuronalen Netzwerken** (Neuro-Symbolic Integration)
- **Kurzfristige Ziele:**
 - **Wissensgraphen:** Nicht alles muss notwendigerweise explizit repräsentiert werden
 - **Deep Learning:** Versuche, das Implizite explizit zu machen

Ethische Fragen der Künstlichen Intelligenz

- Autonome Maschinen
- Tendenzen, Diskriminierung und Ausschluss
- Algorithmisches Profiling von Menschen
- Verhinderung der Ansammlung riesiger Datenmengen für maschinelles Lernen
- Herausforderungen bei der Auswahl von Daten in Qualität, Quantität und Relevanz
- Menschliche Identität im KI-Zeitalter (Maschinenethik)

**“Wenn im ersten Akt ein Gewehr an der Wand hängt,
dann wird es im letzten Akt abgefeuert.”**

Tschechows Gesetz, (Anton Tschechow, 1889)

Prof. Dr. Harald Sack

*Ich sehe was, was Du nicht siehst -
Aktuelle Möglichkeiten und Grenzen der
Künstlichen Intelligenz*

DGI Praxistage 2018
Frankfurt, 09.11.2018

