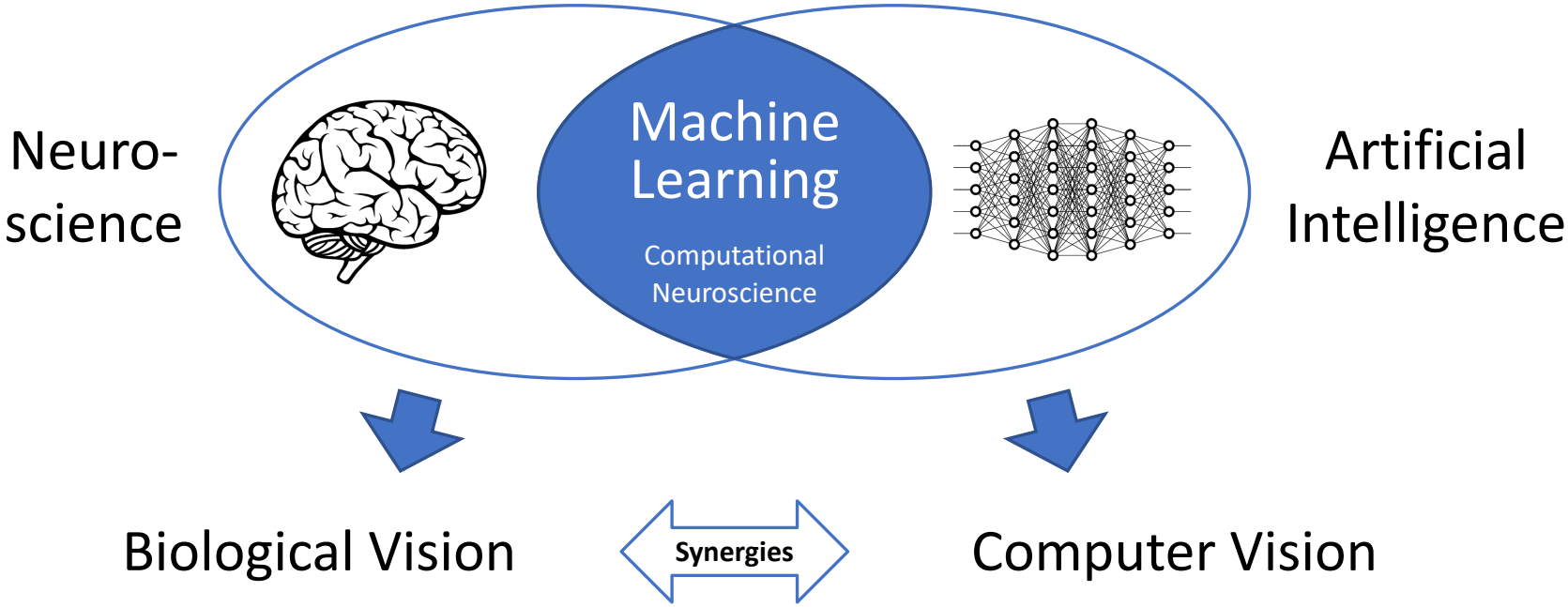
Visuelle Wahrnehmung von Mensch und Maschine: Gemeinsamkeiten und Unterschiede

Alexander Ecker
Uni Tübingen

alxecker

https://alexanderecker.wordpress.com

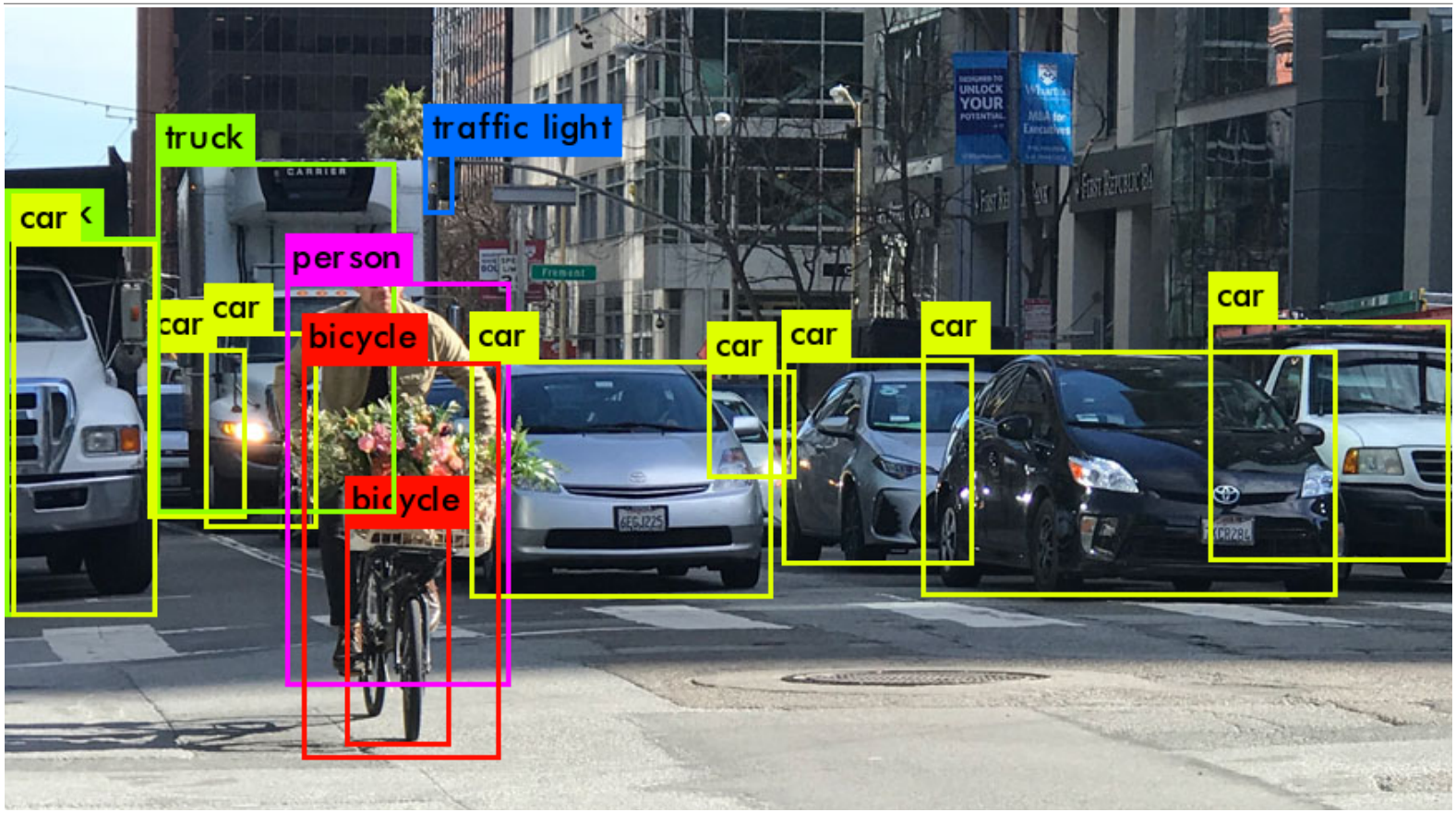
Algorithms of vision in brains and machines



Die KI-Revolution

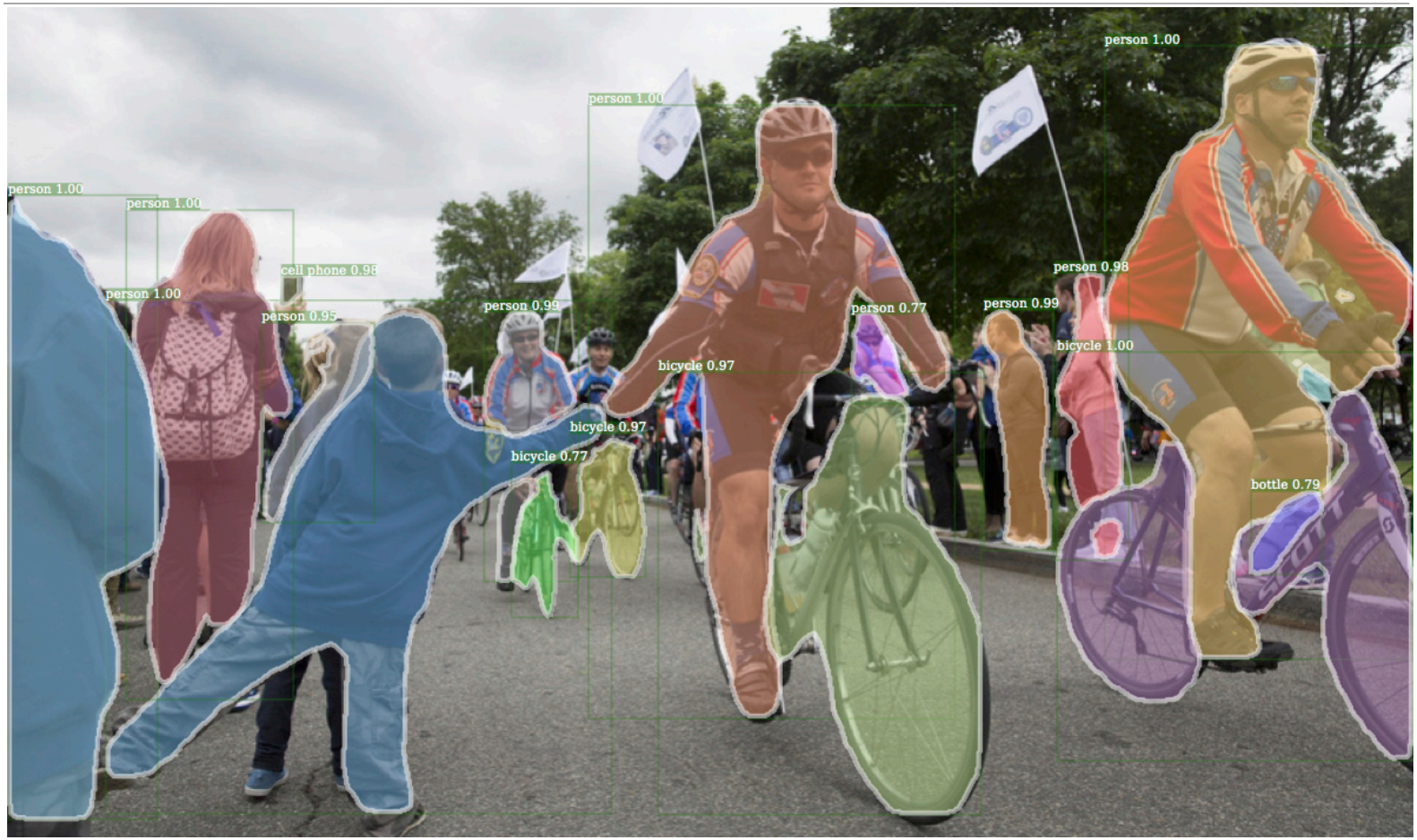
2012 – HEUTE

Objekterkennung



https://medium.com/@jonathan_hui/real-time-object-detection-with-yolo-yolov2-28b1b93e2088

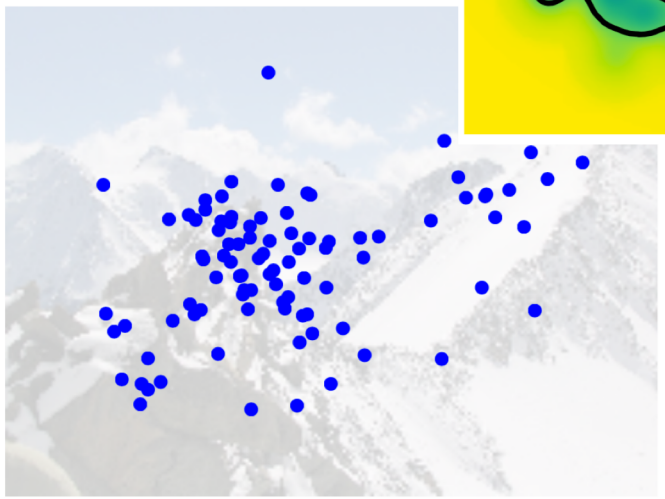
Segmentierung



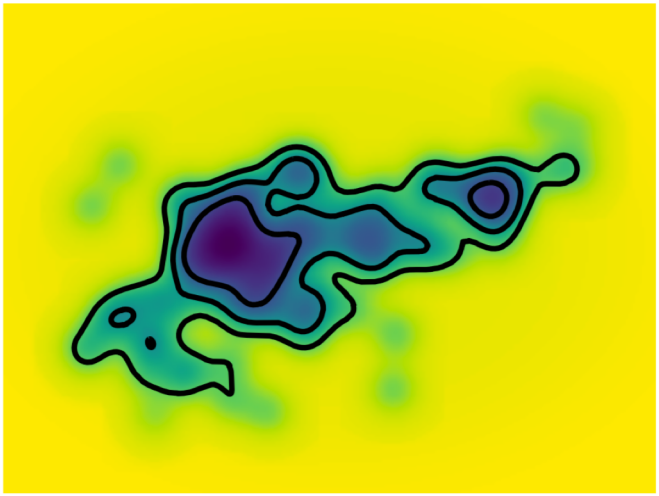
https://github.com/facebookresearch/Detectron

Vorhersage von Augenbewegungen

Bild



Augenpositionen



“Saliency map”

Kümmerer, Theis, Bethge, 2015, ICLR Workshop

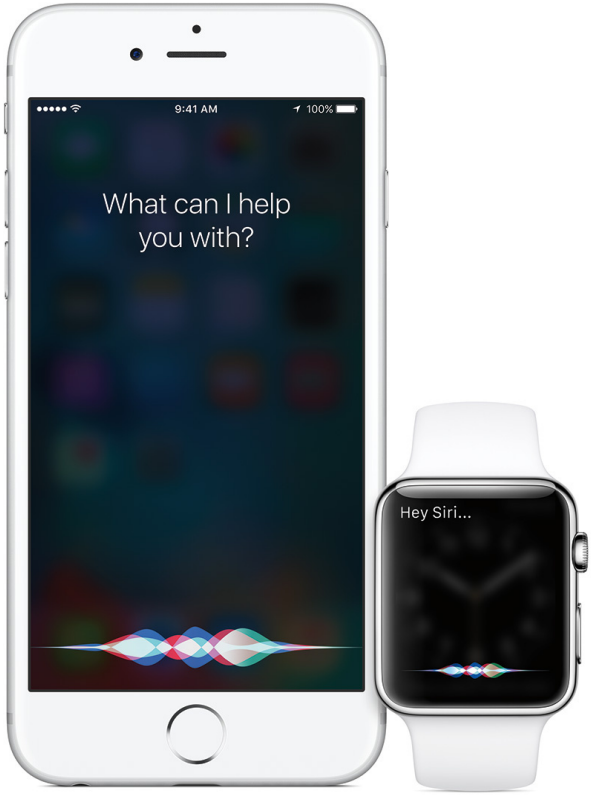
Smart cropping: Twitter

Vorher: Bildmitte

Jetzt: Smart Crop durch neuronalem Netz

Lucas Theis @ Twitter
Kümmerer, Theis, Bethge, 2015, ICLR Workshop

Spracherkennung: Siri, Alexa etc.



Automatische Übersetzung

DeepL | Translator | Linguee | DeepL Pro | Blog | Info

Translate from **German** (detected)

Die Europäische Zentralbank hat das Ende ihrer Anleihenkäufe beschlossen. Nur noch bis zum Jahresende will die Notenbank zusätzliche Milliarden in Wertpapiere von Staaten und Unternehmen stecken, wie die EZB am Donnerstag in Frankfurt mitteilte. Anschließend lässt sie das Programm auslaufen.

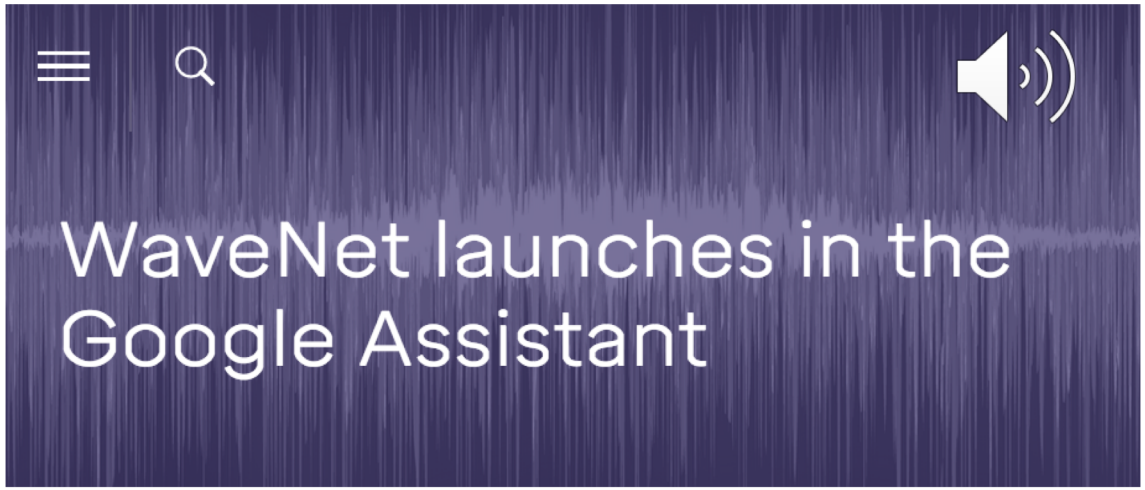
Translate document

Translate into **English**

The European Central Bank has decided to end its bond purchases. Only until the end of the year does the central bank intend to invest additional billions in securities of states and companies, as the ECB announced in Frankfurt on Thursday. It will then phase out the programme.

https://deepl.com

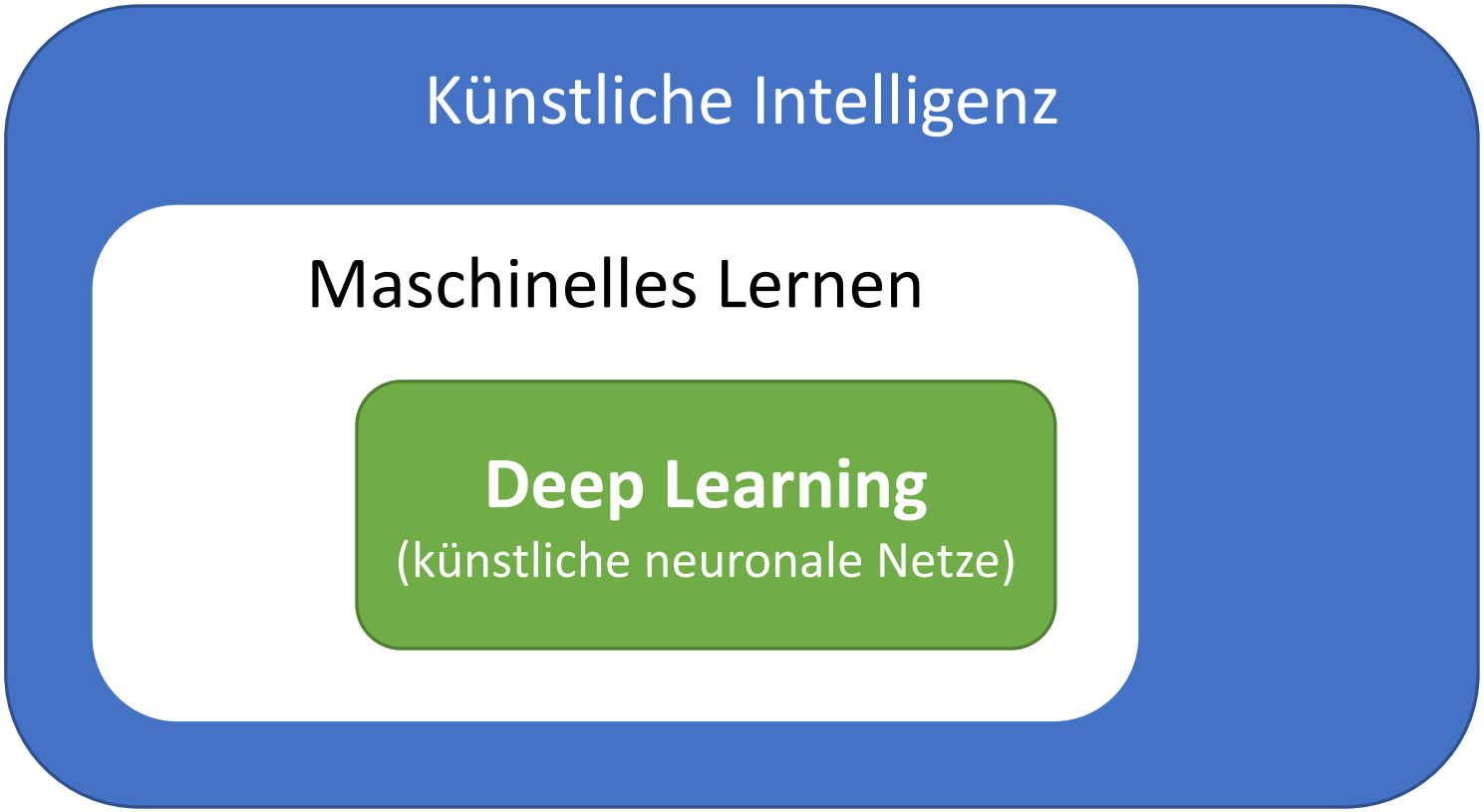
Sprachsynthese



Just over a year ago we presented WaveNet, a new deep neural network for generating raw audio waveforms that is capable of producing better and more realistic-sounding speech than existing techniques. At that time, the model was a research prototype and was too computationally intensive to work in consumer products.

https://deepmind.com/blog/wavenet-launches-google-assistant/

Fortschritte in der KI primär durch Neuronale Netze / Deep Learning



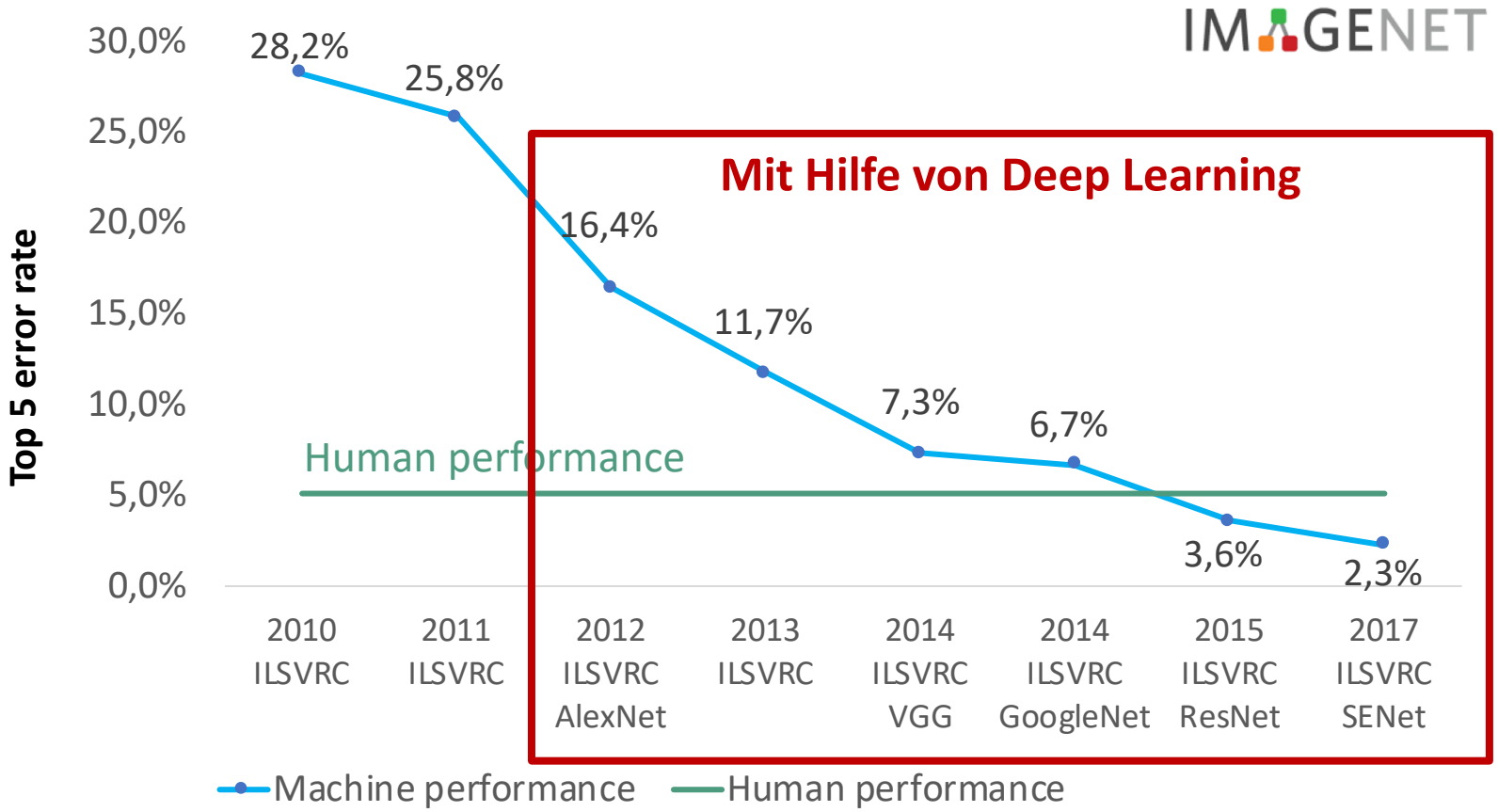
Objekterkennung: IMAGENET

Datensatz mit Benchmark zur Klassifikation von Bildern

- 1 Million Bilder mit “ground truth labels” zum Training (von Hand annotiert)
- 1000 Objektkategorien

Deng et al., CVPR 2009

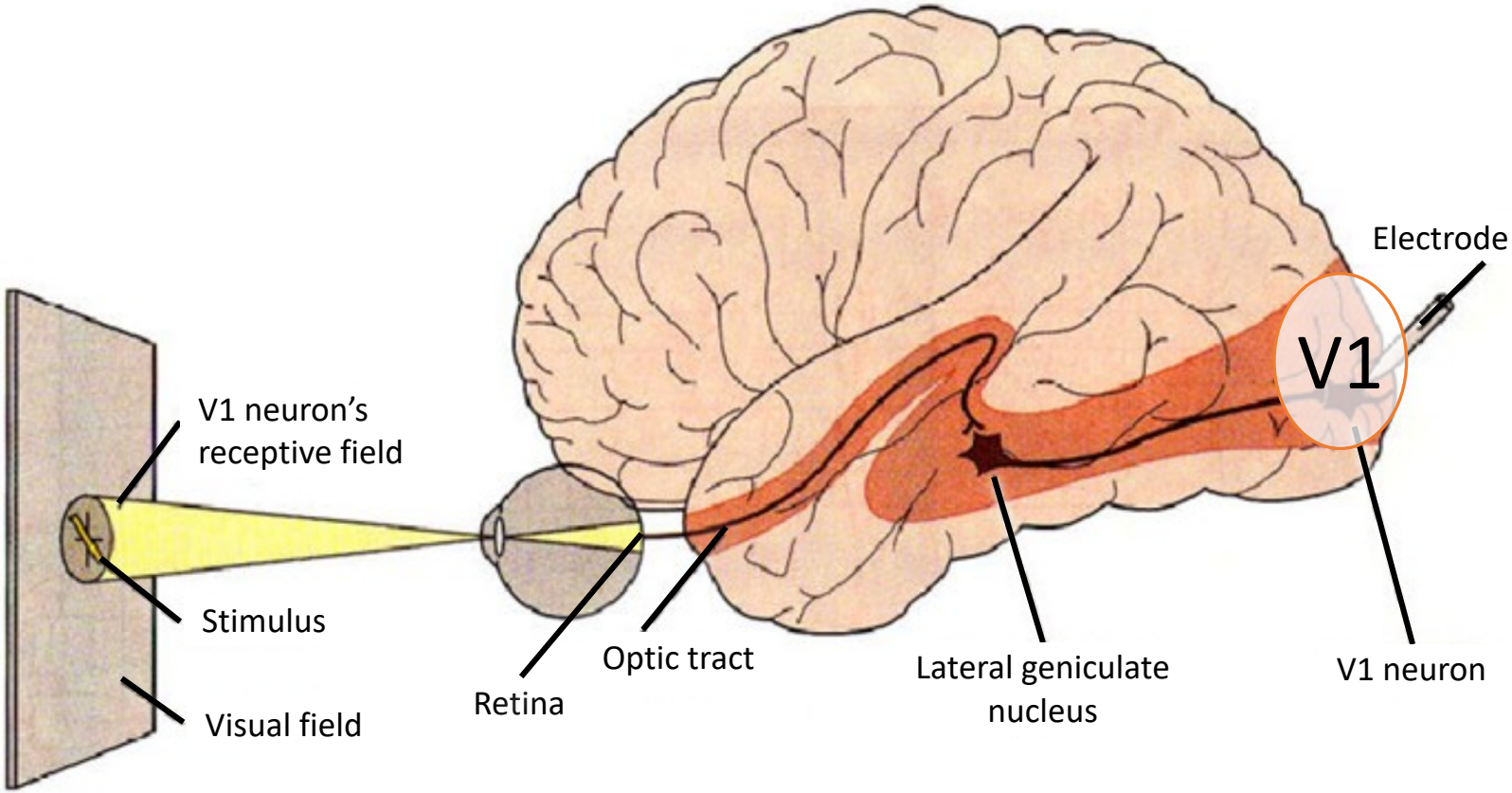
Die KI Revolution: Neuronale Netze



Wie funktionieren neuronale Netze?

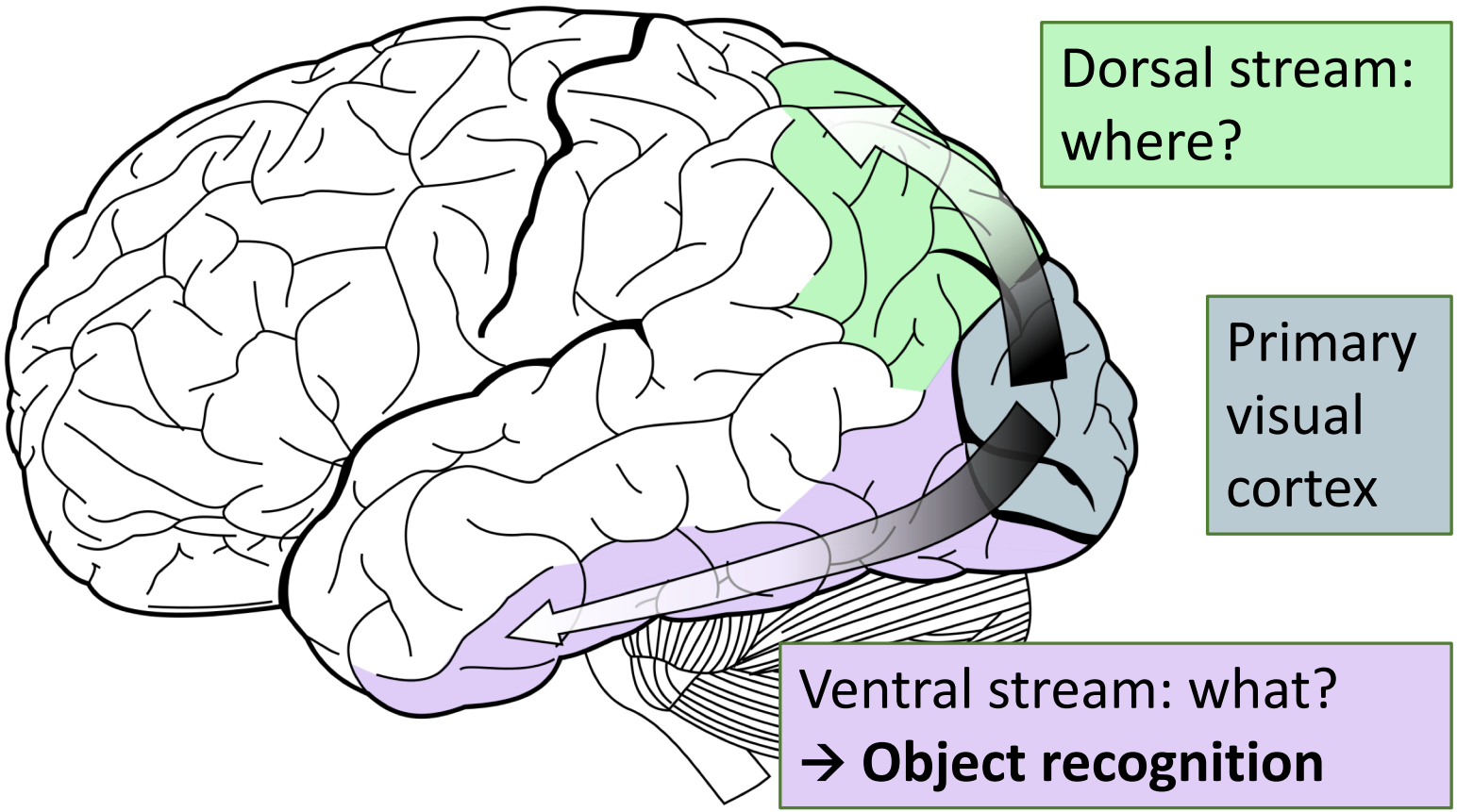
VOM GEHIRN ZUM KÜNSTLICHEN NEURONALEN NETZ

Vom Auge zum Kortex



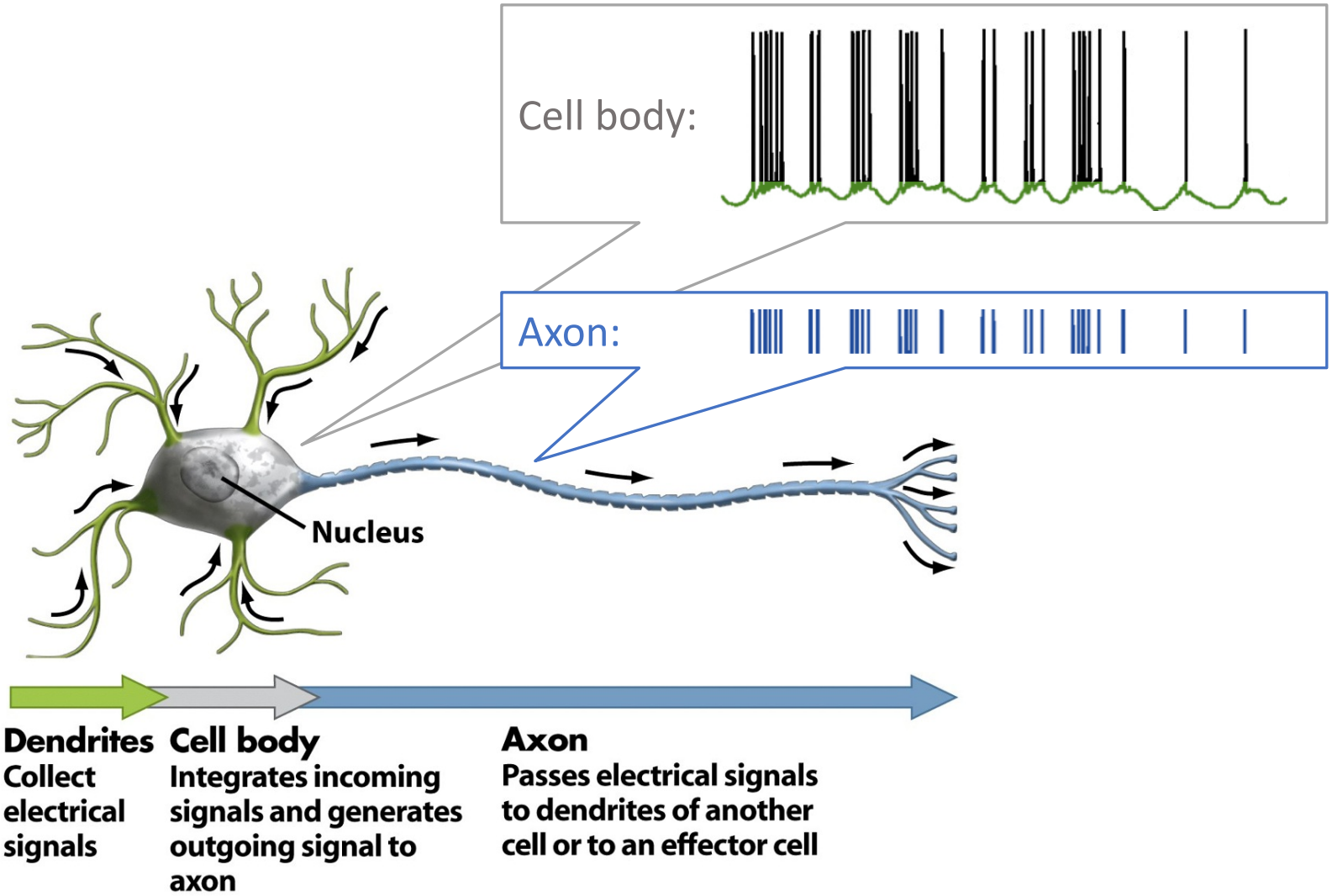
V1 = Primary visual cortex

The visual system: two streams



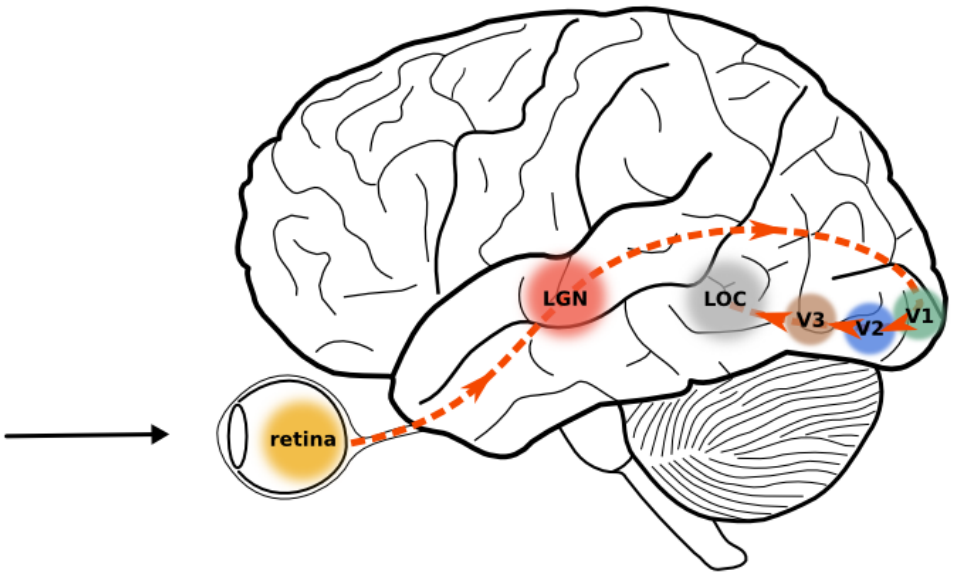
https://en.wikipedia.org/wiki/Two-streams_hypothesis

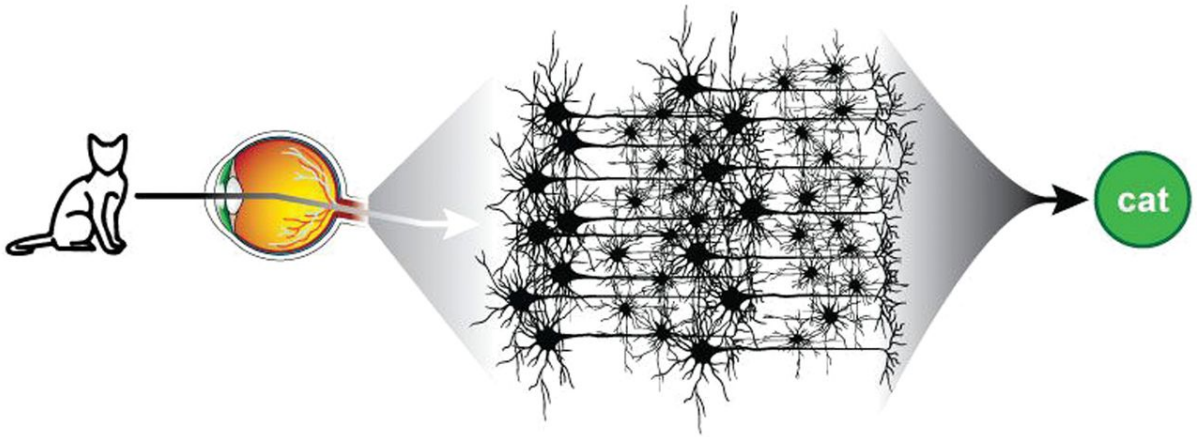
How do neurons communicate?



https://www.thinglink.com/scene/762090261831483394

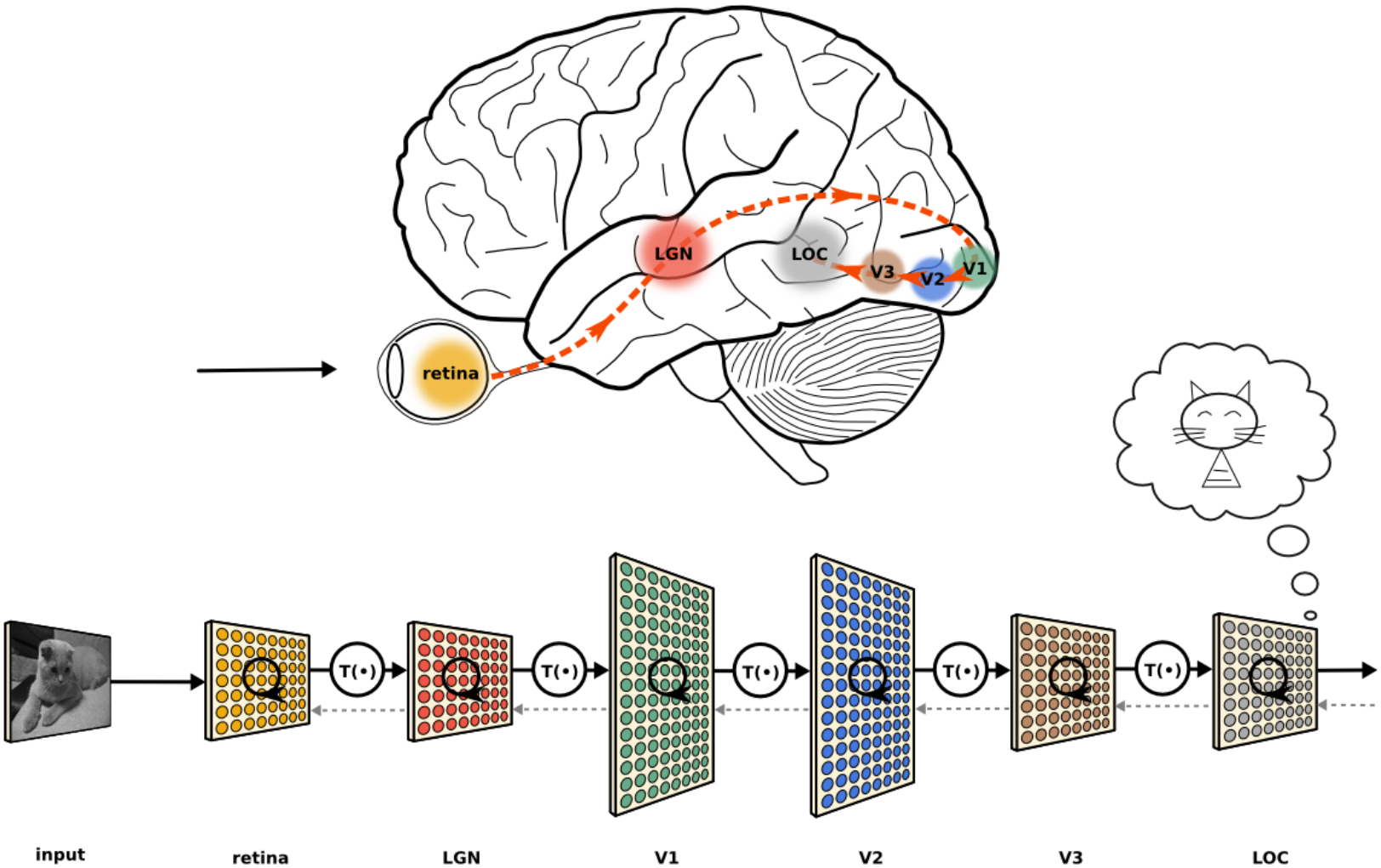
Hierarchische Datenverarbeitung





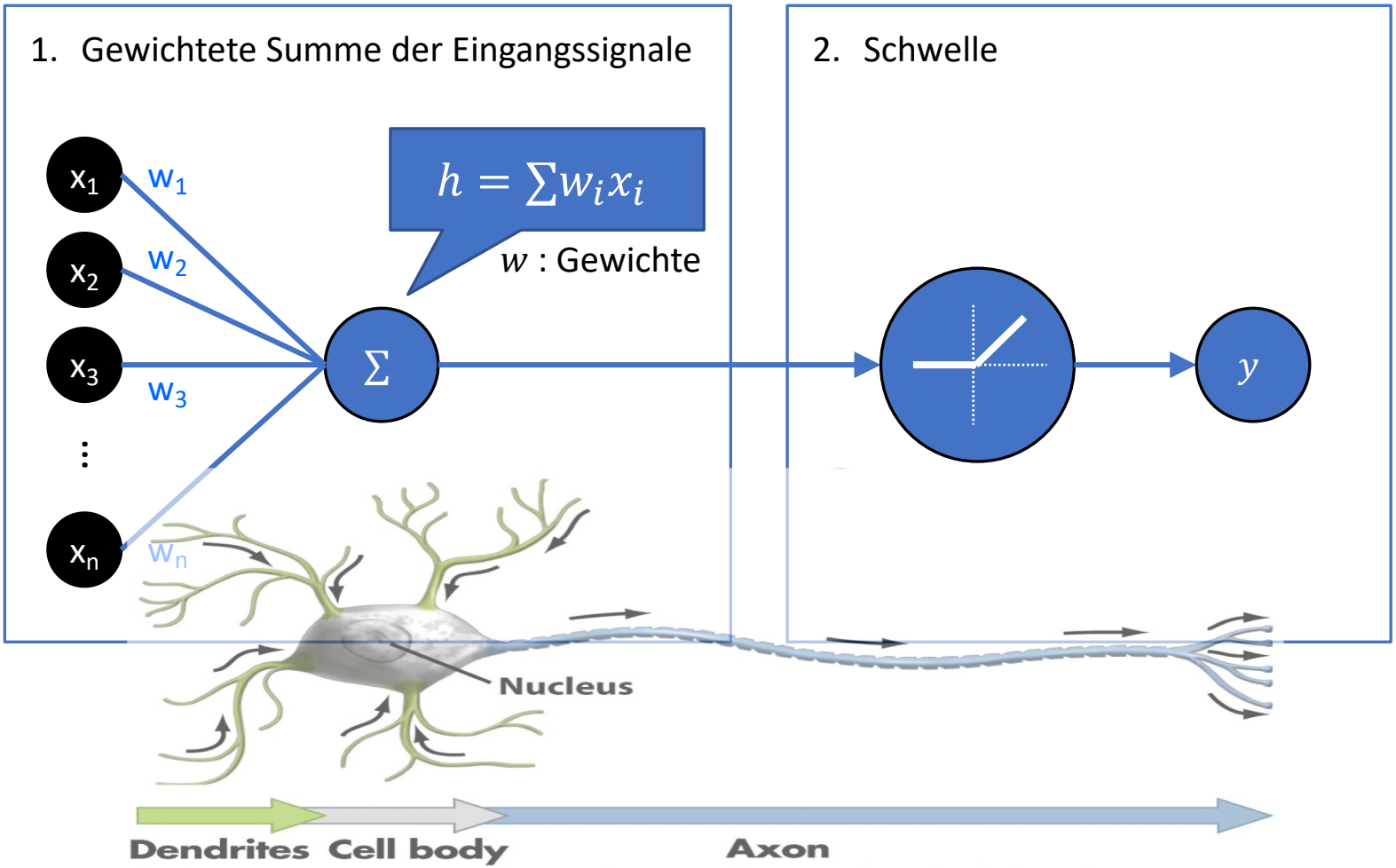
https://neuwritesd.org/2015/10/22/deep-neural-networks-help-us-read-your-mind/
G. Zaharchuk et al. AJNR Am J Neuroradiol doi:10.3174/ajnr.A5543

Hierarchische Datenverarbeitung



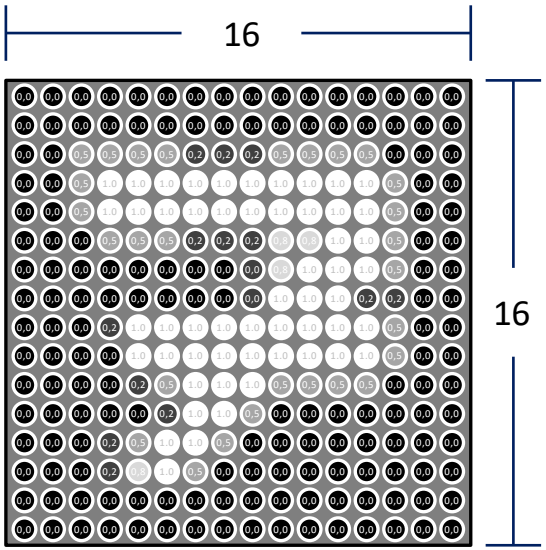
https://neuwritesd.org/2015/10/22/deep-neural-networks-help-us-read-your-mind/

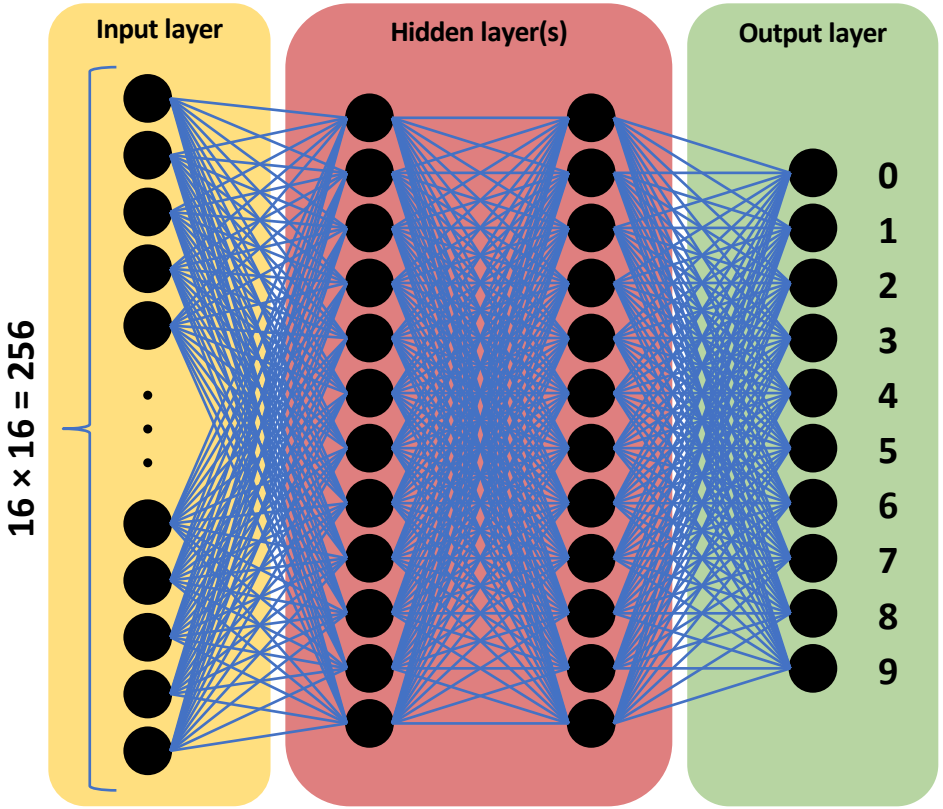
Künstliche neuronale Netze
(Perceptron, Rosenblatt 1958)



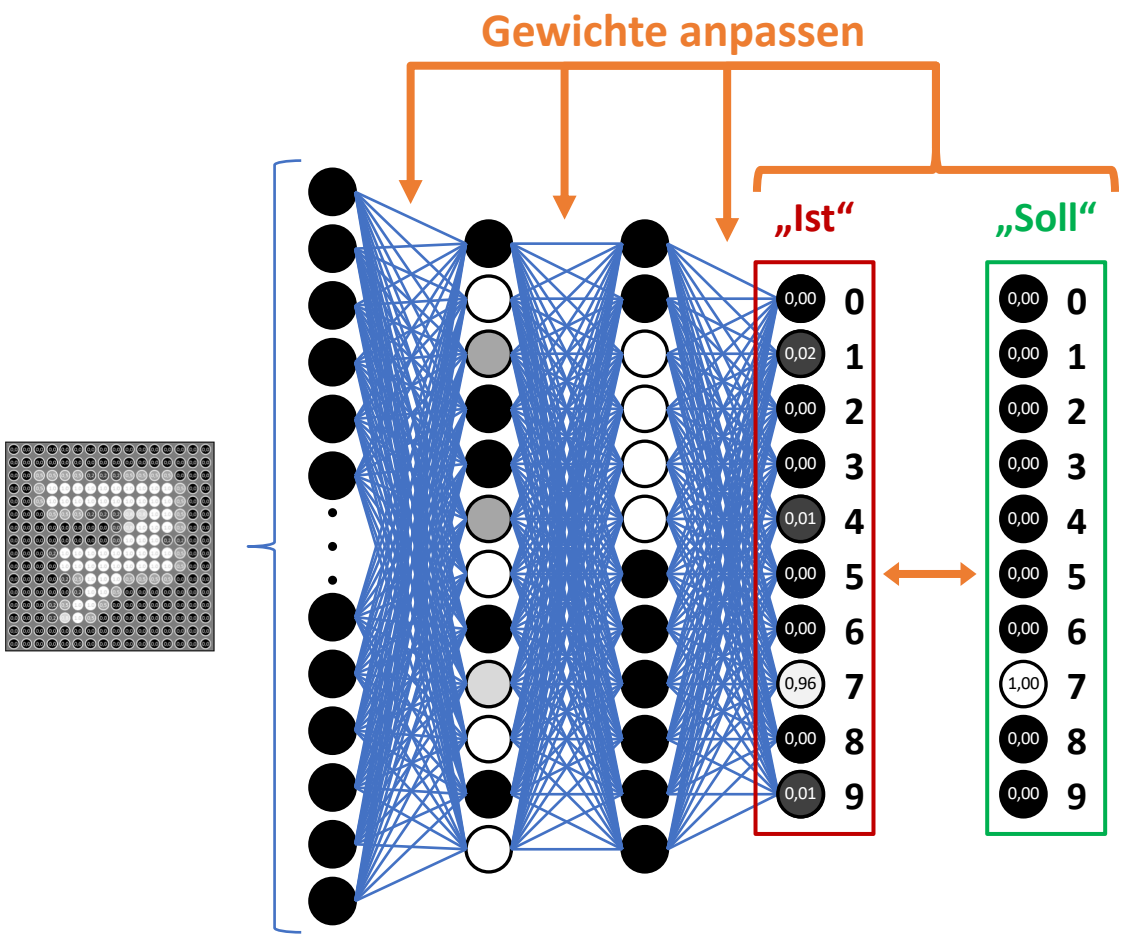
Mehrschichtige neuronale Netze

Beispiel: Klassifikation handgeschriebener Ziffern

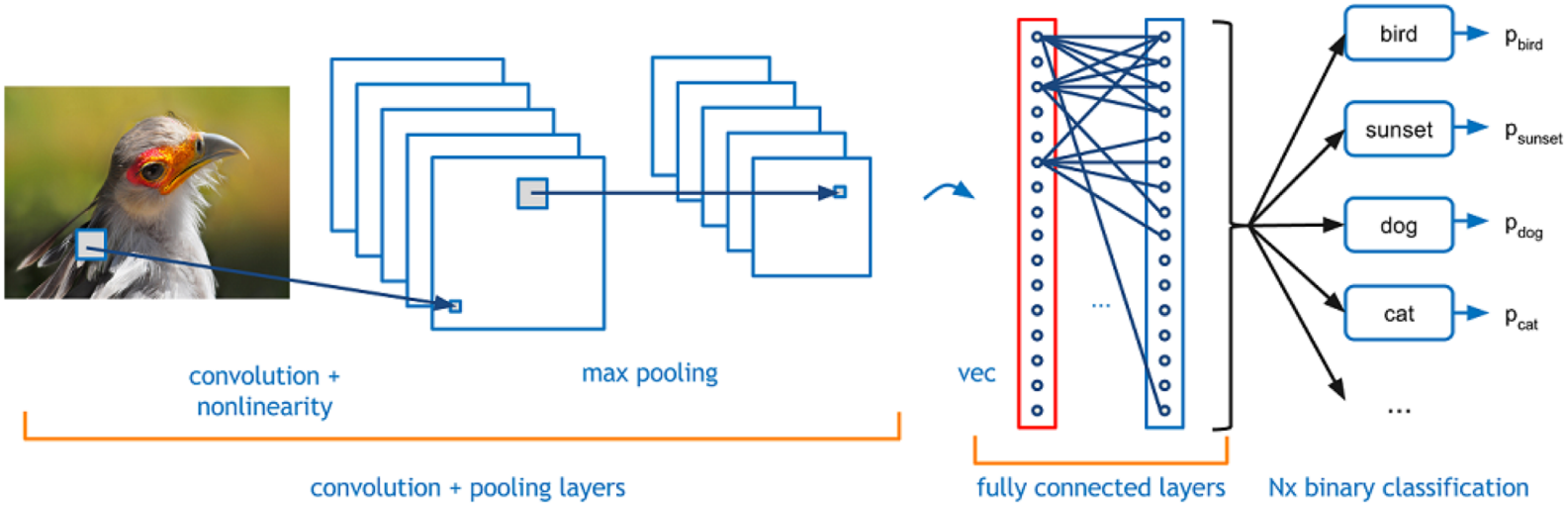




Training neuronaler Netze

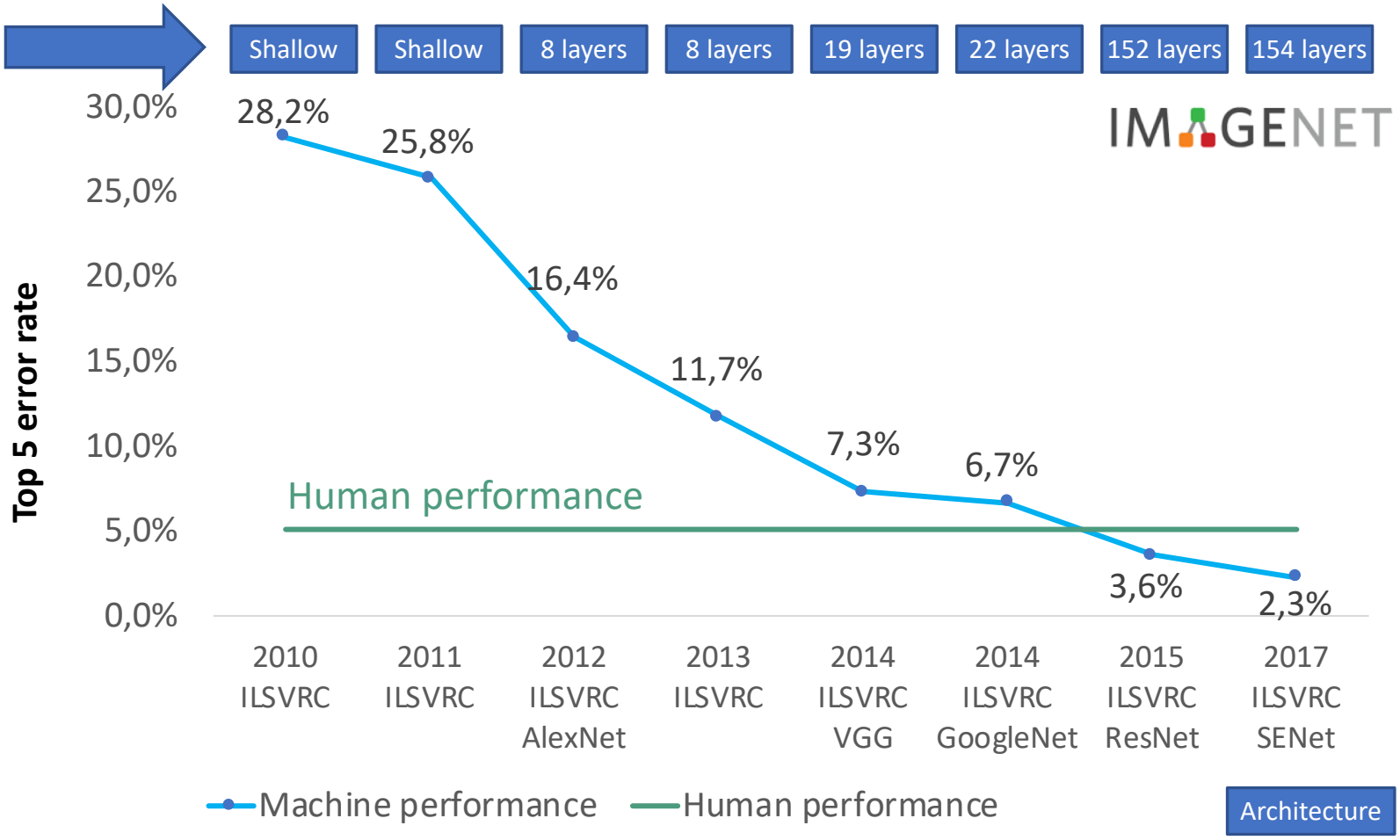


Convolutional neural networks (CNN)

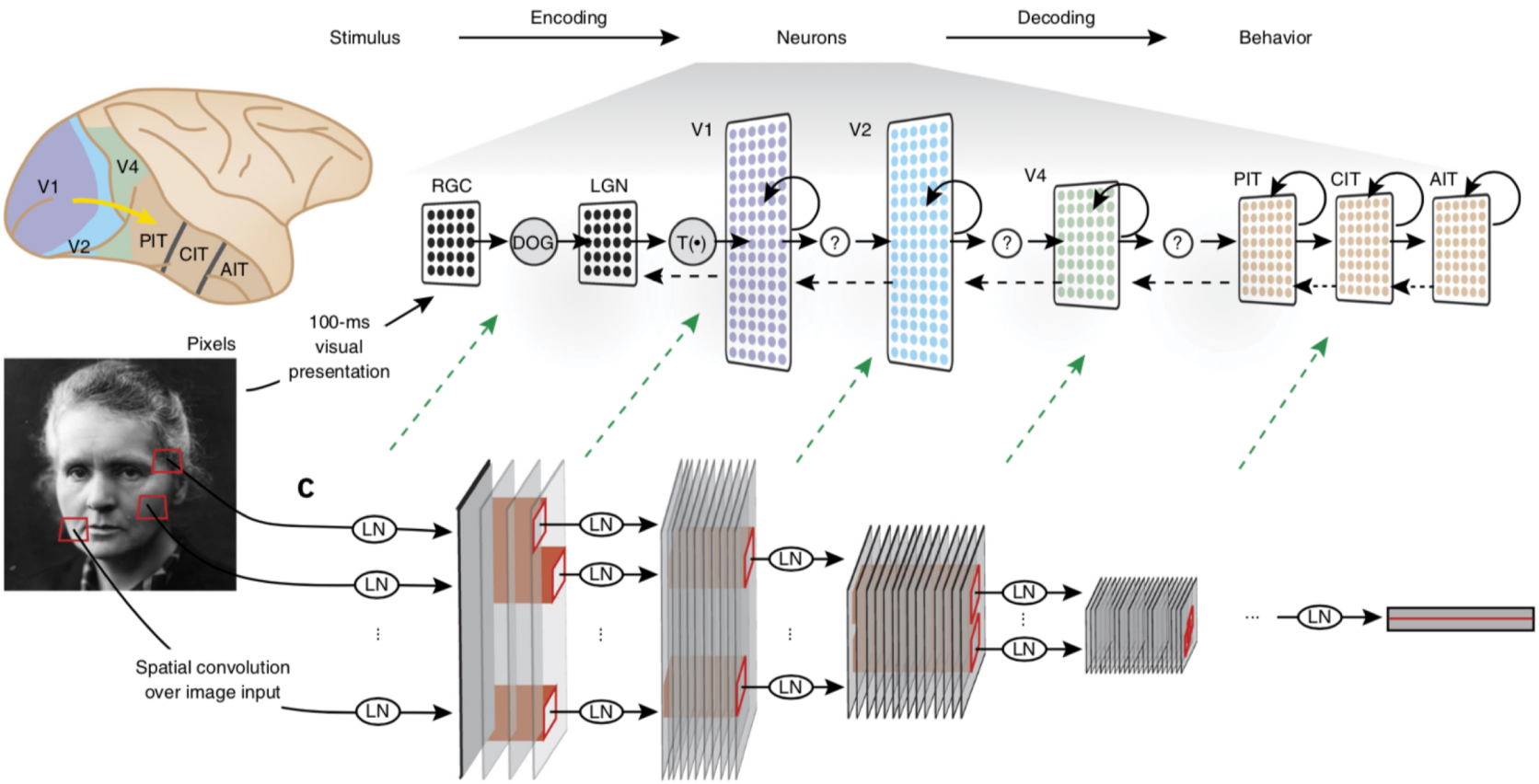


https://adeshpande3.github.io/A-Beginner's-Guide-To-Understanding-Convolutional-Neural-Networks/

Neuronale Netze werden tiefer



Gelernte Repräsentationen sind denen im Gehirn sehr ähnlich

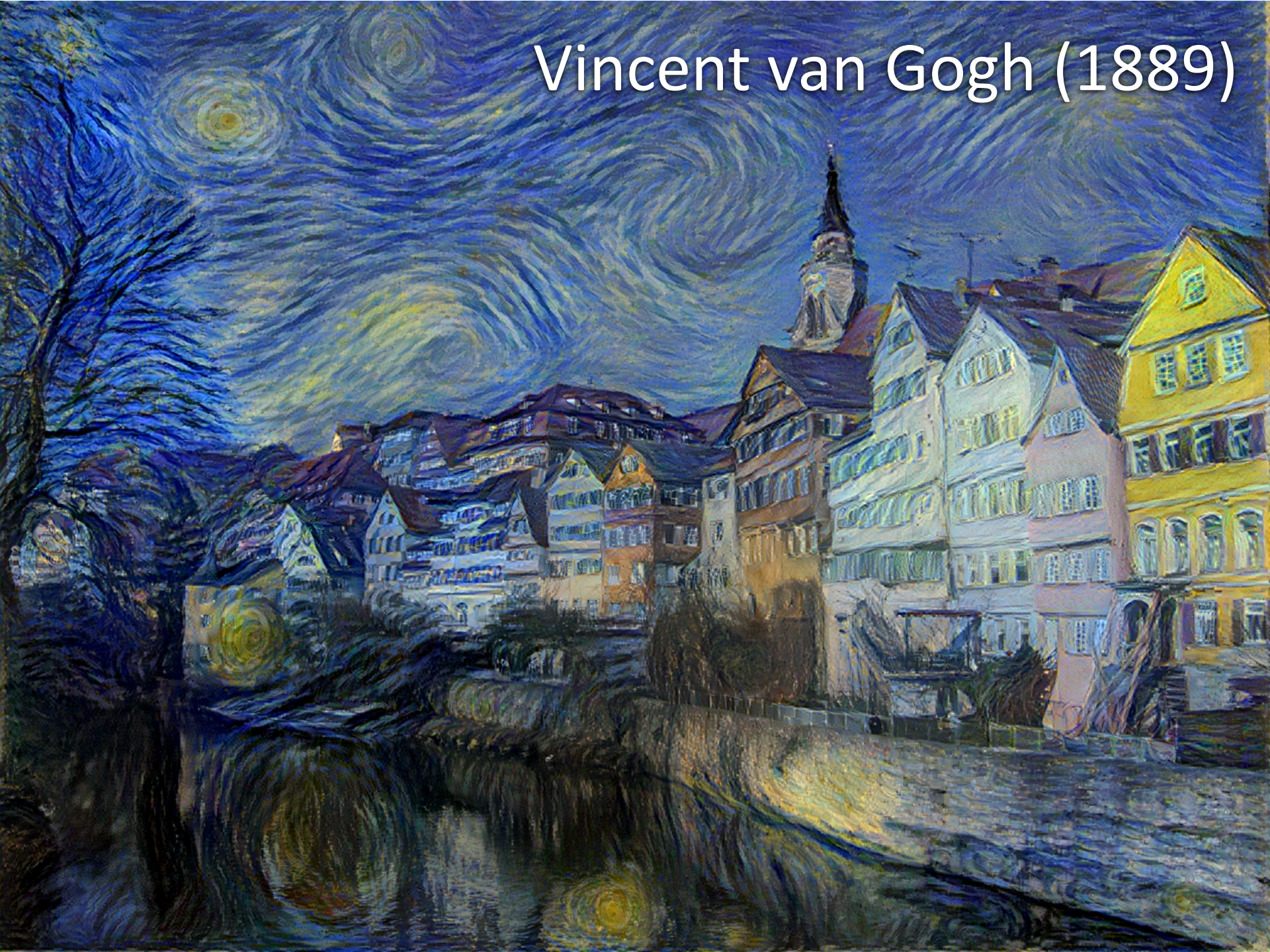


Yamins & DiCarlo 2016

Zwischenfazit

VIELE GEMEINSAMKEITEN ZWISCHEN REPRÄSENTATIONEN IM GEHIRN UND DEEP NEURAL NETWORKS

Exkurs: Kunstgeschichte


Vincent van Gogh (1889)

William Turner (1805)

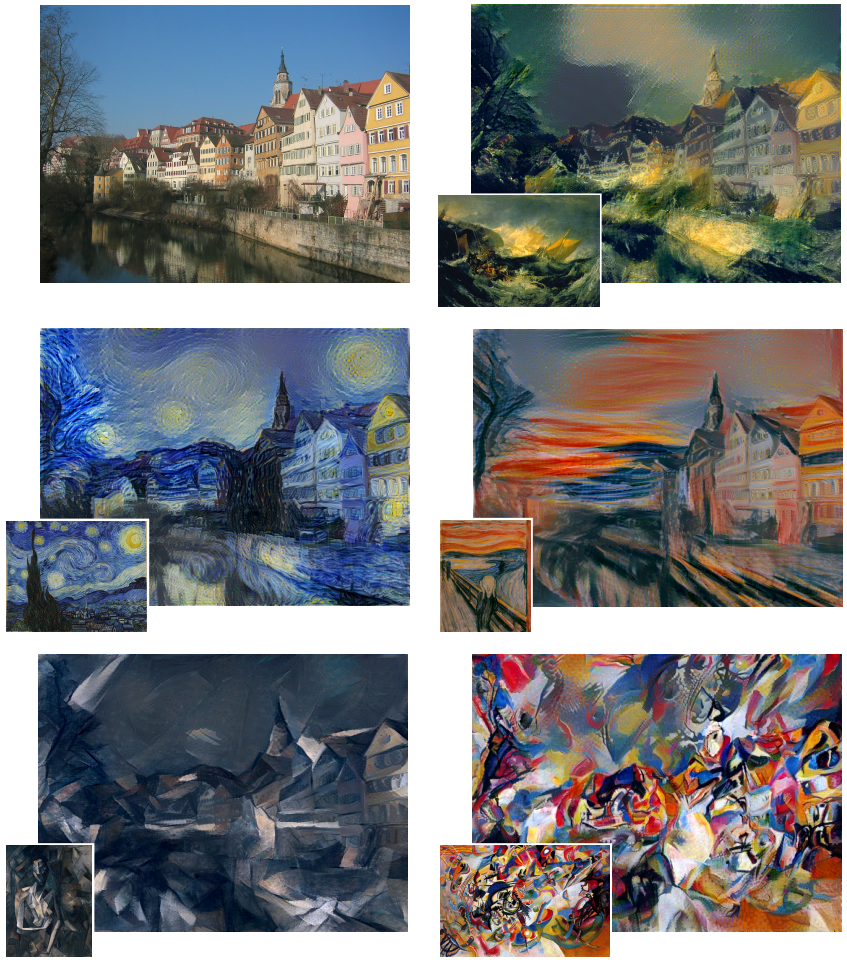
Pablo Picasso (1910)

Edvard Munch (1893)

Wassily Kandinsky (1913)

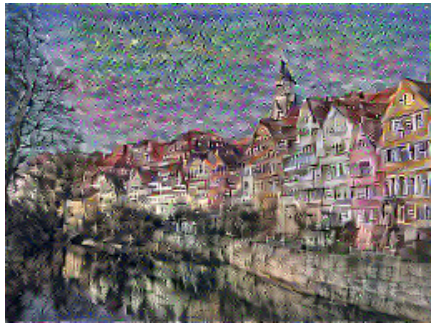
A Neural Algorithm of Artistic Style

Gatys, Ecker, Bethge (CVPR 2016)



Neural Style Transfer

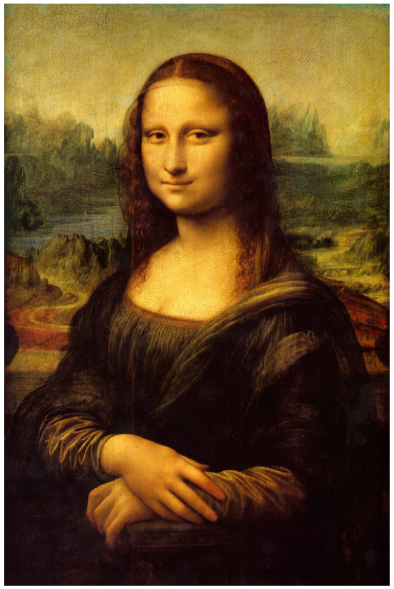
Bildinhalt



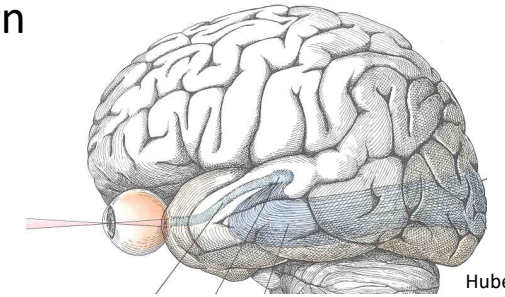
Bildstil (→ Textur)

Gatys, Ecker Bethge, CVPR 2016

Neuronale Bildrepräsentationen



Gehirn



Hubel 1995

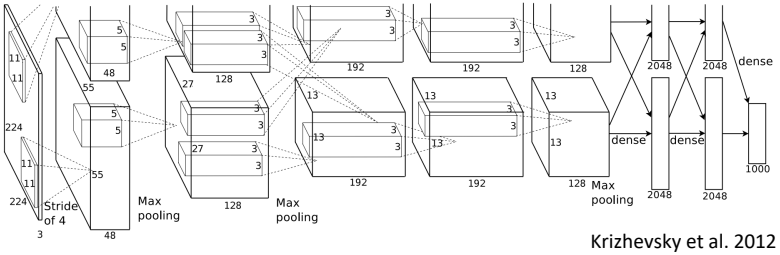
Hund
Katze
…
Auto

Zusammenhang

Yamins & DiCarlo 2014, Güclü & van Gerven 2015,
Khaligh-Razavi & Kriegeskorte 2014

Semantisches Bildverständnis

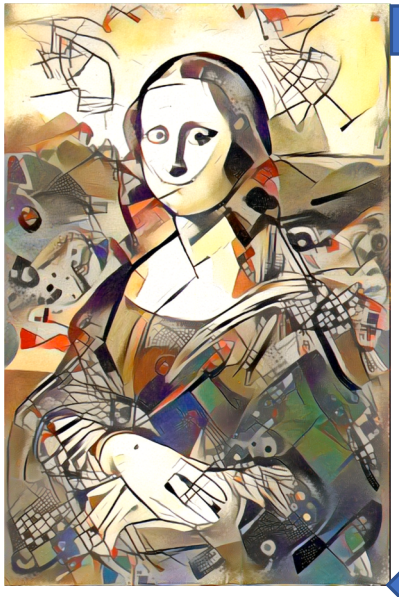
Deep Neural Network



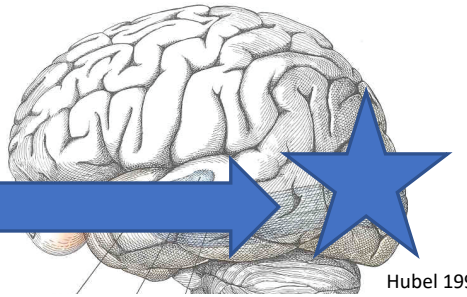
Krizhevsky et al. 2012

Hund
Katze
…
Auto

Neuronale Bildrepräsentationen



Gehirn



Hubel 1995

Hund
Katze
…
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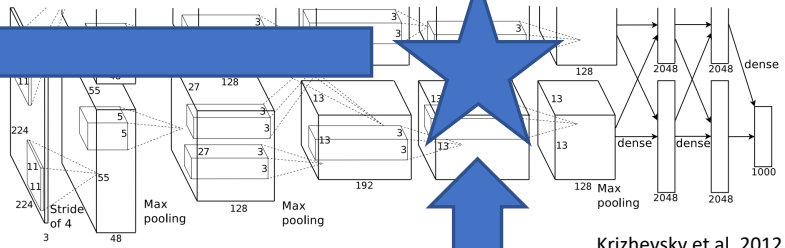
Zusammenhang

Yamins & DiCarlo 2014, Güclü & van Gerven 2015, Khaligh-Razavi & Kriegeskorte 2014

Semantisches Bildverständnis

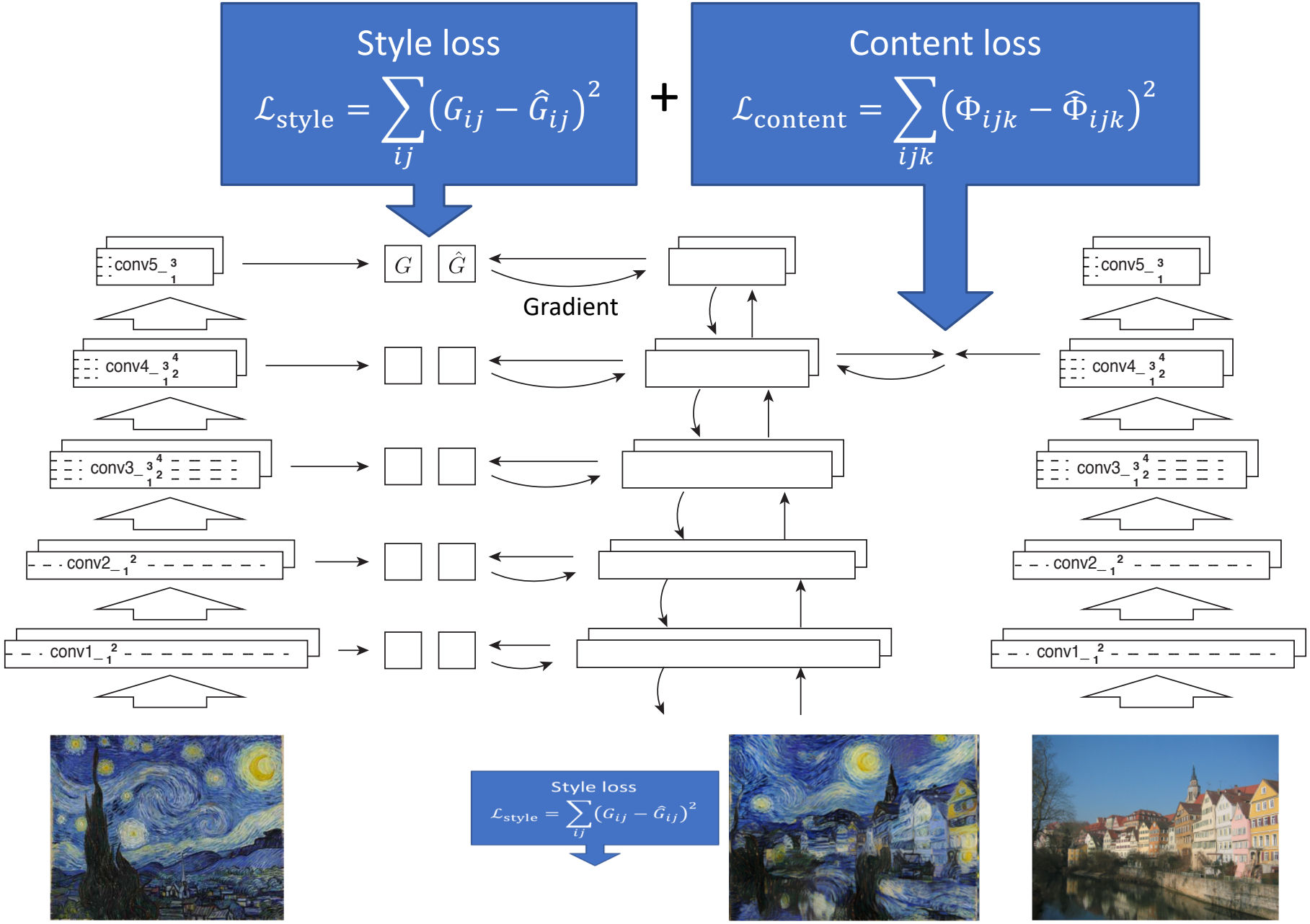
Deep Neural Network



Krizhevsky et al. 2012

Hund
Katze
…
Auto

Veränderung



Gatys, Ecker Bethge, CVPR 2016

Timelapse

Gatys, Ecker Bethge, CVPR 2016

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Kunst zum Selbermachen
https://deepart.io

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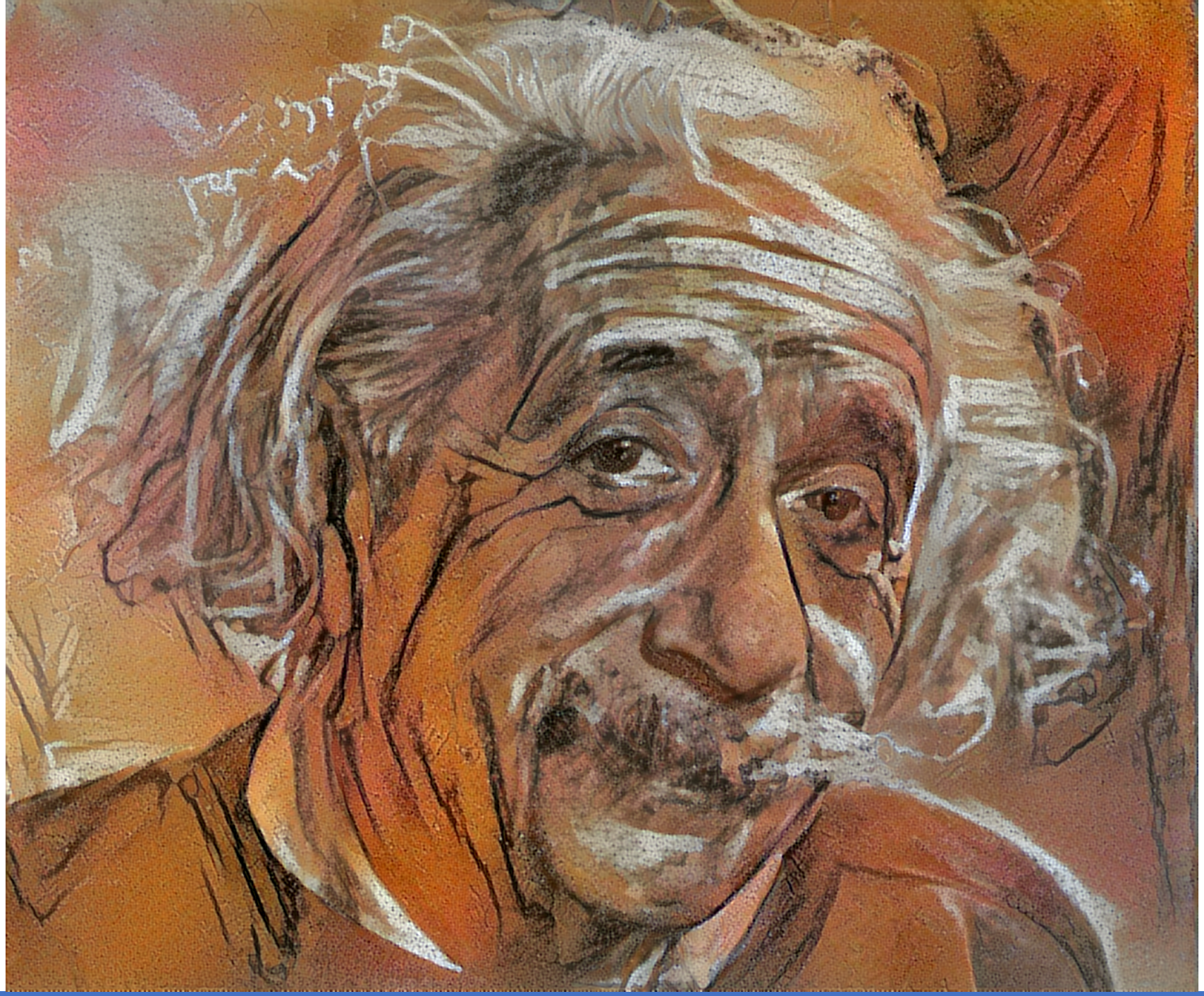
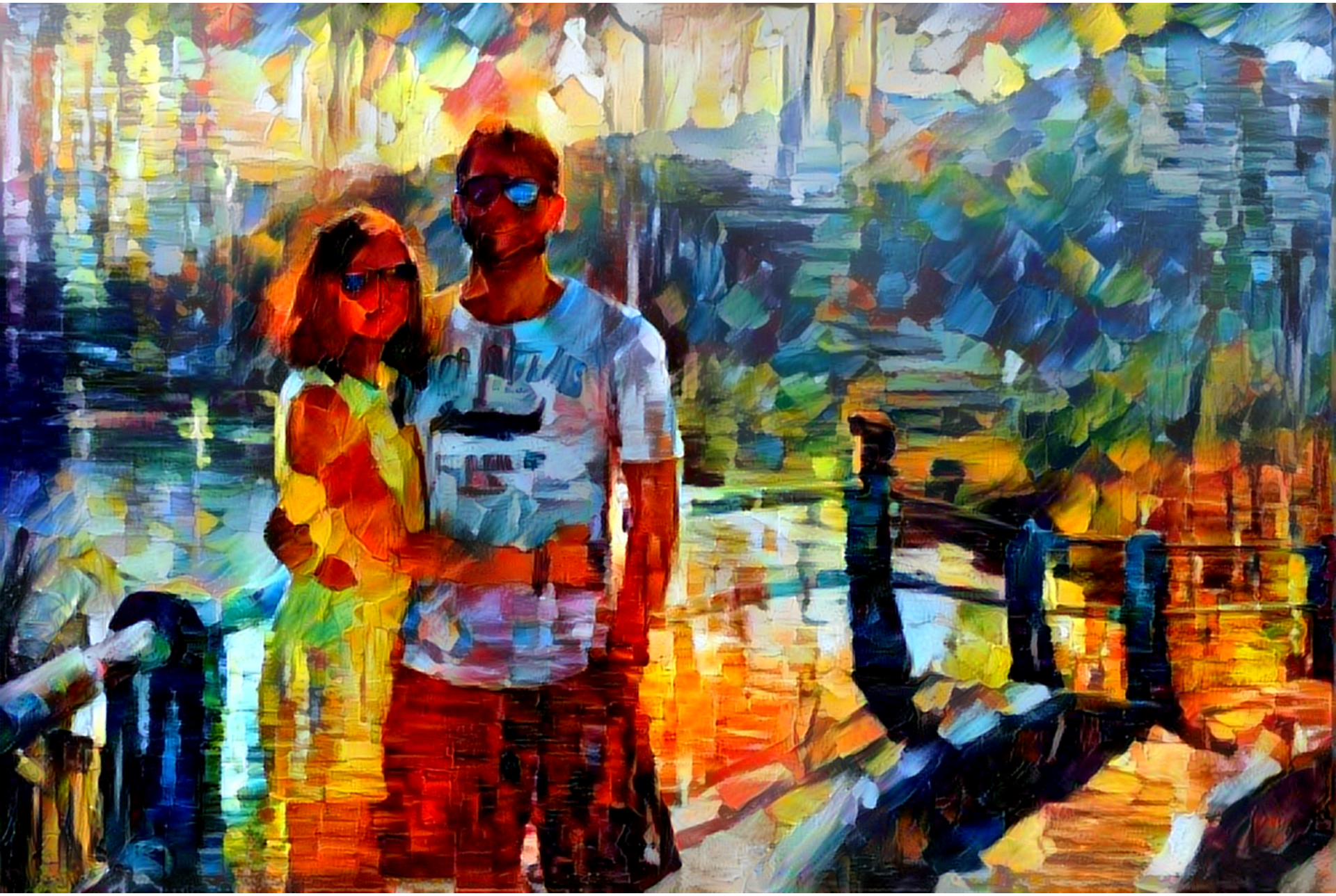
2 Choose style

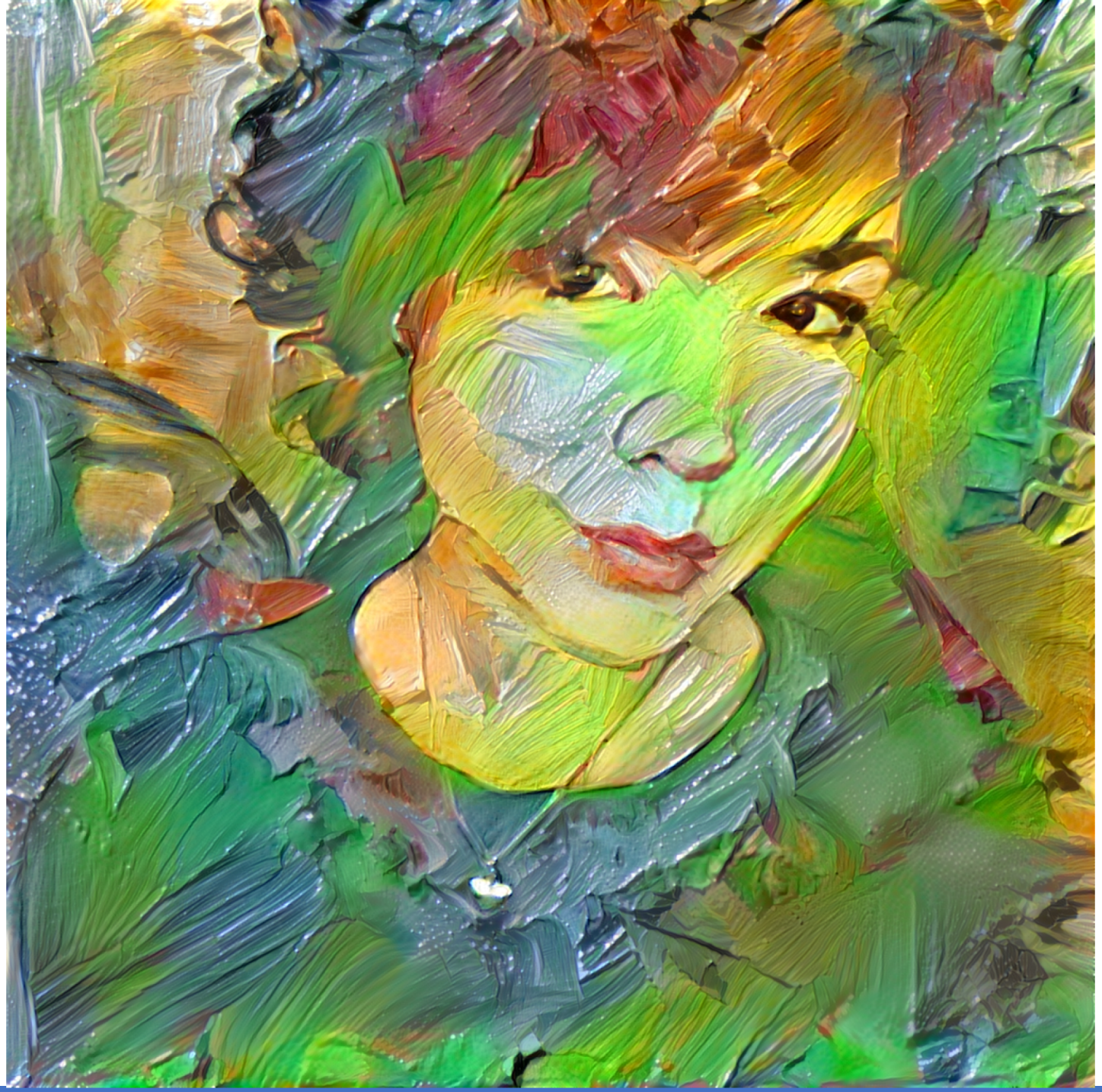
Choose among predefined styles or upload your own style image.

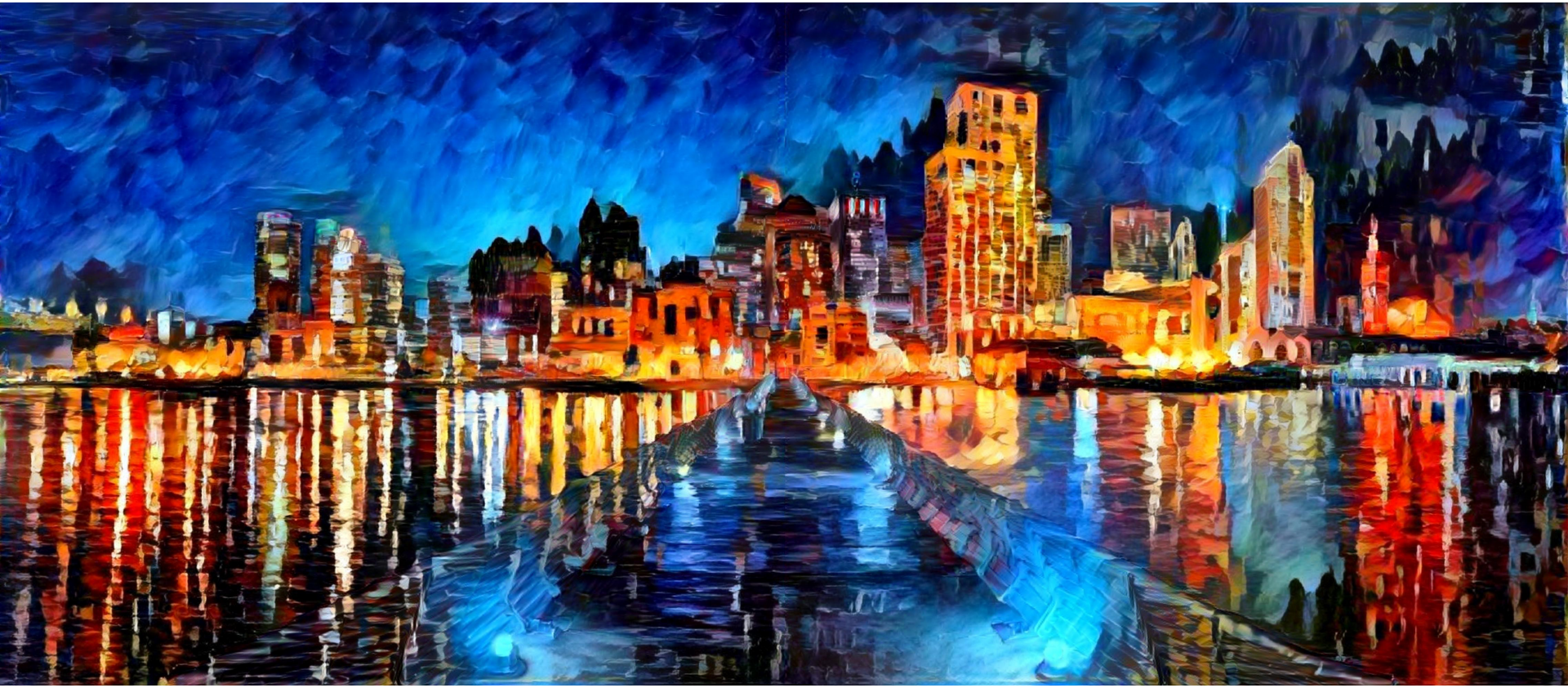
3 Submit

Our servers paint the image for you. You get an email when it's done.



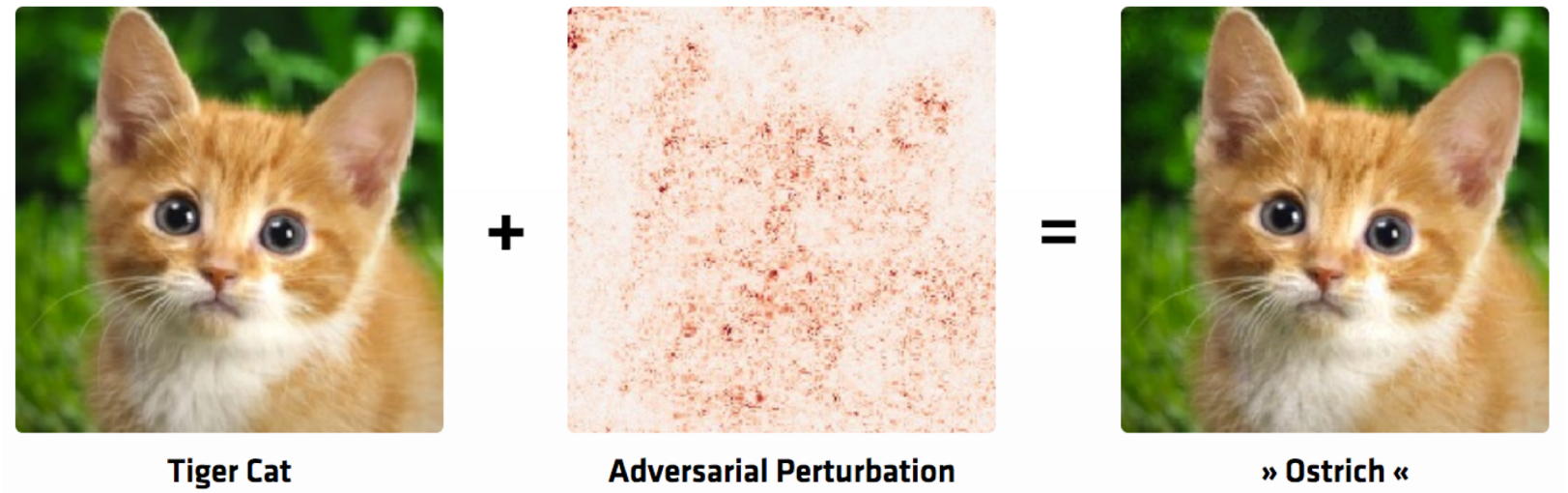






Computer = Gehirn?

Unterschiede zwischen Mensch und Maschine: „Adversarial examples“



Rauber & Brendel, https://robust.vision

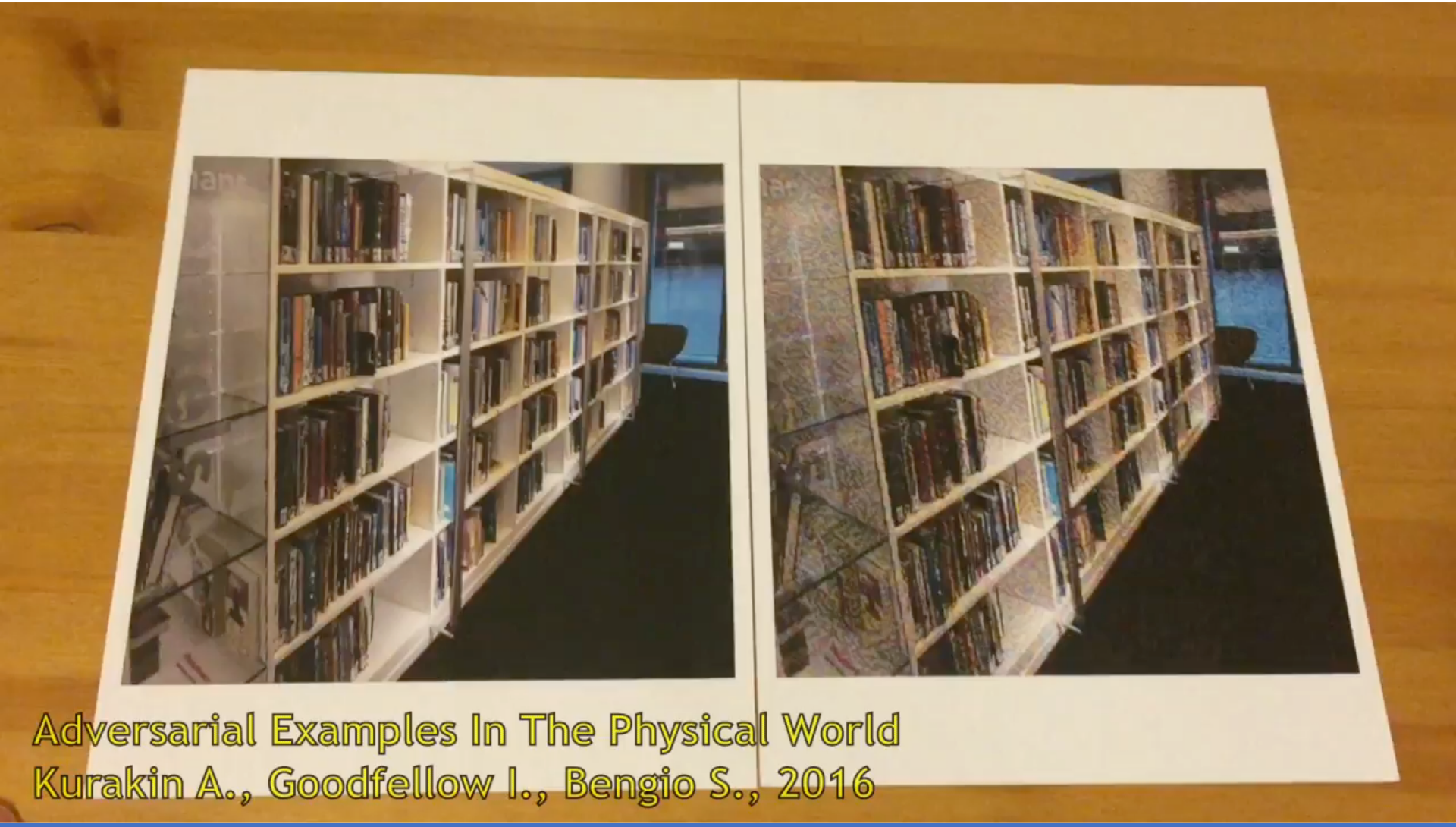
Risiko für selbstfahrende Autos?

(a) original image

(b) adv. example

Fischer et al. ICLR 2017

Real-world Beispiel



Unterschiede Teil II: Katze oder Elefant?

(a) Texture image

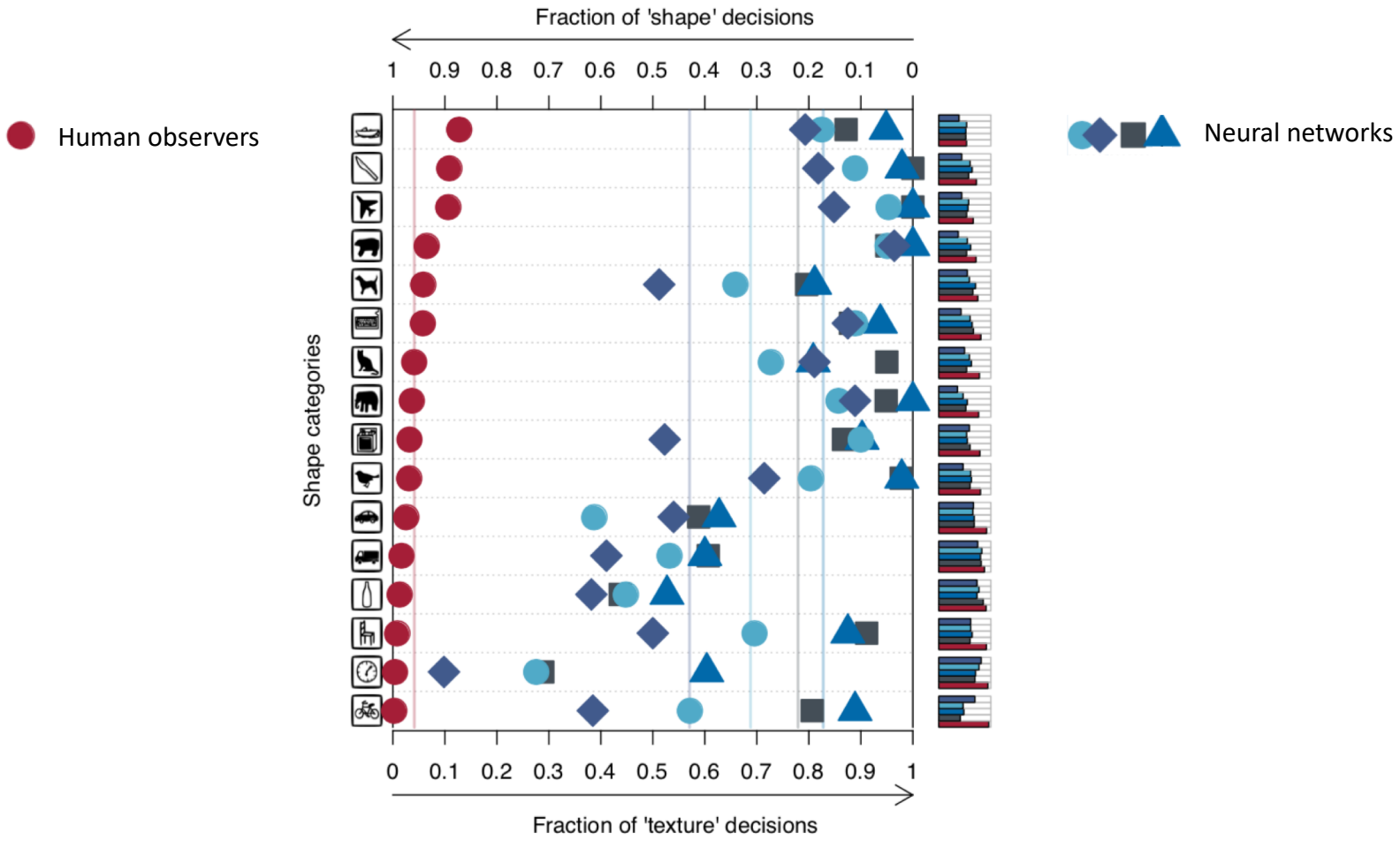
81.4%	**Indian elephant**
10.3%	indri
8.2%	black swan

(b) Content image

71.1%	**tabby cat**
17.3%	grey fox
3.3%	Siamese cat

Geirhos et al., arXiv 2018

Mensch vs. kNN: Form oder Textur?

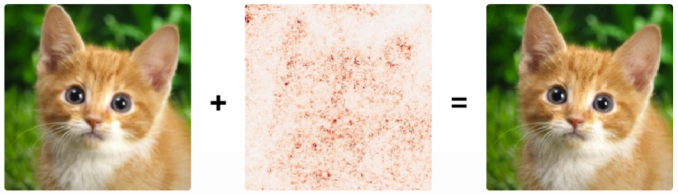


Geirhos et al., arXiv 2018

Zusammenfassung

Enorme Fortschritte in der KI durch Deep Learning.

Große Ähnlichkleiten …



Große Unterschiede …

… zwischen den gelernten Repräsentationen im Gehirn
und in tiefen neuronalen Netzen.