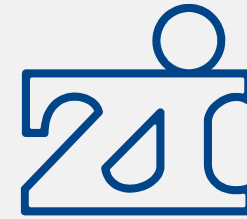


Andreas Meyer-Lindenberg



Zentralinstitut für
Seelische Gesundheit

Landesstiftung
des öffentlichen Rechts

*Methoden und Anwendungen der
Künstlichen Intelligenz in der Psychiatrie*

Pro mente Wien

11.1.2024

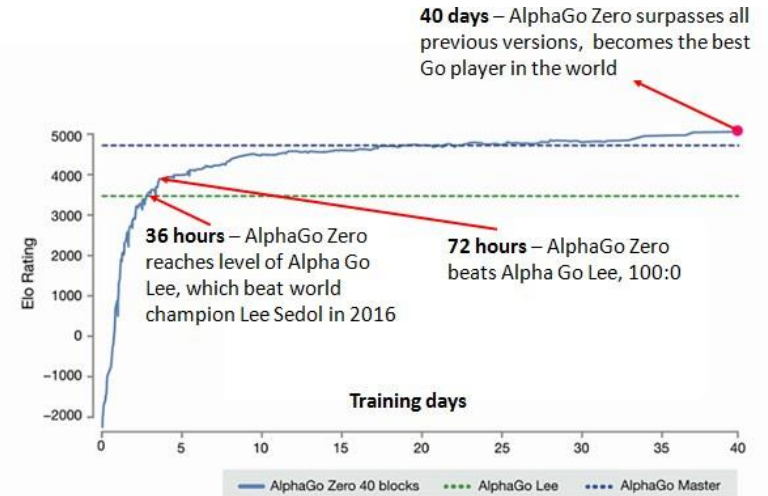
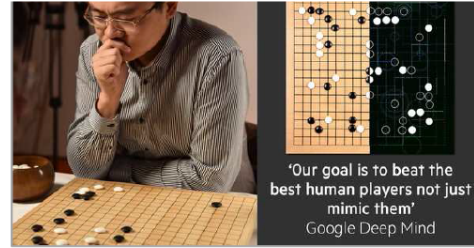


Rasante Fortschritte in der künstlichen Intelligenz



Zentralinstitut für
Seelische Gesundheit
Landesstiftung
des öffentlichen Rechts

! Go originated in China more than 2,500 years ago. As simple as the rules are, Go is a game of profound complexity. This complexity is what makes Go hard for computers to play, and an irresistible challenge to AI researchers. [adapted from Hassabis, 2016]



➔ The problem: 2.57×10^{210} possible positions – that is more than the number of atoms in the universe, and more than a googol times (10^{100}) larger than chess.

Training set

30 million moves recorded from games played by humans experts

Creating deep neural networks

12 network layers with millions of neuron-like connections

Predicting the human move
(57% of time)

Data-driven learning

Learning non-human strategies

AlphaGo designed by Google DeepMind, played against itself in thousands of games and evolved its neural networks; Monte Carlo tree search [Hassabis, 2016]

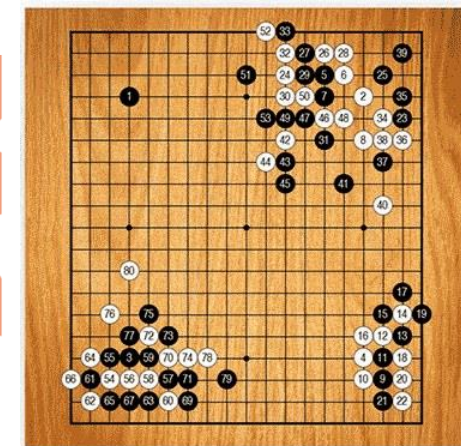
March 2016:

Beating Lee Se-dol (World Champion)
AlphaGo won 4 games to 1.
(5 years before time)

! Achieving one of the grand challenges of AI

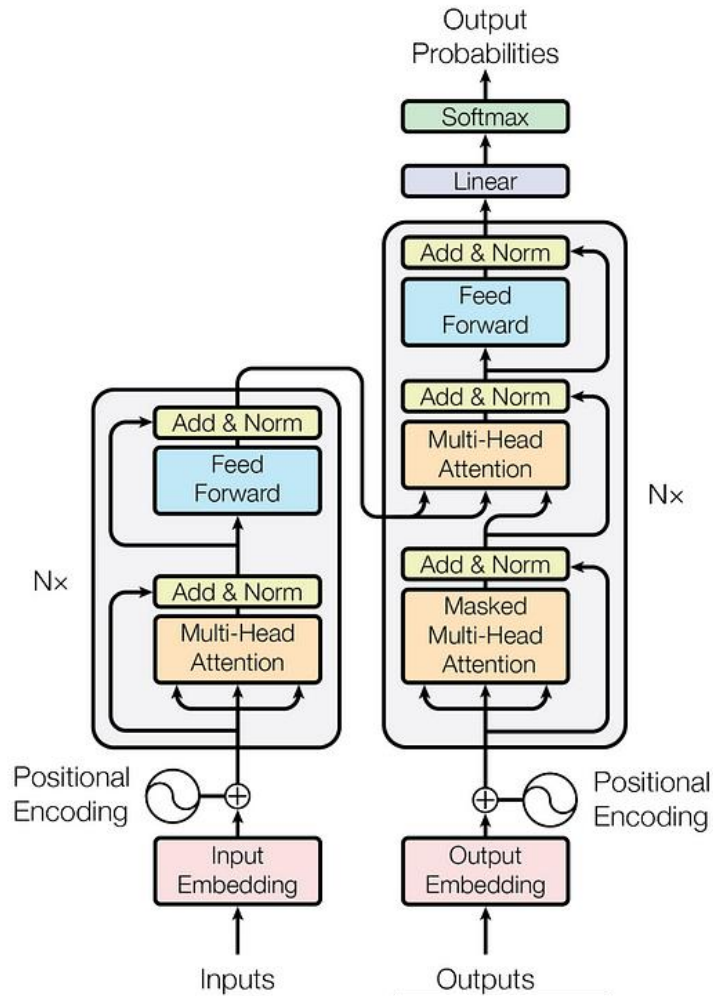
Reinforcement learning

By 19/10/2017,
AlphaGo Zero
has been introduced.
...
Human factor
practically zero.



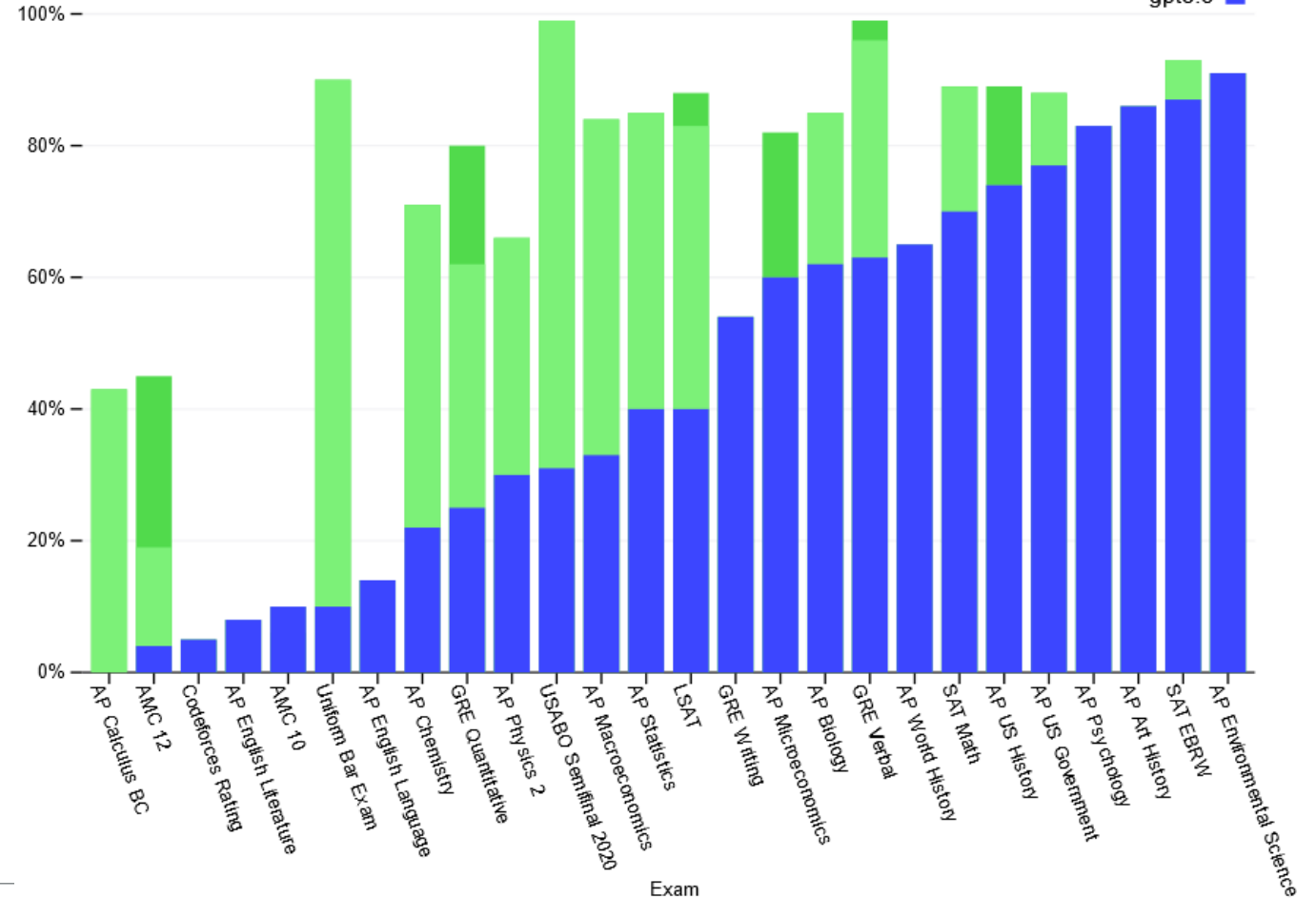
88 at 61
Captured Stones

GPT-4 (Generative Pre-Trained Transformer)



Exam results (ordered by GPT-3.5 performance)

Estimated percentile lower bound (among test takers)



KI-Anwendungen in der Medizin sind Realität

Company	FDA Approval	Indication
Apple	September 2018	Atrial fibrillation detection
Aidoc	August 2018	CT brain bleed diagnosis
iCAD	August 2018	Breast density via mammography
Zebra Medical	July 2018	Coronary calcium scoring
Bay Labs	June 2018	Echocardiogram EF determination
Neural Analytics	May 2018	Device for paramedic stroke diagnosis
IDx	April 2018	Diabetic retinopathy diagnosis
Icometrix	April 2018	MRI brain interpretation
Imagen	March 2018	X-ray wrist fracture diagnosis
Viz.ai	February 2018	CT stroke diagnosis
Arterys	February 2018	Liver and lung cancer (MRI, CT) diagnosis
MaxQ-AI	January 2018	CT brain bleed diagnosis
Alivecor	November 2017	Atrial fibrillation detection via Apple Watch
Arterys	January 2017	MRI heart interpretation

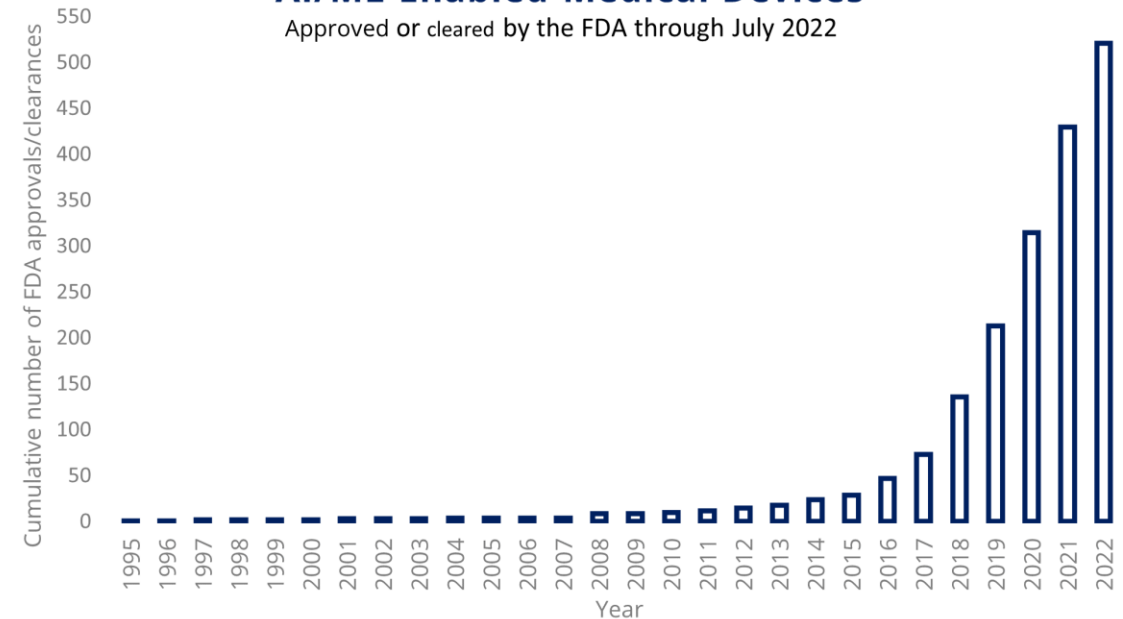
In Deutschland (Stand August 2022)

14 verschreibungsfähige Digitale Gesundheitsanwendungen (DIGA) in der Psychiatrie

Schwerpunkt Depression, Angsterkrankungen, Sucht

AI/ML-Enabled Medical Devices

Approved or cleared by the FDA through July 2022

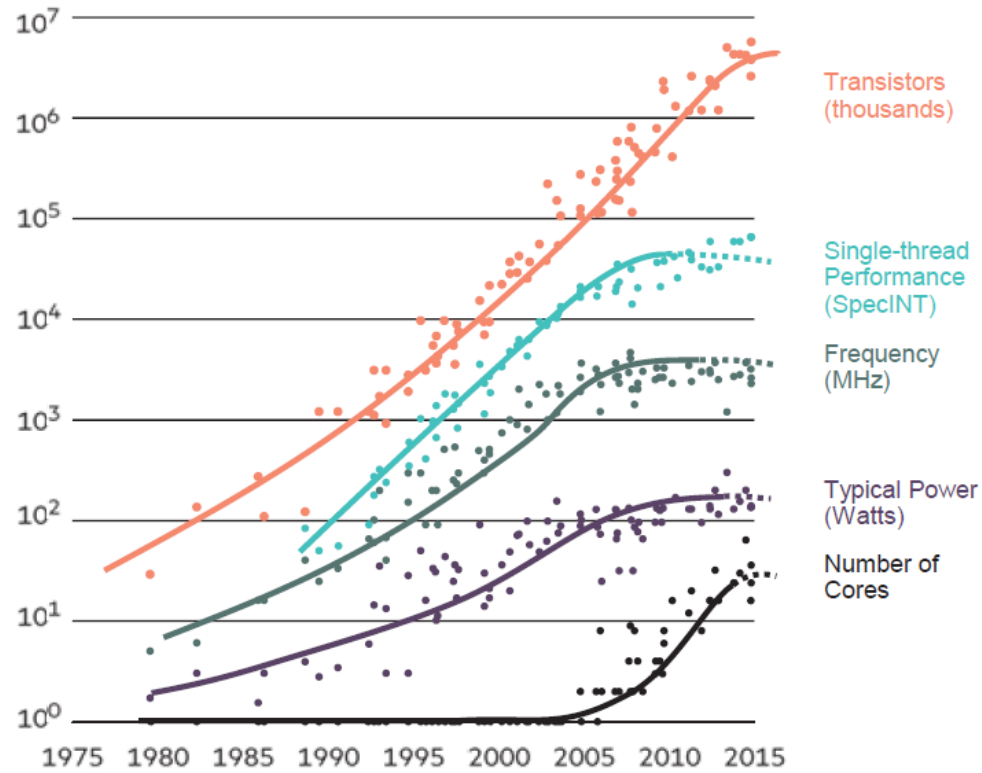


Topol Nat Med 2019

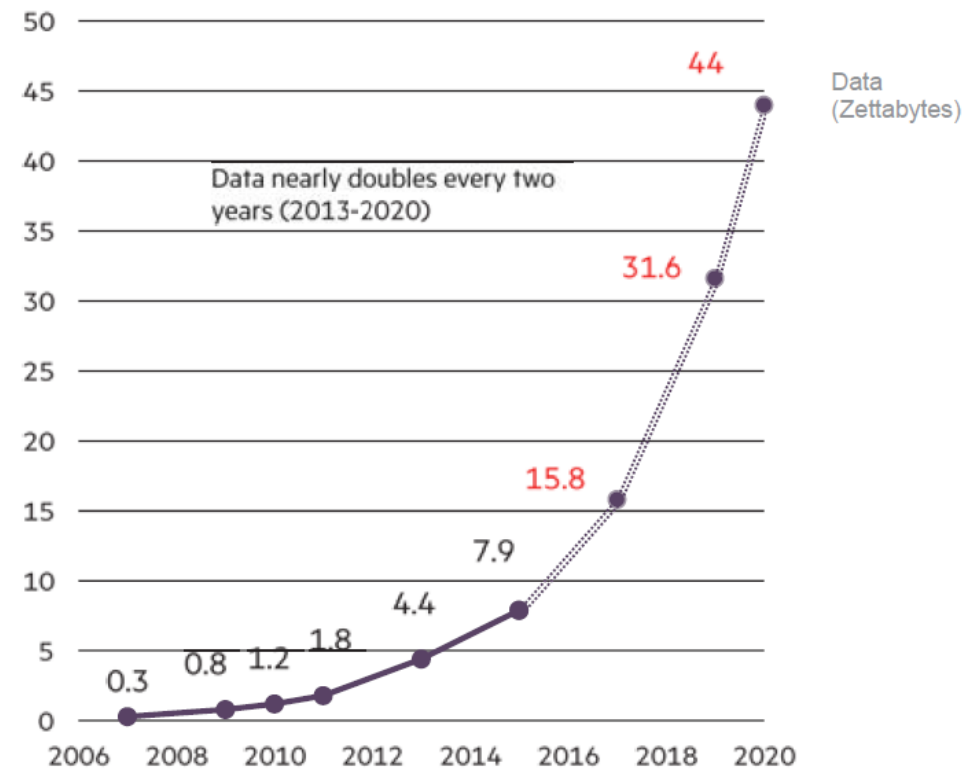
Big data



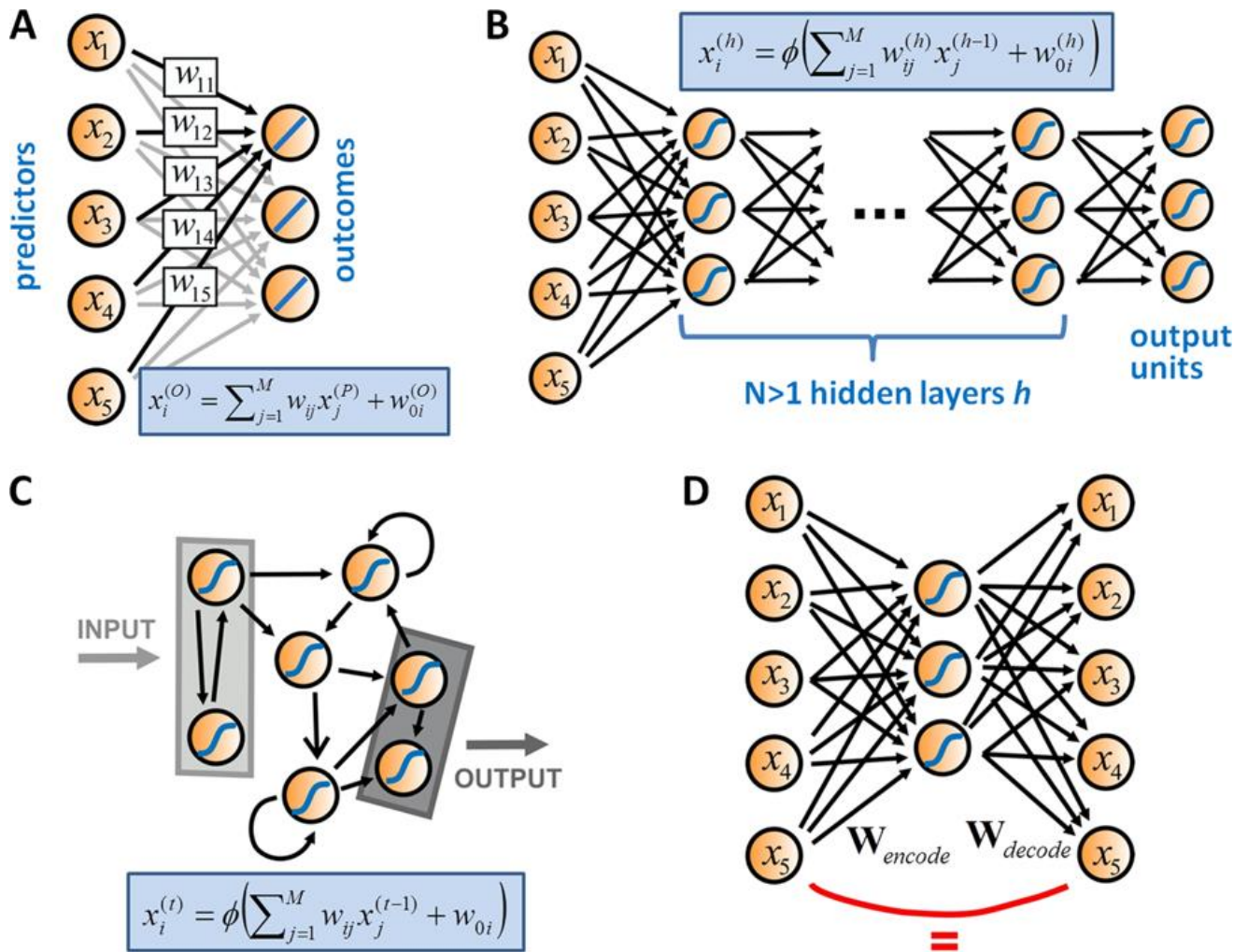
Microprocessors



Data growth

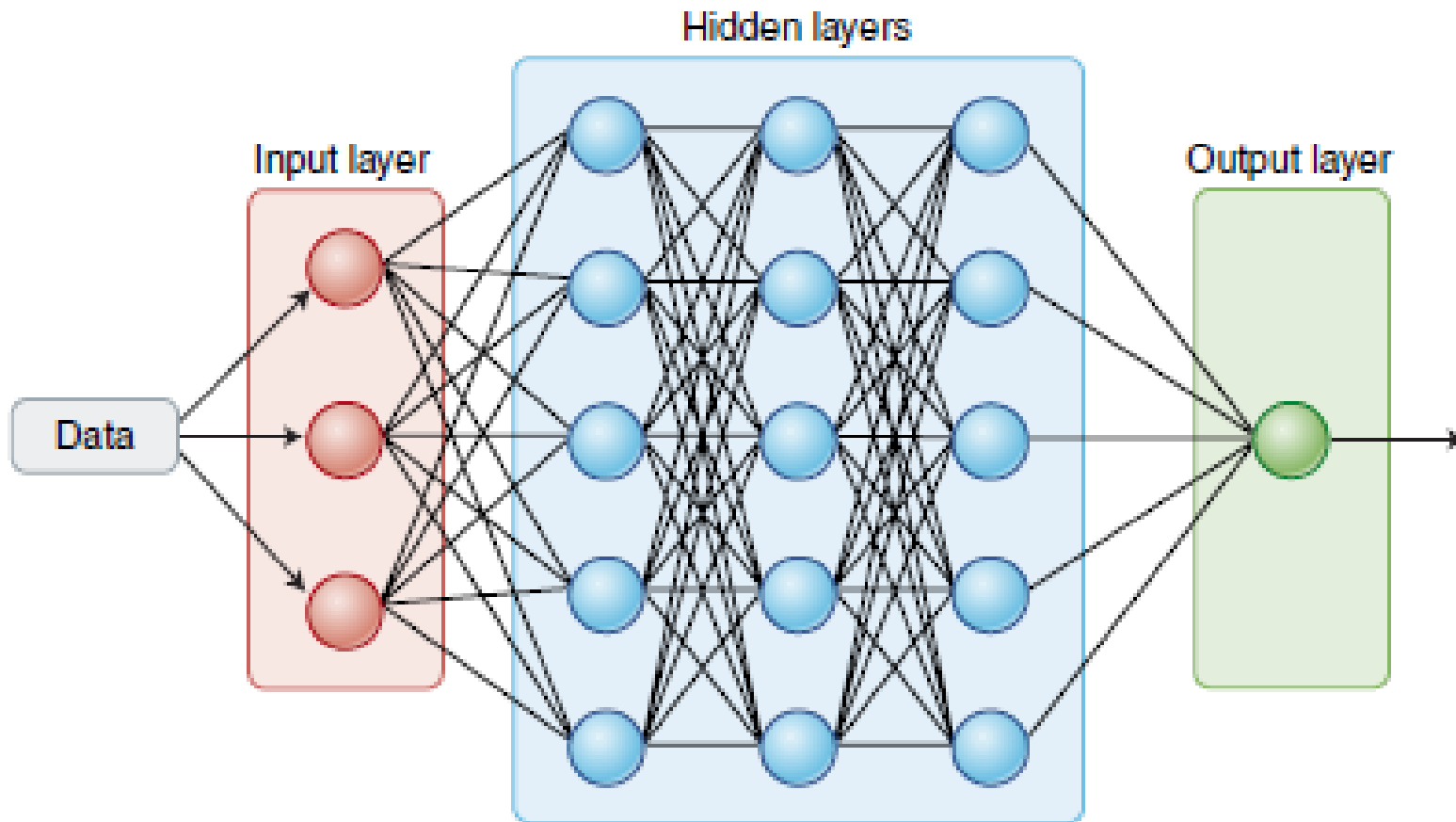


Wie funktioniert KI? Neural networks



Durstewitz et al. **Mol Psychiat** 2019

Wie funktioniert KI? Deep neural networks



Topol Nat Med 2019

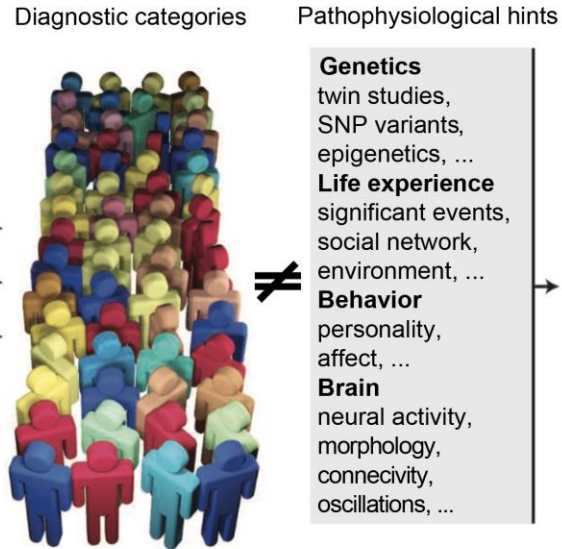
Mit künstlicher Intelligenz zur individuellen Therapie



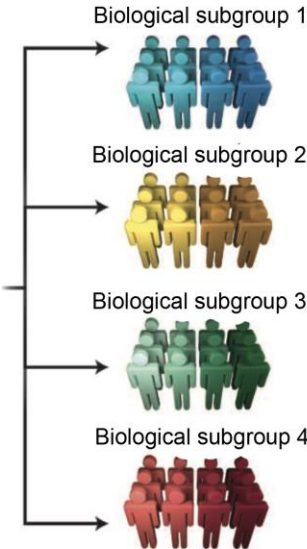
A Differential diagnosis



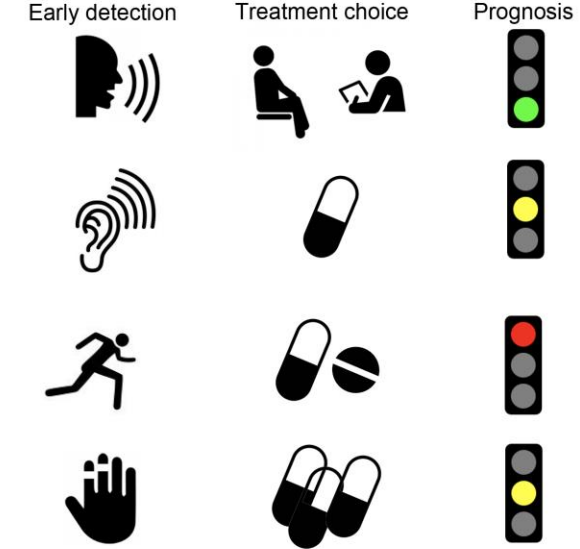
B Inter- and intra-disease variability



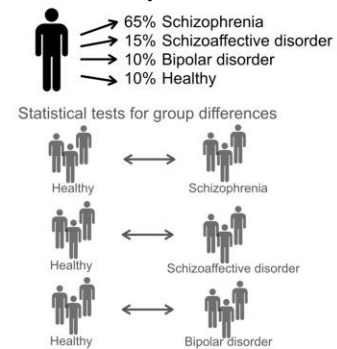
C Endophenotypes



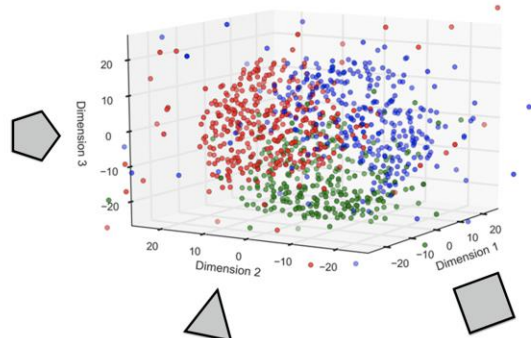
D Clinical prediction in single subjects



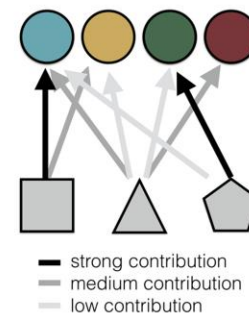
Multi-class prediction



Extract manifolds from diverse data



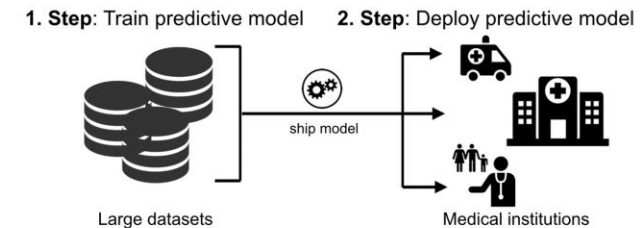
Latent disease factors



Prediction from observation data

Predicting drug response

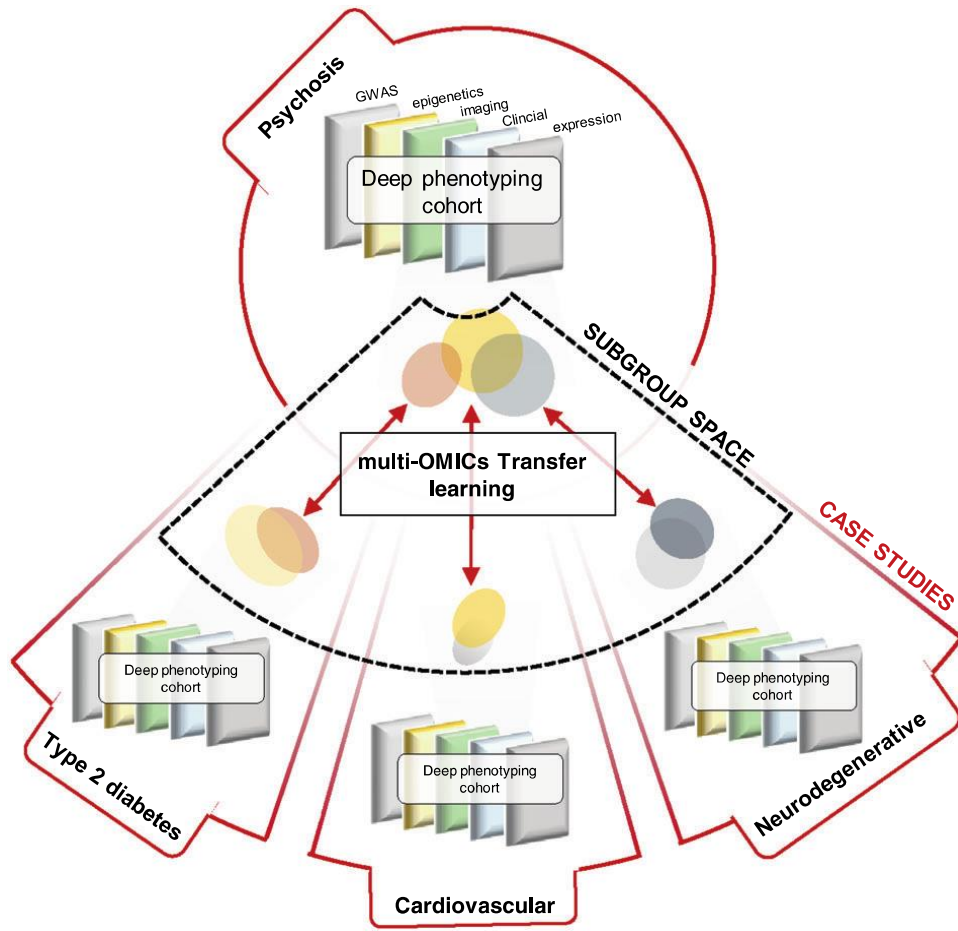
Predicting disease trajectory



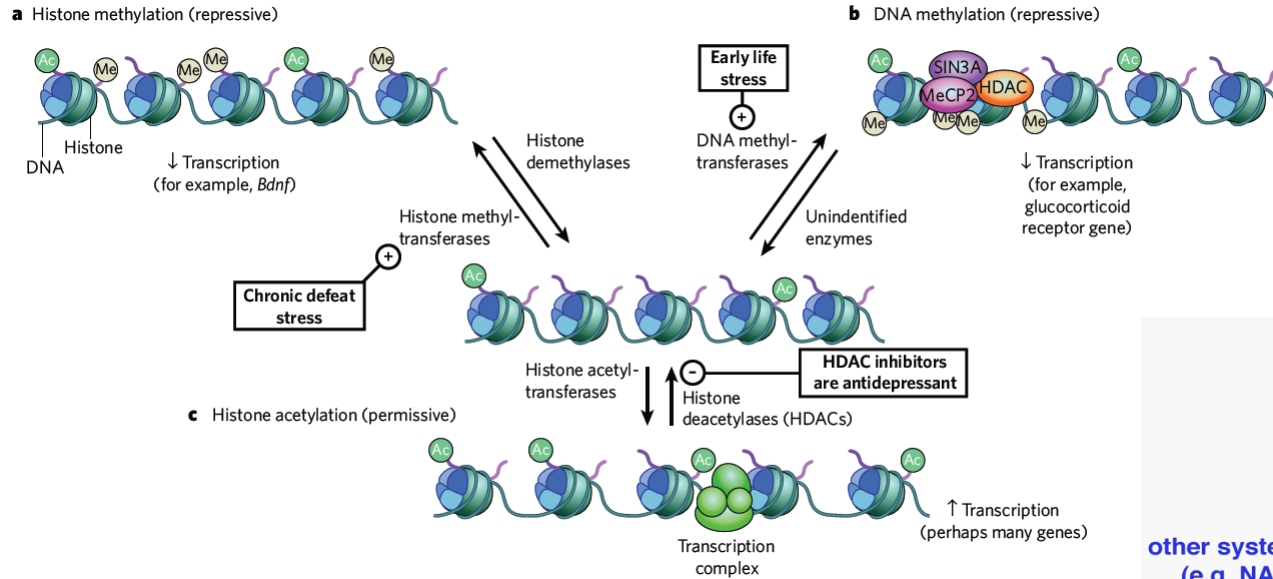


- Selbsttötungen sind eine führende Todesursache junger Menschen. Die große Mehrzahl findet auf dem Boden behandelbarer psychischer Störungen (besonders Depressionen) statt und wären vermeidbar.
- Durch die breite Nutzung sozialer Medien auf Smartphones ergeben sich in Verbindung mit künstlicher Intelligenz hier neue Möglichkeiten.
- Sowohl die Art der Mediennutzung¹ als auch die geposteten Inhalte, Texte (z.B. Facebook² und Twitter³) und Bilder (z.B. Instagram⁴) können mit Methoden des maschinellen Lernens Frühwarnzeichen der Depression in Echtzeit liefern. Facebook setzt neuronale Netzwerke für die Erkennung von Nutzern mit Suizidrisiko ein⁵.
- Methoden der künstlichen Intelligenz sind dabei traditionellen Methoden deutlich überlegen⁶.
- Erste randomisierte Studien zeigen, dass Online-Interventionen Suizide verhindern können⁷. Solche Interventionen können wahrscheinlich bald auch über Smartphones direkt an gefährdete Personen in ihrer momentanen Lebenssituation gerichtet werden.

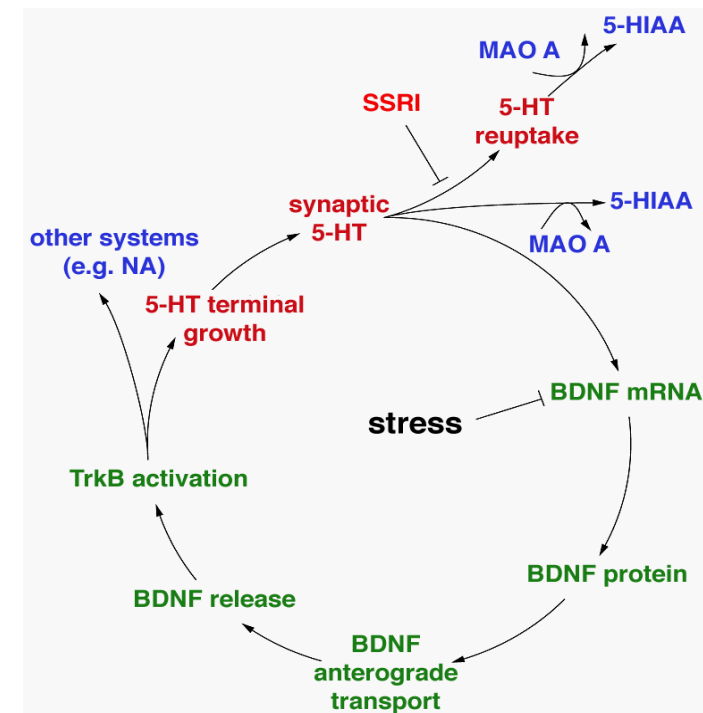
1. Frison et al. Cyberpsychol Behav Soc Netw. 2017
2. De Choudhury et al. Proceedings of the 17th ACM conference on Computer supported cooperative work & social computing 2014
3. Tsugawa et al. Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems 2015
4. Reece and Danforth EPJ Data Sci. 2017
5. <https://code.fb.com/ml-applications/under-the-hood-suicide-prevention-tools-powered-by-ai/>
6. Torous et a. Curr Psychiatry Rep 2017
7. van Spijker et al. PLoS One. 2014.



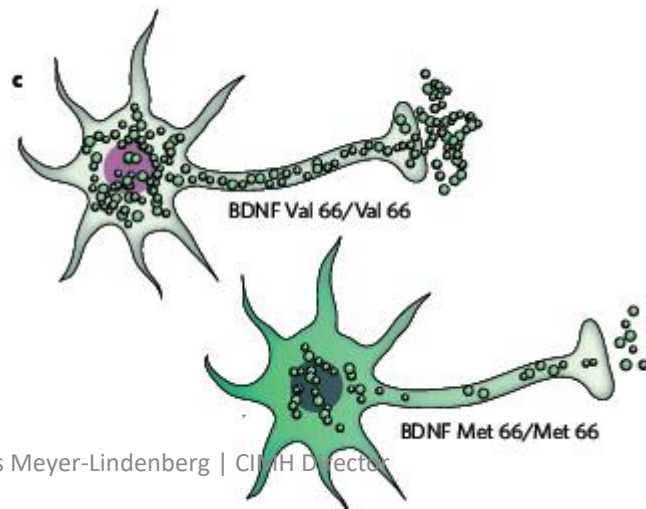
Schwarz et al., **Mol Psychiat** 2021



Altar, TIPS 1999



Krishnan and Nestler **Nature** 2008



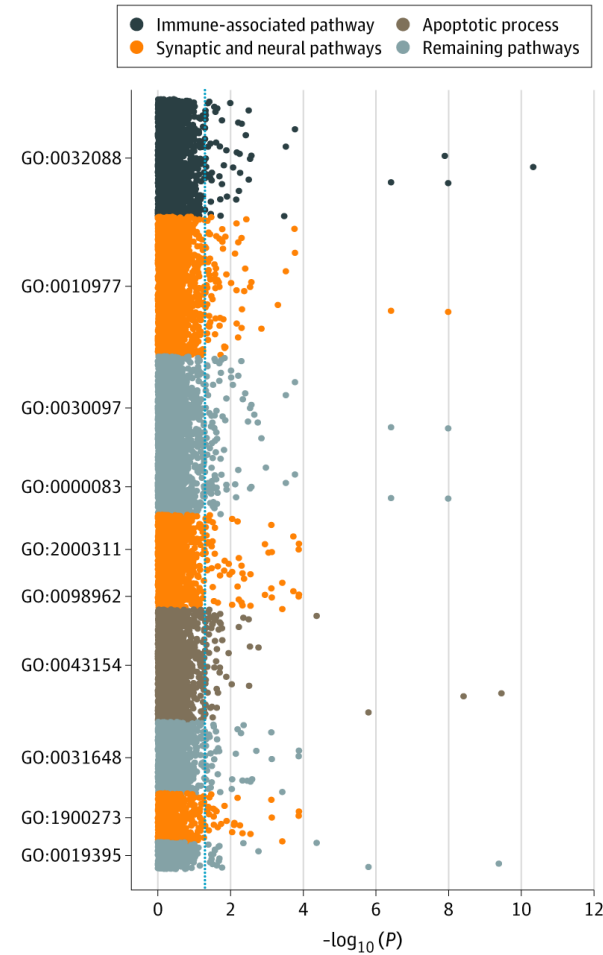
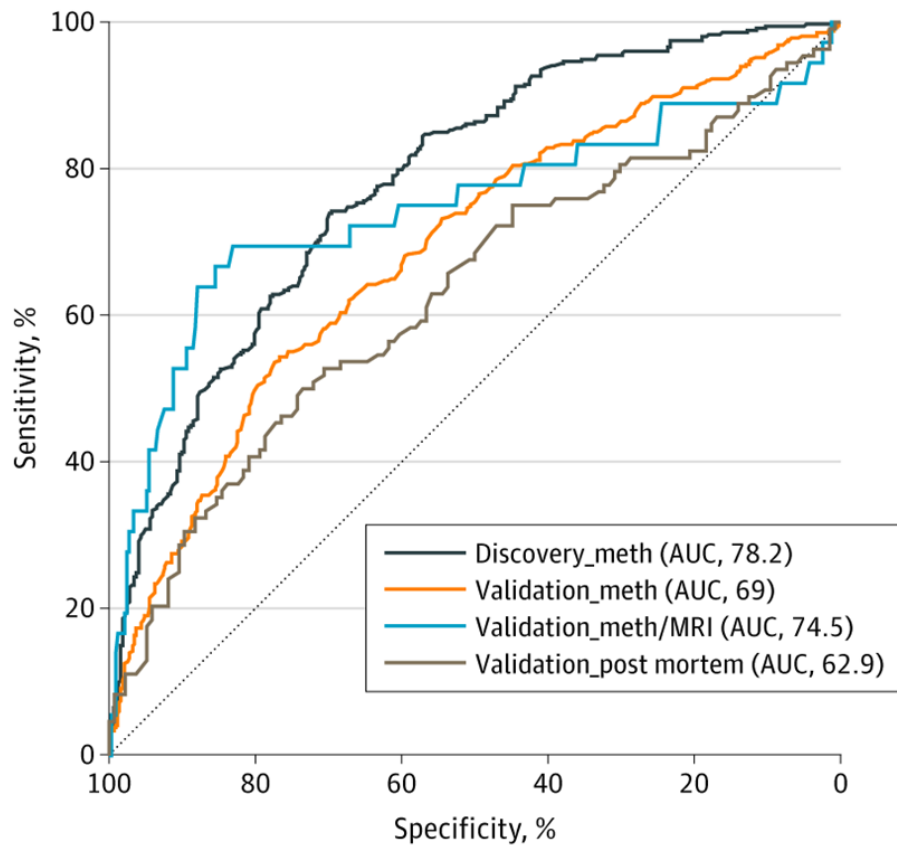
Schizophrenie-bezogene Epigenetik: vom Bluttest zu zellulären und hirnbezogenen Phänotypen



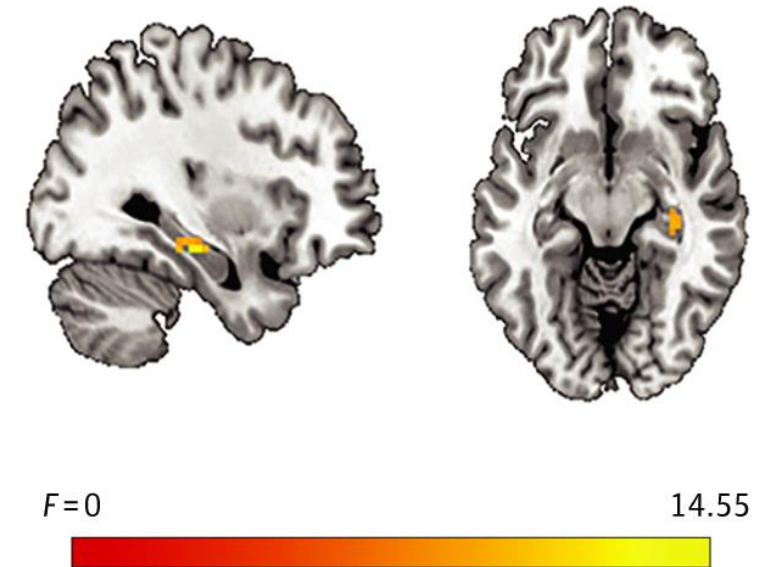
Cohort	Tissue	Status	Sex (m/f)	Age	Methylation	Genotype	Imaging
discovery_{Meth}	Whole Blood	Control	142/180	37.7±15.2	322		
		Case	254/99	43.7±14.7	353		
Control		319/114	45.0±12.1	433			
Case		283/131	46.6±13.6	414			
validation_{Meth}		Control	216/225	29.7±11.4	441	246	263
		Case	28/8	33.8±10.4	36		
validation_{Meth/MRI}		Control	73/90	27.1±8.8	163	142	163
		Case					
validation_{MRI}	brain	Control	90/46	46.5±16.1	136		
		Case	59/49	52.7±14.5	108		

Chen et al., **JAMA Psychiat** 2020

Machine learning for multivariate biomarkers: Reproducible Epigenetic Risk Profile for Schizophrenia With Brain Methylation and Function



A Validation methylation/MRI

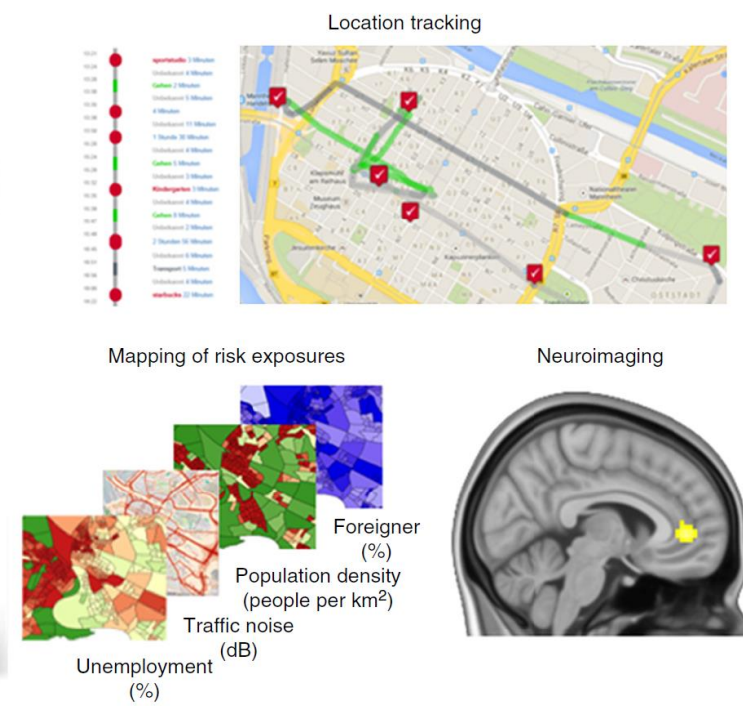
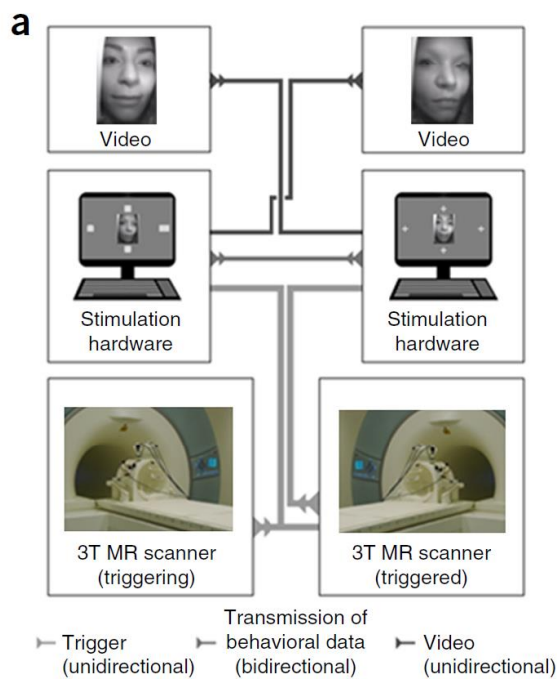


Mobiltelefone als Diagnostik-Tools

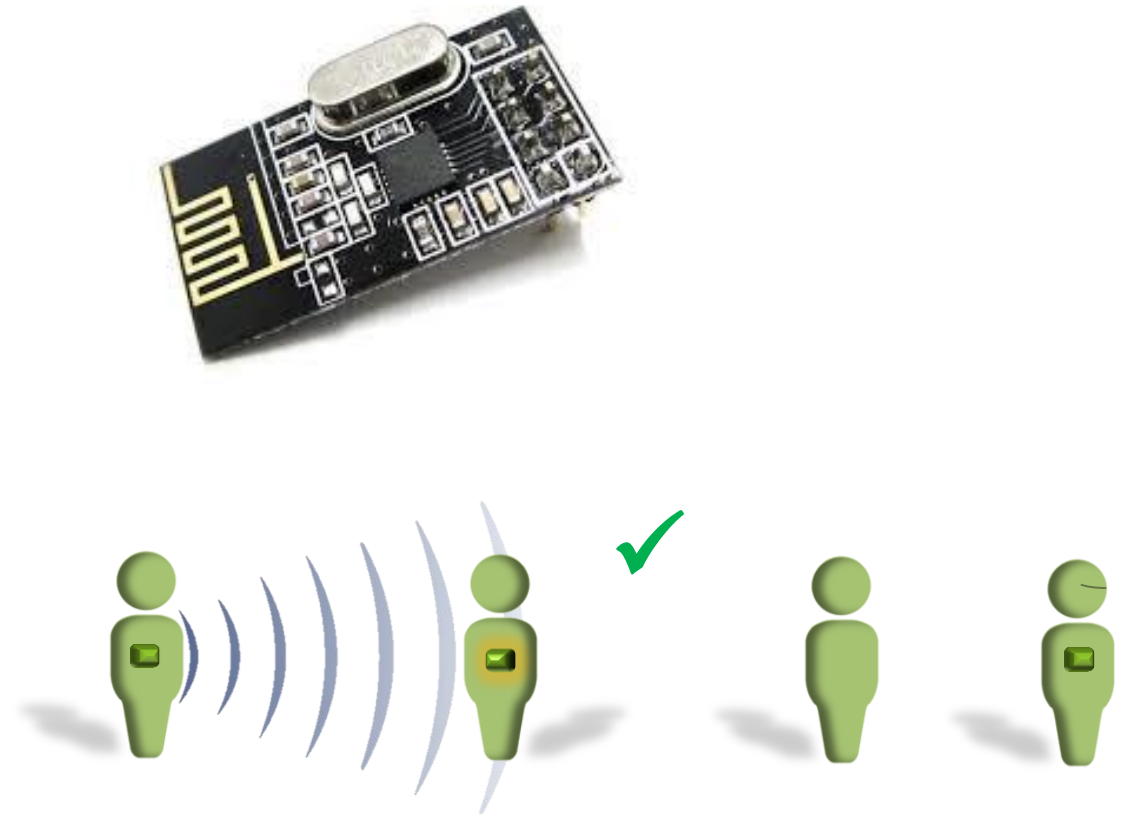
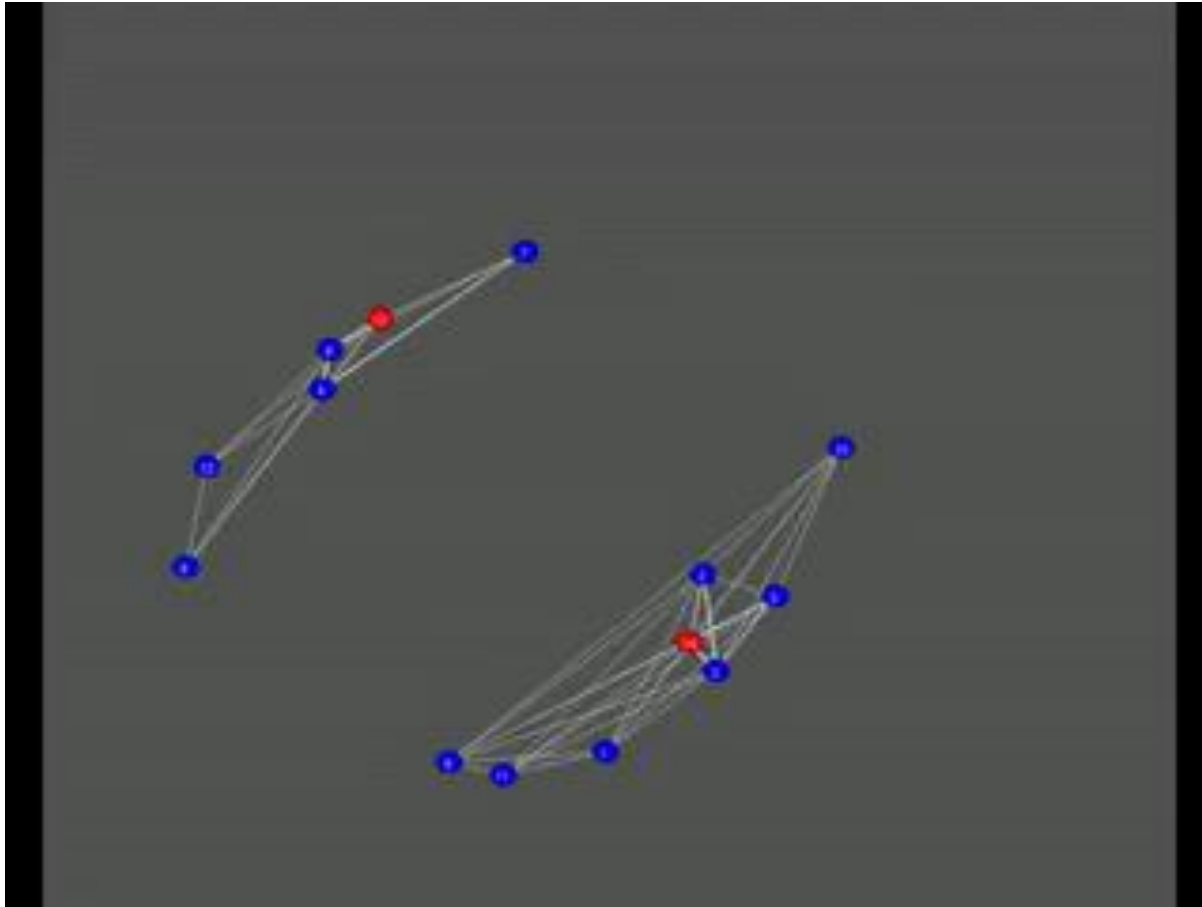


- Weltweit stehen mehr Mobiltelefone zur Verfügung als Zahnbürsten oder gar Toiletten
- Mobiltelefone haben zentrale Rolle in der Lebensplanung, Lebensgestaltung und Informationsgewinnung
- Personen vertrauen sich Mobiltelefonen gegenüber leichter an als gegenüber Paper-Pencil
- Vertrauensunterschied Staat versus private Unternehmer (z.B. Health Tracker und Sport-Apps)
- Heute sind Online-Angebote die zentrale Quelle wenn es um Gesundheitsinformationen und Informationen zur psychischen Gesundheit geht (Skinner et al. 2003; PEW Research 2013)
- Behandlungsentscheidungen und Suche nach Behandlungsformen erfolgen web-informiert

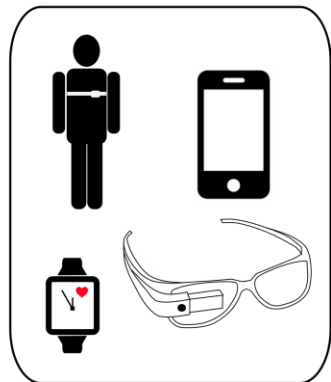
„Big data“ aus der Lebenswelt: Ecological momentary assessment



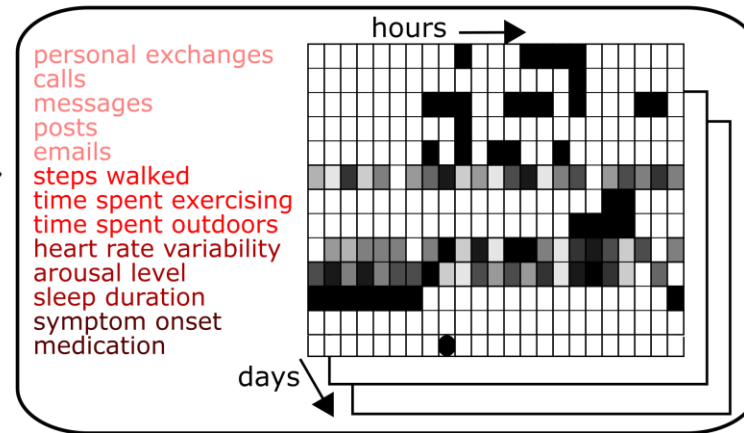
Neue Sensoren



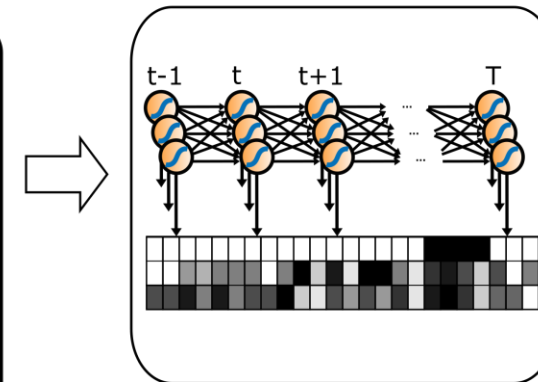
raw EMA & sensor data



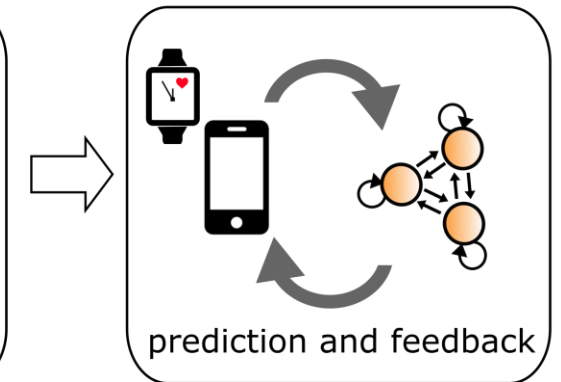
multimodal feature extraction



RNN training



risk forecast & intervention



Durstewitz, Koppe und Meyer-Lindenberg, **Mol Psych** 2019


```
Welcome to

      EEEEE LL      IIII  ZZZZZ  AAAAA
      EE     LL     II     ZZ    AA   AA
      EEEEE LL     II     ZZ    AAAAAA
      EE     LL     II     ZZ    AA   AA
      EEEEE LLLLL IIII  ZZZZZ  AA   AA

Eliza is a mock Rogerian psychotherapist.
The original program was described by Joseph Weizenbaum in 1966.
This implementation by Norbert Landsteiner 2005.

ELIZA: Is something troubling you ?
YOU:   Men are all alike.
ELIZA: What is the connection, do you suppose ?
YOU:   They're always bugging us about something or other.
ELIZA: Can you think of a specific example ?
YOU:   Well, my boyfriend made me come here.
ELIZA: Is it important to you that your boyfriend made you come here ?
YOU:   He says I'm depressed much of the time.
ELIZA: I am sorry to hear that you are depressed.
YOU:   It's true. I am unhappy.
ELIZA: Can you explain what made you unhappy ?
YOU:
```

Question:

A 12-year-old girl is brought to the emergency department by her mother because of a 1-week history of worsening leg swelling. The patient also noticed blood in her urine yesterday. The bleeding has not recurred. She had an upper respiratory tract infection and sore throat 1 week ago that caused her to miss several days of school. Medical history is otherwise unremarkable, and she takes no routine medications. Menarche has not yet occurred. BMI is 20 kg/m². Vital signs are temperature 37.0°C (98.6°F), pulse 78 beats/min, respiratory rate 12 breaths/min, and blood pressure 136/84 mm Hg. Pulse oximetry while the patient is breathing ambient air shows an oxygen saturation of 100%. Physical examination shows erythema of the posterior pharynx, mild cervical lymphadenopathy, and 3+ pitting edema in both knees. Results of urinalysis are shown:

Protein	150 mg/dl
Blood	Positive
Leukocyte esterase	Positive
Nitrite	Negative
White cells	5–10/high-power field
Red cells	10–25/high-power field
Casts	1–2/low-power field

Results of which of the following laboratory studies are most likely to be abnormal in this patient?

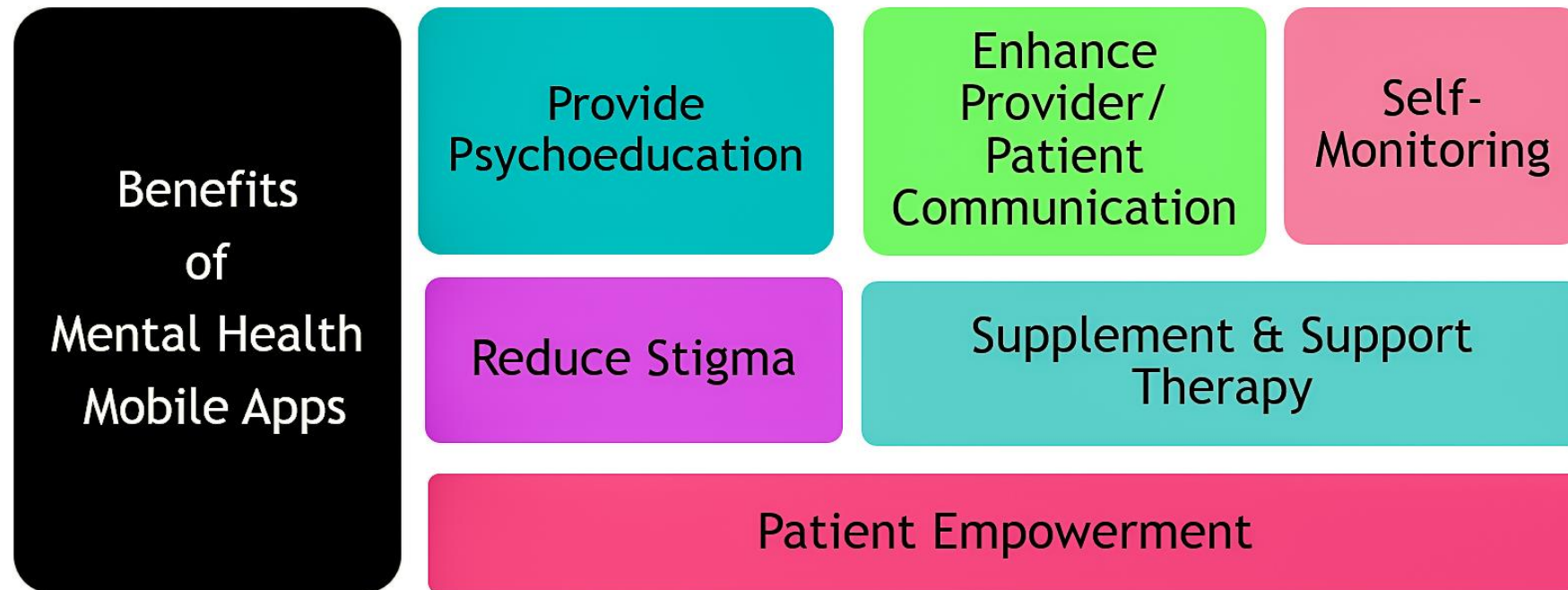
- (A) Bleeding time
- (B) Erythrocyte count
- (C) Serum concentration of C3
- (D) Serum IgA concentration
- (E) Serum rheumatoid factor assay

The correct answer is (C) Serum concentration of C3. This patient has signs and symptoms of acute poststreptococcal glomerulonephritis (APSGN), a type of glomerular disease that typically occurs 1 to 3 weeks after a streptococcal infection of the skin or pharynx. APSGN is mediated by immune complexes that deposit in the glomerular basement membrane and activate the complement pathway, leading to inflammation, hematuria, proteinuria, and reduced glomerular filtration rate. The resulting fluid retention causes hypertension and edema. The serum C3 level is usually low in APSGN, reflecting complement consumption. The other laboratory studies listed are normal or not relevant in APSGN. Bleeding time is a measure of platelet function, which is not affected by APSGN. Erythrocyte count may be slightly elevated due to hemoconcentration, but not significantly. Serum IgA concentration is elevated in IgA nephropathy, another type of glomerular disease that can cause hematuria and proteinuria, but it is not associated with streptococcal infection or low C3 level. Serum rheumatoid factor assay is used to diagnose rheumatoid arthritis, an autoimmune disorder that does not cause APSGN.

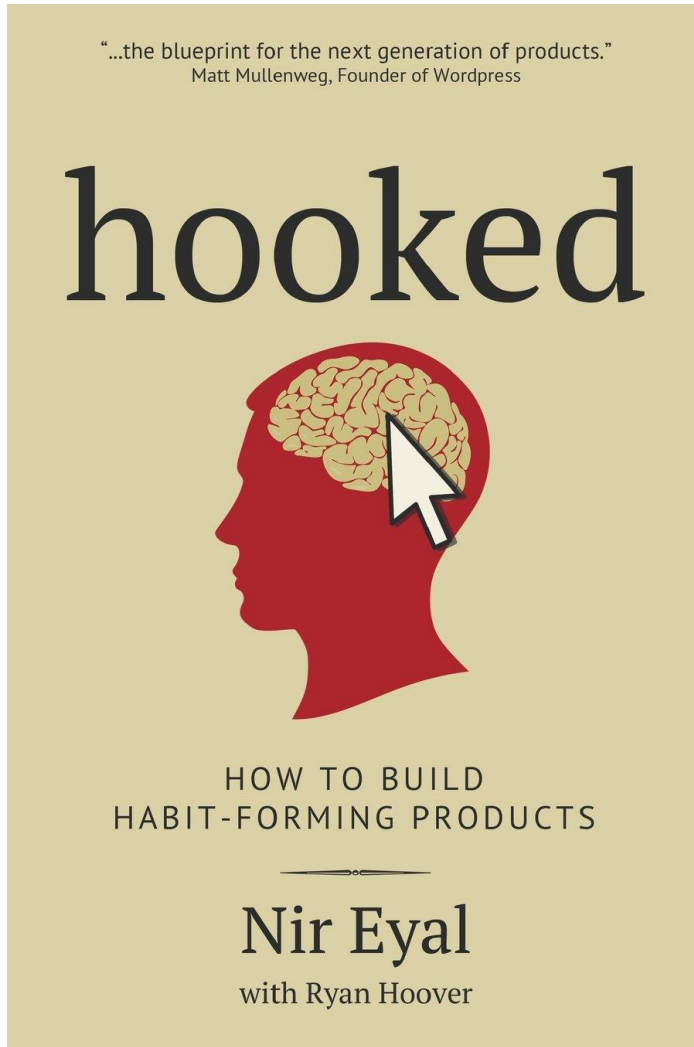
Haug and Drazen, *N Engl J Med* 2023

RELATER - Removing language barriers in treating refugees

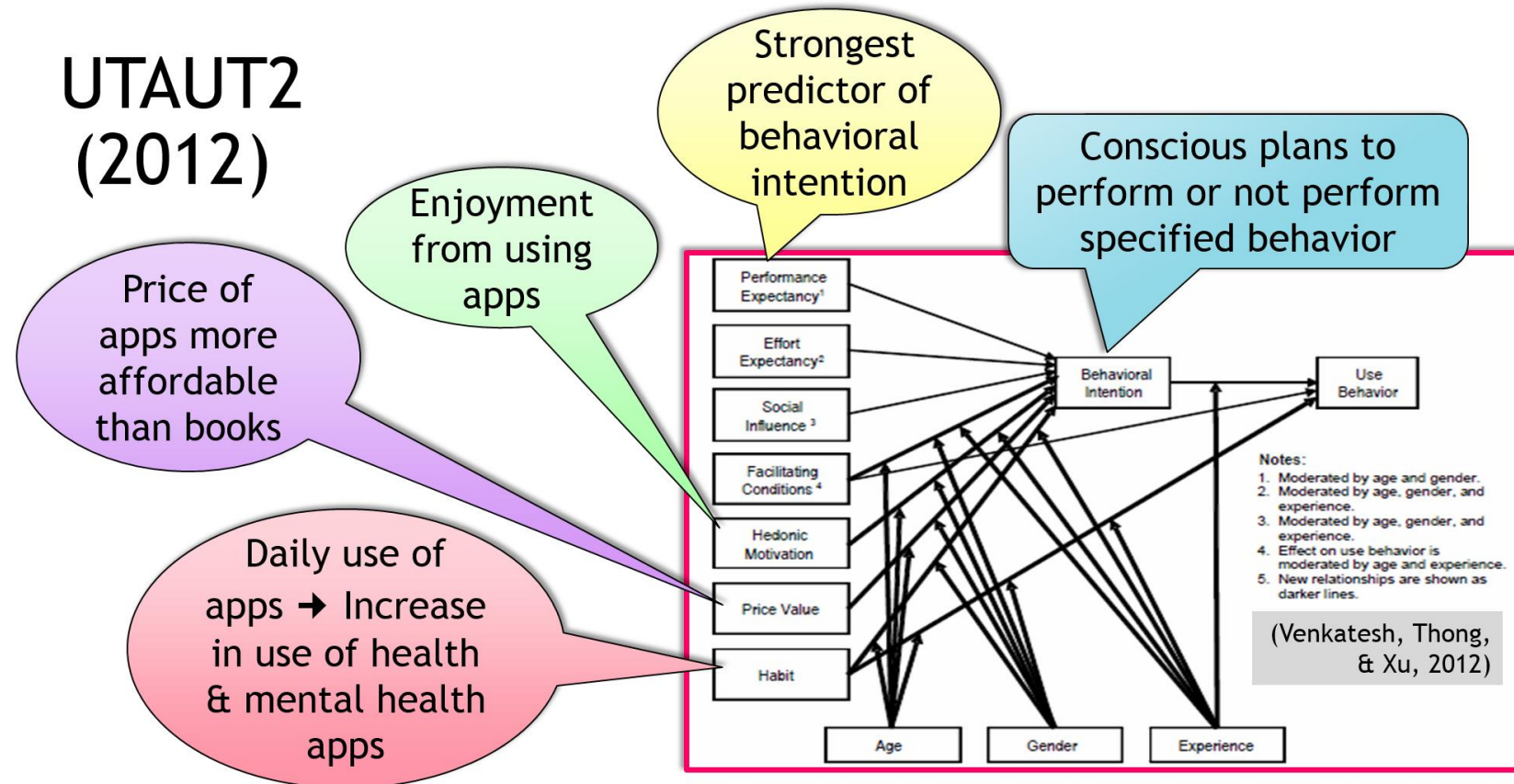




Machen Apps abhängig?



UTAUT2 (2012)



Gamification



Virtuelle Realität und Psychotherapie



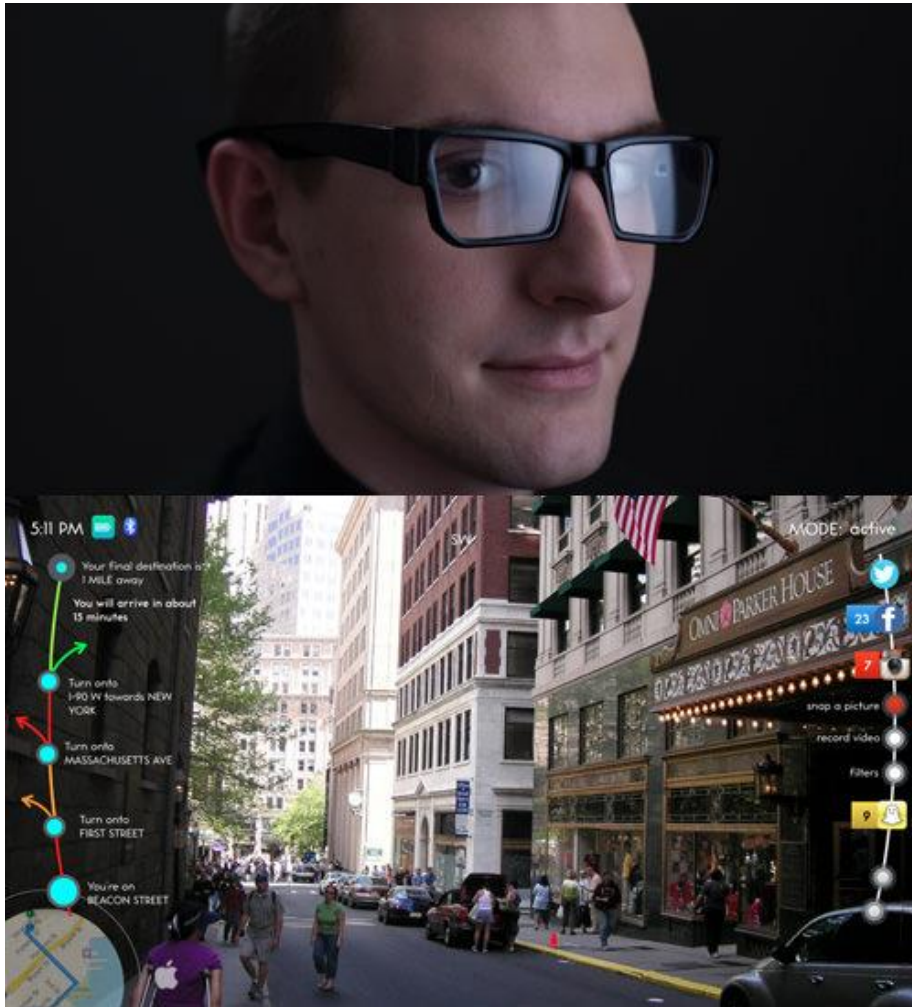
Zentralinstitut für
Seelische Gesundheit
Landesstiftung
des öffentlichen Rechts



Augmentierte Realität und Psychiatrie



Zentralinstitut für
Seelische Gesundheit
Landesstiftung
des öffentlichen Rechts



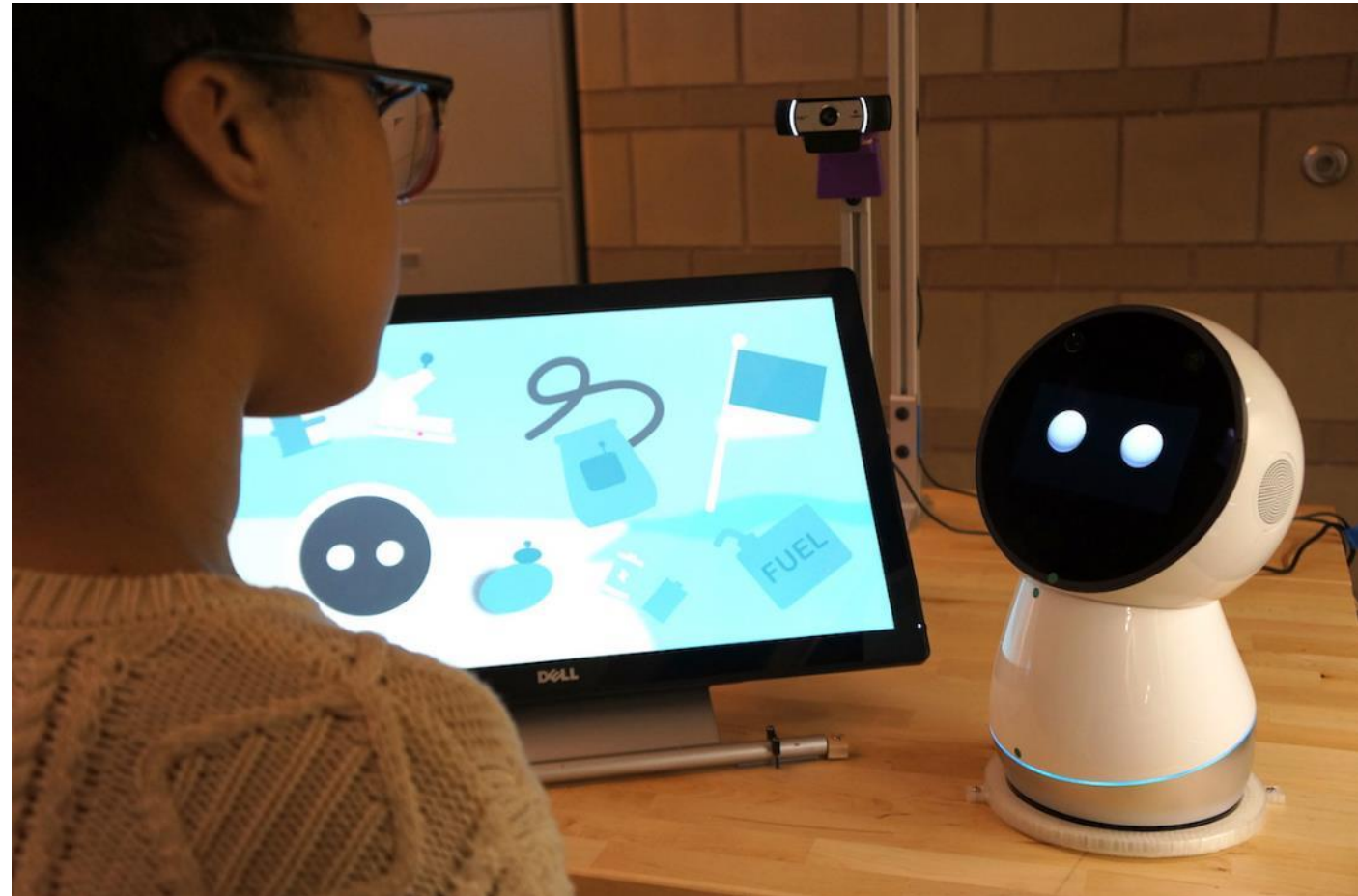
Soziale Roboter



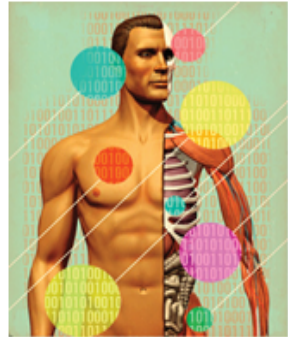
Soziale Roboter - Demenz



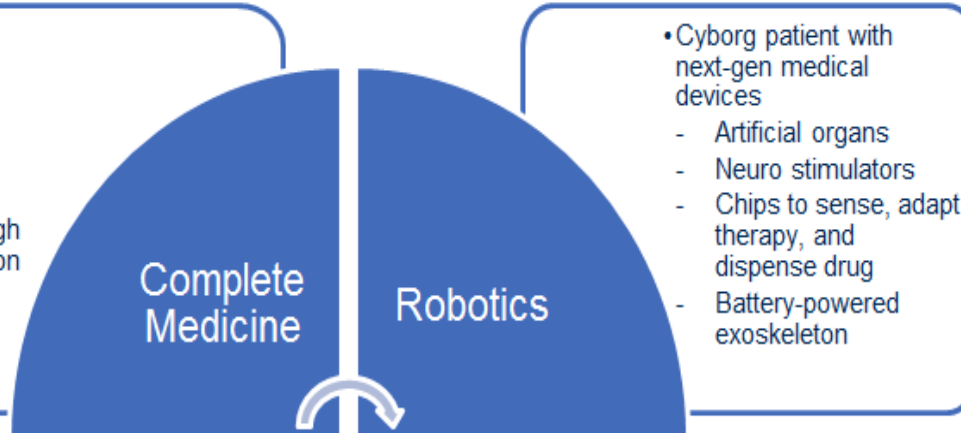
Soziale Roboter - Autismus



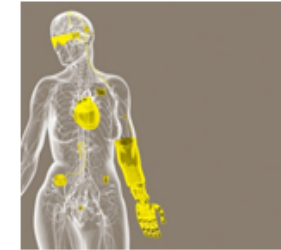
Chancen



- P4 Medicine [Leroy Hood]:
 - Predictive, Preventive, Personalize, Participatory medicine through empirical data on bio molecules and activity



- Cyborg patient with next-gen medical devices
 - Artificial organs
 - Neuro stimulators
 - Chips to sense, adapt therapy, and dispense drug
 - Battery-powered exoskeleton



https://youtu.be/w_0stlqq5g



- IBM's Dr. Watson see you soon...
 - Diagnostics
 - Preventive medicine
 - Prescriptive medicine



- Capitalize on minutely and continuously observed activity and diagnostics
 - Google
 - Apple
 - Samsung, etc.
- Predict transplant outcome



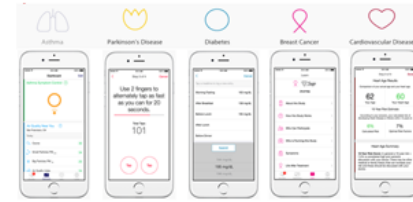
... und Risiken der KI in der Psychiatrie



Google Life Sciences Recruiting Top Brain Scientist

Google Life Sciences is recruiting top brain scientists to advance research in areas such as Alzheimer's disease, Parkinson's disease, and cancer. The graphic features images of Google Fit, Smart Contact Lenses, and Cancer Research, alongside the Google and Apple logos.

Apple Research Tool Kit



FDA seeks lessons from remote clinical trials

FDA is gathering feedback from various stakeholders on the "scope and direction of the use of technologies and innovative methods in the conduct of clinical investigations."

IBM Watson Health logo and icons representing natural language understanding, adaptation, learning, hypothesis evaluation, and data analysis.



Mit digitalen Produkten zufrieden sind Anwender nur, wenn sie einen echten Mehrwert dahinter sehen. Foto: JEFF SWENSEN/NYT /Redux/laif

POLITIK

Big Data und Gesundheit: Viele Hoffnungen, viele Ängste

Dtsch Arztebl 2015; 112(23): A-1026 / B-861 / C-834

Krüger-Brand, Heike E.



Artikel Briefe & Kommentare Statistik

Die wachsende Flut digitaler Daten wirft vor allem in der Medizin und im Umgang mit sensiblen Gesundheitsdaten ethische Fragen auf.



Foto: Fotolia WavebreakmediaMicro

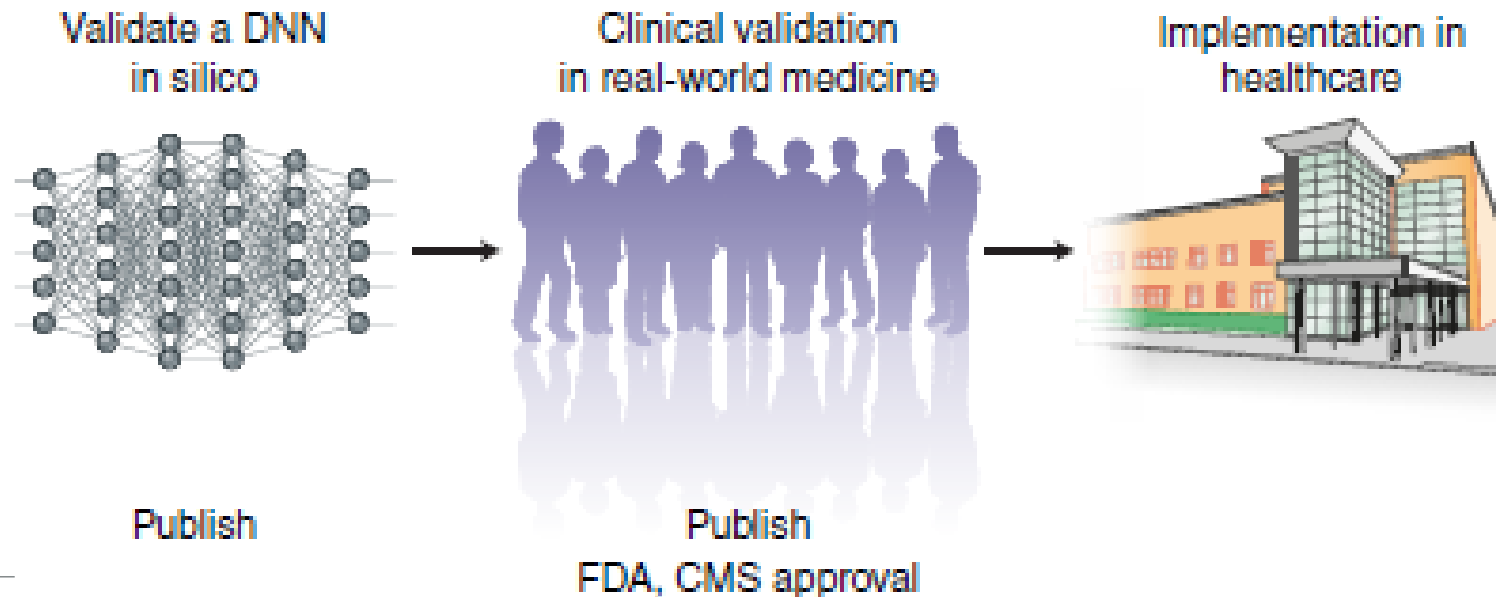
Big Data – das massenhafte Sammeln und Speichern von Daten, ihre Verknüpfung und Nutzung – verspricht große Fortschritte in der Medizin, birgt aber auch Risiken und wirft daher ethische und rechtliche Fragen auf. „Die Vermessung des Menschen – Big Data und Gesundheit“ lautete das Thema der diesjährigen Jahrestagung des Deutschen Ethikrates in Berlin, zu der sich mehr als 500 Teilnehmer einfanden. Zu den Rednern gehörte unter anderem auch der EU-Kommissar für Digitale Wirtschaft und Gesellschaft, Günther Oettinger.

Rahmenbedingungen der KI in der Medizin



- „Die Bundesregierung wird prüfen, wie **Transparenz, Nachvollziehbarkeit und Überprüfbarkeit** der KI-Systeme hergestellt werden können, um einen effektiven **Schutz gegen Verzerrungen, Diskriminierungen, Manipulationen** oder sonstige missbräuchliche Nutzungen insbesondere beim Einsatz von algorithmenbasierten Prognose- und Entscheidungssystemen zu ermöglichen.“ (KI-Strategie der Bundesregierung, November 2018)

From AI algorithm to changing medical practice



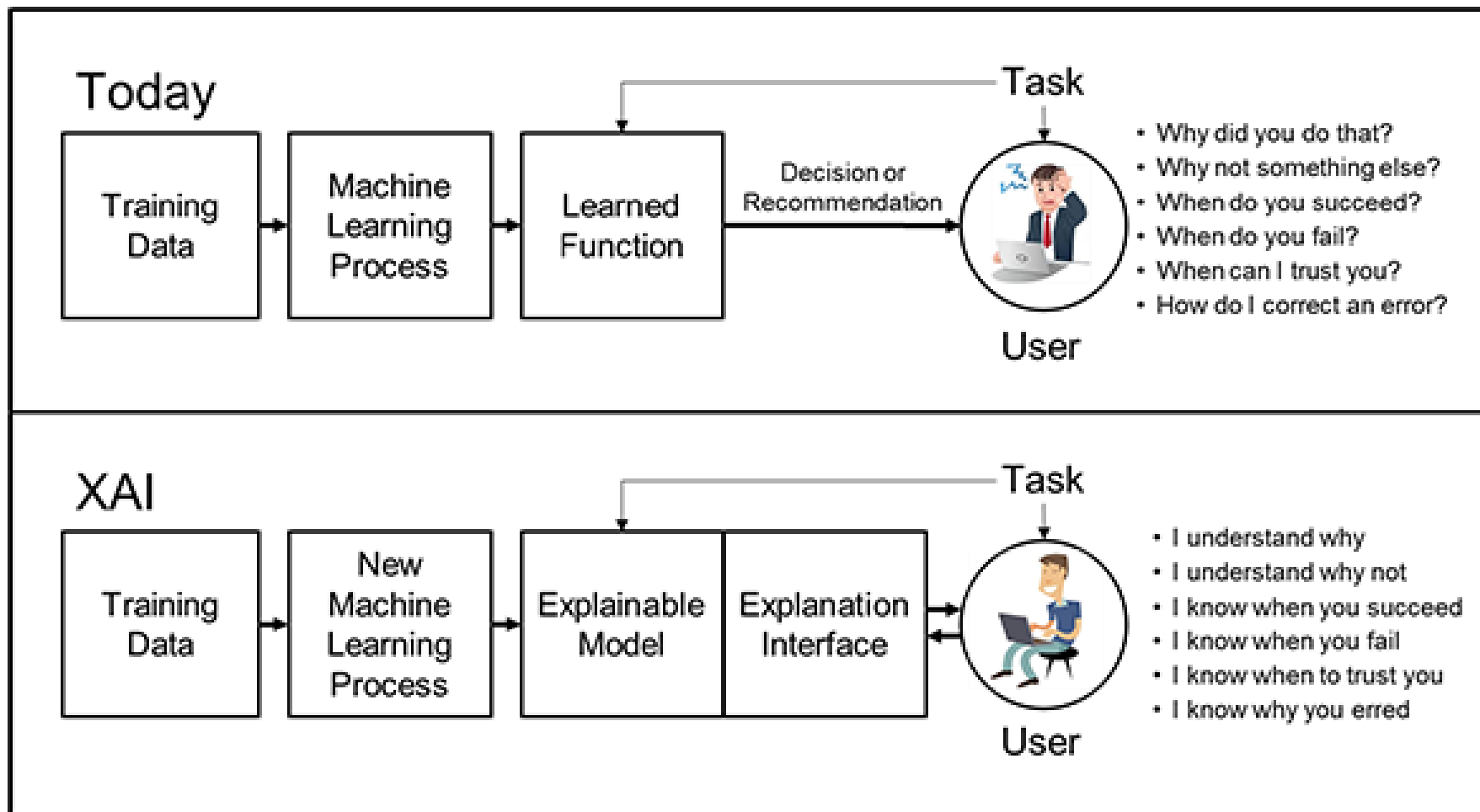
Big Data und Gesundheit –
Datensouveränität als
informationelle Freiheitsgestaltung

STELLUNGNAHME



Source: DEV
Community,
<https://medium.com/eximius-ventures/web-3-0-101-c75cda55f0fa>

Wie entstehen die AI-Entscheidungen? – Explainable AI



<https://www.darpa.mil/program/explainable-artificial-intelligence>

Medizin und autonomes Fahren: Analogien



Human driver monitors environment			System monitors environment		
0 No automation The absence of any assistive features such as adaptive cruise control.	1 Driver assistance Systems that help drivers maintain speed or stay in lane but leave the driver in control.	2 Partial automation The combination of automatic speed and steering control—for example, cruise control and lane keeping.	3 Conditional automation Automated systems that drive and monitor the environment but rely on a human driver for backup.	4 High automation Automated systems that do everything—no human backup required—but only in limited circumstances.	5 Full automation The true electronic chauffeur: retains full vehicle control, needs no human backup, and drives in all conditions.

Humans and machine doctors					
0 Now	1 Now	2 Now	3 Now	4 Unlikely	5 Unlikely

Topol Nat Med 2019

Vielen Dank
für Ihre Aufmerksamkeit

www.zi-mannheim.de
info@zi-mannheim.de

