



Artificial intelligence will make doctors obsolete?

Prof. Dr. Jörg Goldhahn

Deputy head of the Institute for Translational Medicine, ETH Zurich

Medical director of the new bachelor in medicine at ETH Zurich, Switzerland

With material from Vanessa Rampton, McGill University Montreal, Canada

The
Branco Weiss
Fellowship
Society in Science

About ETH founded in 1855 as a «center for innovation and knowledge»



20,600 students, incl.
4,000 doctoral students,
from over 120 countries



407 spin-offs since 1996



90 patent applications and
200 invention reports every year



530 professors



21 Nobel Prize winners, incl. Albert
Einstein and Wolfgang Pauli
2 Fields Medal winners
2 Pritzker Prize winners



11th in THE ranking (2018/19)
7th in QS ranking (2018/19)
19th in ARWU ranking (2018/19)

Medical research at ETH



Tadeus Reichstein



Vladimir Prelog



Leopold Ruzicka



Richard Ernst



Kurt Wüthrich

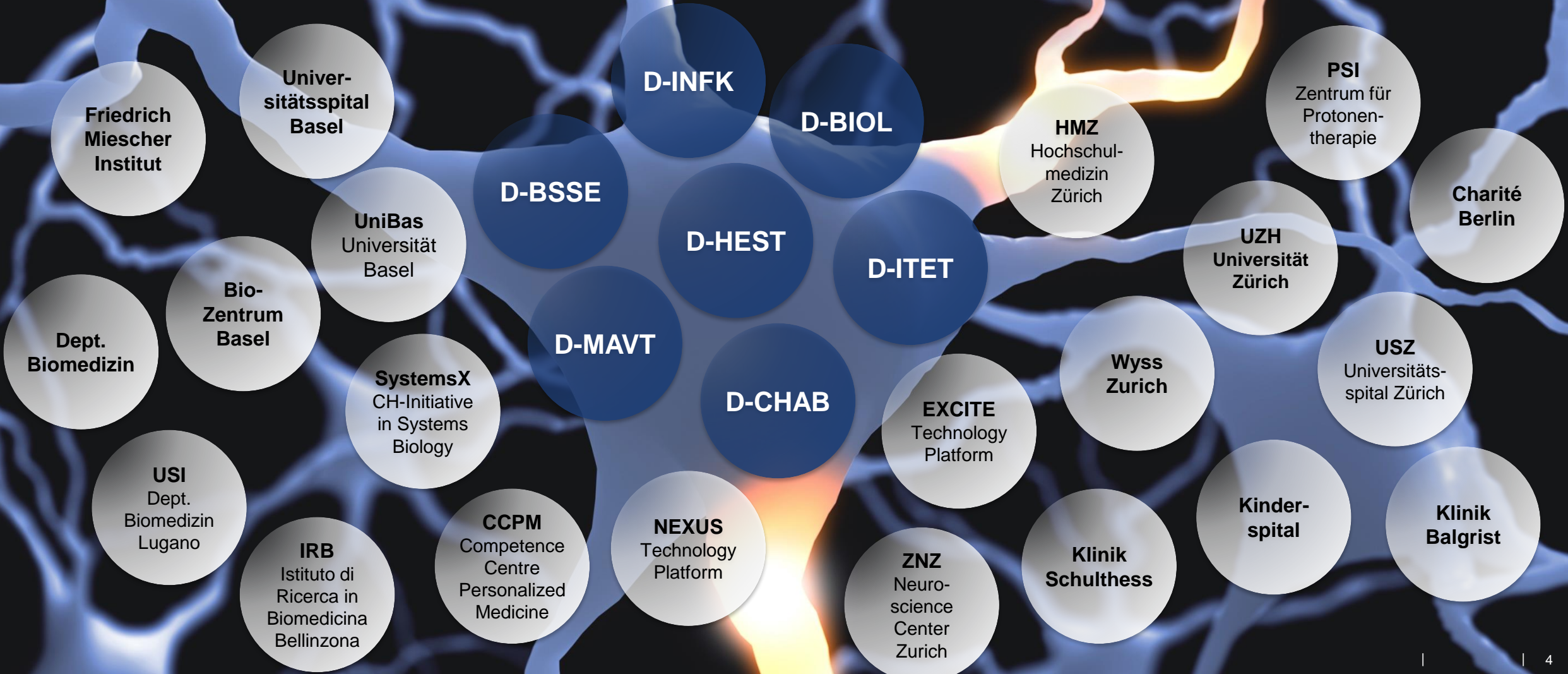
Department for Health sciences and technology *since 2012*



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Observations

Why Doctors Reject Tools That Make Their Jobs Easier

From the thermometer's invention onward, physicians have feared—incorrectly—that new technology would make their jobs obsolete

By Gina Siddiqui on October 15, 2018

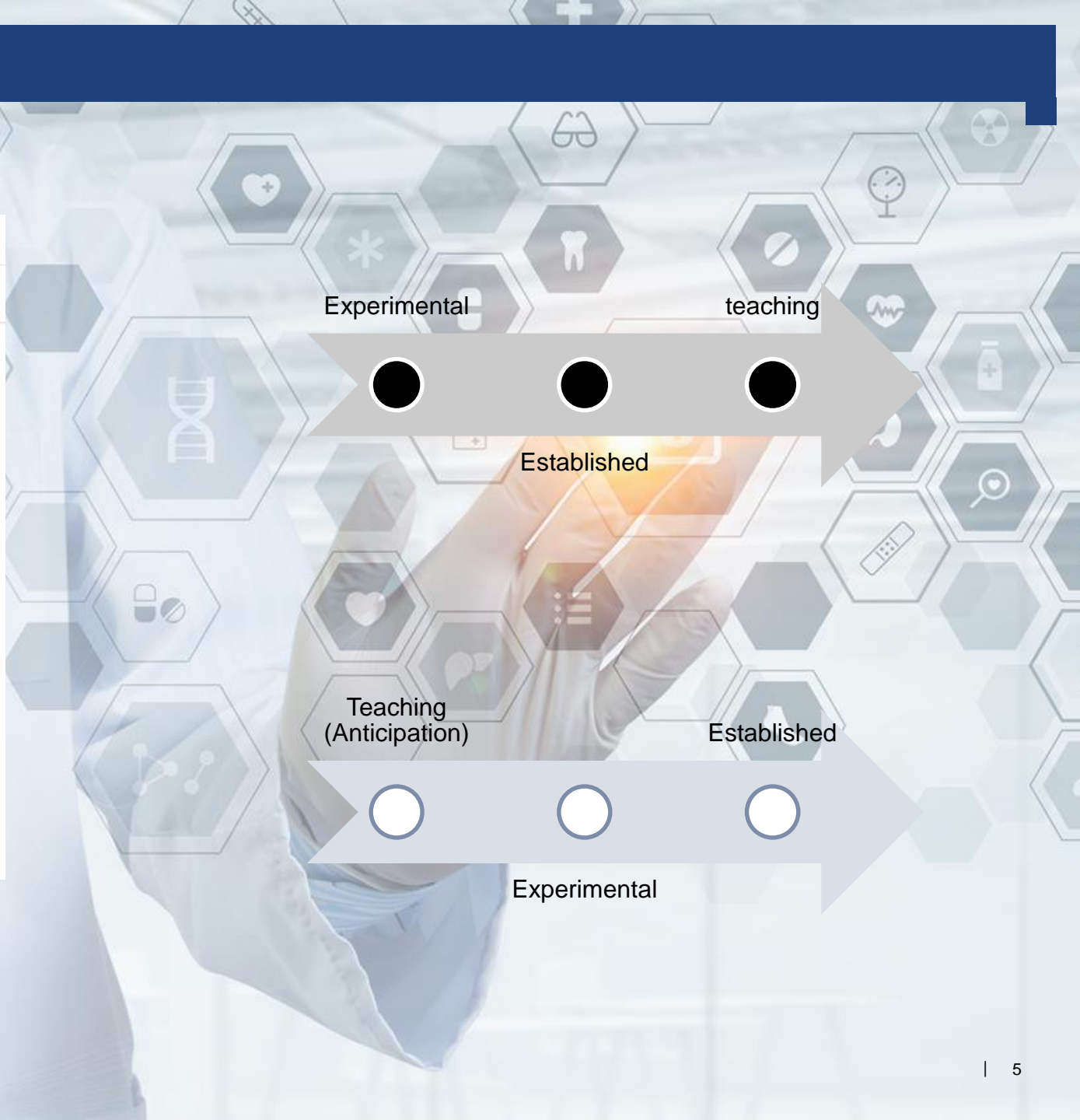
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l e b

LATEST NEWS

A Machine Gets High Marks for Diagnosing Sick Children

How Climate Change May Affect Winter "Weather Whiplash"

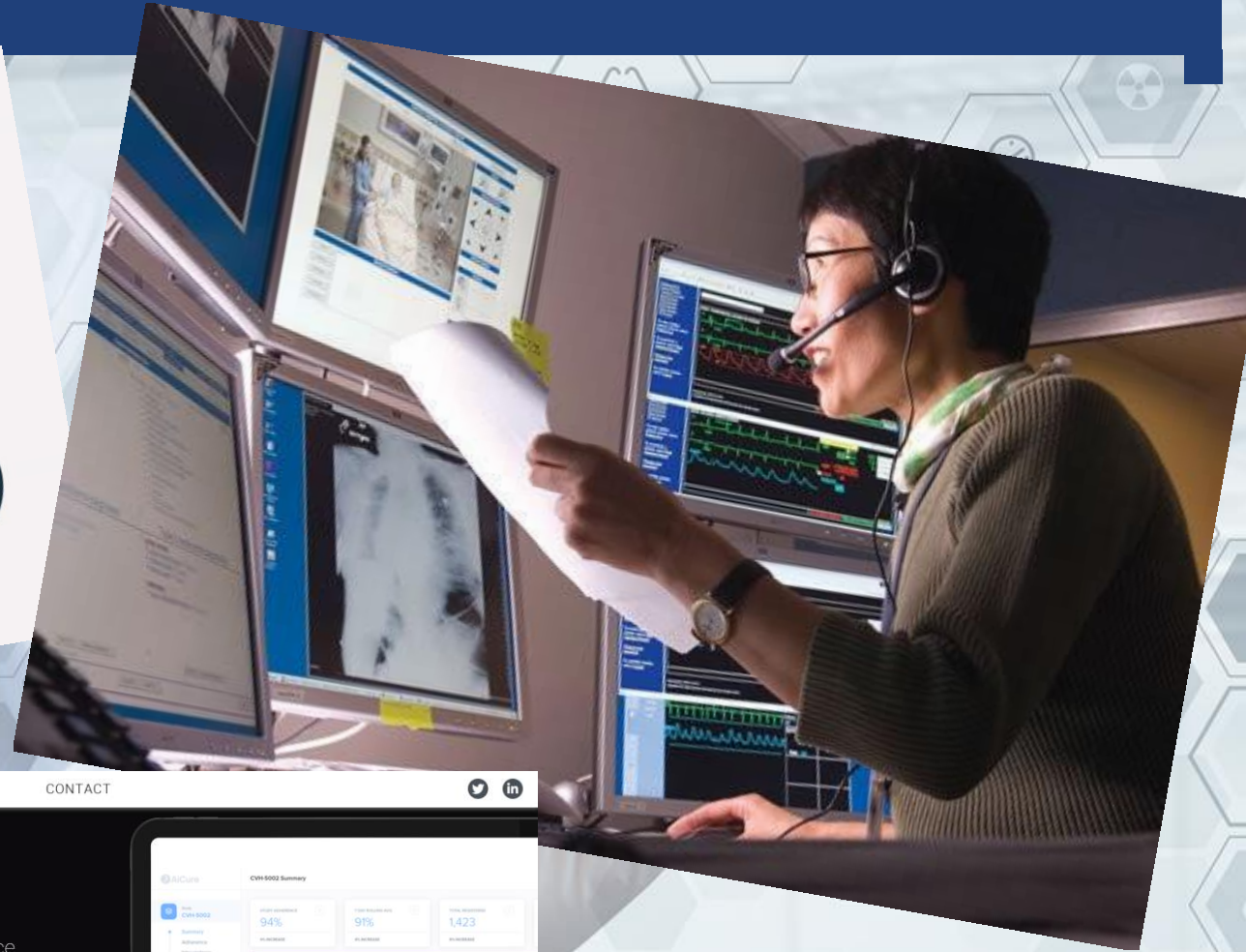


Examples

Markets Product News About Us Careers **REQUEST A DEMO**

SENSELY

EXPLORE
Characters
Conversation
Integration
Content



HOME DATA INSIGHTS COMPANY CONTACT

Adherence
Retention
Deception
Digital Biomarkers

CVH 5002 Summary

Adherence: 94%
Retention: 91%
Total Population: 1,423

Measure	Series	Population
ADHERENCE	Adherence	94%
	Retention	91%
RETENTION	Adherence	94%
	Retention	91%
DECEPTION	Adherence	94%
	Retention	91%
DIGITAL BIOMARKERS	Adherence	94%
	Retention	91%

Examples

Exponential Medicine
@ExponentialMed

Australian researchers have developed a new #vaccine believed to be the first in the world to be designed by #AI (via @BIAUS) businessinsider.com.au/australian-res...



Australian researchers just released the world's first AI-developed vaccine
A team at Flinders University in South Australia has developed a new vaccine believed to be the first human drug in the world to be designed by AI. businessinsider.com.au

Home > DocWire Picks > IDx-DR, the First FDA-Approved AI System, is Growing Rapidly

2 10:10

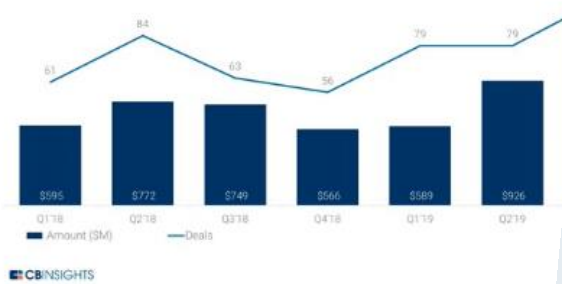
IDx-DR, the First FDA-Approved AI System, is Growing Rapidly

By [Jack Carfagno](#) - November 12, 2019

Eric Topol @EricTopol

The surge in #AI-#healthcare investments @CBinsights cbinsights.com/reports/CB-Ins... time will tell: ? smart money

AI in healthcare funding reaches a new high in VC-backed deals and financing to healthcare AI startups, Q1'18 - Q3'19



51 11:46 PM - Nov 7, 2019

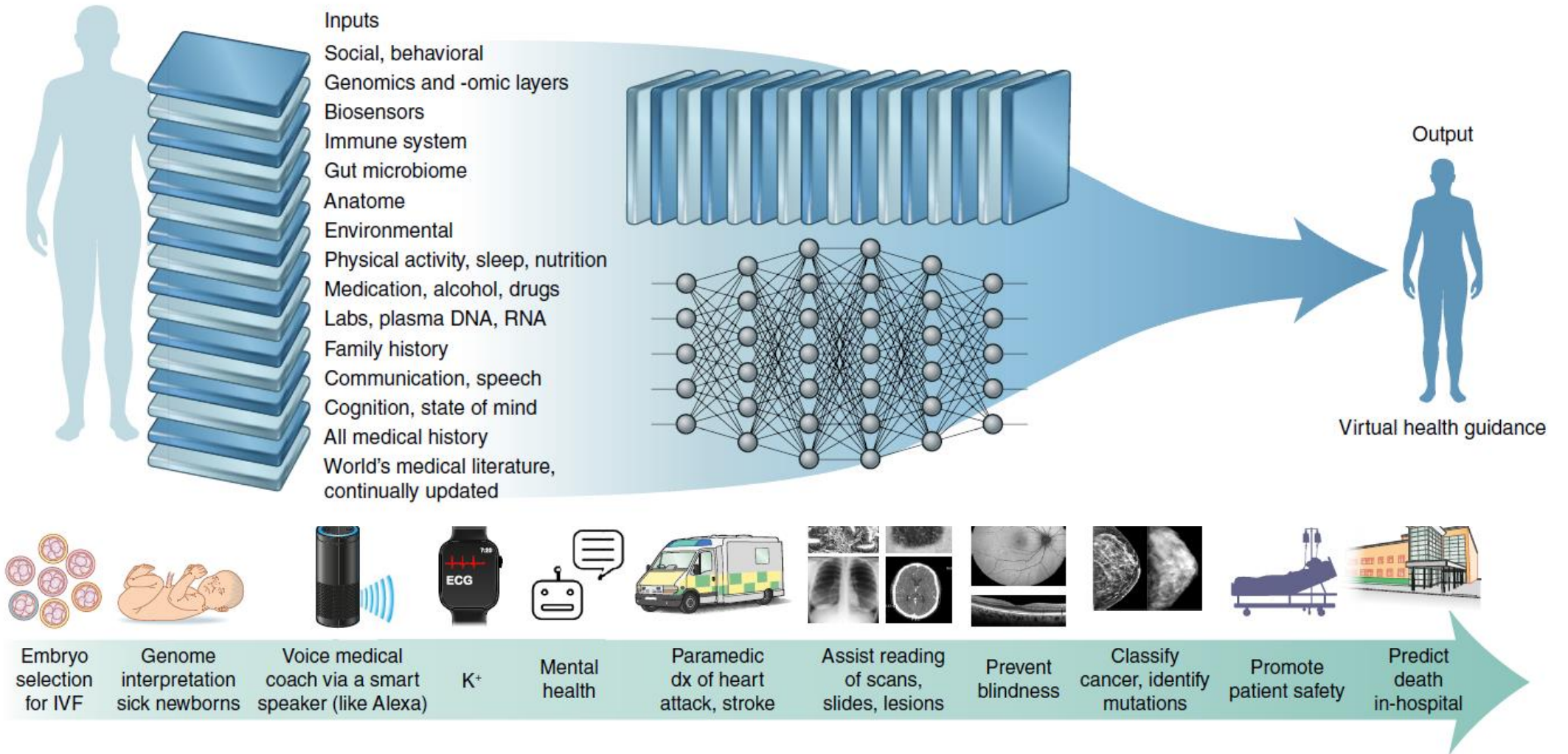
Eric Topol @EricTopol

Deep learning #AI from a single chest X-ray to predict long term mortality jamanetwork.com/journals/jaman... @JAMANetworkOpen by Michael Lu and colleagues

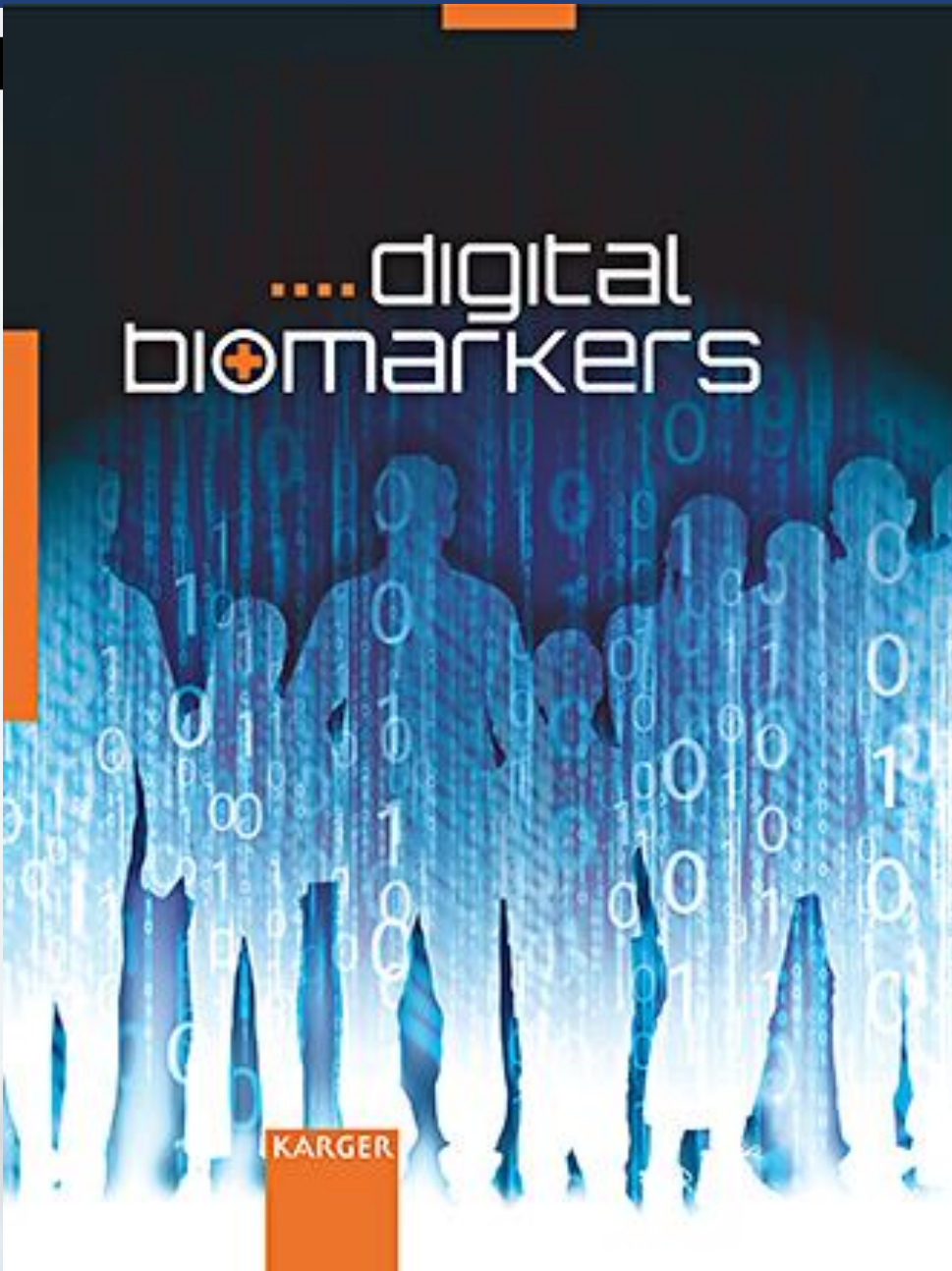


Company	FDA Approval	Indication
Apple	September 2018	Atrial fibrillation detection
Aidoc	August 2018	CT brain bleed diagnosis
iCAD	August 2018	Breast density via mammography
Zebra Medical	July 2018	Coronary calcium scoring
Bay Labs	June 2018	Echocardiogram EF determination
Neural Analytics	May 2018	Device 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

Das



High-performance medicine: the convergence of human and artificial intelligence.
 Topol E. Nature Medicine, Vol 44 (25): 44–56, 2019



Technological advances impacting healthcare and the magnitude of disruption.

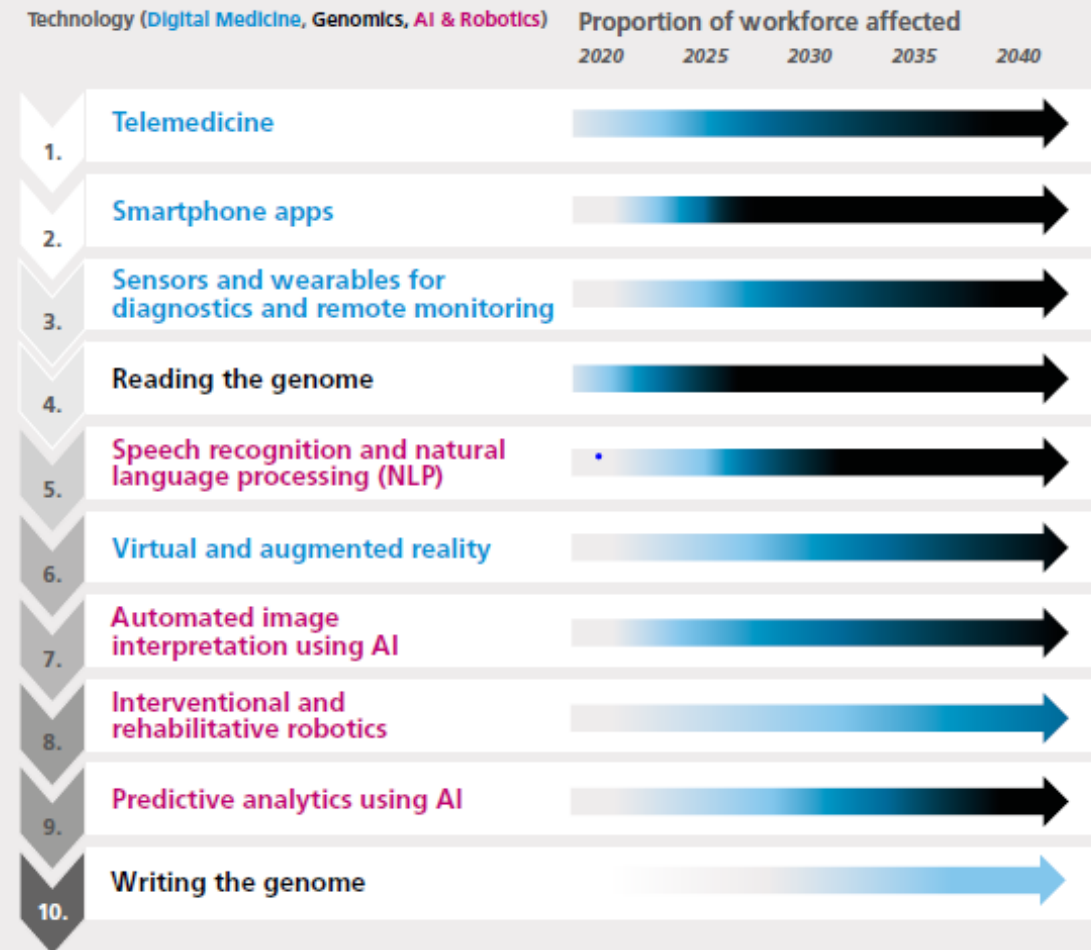


Figure 1: Top 10 digital healthcare technologies and their projected impact on the NHS workforce from 2020 to 2040

Arrow heat map represents the perceived magnitude of impact on current models of care and, by inference, on the proportion of workforce affected

<20%	20%	50%	>=80%

The spark

BMJ 2018;363:k4563 doi: 10.1136/bmj.k4563 (Published 7 November 2018)

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HEAD TO HEAD



Could artificial intelligence make doctors obsolete?

Machines that can learn and correct themselves already perform better than doctors at some tasks, says **Jörg Goldhahn**, but **Vanessa Rampton** and **Giatgen A Spinas** maintain that machines will never be able to replicate the inter-relational quality of the therapeutic nature of the doctor-patient relationship

Doctors [redacted] will become obsolete [redacted]

In the meantime, we should expect stepwise introduction of AI technology in promising areas, such as image analysis or pattern



Could artificial intelligence make doctors obsolete?

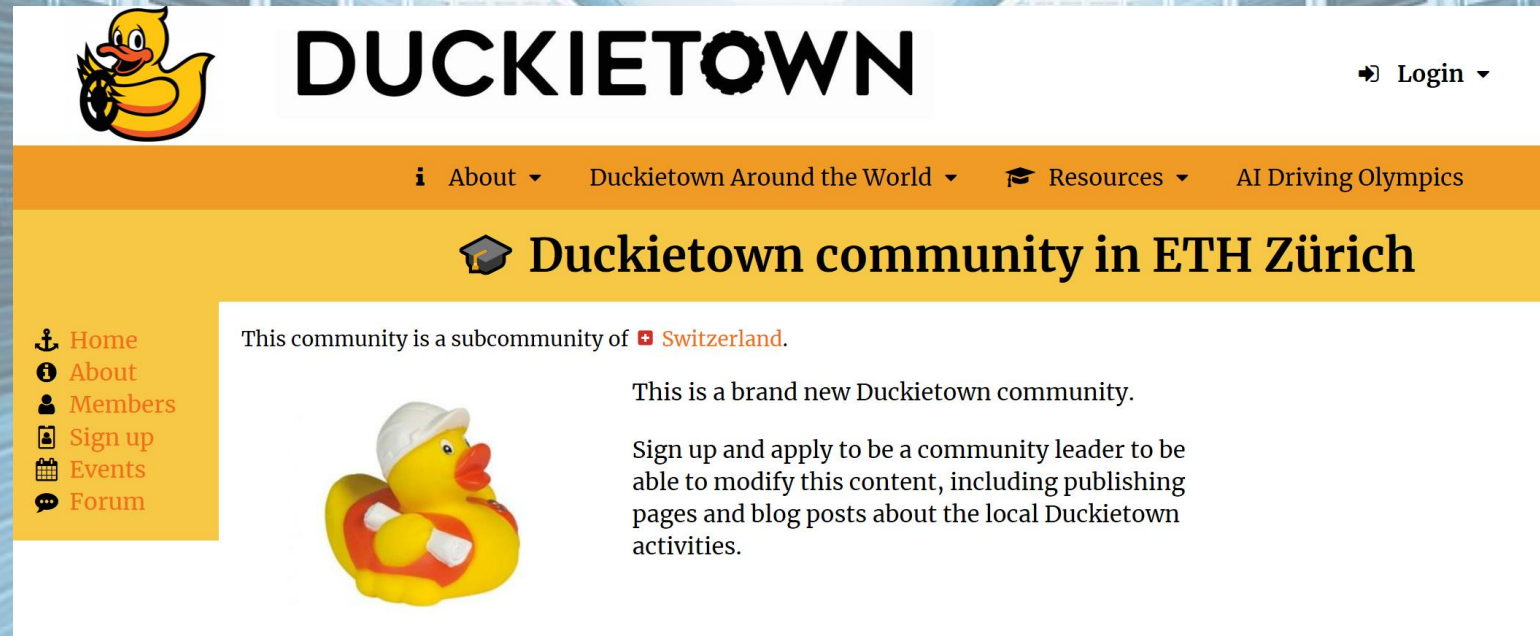
Goldhahn J, Rampton V, Spinas G. BMJ 2018;363:k4563

Definitions of artificial intelligence

- “artificial intelligence (AI), the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings.” Intelligent beings are those that can adapt to changing circumstances (ENCYCLOPÆDIA BRITANNICA)
 - Learning
 - Reasoning
 - Self-correction
- Weak (narrow) AI can only appear to think but is not actually conscious in any sense of the word. Weak AI simply acts upon and is bound by the rules imposed on it and it could not go beyond those rules.
- Strong artificial intelligence (strong AI) is an artificial intelligence construct that has mental capabilities and functions that mimic the human brain.

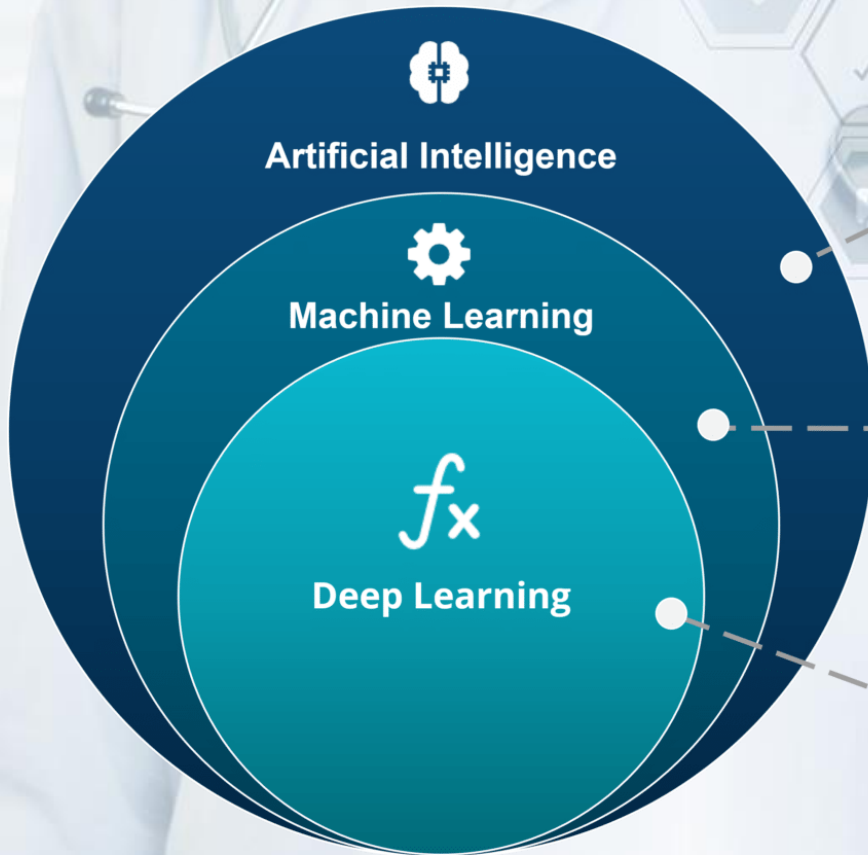
Machine learning

...means that, learning algorithms – not computer programmers – create the rules.



The screenshot shows the Duckietown website interface. At the top left is the Duckietown logo, a yellow duck holding a steering wheel. To its right is the word "DUCKIETOWN" in large, bold, black letters. Further right is a "Login" button with a right-pointing arrow and a dropdown arrow. Below this is a navigation bar with orange background and white text, containing links for "About", "Duckietown Around the World", "Resources", and "AI Driving Olympics". Below the navigation bar is a yellow banner with the text "Duckietown community in ETH Zürich" and a graduation cap icon. On the left side of the page is a vertical menu with orange background and white text, listing "Home", "About", "Members", "Sign up", "Events", and "Forum" with corresponding icons. The main content area has a white background and contains the text "This community is a subcommunity of Switzerland." with a Swiss flag icon. Below this text is a yellow duck wearing a white cap and a red and white life ring. To the right of the duck is the text "This is a brand new Duckietown community." and "Sign up and apply to be a community leader to be able to modify this content, including publishing pages and blog posts about the local Duckietown activities."

From learning to artificial intelligence



ARTIFICIAL INTELLIGENCE

A technique which enables machines to mimic human behaviour

MACHINE LEARNING

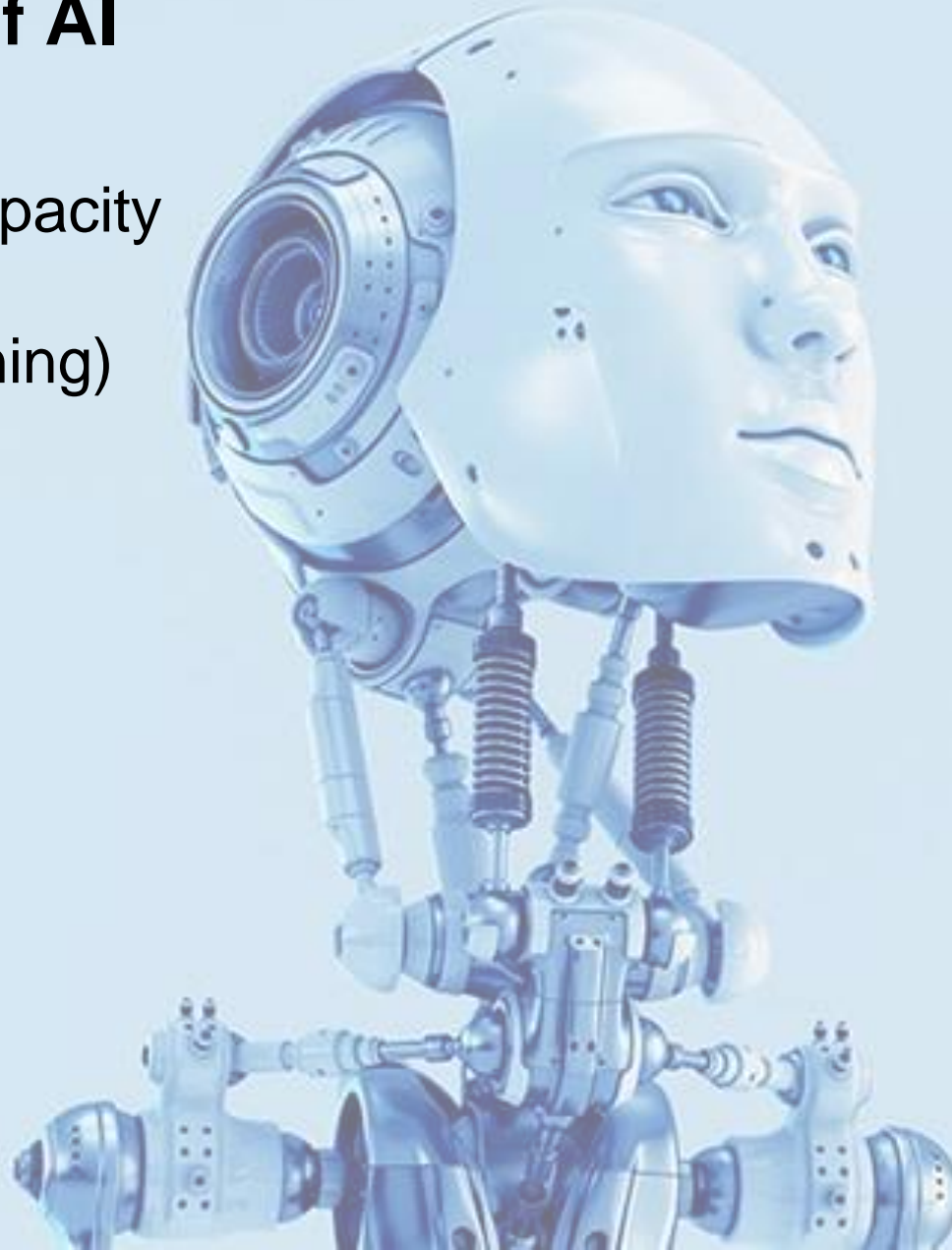
Subset of AI technique which use statistical methods to enable machines to improve with experience

DEEP LEARNING

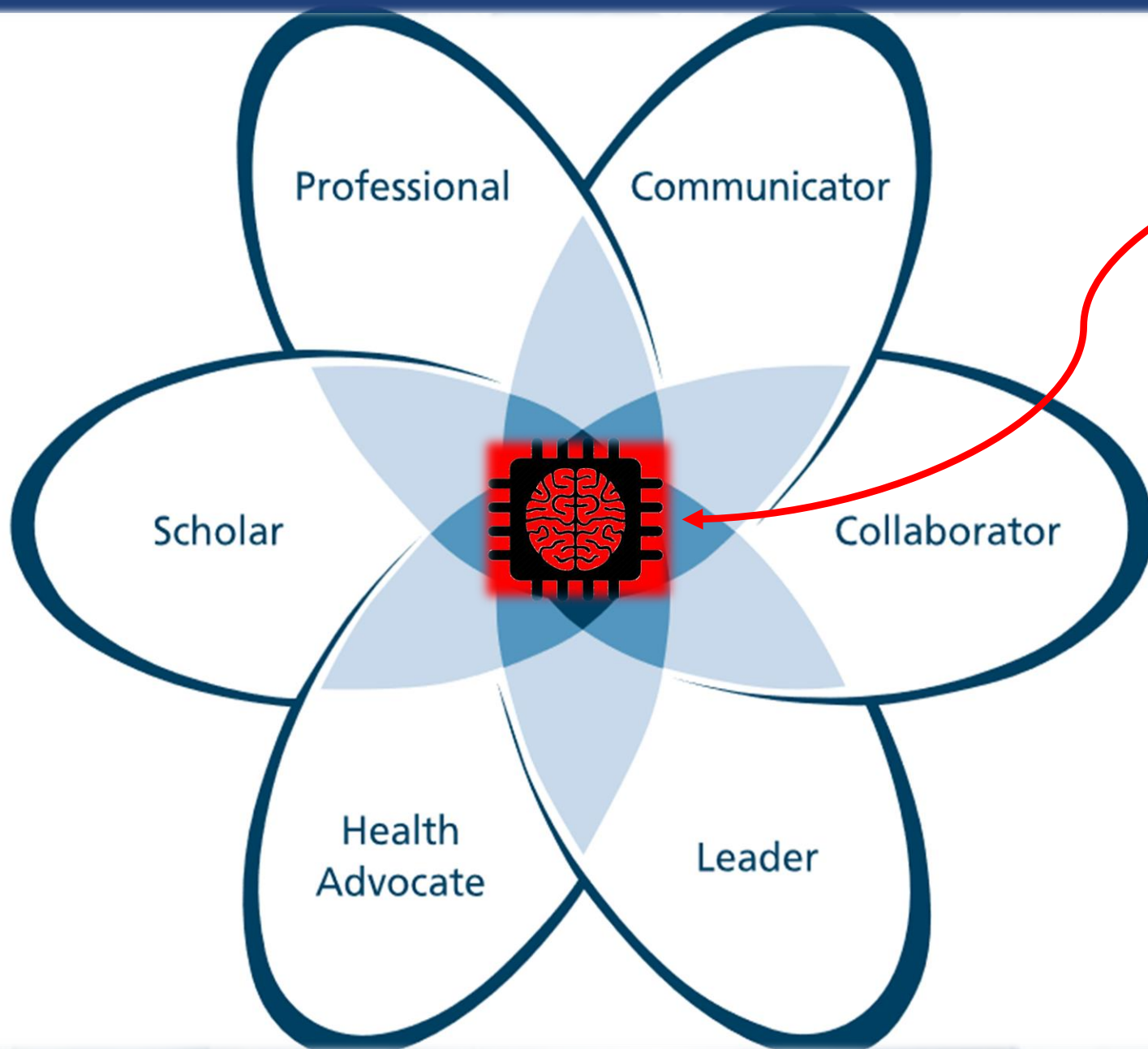
Subset of ML which make the computation of multi-layer neural network feasible

Characteristics of AI

- ✓ Almost unlimited capacity to learn (machine learning, deep learning)
- ✓ Big data handling
- ✓ No data loss
- ✓ 24/7
- ✓ Remote
- ✓ Scalable
- ✓ Cheap



- ? Black box
- ? Intuition
- ? Empathy
- ? Ethical implications
- ? Responsibility
- ? Data safety
- ? Privacy

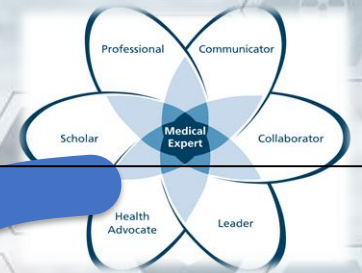


Artificial Intelligence replaces expert knowledge via

- Access to almost unlimited resources
- High throughput data processing
- Complex algorithms
- High reproducibility
- 24/7 online availability
- Cheaper service

AI – impact of roles (CanMed)

In review Lancet Digital Health



A Systems

- Collaborator:** increased collaborations with non-tech professions empowered by AI (psychologists, physiotherapists, nurses).
- Leader:** need to lead introduction of new AI technologies w/o being pushed. Importance of patient well-being & 'first do no harm'.
- Health Advocate:** problems of social justice & AI-driven solutions: Who benefits most? Will AI reduce or amplify current social disparities?
- Scholar:** need for information literacy, continuous learning about new technologies, and understanding AI models to prevent biases.
- Professional:** physicians should accept rather than prevent AI from taking over certain tasks and functions, & fiercely protect social sciences and humanities-based CanMEDS roles.
- Communicator:** importance of managing patient expectations with regards to possibilities offered by AI.
- Medical Expert:** translating back importance of integrated knowledge inaccessible to AI systems into health care systems.

Challenge Teaching

Medizinstudium

Digitalisierung der Medizin: Konsequenzen für die Ausbildung

Schreibgruppe der AG Digitalisierung: Joachim Buhmann^a, Juerg Felix^b, Thomas Gächter^c, Tobias Kowatsch^d, Roger Lehmann^e, Nicola von Lutterotti^f, Kuno Schedler^g, Johann Steurer^h, Christian Wolfrumⁱ

^a Prof., ETH Zürich; ^b Dr., Projektleiter Joint Medical Master, St.Gallen; ^c Prof., Universität Zürich; ^d Prof., Universität St. Gallen; ^e Prof., Universitätsspital Zürich; ^f Dr., Wissenschaftsjournalistin, Zürich; ^g Prof., Universität St. Gallen; ^h Prof., Universität Zürich; ⁱ Prof., ETH Zürich, für die Arbeitsgruppe «Digitalisierung der Medizin»

Arbeitsgruppe «Digitalisierung in der Medizin»

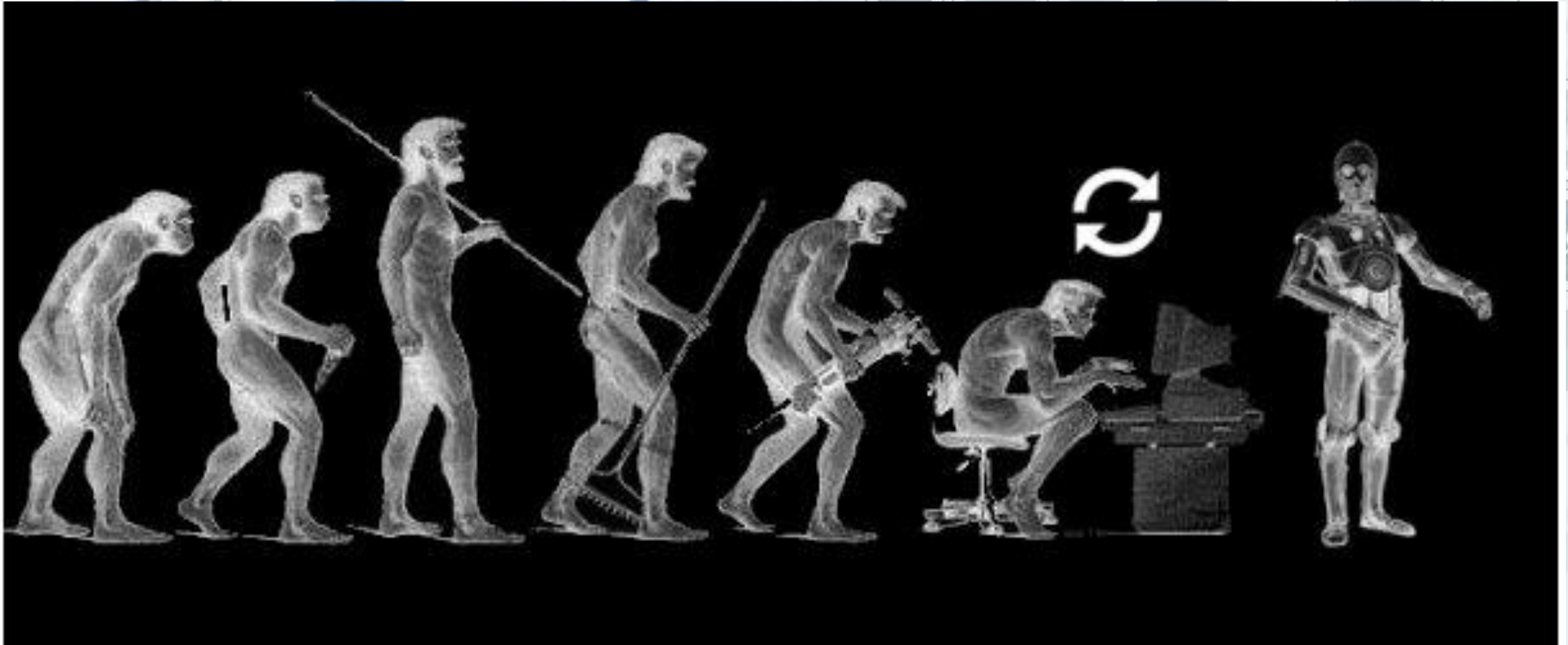
Die Mitglieder des Bildungsnetzwerks Medizin bildeten eine Arbeitsgruppe zum Thema Auswirkungen der Digitalisierung in der Medizin auf die Ausbildung. In einer ersten Sitzung wurden Ideen zum Thema gesammelt. Eine «Schreibgruppe» verfasste bei einer zweitägigen Klausur dann einen ersten Entwurf. Dieser wurde in einer weiteren Sitzung mit der gesamten Arbeitsgruppe diskutiert und die Kommentare in das Manuskript integriert. Weitere Mitglieder der Arbeitsgruppe waren: Universität Zürich/Universitätsspital Zürich, Prof. Matthias Baumgartner, Prof. Matthias Guckenberger, Prof. Jürg Hodler, Prof. Roger Lehmann, Dr. Christian Schirlo; Universität Luzern, Prof. Verena Briner; Universität Basel, Prof. Thorsten Schwede; ETH Zürich, Prof. Jörg Goldhahn, Prof. Gunnar Rätsch; Universität St.Gallen/Kantonsspital St.Gallen, Prof. Sandro Stöckli; Schweizerisches Institut für Weiter- und Fortbildung, Dr. Werner Bauer.

Preparing the healthcare workforce to deliver the digital future

An independent report on behalf of the
Secretary of State for Health and Social Care
February 2019







To be modified