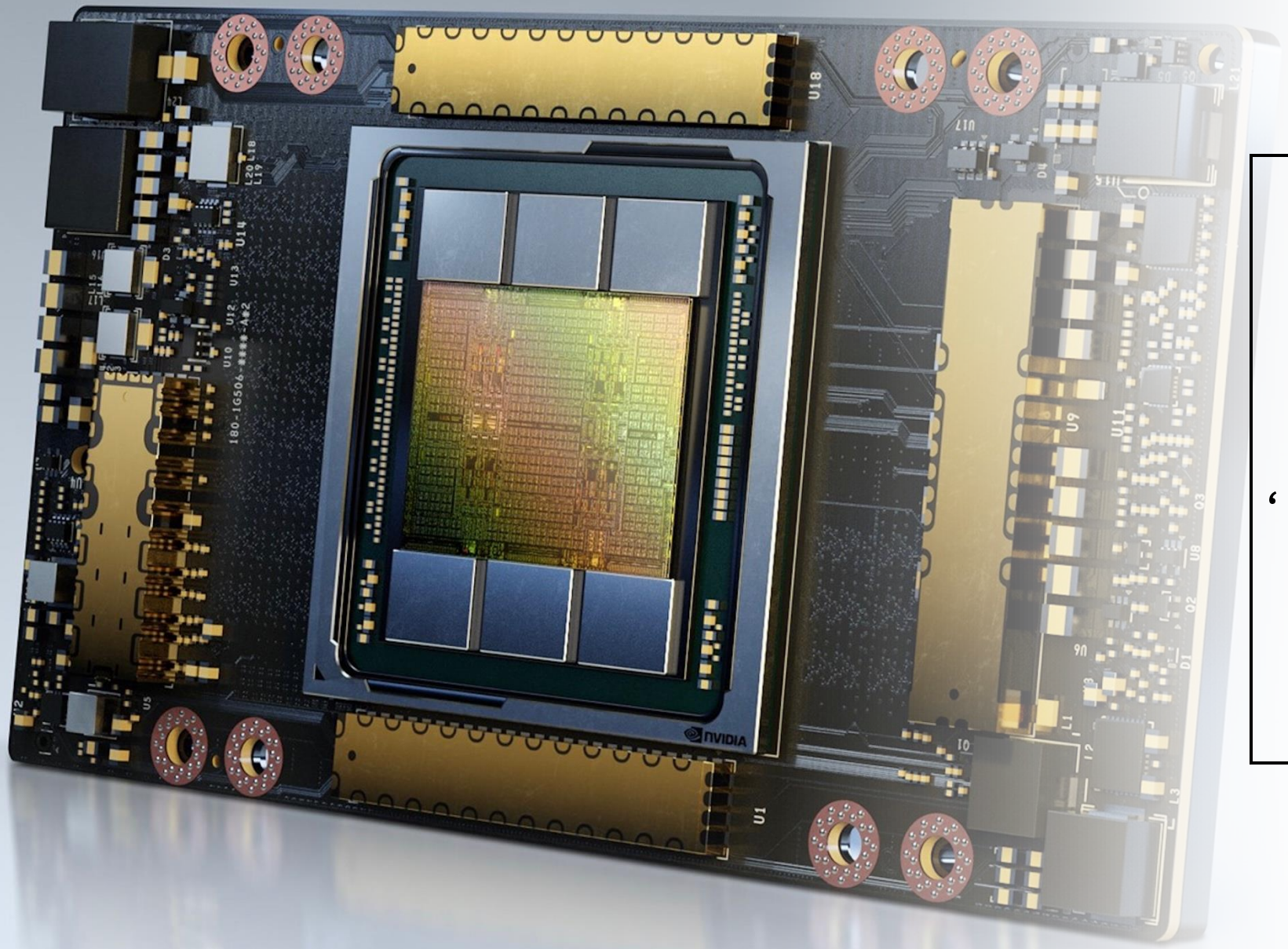
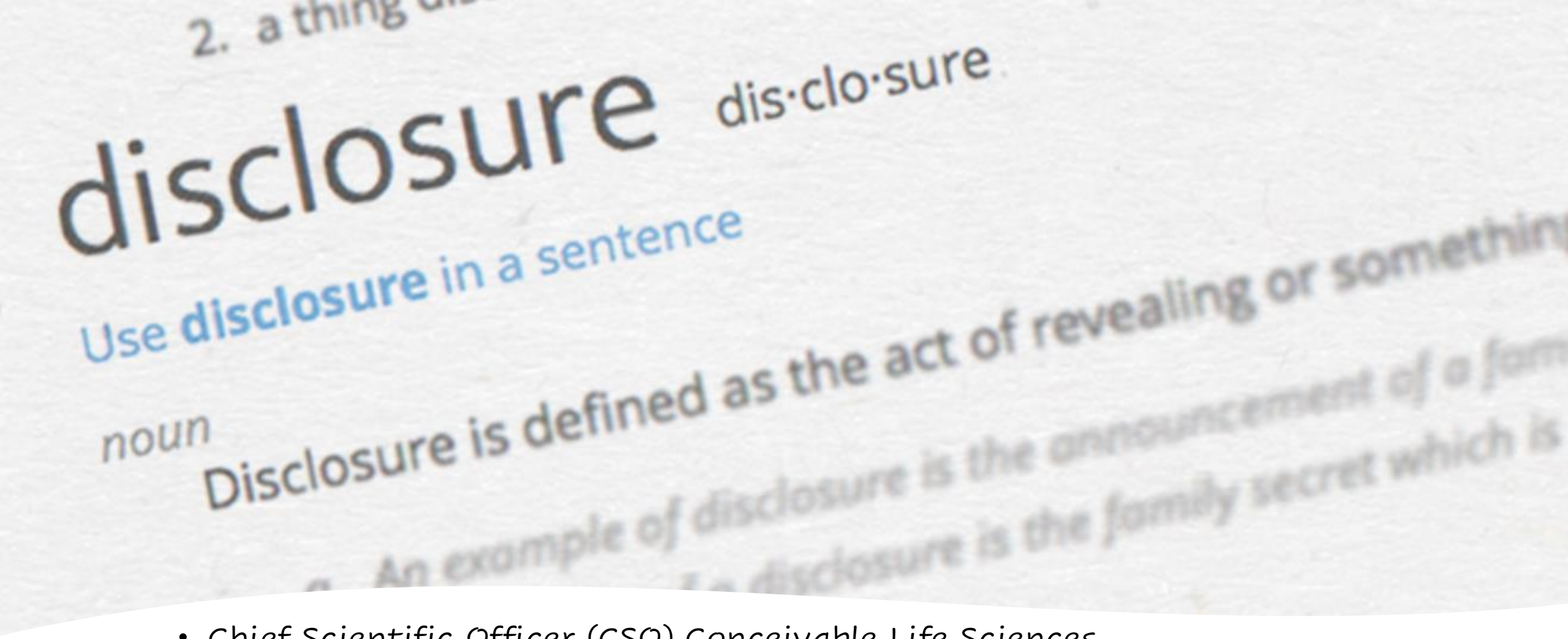


‘How AI Affects Our Life’

Jacques Cohen

Jacques@conceivable.life



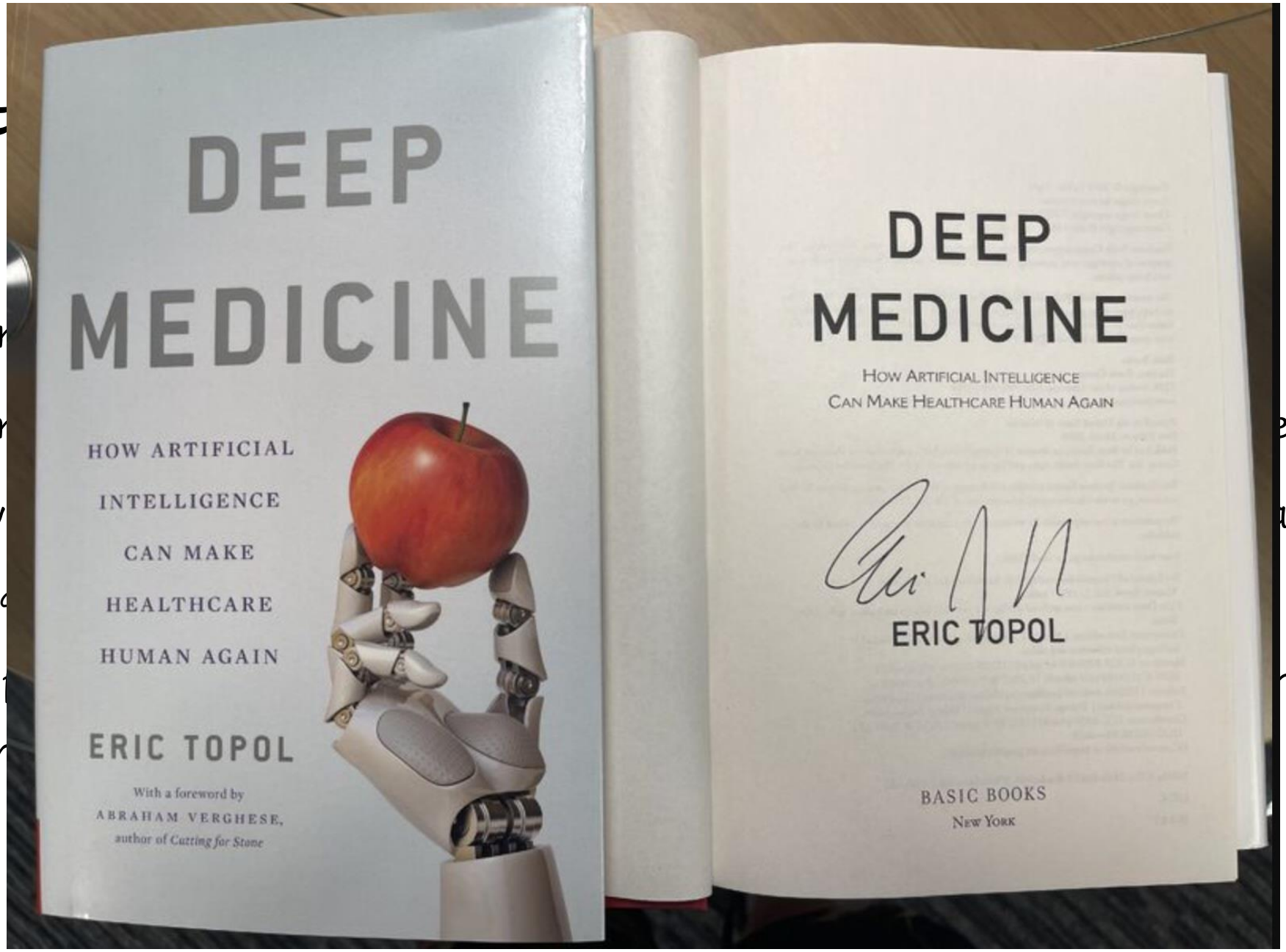
- Chief Scientific Officer (CSO) Conceivable Life Sciences
- CSO and co-founder IVF 2.0
- Co-founder Althea Science
- President and co-founder i3
- Advisory Board Member: Kindbody, TMRW Life Sciences, Orchid, Specialty Fund

AI 'fact

- Already
- AI can ir
- The num es.
- There w rly 2023

(Dr. David Sa

- 'AI in re ment in other ar



AI adoption rate:

- The global AI business adoption rate is skyrocketing from 50% in 2022 to 72% in 2024.
- AI-mediated voice search is used by 41-50% of US-based mobile users every day
- AI usage rate is culture dependent: very different from country to country
- Just 25% of Belgians have used generative artificial intelligence (AI) (Deloitte)
- That figure is >80% in India.

Deloitte, McKinsey and company
Deloitte's "Generative AI in Asia-Pacific" report

Some 'economic facts' about AI:

- The global AI market size is estimated to be $215* billion this year.
- It is projected to reach $1,811.8 billion by 2030.
- And grow at CAGR of 38.0% from 2021 to 2030 (compound annual growth rate)
- A CAGR > 20% is considered 'explosive'; a healthy CAGR is 5-10%.
- Tony Gordon's 'Cooper Surgical' for instance is 4.8% a year!
- Global GDP will grow by $15.7 trillion by 2030 thanks to AI.
- AI's contribution is so large it could cause considerable ups and downs in the economy

Accenture, MarketsandMarkets, Deloitte, Gartner, Forbes

*All USD

Industries with a low probability of automation (lower than 40 %) include:

education

healthcare

social work

Arts and sport

Entertainment

Management

business, finance

public administration and utilities

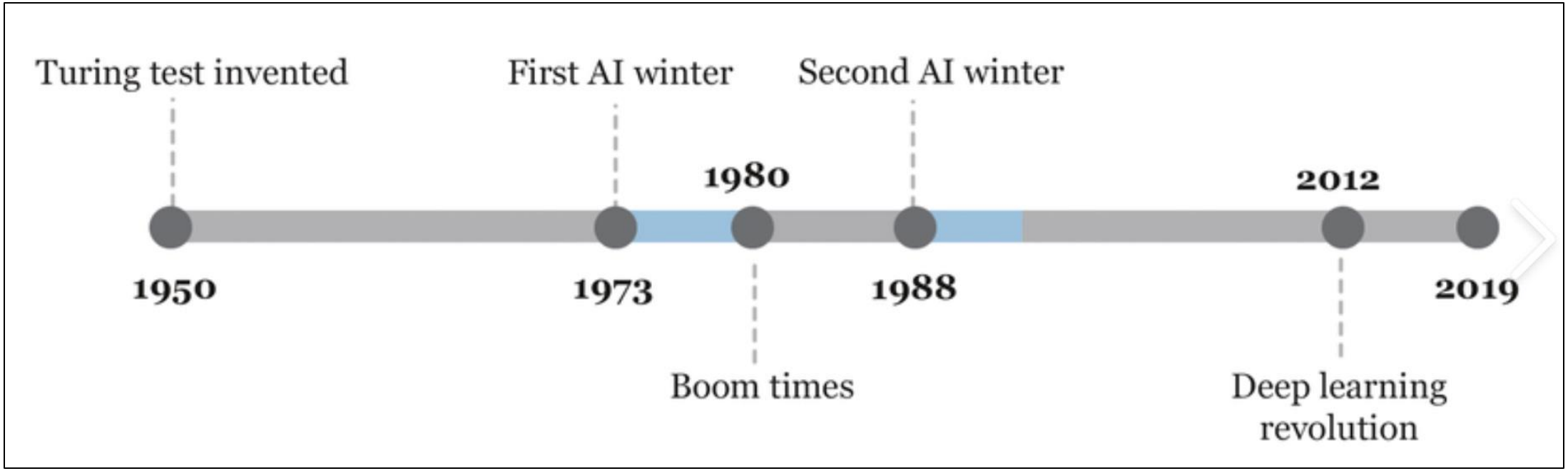
•*Adamczyk et al., 2021; Caravella and Menghini, 2018; Egana-delSol et al., 2021; Ill´essy et al., 2021; Yamashita and Cummins, 2021).*

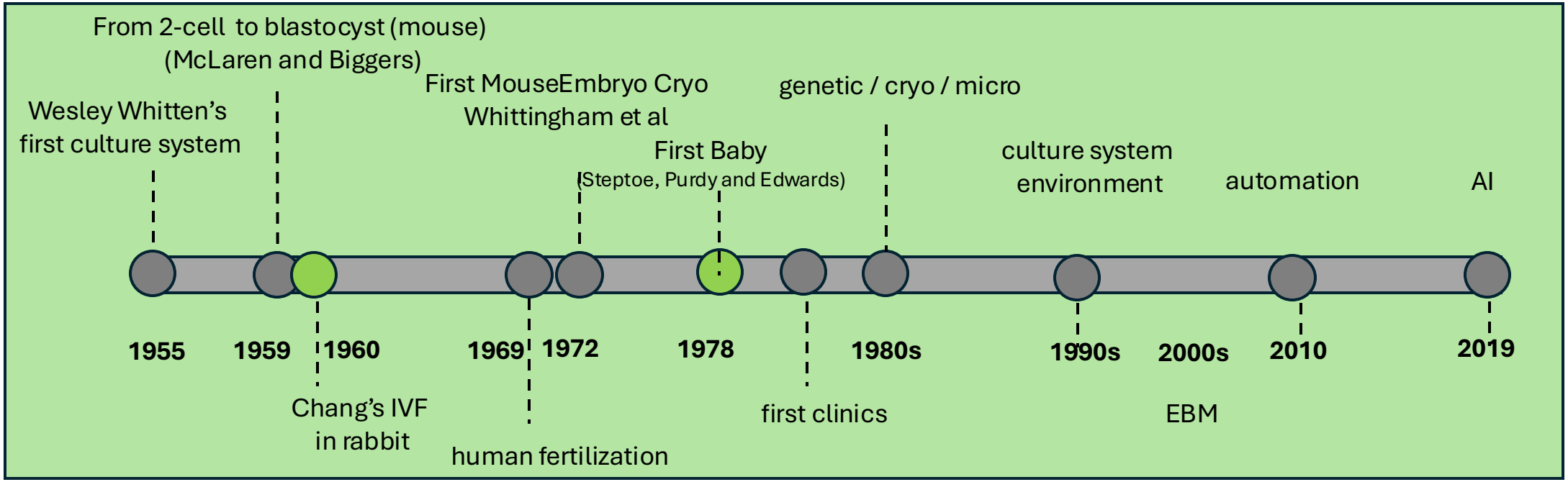
Industries with a HIGH probability of automation include:	
	Manufacturing
	Retail and e-Commerce
	Transportation and logistics
	Agriculture
	Financial services
	Hospitaility
	Constuction
	Customer service
	Media and journalism
	Legal services
	Pharma and biotech

Areas of cost savings in healthcare involving AI:

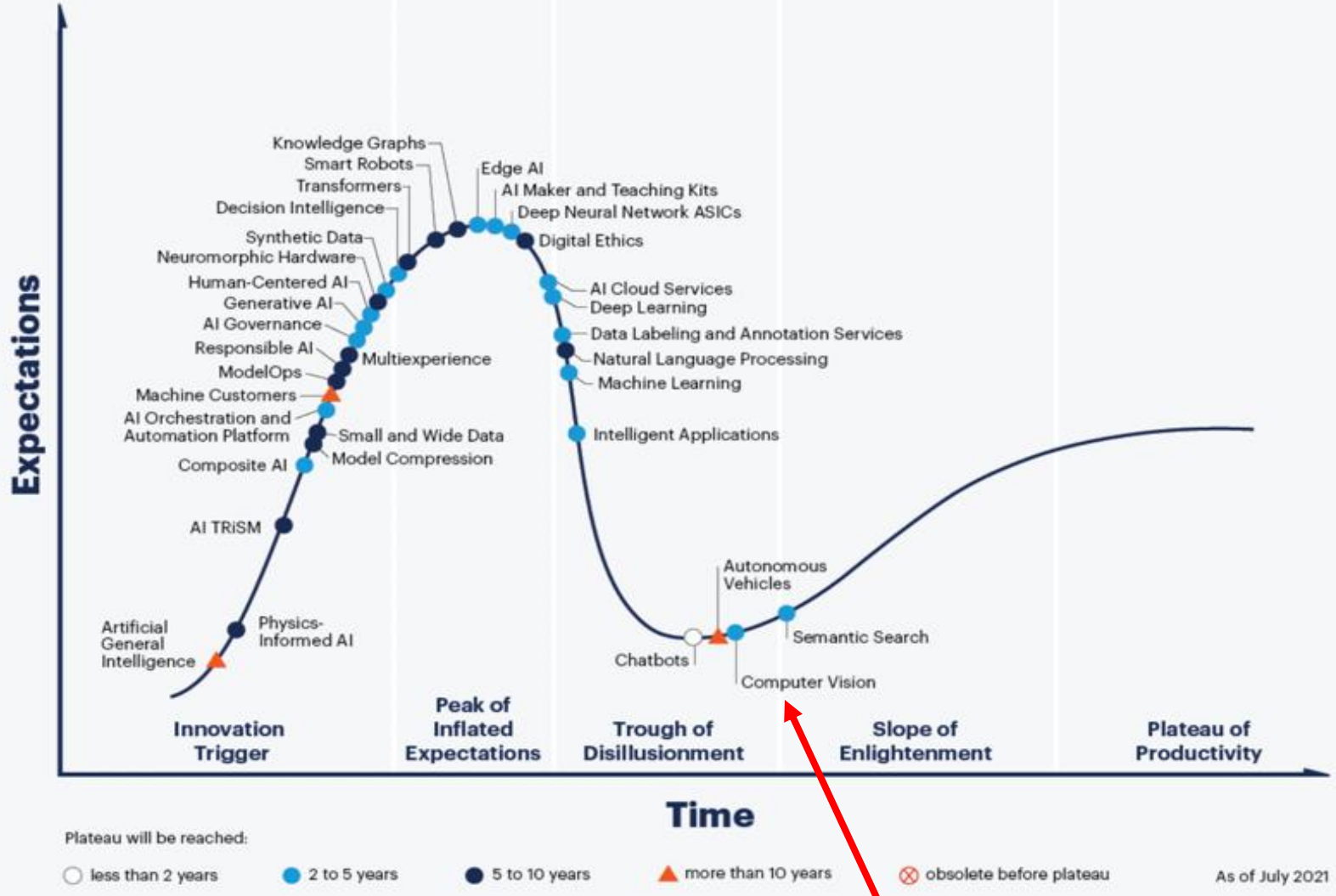
- Preventive medicine
- Drug discovery
- Teaching approaches: AR, VR, virtual lab, simulation, games
- Performing procedures (this is us!)

Bohr and Memarzadeh 2020: Artificial Intelligence in Healthcare DOI: https://doi.org/10.1016/B978-0-12-818438-7.00002-2


Turing test invented
First AI winter
Second AI winter
1980
2012
1950
1973
1988
2019
Boom times
Deep learning revolution


From 2-cell to blastocyst (mouse)
(McLaren and Biggers)
Wesley Whitten's first culture system
First MouseEmbryo Cryo
Whittingham et al
First Baby
(Steptoe, Purdy and Edwards)
genetic / cryo / micro
culture system environment
automation
AI
1955
1959
1960
1969
1972
1978
1980s
1990s
2000s
2010
2019
Chang's IVF in rabbit
human fertilization
first clinics
EBM

Hype Cycle for Artificial Intelligence, 2021



gartner.com

Gartner

Artificial intelligence in the in vitro fertilization laboratory: a review of advancements over the last decade

Why is the IVF lab suitable for AI applications?

- The IVF laboratory is a complex environment
- that requires precision,
- accuracy, and
- consistency
- to ensure optimal outcomes.

Jiang and Bormann, 2023

AI will improve various processes and procedures in the IVF lab

- such as assessing oocyte quality,
- sperm selection during ICSI,
- fertilization assessment,
- embryo assessment,
- ploidy prediction,
- embryo transfer selection,
- cell tracking,
- embryo witnessing,
- micromanipulation,
- quality management

Check for updates

Artificial intelligence in the in vitro fertilization laboratory: a review of advancements over the last decade

Victoria S. Jiang, M.D. and Charles L. Bormann, Ph.D.

Division of Reproductive Endocrinology and Infertility, Vincent Department of Obstetrics and Gynecology, Massachusetts General Hospital/Harvard Medical School, Boston, Massachusetts

The integration of artificial intelligence (AI) and deep learning algorithms into medical care has been the focus of development over the last decade, particularly in the field of assisted reproductive technologies and in vitro fertilization (IVF). With embryo morphology the cornerstone of clinical decision making for IVF, the field of IVF is highly reliant on visual assessments that can be prone to error and subjectivity and be dependent on the level of training and expertise of the observing embryologist. Implementing AI algorithms into the IVF laboratory allows for reliable, objective, and timely assessments of both clinical parameters and microscopy images. This review discusses the ever-expanding applications of AI algorithms within the IVF embryology laboratory, aiming to discuss the many advances in multiple aspects of the IVF process. We will discuss how AI will improve various processes and procedures such as assessing oocyte quality, sperm selection, fertilization assessment, embryo assessment, ploidy prediction, embryo transfer selection, cell tracking, embryo witnessing, micromanipulation, and quality management. Overall, AI provides great potential and promise to improve not only clinical outcomes but also laboratory efficiency, a key focus because IVF clinical volume continues to increase nationwide. (Fertil Steril® 2023;120:17–23. ©2023 by American Society for Reproductive Medicine.)

Key Words: Artificial intelligence, machine learning, predictive modeling, IVF, embryology, time-lapse imaging, assisted reproduction, ART

Jiang and Bormann, 2023

"Human skill-sets including hand eye coordination to perform an embryo transfer is probably the only step of IVF that is outside the realm of AI & ML today"

Allabadia et al, 2023

There is a need for better or accurate definitions:

- AI
- Different forms of AI
- Robotics
- Optimization
- Automation
- Level of automation
- Rate of intervention
- Autonomy
- Level of autonomy

Forms of AI in IVF (too much to cover all of this)

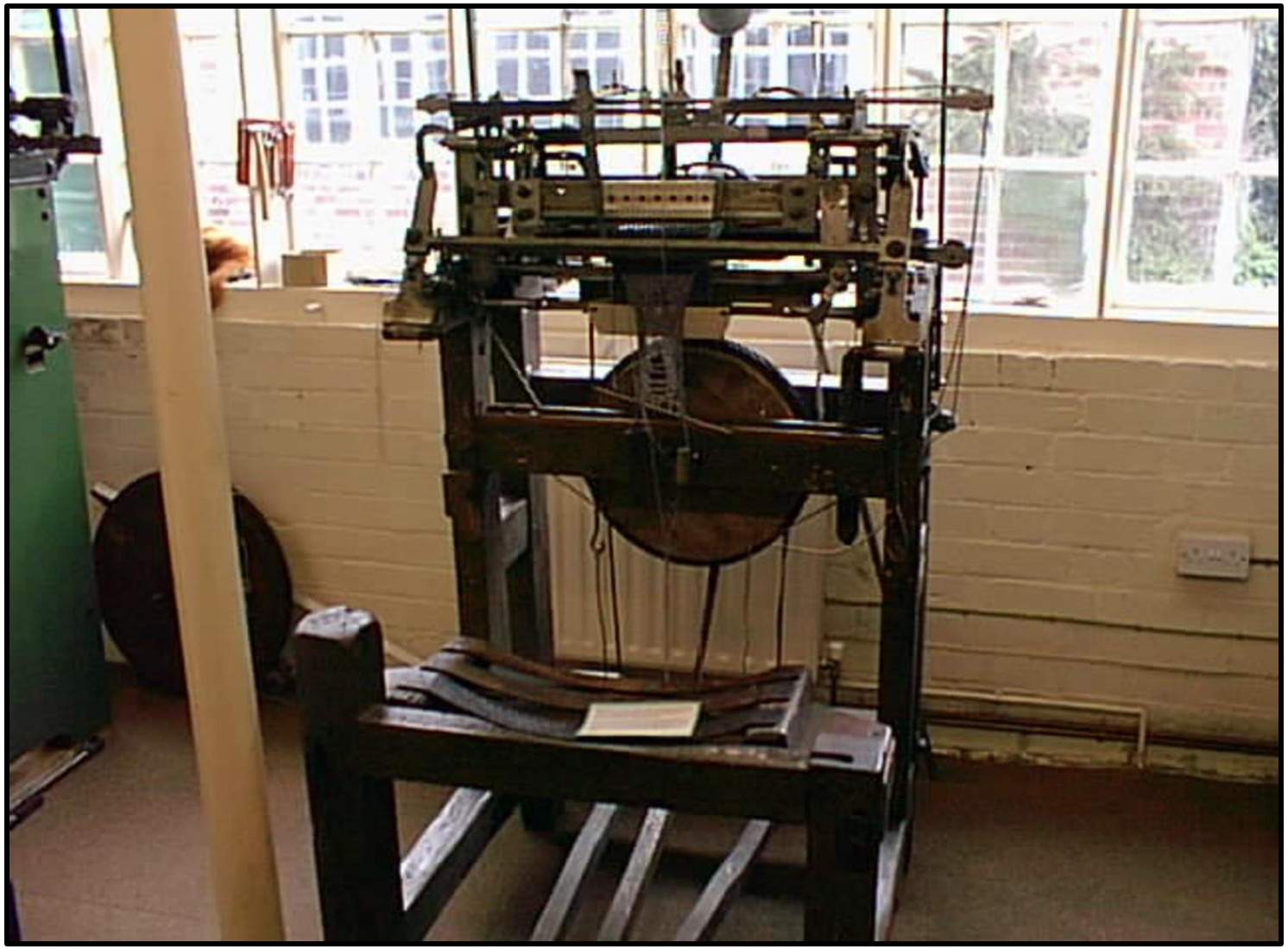
1. **Narrow AI (Weak AI)**
    1. Specialized in one task (e.g., embryo grading, image analysis).
2. **General AI (Strong AI)**
    1. Hypothetical AI that can perform any intellectual task a human can. (currently non-existent)
3. **Machine Learning (ML)**
    1. **Supervised Learning**: Learns from labeled data (e.g., predicting embryo quality).
    2. **Unsupervised Learning**: Finds patterns in unlabeled data (e.g., clustering patient outcomes).
    3. **Reinforcement Learning**: Learns by trial and error (e.g., optimizing lab protocols).
4. **Deep Learning**
    1. Neural networks with many layers, useful for image recognition (e.g., automating embryo selection).
5. **Natural Language Processing (NLP)**
    1. AI that understands human language (e.g., patient care chatbots, automating communication).
6. **Expert Systems**
    1. Rule-based systems mimicking human decision-making (e.g., assisting embryologists with decision protocols).
7. **Robotics & AI**
    1. Physical robots guided by AI (e.g., robotic ICSI, egg retrieval, denudation, plunging).
8. **Cognitive Computing**
    1. Mimics human thought processes (e.g., personalized treatment suggestions from vast datasets).
9. **Artificial Neural Networks (ANNs)**
    1. Modeled after the brain, used for predictive tasks (e.g., IVF success prediction).

Fernandez et al, 2020; Riegler et al, 2021; Jiang and Bormann, 2023; Abdullah et al, 2022; Zhang et al, 2024

Concerns about our job:

The future of work” is suddenly everywhere—which is an interesting feat for a 500-year-old discussion.

in the late 16th century, Queen Elizabeth I supposedly denied a patent to the inventor of a new automated knitting machine because she feared it would take jobs of “*young maidens who obtain their daily bread by knitting*”



Inventor

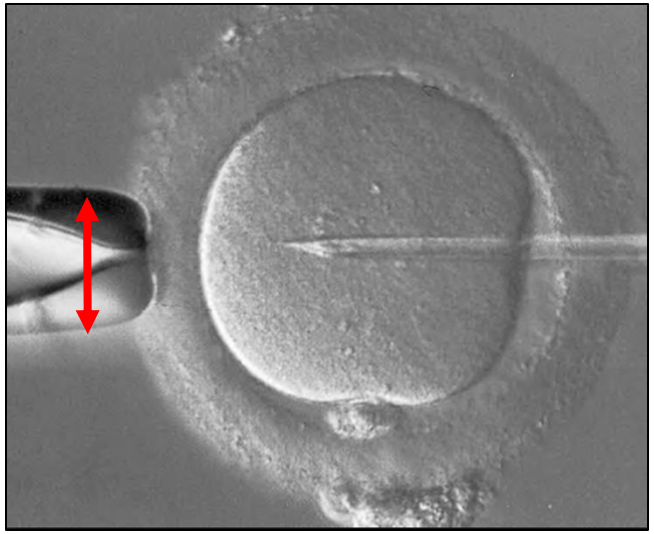
William Lee

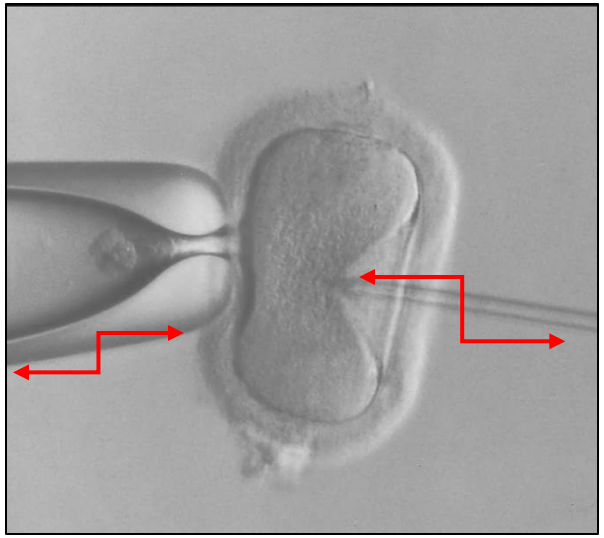
Born	1563 Calverton
Died	1614 | Age 51

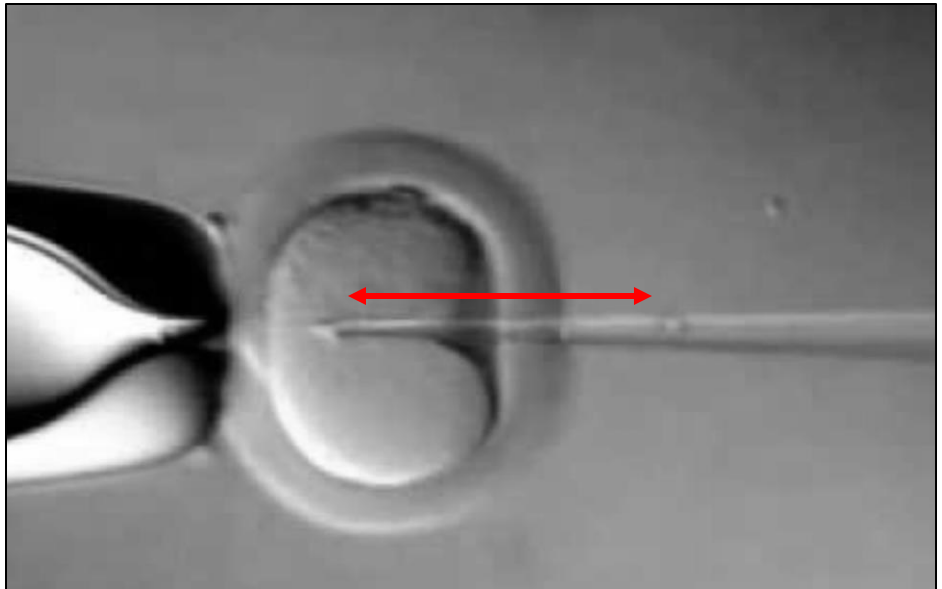
Concerns about our embryology jobs?

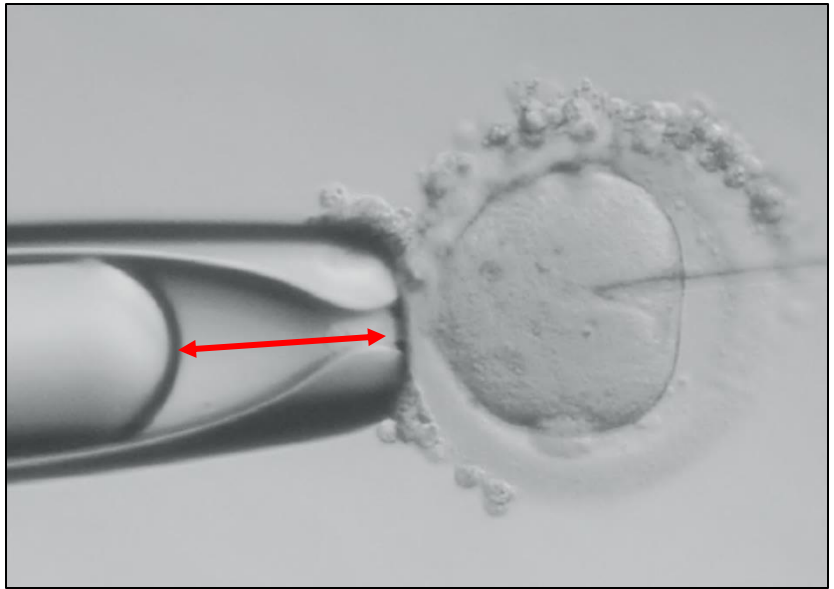
- Change is normal and interesting
- These new AI and automation tools may remove or reduce issues such as burnout
- AI chatbots and 'expert systems' may assist the embryologist during repetitious tasks on busy days
- Automated systems are already in use in IVF (CASA, TL systems) – has it made a difference to staffing numbers?

An AI assistant to improve standardization

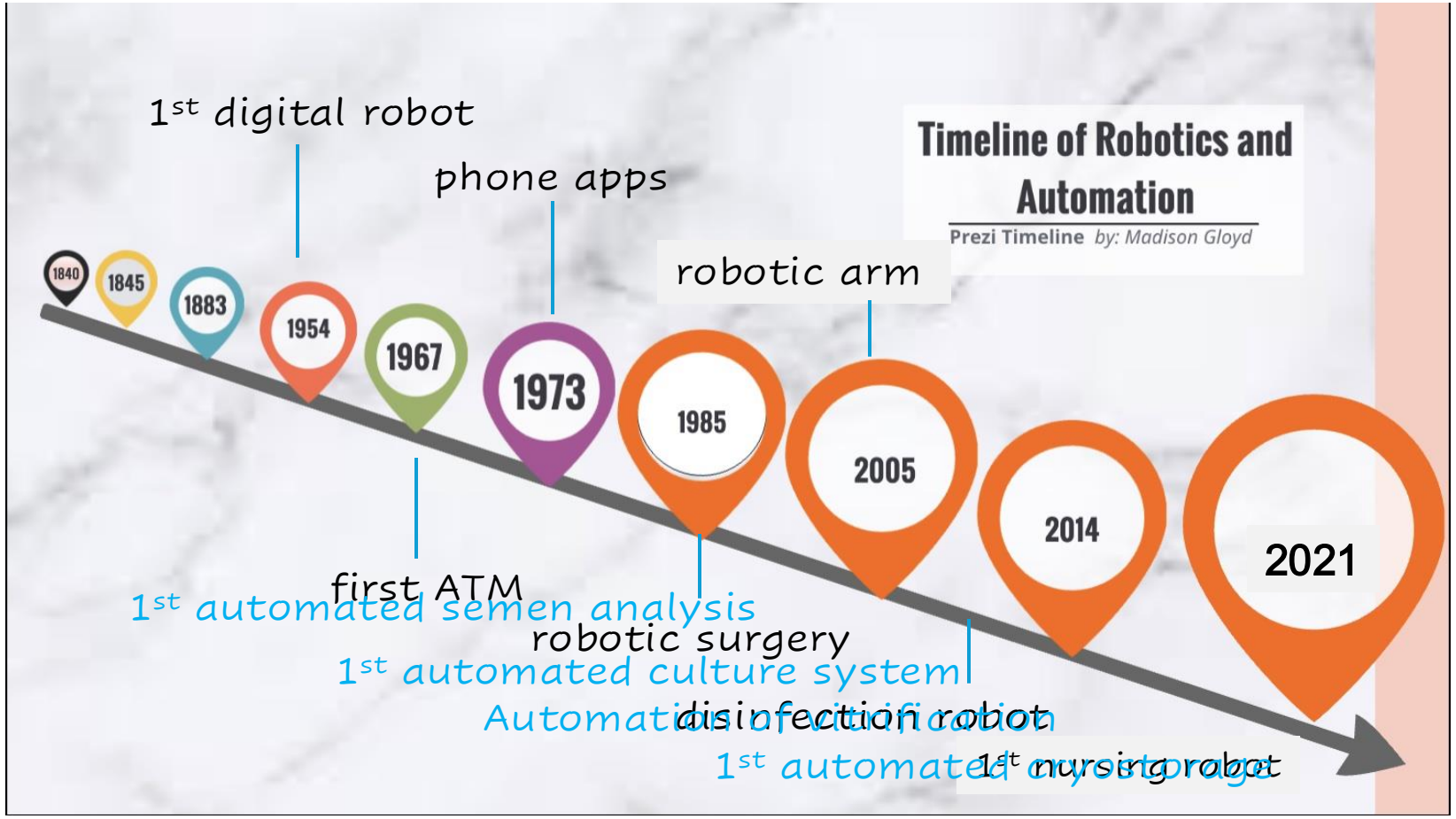




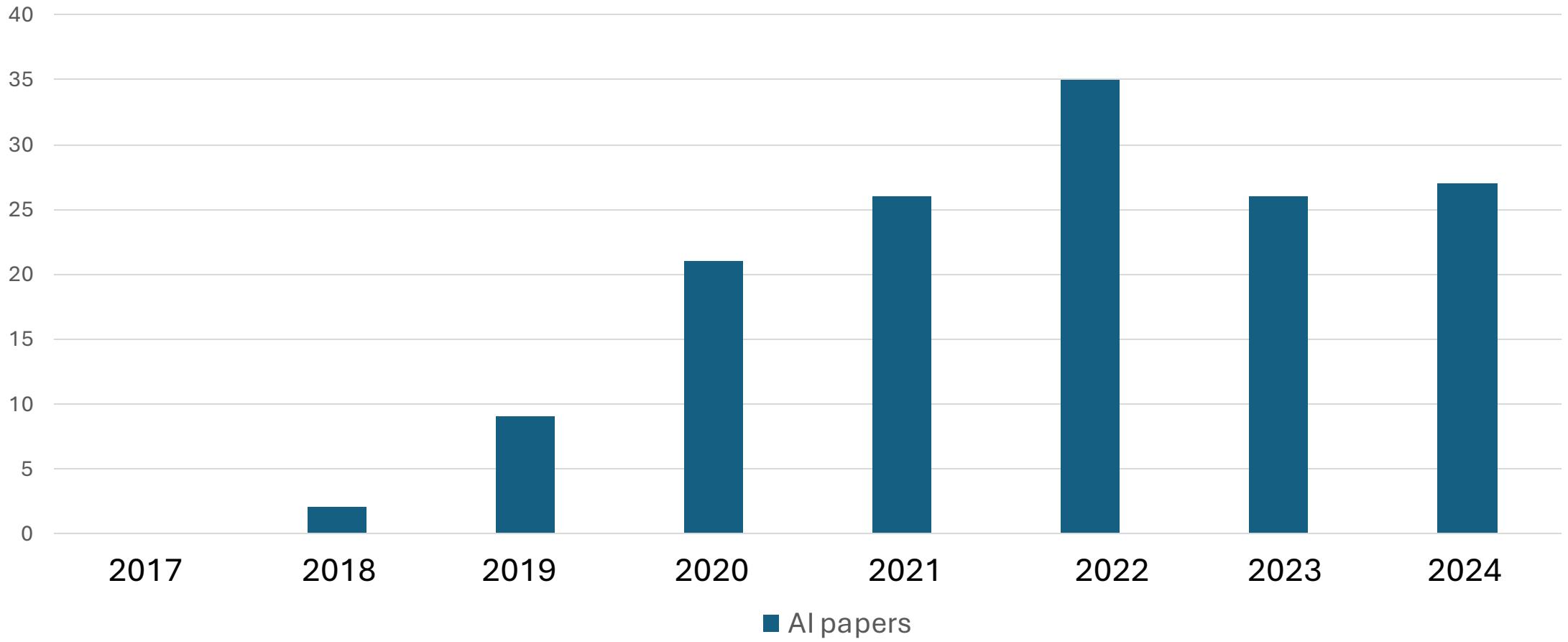




AI and Automation are all around us



Number of papers on AI and the IVF laboratory



It is not explosive

There seem to be as many AI start-up companies in IVF as there are novel publications*

(corrected for new papers presenting data evaluations)


An AI Entering Data In The EHR

How will AI impact IVF affordability and accessibility

What are the costs of production?

What are the costs of production of an AI in healthcare?

It depends on complexity and specifications:

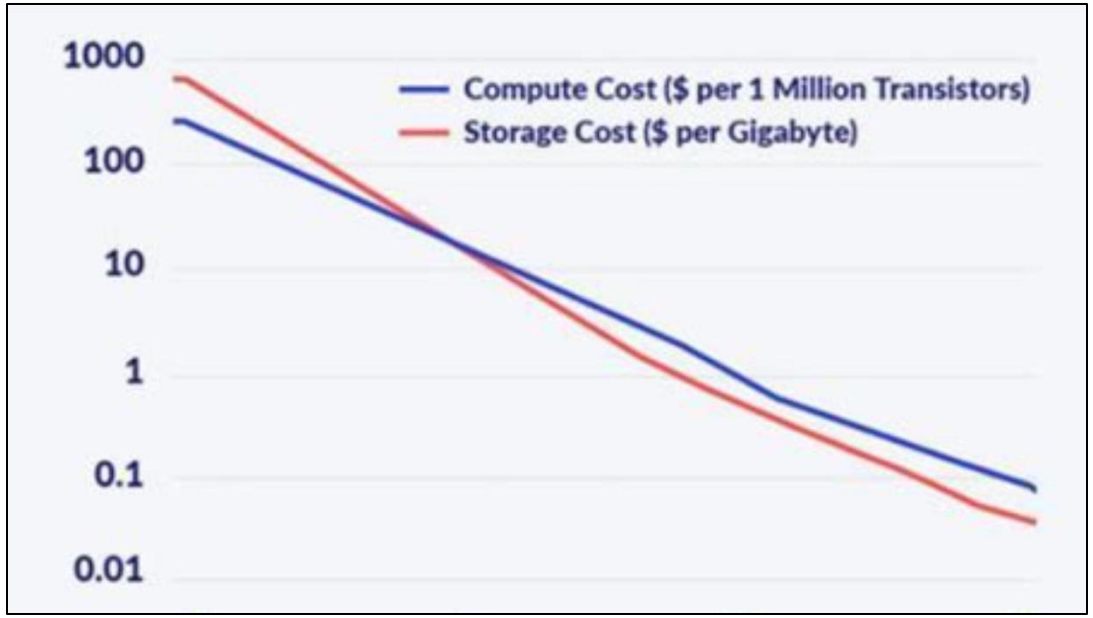
1. R&D - Advanced machine learning models require large datasets and complex training processes. 200k – 500k
2. Data collection/annotation: High quality and well-labelled data: depending on volume costs range from 100k – 1 million.
3. Cloud storage, processing power, security, HIPAA: 30 – 75 k annually
4. Software development: front and backend systems to interact with patient management systems: 50 – 100k
5. Regulatory compliance: predicate is unlikely, count on 250k
6. Testing in clinics: 50k-200k

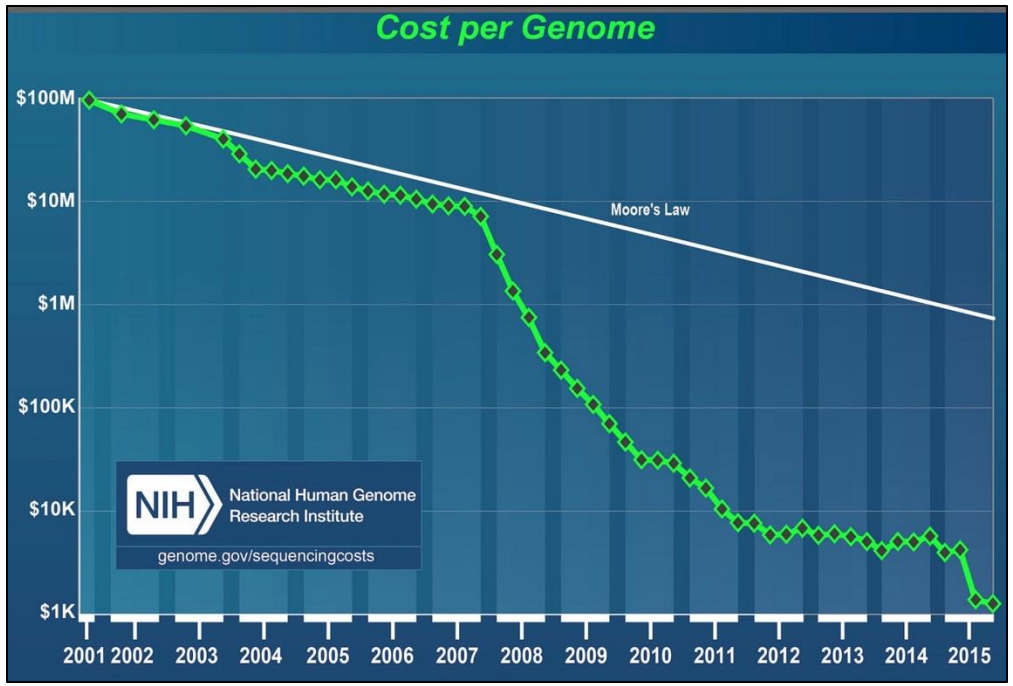
Total estimated development: 680k – 2 million

Estimated Maintenance: 100k – 200k annually

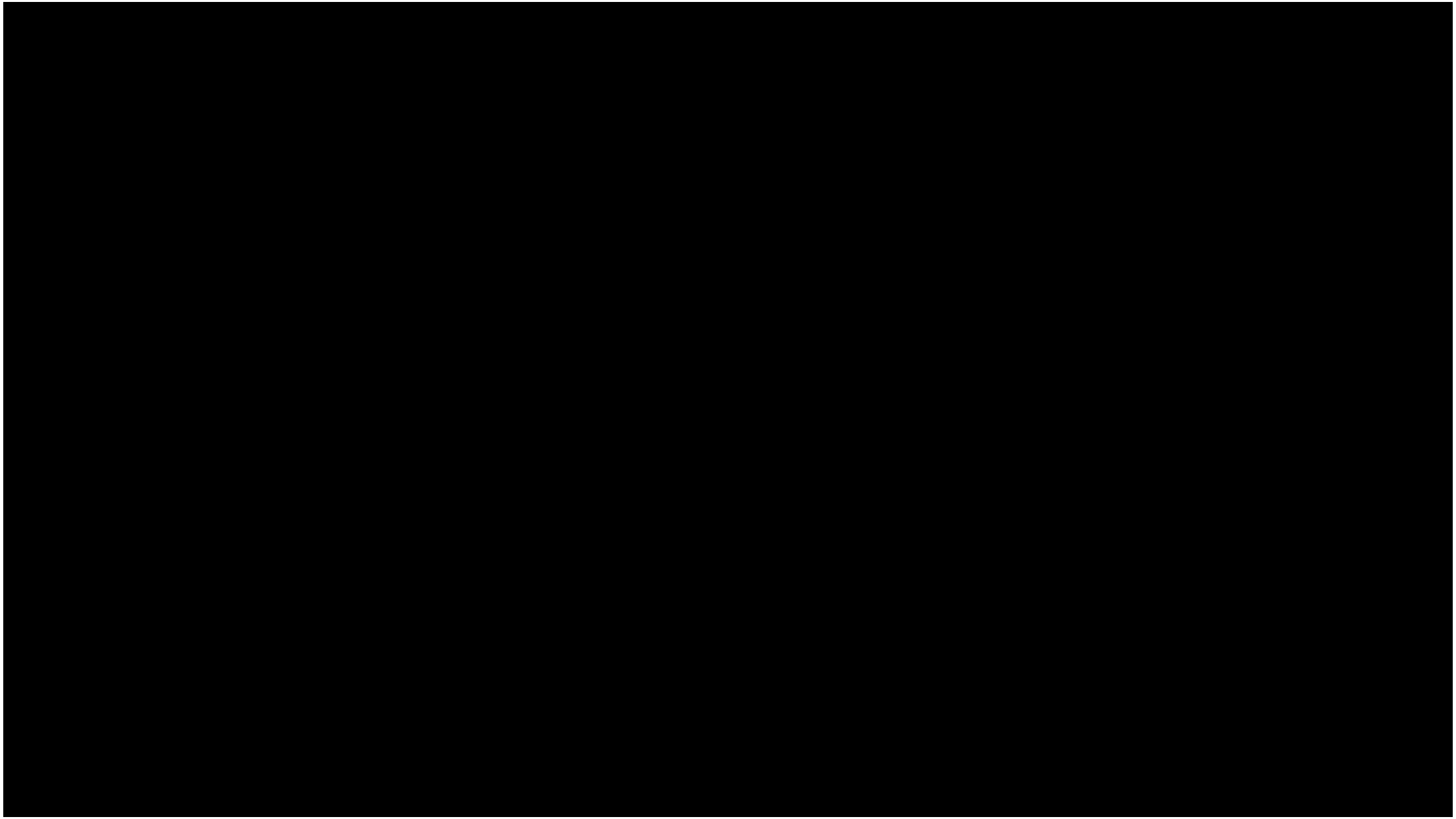
Digital Health, Forbes

computing and storage costs over time





costs of DNA sequencing over time:
A model for AI costs?
A model for automation?



Conclusions:

- AI and automation should **not replace** but **augment** the clinical embryologist

- Embryologists under-estimate their talents when comparing with AI and robots

- The lab SOP is maybe 2000 pages. It may cover many aspects of lab routine but does not represent human creativity, intelligence and improvisation

- Growth rates of AI development and implementation is so rapid it may affect global markets

conceivable

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