



Artificial intelligence and its applications in medicine

Lei Zhang, Nyi Nyi Soe, Phyu Mon
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HALEY JOEL OSMENT JUDE LAW



A STEVEN SPIELBERG FILM

AI.

ARTIFICIAL INTELLIGENCE



Brief history of artificial intelligence

- Definition of AI: the capability of computer systems or algorithms to **imitate intelligent human behaviour**

The plot: A robotic boy, the first programmed to love, David (Haley Joel Osment) is adopted as a test case by a Cybertronics employee (Sam Robards) and his wife (Frances O'Connor). Though he gradually becomes their child, a series of unexpected circumstances make this life impossible for David. Without final acceptance by humans or machines, David embarks on a journey to discover where he truly belongs, uncovering a world in which the line between robot and machine is both vast and profoundly thin.

Timeline Generalizing AI

#TechVision

1956

The Dartmouth Summer Research Project on Artificial Intelligence workshop, considered a founding moment for the field of AI, convenes¹²⁸

1986

Dave Rumelhart, Geoffrey Hinton, and Ronald Williams publish a landmark paper on back-propagation - laying the foundation for modern neural networks¹²⁹

2012

AlexNet, a convolutional neural network trained on GPUs, achieves a breakthrough performance on the ImageNet benchmark test¹³⁰

2015

OpenAI is founded¹³¹

2016

AlphaGo beats 18-time world Go champion Lee Sedol¹³²

2017

Google introduces the Transformer AI network architecture in a paper titled "Attention Is All You Need." Transformers now underpin most foundation models¹³³

2019

Hugging Face releases V1 of its Transformers NLP library¹³⁴

2020

OpenAI trains GPT-3 (Generative Pre-trained Transformer), which becomes the world's most sophisticated large language model¹³⁵

2021

The European Union proposes the AI Act, the first legislation concerning AI, that would ban, regulate, or allow AI applications based on an assigned risk category¹³⁶

2021

Researchers at Stanford University publish a paper coining the phrase "foundation models"¹³⁷

2021

The Beijing Academy of Artificial Intelligence announces Wu Dao 2.0, a multimodal text and image foundation model with 175 trillion parameters¹³⁸

2022

A piece of AI-generated art wins first place in the digital arts category at the Colorado State Fair's fine arts competition¹³⁹

2022

DeepMind introduces Gato, a general purpose agent foundation model that can perform a wide range of tasks across multiple modalities and embodiments¹⁴⁰

2022

OpenAI releases ChatGPT, a highly sophisticated chatbot¹⁴¹

2023

2024

Several new search engines have emerged, featuring foundation-model-based "quick answer" services that give users direct and thorough answers to queries

2024

A new generation of virtual assistants is built with transformer-based foundation models. Increased adoption is attributed to more sophisticated and natural language ability

2027

A prestigious art museum opens a gallery dedicated solely to AI-generated artwork

2025

A consumer electronics firm introduces ear buds that use an on-device foundation model to translate over 100 languages in near-real time

2030

75% of knowledge workers globally interact with an application, service, or agent powered by foundation models daily

2033

A university deploys a general-purpose foodservice robot, built with a foundation model, to take on odd jobs in the cafeteria. The robot learns new tasks easily, so can fill open roles as needed



Introduction to Medical AI

- What is Medical AI?

Medical AI involves the application of artificial intelligence technologies such as machine learning, NLP, computer vision, and robotics in healthcare settings to improve diagnosis, treatment, and patient management.

- Rapid Development of AI Technology

Medical AI has rapidly developed due to advancements in computational power, big data availability, algorithmic innovations, interdisciplinary collaboration, and significant funding.

The market will be **ACCELERATING**
growing at a **CAGR** of over

(Compound Annual Growth Rate)

33%




**INCREMENTAL
GROWTH**

\$ 75.54 bn

2018

2023

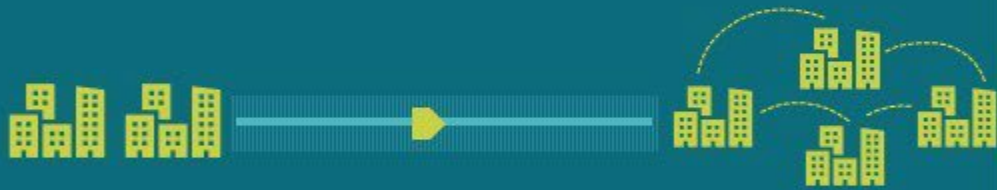


The year-over-year growth rate
for **2019** is estimated at

29.43%



The market is **FAIRLY FRAGMENTED** with
many players occupying the market share



61%

of the growth
will come from
NORTH AMERICA

One of the **KEY DRIVERS** for this
market will be the **BENEFIT OF
INCREASE IN EMPLOYEE
PRODUCTIVITY**



READ THE REPORT:

GLOBAL ARTIFICIAL INTELLIGENCE (AI)
MARKET 2019-2023

10,000+ reports covering niche topics

INFORMATION TECHNOLOGY

Read them at:

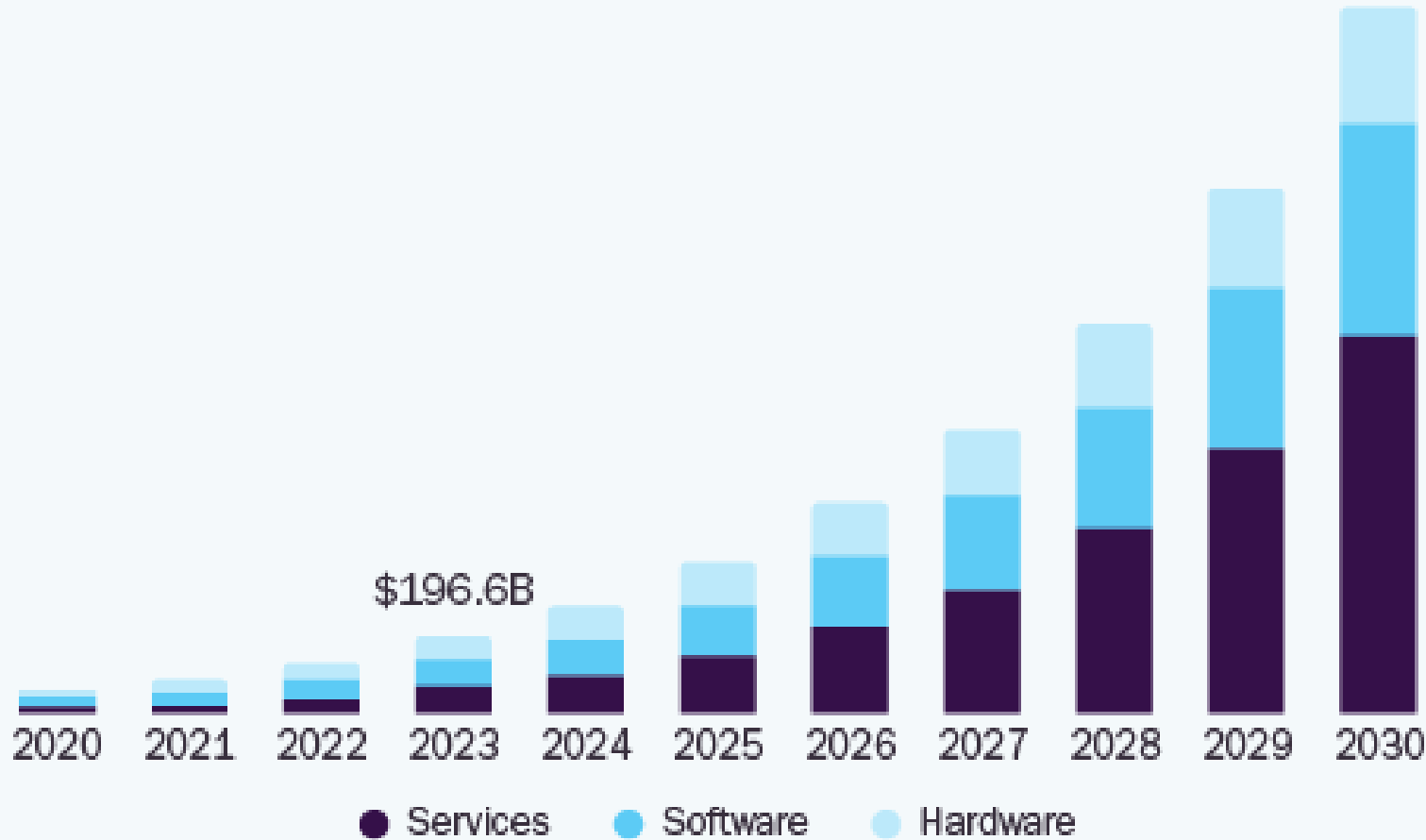
www.technavio.com



 **technavio**

Global Artificial Intelligence Market

Size, by Solution, 2020 - 2030 (USD Billion)



36.6%

Global Market CAGR,
2024 - 2030

Source:
www.grandviewresearch.com

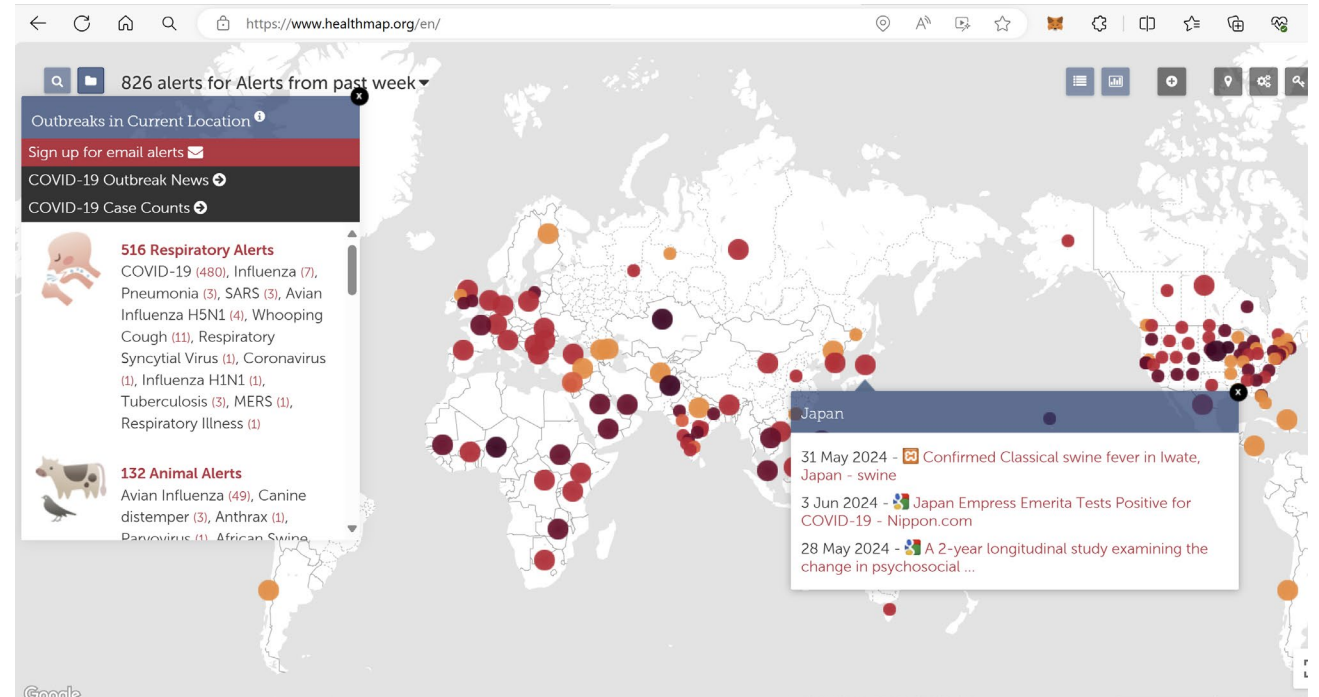
Early Detection and Diagnosis

Predictive Analytics:



Example: HealthMap, an AI-driven platform that tracks disease outbreaks by analyzing online news, social media, and other data sources.

Reference: HealthMap (<https://www.healthmap.org/>)



Early Detection and Diagnosis



Imaging and Diagnostics:



WELCOME TO THE SKCIN APP

A comprehensive, educational and self-management mobile application, dedicated to the prevention and early detection of skin cancer.

Early Detection and Diagnosis

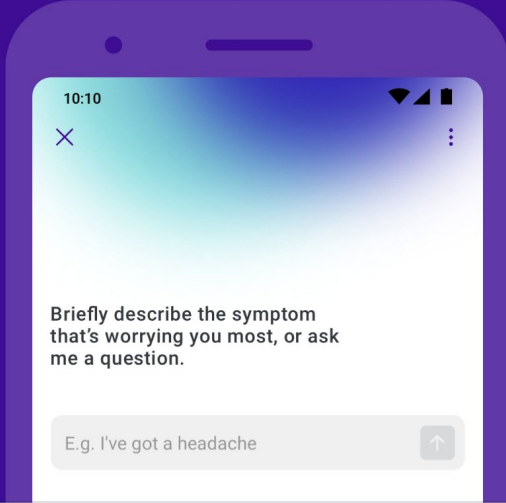


Symptom Checkers:

Example: Babylon Health's AI-powered app provides symptom checking and triage advice, helping users understand when to seek medical care.

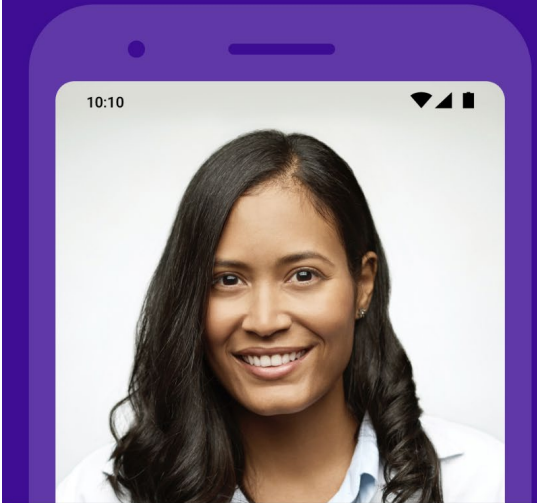
Reference: Babylon Health
(<https://www.babylonhealth.com/>)


Check your symptoms
Get instant information



Our triage chatbot service is registered with MHRA and CE marked as a Class 1 medical device. Meaning it conforms to all European regulatory standards.
MHRA registration number: 7139

Get access to a doctor, 24/7




babylon

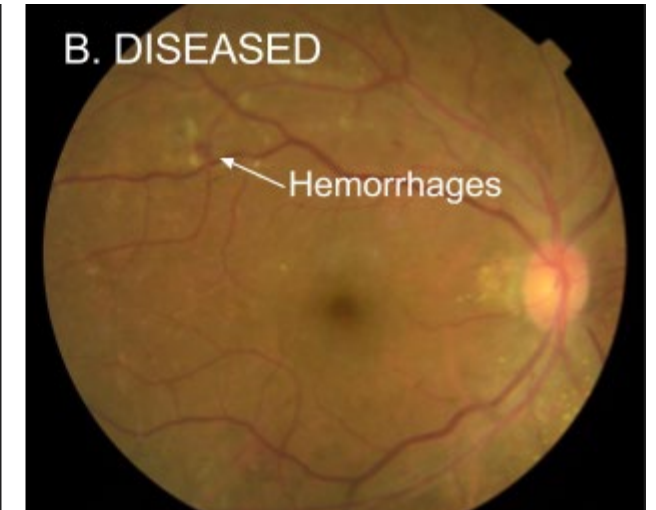
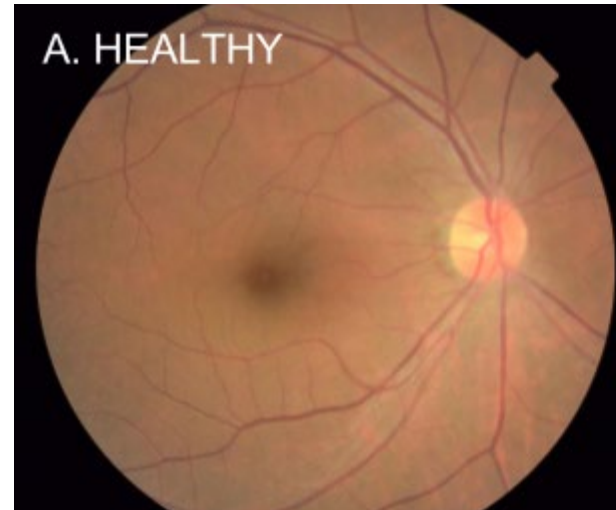
Early Detection and Diagnosis



AI-enabled tools, exemplified by Google DeepMind's diabetic retinopathy detection system, facilitate early disease detection, enabling prompt intervention and better management of chronic conditions.

Gulshan et al. (2016) showed that AI algorithms can accurately identify diabetic retinopathy from retinal images, potentially preventing vision loss in diabetic patients.

Deep Learning for Detection of Diabetic Eye Disease

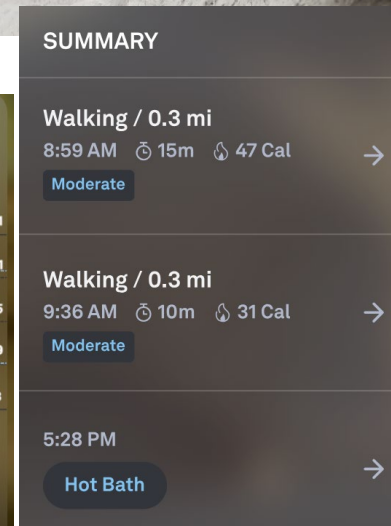
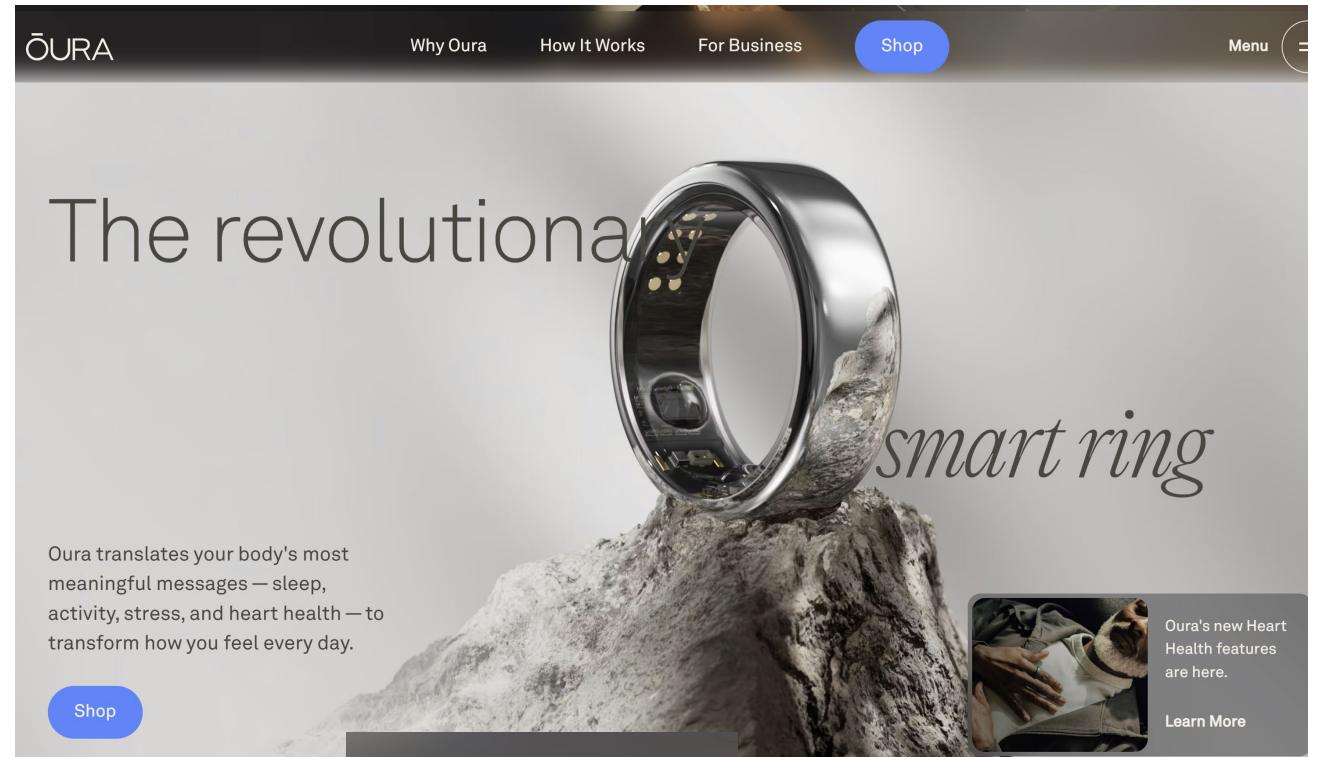


Monitoring and Surveillance

Wearable Technology:



Example: The Oura Ring, a smart ring that monitors vital signs such as body temperature, heart rate, and respiratory rate, was used for early detection of COVID-19 symptoms in healthcare workers.



Health self-service automation



Generative AI Chatbots

Healthcare chatbots support medical professionals and enrich patient experiences with intelligent self-service automation

The screenshot shows the IBM Watson Assistant website. The navigation bar includes the IBM logo, 'Products', 'Solutions', 'Consulting', 'Support', and 'Think'. Below this, there are links for 'watsonx', 'watsonx Assistant', 'Features', 'Integrations', 'Use cases', 'Industries', 'Pricing', and 'Resources'. There are also buttons for 'Try it for free' and 'Book a live demo'. The main content area features the heading 'Better health outcomes with generative AI chatbots for healthcare' and a sub-heading 'Healthcare chatbots support medical professionals and enrich patient experiences with intelligent self-service automation'. Below the text are two buttons: 'Start free trial' and 'See Assistant in action'. On the right side of the page, there is a video player with the title 'Enquire: modernizing HR within the NHS' and a play button overlay. The video player shows a scene with people in an office setting.

Enquire: modernizing HR within the NHS (4:14)

Close

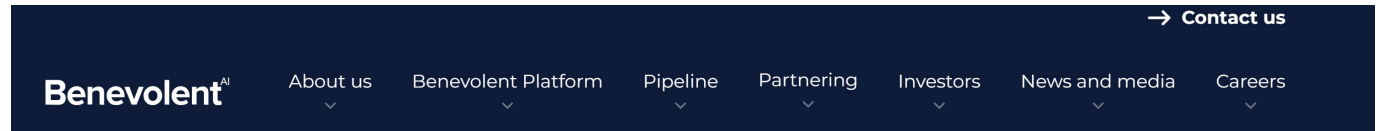
Treatment and Management



Drug Discovery:

Example: BenevolentAI used AI to identify existing drugs that could be repurposed to treat COVID-19.

Reference: BenevolentAI
(<https://www.benevolent.com/news-and-articles/how-ai-is-helping-to-find-treatments-for-covid-19>)



ABOUT US

AI-enabled drug discovery

We empower both biopharmaceutical companies and our internal scientists to harness the full potential of data and AI to accelerate the next generation of scientific advances. We have built our AI-enabled drug discovery engine to drive a revolution in drug discovery. The Benevolent Platform™ unlocks the power of a vast biomedical data landscape to provide a multidimensional representation of human biology across all diseases.

We believe this approach will improve the probability of clinical success, and help us deliver life-changing treatments to patients – **because it matters.**



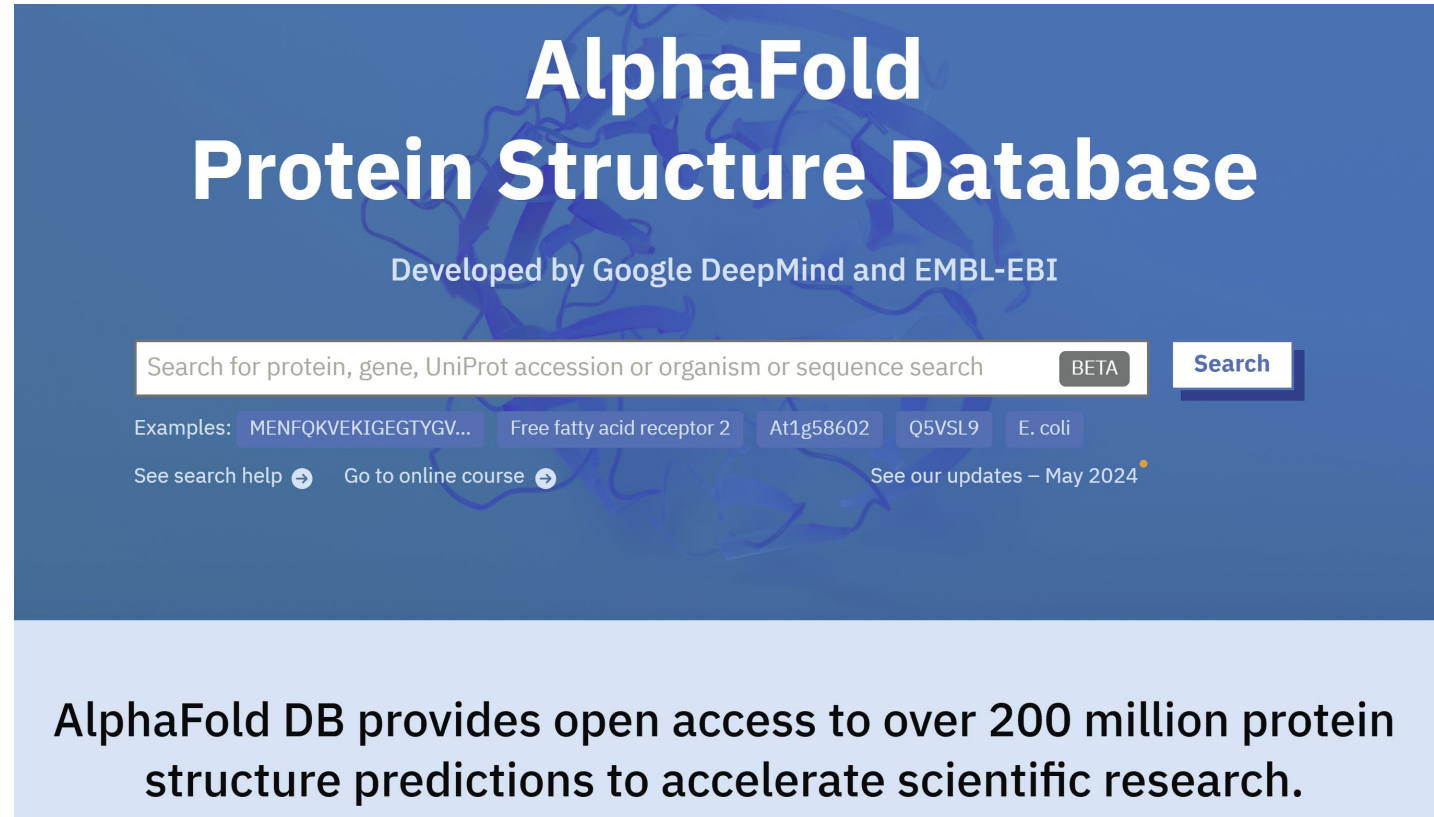
Treatment and Management



Genomic Analysis:

Example: DeepMind's AlphaFold uses AI to predict protein structures, significantly advancing research in understanding pathogen mutations and aiding in vaccine development.

Reference: Nature
(<https://www.nature.com/articles/d41586-020-03348-4>)

A screenshot of the AlphaFold Protein Structure Database website. The page has a dark blue background with a faint protein structure. At the top, the text "AlphaFold Protein Structure Database" is displayed in white, with "Developed by Google DeepMind and EMBL-EBI" below it. A search bar contains the text "Search for protein, gene, UniProt accession or organism or sequence search" and a "BETA" button. To the right of the search bar is a "Search" button. Below the search bar, there are examples: "MENFQKVEKIGEGTYGV...", "Free fatty acid receptor 2", "At1g58602", "Q5VSL9", and "E. coli". At the bottom of the search bar area, there are links for "See search help", "Go to online course", and "See our updates - May 2024". A light blue banner at the bottom of the screenshot contains the text: "AlphaFold DB provides open access to over 200 million protein structure predictions to accelerate scientific research."

[AlphaFold](#) is an AI system developed by [Google DeepMind](#) that predicts a protein's 3D structure from its amino acid sequence. It regularly achieves accuracy competitive with experiment.

Treatment and Management



Clinical Trials:

Example: PathAI uses AI to optimize clinical trial designs by analyzing pathology data, improving the efficiency and accuracy of trials.

Reference: PathAI (<https://www.pathai.com/>)



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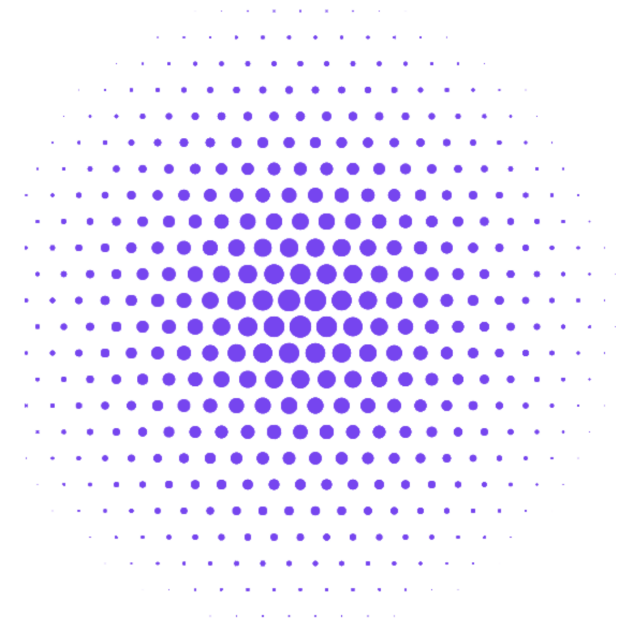
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[PathAI Diagnostics](#)

Our Mission is to Improve Patient Outcomes with AI-Powered Pathology

At PathAI, we're dedicated to improving patient outcomes with reliable AI-Powered technology and meaningful collaboration with biopharma and pathology laboratories – aiming to provide invaluable insights for biomarker discovery and drug development, and to improve laboratory workflows.

[Learn About PathAI](#)



Challenges and Shortcomings



Data Privacy

The use of AI in healthcare raises concerns about the privacy and security of patient data, especially with unauthorized access or data breaches.

Organizations must implement robust data protection measures to safeguard sensitive health information. Privacy Rights Clearinghouse provides resources on data privacy practices.



'Bias and Fairness'

AI algorithms may inherit biases from training data, leading to disparities in healthcare delivery and outcomes, particularly among marginalized populations.

Addressing bias and ensuring fairness in AI algorithms is crucial to promoting equitable healthcare access and treatment. Obermeyer et al. (2019) discuss the implications of bias in algorithmic decision-making.



'Regulation'

The regulatory landscape for medical AI is complex and often lacks standardized frameworks, leading to challenges in ensuring the safety, efficacy, and ethical use of AI technologies.

Regulatory bodies, such as the Food and Drug Administration (FDA), play a vital role in developing and enforcing regulations to govern the deployment of AI in healthcare.



'Integration'

Integrating AI technologies into existing healthcare systems poses technical challenges, including compatibility issues, interoperability concerns, and resistance to change from healthcare professionals.

Overcoming integration barriers requires collaborative efforts among technology developers, healthcare providers, and policymakers. Raghupathi & Raghupathi (2018) explore strategies for successful AI integration in healthcare settings.



'Cost'

The initial implementation costs associated with adopting AI in healthcare can be prohibitive for some healthcare organizations, limiting access to advanced AI-driven technologies.

Efforts to reduce costs and increase affordability through innovation, scalability, and value-based pricing models are essential for ensuring widespread adoption of AI in healthcare. Sengupta & Pachava (2020) discuss the economic considerations of implementing AI in healthcare.

Workshop outline

Risk prediction

- Text-based
- Machine-learning
- Example: identify the risk of HIV/STIs in individuals
- Dataset: HIV/STI status and Behavioural indicators (computer-generated)
- Platform: PyCaret

low-code machine learning

GET STARTED

PyCaret is an open-source, low-code machine learning library in Python that automates machine learning workflows.

Workshop outline

Image recognition

- Image-based
- Deep-learning
- To distinguish STI-related skin lesions
- Labelled and open-sourced STI images
- Platform:
TeachableMachine

Teachable Machine

Train a computer to recognize your own images, sounds, & poses.

A fast, easy way to create machine learning models for your sites, apps, and more – no expertise or coding required.

[Get Started](#)



Conclusion

In conclusion, medical AI holds immense promise for transforming disease management in medicine, revolutionizing healthcare delivery, improving patient outcomes, and advancing public health.

However, realizing the full potential of medical AI requires addressing various challenges, including ethical considerations, regulatory frameworks, and equitable access, while embracing continued innovation, collaboration, and responsible implementation.