

ARTIFICIAL INTELLIGENCE

the landscape in clinical medicine

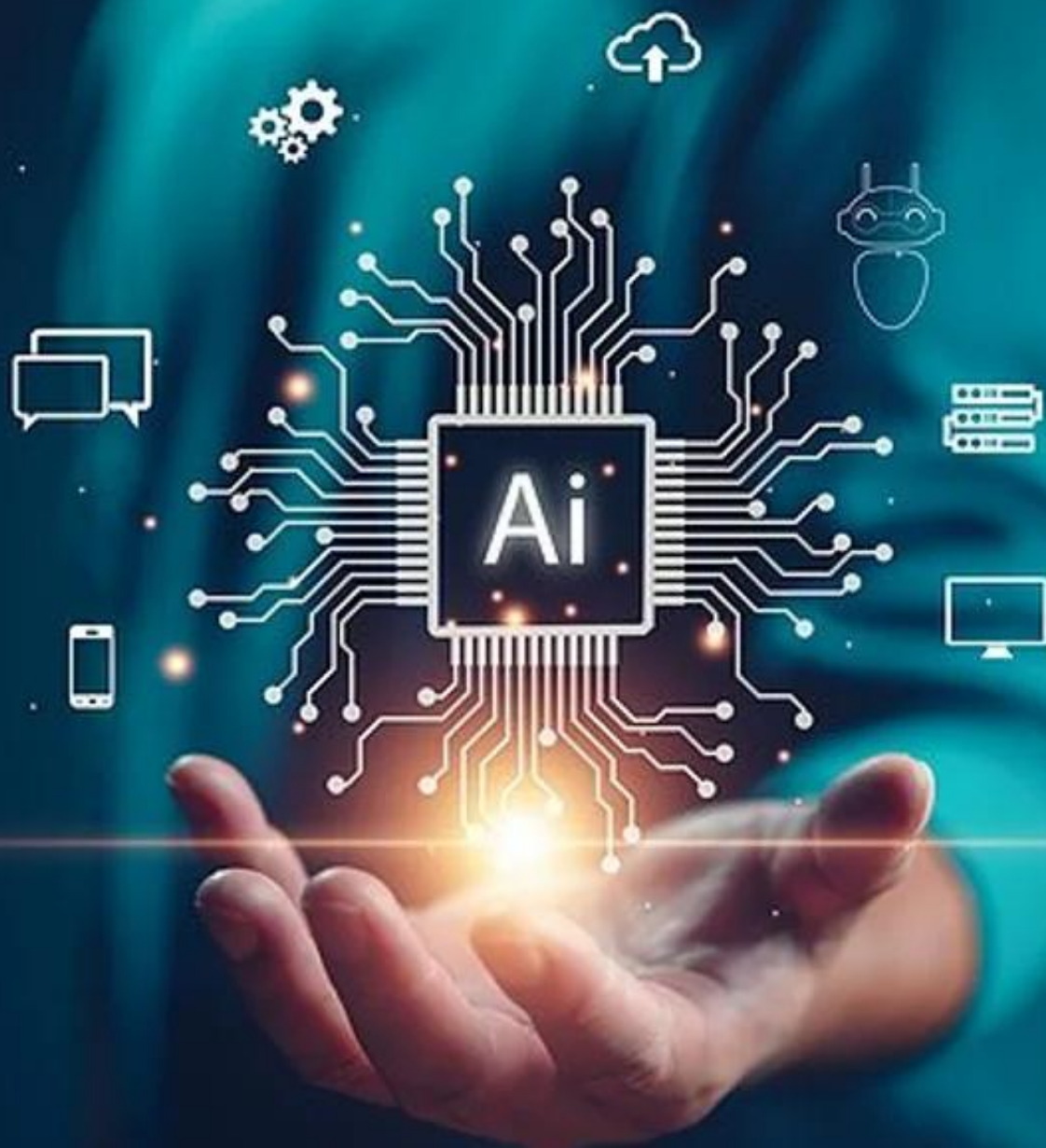
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Professor of Internal Medicine

Disclaimer

“No conflict of interest with AI tech firms”

What is Artificial Intelligence?



Branch of Computer Science capable of performing tasks typically requiring **human intelligence**

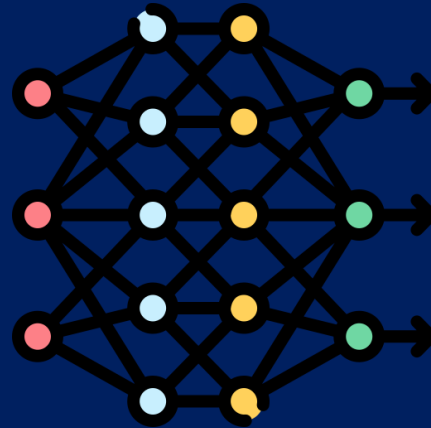
AI enables machines to mimic cognitive functions

- Learning
- Reasoning
- Problem Solving
- Decision making
- Natural Language understanding
- Recognizing patterns

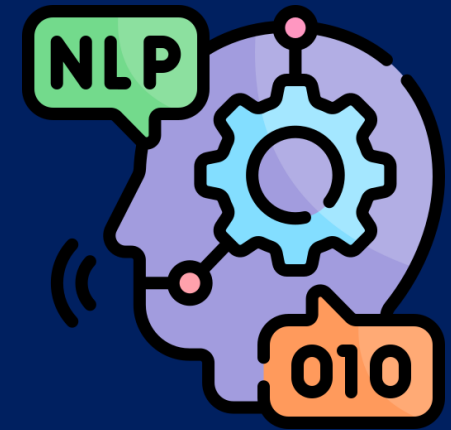
Subsets of AI



**MACHINE LEARNING
(ML)**



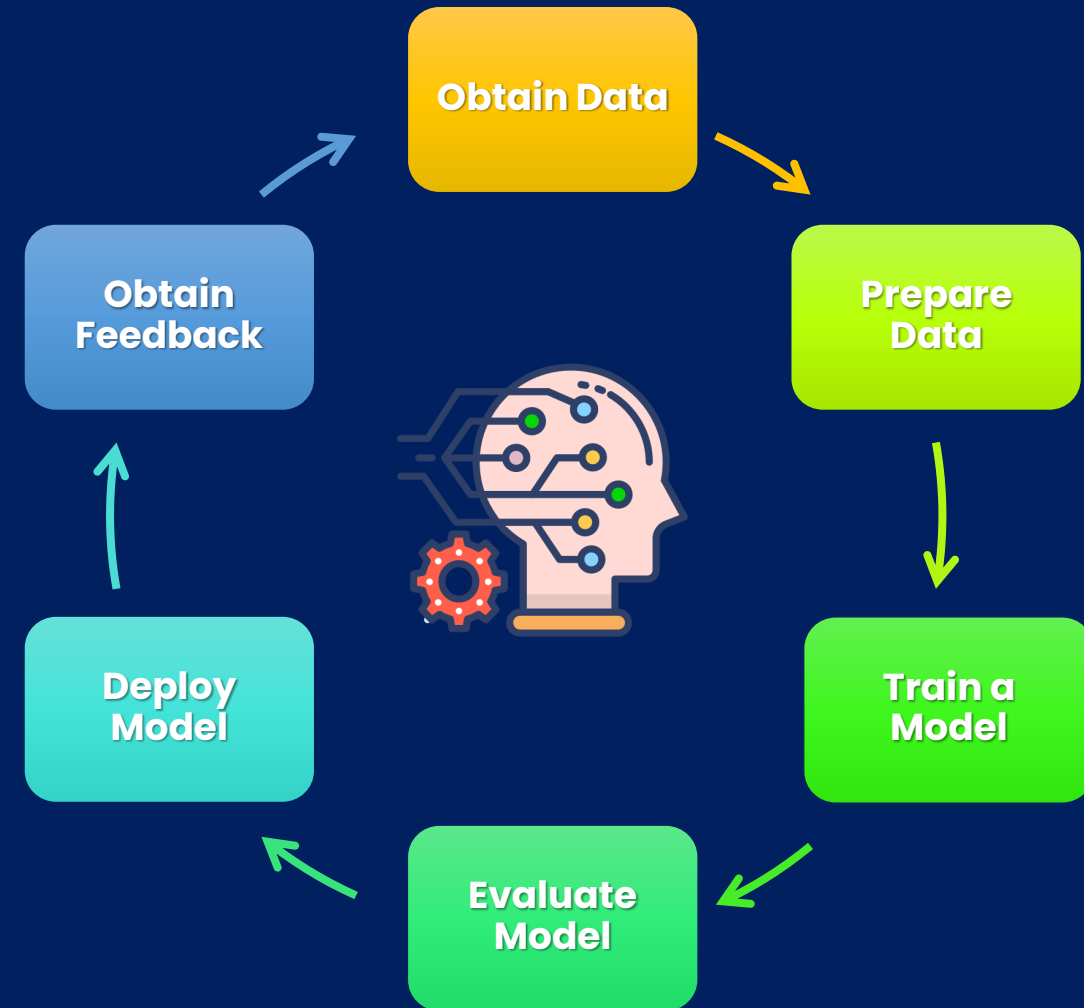
**DEEP LEARNING
(DL)**



**NATURAL LANGUAGE
PROCESS (NLP)**

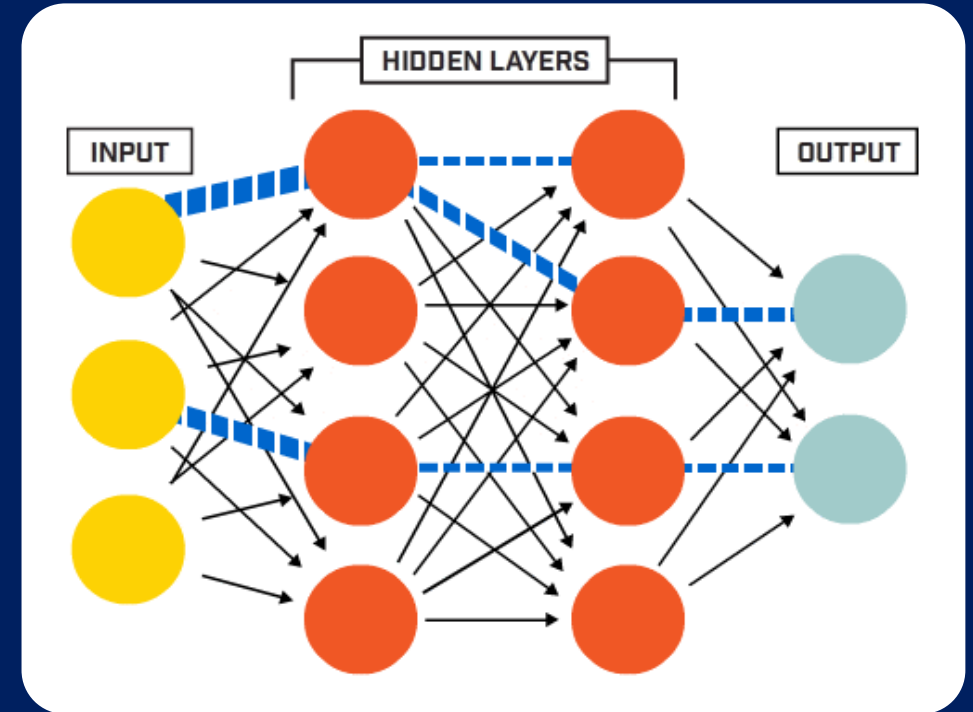
Machine Learning (ML)

- It is a **core method** in AI
- It focuses on **data driven learning** and **decision making**



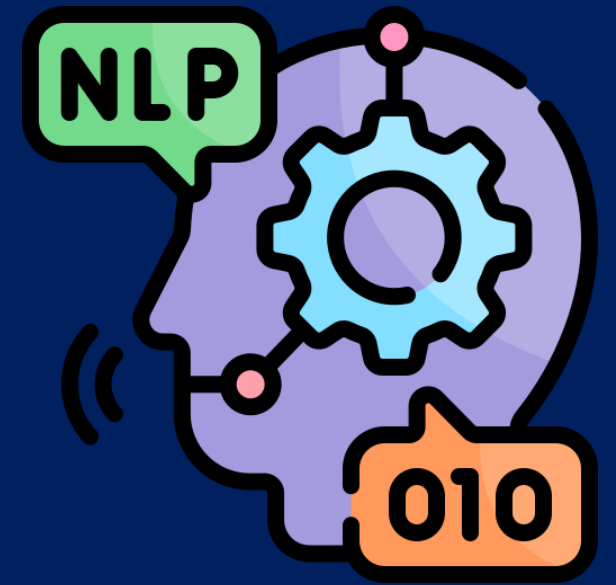
Deep Learning (DL)

- It is a **subset** of machine learning
- It uses neural networks with **multiple layers** to analyze **vast amount of data** to solve **complex problems**



Natural Language Processing (NLP)

- It is a branch of AI that focuses on enabling machines to **understand, interpret** and **generate** human language



AI used in following areas of Clinical Medicine

- **Diagnosis**
- **Treatment**
- **Robotic Surgery**
- **Mental Health**
- **Medical Education**
- **Medical Documentation**
- **Drug Discovery**
- **Communication & Preventive Medicine**
- **Virtual Health Assistance & population health**

AI in Medical Diagnosis

Medical Images:

- **X-rays**
- **CT Scans**
- **MRIs**
- **Mammography**

⇒ **AI driven diagnostic system offer unparalleled precision, accuracy and efficiency**

Benefits of AI powered **image interpretation**

- It can **identify subtle change** which may escape human eyes
- It can also **identify disease at early stage** leading to more effective **intervention** and **improve patient outcome**

Scientist of **Harvard Medical School** developed a new **AI system**

- **CHIEF** (Clinical Histopathology Imaging Evaluation Foundation)
- Published in **Nature**, September 4, 2024



HARVARD
MEDICAL SCHOOL

How this Chat GPT-like AI model developed?

- Trained on **15 million digital images** chunked into sections of interest
- Trained further on **60,000 whole slide images** of tissues which included **lung, breast, prostate, colorectal, stomach, esophageal, kidney, liver, pancreatic, cervical, uterine, ovarian, testicular, adrenal gland, bladder, thyroid, brain, skin** and **soft tissues**

Uploading a digital histopathological image

Cancer Detection:

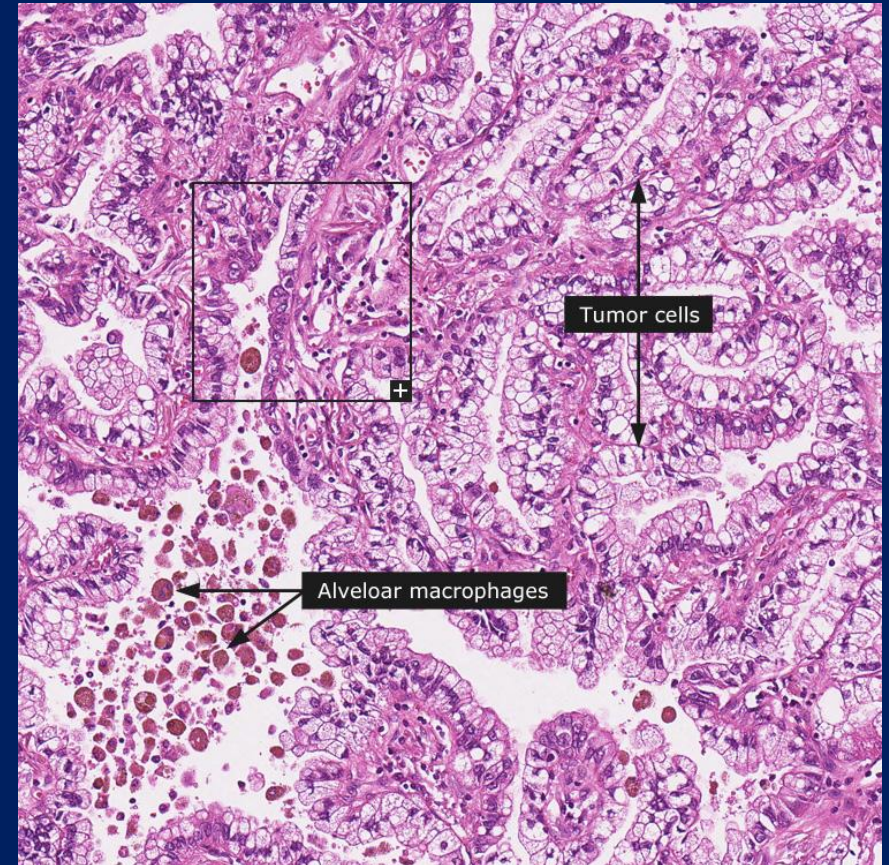
- **CHIEF** achieved **94 percent accuracy** in cancer detection
- This allowed it to **accurately diagnosis cancer** of **19** different organs



Uploading a digital histopathological image... cont.

CHIEF identified-

- **Genetic variations** in a Tumor
- Important **genes related to cancer** growth and suppression
- Specific **DNA pattern** of a tumor
- **Mutations** in cancer genes



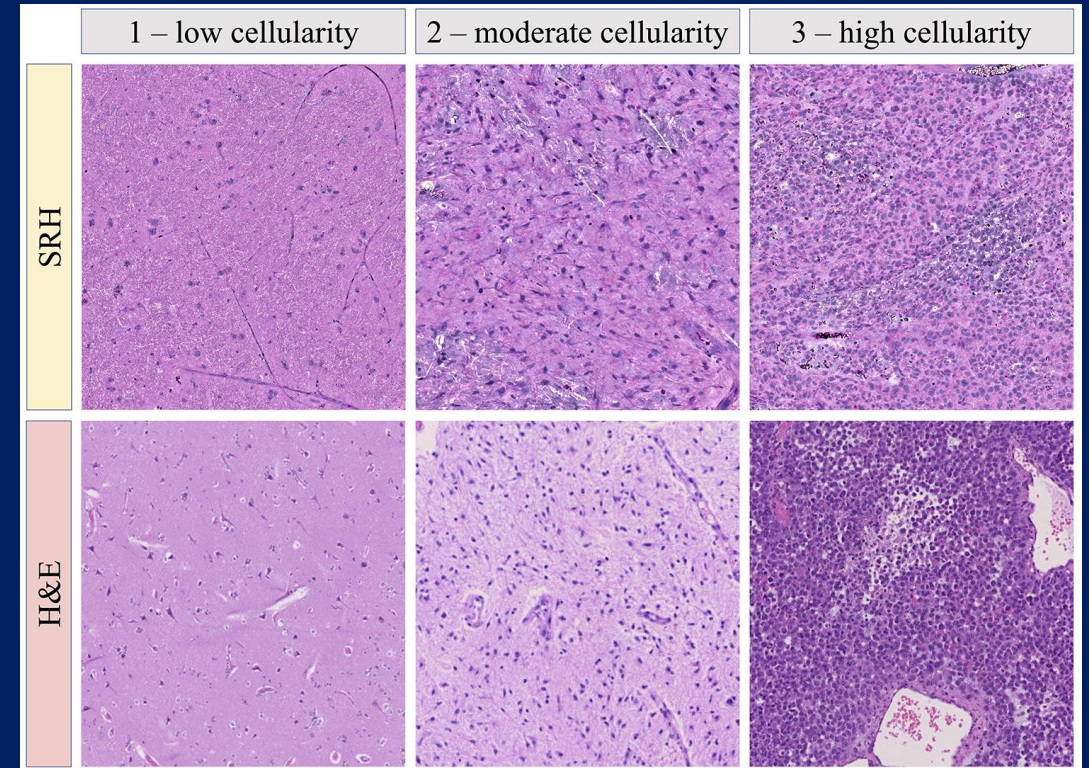
Uploading a digital histopathological image... cont.

All of these are invaluable in **predicting patient's response to standard treatment-**

- **Surgery**
- **Chemotherapy**
- **Radiotherapy**
- **Immunotherapy**

Uploading a digital histopathological image... cont.

- **CHIEF** successfully **predict** patients with long-term **survival** or shorter-term **survival**
- High versus low **death risk** patients
- Extracted **novel insights** about **tumor behavior**



Treatment Experience with AI: Case 01

A child presented with worsening dystonia

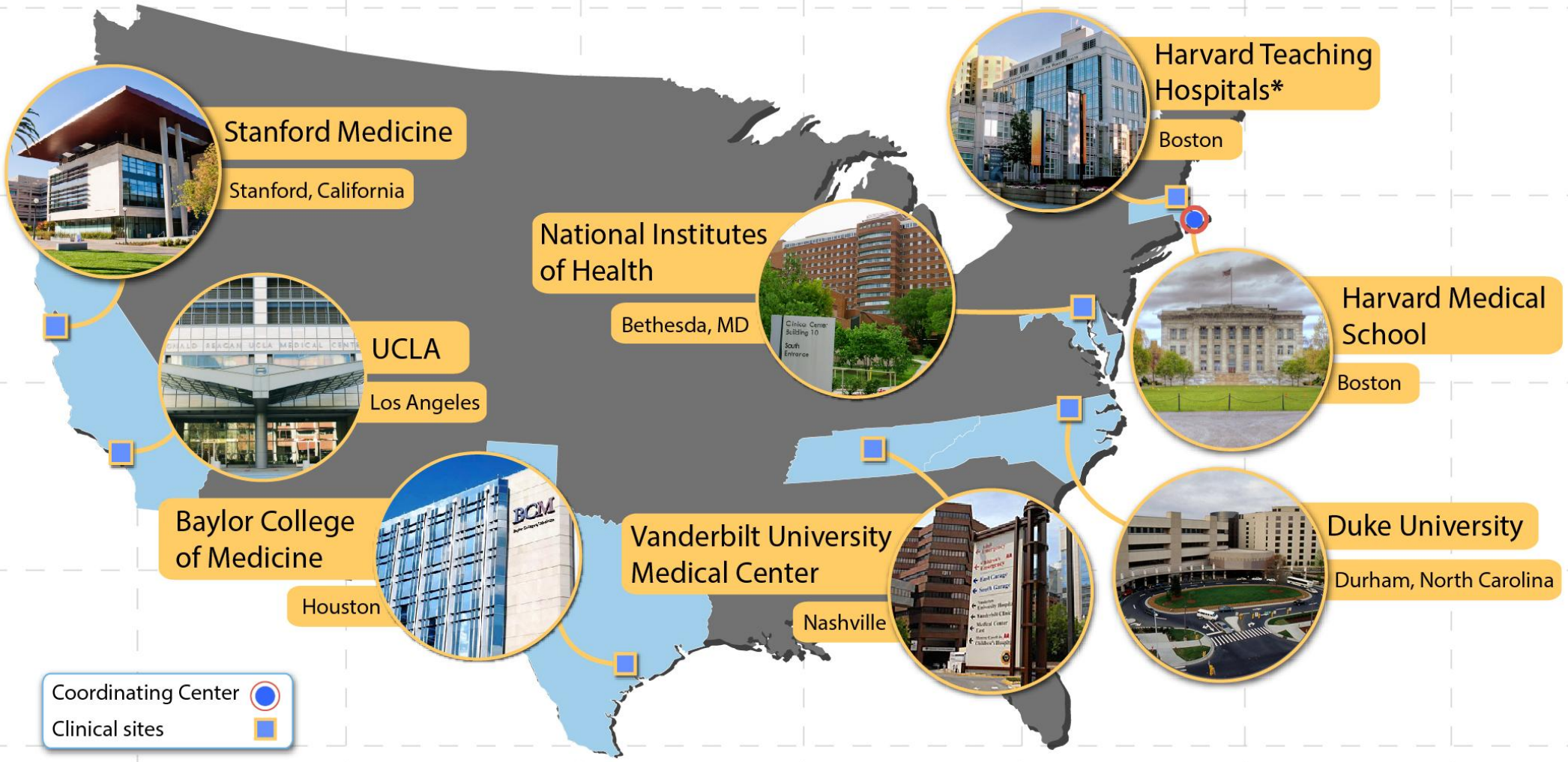
- Not walking
- Not talking



⇒ Seen by **7 neurologists** which included **Harvard neurologists**, but they **could not identify the disease**, no treatment was helpful

Undiagnosed Diseases Network

Seven clinical sites and a coordinating center

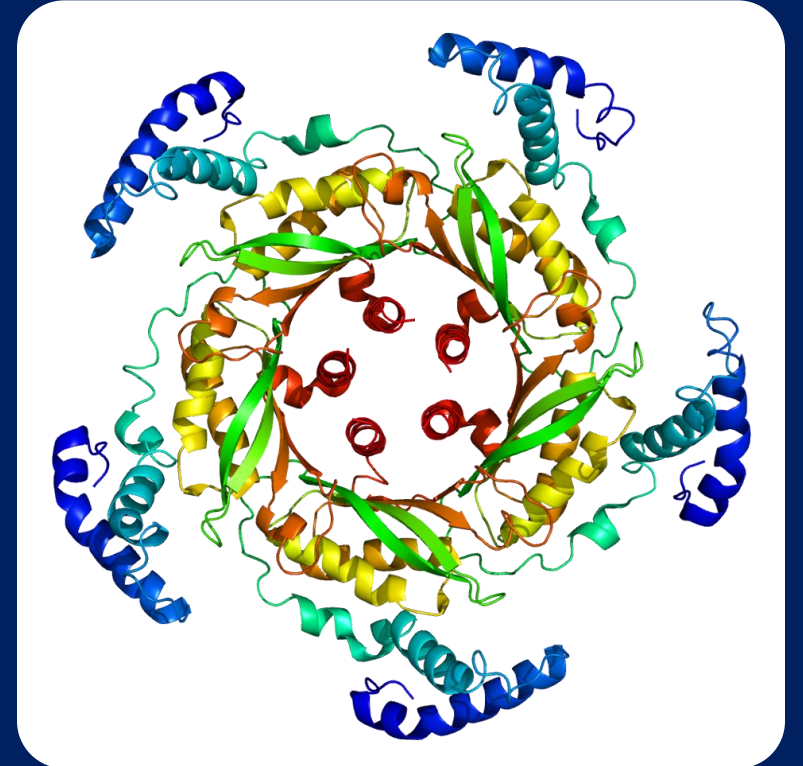


Case 01... cont.

- Whole **genome sequence**
- Every **3 billion genetic letters** with the help of AI
- Figure out **difference from reference** human being
- Then **refer to right expert**

Case 01... cont.

- Found **mutation in a gene**
GTP Cyclohydrolase-1
- It turns **chemicals into neurotransmitters** which allows neurons to **interact with each other for normal functioning**
- Because of this deficiency, the **child** was **losing milestones**



Case 01... cont.

- Then the child was given **L-DOPA, folinic acid** and **5-hydroxy tryptophan**
- Within a month the **child started walking** and **talking**

Treatment Experience with AI: Case 02

4 years old kid presented with history of bloody stool

- In 2005: underwent colonoscopy – **showed Pancolitis**
- In 2013: at the age of 13 years treated with **Sulfasalazine** with **relative control**
- In 2015: he flared and given **prednisolone, vancomycin** with **no benefit**

Case 02... cont.

- In 2016: he was started **6MP**, with 3 months treatment with **no result**
 - Then he was given **infliximab** transient improvement again **flared**
 - Multiple treatment including **steroid** enema **disease continued to worse**

Case 02... cont.

- He started to having **bloody diarrhea** hourly
- Hospitalized and was given **tacrolimus** followed by **Vedolizumab**
 - **no improvement**

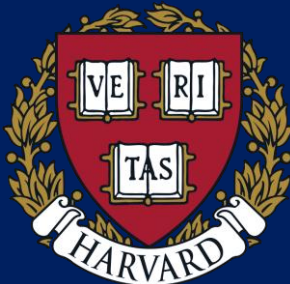
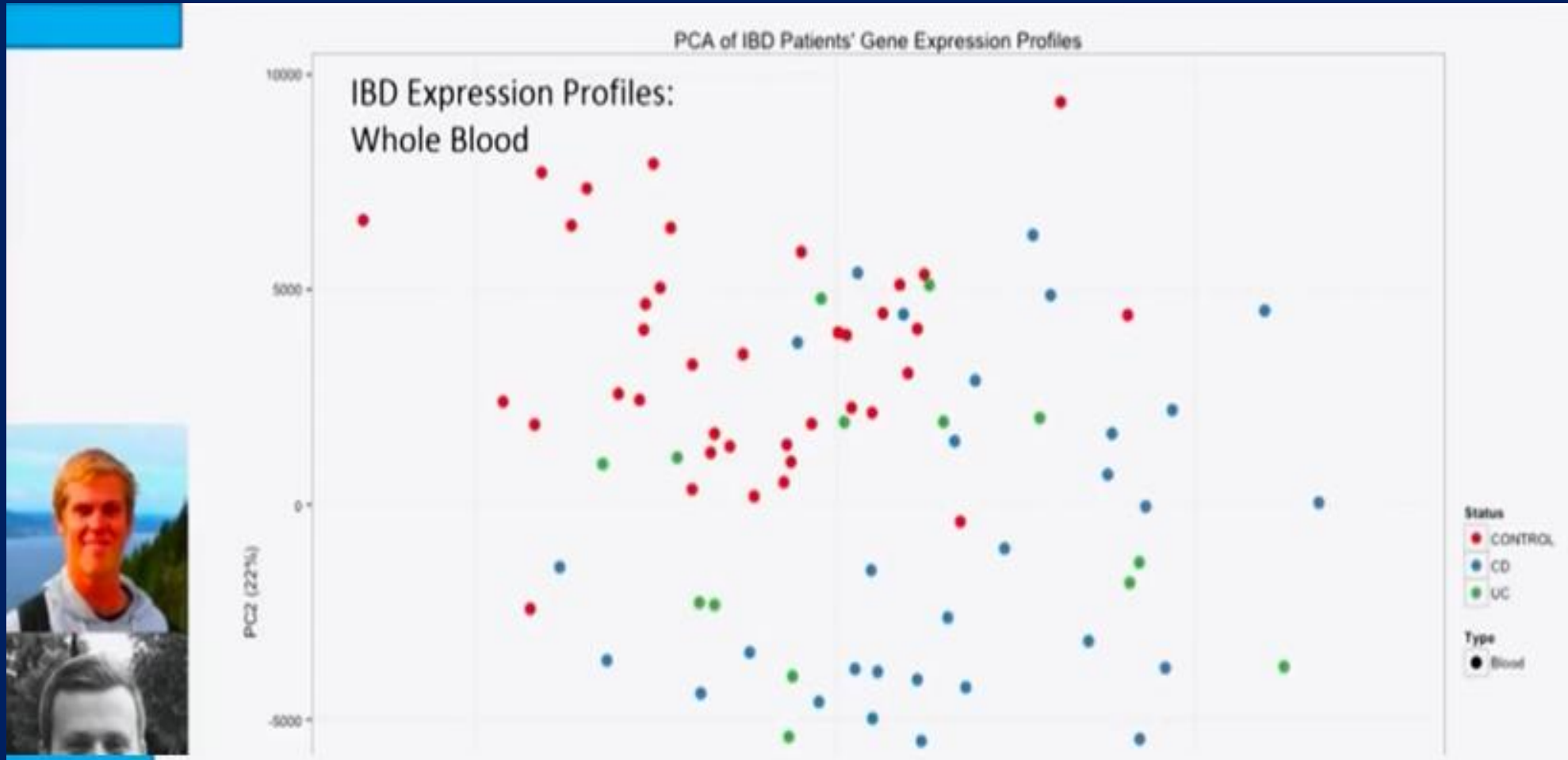
⇒ **Doctors decided to go for colectomy**

Case 02... cont.

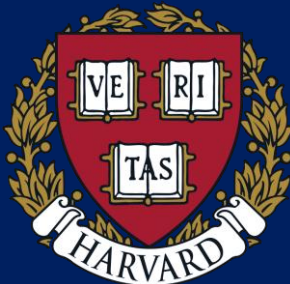
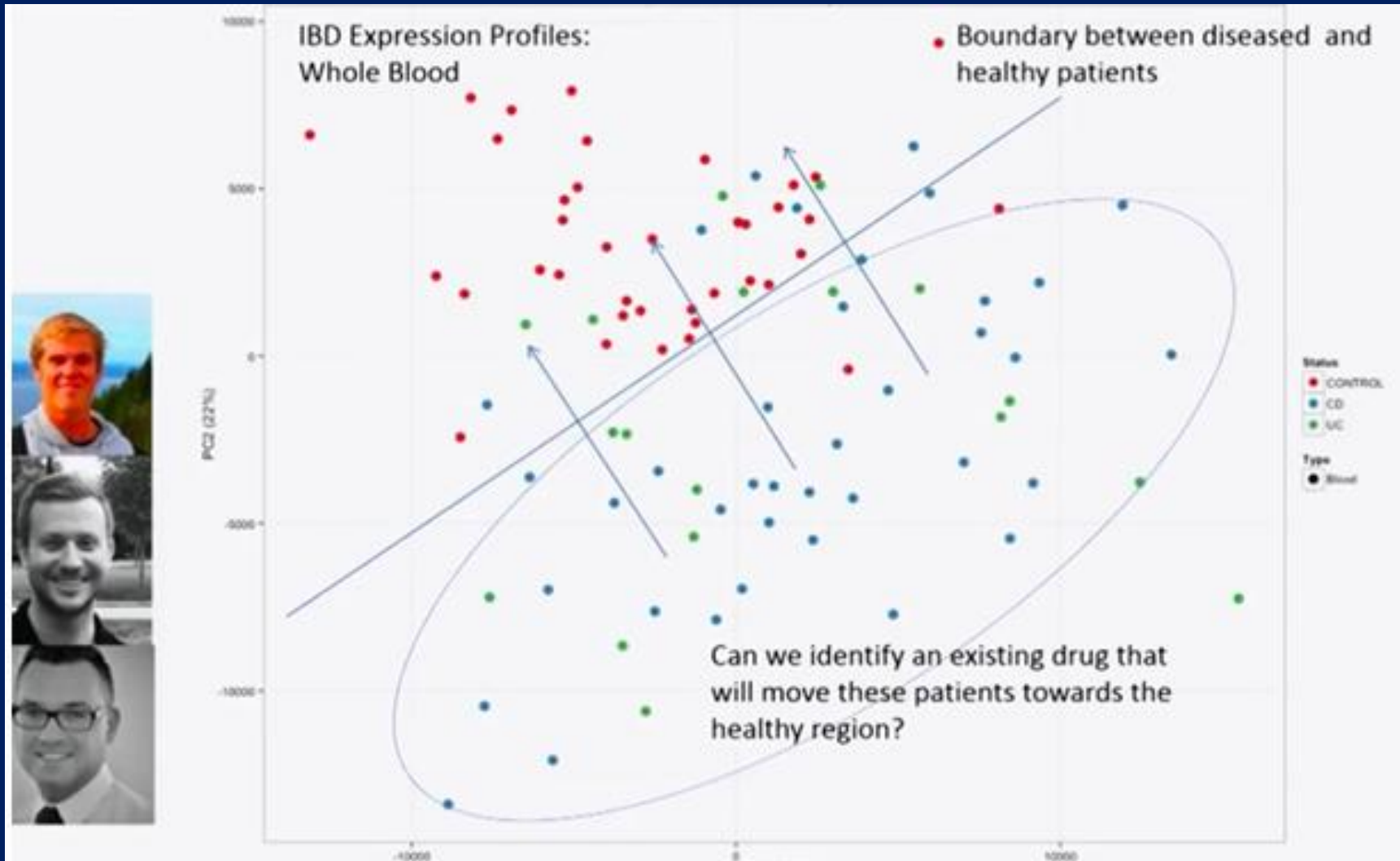
- **4 weeks before operation**, the boy's parents seek help from a team of **biomedical engineers** of Harvard
- Then his **histopathology slide and blood samples** were taken by those 4 biomedical engineers, **none of them were doctors**
- They started matching with the **help of AI**, subjects of IBD responded to treatment



Case 02... cont.



Case 02... cont.



Case 02... cont.

- The called the professor to inform him that the best ranked compound for the patient is
- **Indirubin**
 - Chemical compound most often produced as a byproduct of bacterial metabolism
 - Constituent of indigo Naturalis (also known as **qing dai**)



Therapeutic efficacy of the Qing Dai in patients with intractable ulcerative colitis

Hideo Suzuki, Tsuyoshi Kaneko, Yuji Mizokami, Toshiaki Narasaka, Shinji Endo, Hirofumi Matsui, Akinori Yanaka, Aki Hirayama, Ichinosuke Hyodo

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Author contributions: Suzuki H designed the research and analyzed the data; Kaneko T performed the basic research; all other authors revised the draft and approved the final version for publication.

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2 g/d of Qing Dai orally and continued taking other medications for UC as prescribed. Electron spin resonance was applied to explore the mechanisms of action of Qing Dai. After 4 mo of treatment with Qing Dai, the CAI score decreased from 8.3 ± 2.4 to 2.4 ± 3.4 (mean \pm SD; $P < 0.001$). Similarly, the endoscopic Matts grade decreased from 3.4 ± 0.5 to 2.2 ± 0.8 ($P = 0.02$). Six of 7 patients who were on prednisolone upon enrollment in the study were able to discontinue this corticosteroid. Electron spin resonance revealed that Qing Dai possesses strong hydroxyl radical scavenging activity. Qing Dai showed significant clinical and endoscopic efficacy in patients who failed to respond to conventional medications. Scavenging of hydroxyl radicals appears to be a potential mechanism through which Qing Dai acts, but the significance of the scavenging ability of Qing Dai with respect to the anti-inflammatory effect in UC patients warrants further investigation.



Case 02... cont.

They started with the chemical compound
– the boy showed **dramatic response**

Bloody diarrhea stopped

He was discharged from hospital and **avoided Colectomy**



AI in Medical Education

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graph TD; A[AI in Medical Education] --> B[Chatbots]; A --> C[Intelligent Tutoring Systems (ITS)]; A --> D[Virtual Patients]; A --> E[Adaptive Learning];
```

Chatbots

**Intelligent
Tutoring
Systems (ITS)**

Virtual Patients

**Adaptive
Learning**

Chatbots

- It can **efficiently summarize** and **evaluate** research and medical literatures
- It can act as **interactive tutors** in **clinical settings** help students/Doctors to understand **complex clinical scenarios** and assist in developing **decision making skills**

ITSs (Intelligent Tutoring System)

- It can act as a **well-trained human tutor**.
- It can **identify students' strengths** and **gaps** in his knowledge and can create a **personalized learning module** best for the student's need and progress.

Virtual Patients

- Interactive computer simulations of **real-life clinical scenarios** for health professions training and education
- Virtual patients are programmed to exhibit **realistic symptoms**, **respond to student's interventions**, and generate **dynamic clinical experiences**

Adaptive Learning System

- Computer algorithms determine the **learner's knowledge level** and provide **individualized instructional** content to guide towards content mastery
- Personalized and adaptive teaching methods **improve learning efficacy** and **efficiency**

03 levels of AI skills in Medical education

1. Basic skills: Practical ability to use clinical AI tools

2. Proficient skills: Ability to critically assess the utility of clinical AI applications

3. Expert skills: Deep technical understanding of machine learning combined with clinical expertise that enables experts to drive meaningful advancements in medical AI

Challenges and limitations of AI in Clinical Practice

1

Data Quality

AI algorithms are only as good as the data they are trained on. Incomplete or inaccurate data can lead to unreliable results i. e. AI hallucination

2

Lack of Standardization

The lack of standardized AI tools and data formats can hinder interoperability and widespread adoption

3

Human-AI Collaboration

Effective implementation requires a collaborative approach between AI systems and healthcare professionals

Ethical Considerations in AI-Driven Healthcare

- Data Privacy
- Algorithmic Bias
- Transparency
- Explainability

Conclusion

- Globally **AI** is going to play **significant role in medical science**
- **AI** has to be **implemented in our healthcare system** ASAP and we all **need to be part it**
- **Unified AI tools** and formats are needed for **widespread use**

AI will not replace humans, but.. those who use it will replace those who don't

Thank You

