AI and its Application in Medical Imaging and Diagnostics

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INTRODUCTION

As the artificial intelligence (AI) field quickly grows and evolves, one reasonable place to utilize AI and machine learning is in the medical field, where there is ample data for the machine to analyze and make decisions from. One particular area of focus is data extraction and diagnosis for medical files, especially medical imaging. Machine learning programs are generally more efficient than current methods, but many people argue that the risk of using AI is still too high and that the technology should be improved before being commonly implemented. As a result, one has to ask: how is medical imaging used in medical imaging and diagnostics, and what are its strengths and weaknesses?

What are artificial intelligence and machine learning?

Artificial intelligence is the broad field of study in which the goal is to allow machines and programs to be able to learn and think like people; the programs generally learn by changing and adapting their algorithms over multiple trials. In other words, the program codes itself (Fig 1).

Machine learning uses massive amounts of "training data" to be able to be able to structure the data or predict future data.

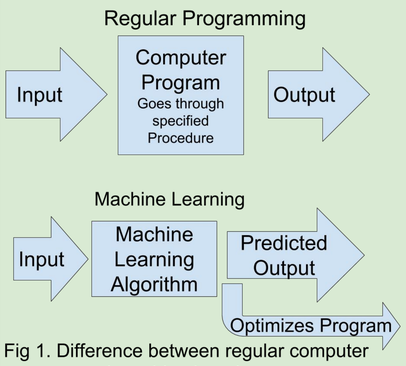


Fig 1. Difference between regular computer program and machine learning program

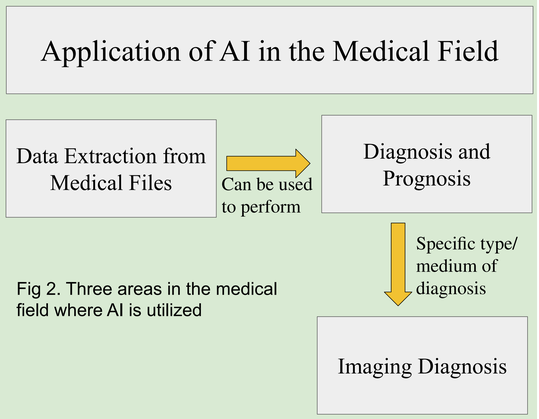


Fig 2. Three areas in the medical field where AI is utilized

HOW AI IS USED IN THE MEDICAL FIELD

AI Reading Medical Files and Diagnosis

AI reviews notes and identifies key terms in order to find relevant studies or files to help doctors and other scientists on their studies. AI can use the important notes and details to provide a diagnosis.

AI for Imaging Diagnosis

Identifying key features or areas of disease by hand can be difficult to determine and leaves room for error/misinterpretation; thus, AI is used to help with the process and detect minute details accurately and quickly. Examples include: identify bone fractures and other musculoskeletal injuries, symptoms/physical signs of common colds, tumors (Fig 3), etc. (Brensick, 2018).

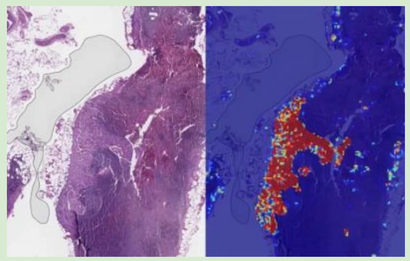


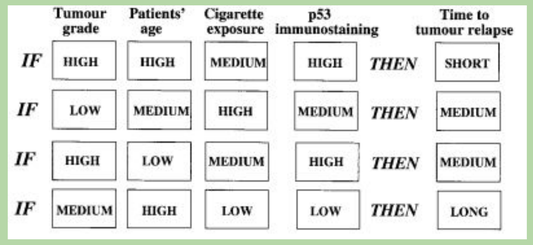
Fig 3. Lymph Node Assistant (LYNA) uses an image recognition deep learning model to identify tumors in lymph nodes. In tests, LYNA achieved 99% detection accuracy.

CLINICAL TRIALS

At the Radiological Society of North America's annual meeting, Siemens Healthineers presented the AI-Rad Companion Chest CT. "The intelligent software assistant can take vendor-agnostic CT images and highlight various thoracic structures, as well as mark any potential abnormalities and include their measurements in structured reports—targeting the heart, aorta, lungs, and coronary arteries" (Joffe, Shah, 2018)

In a current clinical trial study conducted by Royal Marsden NHS Foundation Trust, researchers use machine learning on Whole Body Magnetic Resonance Imaging (WB-MRI) for myeloma patients. WB-MRI uses the movement of water molecules in tissues to find locations and growth of cancerous cells. Although it is very accurate, the number of layers of pictures makes analyzing and interpreting the scan take a long time (Fig 4). However, using machine learning, the "computers can be 'trained' to rapidly pin-point sites of disease and thus aid the radiologist's expert interpretation."

Fig 4. Whole Body MRI creates many layers of images of the body, each layer being ¼ inches thick



	Tumour grade	Patients' age	Cigarette exposure	p53 immunostaining		Time to tumour relapse
IF	HIGH	HIGH	MEDIUM	HIGH	THEN	SHORT
IF	LOW	MEDIUM	HIGH	MEDIUM	THEN	MEDIUM
IF	HIGH	LOW	MEDIUM	HIGH	THEN	MEDIUM
IF	MEDIUM	HIGH	LOW	LOW	THEN	LONG

Fig 5. ANNs and Neuro Fuzzy Modeling use multiple factors (or variables) to predict relapse. The weight (importance) of each variable is determined through analyzing the results of previous trials

Google's DeepMind system was able to correctly identify eye diseases and give referral recommendations in more than 94% of cases (Ross, 2018). Compared to prior programs, this program also gives its reasoning, meaning that physicians and researchers can learn from the program's process.

In 2003, James W. F. Catto and others in the academic Urology Unit at the University of Sheffield compared the predictive accuracies of two machine learning methods (Artificial Neural Networks and Neuro-Fuzzy Modeling) to traditional methods on bladder cancer relapse (Fig 5). The AI "predicted relapse with an accuracy ranging from 88% to 95% [, which] was superior to statistical methods (71-77%)."

BENEFITS AND DISADVANTAGES

Benefits	Disadvantages
• Can perform parts of physician or other medical professional's jobs - Not only is AI faster, but it is also more accurate and precise • Does not have to be paid wages (better long term for hospitals and medical companies) • Can work unlimited hours - physicians become fatigued and cannot work similar hours • Still has many new possibilities and untapped potential; this field is improving day by day ** Should not be a problem, since AI can fill the current shortage of physicians and doctors (especially in less developed/poorer areas); also, if AI is just being used as a tool / assistant, it would not take jobs away.	• Removes the human element from medicine, which is an important factor in treating patients - Public has stigma and negative perception around "robots" • High initial investment cost -"One hundred twenty-one digital health companies leveraging AI/ML... have raised a total of $2.7B...from 2011 through 2017" (Zeing, Tran, 2018) • Still makes mistakes, which can be greatly magnified if program is bad or data is faulty - Many experts suggest that, in order to prevent fatal mistakes, AI should be used as a tool or assistant but should not be the one making the final/only decision • Takes jobs away from physicians and other medical professionals **

CONCLUSION / NEXT STEPS

I now know what AI is and how it is being implemented in the medical field: AI uses machine learning to extract patterns and trends over repeated trials and examples. It can make a diagnosis from those sets of data.

Many clinical trials have been conducted, especially in medical imaging. Examples include finding thoracic abnormalities, interpreting Whole Body MRI Scans for myeloma, and using various machine learning methods to predict cancer relapse. I also learned of the effects and consequences of the implementation of AI, as indicated in the benefits and disadvantages.

With a deeper understanding of the topic and field in question, we can determine what the next steps for AI should be. There are still many ways AI can be developed and improved upon, but it has a promising future.

For future work, I can examine other uses of AI in medicine. Some areas include AI-assisted surgery, drug creation (Fig 7), or AI nursing.

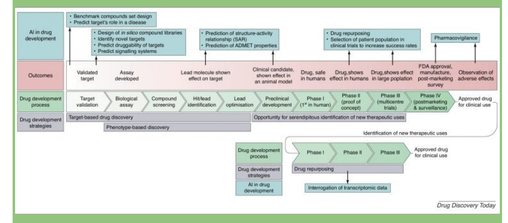


Fig 6. Shown is a flowchart of the typical drug development process and how AI can help at many different sections, such as predicting signaling systems and structure-activity relationship to drug repurposing.

ACKNOWLEDGEMENTS / REFERENCES

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