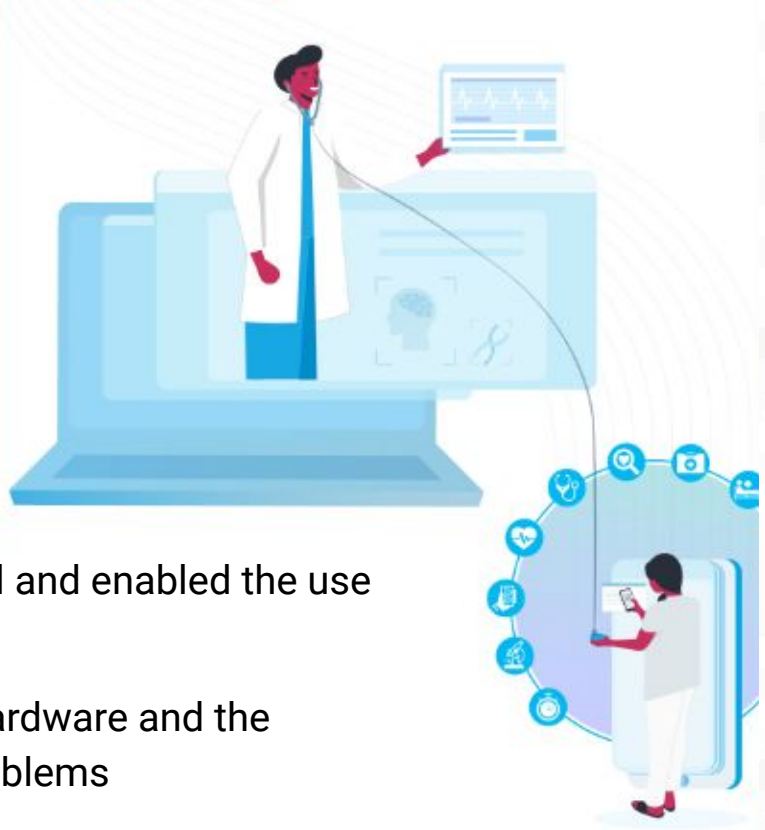
AI in Healthcare

How AI is Changing Medicine

Healthcare + AI

- For decades, researchers have been trying to apply computer analysis in every field of medicine
- In 1976, Gunn explored the possibility of using computer analysis in abdominal pain diagnostics
- Unfortunately at that time, even with the development of intelligent algorithms, the applications are limited due to hardware constraints



- In the past decade, better and faster hardware emerged and enabled the use of computers in high-stake domain such as medicine
- Researchers can now utilise the computing power of hardware and the intelligent approach of algorithms to solve pressing problems

How does AI fit into healthcare?

- Similar to how AI is revolutionising other domains, AI is changing various fields in medicine
- One popular application is medical imaging, where CNN is acting as a tool to speed up diagnostics and treatment prescriptions
- AI can be trained to detect specific diseases based on medical images and used to diagnose patients more accurately
- Doctors are also prone to exhaustion, which contributes to occasional mistakes
- These tools can act as a second opinion for doctors in this field

In this section, you will discover more about the applications of AI in the various field in healthcare

Healthcare Application 1: Axial AI by Skymind

Source: https://www.youtube.com/watch?v=WU6RmVwp89Q

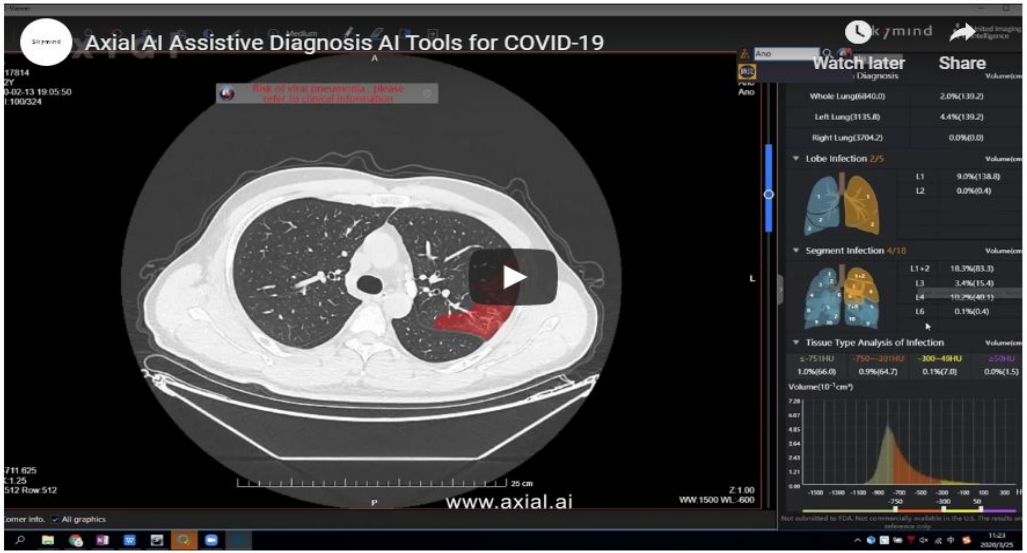
Axial AI to Diagnose COVID-19 Patients

- Deployed in Wuhan hospitals, Huo Shen Shan and Lei Shen Shan Hospital for diagnosis of COVID-19 in over 6,000 patients.
- Gives doctors a unique, quantitative, view of the trauma happening inside the patient's lungs.
- Allowed doctors to make more efficient use of ventilators, ICU beds, and tracking if a treatment is being effective in increasing the patient's likelihood of survival

AI tool which analysed COVID-19 in Wuhan available to NHS

RSS Print

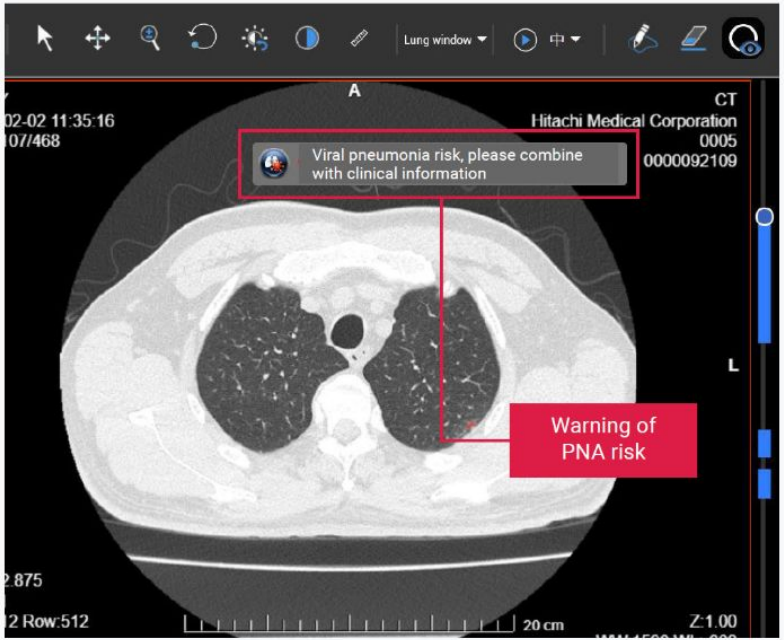
Axial AI, *an AI software developed by Skymind that provides solutions for multiple diseases analysis for hospitals and research facilities, has announced the availability of its Axial AI tool for use by the NHS for free.*

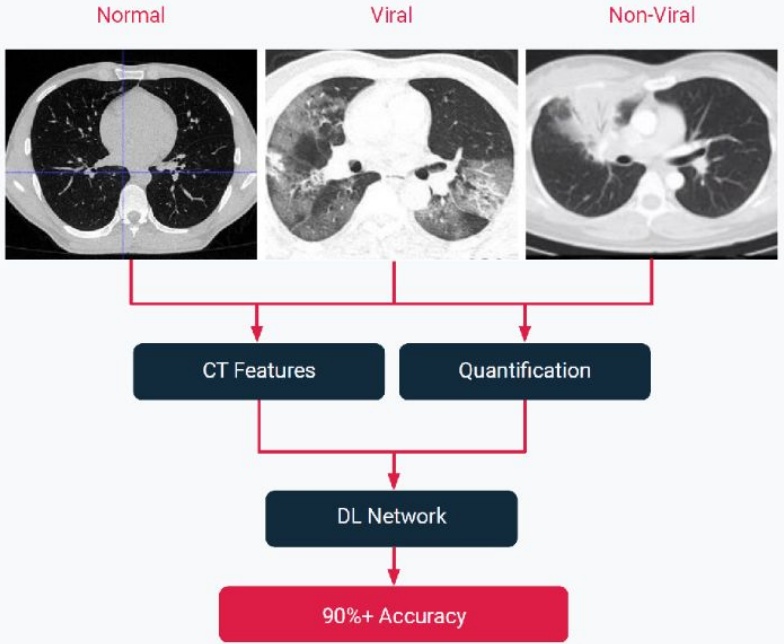


Source: https://www.med-technews.com/news/ai-tool-which-analysed-covid-19-in-wuhan-available-to-nhs/

AI-Classification of Viral Pneumonia

AI-CLASSIFICATION





Source: https://axial.ai/

Features

- AI-based COVID-19 CT scan diagnosis platform helps medical teams analyse the progression of COVID-19 in patients faster with an accuracy rate of more than 90%.
- Apply deep learning (DL)-based segmentation to automatically quantify infection regions of interest (ROIs) and their volumetric ratios with respect to the lung
- Automate the analysis of CT Scan images within 10 seconds, thereby speeding up the recovery strategy for an infected patient.

AI in Healthcare

Conducting Clinical Trials

Healthcare Application 2: Conducting Clinical Trials

LABIOTECH.eu

TOPIC SECTION BIOTECH MAP EVENTS JOBS

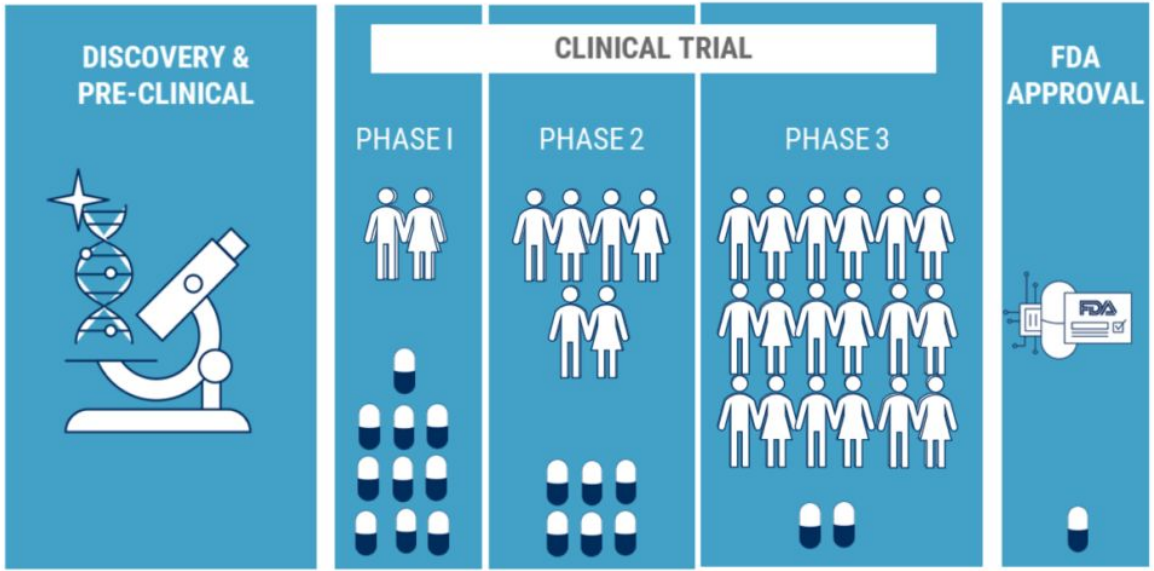
Novadiscovery Carries out Clinical Trials using AI and Simulations

JONATHAN SMITH - 14/02/2020 3 MINS - AI , STARTUP OF THE WEEK

Source: https://www.labiotech.eu/ai/novadiscovery-ai-clinical-trial/

Problem Statement

- Before a developed drug or treatment can be marketed, it must be assessed vigorously through clinical trials
- Traditionally, these assessments are conducted by the means of Randomised In Vivo Clinical Trials (RVCT) which rely on conducting physical clinical trials on selected group of patients



Source: https://www.cbinsights.com/research/briefing/ai-in-healthcare-future-clinical-trial/

Limitations

- Firstly, RVCT is time-consuming, in most instances a new drug might take up to five years or more to be properly tested and approved
- Secondly, RVCT can spend astronomical figures throughout the process and this is reflected onto the consumers

- Thirdly, RVCT is hardly applicable on rare diseases, because of lack of patients

Sources: Alimguzhin, V., Mancini, T., Massini, A., Sinisi, S., & Tronci, E. (2019). In Silico Clinical Trials through AI and Statistical Model Checking. In *OVERLAY@ AI* IA*.
https://99designs.com/infographic-design/contests/worldwide-clinical-trials-create-creative-infographic-awareness-week-617222

How AI can complement doctors to help patients

- *In Silico* Clinical Trials (ISCT) addresses the limitations of RVCT
- Similar to verifying cyber-physical systems through simulation, ISCT replaces the physical entity (patient) with a computational model (virtual patient)
- Virtual patient is an AI computational model which accounts the biological properties of patient physiology and prospective drugs or treatment
- Through ISCT, researchers can input the candidate drugs and obtain simulated results on the effects the candidate drug has on the patient, developing patient-specific treatments

Generate a set of virtual patients whose predictions coincide with the patient physiology, reaction to drugs and *in vivo* clinical data

Use virtual patient validated with *in vivo* data to assess the safety and efficacy of candidate drug through simulation

Alimguzhin, V., Mancini, T., Massini, A., Sinisi, S., & Tronci, E. (2019). In Silico Clinical Trials through AI and Statistical Model Checking. In *OVERLAY@ AI* IA* (pp. 17-22).\

The Challenges

- Ideally, the set of virtual patients must be diverse enough to include all human patient phenotypes
- Thus, a large dataset is needed in order to be able to encompass all phenotypes
- In addition, Novadiscovery stressed that this approach currently require a lot of expertise and there is no way to build a model for some disease that is not known to the researchers

nova

DISCOVERY

Sources:
https://www.labiotech.eu/ai/novadiscovery-ai-clinical-trial/

Alimguzhin, V., Mancini, T., Massini, A., Sinisi, S., & Tronci, E. (2019).
In Silico Clinical Trials through AI and Statistical Model Checking.
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AI in Healthcare

Antibiotics and Drug Discovery

Healthcare Application 3: Antibiotics and Drug Discovery

- Antibiotics are the cornerstone of modern medicine
- Unfortunately, the irrational use of drugs in humans and animals as well as insufficient patient education is undermining the efficiency of antibiotics
- Thus, without new discovery and development of antibiotics, it is projected that deaths caused by resistant infections will reach 10 million per year by 2050

Sources: Stokes, J., Yang, K., Swanson, K., Jin, W., Cubillos-Ruiz, A., Donghia, N., MacNair, Cr., French, S., Carfrae, L., Bloom-Ackerman, Z., Tran, V., Chiappino-Pepe, A., Badran, A., Andrews, I., Chory, E., Church, G., Brown, E. & Jaakkola, T., & Barzilay, R. & Collins, J. (2020). *A Deep Learning Approach to Antibiotic Discovery. Cell*, *180(4). 688-702.e13.* doi: 10.1016/j.cell.2020.01.021.
https://twitter.com/WHOWPRO/status/985697328873947136

Limitations

- Traditional antibiotics discovery is not effective, as same molecules are being discovered repeatedly
- So scientists have turned to screening large synthetic chemical libraries
- Unsurprisingly, these libraries are too costly to curate, calling for the need of new screening method to screen up to millions of molecules

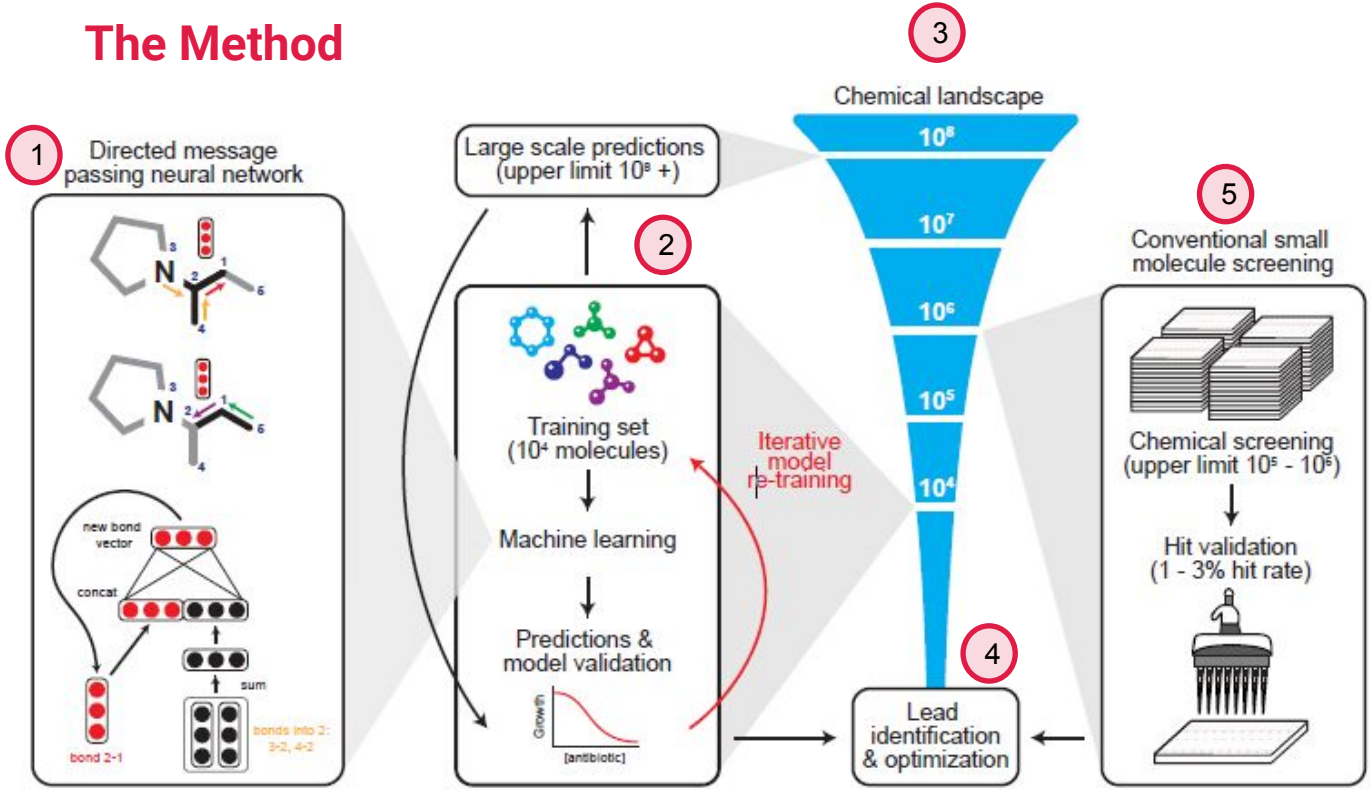
Source: https://diagnostics.roche.com/global/en/article-listing/health-topics/infectious-diseases/amr-ams.html

The Solution?

- Firstly, the researchers trained a DNN to predict *E. coli* using a collection of 2335 molecules
- Subsequently, researchers used the model to sift through several discrete libraries with more than 107 million molecules to identify lead compounds with activity against *E. coli*
- The model outputs a binary classification of whether the compound is growth-inhibitory to *E. coli* or not
- The molecules were ranked and potential compounds are selected based on predetermined threshold, chemical structure and availability

Stokes, J., Yang, K., Swanson, K., Jin, W., Cubillos-Ruiz, A., Donghia, N., MacNair, Cr., French, S., Carfrae, L., Bloom-Ackerman, Z., Tran, V., Chiappino-Pepe, A., Badran, A., Andrews, I., Chory, E., Church, G., Brown, E. & Jaakkola, T., & Barzilay, R. & Collins, J. (2020). *A Deep Learning Approach to Antibiotic Discovery. Cell*, *180(4). 688-702.e13.* doi: 10.1016/j.cell.2020.01.021.

The Method

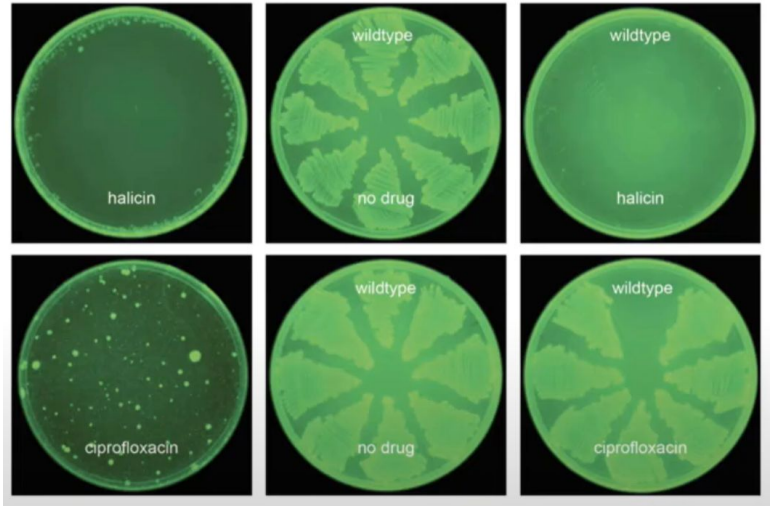


1. Molecule structures are turned into atoms and bonds
2. A DNN is trained
3. Sift through chemical libraries
4. The model outputs a binary classification
5. Clinical tests are conducted to verify the results

Stokes, J., Yang, K., Swanson, K., Jin, W., Cubillos-Ruiz, A., Donghia, N., MacNair, Cr., French, S., Carfrae, L., Bloom-Ackerman, Z., Tran, V., Chiappino-Pepe, A., Badran, A., Andrews, I., Chory, E., Church, G., Brown, E. & Jaakkola, T., & Barzilay, R. & Collins, J. (2020). *A Deep Learning Approach to Antibiotic Discovery. Cell*, *180(4). 688-702.e13.* doi: 10.1016/j.cell.2020.01.021.

Findings

- The researchers identified two compounds that have inhibitory properties against *E. coli*
- One of them is halicin, which is structurally different from conventional antibiotics, but is a potent inhibitor of *E. coli*
- They also found that halicin has inhibitory properties against wide range of pathogens
- In addition, another eight compounds which are structurally-distant from known antibiotics were discovered
- Two out of these eight compounds possess ability to overcome an array of antibiotic-resistant properties in *E. coli*



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Antibiotics AI Project

Source: https://www.youtube.com/watch?v=c-YwAVpGJ7U

AI in Healthcare

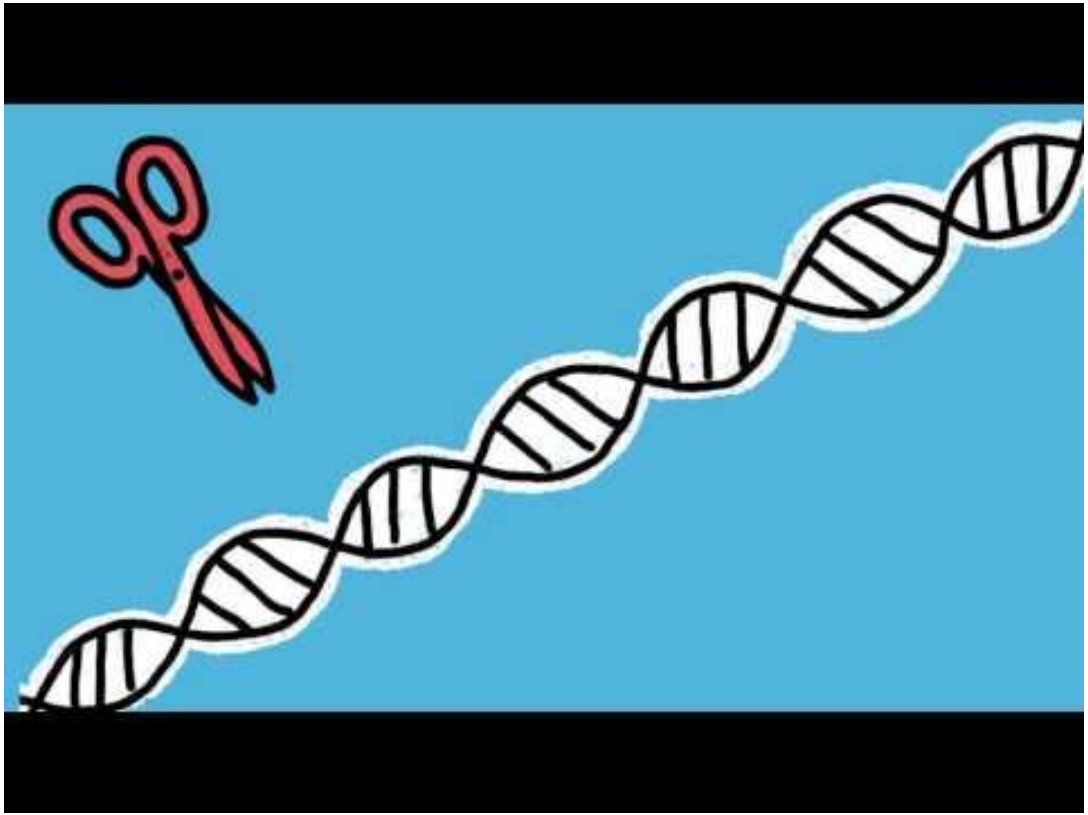
Ethical Concerns of AI in Healthcare

Ethical Concerns of AI in Healthcare: Gene Editing

- Healthcare is incredibly personal to humans, and thus received most controversies whenever a new technology is introduced
- One controversial issue is with **gene editing**
- Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR), specifically the CRISPR-Cas9 system is a technology that can be used to edit genes
- This technique relies on short guide RNAs (sgRNA) to target and edit a specific location on the DNA
- Altering and substituting definite fragments of DNA requires extreme precision and thus challenging, and AI can ease up this process with substantial precision

Gomez-Gonzalez E, Gomez E, Marquez-Rivas et al. Artificial Intelligence in Medicine and Healthcare: a review and classification of current and near-future applications and their ethical and social impact. arXiv:2001.09778,2020.

Ethical Concerns of AI in Healthcare: Gene Editing



Source: https://www.youtube.com/watch?v=p5G5aMnExpI

Ethical Concerns of AI in Healthcare: Gene Editing

- With the help of AI, gene editing is easier and thus opens up a wide range of applications and also questions
- Some of the issues are:
  - Does gene editing impact human genetic heritage, at what cost?
  - Is it ethical to design experimental human beings and what will happen if they become adult and procreate?
  - What if these human beings are created to be superior and used for malicious purposes, i.e. weaponisation and terrorism?

Gomez-Gonzalez E, Gomez E, Marquez-Rivas et al. Artificial Intelligence in Medicine and Healthcare: a review and classification of current and near-future applications and their ethical and social impact. arXiv:2001.09778,2020.