Artificial Intelligence Applications in Health

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The formal side of the AI Lab

- Three broad aims of the AIR Lab
  - Research - *development* and prototyping of new technologies
  - Outreach - *deployment and use* of the technologies by *end-user*
  - Capacity building - student training and *collaboration*

Computational methods and AI

- *Computational methods* - Mathematical and algorithmic methods used to study complex systems.
- …..now enabled by compute power
- *Artificial Intelligence* - Loosely, getting specific "intelligent" aspects of a human being and putting them into a piece of software, machine, internet, etc.

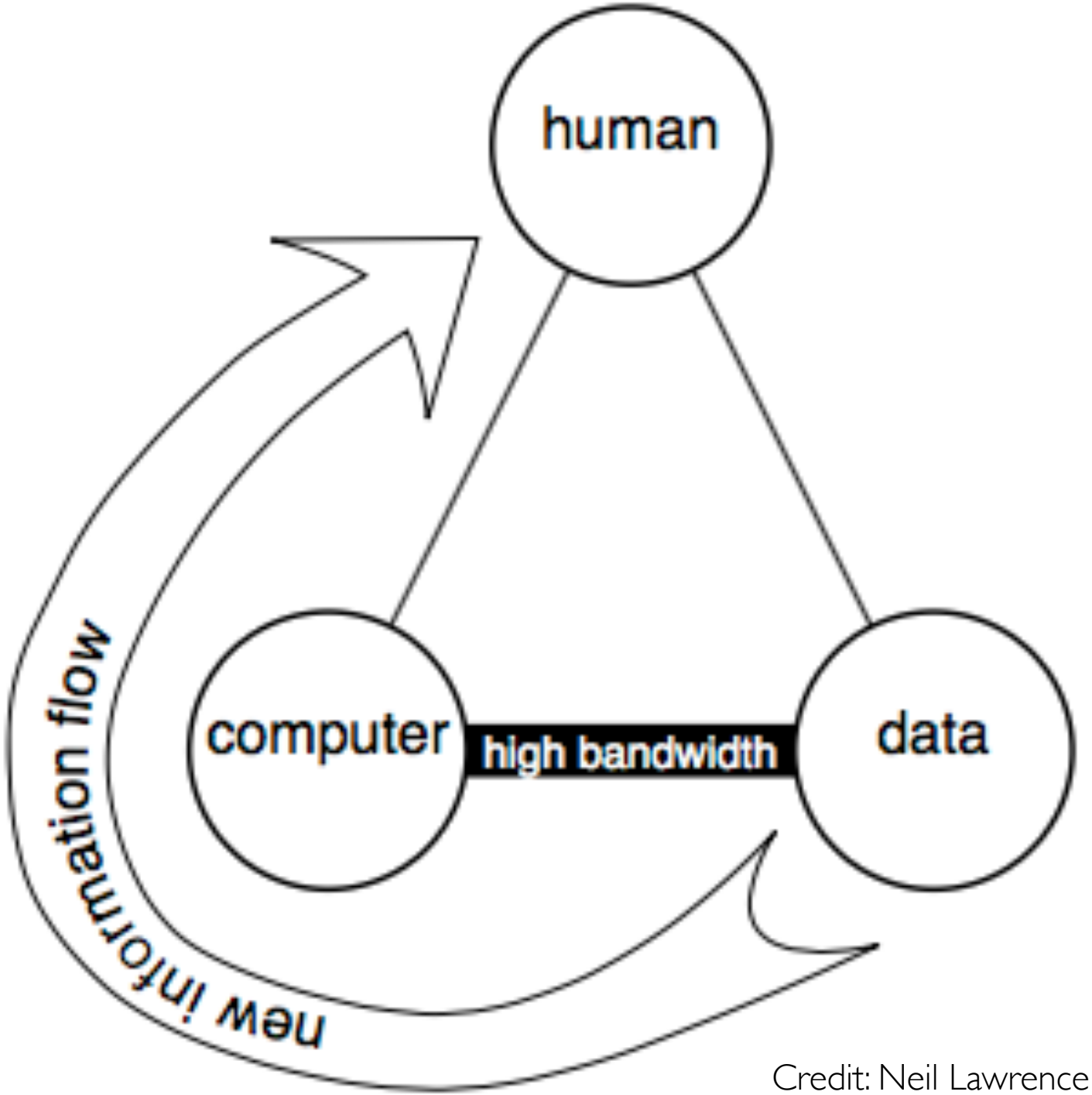
AI & Data Science opportunities

- More sources of (*unbiased*) data (Big Data)
- Novel methods of data analysis
- Better computation power supporting (near) *real-time* analytics
- Cheaper and more powerful hardware for collection and processing data

New Data Trinity

We are influenced by more and newer types of data than ever before…..

…and *its increasing*



Credit: Neil Lawrence

Artificial Intelligence

- Artificial Intelligence is the development of computer systems that are able to perform tasks that would require human intelligence.

- Examples of these tasks are visual perception, speech recognition, decision-making, and translation between languages.

AI in Healthcare

- Highly repetitive work
- Empower doctors - help them deliver faster and more accurate
- Augment the professionals, offering them expertise and assistance.
- Replace personnel and staffing in medical facilities, particularly in administrative functions,
- Managing wait times & automating scheduling

- Application of **AI in healthcare** has two main branches:
  - Virtual branch
  - Physical branch.

AI in Healthcare: Virtual Branch

- Virtual component is represented by Machine Learning (Deep Learning)
- ML- application of Artificial Intelligence that gives machines the ability to learn and improve through experience without the help of humans or new programming.
- It is one of the most exciting areas for development of computational approaches to **automatically make sense of data.**
- Three types of machine learning algorithms:
  - Unsupervised (ability to find patterns)
  - Supervised (classification and prediction algorithms based on previous examples)
  - Reinforcement learning (use of sequences of rewards and punishments to form a strategy for operation in a specific problem space)

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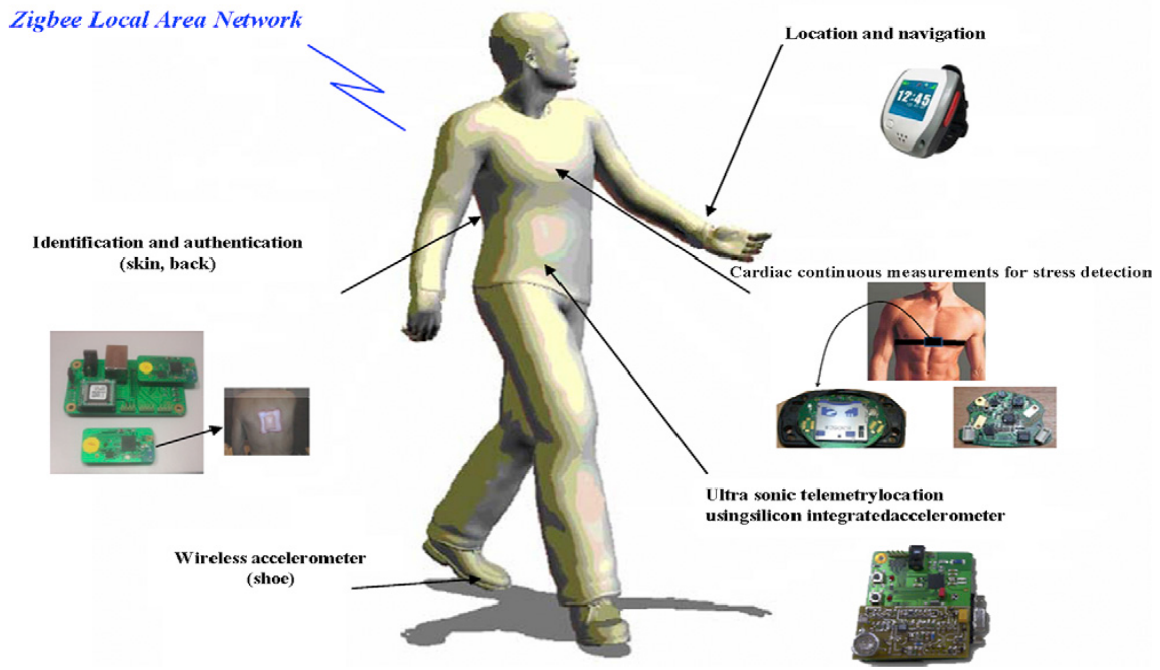
AI in medicine: Physical Branch

- Includes
  - Physical objects,
  - Medical devices
  - Sophisticated robots for delivery of care (carebots)/ robots for surgery.



AI applications areas in Health

- Managing Medical Records and Data - Electronic Medical Records
- Cloud Computing
- mHealth
- Expert Systems
- Models for disease spread
- Natural Language Processing
- Signal Processing
- Computer Vision

Electronic Medical Records

- EMRs - digital versions of patient and population health information, are important source of data for health informatics.
- HI - describes the acquisition, storage, retrieval and use of healthcare information to improve patient care across interactions with the health system.
- Has expanded potential applications of AI to improve public health informatics and decision making.
- OpenMRS is one example of an EMR platform that is currently being used in more than 15 African countries.
- DHIS2 is another open source EMR platform used for collecting, validating, analysing and presenting aggregate and patient-based statistical data.
- *AI applications on the data for creating complex predictive models.*

Cloud Computing

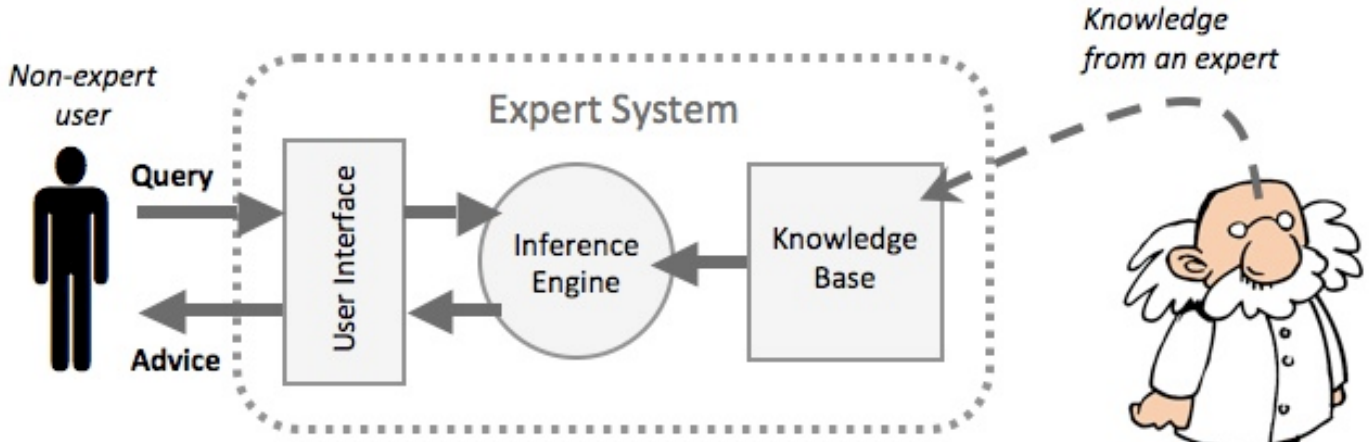
- Expansion of cloud computing has led to the expansion of AI applications for health.
- Cloud computing refers to the use of a network of remote servers to store, manage, access and process data rather than a single personal computer or hard drive.
- Resource constrained organisations, particularly those in LMICs are now able to access computing power that would have been unattainable previously.
- EMRs can be maintained in the cloud with adequate privacy and security precautions with a multitude of data related to public health.
- *Through machine learning, connected devices and IoT - one application can be the use of interactive voice response calls for disease management.*

mHealth

- mHealth uses mobile and wireless technologies to achieve health objectives.
- The rapid availability and expansion of mobile phones in low-income countries has created several opportunities for using these technologies to support health efforts.
- Mobile phones have been used by community health workers (CHWs) to improve the provision of health services within resource-poor settings.
- E.g., Mobile phones have also been used to communicate health information to patients in resource-poor settings when face-to-face interactions are not feasible.
- *Application can be the use of* ***Image recognition*** *for disease diagnosis - examine photos for disease diagnosis.*
- Pattern recognition - *use AI applications on phone to listens to the sound of coughing and breathing - accurately diagnose pneumonia or asthma.*

Expert Systems

- Expert system - computer system designed to emulate the decision-making capabilities and performance of human experts
- In resource-poor settings, expert systems can be used to support health programmes in several ways.
- First, medical expert systems can support physicians in diagnosing patients and choosing treatment plans as is done in high-income countries.
- For some conditions, they can act in place of a human expert if one is not readily available, which is often the case in poor communities.
- *AI applications can be through chatbots, virtual assistants- AI programs that can enable conversational dialogues with patients and clinicians - improve the patient experience and reduce the physician workload.*



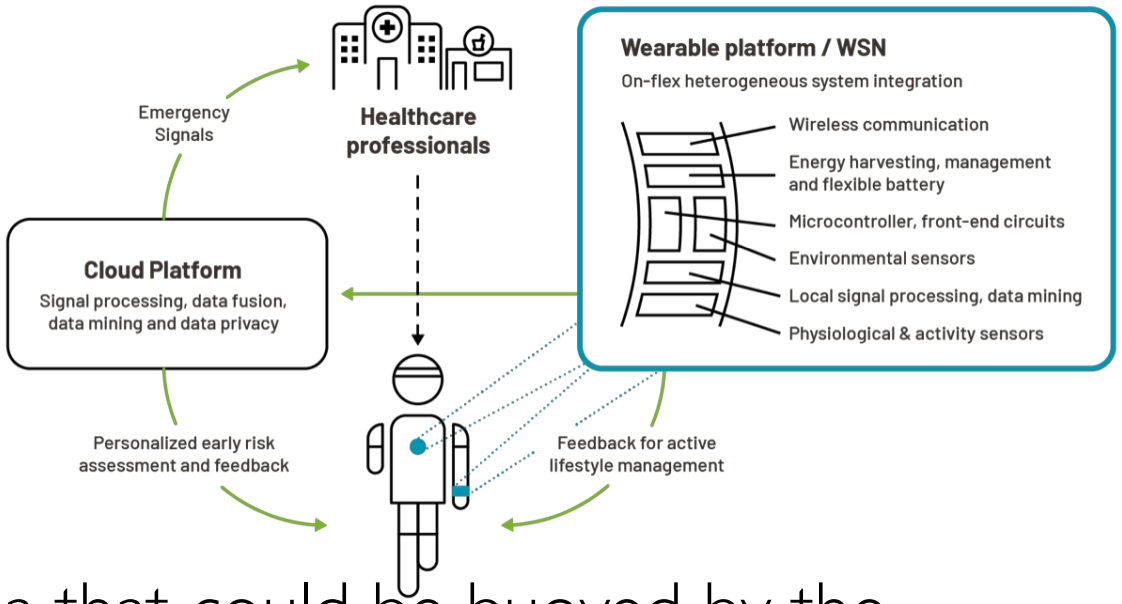
Models for Disease Spread

- AI is already being used to predict, model and show the spread of disease in epidemic situations around the world, including in resource-poor settings.
- Exploit electronic health record data, telecom data, demographic data - translating large, heterogeneous, and often disparate datasets into effective public health management tools.
- E.g. A machine learning tool developed - to identify weather and land-use patterns associated with dengue fever transmission in Manila.
- The machine learning algorithm has learnt over many iterations how to fine-tune its model to predict dengue occurrence with increasing accuracy.
- *AI applications can be used for disease modelling, disease incidence and surveillance.*

Natural Language Processing

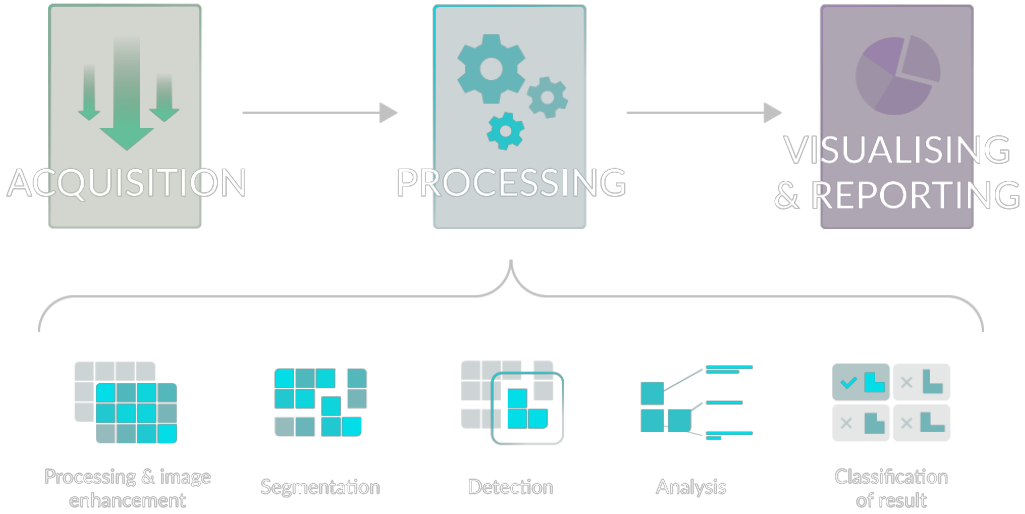
- NLP is a specialised branch of AI focused on the interpretation and manipulation of human-generated spoken or written data.
- NLP can also be explicitly used to address health challenges in resource- poor settings
- E.g. can be used for surveillance and outbreak predictions using data from electronic health records and online media and social media sources (twitter, Facebook).
- Relevant articles are then plotted on a map using geo-coding information, which can help epidemiologists and programme managers monitor the spread of diseases.[2]
- *AI applications for NLP can help in comparing and detecting changes in clinical guidelines, extracting clinical concepts from EMRs, lab reports, developing human-to-machine language instructions.*

Signal Processing



- Signal processing is another related area that could be buoyed by the rapid expansion of mobile devices that can capture and transmit signals and the emergence of cloud computing.
- Opportunities in resource-poor settings currently focus on signals that can be collected with **mobile phones** or **smart wearable devices** that can collect multiple kinds of digital data.
- *Signal processing opportunities in resource-poor settings are promising, particularly when paired with machine learning principles and cloud computing.*

Computer Vision



- AI plays a major role in enabling intelligence in the radiology images obtained through scanning machines. X-rays, CT scanners and MRI machines etc.
- Computer vision - shown major promise is in identifying cancerous cells and tumours from images and biopsy results.
- Recently, computer vision algorithms have proven themselves more effective at identifying skin cancer tumours than doctors.
- *AI applications through the use computer vision and image processing provide an easy solution through intelligent the medical diagnostic imaging.*

Open Issues and Challenges

- Successful implementation of any AI system requires a clear definition of the clinical problem to be addressed.
- Building and updating the knowledge base is challenging in the best of circumstances and would be compounded in resource-poor settings.
- Many expert systems also lack an accuracy tracking mechanism, which could undermine the trust of clinicians and patients.

Open Issues and Challenges - Expert Systems

- Supervised machine learning applications require high-quality datasets that can be used to train machine learning algorithms to identify risk factors or make disease diagnoses.

- For many diseases and conditions relevant to resource-poor settings, such datasets can be difficult and time-consuming to collect.

Open Issues and Challenges - NLP systems

- Require substantial resources to compile the natural language corpora, address different record structures and deal with linguistic content.
- These challenges would likely be multiplied when considering healthcare settings in low-income countries.
- Countries in low-resource settings sometimes maintain hand-written health records in local languages.
- Therefore, building the natural language corpora could require substantial effort.

Open Issues and Challenges -mHealth

- While internet connectivity is improving throughout the world, some resource-poor settings remain without access to the substantial bandwidth necessary to upload very large signal datasets to the cloud.

- mHealth tools used by CHW, have the ability to work offline and sync with remote databases when the bandwidth is sufficient.

- Storing such data locally could also require substantial investment in IT infrastructure.

Open Issues and Challenges - Privacy

- Discussions around the ethics of electronic health records and AI have focused largely on privacy, confidentiality, data security, informed consent and data ownership.
- Apply to resource-poor settings - the relevance of these issues varies depending on differences in culture, literacy, patient–provider relationships, available IT infrastructure and regulatory issues in LMICs.
- One proposed approach for maintaining secure and transparent health records is the use of 'blockchain'.
- Comply with government healthcare standards.

Open Issues and Challenges - Doctor/Patient Comfort

- The idea of machines and apps looking after your health can be a little intimidating to the patient.
- Doctors might feel threatened - might feel dictated by a machine.

- Training and expertise to use AI systems – AI can meaningfully improve people's lives, but the patients should have some level of experience in using the applications.

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Thank You !