Patient Safety, AI and Healthcare

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“The development of **smart technologies** to analyse great quantities of data quickly and with a higher degree of accuracy than is possible by human beings opens up a whole new field of medical research and gives us a new weapon in our armoury in the fight against disease.

“Achieving this mission will not only save thousands of lives. It will incubate a whole new industry around AI-in-healthcare, creating high-skilled science jobs across the country, drawing on existing centres of excellence in places like Edinburgh, Oxford and Leeds – and helping to grow new ones.”
Leeds Centre for Doctoral Training
AI in Medical Diagnosis and Care

*Training research leaders of tomorrow to transform clinical practice using artificial intelligence*

The CDT will train 50 PhDs at Leeds

Leeds is a leading centre for research in both AI and cancer

Unique and rich collection of NHS datasets

Situated in Leeds Institute for Data Analytics (200 researchers and data scientists from many disciplines)

Immersion in clinical environment of Leeds Teaching Hospitals Trust
Any cancer
• Melanoma, Ovarian
• Myeloma

Projects need
• Clinical Experts
• AI/ML Experts

UK needs
• Clinician Scientists in AI/ML
Newt Gingrich, 2006, Capitol Hill Address:
“It's simple, paper medical records kill people every day. Instead of saving lives, our current paper-based health system is killing them. As many as 98,000 Americans are killed each year due to medical errors.”

1) Sharp rise in US pedestrian deaths blamed on people using their smartphones while driving or crossing the road. … injured as a result of ‘distraction’ crossing [roads] while using their phone.
3) Health Apps and AI …
About AI

Artificial Intelligence (AI)

- intelligence demonstrated by machines, in contrast to the natural intelligence displayed by humans.
- Computers that mimic "cognitive" functions that humans associate with the human mind, such as "learning" and "problem solving".

The Turing Test (1950)

- ability to exhibit intelligent behaviour indistinguishable from that of a human.

About AI…

“is it a robot?”

I, Robot was first drafted in 1939

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1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.

2. A robot must obey any orders given to it by human beings, except where such orders would conflict with the First Law.

3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

—Asimov’s Three Laws of Robotics
Robots that are more likely …

"Oh, what's in here?"

"Hm... Hmm..."

What do you mean do NOT harm humans?

About AI ... is it here?

Artificial Narrow Intelligence (ANI)

Decision-support

Advice to a Human

Algorithms
- Rules based
- Heuristics
- Randomisation
- Data (lots of it)

Identity
+ Location
+ Direction
+ Preferences

Identities (lots of them)
+ Maps (vectors)
+ Current traffic volume & speed
+ Historic traffic history (lots)
+ Personal history
+ Personal preferences
AI and Hype

Hype Cycle for Emerging Technologies, 2018

ANI is already mainstream

AGI is still a long way off

gartner.com/SmarterWithGartner

Source: Gartner (August 2018)
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Supervised Machine Learning relies on a sample data that has been labelled for use as a Training Set to learn and a Test Set to test:

**Training Set**
- Not Apple
- Apple
- Not Apple
- Apple
- Apple
- Not Apple

**Test Set**
- Apple
- Apple
- Apple
- Apple
- Apple
- Apple

Q. Is this an Apple?

A. = 1

**Classifier Algorithm**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>1</td>
</tr>
<tr>
<td>Banana</td>
<td>0</td>
</tr>
<tr>
<td>Apple</td>
<td>0</td>
</tr>
<tr>
<td>Apple</td>
<td>1</td>
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</tr>
<tr>
<td>Not Apple</td>
<td>0</td>
</tr>
<tr>
<td>Not Apple</td>
<td>1</td>
</tr>
</tbody>
</table>

True Positive (TP) 2
True Negative (TN) 2
False Positive (FP) 1
False Negative (FN) 1

and then used…

...better, we hope.
A simple model for AI in Clinical Decision Making

Patient pathway

Algorithm – supports clinical decision

Health Information System

Data from other systems
Three threats to Patient Safety

1) The Health Information Systems are not constants, in fact they are highly variable.

2) Historical data has bias that machines can (and will) learn to replicate.

3) The smartest AI will evolve beyond our comprehension (and therefore beyond regulation?).
An Electronic Health Record (EHR) System is a complex socio-technical system.

Data in EHR’s is generated as the output of a complex interplay of four forces that are always changing and always affecting each other in non-linear ways.
AI and Ethics

BUY THIS BOOK
READ IT

WEAPONS OF MATH DESTRUCTION

HOW BIG DATA INCREASES INEQUALITY AND THREATENS DEMOCRACY

CATHY O'NEIL

‘Fascinating and deeply disturbing’

YUVAL NOAHR HARARI, GUARDIAN BOOKS OF THE YEAR

Never do AI again!
Continuous Machine Learning

Learning from Experience

Q. Is this an Apple?

Input

Classifier Algorithm

Output A. = 0

Add new example to training set

= Not Apple

= Apple

= Not Apple

= Apple

Q. Is this an Apple?

Input

Classifier Algorithm

Output A. = 1

Retrain algorithm

A/B testing

1. Create two versions of the thing to be tested (Versions A and B)
2. Randomly assign users to either A or B
3. Evaluate the results
4. Implement the thing with the best outcomes
5. Decide on a new thing to be tested
6. Repeat

![A/B testing example]

Source: https://en.wikipedia.org/wiki/A/B_testing
Some thoughts

• What if Google Maps randomly advised some car drivers to go the wrong way?
• Would that provide better, more up to date, data on all the possible routes for Google?
• Would it best for everyone even if some people suffered a bit (especially if they didn’t know)?

• Could we randomly give some patients the wrong treatment to learn whether different treatments might be better?
Discussion: Three scenarios for AI in clinical practice

What are the potential benefits and risks for patient safety?

What might the following stakeholder groups feel about this technology:
- Senior Clinicians
- Young Clinicians
- Managers
- Patients
- Taxpayers

Should this technology be implemented …. Never/ One day/ Soon/ Now?

What safety precautions would you recommend?
Imagine that a whole hospital could be run from a single, central command centre like an air traffic control centre in an airport.

- All data about all patients would be instantly accessible centrally.
- Big screens would display the whole hospital to clinicians and managers.
- AI would raise alerts for bottlenecks, safety issues and deteriorating patients.
Imagine a busy A&E Department that could be managed by an AI Triage system.

- Patients would arrive and use touch screens to self-register
- The AI would interrogate the patient to determine illness, diagnosis and treatment
- If it needed the AI would order phlebotomy and robot-based diagnostic tests
- Doctors would get 4 minutes to confirm the AI’s recommendation
Imagine that a GP could have an AI Assistant to support their GP consultations.

- The GP could ask the assistant for medical definitions and terms
- The AI Assistant could translate medical advice from English to the other languages
- The AI Assistant could record the Consultation
1. Understand users, their needs and the context.
2. Define the outcome and how the technology will contribute to it.
3. Use data that is in line with appropriate guidelines for the purpose for which it is being used.
4. Be fair, transparent and accountable about what data is being used.
5. Make use of open standards.
6. Be transparent about the limitations of the data used.
7. Show what type of algorithm is being developed, or deployed, the ethical examination of how the performance will be validated, and how it will be integrated into health and care provision.
8. Generate evidence of effectiveness for the intended use and value for money.
9. Make security integral to the design.
10. Define the commercial strategy.

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