# Artificial Intelligence in Medicine: Could Machines replace Clinicians?

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# Could machines replace clinicians?

What (if anything) is the relation between facts, values, and the concept of health?

- Facts, values and health are abstract ideas
- AI is  not an abstract idea
- Health – Objective  (externally observable fact ) versus Subjective (internal feeling of what it is like: not an externally observable fact)

# Fact / Value dichotomy

- If it's not externally verifiable then it is not a fact - objective truth versus subjective truth
- Logical positivism – scientific facts are value-free
- Post-modernism – there are only subjective truths and no objective facts – facts and value are the same thing
- Robert Harris: *"Value-judgements can be objective and rational. They are subject to rational analysis like empirical facts. They can draw upon empirical and non-empirical facts for their basis. They may often be more important than facts because they give meaning to facts."*
- Facts and values are entangled *"Only by admitting to the role of values in the identification and processing of facts will scientists and others be able to debate openly their value commitments."*
- I argue that the concept of health is an entanglement of facts and values
- Artificial Intelligence (no personal values) versus human intelligence (fact and value-based judgments)

# Could machines replace clinicians?

- Practical considerations – is it possible to design and build a machine which replaces clinicians? A factual question – either it is or it is not
- Ethical considerations – should we allow machines to replace clinicians? A question about values or priorities
- Philosophical considerations :
  - Metaphysical: are there any attributes which clinicians can have which machines cannot? If there are then impossible for machines to replace clinicians.
  - Methodological: how could we find out if there are any such attributes?
    - Build a machine and test it
    - First – need to know what a clinician is! A clinician is a human with special roles
    - Turing test
    - An imitation is not the genuine article! Similarity is not identity.
    - The problem of identity – no two humans are exactly the same – goes beyond physical characteristics - no two humans think in exactly the same way – Descartes: I think therefore I am

# Are there any attributes which clinicians can have which machines cannot?

1) Diagnosis & Treatment
2) Care
3) Consent

# Diagnosis

- Symptom (X) → Sign (Y) Meaning → Diagnosis (X=Y) Judgment (X=Y & ┐┐Y)

Chicken Pox

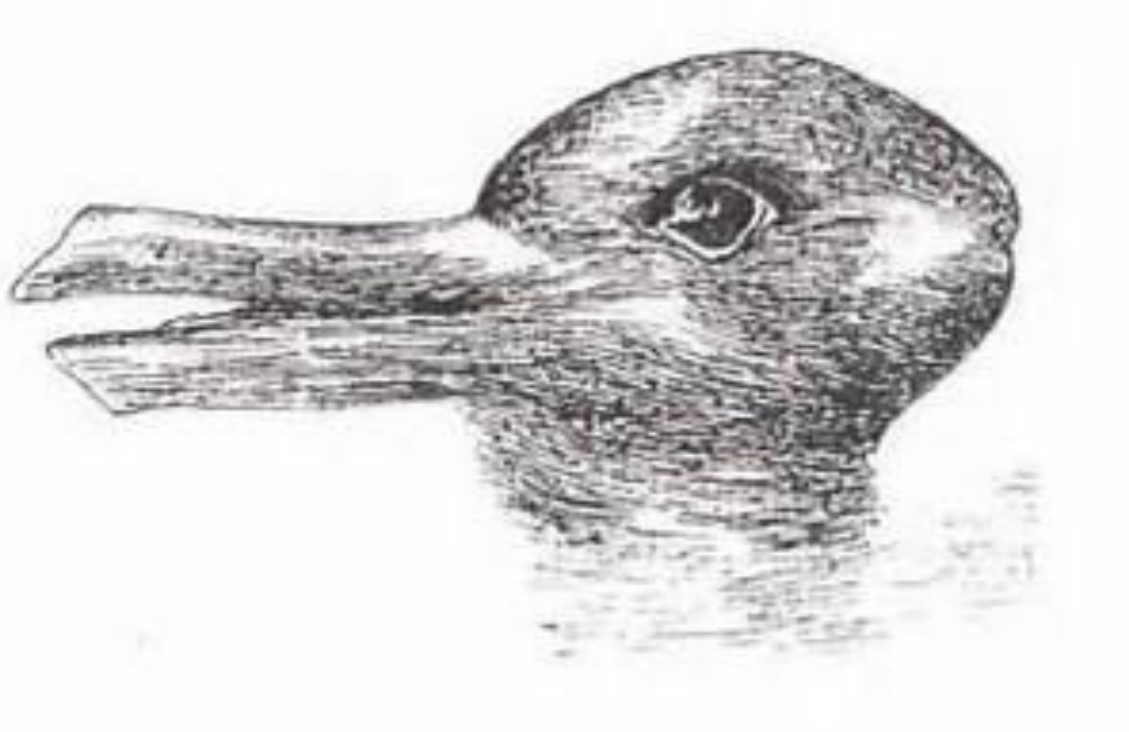
The rash is chicken-pox
objective – value-free

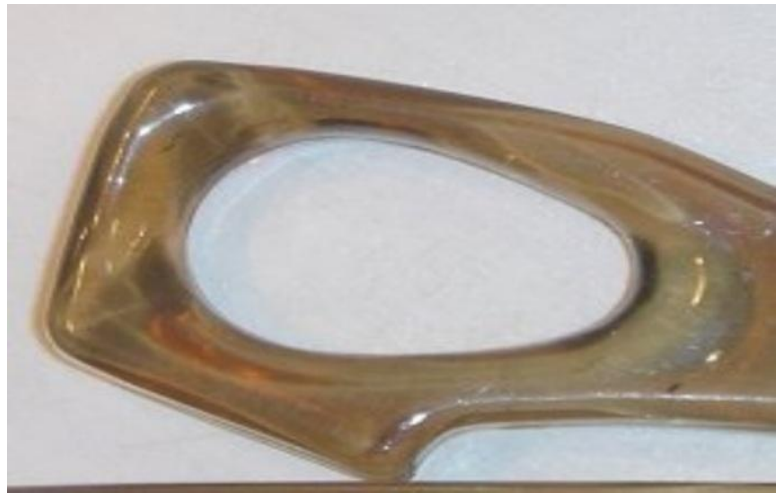
- Problem – clinician error – clinician disagreements
- Verification:
  - Confirmatory evidence
  - Correct diagnosis + correct treatment = Relief of symptom
- If symptoms not relieved = incorrect diagnosis or incorrect treatment

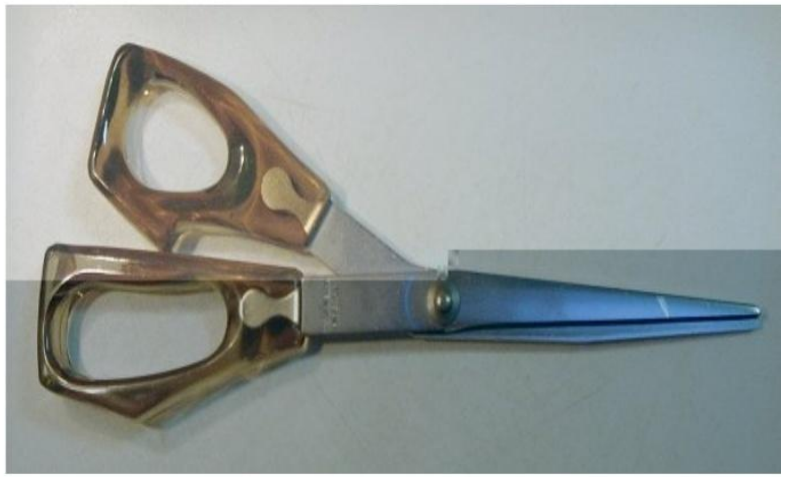
(Please forgive the over-simplification!)

# Clinician Disagreements

- Identical data-set → Different conclusions
- Explanation:
  - Different experiences? Direction of attention and/or personal preference
    - Consider an ornithologist, a botanist and an architect going out on a walk and writing a report – may seem like they've gone on different walks!
  - Failure to account for all the data?
  - Failure to rule out irrelevant data?
  - Inadequate knowledge-base?
  - Different data-processing?
  - Any combination of above (+ others not on list)







# Learnings from Machine Learning

- Development of algorithms that enable modelling and analysis of large data-sets; such as:
  - Classic or symbolic (Hunt et al)
  - Statistical modelling (Nilsson)
  - Neural networks (Rosenblatt)
  - Pattern recognition
  - Discriminant analysis
  - Bayesian classifiers
  - Top-down inductive decision trees
  - Kohonen’s self-organizing network
  - Hopfield’s associative memory

*Table 3:* Results of various classifiers in the ishaemic heart disease diagnosis (Kukar, 2001). The percentage of reliably diagnosed cases together with the amount of wrongly classified cases is given both for the positive and negative cases.
(a) Stepwise calculation of posttest probabilities.
(b) Using all attributes at once to calculate posttest probabilities.
(c) Using all attributes at once to evaluate the reliability of classification of single new cases.

| classifier | positive cases | | negative cases | |
|---|---|---|---|---|
| | reliable (%) | errors (%) | reliable (%) | errors (%) |
| physicians | 73 | 3 | 46 | 8 |
| semi-naive Bayes (a) | 79 | 5 | 46 | 3 |
| Assistant-I (a) | 79 | 5 | 49 | 8 |
| neural network (a) | 78 | 4 | 49 | 8 |
| semi-naive Bayes (b) | 90 | 7 | 81 | 11 |
| Assistant-I (b) | 87 | 8 | 77 | 6 |
| neural network (b) | 86 | 5 | 66 | 9 |
| naive Bayes (c) | **89** | **5** | **83** | **1** |
| semi-naive Bayes (c) | **91** | **6** | **79** | **2** |
| Assistant-I (c) | 77 | 18 | 55 | 18 |
| Assistant-R (c) | **81** | **5** | **77** | **2** |
| $k$-NN (c) | 64 | 12 | 80 | 12 |
| neural network (c) | 81 | 11 | 72 | 11 |

Igor Kononenko, *Machine Learning for Medical Diagnosis: History, State of the Art and Perspective*

# Could Machines replace Clinicians?

- Machines: Combining different types of algorithms  improves the number of reliably classified positive cases and the number of reliably classified negative cases
- Clinicians: Group decisions more reliable than single individual
- If diagnostic superiority  = highest value then machines win!

# Care

- Patient first approach (priority)
- Patient goes to doctor for:
  - Diagnosis and Treatment
  - Monitoring of effectiveness of Treatment
  - Prevention (e.g. routine screening, vaccinations)
  - Advice
  - Reassurance
- Assumption: doctor knows best
- Value-laden

# Consent

- Agreement between clinician and patient for carrying out examination, investigation, treatment or involvement in research
- Interactive model - process between doctor and patient:
  - Doctors explains / patient listens / patient queries / doctor answers
- Aim: Patient gains sufficient understanding of available choices to enable  patient decision-making
- Value = patient's autonomy (right/freedom to decide) greater than patient health  (if true that doctor knows what is best for patient's health)
- A shift away from old-style paternalistic (doctor knows best) model

“Informed consent empowers patients and allows them to take part in critical decision making, as long as they agree to play an active part and have the capacity to do so.”

(R Worthington, *Clinical Issues on consent: some philosophical concerns*)

Shift in clinician's role from advising patients to consulting:

*"Doctors should do their best to find out about patients' individual needs and priorities when providing information about treatment options"* (GMC, *Seeking Patients' consent: the ethical considerations*, 1998)

# Judgement versus values

- Shift in clinician's role to find out what the patient *wants* rather than what doctor *believes* patient needs
- Assumption: Patient is best person for making decisions about their health – a value judgment - is it true?
- Conflict between patient autonomy (freedom to decide) and doctor autonomy (desire to care for patient's health)

# Meaning and Value

- What does it mean to say: “Doctors should do their best”?
- Vague value judgement - different individuals may have different values – may not be in patients’ best interest
- Problems:
  - Patient doesn’t agree to give consent
  - Patient pressurised to consent
  - Patient seems to agree (signs consent form)
  - Outcome not as patient wants - patient unhappy because did not agree to unwanted outcome (even if informed of potential risk)

The clinician has legal responsibility for making a moral decision on behalf of another human being – high price for getting it wrong - not reciprocal

# Judgement and Responsibility

- Who knows best? – either clinician or patient
- Or lawyers? Binary judgement
- Facts about whether  correct process has been followed  but not about whether the decision itself is correct (unless there is agreement on the standard for correctness)
- Whose responsibility:
  - Doctor for finding out what patient prefers?
  - Patient for ensuring that  they have communicated their preferences to doctor?

“knowing itself involves the personal employment of standards, most implicitly, for judging what we know and whether we have succeeded or failed in knowing it”.

Richard T. Allen, *Polanyi’s Overcoming of the Dichotomy of Fact and Value.*

# Value-based judgment v. value

- Machine is devoid of personal values - cannot experience what it is like to be human because a machine is not human
- There is something it feels like to be reassured which goes beyond words – cannot be captured by an algorithm
- The specialness of human interaction
- Advice (value-based judgement) is not the same as reassurance (value not judgement)
- Machine cannot offer reassurance. Why is this?
- Suggestion: Cannot hold a machine accountable for a decision – transference of power
- Is there a connection between reassurance and accountability?
- Does the feeling of reassurance arise from the belief that someone else is responsible for a decision and, therefore, accountable?

# Final Move – argument from evolution

- Instead of humans adapting to the natural environment, humans are modifying the natural environment
- This means that some natural biological functions are redundant and new functions are required.
- We are social beings living in an unnatural world of social laws
- We must either adapt to social laws or modify the laws
- Most of us cannot modify social laws and must therefore adapt to them
- If health = fitness for environment then social laws affect our health
- If health is priority value then social laws must be modified to allow all individuals freedom to adapt to social environment
- Reciprocity rather than blame - patients must accept equal responsibility for communicating

# Summary

- Machines are changing our world and the way  in which we behave and think including our thinking about health
- Learnings from AI in Medicine  indicate that different ‘modes of thinking’ can be deployed in diagnoses, and that these are value-laden.
- Machines are proving to be more reliable than clinicians in terms of diagnostic accuracy
- The doctor-patient relationship involves more than diagnosis
- Given that advances in technology mean physical defects can be corrected and patients can access information independently of clinician, reassurance may be of greater importance for health and  not deliverable by machines.
- Implications for our thinking about health and practicalities of health-care.

# Thank you for listening

# The concept of Health

- Health is a universal value  - either it is or it is not  (a fact)
- We talk of ‘good’ and ‘bad/poor’ health  (a value judgement)
- Our thinking about health is changing
- ‘Good health’  means ‘the absence of distressing symptoms’ (a value judgement – provides a standard by which to measure health)

- Pervasiveness of machines
- Computers, iphones, fitbits, ATMs
- MACHINES ARE CHANGING OUR WORLD AND THE WAY IN WHICH WE BEHAVE AND THINK INCLUDING OUR THINKING ABOUT HEALTH

# Is it possible for machines to replace clinicians?: Historic view

- Industrialisation – machines capable of repetitive menial tasks - factory workers redundant
- Computerisation – machines capable of logical processing –e.g. bank cashiers replaced by ATMs and on-line banking
- Intelligent machines – machines capable of beating chess champions
- Auto-pilots – manual + intelligence e.g. driverless cars

# Could machines replace clinicians?

- Pics of Traditional blood pressure monitoring versus digital machine

Machines can take on *some* of the tasks traditionally performed by humans.
Could machines take on *all* the tasks of humans?

# MACHINE VERSUS HUMAN

The nature of machines and humans

What does it mean to be healthy?  Physical and Mental

We don’t talk of machines being healthy: machine either work or don’t work: (fact) Functionality (value)

# Evolution of Humans

# Pictures of bionic man