



Advanced multivariable tools:

The end or the beginning of SDM?

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Disclosure

Co-founder, shareholder and scientific advisor to **Council**, a TU Delft spin-off which builds and commercializes Behavioral AI Technology (*health, government, HR, financial sector*)

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Survey amongst medical professionals about the role of AI

- “The role of a skilled physician is to **take into consideration** what a machine / AI tells him and make the correct connection with clinical reality.”
- “AI as an additional tool, **not as something that will replace MDs** or decrease autonomy and authority. A MD will always have the final verdict”
- “AI should never be a “black box”. **Doctors should be able to explain the results from AI tools with reasoning.**”

Martinho et al. (2021) – Artificial Intelligence in Medicine

Survey amongst patients / consumers about the role of AI

How do people answer to the question:

Should medical professionals be replaced by AI?

- **NO!** We need human insights and understanding
- **YES!** AI is more reliable, doesn't get tired
- It would work for others, **but not for me**, because I am unique

Longoni et al. (2019) – Journal of Consumer Research

What do these studies tell us?

Patients and doctors alike clearly see the benefits of AI in the medical domain

But there is a mutual **wish to be taken seriously**:

- The doctor as an **expert** (with experience, know-how,...)
- The patient as a **person** (with preferences, fears,...)

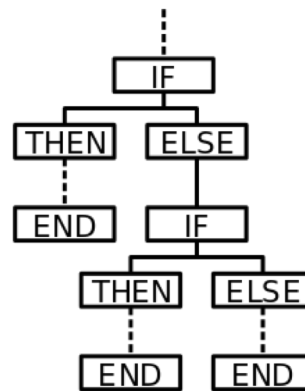
Herein lies an essential aspect of shared decision making

Explainability, Subtlety and Flexibility (of the AI) are key to ensure a fruitful conversation between doctor and patient.

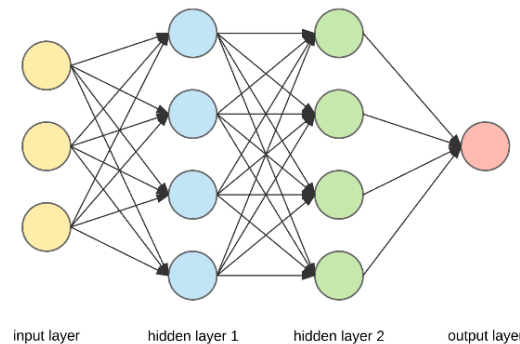
How does AI codify and support (medical) decisions?

Two extreme examples of how AI captures human knowledge:

A rule based system (expert system, protocol)

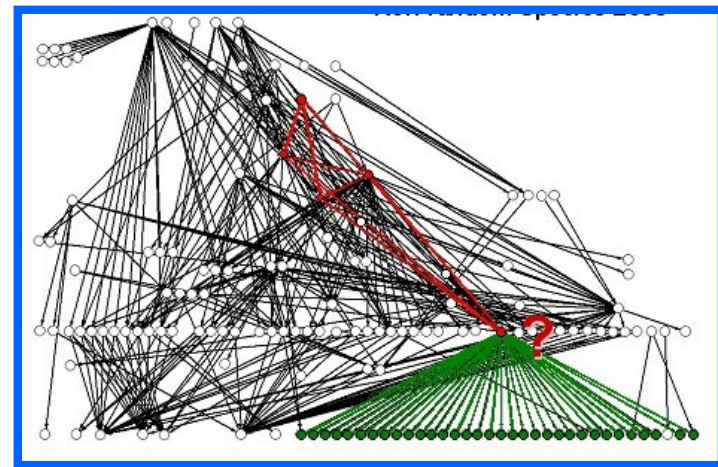
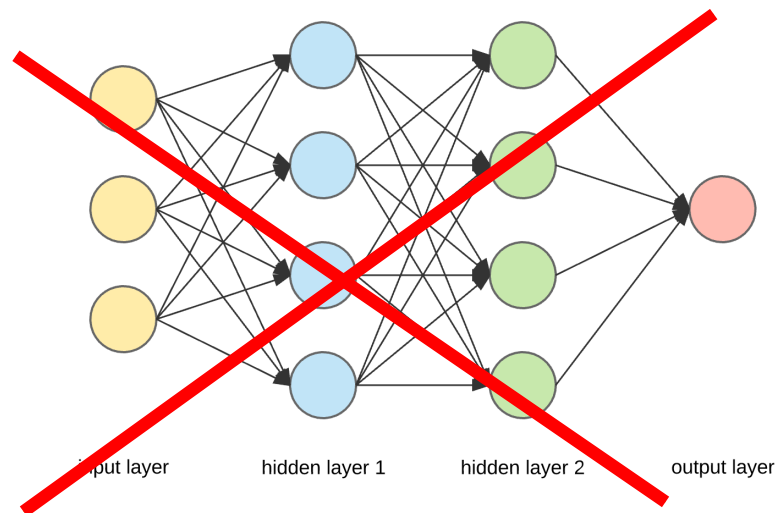


A (deep) neural network or other form of machine learning



Problematic from viewpoint of SDM

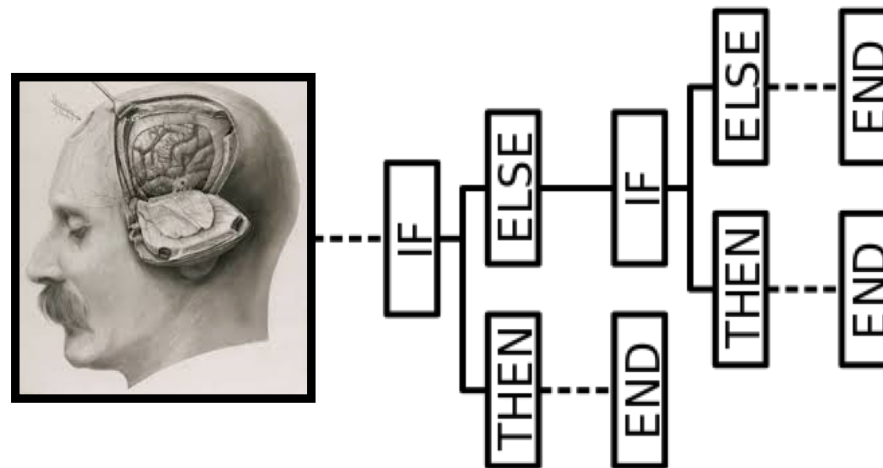
Machine learning tools are based on **extremely flexible and subtle but in-transparent** web of connections.



Need large volumes of training data (**objective health outcomes**) which are not always available and if they are, they might be **biased**.

Problematic from viewpoint of SDM

Rule-based expert systems are fully transparent but **leave no room for discussion, are disconnected from subtle aspects of patients and context.**



Demand explication of knowledge by experts.

A 3rd way: Behavioral AI Technology

What does BAIT promise?

Benefits of AI (digitization of expertise, scalability, uniformity and efficiency; *"your colleagues in your pocket"*)

While maintaining:

- **Explainability** – no black box, but insight into drivers of decision
- **Subtlety** – no protocol, but weighing of various aspects*
- **Flexibility** – outcome is a probabilistic

And without needing explication of expert knowledge nor BigData

**Including the patient's wishes*

A 3rd way: Behavioral AI Technology

Covid-19 patient – admit to ICU? If yes, intubate or not?

Step 1: choice experiment with hypothetical cases

Your choices reveal your expertise
(importance you attach to factors)

Cases constructed such, that each
choice contains maximum information

Hence: 16 intensivists * 25 choices
suffices to capture knowledge base

Uitplaatsen regionaal/landelijk	Kan wel
IC capaciteit	Beperkt (1 a 2 bedden)
Acute conditie patiënt	Fors hypoxisch: zuurstofbehoefte zal in uren kunnen toenemen tot meer dan 15L/u
Leeftijd (bij benadering)	70 jaar
Comorbiditeit: Cognitieve stoornis	Normaal Ernstig beperkt
Comorbiditeit: Hart/vaten	Normaal Ernstig beperkt
Comorbiditeit: Pulmonaal	Normaal Ernstig beperkt
Comorbiditeit: Nier	Normaal Ernstig beperkt
Comorbiditeit: Lever	Normaal Ernstig beperkt
Comorbiditeit: Afweersysteem	Normaal Ernstig beperkt
Ziekte beloop COVID pneumonie	Progressief
BMI	>40
Behandelwens patiënt	Niet invasief beademen

Zou u een COVID-19 patiënt met de bovenstaande eigenschappen opnemen in de IC?

Maak een keuze...

Maak een keuze...

Niet opnemen

IC opname zonder invasief beademen

IC opname met invasief beademen

orige Volgende →

A 3rd way: Behavioral AI Technology

Covid-19 patient – admit to ICU? If yes, intubate or not?

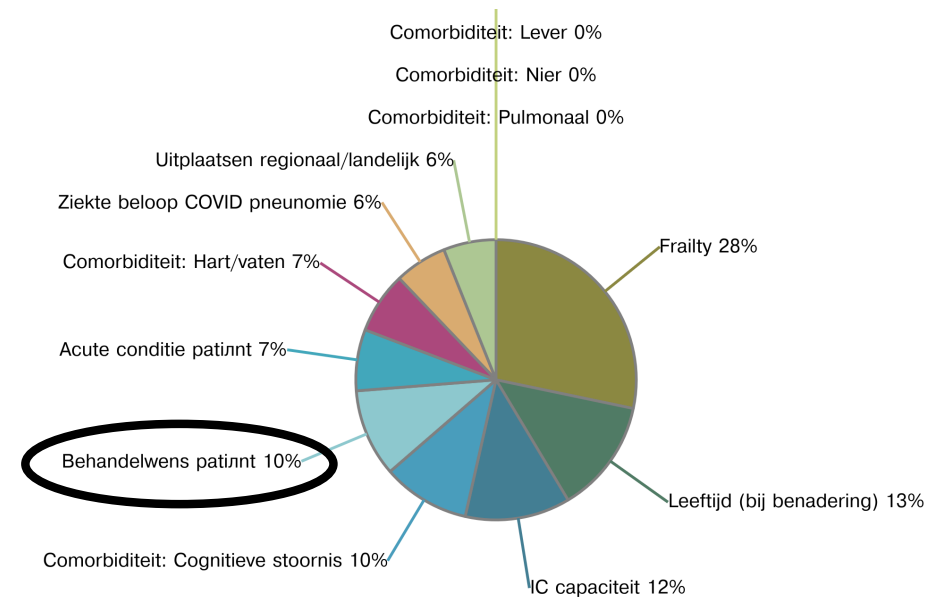
Step 2: model estimation and introspection

How do we make our choices?

Which handful of factors
determines our decisions?

Are effects linear
(proportional) or not?

Do expert-segments differ in
their decision making?



A 3rd way: Behavioral AI Technology

Covid-19 patient – admit to ICU? If yes, intubate or not?

Step 3: 'play' with the model

For artificial cases generated by intensivists, model generates expert opinion (*e.g. 89% of peers would admit this patient to ICU*)

Indicates which were **key factors behind the prediction** (pos. and neg. through color-coding)

Offers first test of 'face validity' and stimulates discussion.

Name ^	Score
Uitplaatsen regionaal/landelijk	Kan niet
IC capaciteit	Beperkt (1 a 2 bedden)
Acute conditie patient	Acuut respiratoir bedreigd: directe intubatie noodzakelijk
Leeftijd (bij benadering)	30
Comorbiditeit: Cognitieve stoornis	Normaal
Comorbiditeit: Hart/vaten	Normaal
Comorbiditeit: Pulmonaal	Normaal
Comorbiditeit: Nier	Normaal
Comorbiditeit: Lever	Normaal
Comorbiditeit: Afweersysteem	Normaal
Ziekte beloop COVID pneumonie	COVID + complicaties
BMI	20 - 40
Frailty	1 en 2
Behandelwens patient	Niet invasief beademen

IC Opname = 89%

A 3rd way: Behavioral AI Technology

Covid-19 patient – admit to ICU? If yes, intubate or not?

Step 4: validate and learn

Retrospective validation: apply Nov '20 model on decisions made in March '20:

1. Four intensivists scored same 20 patients in terms of input factors.
2. Councyl-model predicted admission / intubation.
3. Comparison between predictions, stated and true outcomes

Results (summary):

- >80% correspondence
- When no 'match', model correctly predicted that intensivists where not in mutual agreement either

A 3rd way: Behavioral AI Technology

Covid-19 patient – admit to ICU? If yes, intubate or not?

Step 5: continuous learning and validation

A self-learning decision support system

- Every new (real-life) choice is fed into the model
- So it **keeps track of updated knowledge**, evolution of norms, new compositions of the team
- Learning rate is controlled, e.g. more weight to senior staff or to choices made w high certainty

A 3rd way: Behavioral AI Technology

Similar results for a National case study into surgery v. comfort care for a critically ill neonate (NEC)

Weight for parental preferences: 10% (same as ICU-Case)

Now what are the prospects of BAIT for SDM?

- (How) will it affect autonomy of the expert and patient? (“hiding behind the numbers”)
- How to deal with the numbers? “90% of us wouldn’t operate”
 - “then please give me one of the other 10%”
- Will it help or hinder appeal processes?
- How to avoid *echo chamber* effects – converging expert beliefs; or should we be glad with them?

Our twisted relation with AI...

Is AI any good at recommending jokes?

- **YES**, people like jokes recommended by AI better than those recommended by humans
- **NO**, people like jokes recommended by humans better than those recommended by AI
- **It depends:**
 - When people know the joke is recommended by AI, they don't like it
 - When they do not know this, they like AI-recommended jokes better

(Agrawal 2020)

Thank you for your attention!

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Further reading

Martinho, A., Kroesen, M., & Chorus, C. (2021). A healthy debate: Exploring the views of medical doctors on the ethics of artificial intelligence. ***Artificial Intelligence in Medicine***

Ten Broeke, A., Hulscher, J., Heyning, N., Kooi, E., & Chorus, C. (2021). BAIT: A New Medical Decision Support Technology Based on Discrete Choice Theory. ***Medical Decision Making***

de Metz, J., Thorat, P.J., Chorus, C.G., Elbers, P.W.G., van den Bogaard, B., 2021. Behavioural Artificial Intelligence Technology for COVID-19 intensivist triage decisions: making the implicit explicit. ***Intensive Care Medicine***

<https://councyl.ai/en>



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