Information, understanding and trust:
Explorations in computation and interaction

Ann Blandford

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A focus on digital health technologies

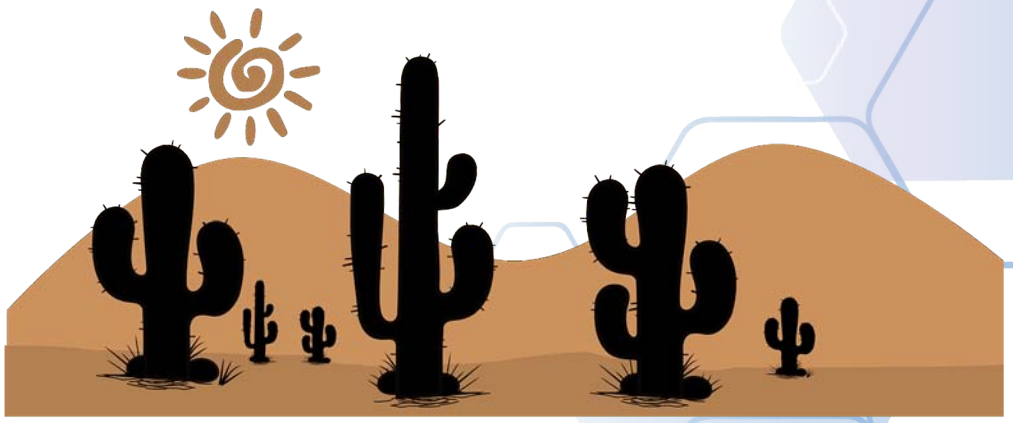

Image by OpenClipart-Vectors from Pixabay

- Increasingly prevalent and valued during the pandemic.
- Needed by most of us, maybe at times not of our choosing.
- Innovations in digital health have variable records of success.
  - The “valley of death” is notorious.
  - Technologies that make it to market aren’t always used as intended.

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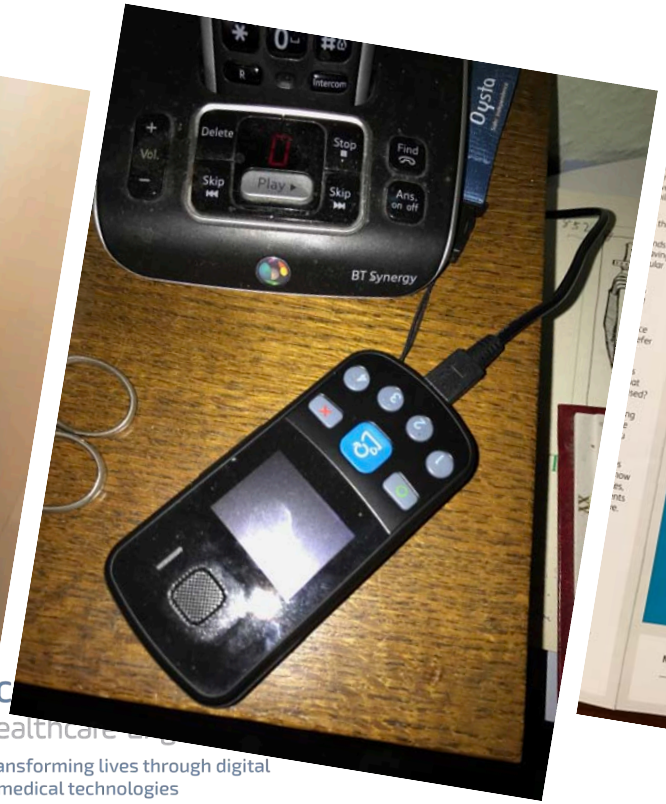
Early examples: dementia care

- Only one of these technologies was adopted and used as intended.



Successes and failures

- Time has been quantified in a way that is agreed across many cultures. The clock is easy to read and interpret. ☺
- The “Oysta” digital tracker implements GPS location tracking, but is too complicated and provides insufficient value to the wearer. ☹
- The “This is me” book also provides insufficient value to the user. ☹
- The falls detector incorporates an accelerometer (a quantification of acceleration) but lacks information on effective range or ability to prevent fall. ☹

Computational modelling for Alzheimer's Disease staging

- Started with a technology innovation.
  - AI model of AD staging and progression based on quantified clinical biomarkers.
- Empirical studies to identify gaps between tool and practice. Issues:
  - Does the clinic have access to the necessary biomarkers?
  - Clinicians typically work with MRI, cognitive tests and "soft" assessments of capabilities.
  - How to trust outcomes of algorithm?

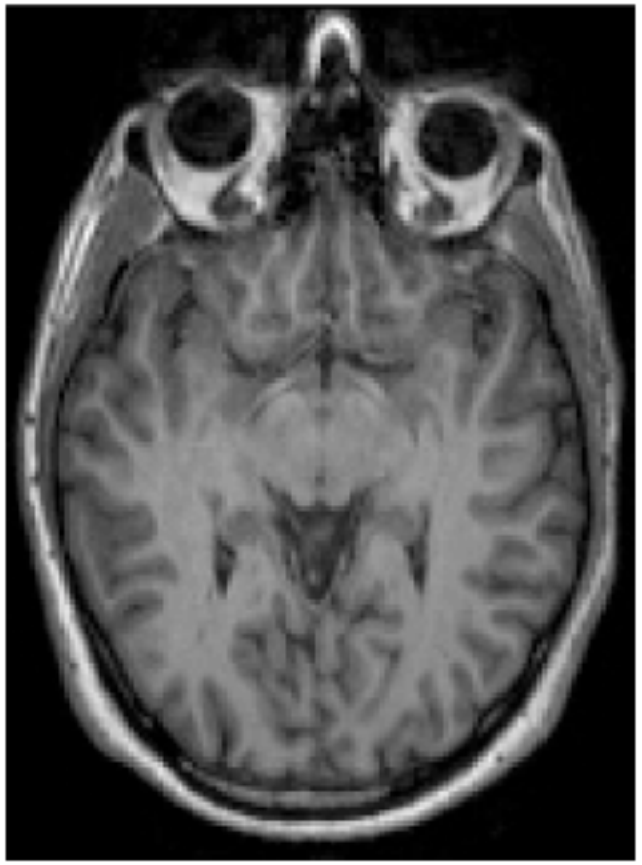


Image from http://niftyweb.cs.ucl.ac.uk/

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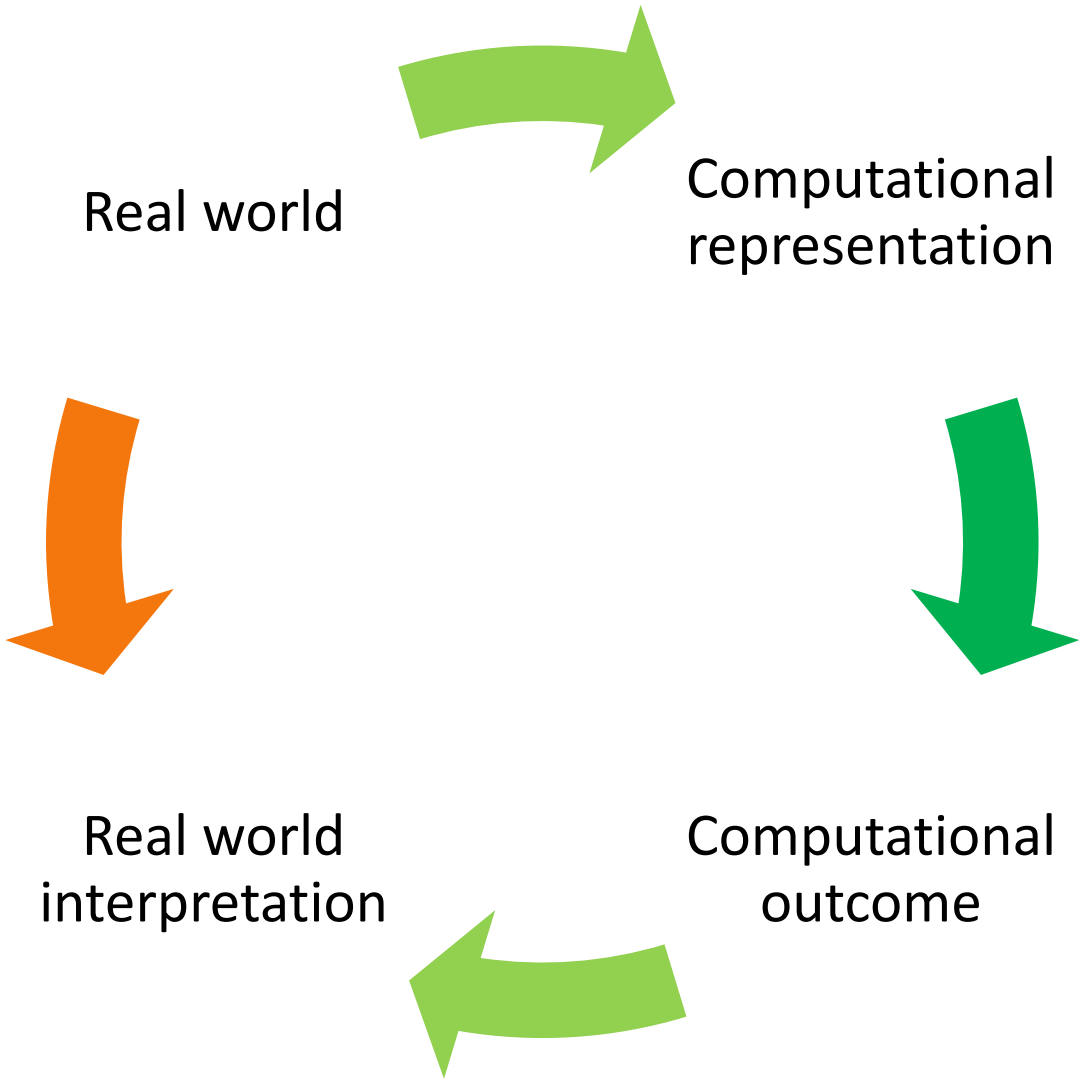
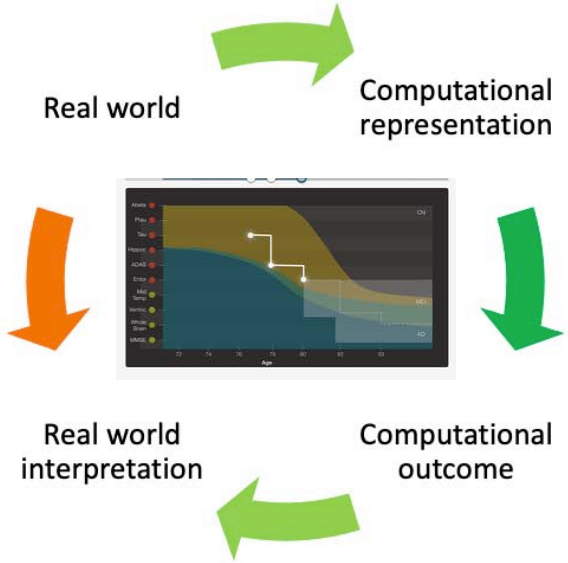
User interface concept: iCompass

- Question: how to move from invention to innovation?
  - Empirical studies to identify gaps between tool and practice.
  - Identify early adopters.
  - Converge on key clinical tasks.
  - Iteratively design interaction.
  - Next steps:
    - From prototype to functioning system.
    - Key clinical validation: on process or outcome?

Cognition supported by computation



Thinking computationally

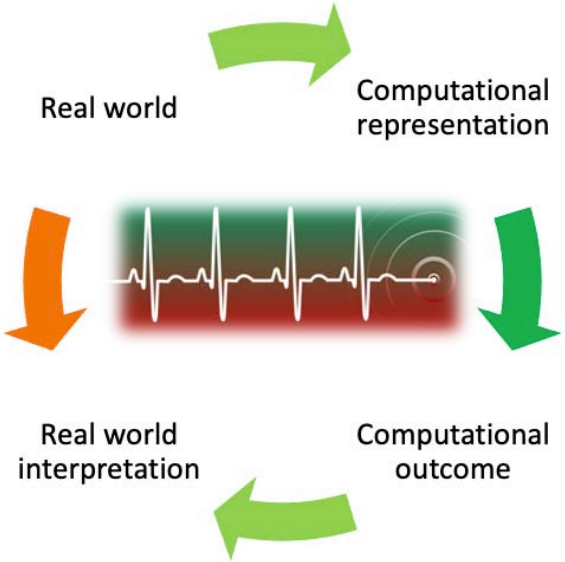


- From real world to computational representation:
  - What are valid measures? How is data gathered? Is data complete, reliable, etc.?
- Computational analysis yields outcome:
  - How has the algorithm been tested? Is it inspectable?
- Interpretation is needed to infer the real-world meaning:
  - E.g. through visualisation.

Example

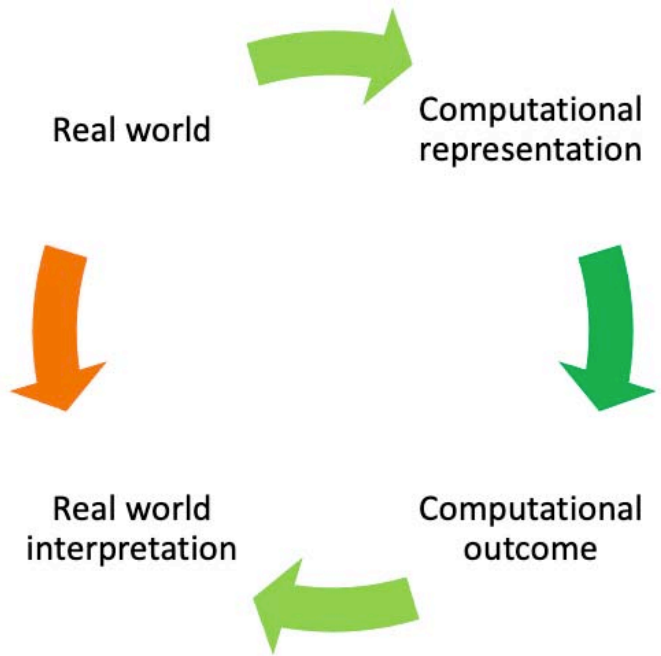
From "Made to Stick" by Chip & Dan Heath

- Baby in neonatal intensive care suddenly turned blue-black. Heart rate monitor indicated normal heartbeat.
- Team assumed collapsed lung and prepared to treat.
- One nurse suspected pneumopericardium, so listened with stethoscope. No heartbeat.
  - Correct diagnosis led to effective treatment…
- Heart rate monitor was indicating electrical signals, not actual heartbeats.



Mental models shape clinical care
(Smith & Koppel, 2014)

- Traditional:
  - Real world: how things really are.
  - Mental model: how clinician understands things.
- Technology-mediated:
  - Real world: how things really are.
  - Reality as represented through technology.
  - Mental model: how clinician understands things.



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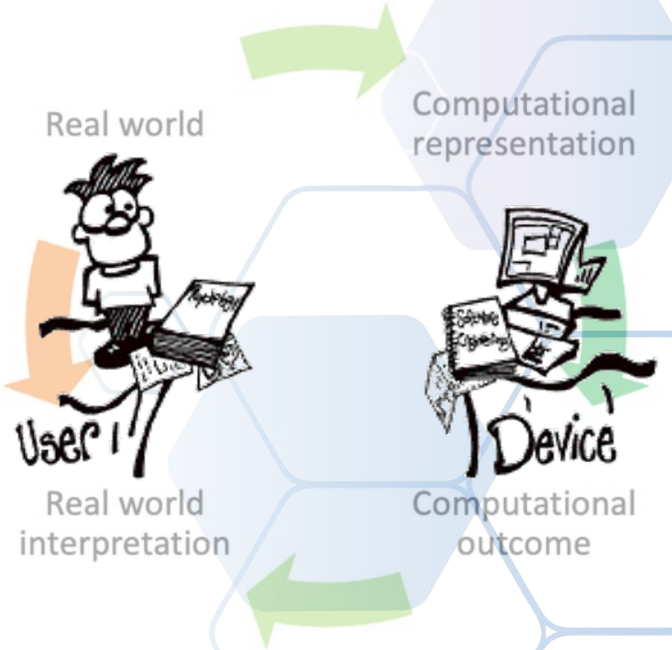
Smith, S. W., & Koppel, R. (2014). Healthcare information technology's relativity problems: a typology of how patients' physical reality, clinicians' mental models, and healthcare information technology differ. *Journal of the American Medical Informatics Association*, *21*(1), 117-131.

Five kinds of mismatches
(Smith & Koppel)

- Information too coarse – missing details that matter.
- Information too fine – demanding details that are not known or do not matter.
- Missing elements of reality that matter.
- Representing multiple “realities”.
- Incorrect information – e.g. from sensors.
- *S&K give 45 examples of different mismatches.*



Smith and Koppel examples

Image by Vachagan Malkhasyan from Pixabay

1. Vomiting:
   - Clinician administers pill to patient; patient vomits.
   - Has the medication been administered or not?
   - Medication administration record demands yes/no answer.
2. Schrodinger's Pharmacy:
   - Doctor has ordered medication but it hasn't yet been approved by the pharmacy.
   - Does the order exist yet or not?
     - Occasionally results in double-dosing.

Smith and Koppel examples in terms of user and system concepts

User concepts:

- Medication.
  - Ordered / not ordered.
  - Dispensed / not dispensed.
  - Given / not given.
- Patient.
  - Received / not received medication.

System concepts:

- Medication.
  - Ordered / not ordered.
  - Given / not given.

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Blandford, A., Green, T. R., Furniss, D., & Makri, S. (2008). Evaluating system utility and conceptual fit using CASSM. *International Journal of Human-Computer Studies*, *66*(6), 393-409.

Example: AI in colonoscopy

Research questions:

- How to draw attention to possible polyps while supporting overall work?
- How do people respond to false positives?

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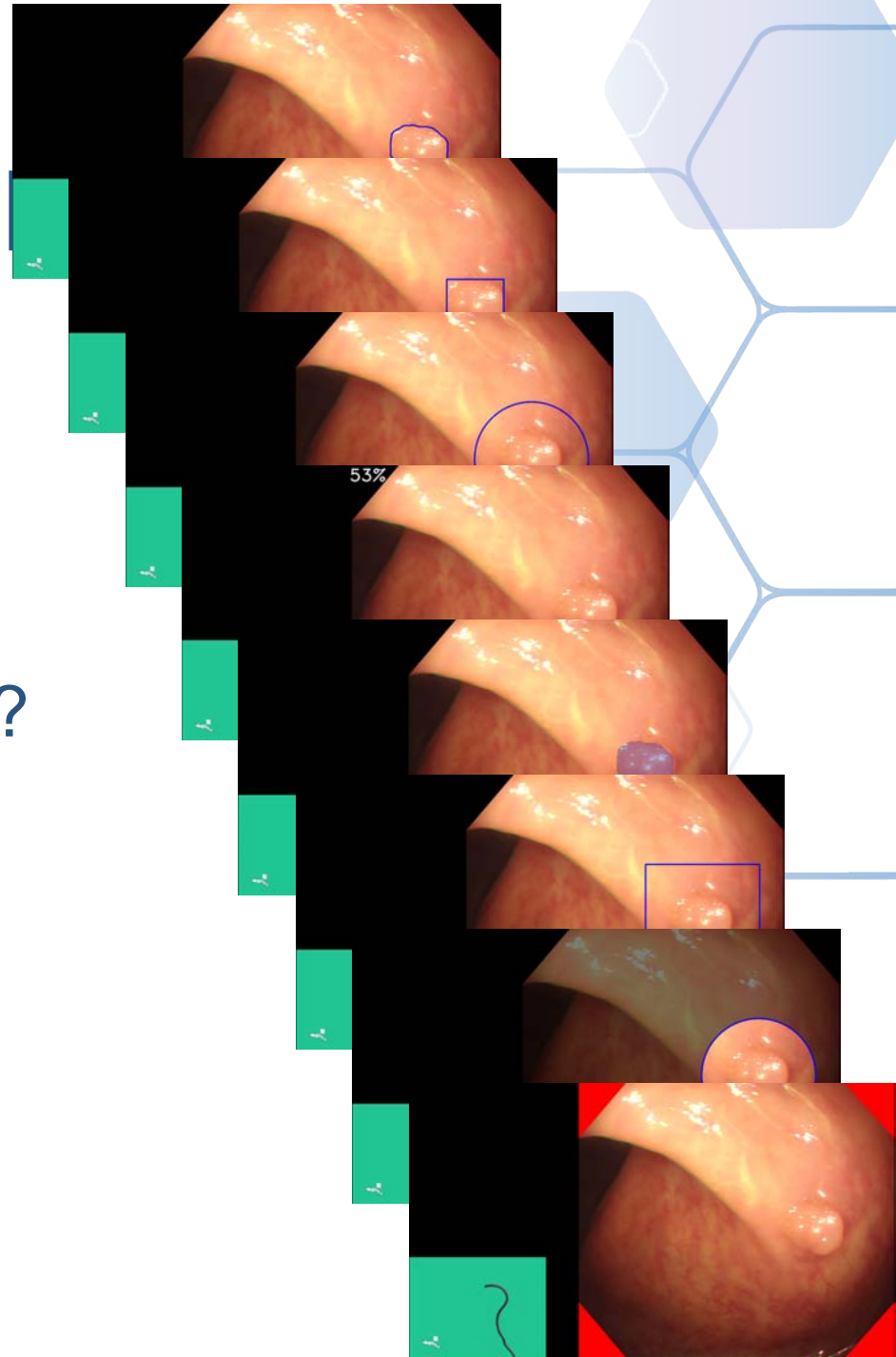

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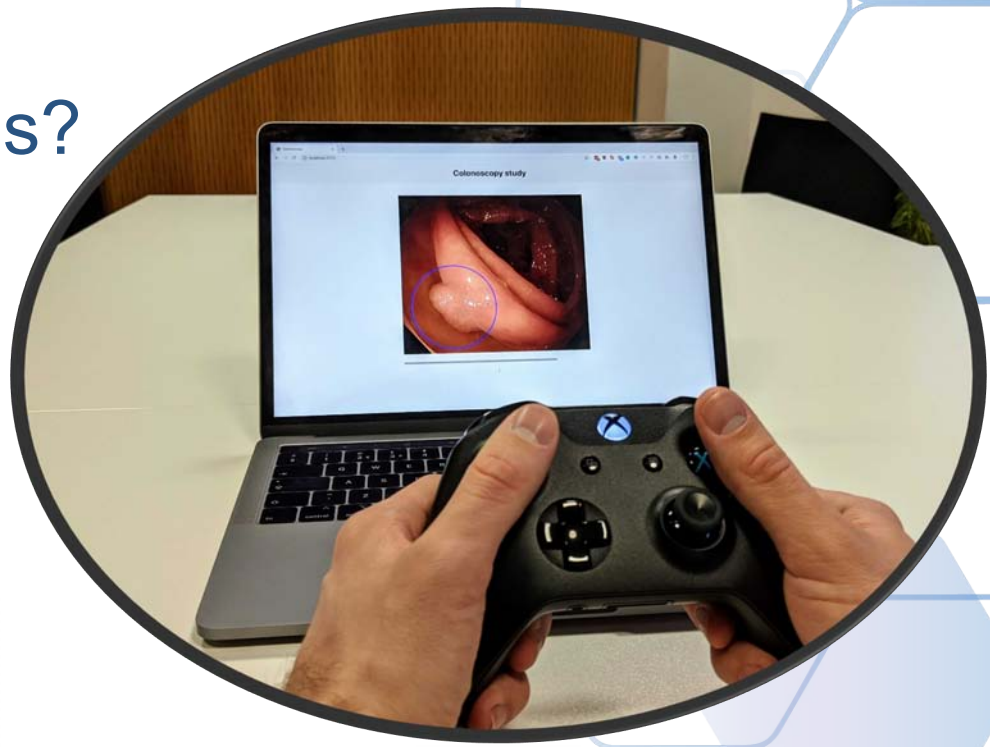

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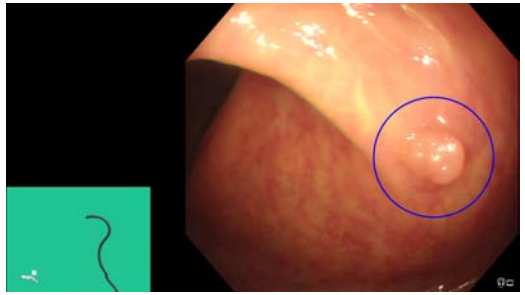
How to draw attention

Real world

Computational representation



Real world interpretation

Computational outcome

Van Berkel, N et al. (forthcoming) Designing Visual Markers for Continuous Artificial Intelligence Support: A Colonoscopy Case Study. To appear in ACM Trans. Health

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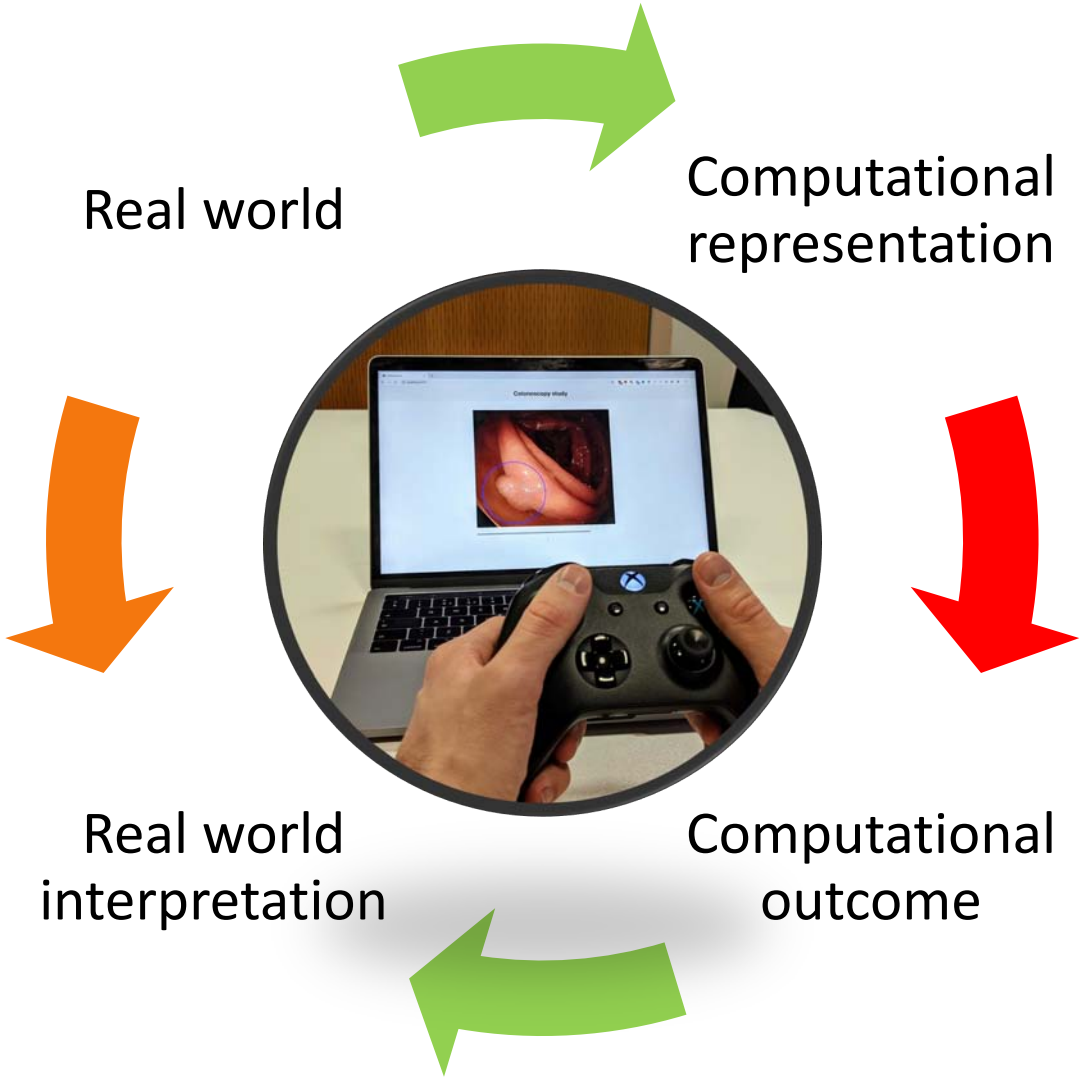
Responding to false positives

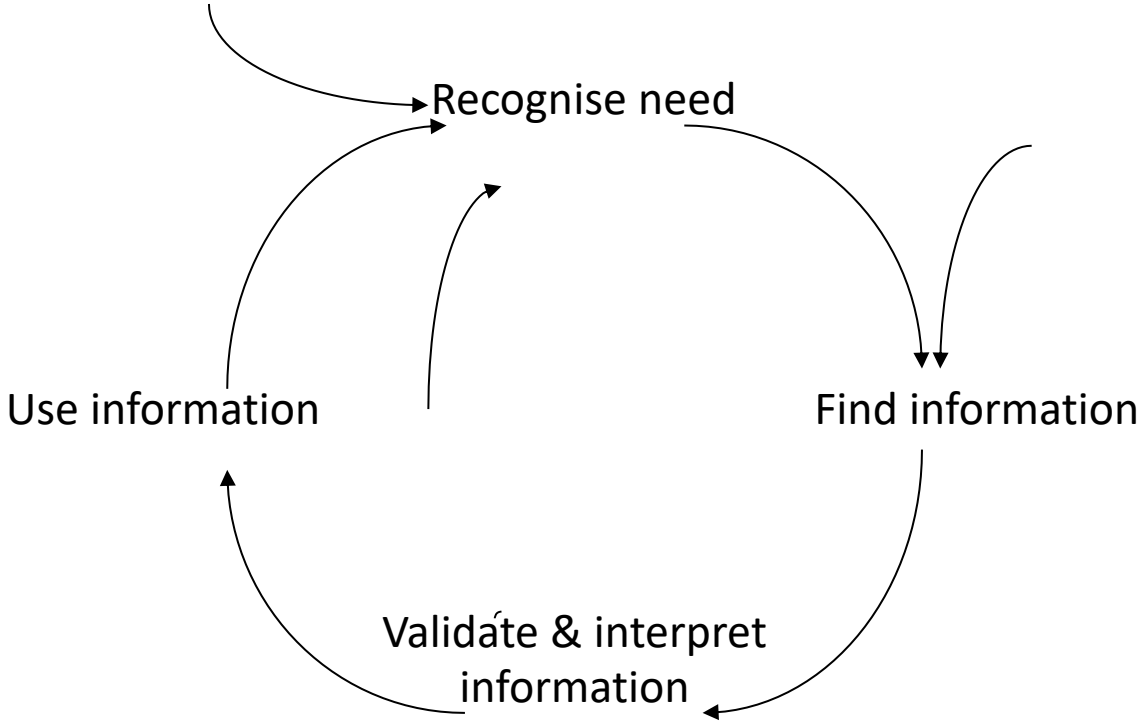


Reviewing interpretation and trust

- These examples have a lot in common:
  - Used by experts (clinicians).
  - Reliant on representation and computation.
  - Each interaction is bounded (within one clinical encounter).
  - No studies yet on how the users develop expertise or build trust in the system.
- Switch to contrasting examples:
  - Used by people managing clinical conditions.
  - Focus on information rather than computation.
  - Extended use of multiple information resources, reliant on interpretation, validation and sensemaking.

Many interactions are extended

E.g., finding a ”new normal” through interactions with information



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Example: online forum for male infertility

- Men used forums as a source of community led advice on health, investigations & diagnoses.
- Men often shared negative emotions of internalised stigma associated with infertility.
- Online forums were used as a safe space for men to share with one another.
- By expressing themselves and interpreting responses, participants found a “new normal”.

What should I do or might I suggest to my urologist?

It’s hard to tell the world that I feel like only half a man.

I don’t know any other men I can discuss this with so I came here

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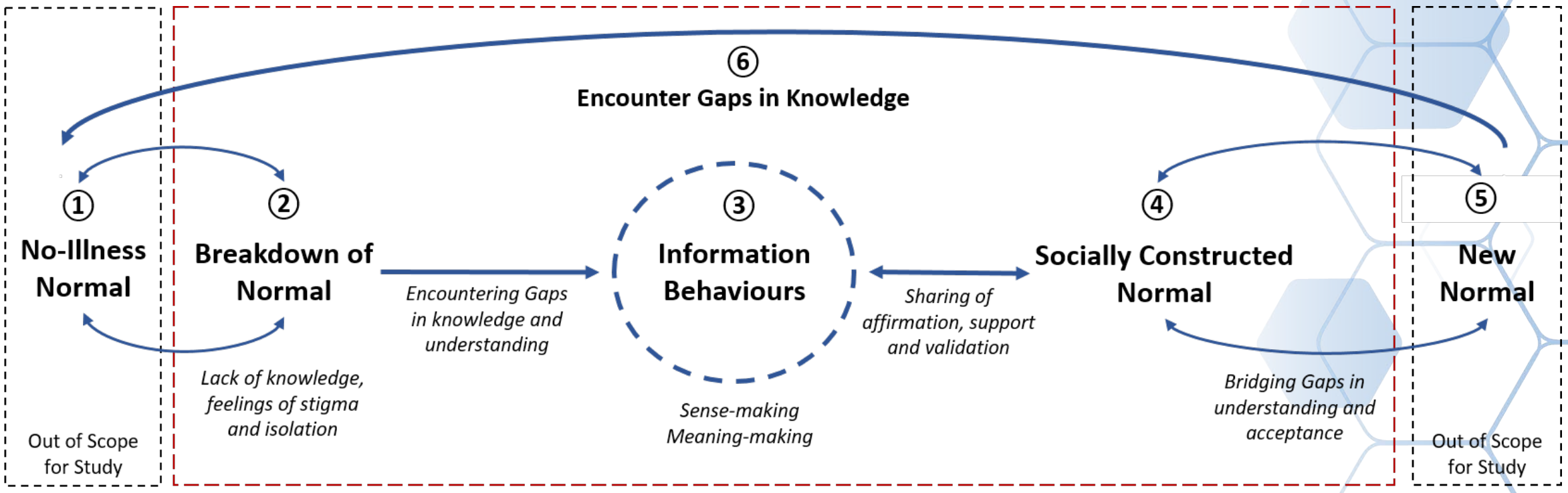
Finding a new normal



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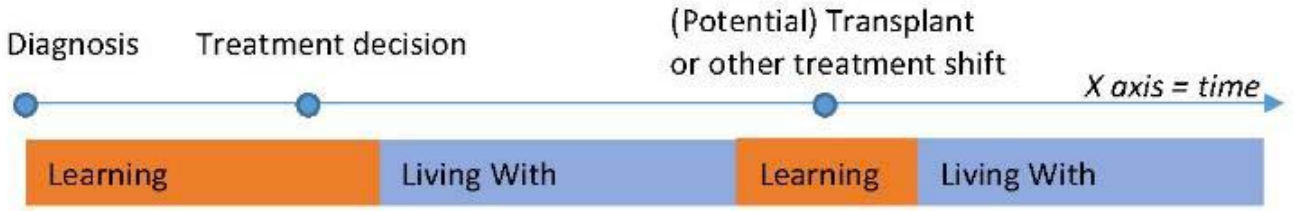
Patel, D., Blandford, A., Warner, M., Shawe, J., & Stephenson, J. (2019). " I feel like only half a man" Online Forums as a Resource for Finding a" New Normal" for Men Experiencing Fertility Issues. *Proceedings of the ACM on Human-Computer Interaction*, *3*(CSCW), 1-20.

Example: self-management and decisions in chronic kidney disease

- People managing Chronic Kidney Disease experience phases:
  - Learning about: information overload, urgency, decisions.
  - Living with: managing routine; different levels of engagement.
- Transitions demand finding a new “normal”.



Burgess, E. R., Reddy, M. C., Davenport, A., Laboi, P., & Blandford, A. (2019, May). " Tricky to get your head around" Information Work of People Managing Chronic Kidney Disease in the UK. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (pp. 1-17).

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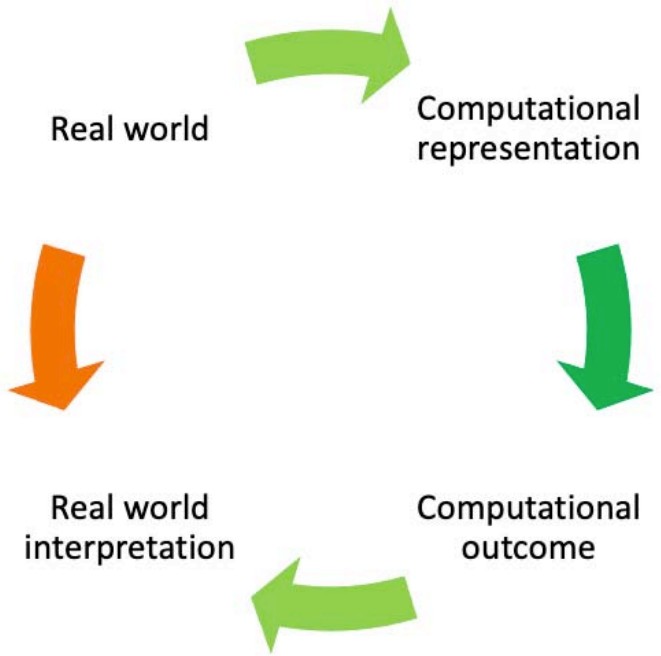
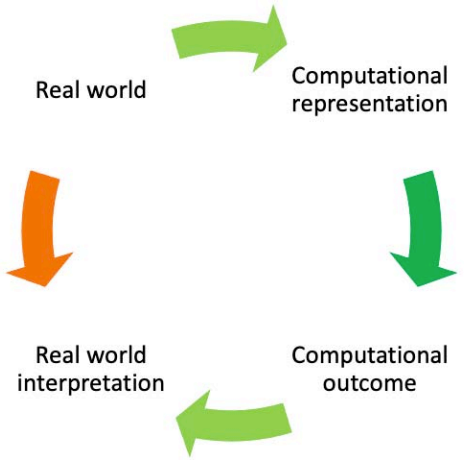
Cognition supported by interaction

- In engaging with online information resources:
  - There's still a digital representation (of an evolving information need).
  - The "computation" is a search engine or approach to data management.
  - Data presentation supports triage, interpretation and validation.
  - The onus lies on the individual to construct their personal meaning through interactions.



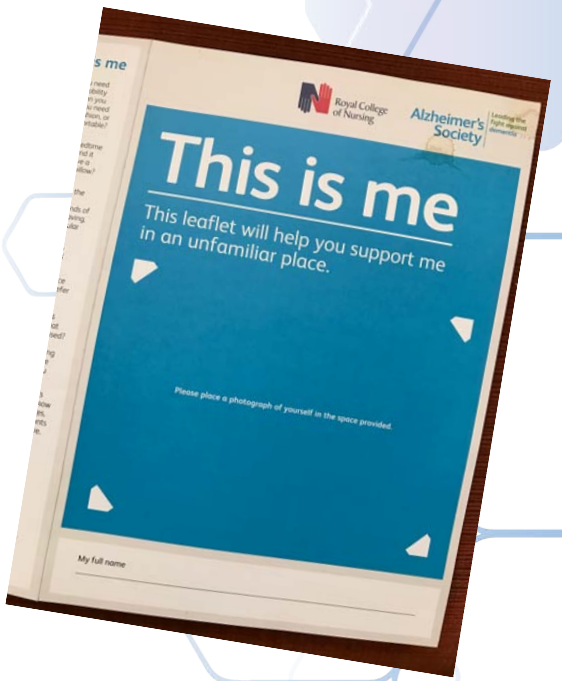
Looking to the future

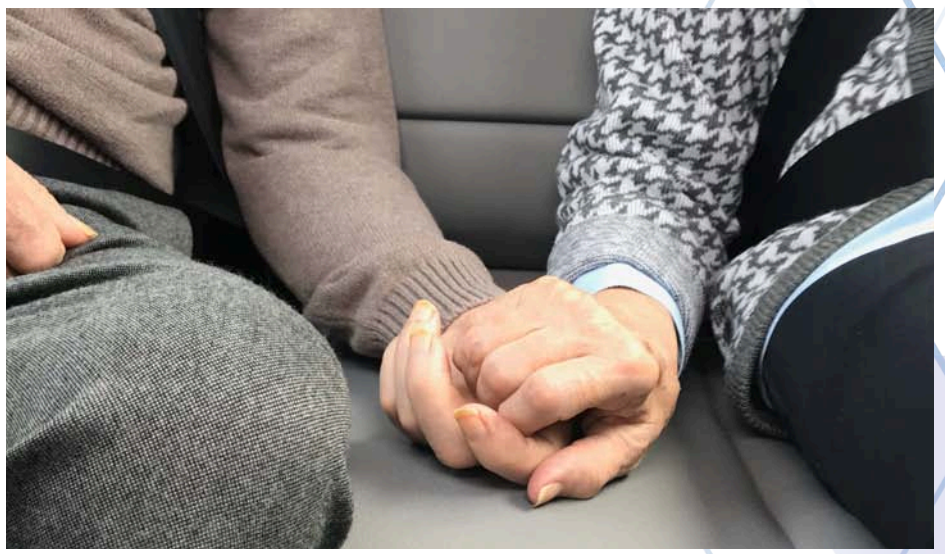


- In developing usable, useful and trusted interactive systems, we need to consider all steps:
  - From real world to computational representation.
  - Computational analysis.
  - How people interpret information.
- We also need to account for people's workflow, values and priorities in developing technologies that both work and matter.

“Not everything that can be counted counts and not everything that counts can be counted”

(source unclear – but probably not Albert Einstein)





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...and more

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Thank you!

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