Data Science for Drug Discovery, Health & Translational Medicine

Guest Lecturers

Prof Grant Cumming
Dr Tara French

What data science can do for patients: Preferred Health Outcomes

Structure

Introduction
Challenge(s) for Data Scientists
Recap/pick up on some points from last lecture
Engagement
    Design Innovation & Participatory Design
Realistic Medicine
Preferred health outcomes
Ecological approach to health & healthcare
Formulating healthcare
Health Web Science, Medicine 2.0 & Health Web Observatories
    Analysis (data science)
Primum non nocere- medical devices
Summary

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Summary


Edinburgh

Consultant Obstetrician & Gynaecologist
Honorary Professor University of the Highlands & Islands
Honorary Senior Lecturer University of Aberdeen

Research Fellow
Institute of Design Innovation, The Glasgow School of Art
Digital Health and Care Innovation Centre

How Data Science can help clinicians treat patients better
A clinician’s perspective

What Data Science can do for patients
Preferred Health Outcomes

to address and solve the particular
problems & challenges facing 21st century medicine
using Information & Communication Technologies
and in particular
those utilising the Web & the Internet to deliver health care

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Summary

Challenge(s) for Data Scientists

Understand the landscape & opportunities

Engineer IoT & Web for health & healthcare

primum non nocere

Medical devices?- regulation

(Quality, Provenance & Governance issues)

Develop Analytical Tools

What are we measuring?

What data?

Where is data?

How curate, visualise, interpret, disseminate, personalise?

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HEALTH
CARE

Challenges 21st century Medicine

↑ population (9 billion 2050)

↑ageing population

↑Chronic diseases

(Long Term Conditions)

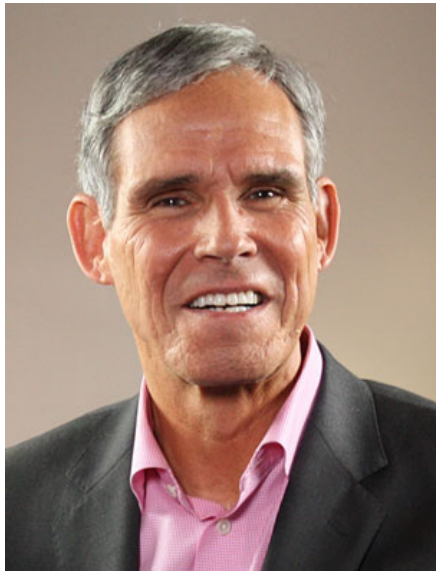
Information overload

Shortage health professionals

Climate change

Environmental degradation

Infectious diseases (pandemics)

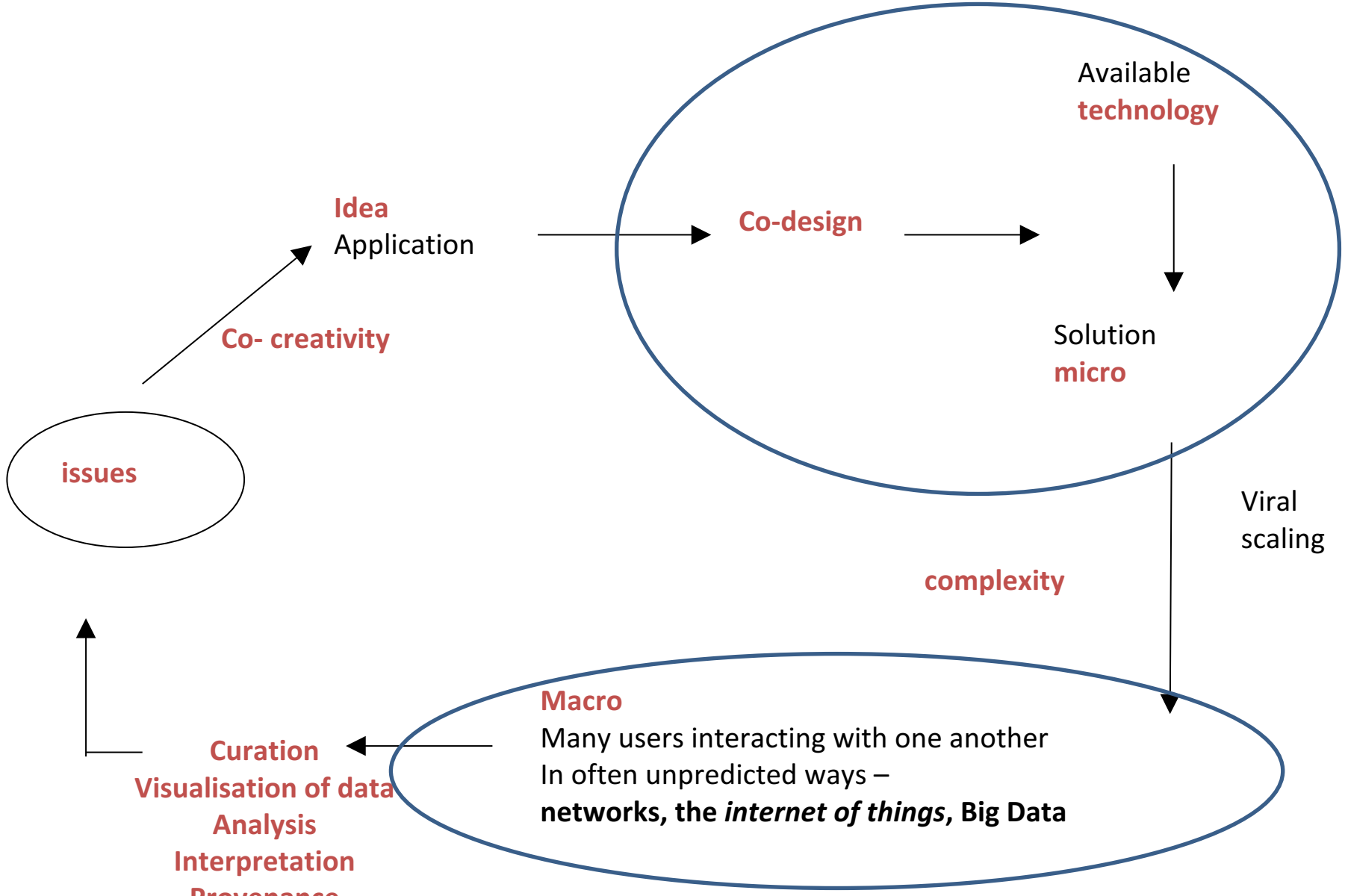


Reactive to proactive health

Population to individual health

Interrogating the Internet for health information and combining this information with that from the IoT, together with health professional patient information systems, and the emerging field of systems biology means that we are entering a new era of medicine in which each person can be “near fully defined at the individual level, instead of how we presently practice medicine which is at a population level”

Eric Topol



*The web must be studied as an entity in its own right to ensure it keeps **flourishing** and prevent unanticipated social effects*
Hendler J, Shadbolt N, Hall W, Berners-Lee T, Weitzner W, 2008: 60–69

Knowledge is the engine of our economy- data is its fuel

There are known knowns.
These are things we know that we know.

(evidence based medicine – quantitative

There are known unknowns.
That is to say, there are things that we know we don't know.

(social context-human behaviour is complex and unpredictable
qualitative- evidence informed medicine

But there are also unknown unknowns.
There are things we don't know we don't know.

Emergent properties- the whole is greater than the sum of the parts
agile iterative approaches cf fixed milestones
complexity with scaling up

Donald Rumsfeld 2002

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Engagement

HealthSpace

Build it and they will come (sic)

ICT over promised & under delivered

BMJ

RESEARCH

Adoption, non-adoption, and abandonment of a personal electronic health record: case study of HealthSpace

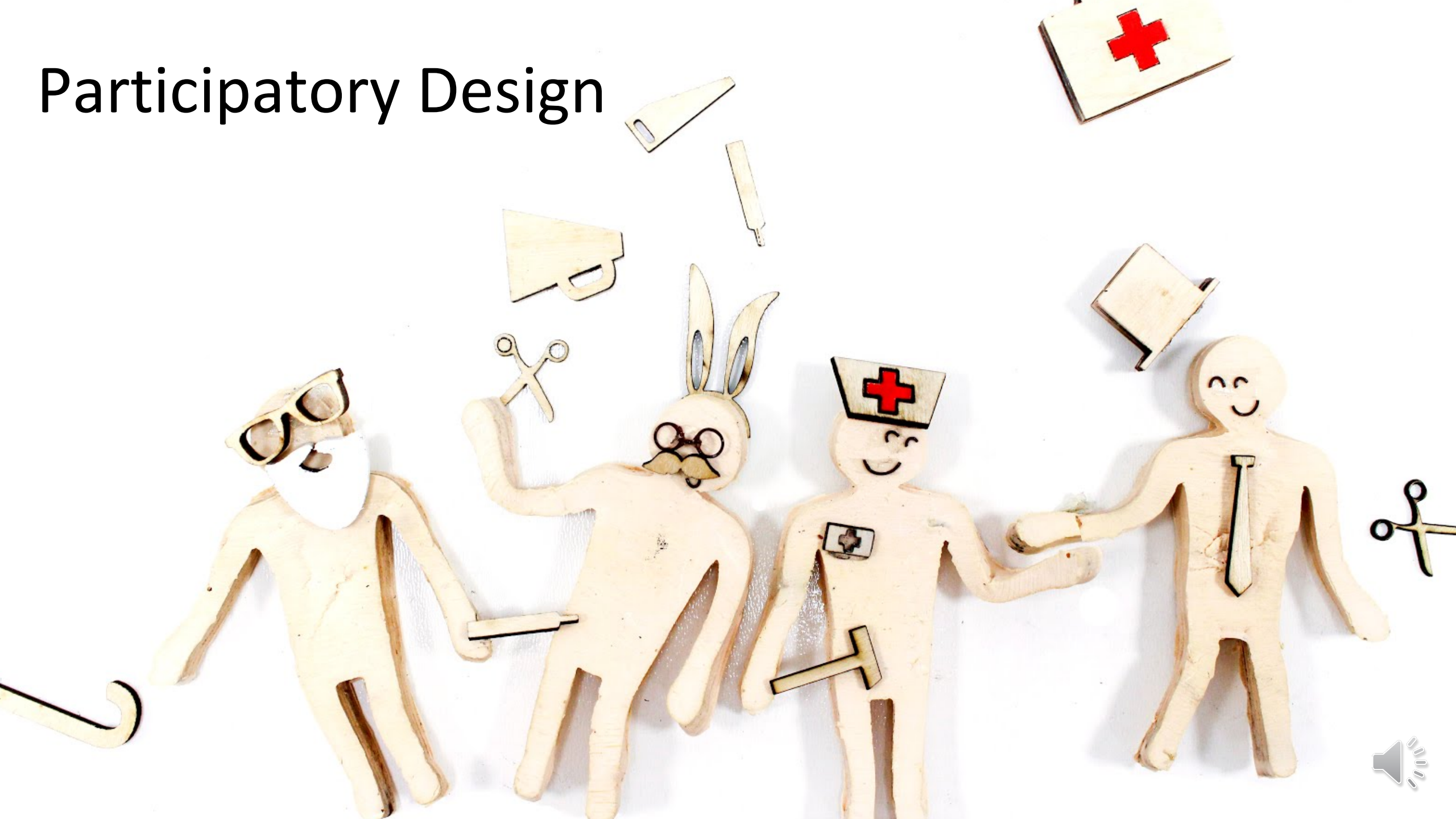
Trisha Greenhalgh, director,[1] Susan Hinder, freelance researcher,[2] Katja Stramer, senior research fellow,[3] Tanja Bratan, research fellow,[3] Jill Russell, senior lecturer[3]

Conclusion

Unless personal electronic health records align closely with people's attitudes, self management practices, identified information needs, and the wider care package (including organisational routines and incentive structures for clinicians), the risk that they will be abandoned or not adopted at all is substantial. Conceptualising such records dynamically (as components of a socio-technical network) rather than statically (as containers for data) and employing user centred design techniques might improve their chances of adoption and use. The findings raise questions about how eHealth programmes in England are developed and approved at policy level.

Design Innovation

Participatory Design



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Realistic Medicine

Chief Medical Officer, Scotland

‘Realistic Medicine puts the person receiving health and care at the centre of decision-making and encourages a personalised approach to their care.'

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Preferable Health Outcomes

Possible futures, preferable futures (Hancock and Bezold, 1994)

Preferred Health Outcomes

health outcomes, preferred by patients
involve a balance between medical evidence and the patients' wishes

Personalisation of healthcare, (patient-centric)
- dialogue
  - takes the best medical evidence and information available
  - creates a management plan that fits with the patient's lifestyle and preferences

may be a compromise on best medical evidence to accommodate the patient's wishes

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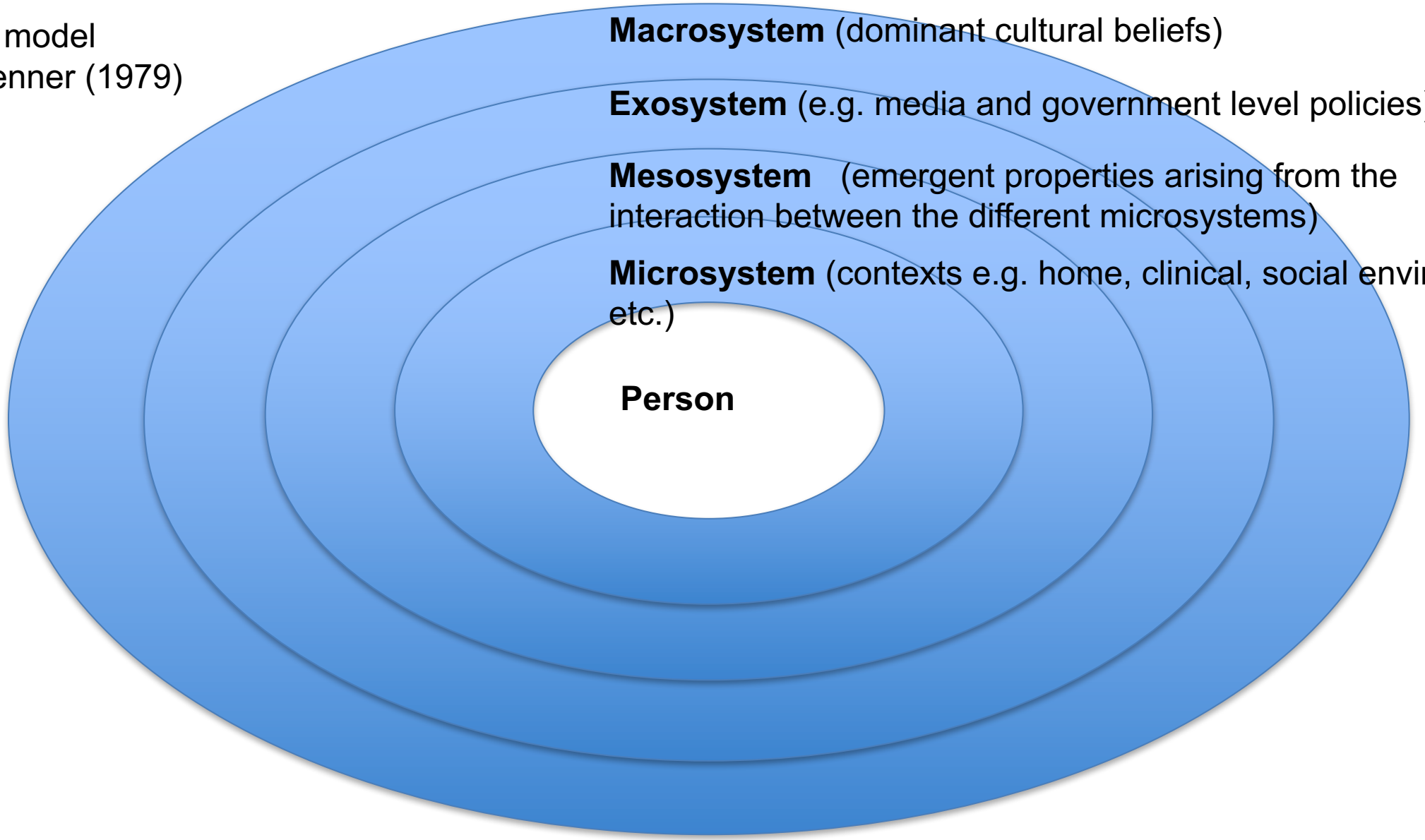
Ecological approach to health

Ecological model
Bronfenbrenner (1979)



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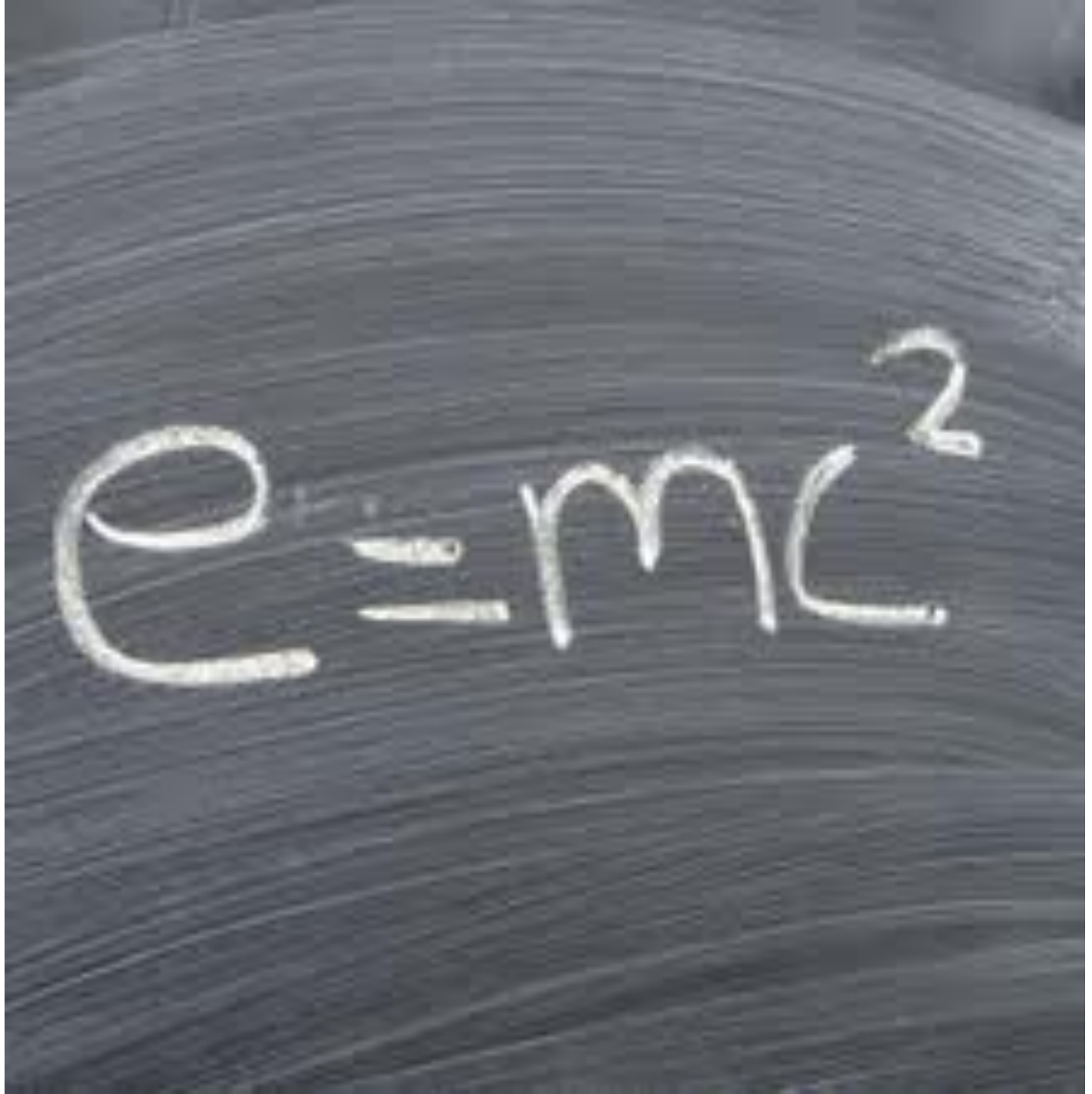
Why Formulate?

Evaluate

- How do we know what will work?
- Will it do harm?
- What are the tools, technologies, and resources needed to make sure we are using the resource effectively
- Are getting what we need?


E=mc²

P4

Personalised

Preventative

Participatory

Predictive

+

C^n

Community

Co-development

Communicating

Crowd Wisdom

Co-production

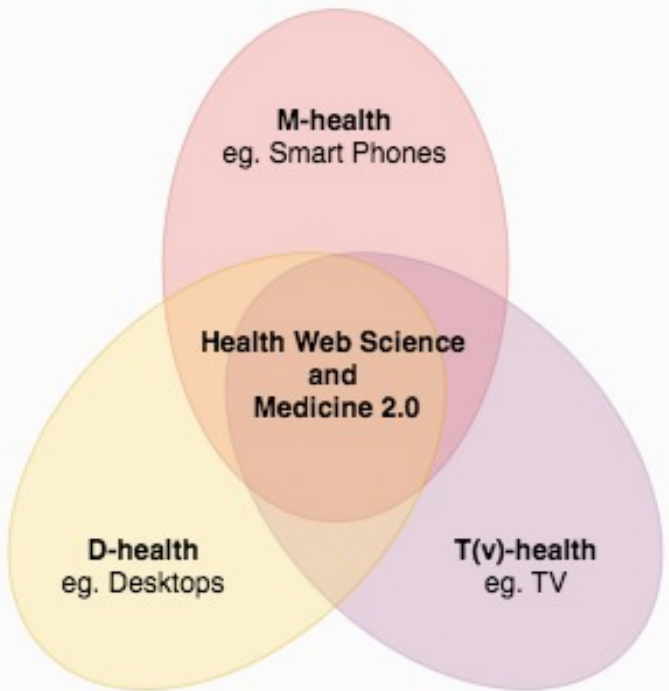
Collaborating

Co-creating

×

i-DMT

Internet Desktop Mobile Television Health



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Health

Health

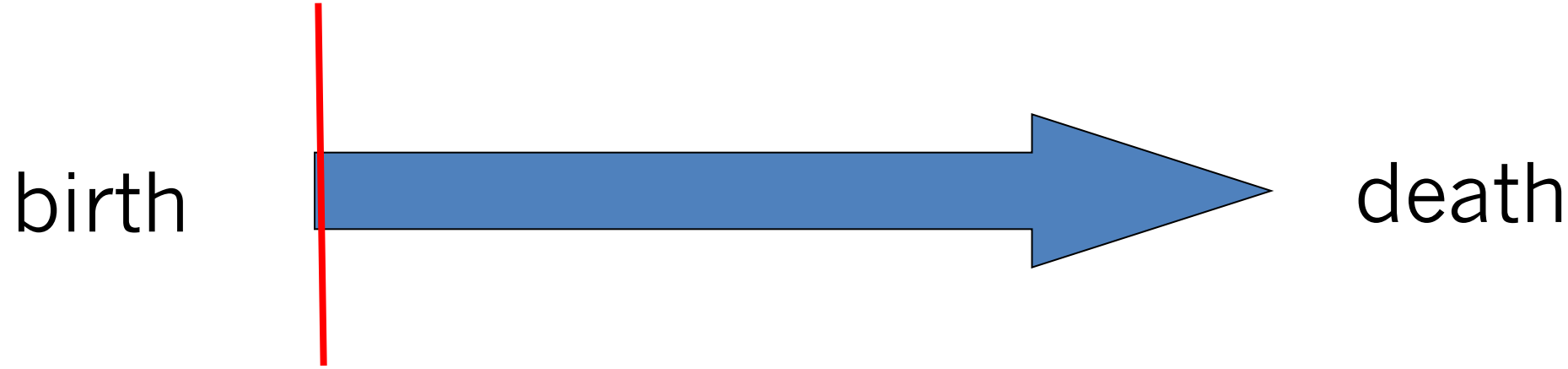
behaviour

outcomes

environments

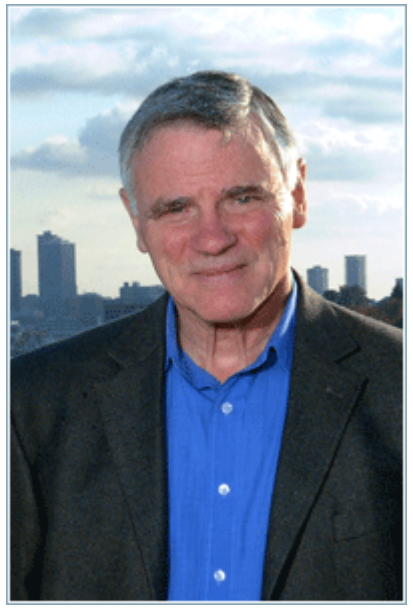
policy

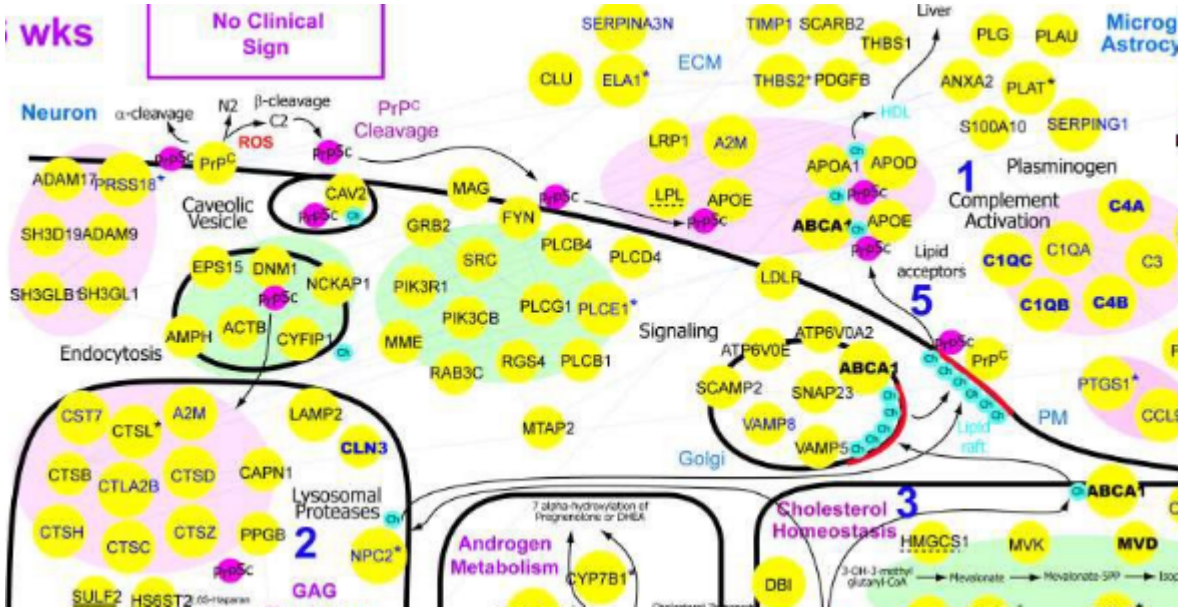
costs



Maximise health at each point - “don’t die of ignorance”

Engage, Educate (*ehealth literacy)*
Encourage (*incentivise, nudge, libertarian paternalism*)
Empower, Enable, Extract *(wisdom of the crowd)*
Efficient, Enhance quality, Evidence based, Ethical, Equitable





Leroy Hood 2003

P4

Preventative
Preventative
Personalised
Participatory

http://p4mi.org/

C^n

- Community
- Co-development
- Communicating
- Crowd Wisdom
- Co-production
- Collaborating
- Co-creating

SALZBURG GLOBAL SEMINAR

The Salzburg Statement on Shared Decision Making

In December 2010, 58 people from 18 countries attended a Salzburg Global Seminar to consider the role patients can and should play in healthcare decisions. Those listed below have agreed a statement that calls on patients and clinicians to work together to be co-producers of health.

The Greatest Untapped Resource in Healthcare?
Informing and Involving Patients in Decisions about Their Medical Care

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Ichoose exemplar
A call to action
Summary

What Is Web Science?

Web science is an emerging interdisciplinary field concerned with the study of large-scale socio-technical systems, such as the World Wide Web. It considers the relationship between people and technology, the ways that society and technology co-constitute one another and the impact of this co-constitution on broader society. *wikipedia*

http://www.webscience.org/web-science/about-web-science/

Health Web Science

Health Web Science's scope parallels that of Web Science but with a health remit- to understand how the web shapes and is shaped by medicine, healthcare and individuals.

- Studies the Web and technologies that use the Internet, their emergent properties and how these are being and can be harnessed or held in check, and by whom, to benefit society in the area of human health.
- Studies how the Web can be *engineered* or *developed* in relation to health, medicine and healthcare.

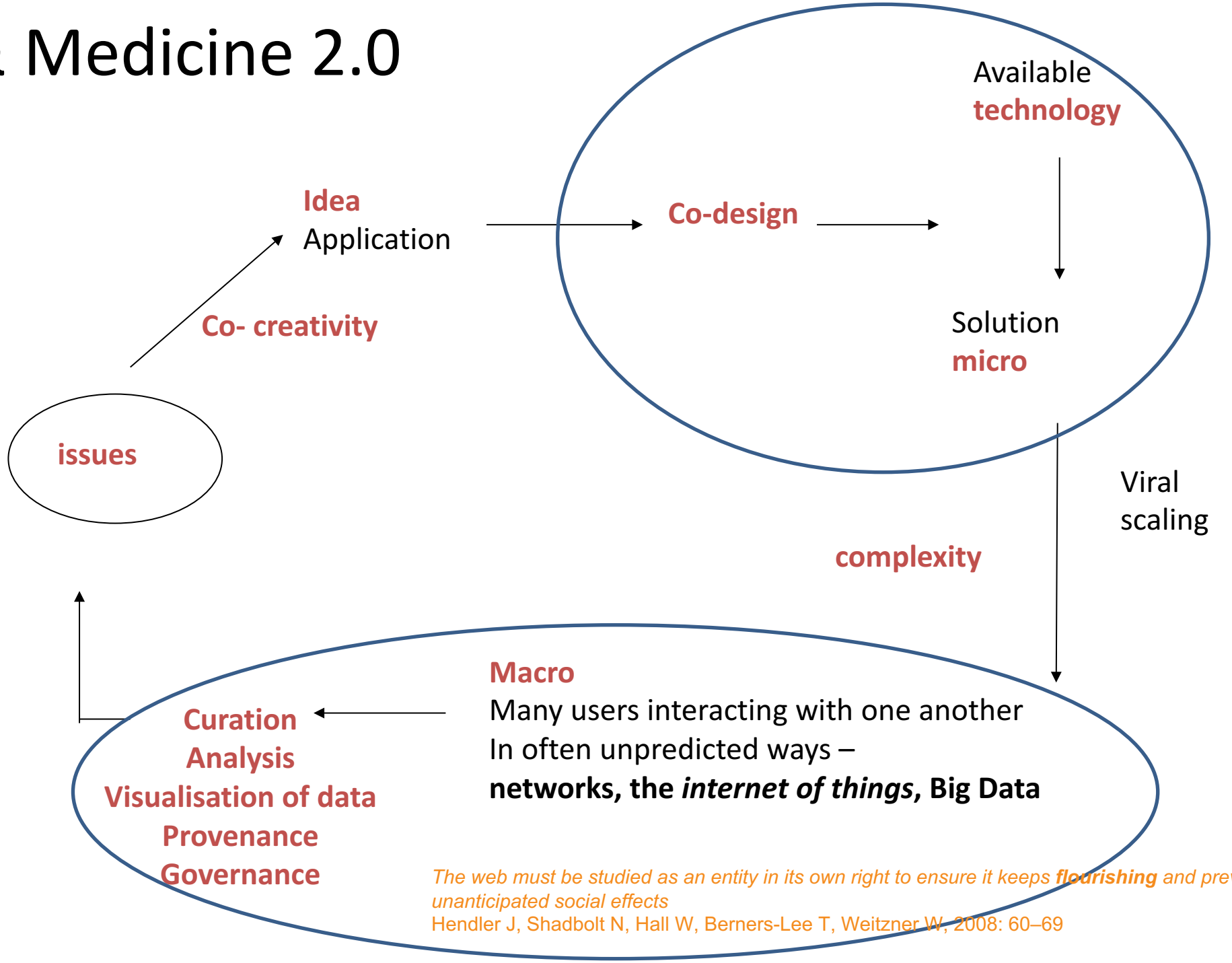

Health Web Science
Joanne S. Luciano, Grant P. Cumming,
Eva Kahana, Mark D. Wilkinson,
Elizabeth H. Brooks, Holly Jarman,
Deborah L. McGuinness and Minna S. Levine
now

What is Medicine 2.0 ?

next generation medicine
enabled by emerging technologies

https://www.marsdd.com/news-and-insights/medicine-20-part-1/

HWS & Medicine 2.0



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Web Observatory

Unlocking the potential of data

https://youtu.be/oeZuDwvGJTk

Health Web Observatory

A health web observatory is a system which gathers and links to **health** data on the Web in order to explore questions about the web, its users and the way that they affect each other with a particular **emphasis** on health and wellbeing

A HWO requires

ICT infrastructure

to interrogate, curate, visualize and make sense of health related data from disparate (decentralised) databases.

health professionals interface

a.) the capability to identify individuals who function as the main actors in a health social network

b.) be able to target these individuals with relevant health information,

c.) for health professionals to be able to assess the stage of health behaviour change a person is in

Individual's interface,

a) Upload their data
b) provide the confidence and trust that the individual is not being manipulated for nefarious reasons thus to be able to research and share information according to their personal values.
c) Personalize their and make sense of their interrogation (preferred health outcomes)

Developers interface

does it do what is says on the tin

Analysis (data science) - overview

Network Analysis

Graph theory

Game theory

Behavioural theory

Big data, Broad data, Mining Data and Triangulation of Data

P4 medicine and the Internet of Things

Expert Patient & Algorithms

Information overload

Text mining, semantic technologies

Healthcare singularity

Analysis (data Science) - specifically

Network analysis

Behavioural change

Personalising

State of change

Evaluating

Analysis (data Science) - specifically

Network analysis

Behavioural change

Personalising

State of change

Evaluating

I am who I am because of everyone
click here for more

Connect & Collaborate - Networks

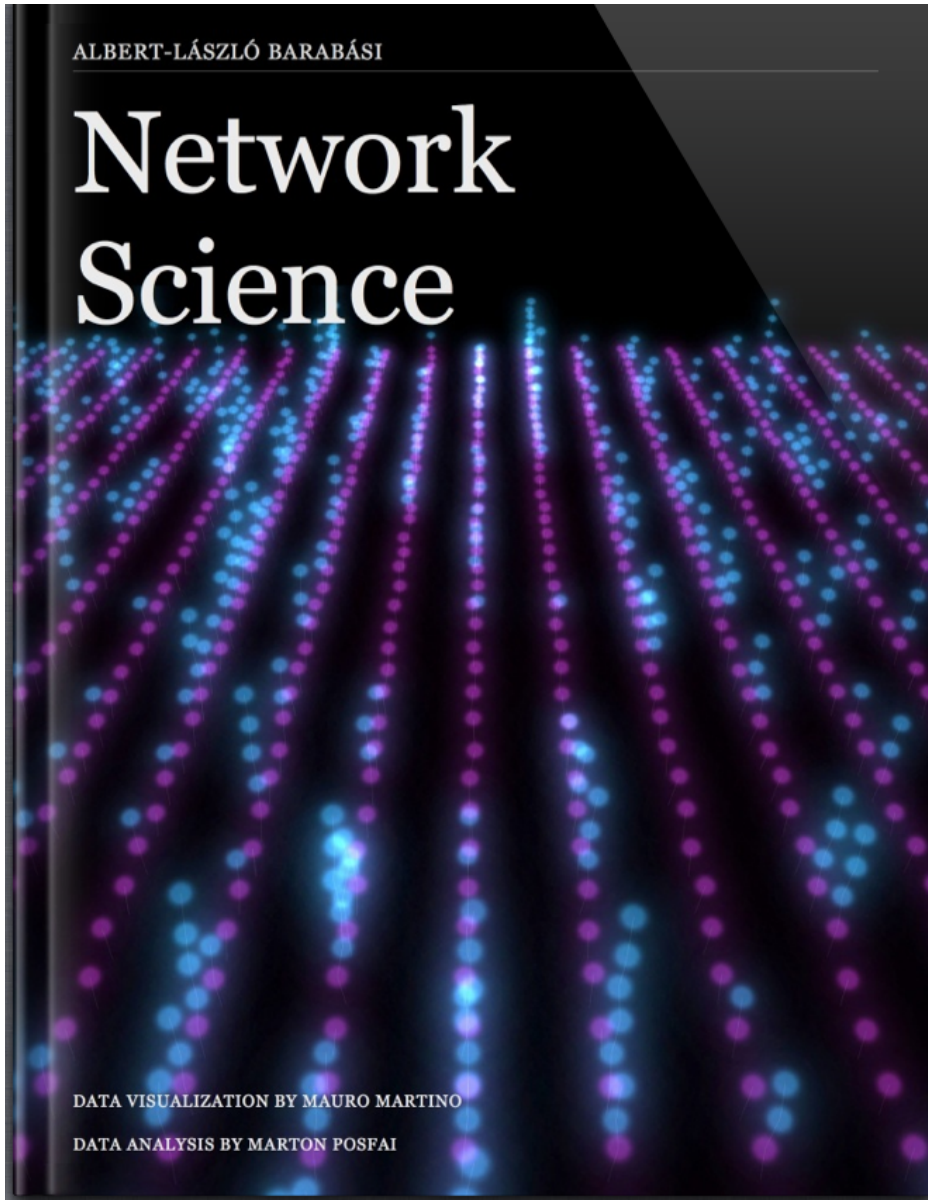
Visualising Data

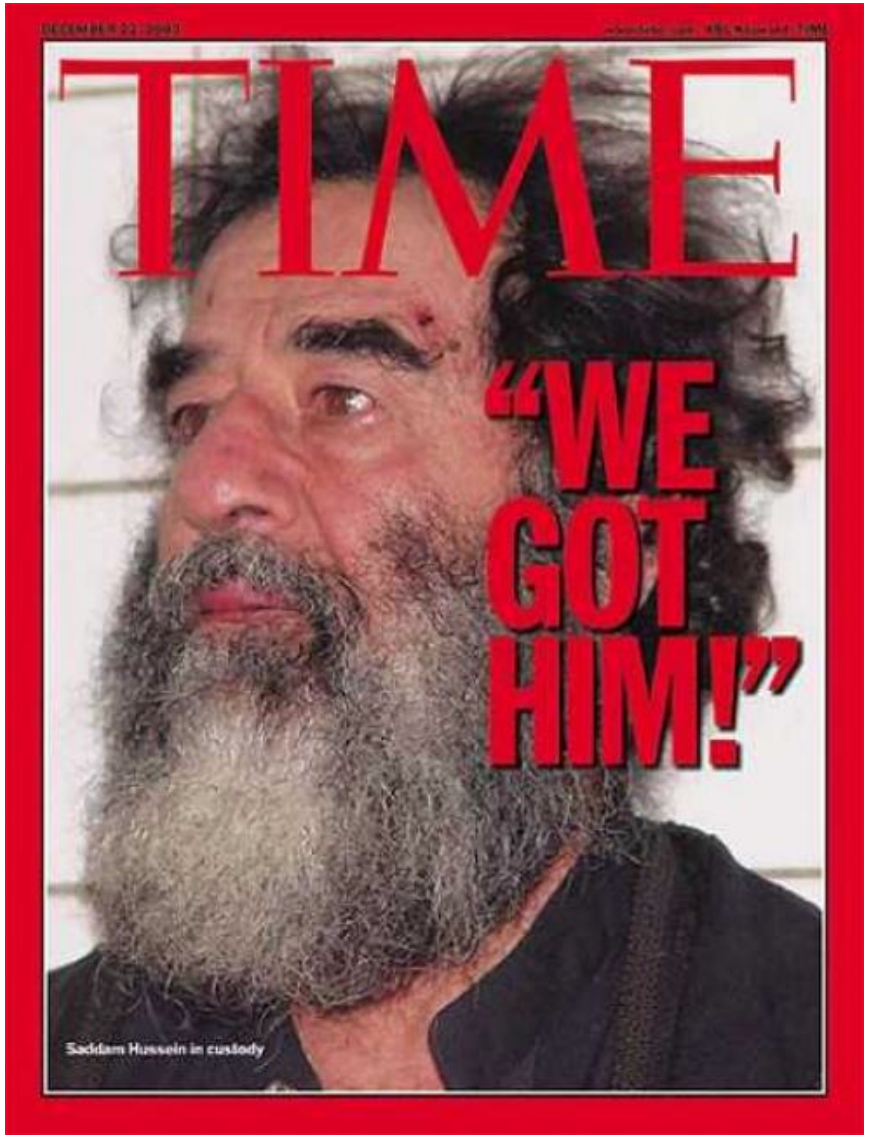
Social graph of 500 million Facebook users

Paul Butler(2010)

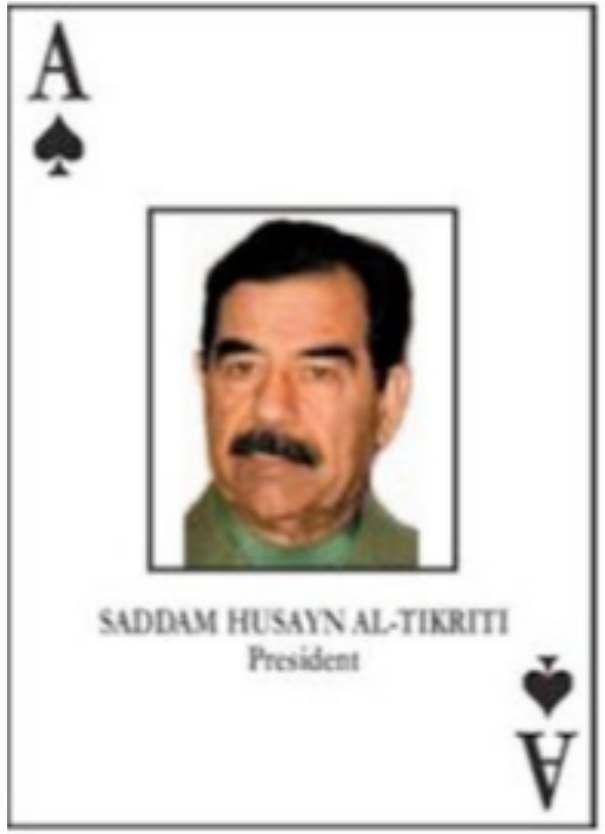
Infrastructure is global but the flow is local

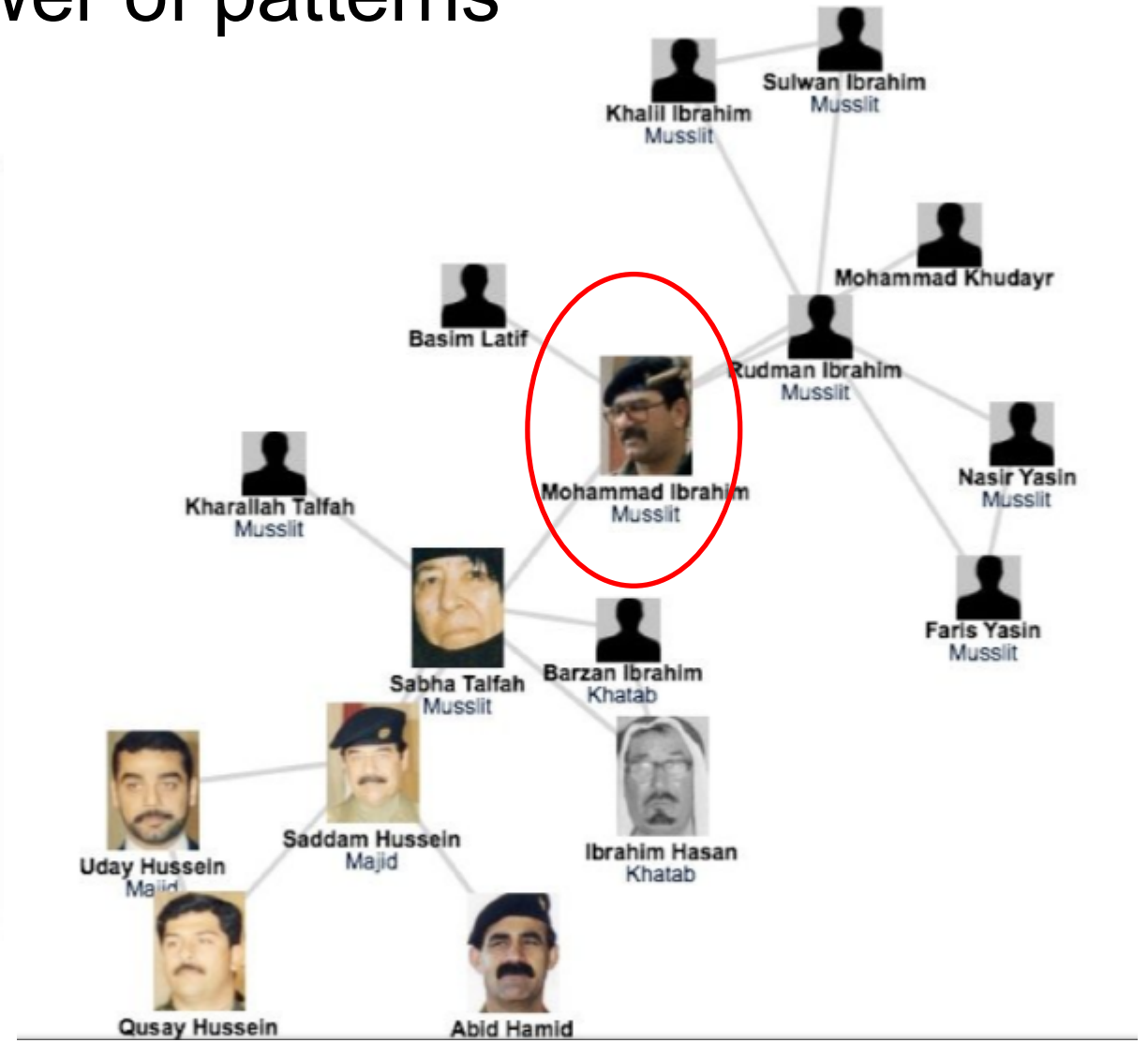
Power of network analysis





Predictive power of patterns





Analysis (data Science) - specifically

Network analysis

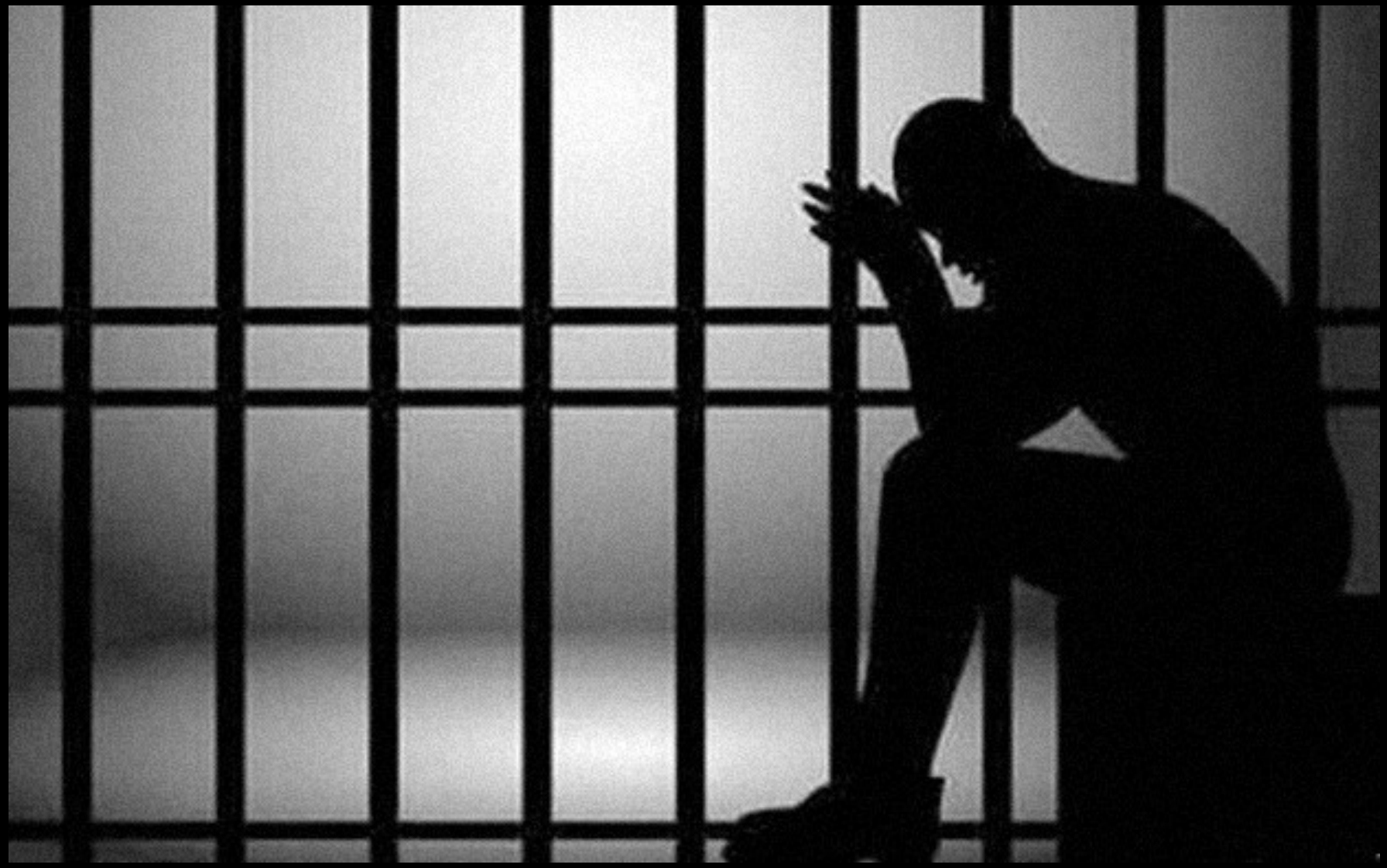
Behavioural change

Personalising

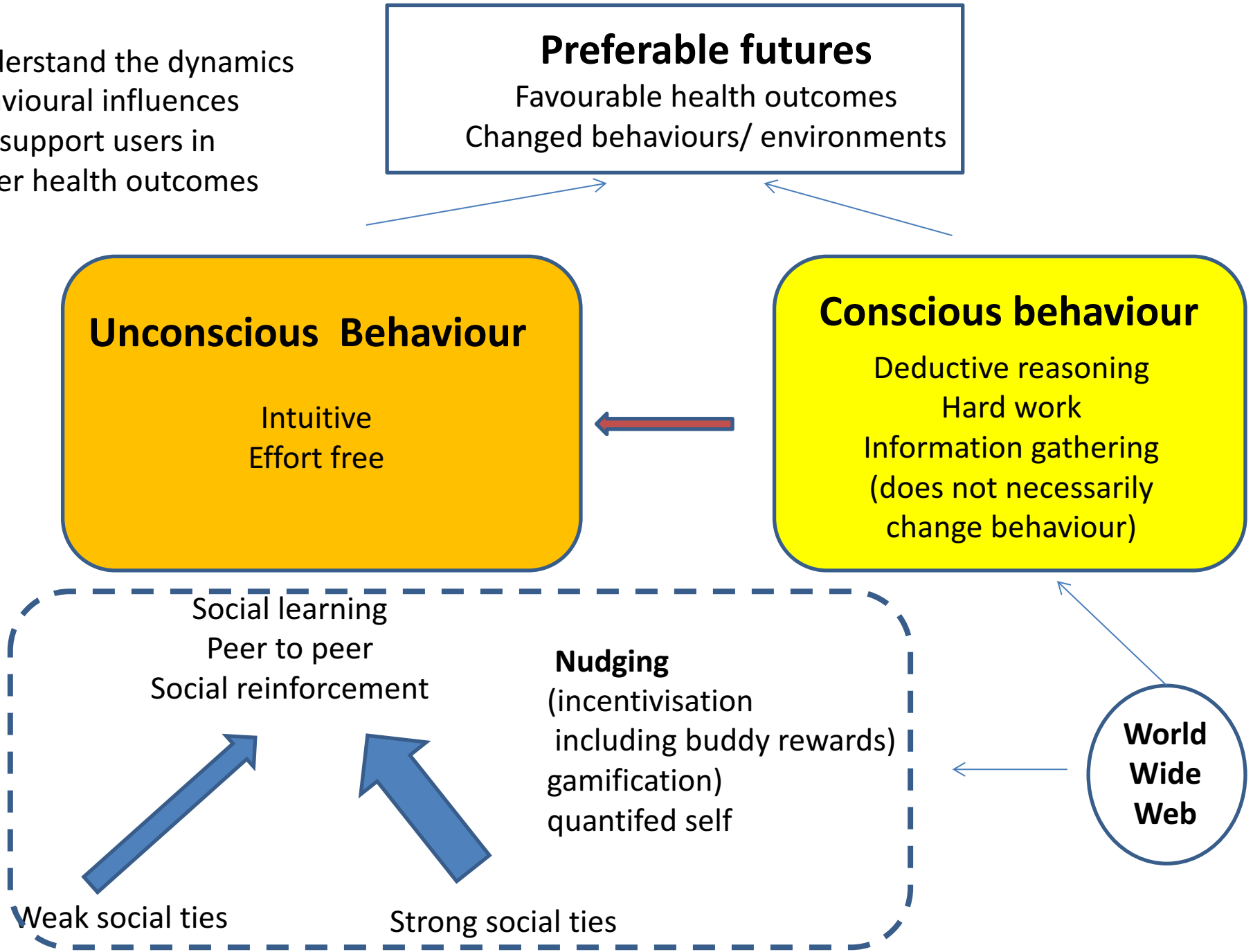
State of change

Evaluating

change environment /change behaviours



HWS seeks to understand the dynamics of these behavioural influences in order to support users in achieving better health outcomes



Analysis (data Science) - specifically

Network analysis

Behavioural change

Personalising

State of change

Evaluating

I-choose

Rationale for I-Choose

(All prices normalized to US$ per pound)

Is the information in the packaging trustworthy?

What are the criteria?

How do I know this is not a “Green Washing”?

Which certification should I trust?

Center for Technology in Government

UNIVERSITY AT ALBANY

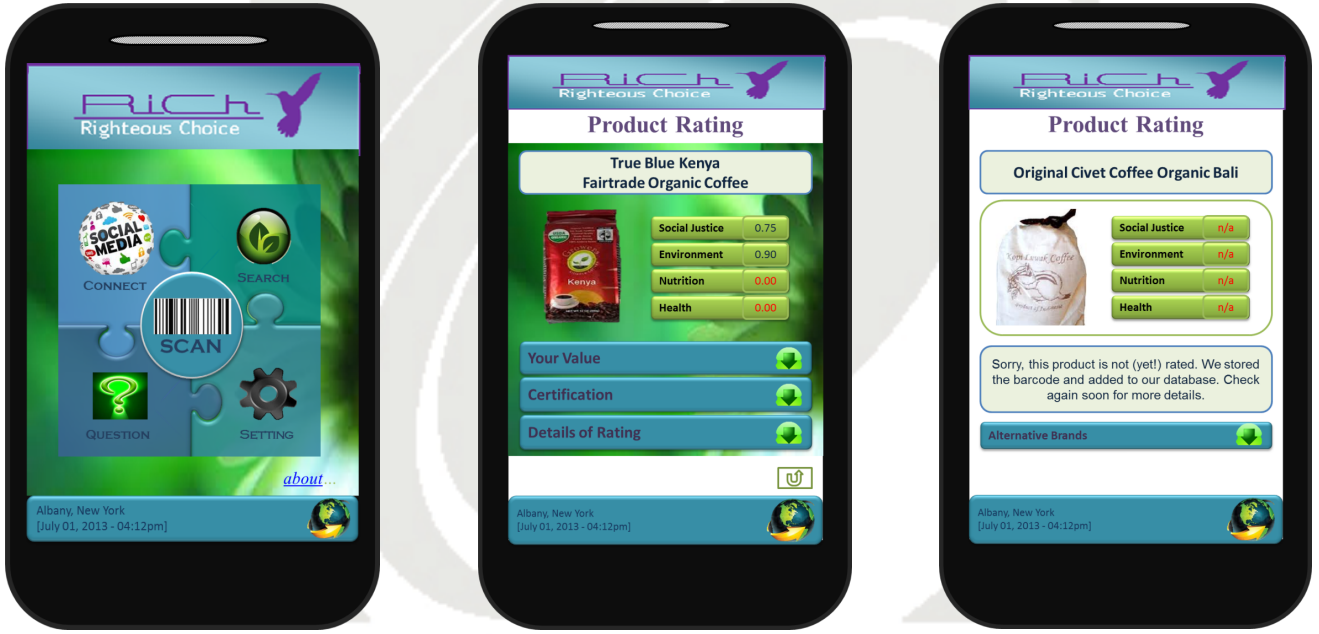
TWC

Rensselaer

I-Choose

Consumer has tremendous difficulties piecing together fragmented data and translating different certification regimes, thus not being able to effectively evaluating the trustworthiness of the sustainable products they are purchasing.

Ellen (the consumer) Wants to buy coffee that is produced by processes that match her value



Analysis (data Science) - specifically

Network analysis

Behavioural change

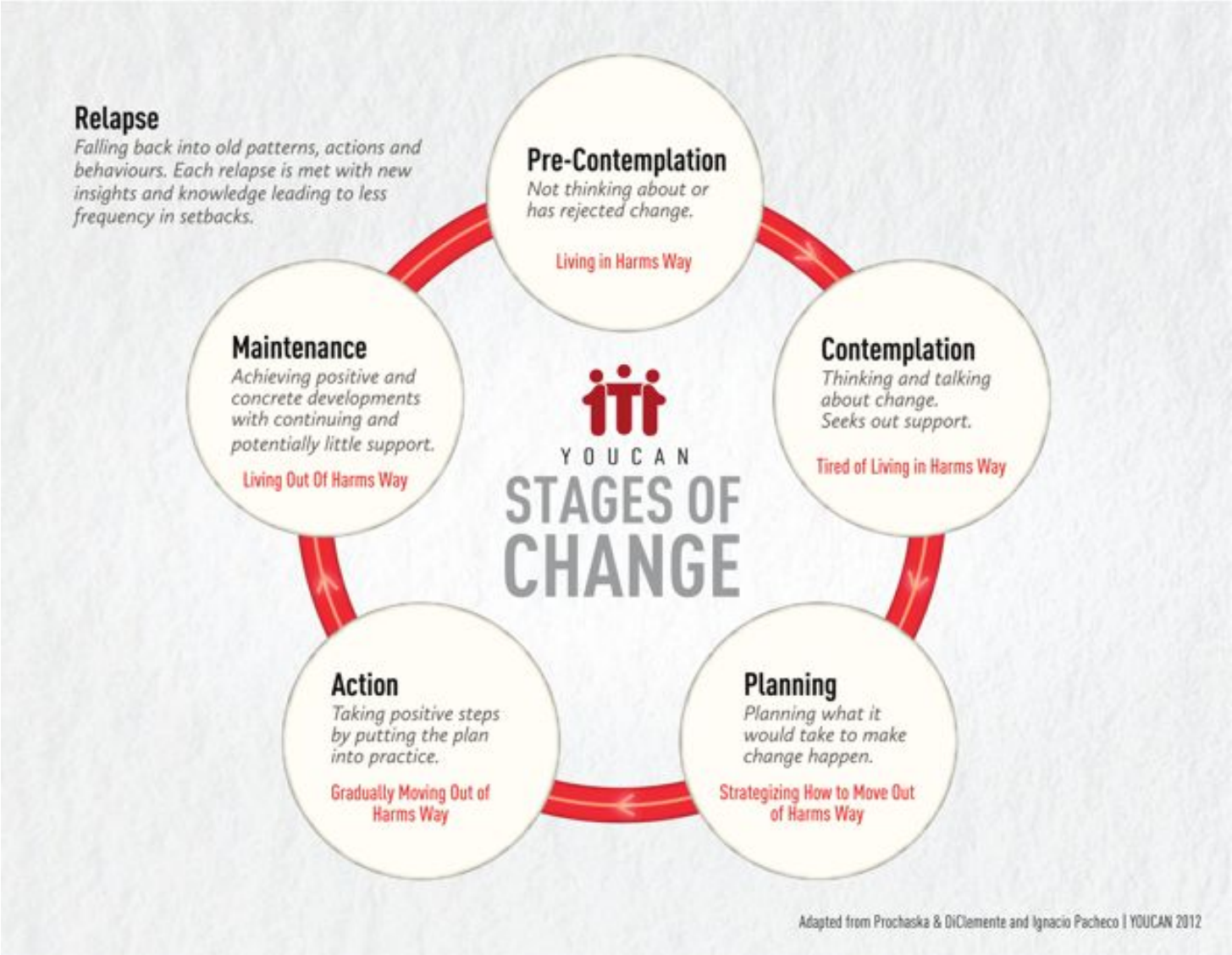
Personalising

State of change

Evaluating

Towards Evaluation

The Transtheoretical Model



The Transtheoretical Model (Prochaska & DiClemente, 1983; Prochaska, DiClemente, & Norcross, 1992)

Analysis (data Science) - specifically

Network analysis

Behavioural change

Personalising

State of change

Evaluating

Preferable future (maximising health through changing environments & behaviours)

Medical Intervention

+

Social prescribing

Government
Health Policy
Public Health

Health Information

Medicine 2.0
P4 medicine

Health Web Science
co-designing health care & Social care through engineering & designing the web

Health Web Observatory

epigenetics environment lifestyle

gender social media

genomics, medical records, etc

.

http://www.menopausematters.co.uk/

http://www.health-e-space.com/index.php?option=com_content&view=article&id=406:nappy-care-and-nappies&catid=149:postnatal&Itemid=375

http://www.toiletfinder.org/

If you build it they will come – not necessarily!

Successful
Used Worldwide
Surveys validated
Usefulness of information

Somewhat Successful
Used in N Scotland
Surveys validated
mindset changed:
Motivating factor:
Environmental
reduction in landfill

Not Successful
Not Used

Towards Evaluation

Contribution to Health Outcome - Ecosystem

P4+Cn X (iDMT) = H			
	Menopause Matters	**Health-e-Space (Nappies)**	**Toilet Finder**
Personalized	No	No	No
Preventative	Yes	No	No
Participatory	Yes	No	Yes
Predictive	No	No	No
Community			
Co-Development	Yes	Yes	Yes
Crowd Wisdom	Yes	No	Yes
App (Smart Phone)	No	No	No
Website (Desktop)	Yes	Yes	Yes
TV	No	No	No
Phone	No	No	No
Health			
Behavior	?	Yes	?
Outcome	Empowerment: Knowledge to enquire with Health Professionals	Change in Mindset: Would consider resuable diapers	Improve Psychological Well being - stop bladder leash and get people out and about
Environments	N/A	Yes: less landfill No: Energy to wash and dry	Yes (reduce urination in street)
Policy	?	Not now	Encourage local authorities to invest in public toilets
Costs	?	? Individuals save money and environment	- toilet +tourism +local economy +health improvement
STAGE OF CHANGE			
SUCCESS	Yes	Somewhat	No
LESSONS LEARNT	Information Useful	Environment values	Needs to be mobile

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Primum non nocere- medical devices
Summary

Medical Device

an instrument, apparatus, implement, machine, contrivance, implant, in vitro reagent, or other similar or related article, including a component part, or accessory which is intended to affect the structure or any function of the body of man or other animals, and which does not achieve its primary intended purposes through chemical action within or on the body of man or other animals and which is not dependent upon being metabolized for the achievement of any of its primary intended purposes

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Challenges 21st century Medicine

↑ population (9 billion 2050)

↑ageing population

↑Chronic diseases

(Long Term Conditions)

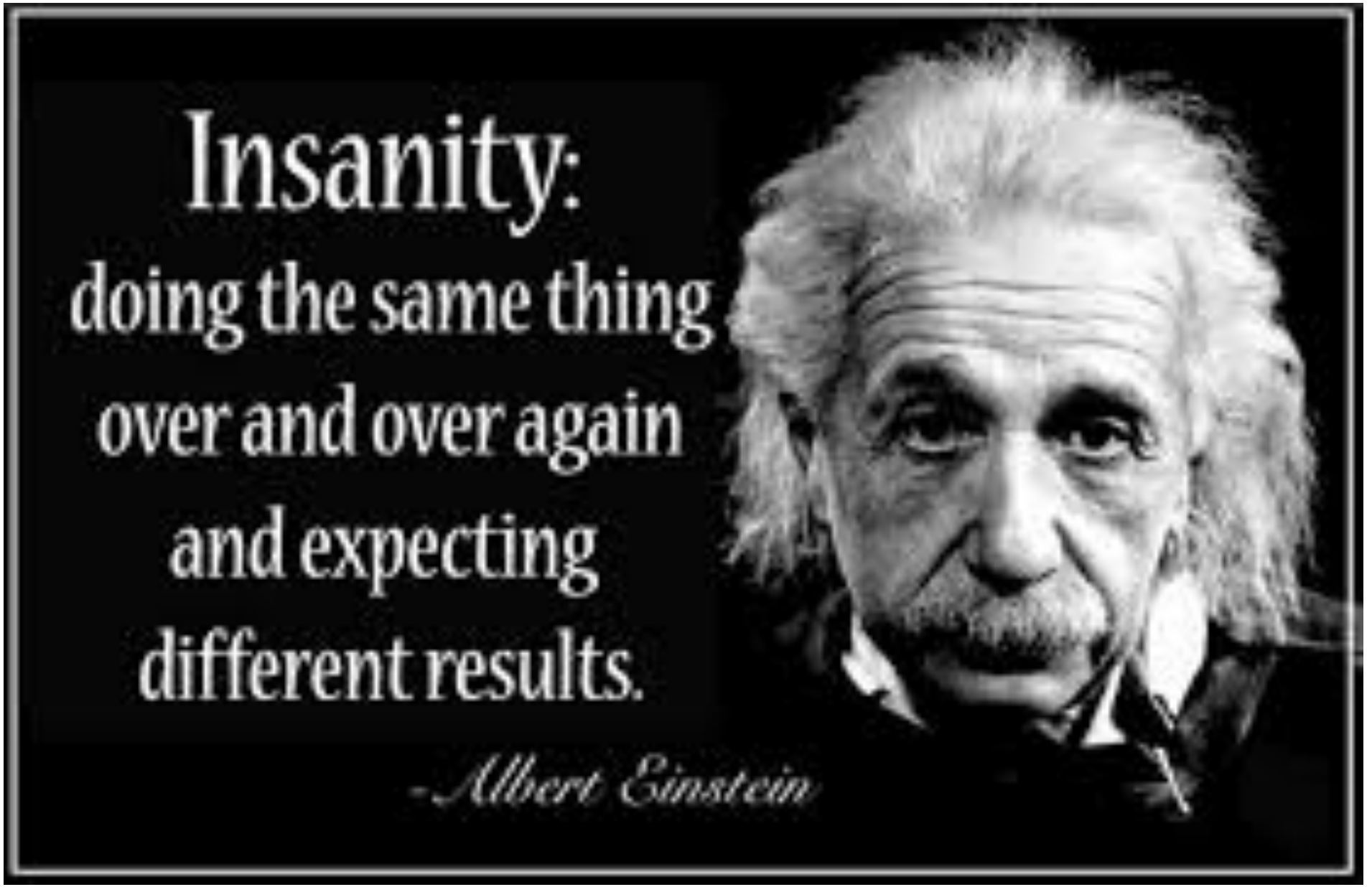
Information overload

Shortage health professionals

Climate change

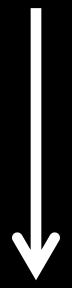
Environmental degradation

Infectious diseases (pandemics)

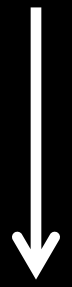

Insanity:
doing the same thing
over and over again
and expecting
different results.
-Albert Einstein

Need to change the models of health care

Have disease



Take pill



Kill something

Biomedical Model

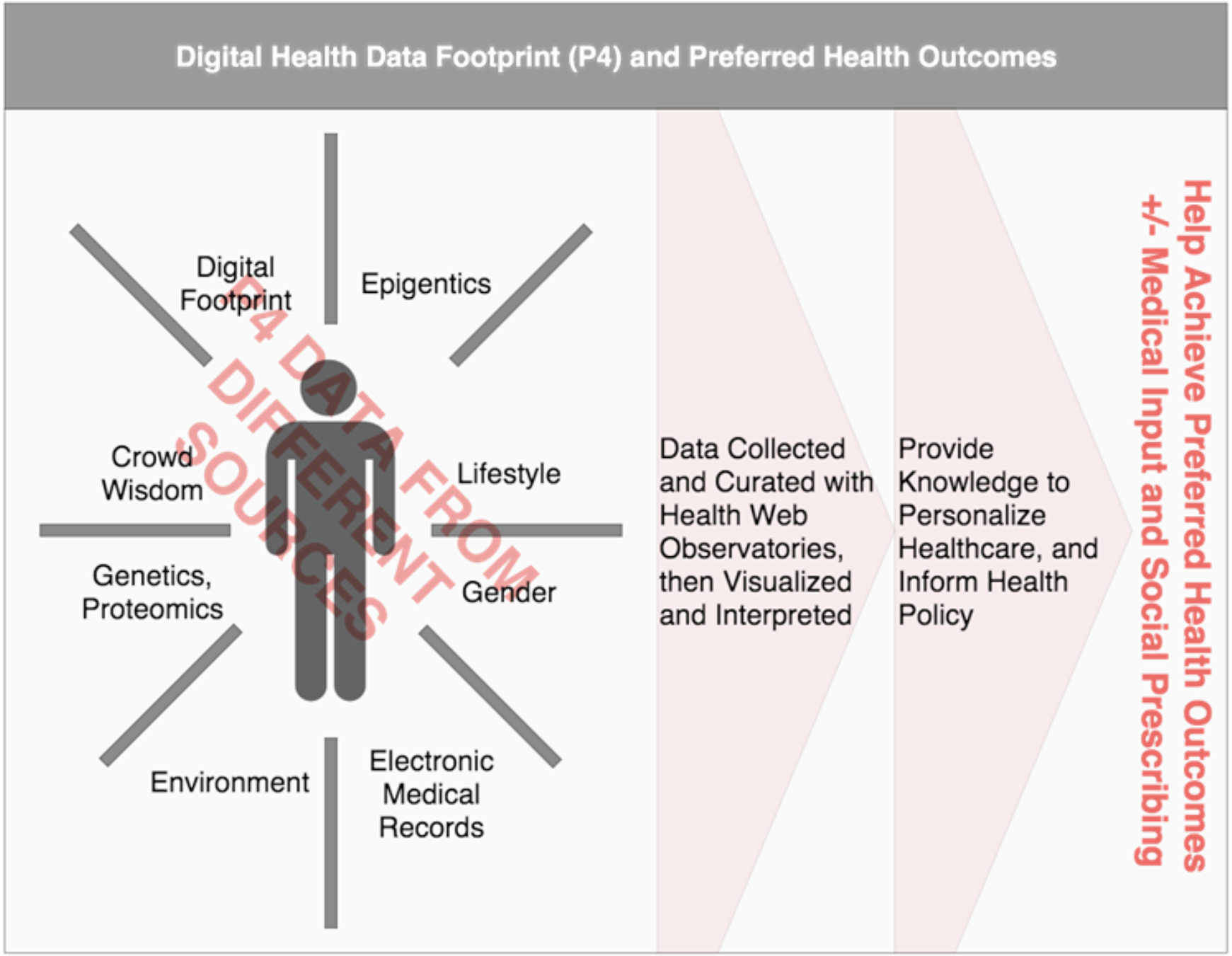
Ecological Model

↓

Changing behaviour & Environments

↓

Preferred Futures


Digital Health Data Footprint (P4) and Preferred Health Outcomes
Digital Footprint
Epigentics
Crowd Wisdom
Lifestyle
Genetics, Proteomics
Gender
Environment
Electronic Medical Records
P4 DATA FROM DIFFERENT SOURCES
Data Collected and Curated with Health Web Observatories, then Visualized and Interpreted
Provide Knowledge to Personalize Healthcare, and Inform Health Policy
Help Achieve Preferred Health Outcomes
+/- Medical Input and Social Prescribing

P4

Personalised

Preventative

Participatory

Predictive

+

C^n

Community

Co-development

Communicating

Crowd Wisdom

Co-production

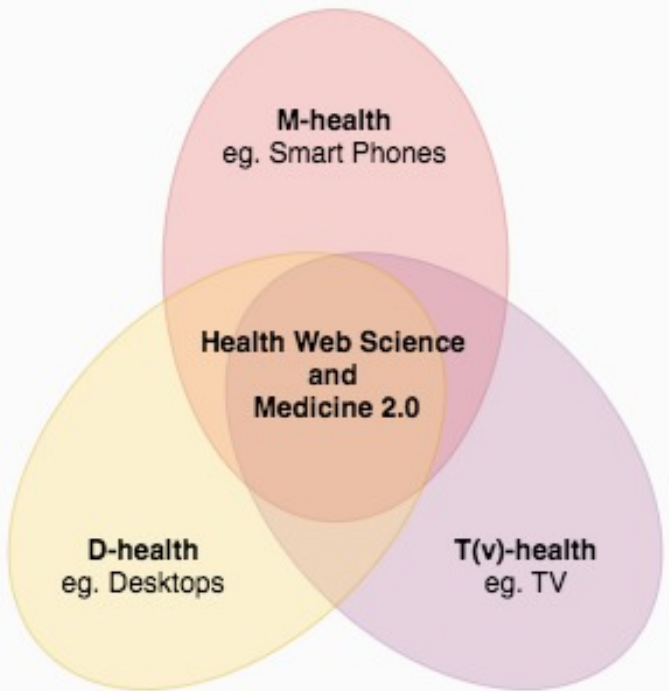
Collaborating

Co-creating

×

i-DMT

Internet Desktop Mobile Television Health



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Health

Health

behaviour

outcomes

environments

policy

costs

Knowledge is the engine of our economy- data is its fuel

2 Take Away Messages

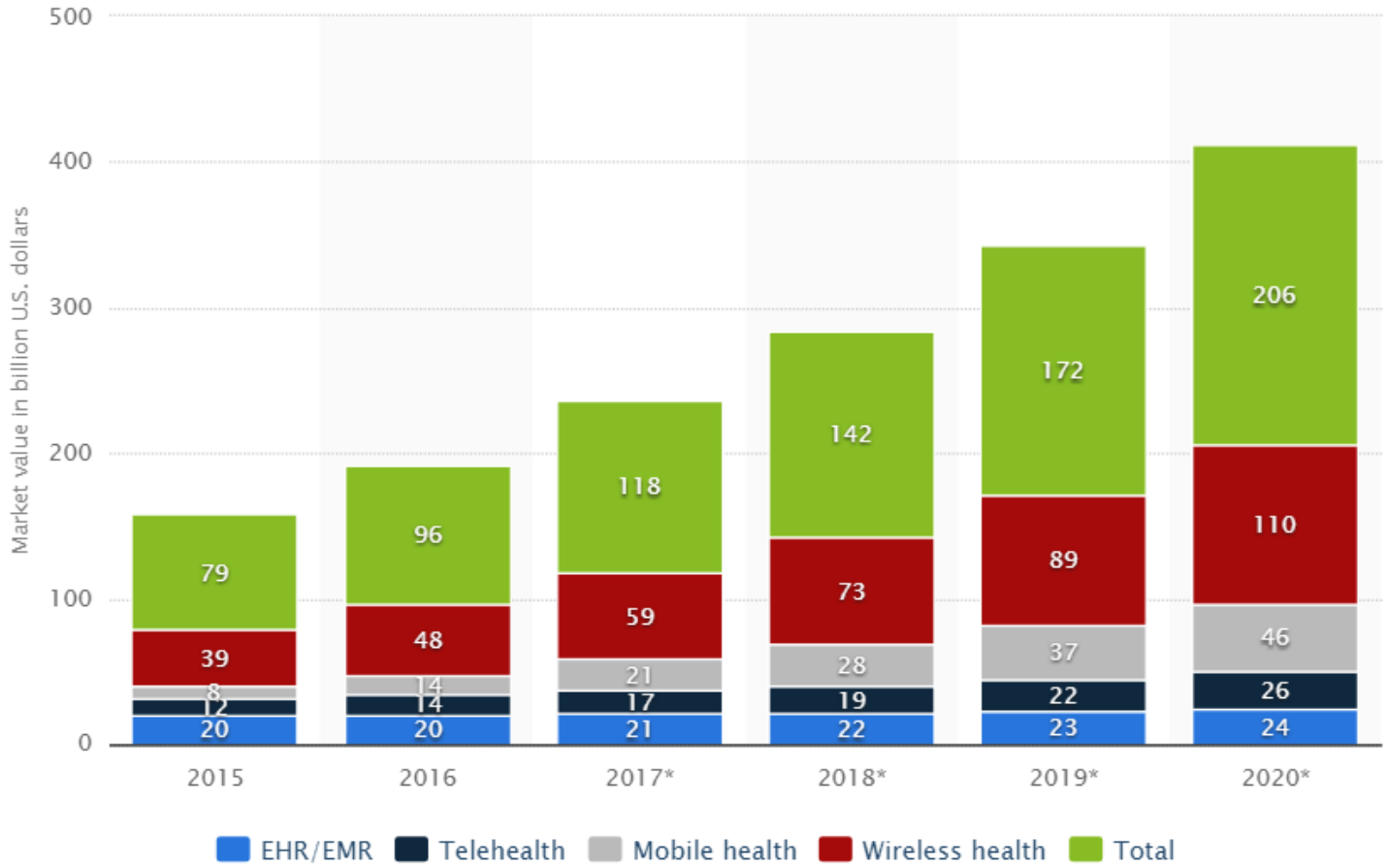
1. The Web's potential to directly benefit human health is limitless. We need to figure out how to use it.

2. Data Science research is a great opportunity for research into new tools and metrics to help evaluate & determine how to use the Web effectively to contribute to achieving preferred health outcomes.

to address and solve the particular
problems & challenges facing 21st century medicine
using Information & communication technologies
and in particular
those utilising the Web & the Internet to deliver health care

Global digital health market from 2015 to 2020, by major segment (in billion U.S. dollars)

PREMIUM +



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ABOUT THIS STATISTIC

This statistic displays the global digital health market in 2015 and 2016, and a projection for 2017 until 2020, by major segment. In 2017, the mobile health market is expected to reach 21 billon U.S. dollars worldwide. The digital health market is expected to reach 206 billion U.S. dollars by 2020, driven particularly by the mobile and wireless health market. The market in the Asia-Pacific region is expected to be a key region in the future.

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