

Ethical Machine Learning

Session #25, August 10, 2021

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Welcome

Kevin Ross

CEO, Precision
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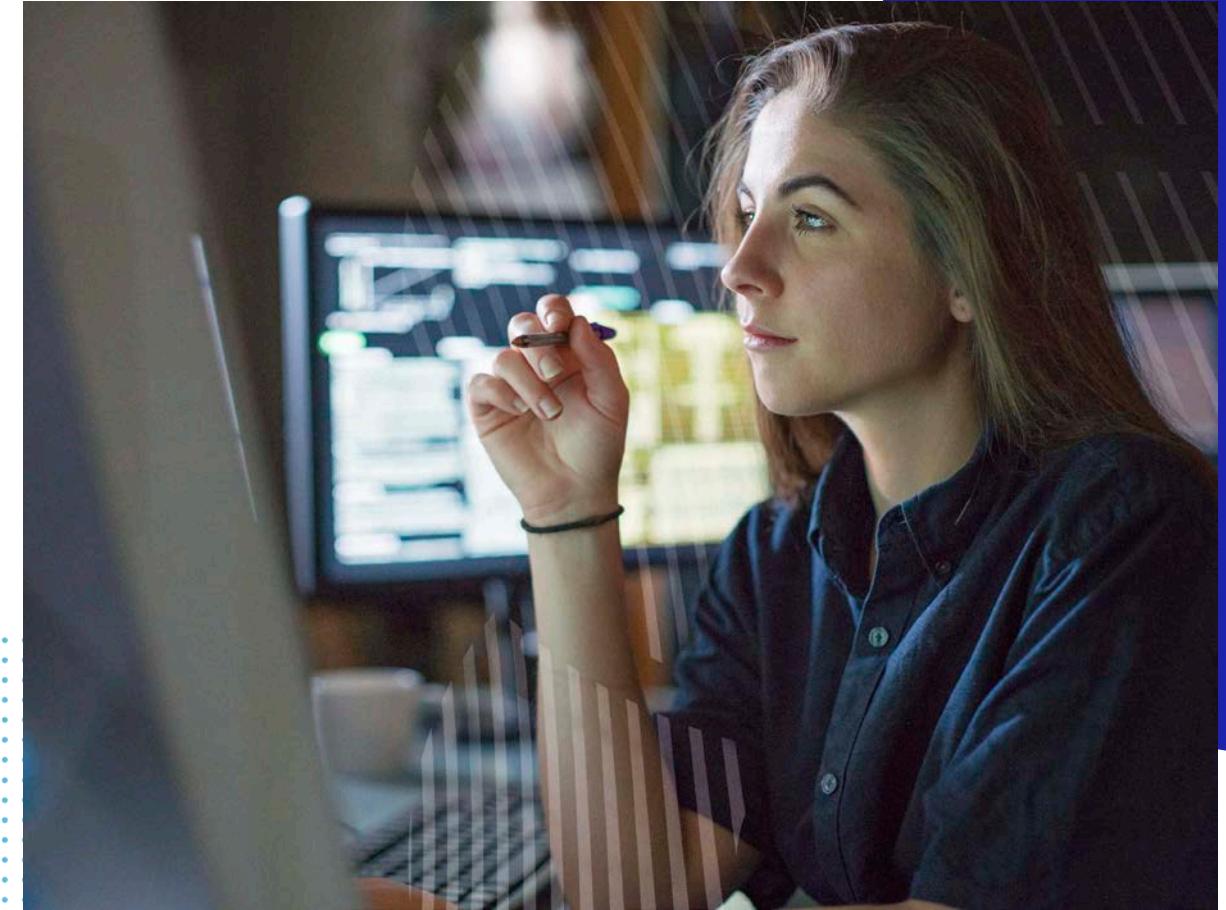
Conflict of Interest

Kevin Ross, Ph.D.

Salary: Precision Driven Health, a partnership funded by Orion Health and the New Zealand government

Agenda

1. Ethics in medicine and research
2. Medical practice today
3. Where does machine learning fit?
4. Machine learning ethics
5. Common issues
6. Guidelines and tools
7. Resources



Learning Objectives

1

Explain the main reasons why ethics is important for machine learning in health

2

Outline what appropriate ethical processes should be incorporated into machine learning design and practice

3

Illustrate the risk of ignoring ethics in machine learning models

He aha te mea nui o te ao

*What is the most important thing
in the world?*

***He tangata, he tangata, he
tangata***

*It is the people, it is the people, it
is the people.*

“



Ethical Machine Learning

Ethics

Value principles that govern a person's behaviour or the conducting of an activity

Machine Learning

Study of algorithms and statistical models that computer systems use to perform a specific task without using explicit instructions

Ethics in Medicine

Hippocratic Oath (~AD275)

I swear by Apollo the physician, and Asclepius, and Hygieia and Panacea and all the gods and goddesses as my witnesses, that, according to my ability and judgement, I will keep this Oath and this contract:

- To hold him who taught me this art equally dear to me as my parents, to be a partner in life with him, and to fulfill his needs when required; to look upon his offspring as equals to my own siblings, and to teach them this art, if they shall wish to learn it, without fee or contract; and that by the set rules, lectures, and every other mode of instruction, I will impart a knowledge of the art to my own sons, and those of my teachers, and to students bound by this contract and having sworn this Oath to the law of medicine, but to no others.
- I will use those dietary regimens which will benefit my patients according to my greatest ability and judgement, and **I WILL DO NO HARM** or injustice to them.
- I will not give a lethal drug to anyone if I am asked, nor will I advise such a plan; and similarly I will not give a woman a pessary to cause an abortion.
- In purity and according to divine law will I carry out my life and my art.
- I will not use the knife, even upon those suffering from stones, but I will leave this to those who are trained in this craft.
- Into whatever homes I go, I will enter them for the benefit of the sick, avoiding any voluntary act of impropriety or corruption, including the seduction of women or men, whether they are free men or slaves.
- **WHATEVER I SEE OR HEAR IN THE LIVES OF MY PATIENTS,** whether in connection with my professional practice or not, which ought not to be spoken of outside, I will keep secret, as **CONSIDERING ALL SUCH THINGS TO BE PRIVATE.**
- So long as I maintain this Oath faithfully and without corruption, may it be granted to me to partake of life fully and the practice of my art, **GAINING THE RESPECT OF ALL MEN FOR ALL TIME.** However, should I transgress this Oath and violate it, may the opposite be my fate.

“

The health of my patient will be my first consideration

The Declaration of Geneva of the WMA

A physician shall act in the patient' best interest when providing medical care

International Code of Medical Ethics

Ethical challenges are not new to healthcare



Financial

- Managing healthcare based on cost and on risk of malpractice lawsuits
- Accepting money from pharmaceutical or device manufacturers
- Upcoding to get treatment covered



Social / Reputational

- Reporting an impaired colleague
- Getting romantically involved with a patient or family member
- Sharing patient information
- Cherry-picking patients



Clinical

- Prescribing a placebo
- Covering up a mistake
- Eligibility for clinical trials
- Consent to treat

Four basic principles of medical ethics

1

Autonomy

autonomy of thought when patients make healthcare decisions

2

Justice

fair distribution of scarce resources, competing needs, rights and obligations, and potential conflicts with established legislation

3

Beneficence

the intent of doing good for the patient involved

4

Non-maleficence

does not harm the patient involved or others in society

Ethics in Research

Research Ethics

- Honesty
- Objectivity
- Integrity
- Carefulness
- Openness
- Respect for Intellectual Property
- Confidentiality
- Responsible Publication
- Responsible Mentoring
- Respect for colleagues
- Social Responsibility
- Non-Discrimination
- Competence
- Legality
- Animal Care
- Human Subjects Protection



Medical practice today



PNAS

Proceedings of the
National Academy of Sciences
of the United States of America

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NEW RESEARCH IN

Physical Sciences

Social Sciences

RESEARCH ARTICLE

Patient–physician gender concordance and increased mortality among female heart attack patients

Brad N. Greenwood, Seth Carnahan, and Laura Huang

PNAS August 21, 2018 115 (34) 8569–8574; first published August 6, 2018 <https://doi.org/10.1073/pnas.1800097115>

Edited by Michael Roach, Cornell University, Ithaca, NY, and accepted by Editorial Board Member Mary C. Waters July 3, 2018 (received for review January 3, 2018)



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JOURNAL OF CLINICAL ONCOLOGY

Health Care Segregation, Physician Recommendation, and Racial Disparities in *BRCA1/2* Testing Among Women With Breast Cancer

Anne Marie McCarthy, Mirar Bristol, [...], and Katrina Armstrong

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Diversity in Clinical and Biomedical Research: A Promise Yet to Be Fulfilled

Sam S. Oh, Joshua Galanter, Neeta Thakur, Maria Pino-Yanes, Nicolas E. Barcelo, Marquitta J. White, Danielle M. de Bruin, Ruth M. Greenblatt, Kirsten Bibbins-Domingo, Alan H. B. Wu, Luisa N. Borrell, Chris Gunter, Neil R. Powe , Esteban G. Burchard

Published: December 15, 2015 • <https://doi.org/10.1371/journal.pmed.1001918> • >> See the preprint

Comment | Published: 13 January 2020

Treating health disparities with artificial intelligence

Irene Y. Chen , Shalmali Joshi & Marzyeh Ghassemi

Nature Medicine 26, 16–17(2020) | [Cite this article](#)

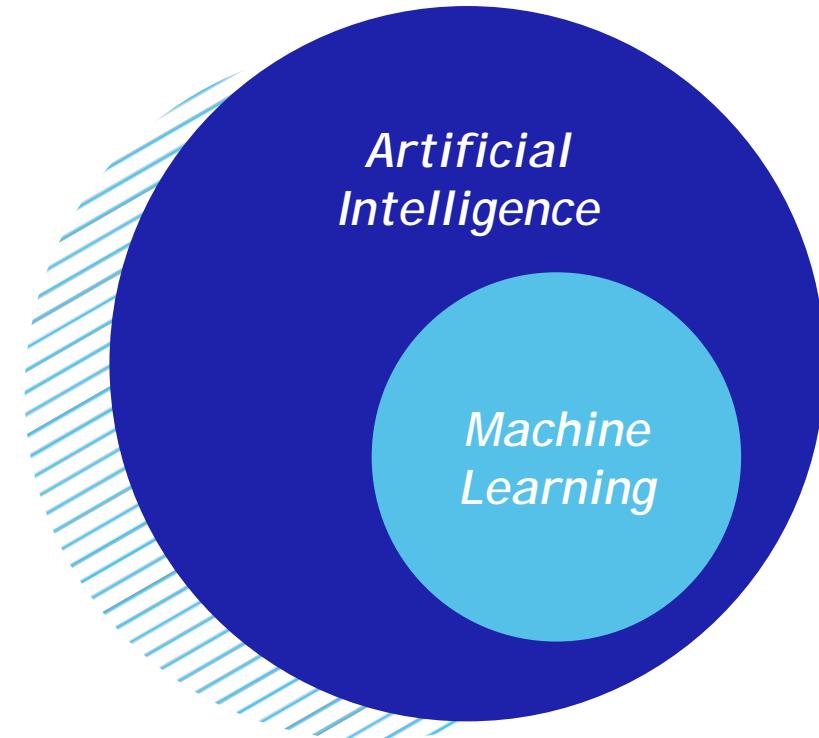
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Healthcare is an imperfect practice, with disparities in care reflecting those in society. While algorithms may be misued to amplify biases, they may also be used to identify and correct disparities.

What is machine learning?



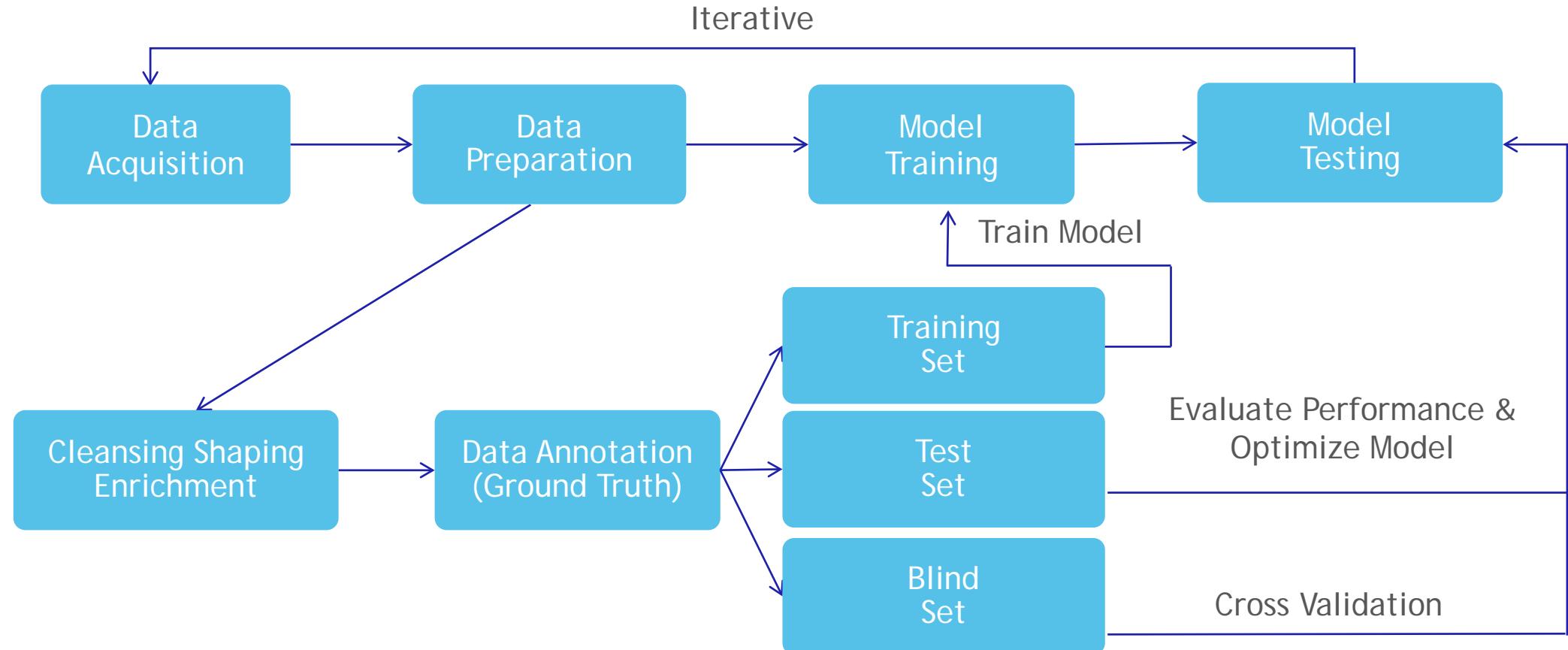
Machine Learning is a subset of Artificial Intelligence



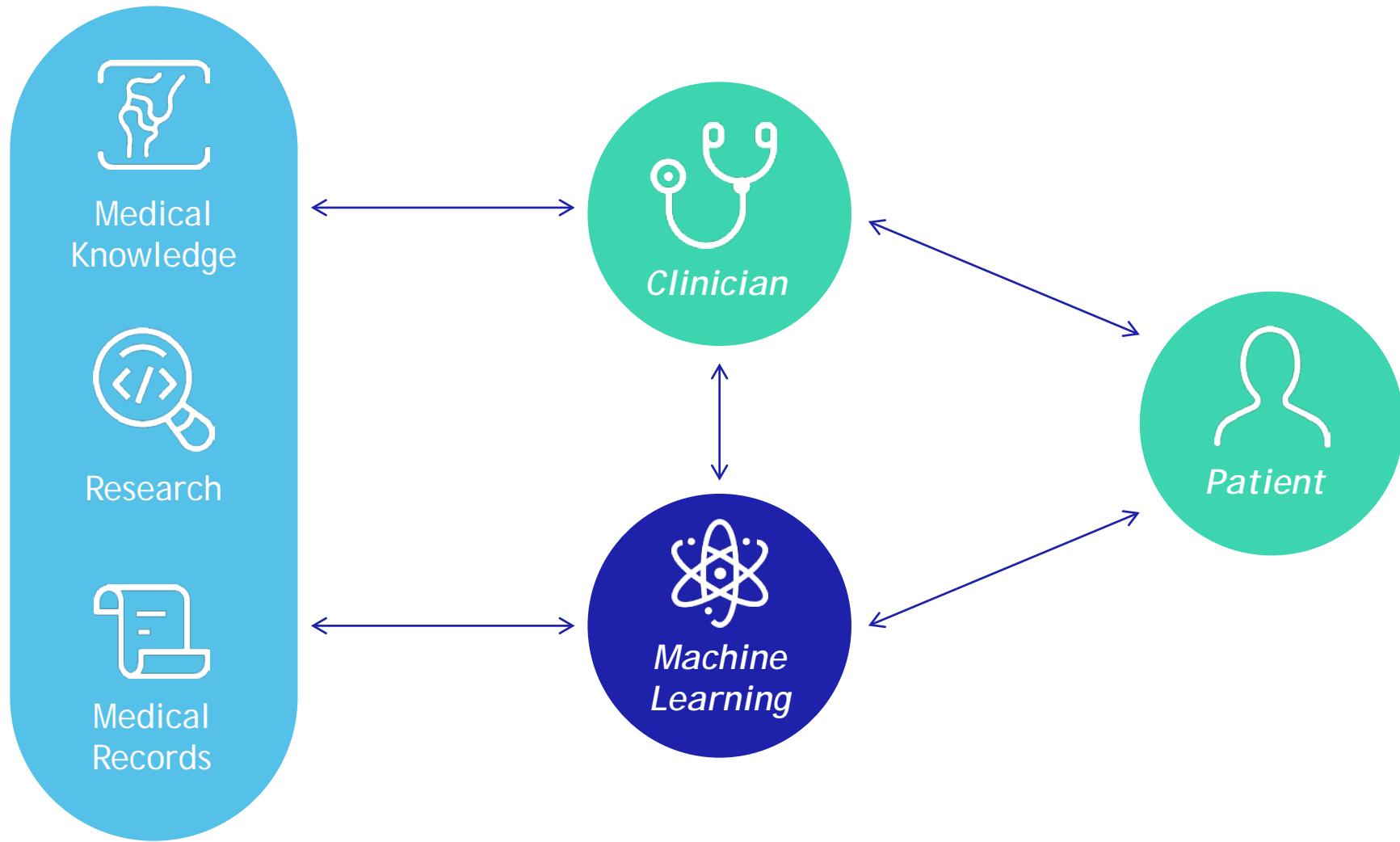
The study of algorithms and statistical models that computer systems use to perform a specific task without using explicit instructions.



Machine Learning model development process



The role of Machine Learning in health





*The goal is
augmented
intelligence*

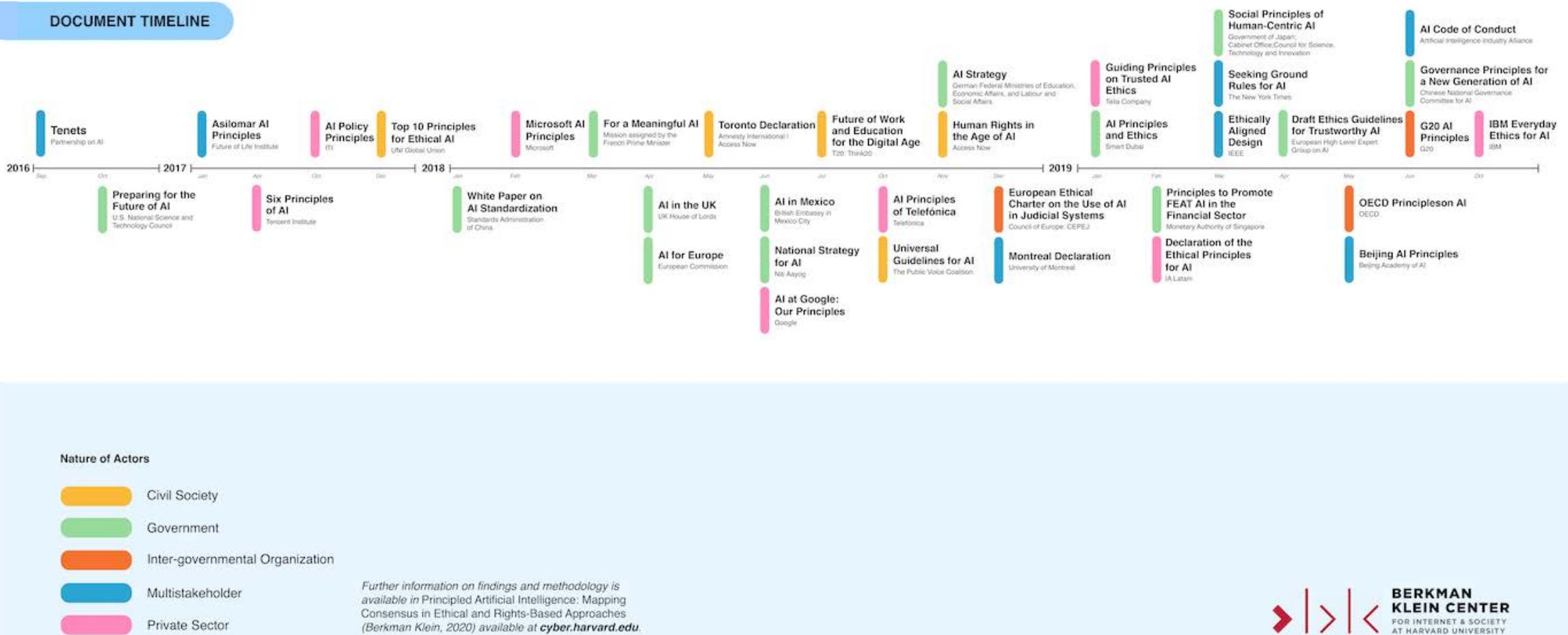
- Humans are good at some areas that computers never will be - empathy, emotional intelligence, moral judgement, complex associations
- Computers are good at areas we never will be - calculations, data processing at scale

Ethics in machine learning

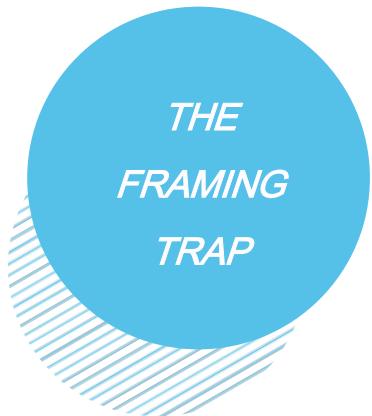


PRINCIPLED ARTIFICIAL INTELLIGENCE

A Map of Ethical and Rights-Based Approaches to Principles for AI



WHO – Five Traps



The context for the problem to be solved is too narrow and limited.



taking solutions developed in one context and to apply them blindly in another context



people must understand why a certain outcome or decision has been taken, the option to appeal and the option for representation, even if the decision that is taken is the appropriate one.



inappropriate, ineffective or inefficient uses of the technology in a setting where it is not needed or is counterproductive



Failure to consider all the possible consequences that may emerge from its introduction.

Core Principles

-  *Generates net benefits*
-  *Do no harm*
-  *Regulatory and legal compliance*
-  *Privacy protection*
-  *Fairness*
-  *Transparency and explainability*
-  *Contestability*
-  *Accountability*

Applicable Law in USA

- **Federal Food, Drug, and Cosmetic Act (FDCA):** The FDA enforces the FDCA, which regulates the safety and effectiveness of drugs and medical devices, including certain forms of medical software.
- **Health Insurance Portability and Accountability Act (HIPAA):** In addition to the Privacy Rule (below) HIPAA authorizes the U.S. Department of Health & Human Services (HHS) to enforce the Security Rule. These rules create privacy and security requirements for certain health information. The HIPAA Breach Notification Rule also requires certain entities to provide notifications of health information breaches.
- **Common Rule:** The Common Rule sets requirements for research on human subjects that either is federally funded or, in many instances, takes place at institutions that receive any federal research funding
- **Federal Trade Commission Act (FTCA):** The FTCA prohibits deceptive and unfair trade practices affecting interstate commerce. These could include acts relating to false and misleading health claims, representations regarding a piece of software's performance, or claims affecting consumer privacy and data security. Health care AI products may raise any of these types of claims.
- **FTC Health Breach Notification Rule:** This FTC rule, separate from HIPAA's Breach Notification Rule, requires certain businesses to provide notifications to consumers after a breach of personal health record information, including information that may be collected to train, validate, or use health care AI systems.
- **State tort law:** When one individual or entity injures another, tort law may allow the injured individual to recover damages. Injury could result from the use of health care AI systems, including when the behavior of developers, providers, hospitals, or other health care actors falls below the standard of care. State law determines the applicable standard of care and when tort liability will exist.

TABLE 7-1 | Typical applicability of various laws and regulations to U.S. health care AI systems
 SOURCE: Developed by authors

Clinical Urgency	Type of health care AI system	Description	Common Rule	HIPAA/ Office of Civil Rights	FTC	FDCA	Liability
	Research	AI intended to assist human subjects research	X	X	X		
	Operations	AI that is used to enhance clinical operations, such as patient management, scheduling, and physician documentation		X	X		
	General health and wellness	AI that is used by consumers for entertainment		X	X		
	Clinical: mobile engagement; health and wellness; medical device data systems	AI that is used by consumers for entertainment AI in certain categories for which FDA has announced that it does not intend to enforce FDCA requirements		X	X	*	X
	Direct-to-consumer	AI that is marketed directly to consumers and constitutes a medical device		X	X	X	X
	Clinical: informing clinical management	AI that assists physicians by informing, enhancing, aggregating, and verifying information		X	X	X	X
	Clinical: driving clinical management	AI that assists physicians by giving treatment, diagnosis, or screening advice, while relying on physician interpretation of said advice to direct patient care		X	X	X	X
	Clinical: treating or diagnosing	Autonomous AI that provides treatment or diagnoses, screens, disease without physician interpretation		X	X	X	X

NOTE: An X indicates that AI systems with the indicated function are likely subject to the legal regime listed. * Although FDA has the authority to regulate software in this category, it has announced that it will exercise enforcement discretion and will generally not apply the requirements of the FDCA to such products.

Some good advice



Beware of marketing hype, but recognize real opportunities.



Seek out robust evaluations of model performance, utility, vulnerabilities, and bias.



Respective effort should be deliberately allocated to identify, mitigate, and correct biases in decision-making tools.



Demand transparency in data collection and algorithm evaluation processes.



Develop AI systems with adversaries (bad actors) in mind.



Prioritize education reform and workforce development.



Identify synergy rather than replacement.



Use AI systems to engage, rather than stifle, uniquely human abilities.



Use automated systems to reach patients where existing health systems do not.

Key Considerations in Model Development

- What will the downstream interventions be?
- Who is the target user of the model's output?
- What are the mechanics of executing the intervention?
- What is the risk of failure and adverse events?
- What is the capacity to intervene given existing resources?
- What accuracy is needed, and are false positives or negatives less desirable?
- What is the desired outcome change following intervention?

Case Study: New Zealand's COVID19 response



New Zealand Algorithm Hub

- National algorithm management solution - the New Zealand Algorithm Hub.
- Six-month initiative to implement use cases supporting NZ's pandemic response.
- National central repository for algorithms and models for NZ.

[Asia Pacific Population Health](#)

COVID-19: Orion Health to deliver national algorithm hub in New Zealand

The concept for the New Zealand Algorithm Hub was initially developed through the Precision Driven Health research partnership between Orion Health and partners.

By [Dean Koh](#) | May 21, 2020 | 12:01 AM



New Zealand-based healthcare software company Orion Health announced this week that it will deliver a free national solution to support scenario modelling, risk prediction, forecasting and planning throughout New Zealand's COVID-19 response.

COVID19 spread scenario models

Short and long-term scenarios using the stochastic individual based models from Plank et. al. (2020).



The screenshot shows a white header with the Te Pūnaha Matatini logo and navigation links for Home, About Us, and Our Research. Below the header, a large title reads "Modelling COVID-19 spread and the effects of Alert Level 4 in New Zealand". A smaller link below it says "Science Policy". At the bottom, there's a dark banner with the text "COVID-19: New Research".

Inputs

Key inputs for these models include:

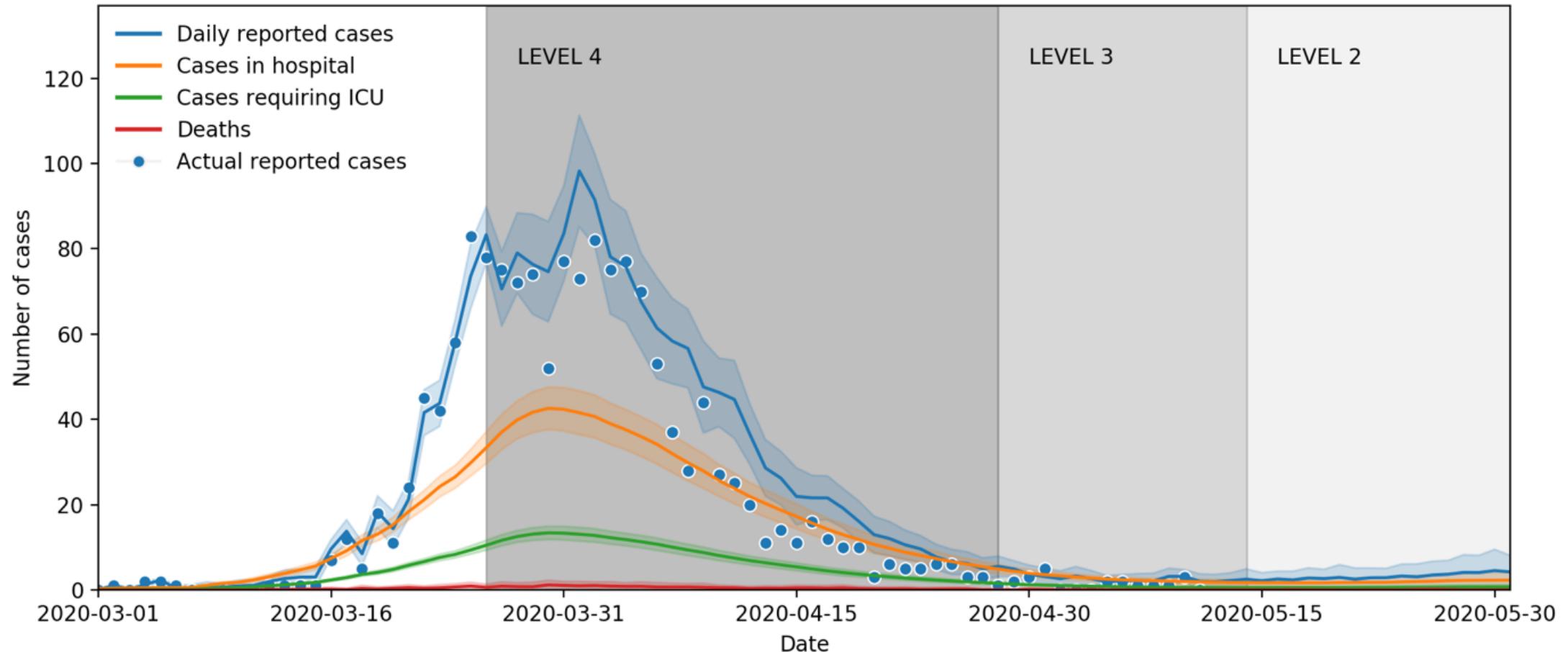
- Initial cases
- Population profile
- Reproduction rates
- Length of infectious and symptomatic periods
- Estimated rates for hospitalisation, cases requiring ICU, subclinical infections and infection fatality rates
- Current ICU capacity
- Effectiveness of control measures at reducing transmission
- Case isolation

These input parameters are reviewed by the team weekly using:

- New case information
- Global academic research
- Other evidence services
- Scenario simulations

National modelling update

Realistic scenarios for short-term observations



Algorithm Hub Goverance



Kevin Ross
Chair



Frith Tweedie
Legal, Privacy



Tim Dare
Ethics



Gill Dobbie
Data Science



Daniel Wilson
Māori Interests



Juliet Rumball-Smith
Public Health Specialist



Alex Kazeml
Clinical Practice



Vince Galvin
All of Govt



Judy Blakey
Consumer

Frequently discussed questions

- Is an algorithm proposed to be used at an individual patient level?
- Is this model appropriate for use in New Zealand?
- Is ethnicity included as an independent variable in a model or algorithm?
- Are we clear on current practices/the status quo? What is the rationale for this model?
- Is the model being communicated in a manner that is clear and transparent?
- What constitutes evidence for social license?
- How do we illustrate relative risk, attribution?



Common issues



gettyimages®
Tero Vesalainen

Consent

Consent is required to treat,
but also for data sharing



Bias

PROBAST tool to assess risk of bias in prediction models, can aid algorithm developers in selecting representative training sets and appropriate predictions



Explainability

Do we need to explain our models?



Diversity, Indigenous Rights



Codifying Moral Values

How do we make trade-offs?



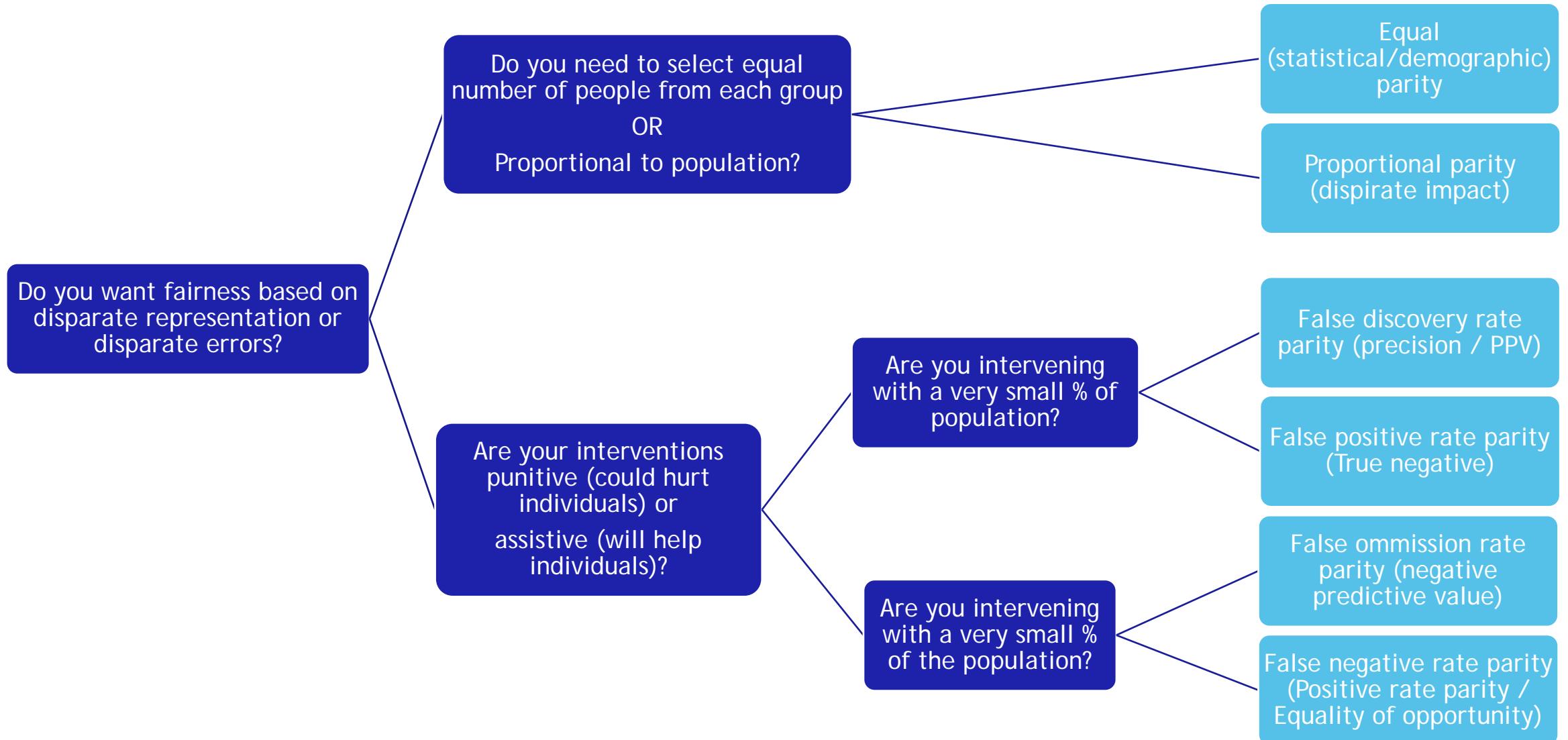
Ethical machine learning toolkit

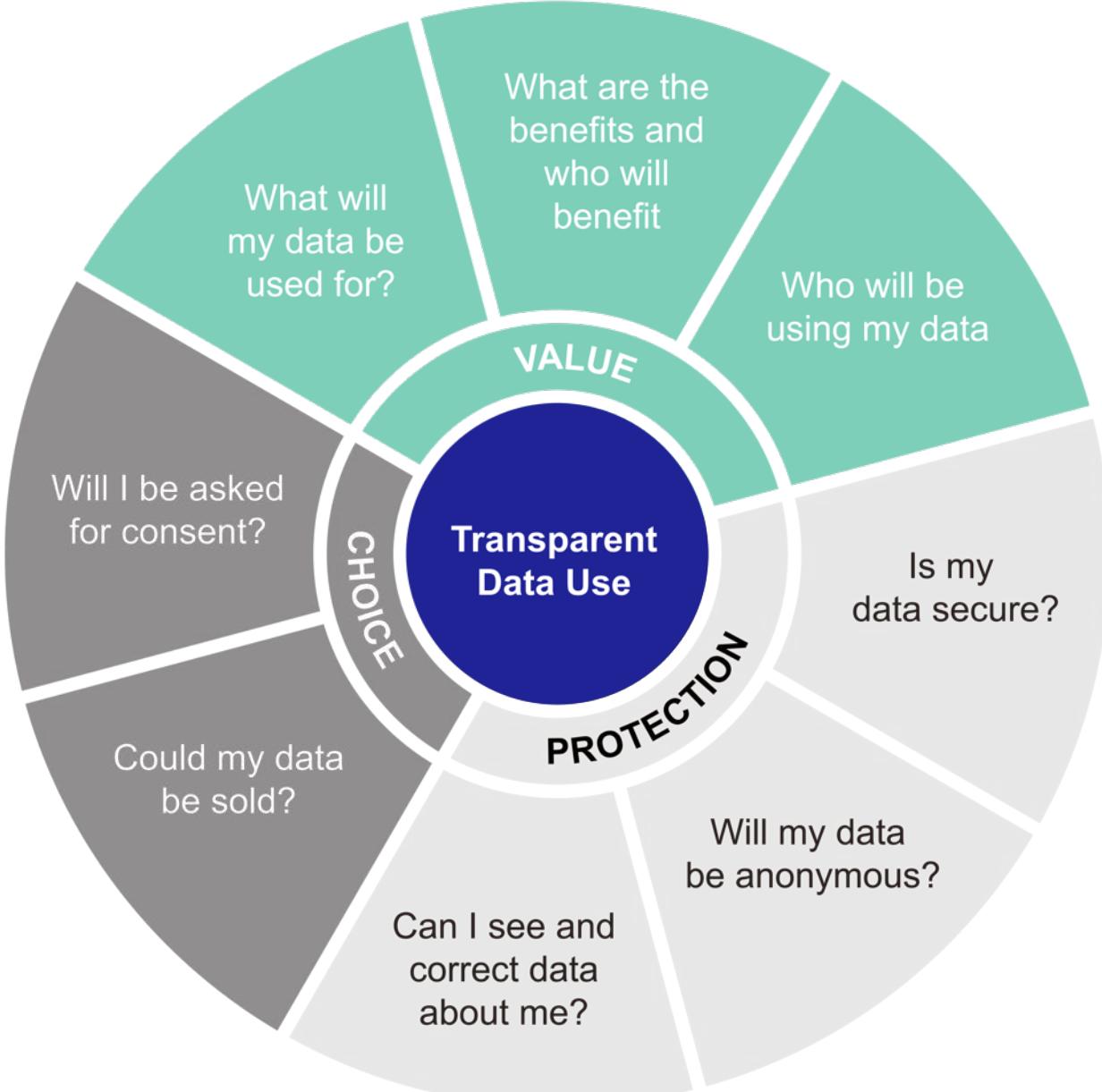


Toolkit for ethical AI

-  *Impact assessments*
-  *Internal or external review*
-  *Risk assessment*
-  *Best practice guidelines*
-  *Industry standards*
-  *Collaboration*
-  *Monitoring and Improvement mechanisms*
-  *Recourse mechanisms*
-  *Consultation*

Fairness tree – which measures matter?





“

The machine is only a tool after all, which can help humanity progress faster by taking some of the burdens of calculations and interpretations off its back. The task of the human brain remains what it has always been; that of discovering new data to be analyzed, and of devising new concepts to be tested.

Isaac Asimov

I, Robot

References

- Courses, talks and books including Coursera and TEDx
- WHO guidance, EU and Australian frameworks
- White House Principles
- Global principles and guidelines
- New Zealand charter and ethics

Full list and links

www.precisiondrivenhealth.com/ethics



Questions

Kevin Ross

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