Innovative technologies to leverage health financing for UHC

Advanced analytics to inform public health decision making

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Overview

Innovative technologies to leverage health financing for UHC

- What is advanced analytics?
- How is the tech changing?

- How is it being used to inform public health decision making?
- What are opportunities and challenges for the future?

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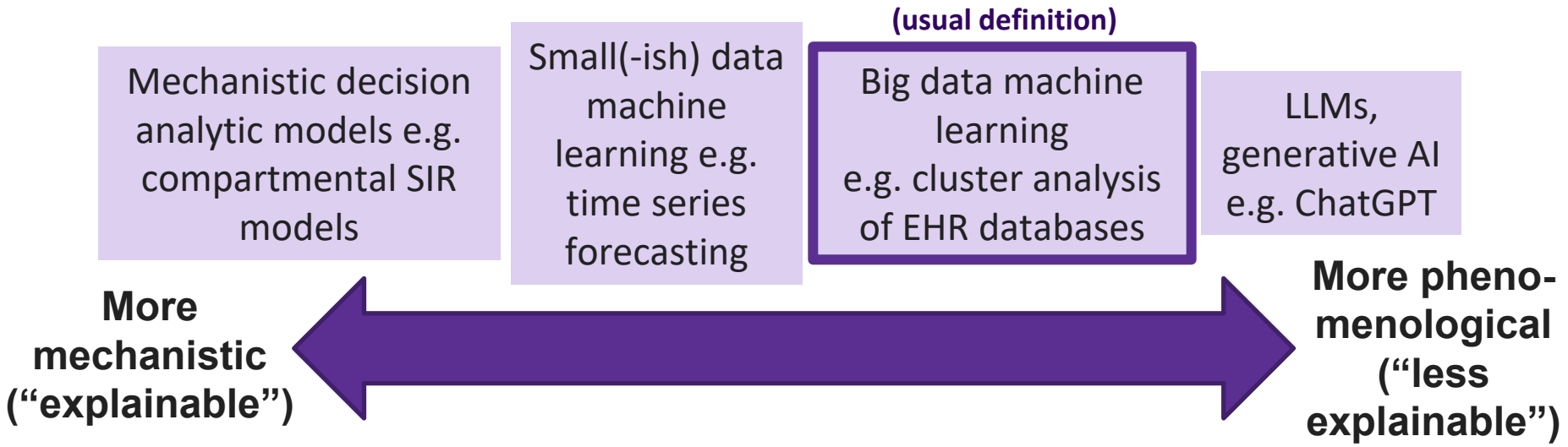
What is advanced analytics?

Advanced analytics is the use of data-driven mathematical, statistical and computational models to make projections and/or inform decision-making.



Advanced analytics in public health decision making

Evidence

Virology, immunology
Field epidemiology
Advanced analytics

Health economics
Implementation science
Attitudinal research

WHO Strategic Group of Experts on Immunization (SAGE) meeting, October 2018. https://www.who.int/immunization/policy/sage/fr/

Deliberative process

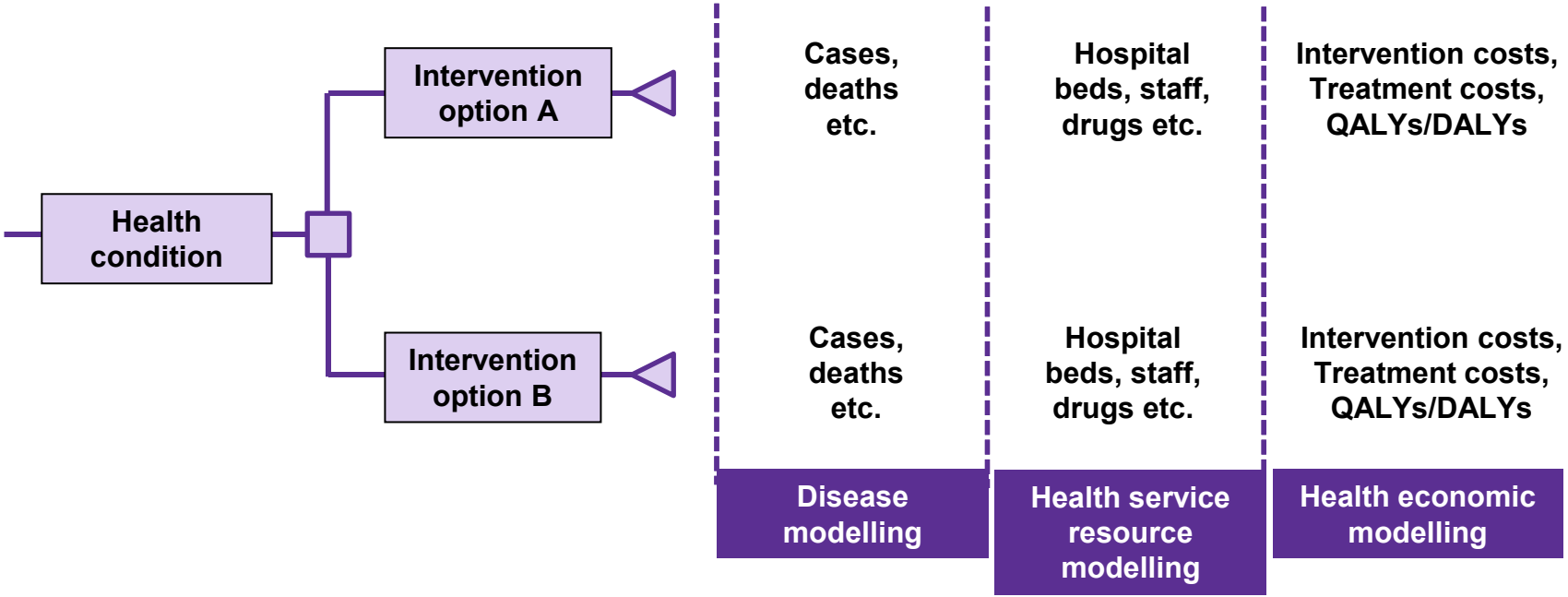
Fair, transparent, legitimate

Experts (multiple disciplines)
Healthcare delivery staff
Patients, the public

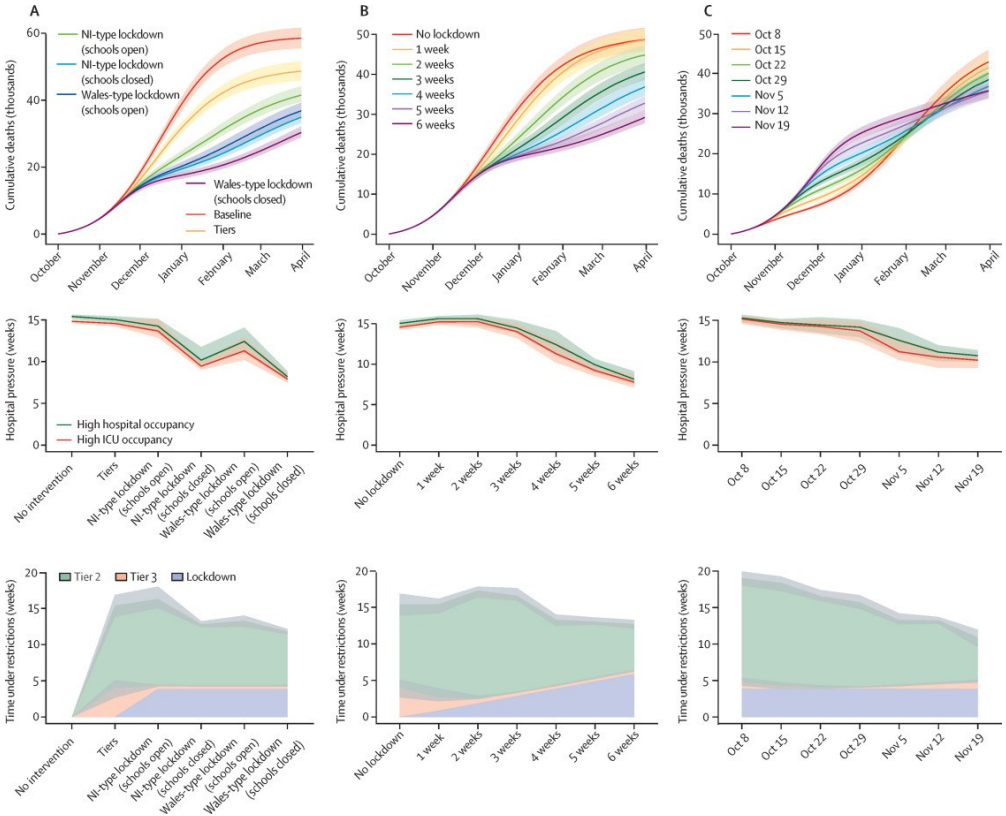
Advisory Committee on Immunization Practice (ACIP) meeting, US CDC. https://www.cdc.gov/vaccines/acip/index.html

Final decision by legitimate decision makers (e.g. Ministers)

Example 1: Decision analytic modelling to guide health technology assessment



Example 2: Modelling to guide pandemic response



Davies N et al. Association of tiered restrictions and a second lockdown with COVID-19 deaths and hospital admissions in England: a modelling study. *Lancet Infect Dis* 2021; 21(4):482-492. doi: 10.1016/S1473-3099(20)30984-1

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Example 3: machine learning in health financing

	Supervised learning				Unsupervised learning	
Application	**Classifi-cation**	**Variable selection**	**Regression**	**Prediction**	**Clustering**	**Outlier detection**
Forecasting health expenditure	√	√	√	√		
Assessing health risks in a pool		√	√			
Claims review, fraud detection	√				√	√
Design/revision of payments	No information					
Provider performance	No information					
Claims analysis to design benefits			√	√	√	
Identifying beneficiaries	√	√	√		√	
Beneficiary enrolment	√					

Adapted from a review paper: Mathauer and Oranje. Machine learning in health financing: benefits, risks and regulatory needs. Bull World Health Organ. 2024 Mar 1;102(3):216-224. doi: 10.2471/BLT.23.290333.

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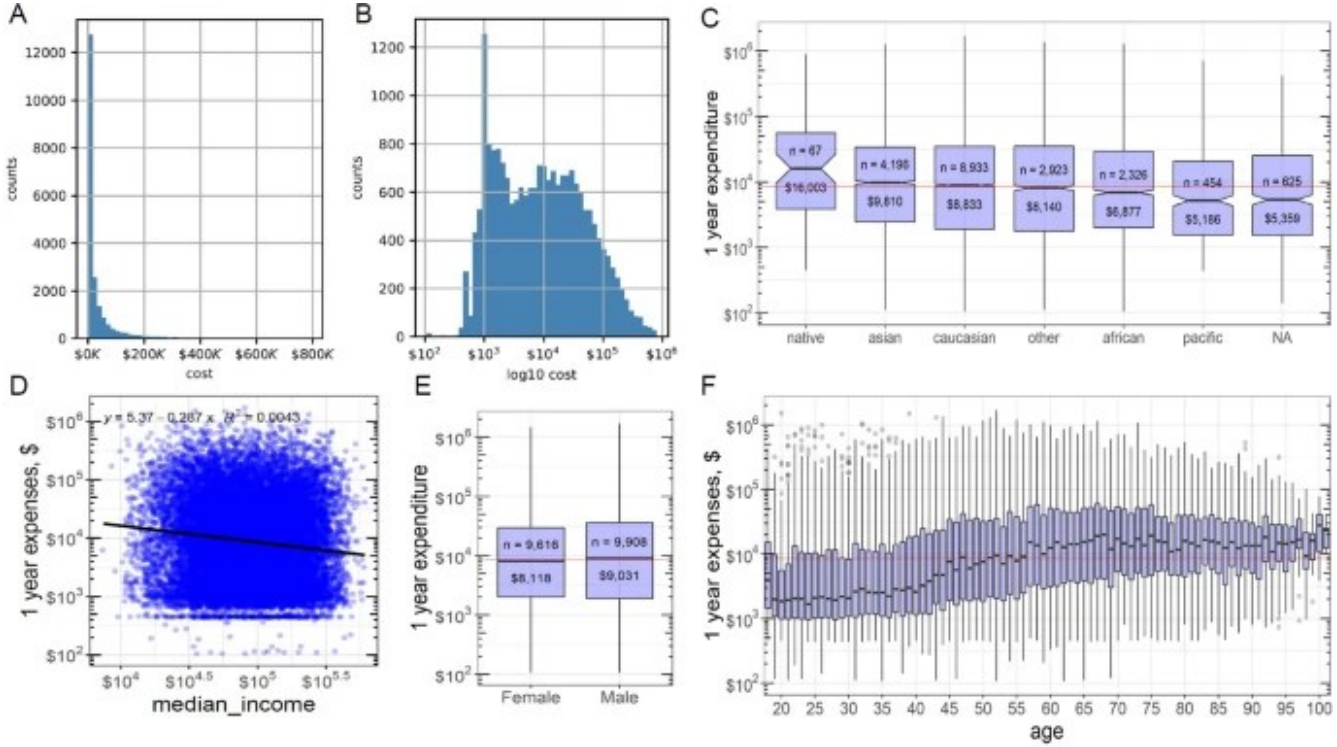
Example 3: machine learning in health financing



Sohn et al. Prediction of future healthcare expenses of patients from chest radiographs using deep learning: a pilot study. *Sci Rep* 2022; 12(1):8344. doi: 10.1038/s41598-022-12551-4.

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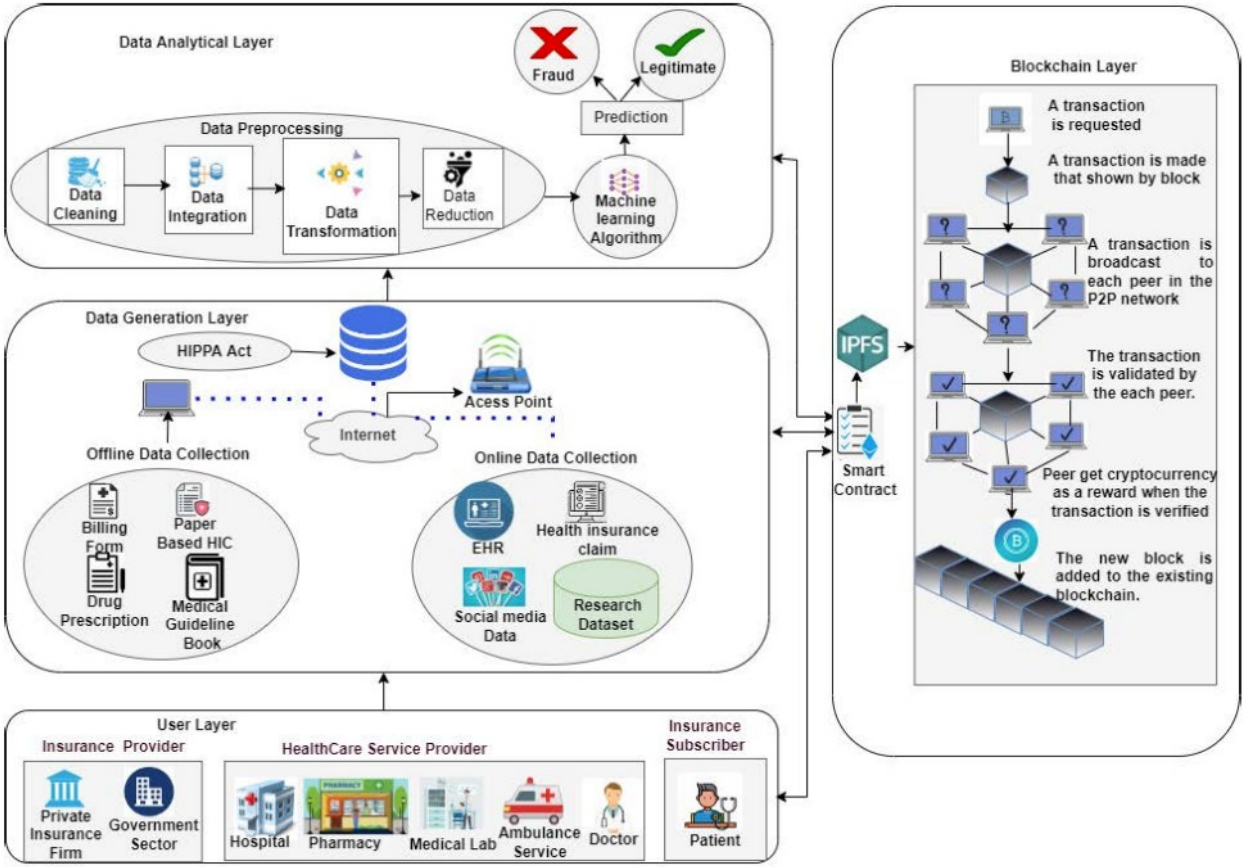
Example 3: machine learning in health financing



Blockchain and AI for healthcare insurance fraud detection

Kapadiya K et al. Blockchain and AI-empowered Healthcare Insurance Fraud Detection: An Analysis, Architecture, and Future Prospects. IEEE Access 2022: 10. https://doi.org/10.1109/ACCESS.2022.3194569

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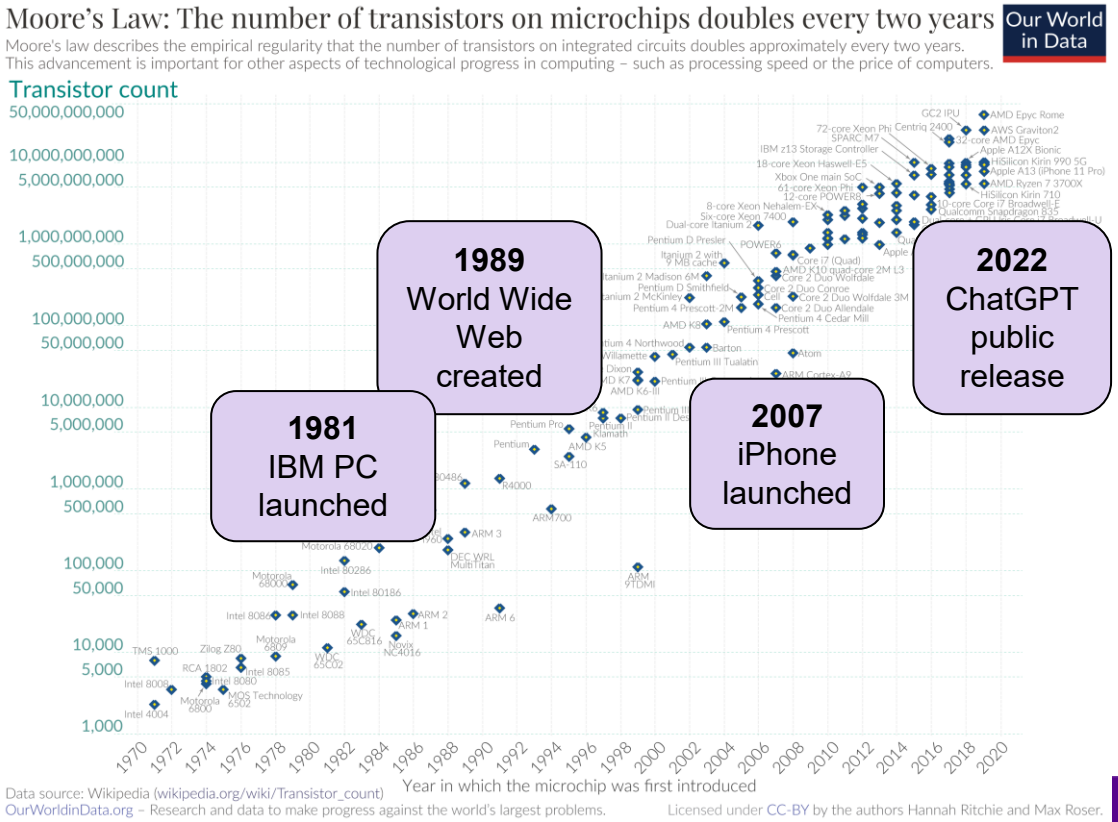
What is changing? Moore's law



https://assets.ourworldindata.org/uploads/2020/11/Transistor-Count-over-time.png

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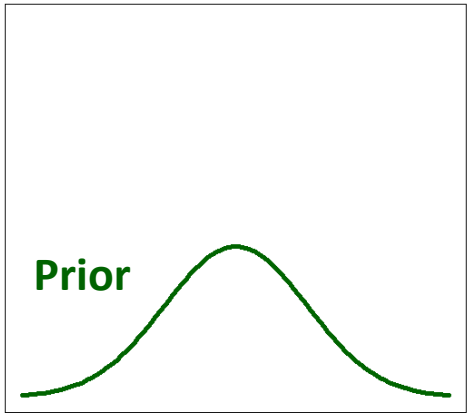
Bayesian statistical inference



Example: What we believe about the probability of dying from a disease.

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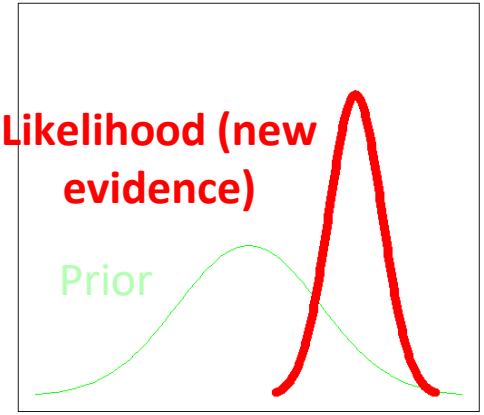
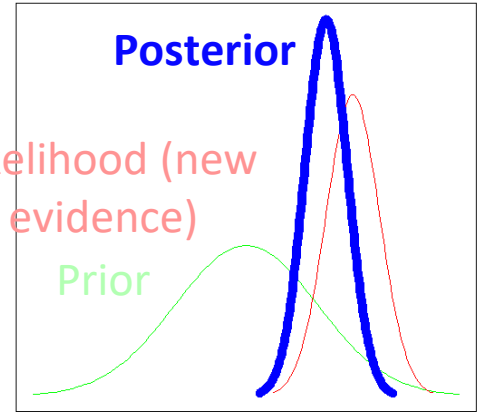
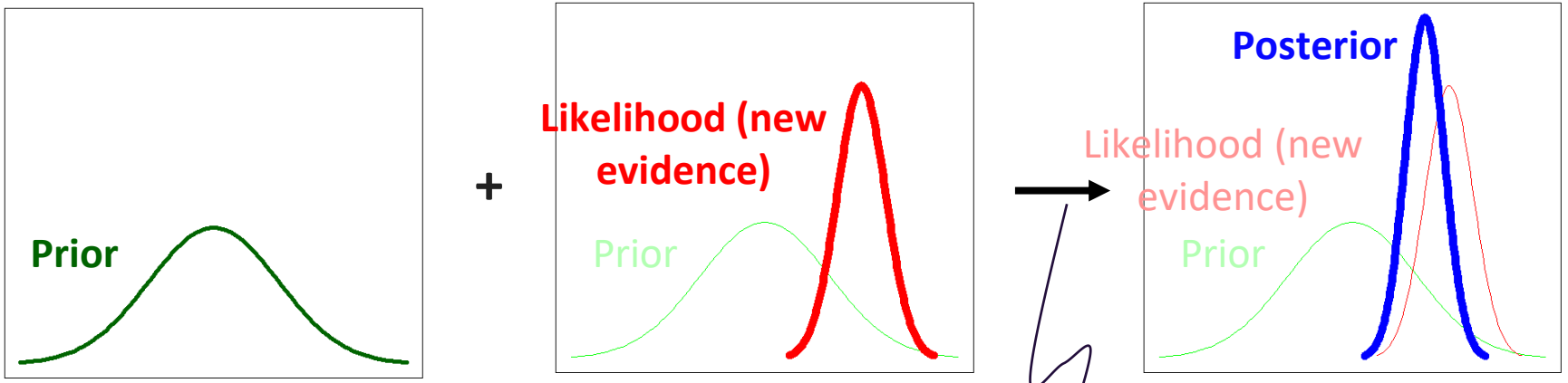


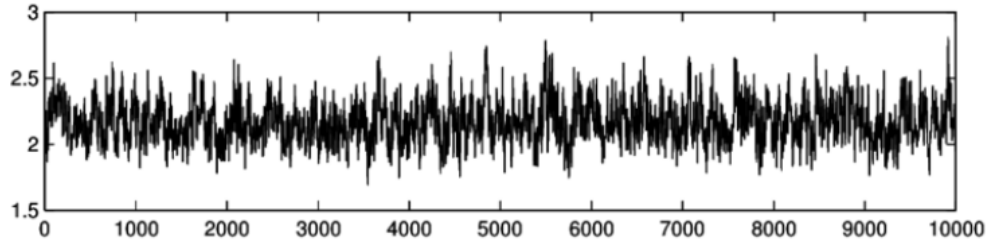
Example: Data from people who have the disease



Example: Our updated belief about the probability of dying from the disease

Bayesian statistical inference





Computationally expensive step!

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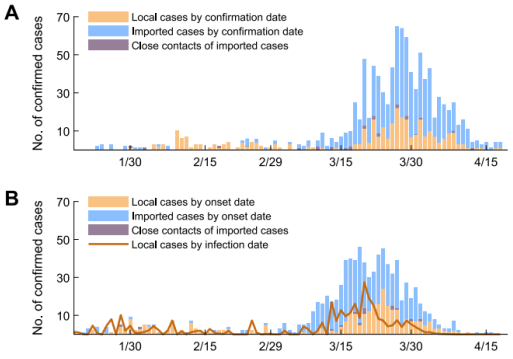
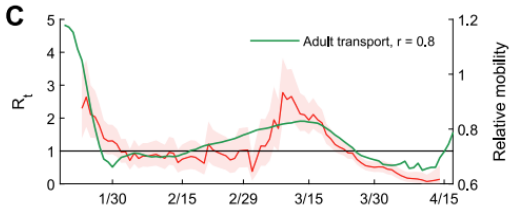
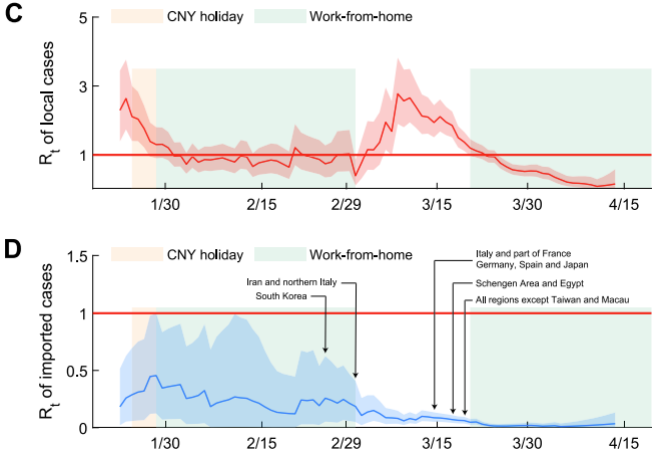
Example: real-time COVID-19 tracking using Bayesian inference

Daily COVID-19 cases in Hong Kong



Population mobility from Octopus (public transport) card use





Inferred Rt (transmissibility of SARS-CoV-2)

Leung K, Wu JT, Leung GM. Real-time tracking and prediction of COVID-19 infection using digital proxies of population mobility and mixing. *Nature Communications* 2012; 12:1501. https://doi.org/10.1038/s41467-021-21776-2

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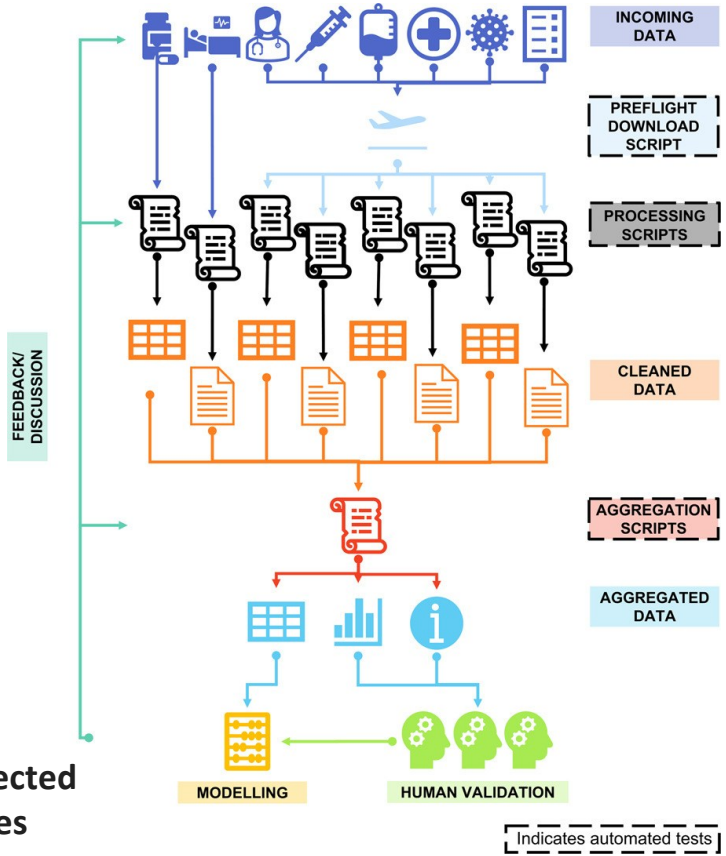
Automated data processing pipelines



Example: case reports for Ebola

Example: projected epidemic curves

Gaythorpe KAM et al. Data pipelines in a public health emergency: The human in the machine. *Epidemics* 2023; 43:100676. doi: 10.1016/j.epidem.2023.100676.

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Public health modelling using AI

Real-world situation

AI-informed literature review

Data

AI-automated data pipeline (extraction, processing)

Conceptual model development

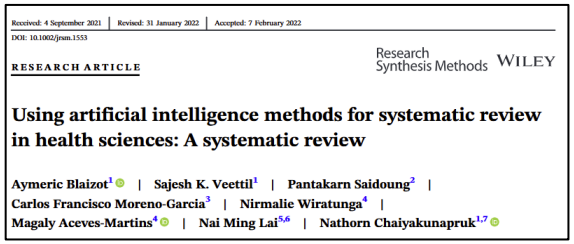
Computer coding

AI code completion and debugging (e.g. Github Copilot)

Results

Automated documentation

Decision-making


Received: 4 September 2021 | Revised: 31 January 2022 | Accepted: 7 February 2022

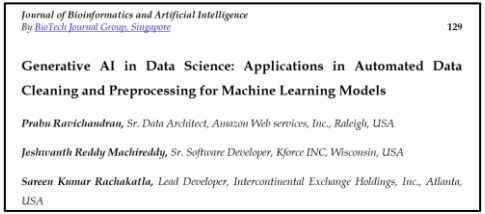
DOI: 10.1002/jrsm.1553

RESEARCH ARTICLE

Research Synthesis Methods WILEY

Using artificial intelligence methods for systematic review in health sciences: A systematic review

Aymeric Blaizot[1] | Sajesh K. Veettil[1] | Pantakarn Saidoung[2] | Carlos Francisco Moreno-Garcia[3] | Nirmalie Wiratunga[4] | Magaly Aceves-Martins[4] | Nai Ming Lai[5,6] | Nathorn Chaiyakunapruk[1,7]


Journal of Bioinformatics and Artificial Intelligence
By BioTech Journal Group, Singapore

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Generative AI in Data Science: Applications in Automated Data Cleaning and Preprocessing for Machine Learning Models

Prabu Ravichandran, *Sr. Data Architect, Amazon Web services, Inc., Raleigh, USA*

Jeshwanth Reddy Machireddy, *Sr. Software Developer, Kforce INC, Wisconsin, USA*

Sareen Kumar Rachakatla, *Lead Developer, Intercontinental Exchange Holdings, Inc., Atlanta, USA*

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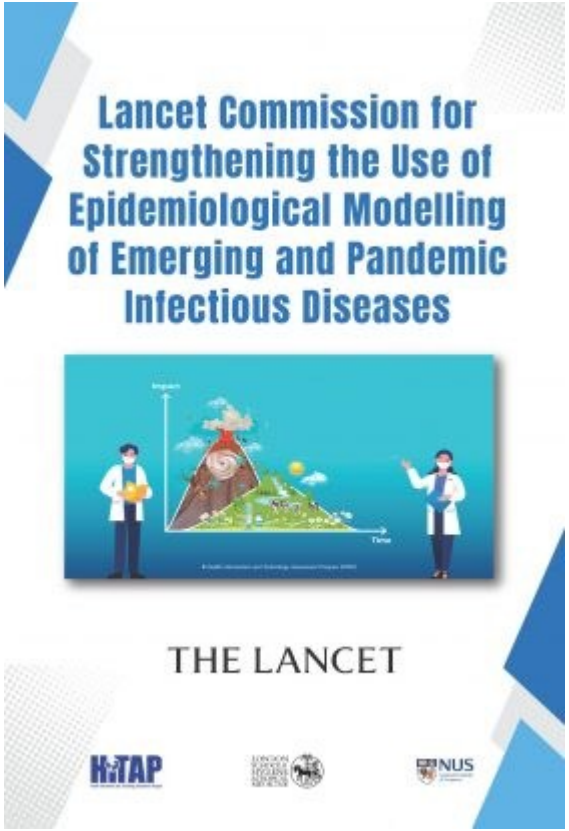
Picture sources: AI informed review (https://doi.org/10.1002/jrsm.1553); AI in Data Science (https://biotechjournal.org/index.php/jbai/article/view/71/69), Github Copilot (Nira - https://nira.com/github-copilot/); Automated documentation (https://news.mit.edu/2019/can-science-writing-be-automated-ai-0418)

Challenges and risks

Challenges	**Possible solutions**
Data biases and incompleteness	Investing in surveillance, EHR (including mobile platforms)
Digital divide in resources (technical, financial, infrastructure) between rich/poor and private/public	Capacity strengthening Skip directly to handheld device era?
Regulatory / data protection	Establishing regulatory frameworks Community engagement - local values
Cultural appropriateness, political buy-in	Locally-developed AI systems Expanded training data sets Diverse development teams
Lack of transparency / explainability	Develop explainable AI systems and mechanistic models

Lancet Commission



Are you interested in reviewing the full report?

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