The Challenge of Medical Artificial Intelligence

Leo Anthony Celi MD MS MPH
Massachusetts Institute of Technology
Harvard Medical School

Artificial Intelligence

How AI is transforming healthcare and solving problems in 2017

New studies and new products are showing how artificial intelligence is transforming the industry.

AHRQ
Advancing Excellence in Health Care

Established in 1989 in response to an Institute of Medicine report that pointed out

"**escalating healthcare costs, wide variations in medical practice patterns, and evidence that some health services are of little or no value**"

JAMA | Original Investigation | INNOVATIONS IN HEALTH CARE DELIVERY

Development and Validation of a Deep Learning Algorithm for Detection of Diabetic Retinopathy in Retinal Fundus Photographs

Varun Gulshan, PhD; Lily Peng, MD, PhD; Marc Coram, PhD; Martin C. Stumpe, PhD; Derek Wu, BS; Arunachalam Narayanaswamy, PhD; Subhashini Venugopalan, MS; Kasumi Widner, MS; Tom Madams, MEng; Jorge Cuadros, OD, PhD; Ramasamy Kim, OD, DNB; Rajiv Raman, MS, DNB; Philip C. Nelson, BS; Jessica L. Mega, MD, MPH; Dale R. Webster, PhD

Dermatologist-level classification of skin cancer with deep neural networks

Andre Esteva[1]*, Brett Kuprel[1]*, Roberto A. Novoa[2,3], Justin Ko[2], Susan M. Swetter[2,4], Helen M. Blau[5] & Sebastian Thrun[6]

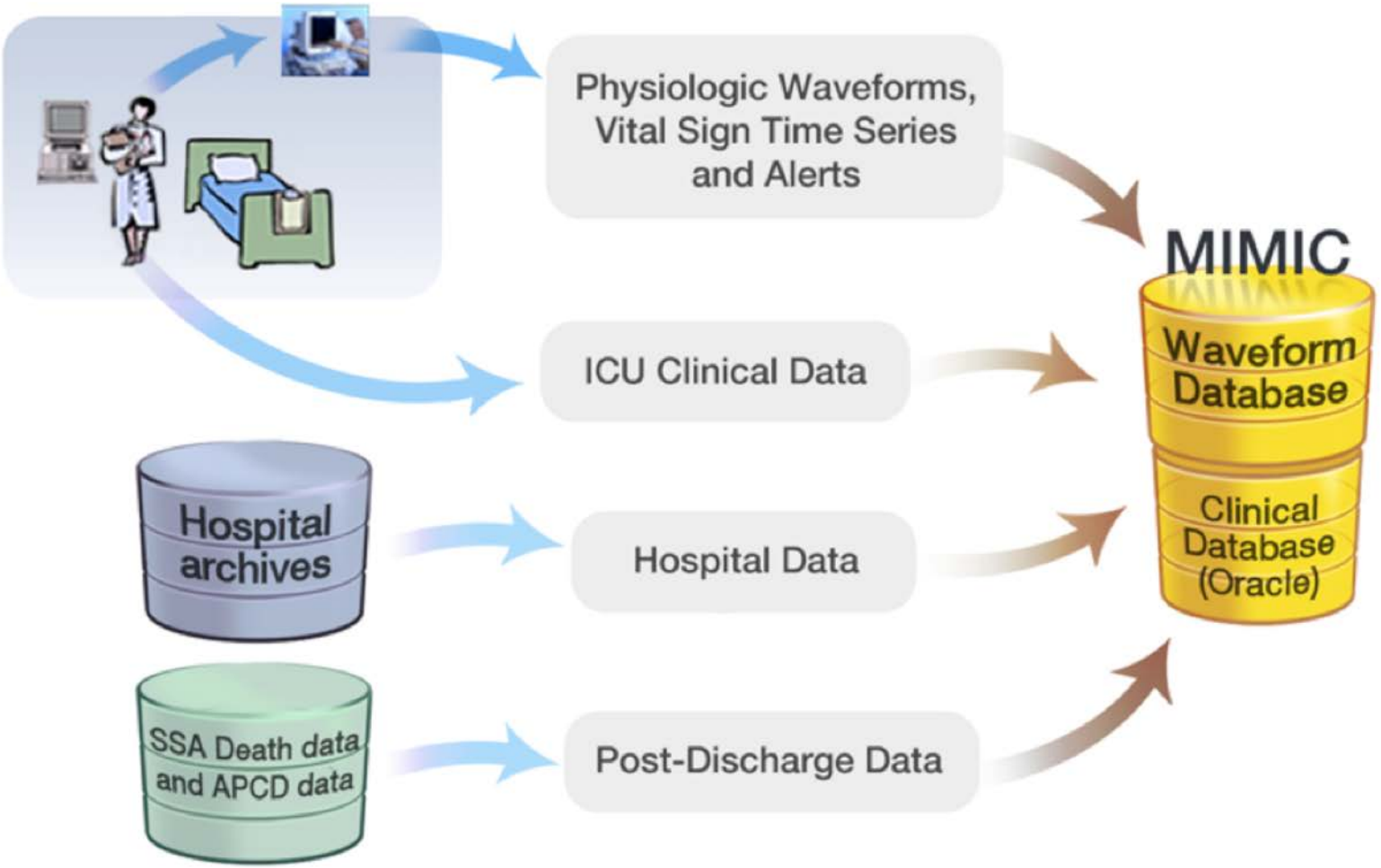
CheXNet: Radiologist-Level Pneumonia Detection on Chest X-Rays with Deep Learning

Pranav Rajpurkar*, Jeremy Irvin*, Kaylie Zhu, Brandon Yang, Hershel Mehta, Tony Duan, Daisy Ding, Aarti Bagul, Curtis Langlotz, Katie Shpanskaya, Matthew P. Lungren, Andrew Y. Ng

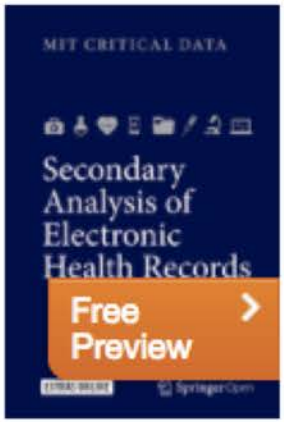
Image classification is a low-hanging fruit when it comes to fixing healthcare.

Crowdsourcing Knowledge Discovery

Medical Information Mart for Intensive Care




eICU Collaborative Research Database
Documents
Data
Community
Code (GitHub)



Open Access

Secondary Analysis of Electronic Health Records

Authors: **MIT Critical Data**

Written with the aim of promoting an inter-disciplinary and ethical approach to health data analytics

» see more benefits

About this Textbook | About the authors

This book trains the next generation of scientists representing different disciplines to leverage the data generated during routine patient care. It formulates a more complete lexicon of evidence-based recommendations and support shared, ethical decision making by doctors with their patients.


CCData
LONDON
Datathon 2016, 3-4 December 2016
This is the 4th annual Critical Care data weekend, bringing together teams of clinicians and data scientists from London and Boston, USA. Critical Care Data London invites clinicians and data scientists, experts and novices to come and explore two iconic clinical data repositories with talks from experts in electronic health records, 'big data' and database design.
Our free Data Science for Doctors pre-course workshop on Friday 2nd December teaches clinicians practical skills in data wrangling, analysis and visualisation using the R language.


DATATHON
Home About Program Data & Tools Registration Sister Event Venue & Contact Register
NUS-MIT Healthcare Analytics Datathon 2017
June 30 ~ July 2 National University of Singapore
Register


JISA Jornadas de Innovación en Salud Digital
About the event Guest Experts MIT guests Organizing Committee Agenda of activities Inscription Contact
JISA ARGENTINA 2018 | Digital Health Innovation Conference
11 and 12 MAY 2018
FACULTY OF MEDICINE, UBA | BUENOS AIRES | ARGENTINA


MIT-HIAE Health Conference and Datathon
May 6/7th
Register
EVENT TOOLS SCHEDULE SPEAKERS COMMITTEE LOCATION PARTNERS


MIMIC
Datathon for Intensive Care DAT-ICU event
20-21st of January // PARIS, FRANCE
Madrid 2017
Critical Care - Datathon
December the 1st - 3rd
Sign up!


ANZICS CORE
CRITICAL CARE DATATHON
28th & 29th April 2018
Faculty of Engineering and IT, Peter Nicol Russell Learning Studio 310,
The University of Sydney


The 2nd Chinese PLA General Hospital-MIT
Health Data Conference and Workshop
2017 Nov 3~5 Beijing

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Back
Close
2017 医疗大数据研讨及Dat...
2017
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麻省理工学院
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Datathon活动
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119365


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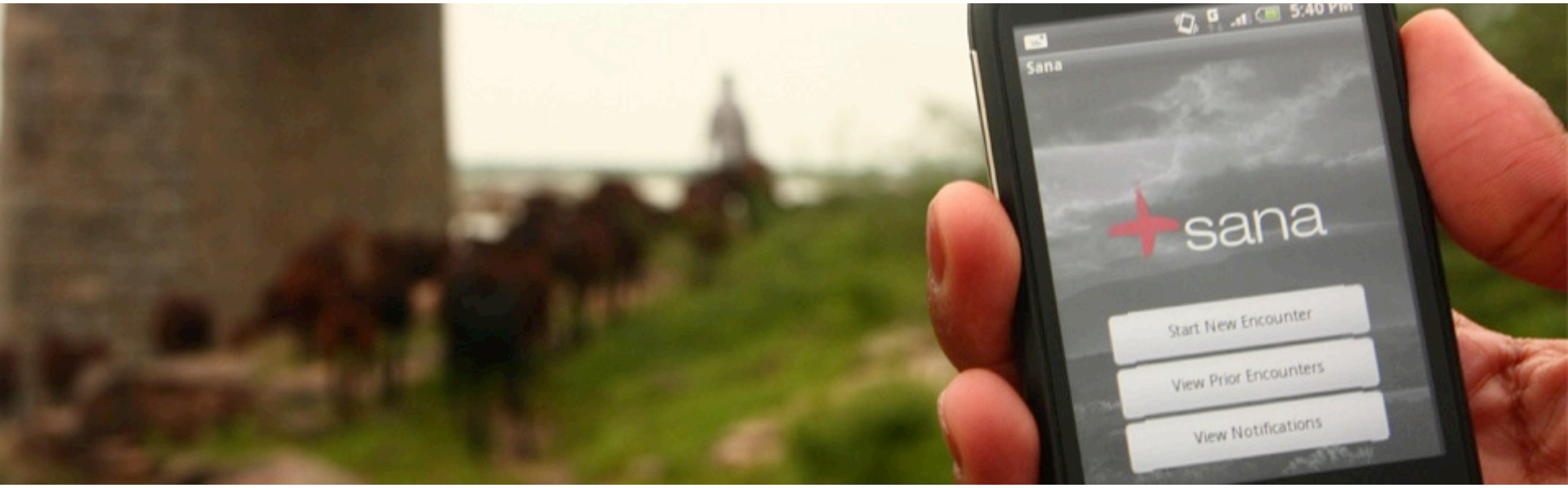
果果 厉害了
素饽饽 赞赞赞
说点什么吧...


2017
颁奖典礼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sana.mit.edu

Global Health Informatics to Improve Quality of Care

Learn how to design health information and communication technology (ICT) solutions for the developing world.

Massachusetts Institute of Technology

Archived
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I would like to receive email from Massachusetts Institute of Technology and learn about other offerings related to Global Health Informatics to Improve Quality of Care.

About this course

4 Reviews 4/5

This is an Archived Course
EdX keeps courses open for enrollment after they end to allow learners to explore content and continue learning. All features and materials may not be available, and course content will not be updated. Check back often to see when new course start dates are announced.

See more

What you'll learn

- Global health burden
- Design thinking
- Health informatics
- Software development process
- Evaluation and monitoring

Meet the instructors

Leo Anthony Celi MD SM MPH
Course Co-director
MIT

Alon Dagan MD
Course Instructor
MIT

Rodrigo Deliberato MD PhD
Course Instructor
MIT

Length:	10 weeks
Effort:	2-3 hours per week
Price:	FREE Verified Certificate option closed
Institution:	MITx
Subject:	Medicine
Level:	Advanced
Languages:	English
Video Transcripts:	English

Share this course with a friend

Prerequisites
None

Global Health Informatics

Principles of eHealth and mHealth to Improve Quality of Care

Edited by Leo Anthony G. Celi, Hamish S. F. Fraser, Vipan Nikore, Juan Sebastián Osorio and Kenneth Paik

Overview

The widespread usage of mobile phones that bring computational power and data to our fingertips has enabled new models for tracking and battling disease. The developing world in particular has become a proving ground for innovation in eHealth (using communication and technology tools in healthcare) and mHealth (using the affordances of mobile technology in eHealth systems). In this book, experts from a variety of disciplines--among them computer science, medicine, public health, policy, and business--discuss key concepts, frameworks, examples, and lessons learned in designing and implementing digital health systems in the developing world.

HST.936

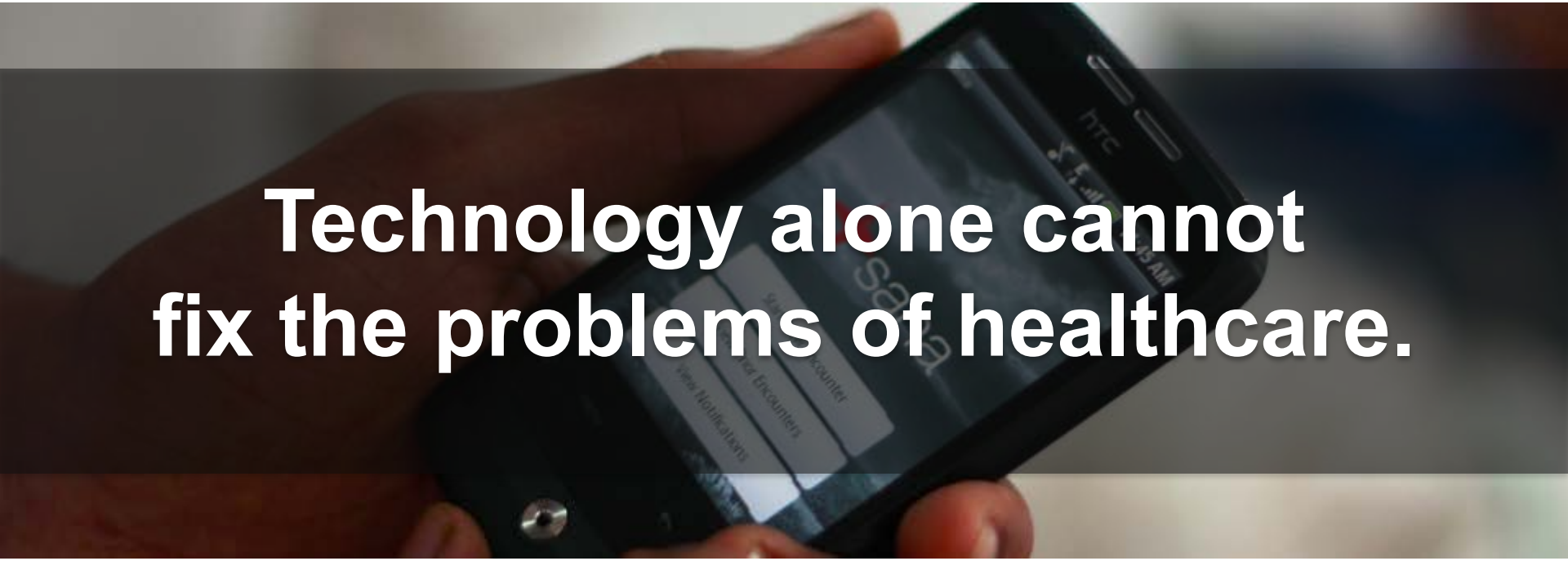
SPRING 2018

GLOBAL HEALTH INFORMATICS

to improve **QUALITY** of **CARE**

Leveraging Big Data in Global Health

This year, our course explores **digital disease surveillance** through the lens of non-traditional data sources. Developing countries are uniquely prone to large-scale emerging infectious disease outbreaks due to disruption of **ecosystems**, **civil unrest**, and poor healthcare **infrastructure** – and without comprehensive surveillance, delays in outbreak identification, resource deployment, and case management can be catastrophic. In combination with context-informed **analytics**, students will learn how non-traditional **digital disease data sources** – including news media, social media, Google Trends, and Google Street View – can fill critical knowledge gaps and help inform on-the-ground decision-making when formal surveillance systems are insufficient.

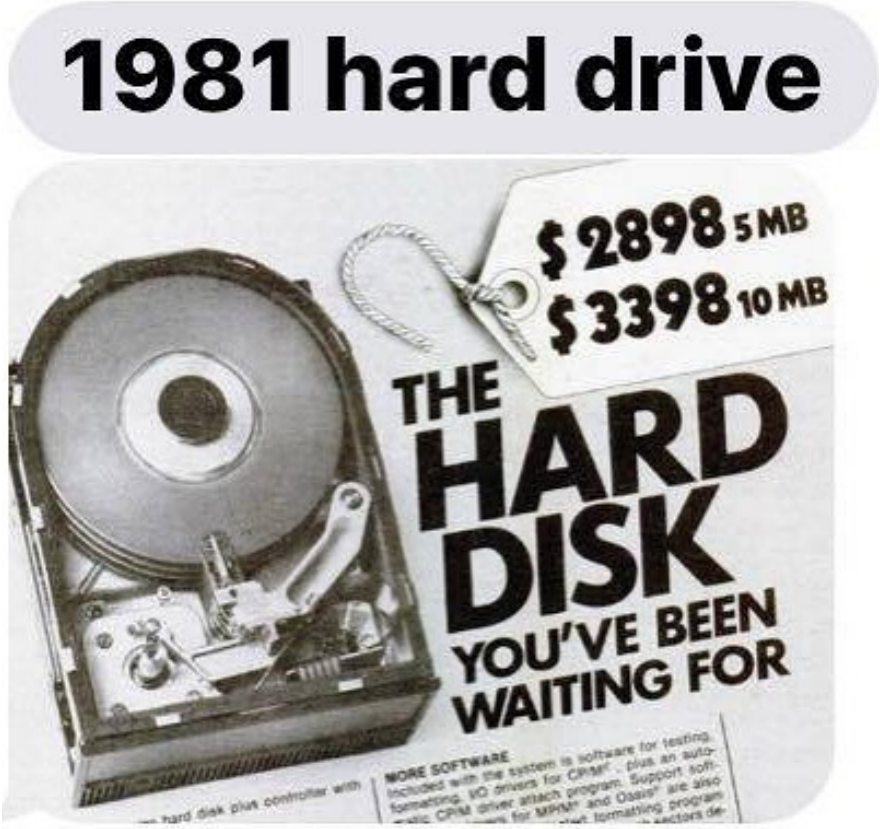

Technology alone cannot
fix the problems of healthcare.

Business Report

The Costly Paradox of Health-Care Technology

In every industry but one, technology makes things better and cheaper. Why is it that innovation increases the cost of health care?

by Jonathan S. Skinner September 5, 2013



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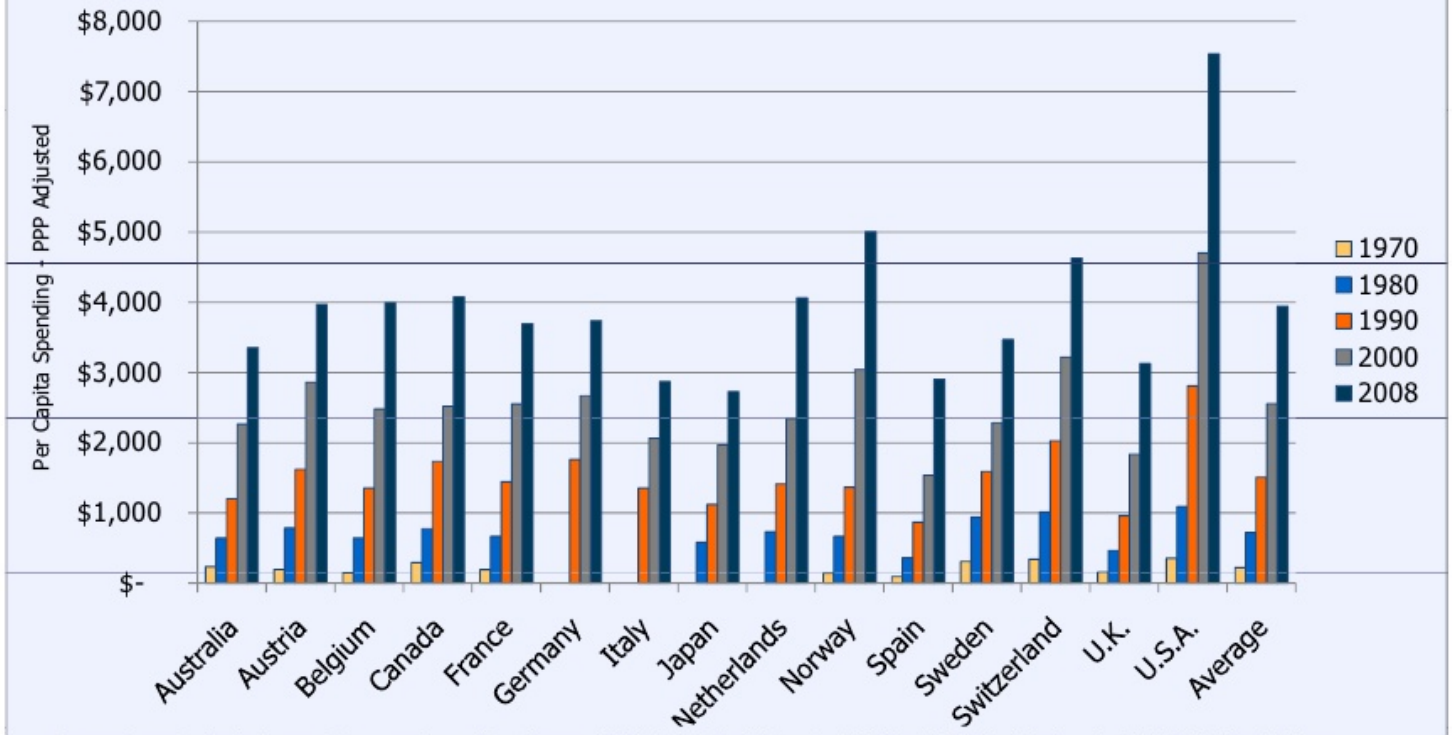
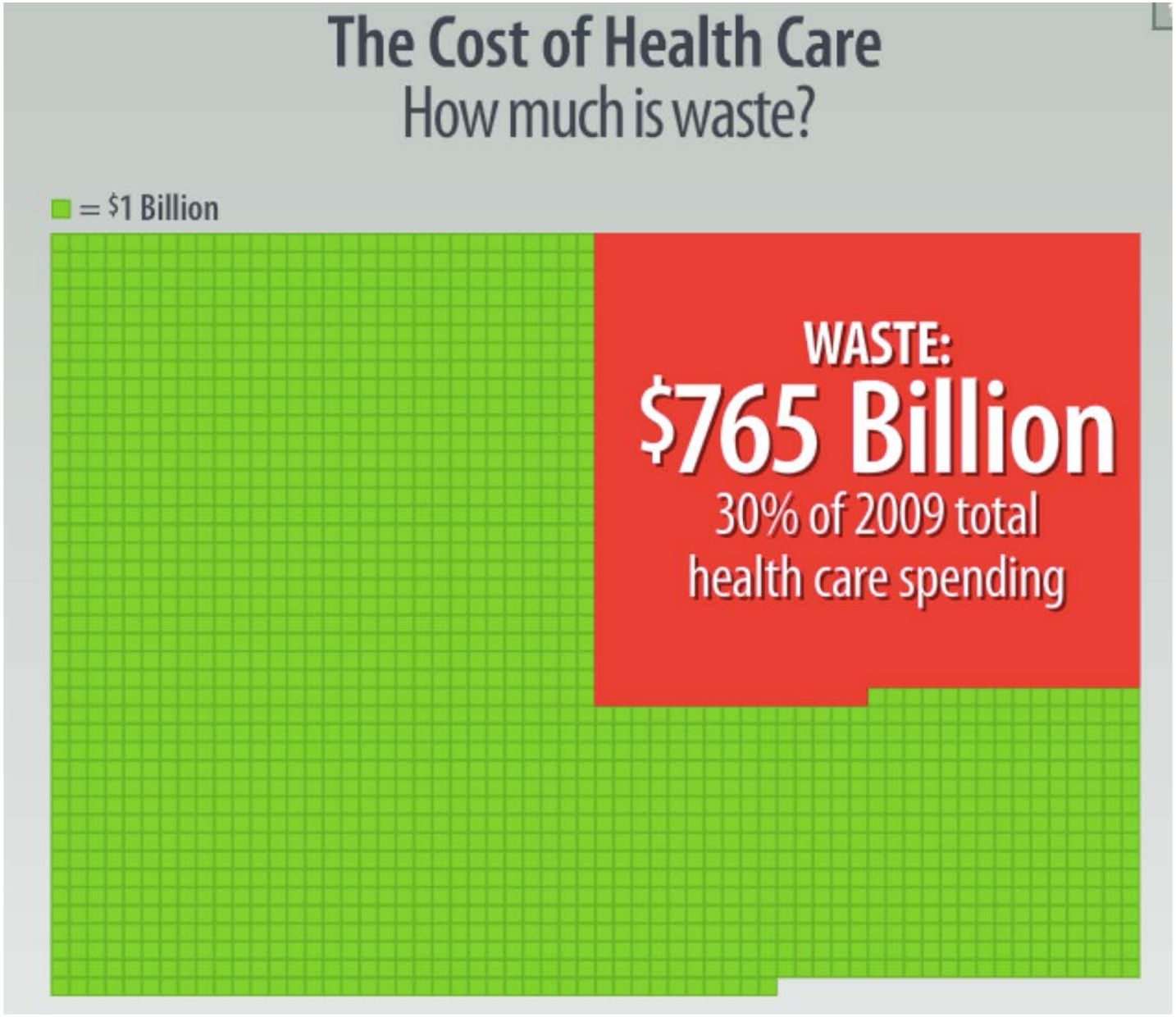
Total Health Expenditure Per Capita, U.S. and Selected Countries, 1970, 1980, 1990, 2000, 2008



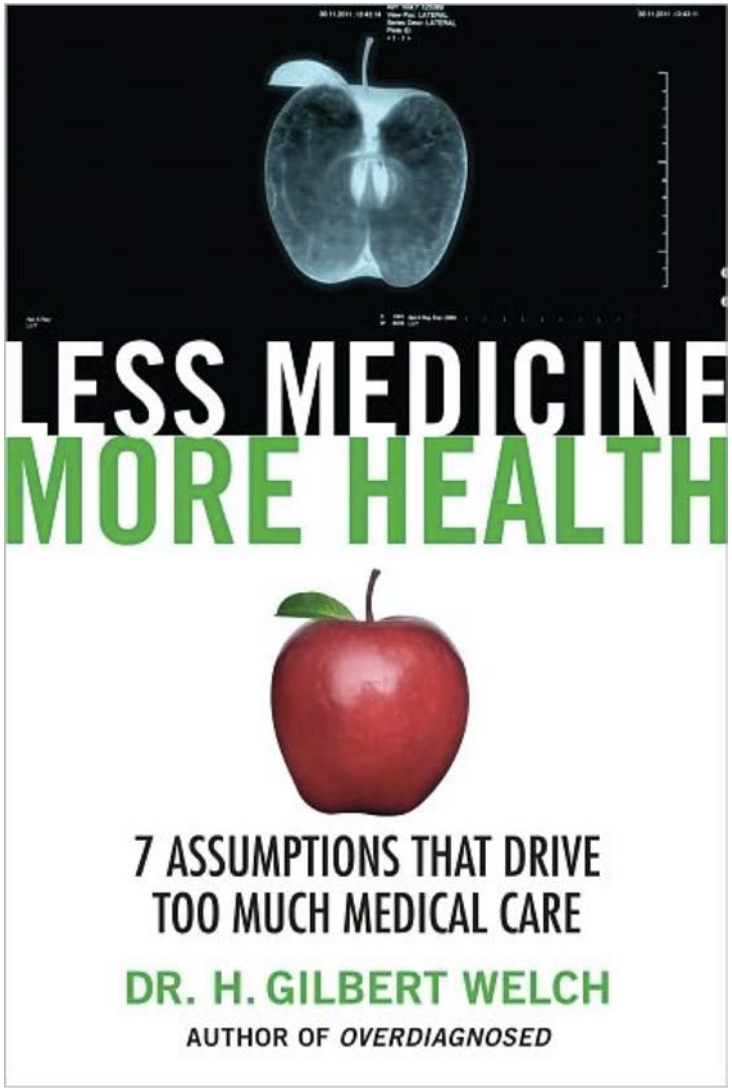
Source: Organisation for Economic Co-operation and Development (2010), "OECD Health Data", *OECD Health Statistics* (database). doi: 10.1787/data-00350-en (Accessed on 14 February 2011).

Notes: Data from Australia and Japan are 2007 data. 2008 figures for Belgium, Canada, Netherlands, Norway and Switzerland, are OECD estimates. 2000 figured for Belgium are OECD estimates. Numbers are PPP adjusted. Break in Series AUS (1998); AUSTRIA(1990); BEL(2003, 2005); CAN(1995); FRA(1995); GER(1992); JAP(1995); NET(1998, 2003); NOR(1999); SPA(1999, 2003); SWE(1993, 2001); SWI(1995); UK (1997. Starting in 1993 Belgium used a different methodology.

THE HENRY J. KAISER FAMILY FOUNDATION


The Cost of Health Care
How much is waste?
= $1 Billion
WASTE:
$765 Billion
30% of 2009 total
health care spending

Overdiagnosis and Overtreatment



Overtesting

- Overdiagnosis - correct diagnosis of a disease that is never going to bother you in your lifetime
- US: number of thyroid cancer detected has tripled over the last 2 decades
- Korea: 15-fold increase in detection of thyroid cancer
- No change in the death rate from thyroid cancer in either country

Overtesting

- Also applies to the increase in
  - monitoring from wireless sensors and other new gadgets
  - all sorts of omics biomarkers
- More sensitive technologies turn up more abnormalities that aren't actually causing problems and never will
- Creates a trail of data that we currently don't know how to interpret

THE HEALTH ORANGE

STAY NOURISHED STAY FIT STAY HAPPY WHAT'S NEW

THE HEALTH ORANGE > STAY HAPPY > HOLISTIC LIVING > 5 Surgeries That Make Hospitals Rich But Are Often Unnecessary

5 Surgeries That Make Hospitals Rich But Are Often Unnecessary

STAT Sections

BLOG POST

The Global Epidemic of Unnecessary Cesarean Sections

HOSPITALS

This orthopedic surgery is the world's most common. But patients rarely benefit, a panel says

QUARTZ

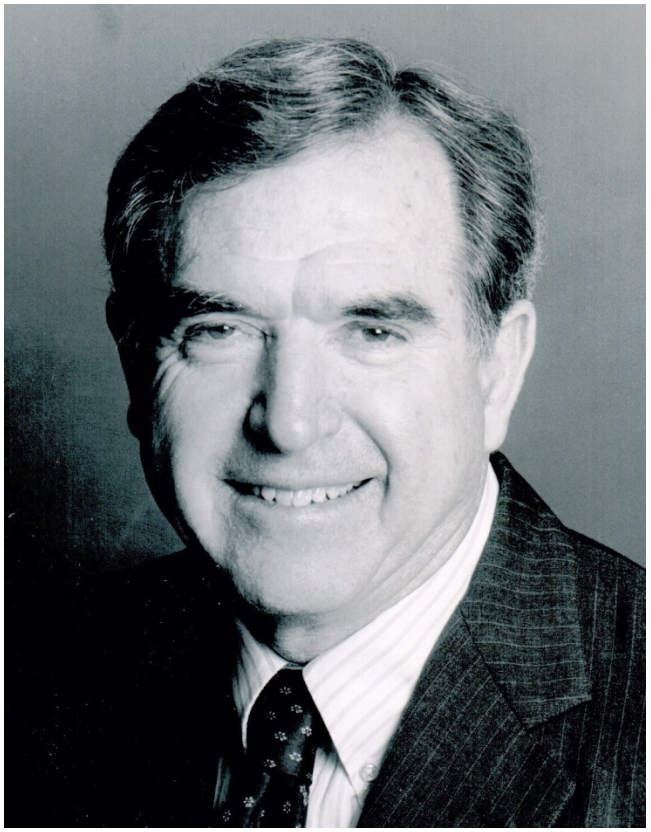
The $100 billion per year back pain industry is mostly a hoax

Vox

EXPLAINERS POLITICS & POLICY WORLD CULTURE SCIENCE & HEALTH IDENTITIES MORE

Thousands of heart patients get stents that may do more harm than good

Stents are commonly used for stable chest pain — but the devices may not be helping.

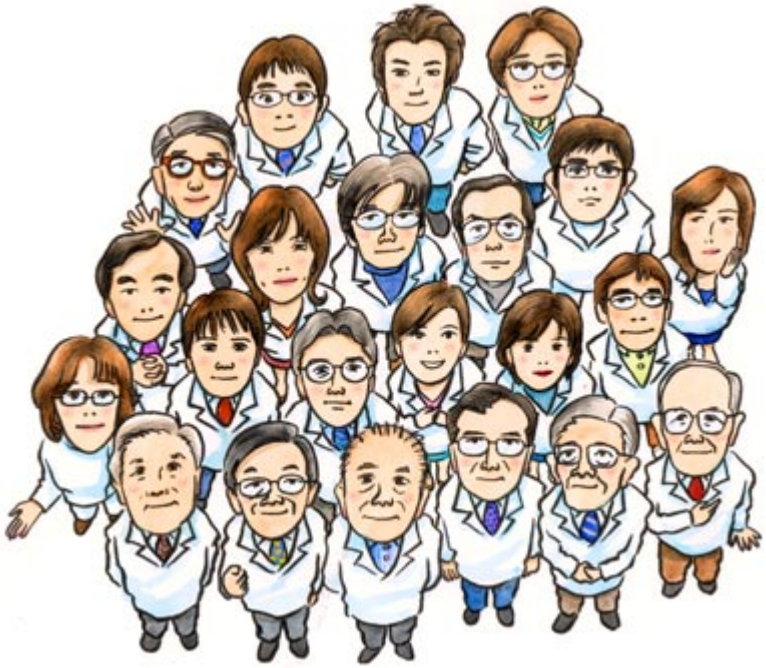


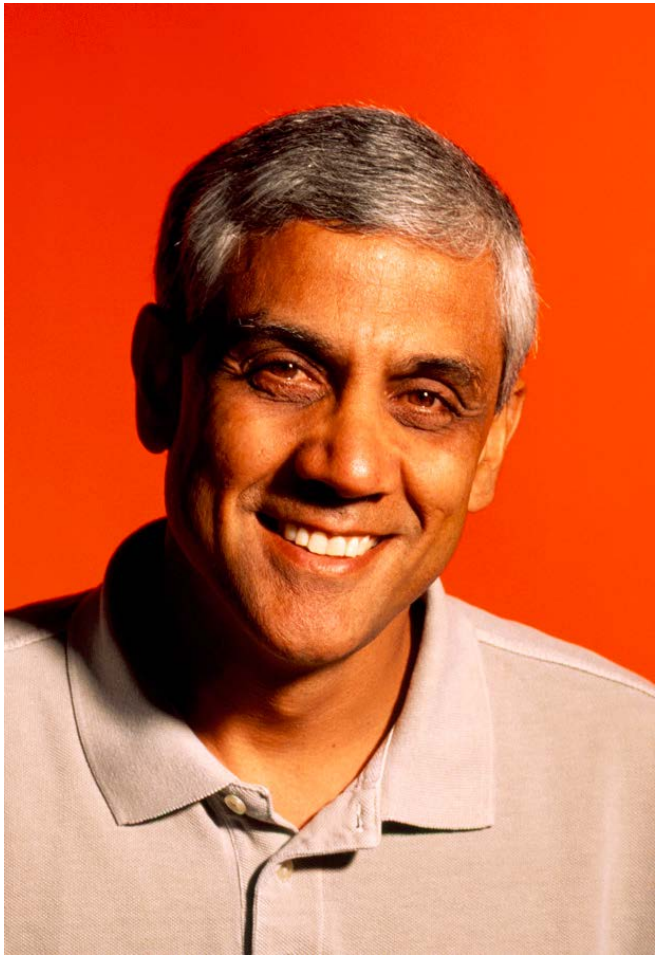
"Many people think that doctors make their recommendations from a basis of scientific certainty, that the facts are very clear and there's only one way to diagnose or treat an illness. In reality, that's not always the case. Many things are a matter of conjecture, tradition, convenience, habit."

Arnold Relman (1923-2014)

Former Editor-in-Chief, New England Journal of Medicine

Vinod Khosla on Healthcare





Care Variation

- Variability in doctor training, knowledge base, experience
- Uncertainties and information gaps
- Doctor and patient biases

Care Variation

- The application of AI may reduce variability around complex clinical decisions that are not explained by patient factors or clinical context
- It has the potential to move clinical decision making from intuitive to data-substantiated, from the realm of art to a domain of science

The NEW ENGLAND JOURNAL of MEDICINE

REVIEW ARTICLE

THE CHANGING FACE OF CLINICAL TRIALS

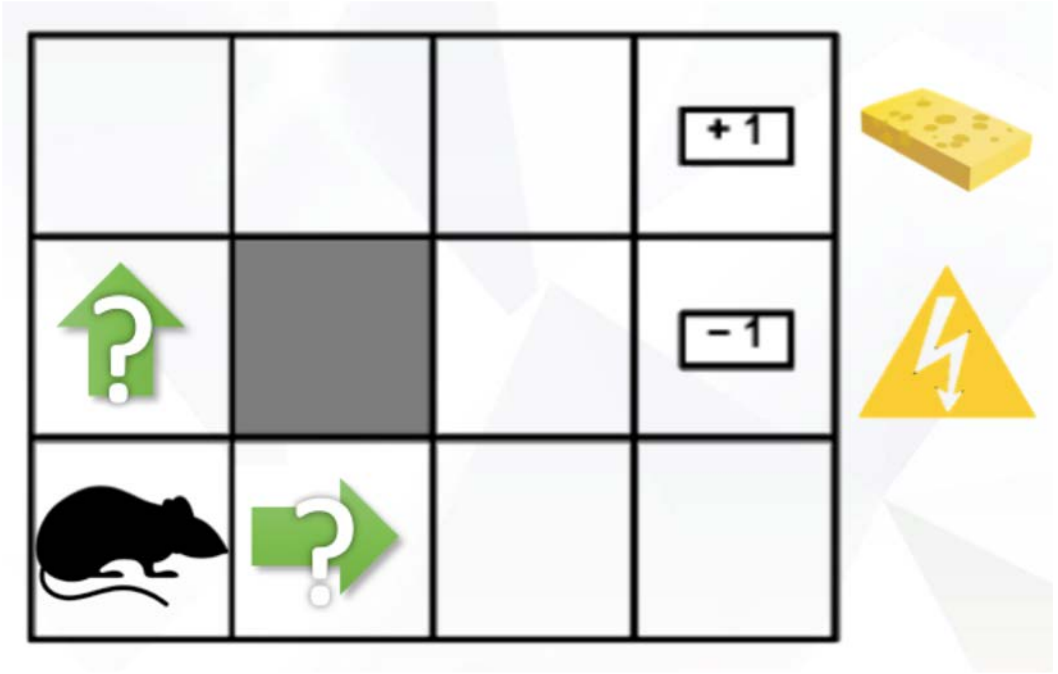
Jeffrey M. Drazen, M.D., David P. Harrington, Ph.D., John J.V. McMurray, M.D., James H. Ware, Ph.D., and Janet Woodcock, M.D., *Editors*

Evidence for Health Decision Making — Beyond Randomized, Controlled Trials

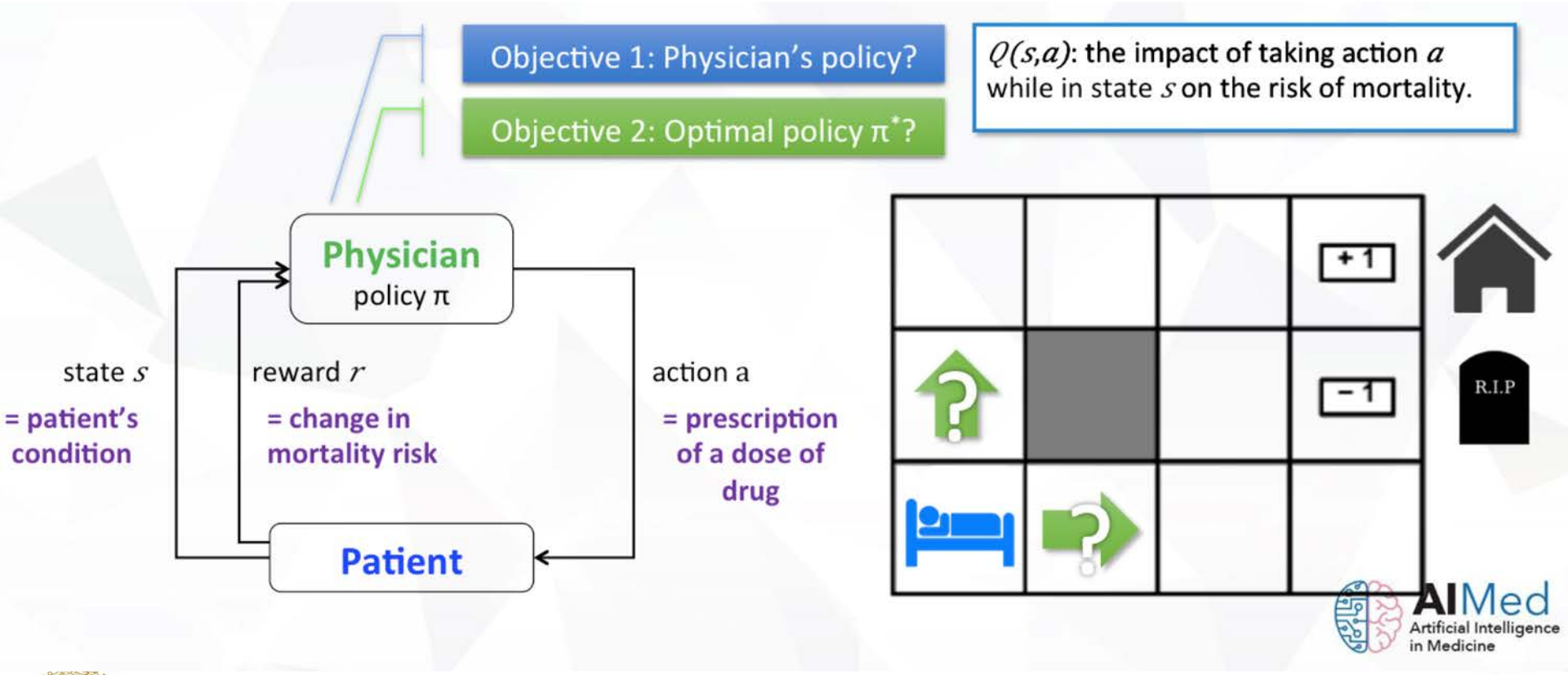
Thomas R. Frieden, M.D., M.P.H.

"For much, and perhaps most of medical practice, RCT-based data are lacking and no RCT is being planned or is likely to be completed to provide evidence for action. It leaves practitioners with large information gaps for most conditions and increases reliance on clinical lore."

Optimizing resuscitation strategy in sepsis with reinforcement learning



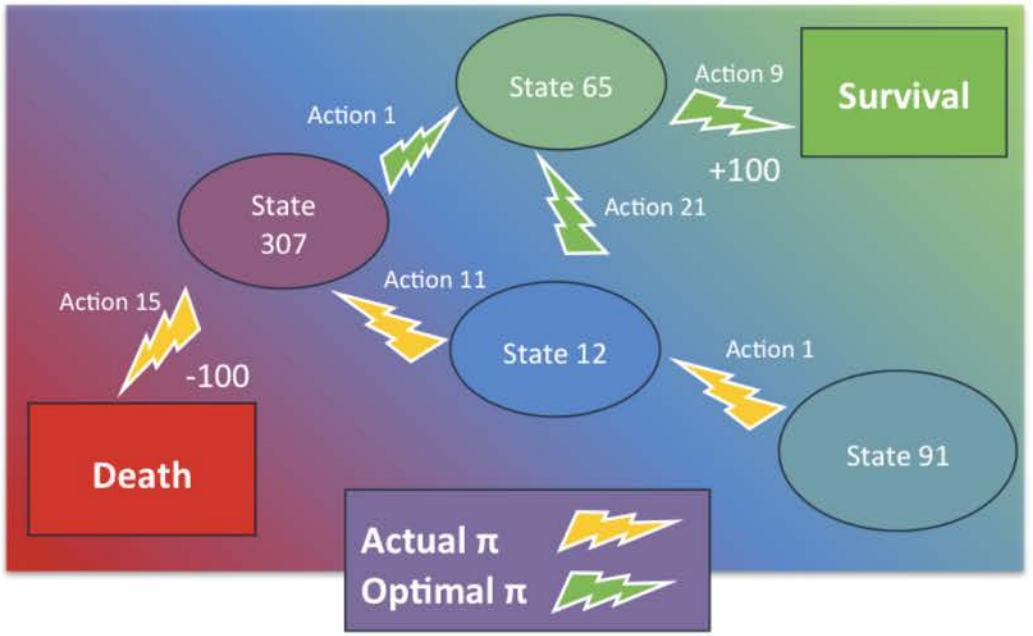
Medical Decision as a Reinforcement Learning Problem



Markov Decision Process

- A general framework used for modelling sequential decision making.
- Most useful in problems involving **complex, stochastic and dynamic decisions**, for which they can find optimal solutions.

- Defined by $\{S, A, T, R\}$
  - S: a finite set of states
  - A: a finite set of actions
  - $T(s\downarrow t+1 , s\downarrow t , a\downarrow t)$: the transition matrix
  - R: the immediate reward



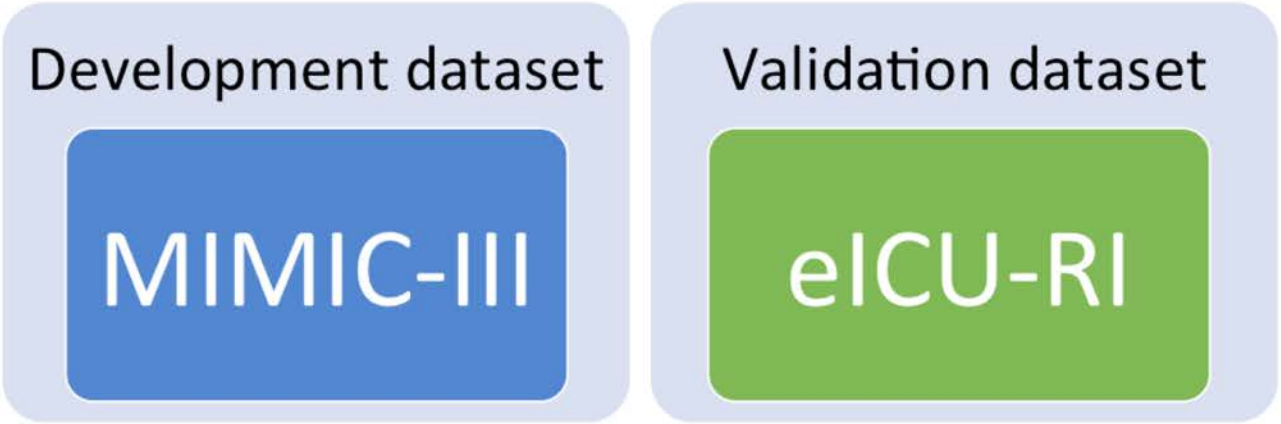
[Schaefer 2005]

Tasks at Hand

- Model the prescription of intravenous fluids and vasopressors using a Markov decision process
- 750 states defined by k-means clustering of time series of 52 variables, up to 72 hrs of data per patient
- Identify optimal decisions from one state to another based on 90-day survival

The datasets

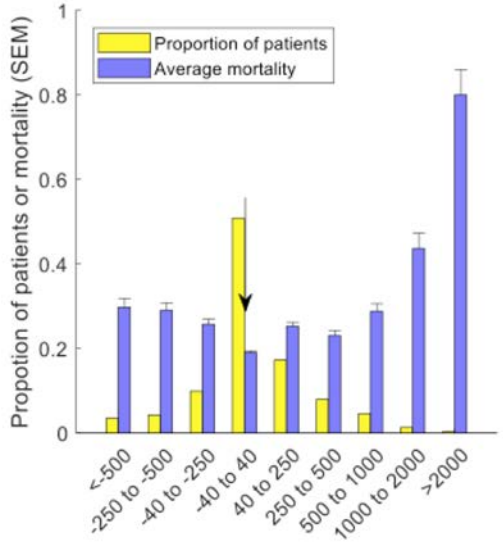
PHILIPS
Healthcare

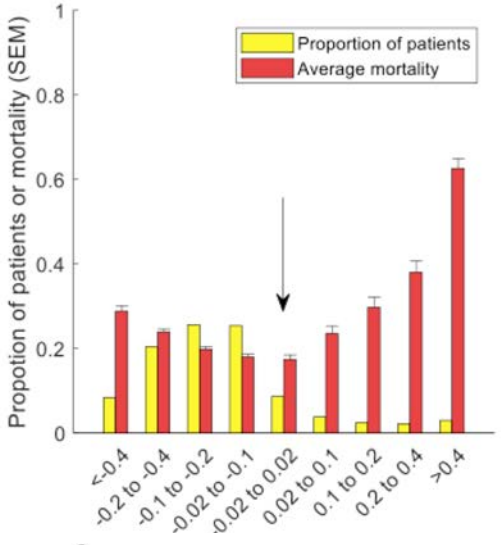


- Inclusion: adults with sepsis [sepsis-3 definition]
- Exclusion: excessive missingness, patients coming from hospitals with low data quality in eICU-RI

Is the optimal strategy associated with the best outcome?

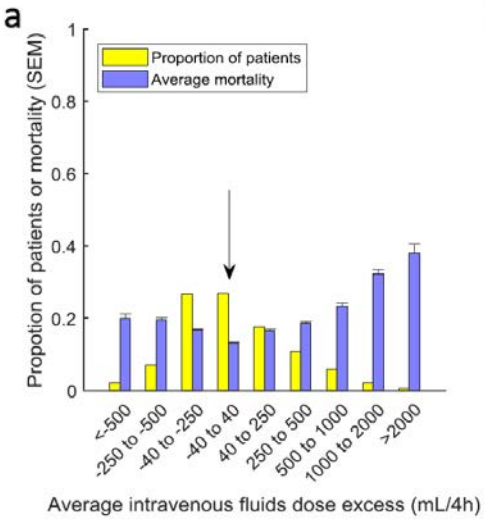
90-day mortality

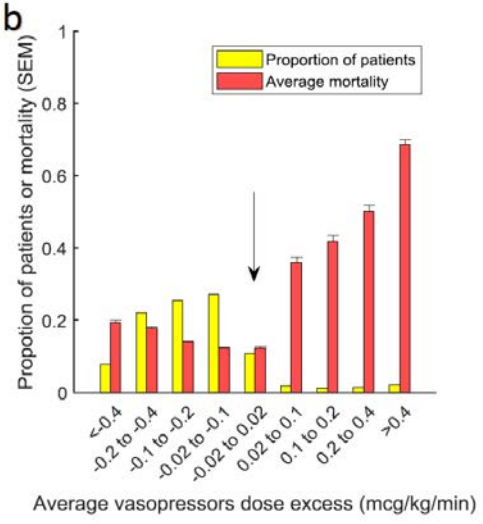




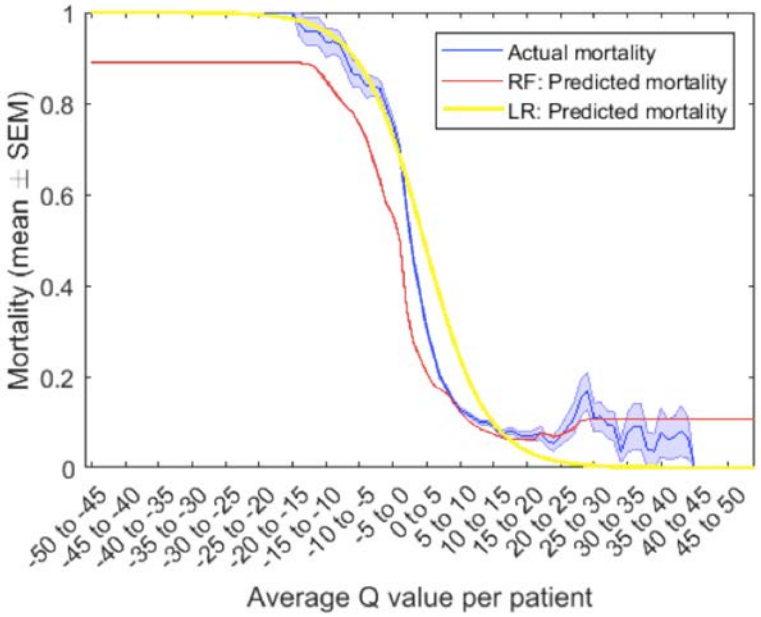
MIMIC Test Set

eICU
Validation Set





Mortality Benefit from Optimal Strategy



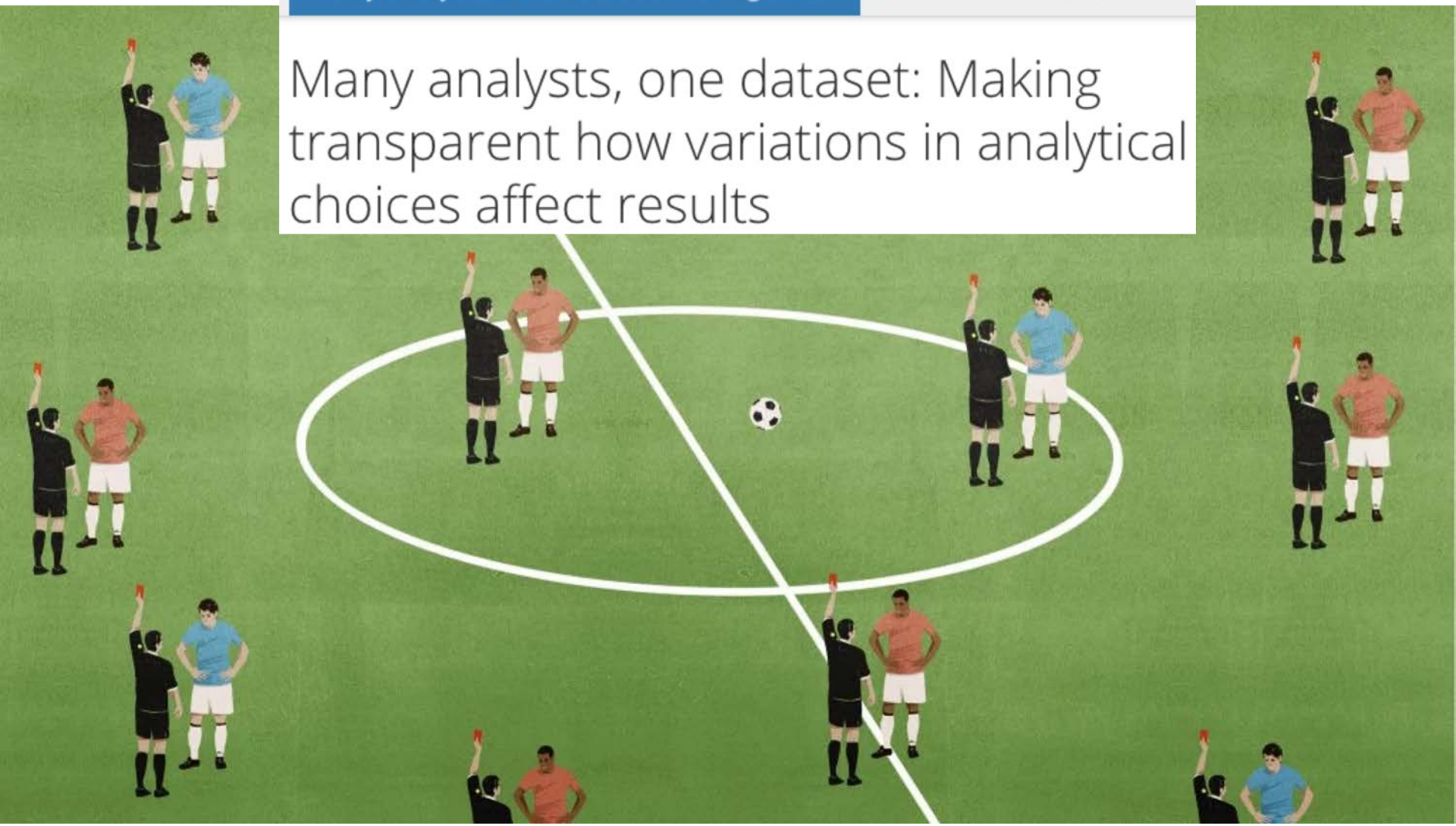
- Random forest and regression models were built that map fluid and vasopressor dose in each state with hospital mortality
- Predicted mortality when optimal action is followed: 9.6% (vs. 17.7% actual); 8.2% absolute reduction (95% CI: 7.8% - 8.5%)

The pitfalls of Big Data are no different from the pitfalls of statistics, except magnified.

Open Science Framework

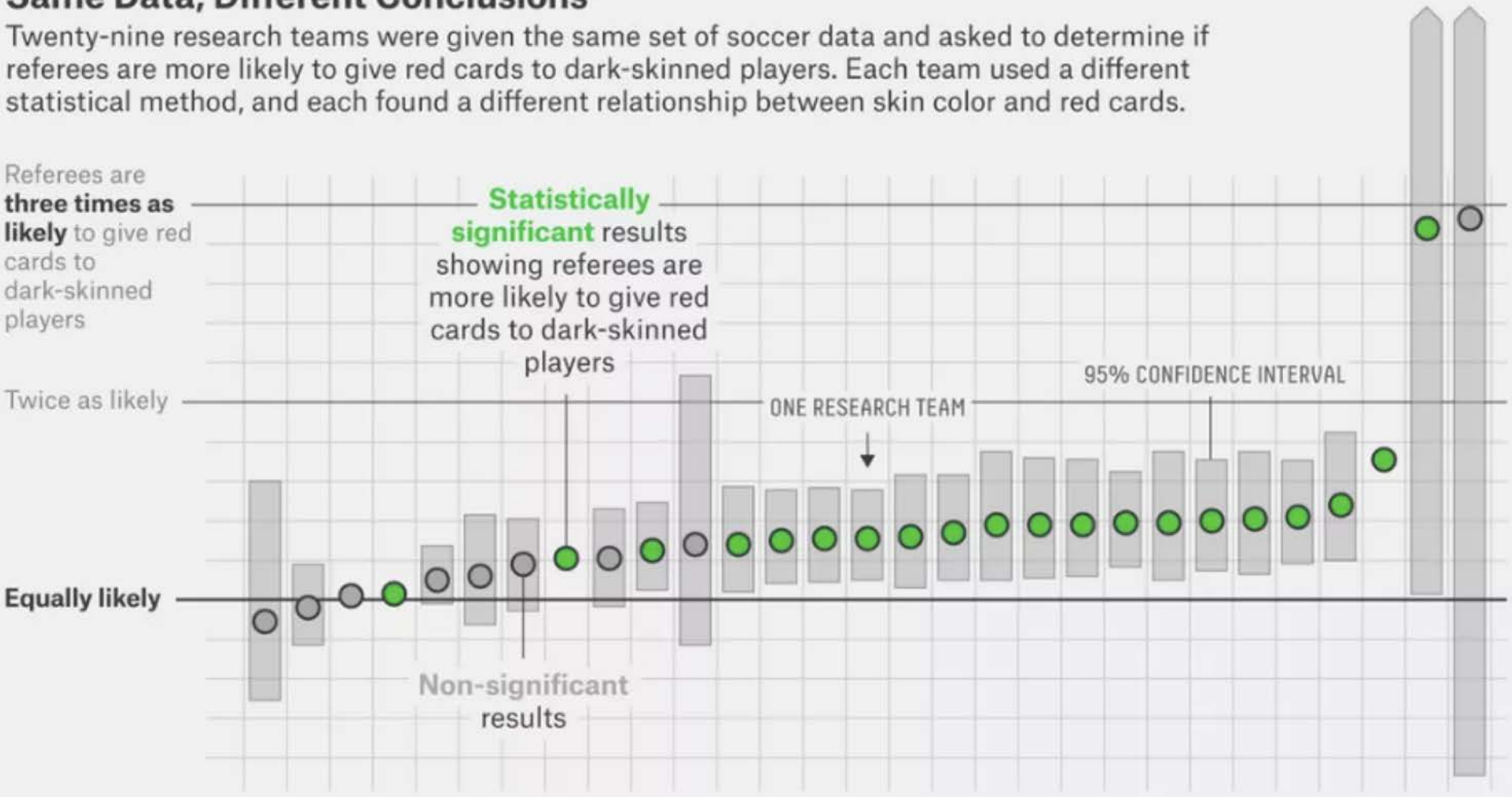
Many analysts, one dataset: Making tra... | Files | Wiki | Analytics | R

Many analysts, one dataset: Making transparent how variations in analytical choices affect results



Same Data, Different Conclusions

Twenty-nine research teams were given the same set of soccer data and asked to determine if referees are more likely to give red cards to dark-skinned players. Each team used a different statistical method, and each found a different relationship between skin color and red cards.



FIVETHIRTYEIGHT

SOURCE: BRIAN NOSEK ET AL.

Machine Bias

There's software used across the country to predict future criminals. And it's biased against blacks.

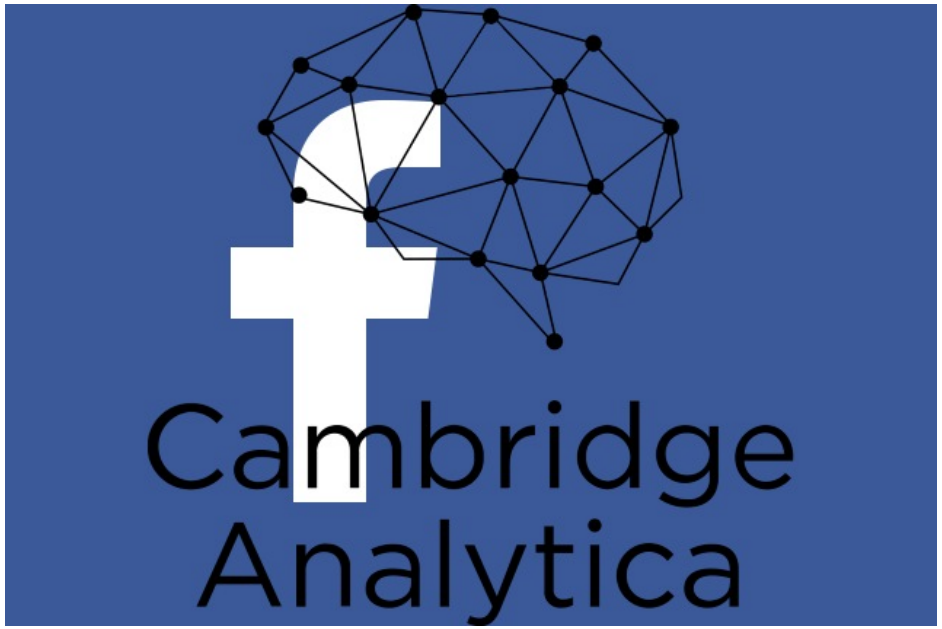
Machine Bias

There's software used across the country to predict future criminals. And it's biased against blacks.

- The formula was particularly likely to falsely flag black defendants as future criminals, wrongly labeling them at almost twice the rate as white defendants.
- White defendants were mislabeled as low risk more often than black defendants.

Machine Bias Scenarios in Healthcare

- Algorithms predicting response to treatment may be biased against certain groups and may suggest withholding treatments from those groups
- Algorithms predicting prognosis may be biased against certain groups and may suggest premature termination of treatments



“The pressing ethical questions in machine learning are not about machines becoming self-aware and taking over the world, but about how people can exploit other people, or through carelessness introduce immoral behavior into automated systems.”

- Nick Bostrom

A Brave New ‘Post-Real’ World

- A world constantly listening to and learning about us, adapting to our wants, while subtly shaping us to its ends
- Two components:
  - Profiling through machine learning
  - Algorithms to ‘curate’ reality

Profiling using Machine Learning

- Facebook in 2016: ‘gigantic machine learning system’
- Learns from every user interaction - every click, every scroll, every link followed to an outside website - to build a ‘profile’ to model the behavior and interests of its users

The Australian
April 30, 2017 ·

Facebook is allowing advertisers to target kids as young as 14 at their most vulnerable, including when they feel "worthless" and "insecure", secret internal documents reveal.

Facebook targets 'insecure' young people

Profiling using Machine Learning

- By monitoring posts, pictures, interactions and internet activity, Facebook can work out when users feel ‘stressed’, ‘defeated’, ‘anxious’, ‘overwhelmed’, ‘nervous’, ‘stupid’, ‘silly’, ‘useless’ and a ‘failure’
- Ads or message delivered at the moment of maximum impact

Algorithms to Curate Reality

- Facebook has increasingly used opaque ‘algorithms’ to curate personalized newsfeed and keeps users glued to Facebook
- Algorithms based on deep analysis of users’ behavior: websites visited outside Facebook (and time spent there), news read, online shopping

The Guardian

Facebook reveals news feed experiment to control emotions

Protests over secret study involving 689,000 users in which friends' postings were moved to influence moods

Poll: Facebook's secret mood experiment: have you lost trust in the social network?

Facebook Cornell Experiment

- 700,000 Facebook users
- Group 1: reduce ‘positive emotional content’ of feed -> fewer posts with ‘positive emotional content’
- Group 2: reduce ‘negative emotional content’ of feed -> fewer posts with ‘negative emotional content’
- Emotional Contagion

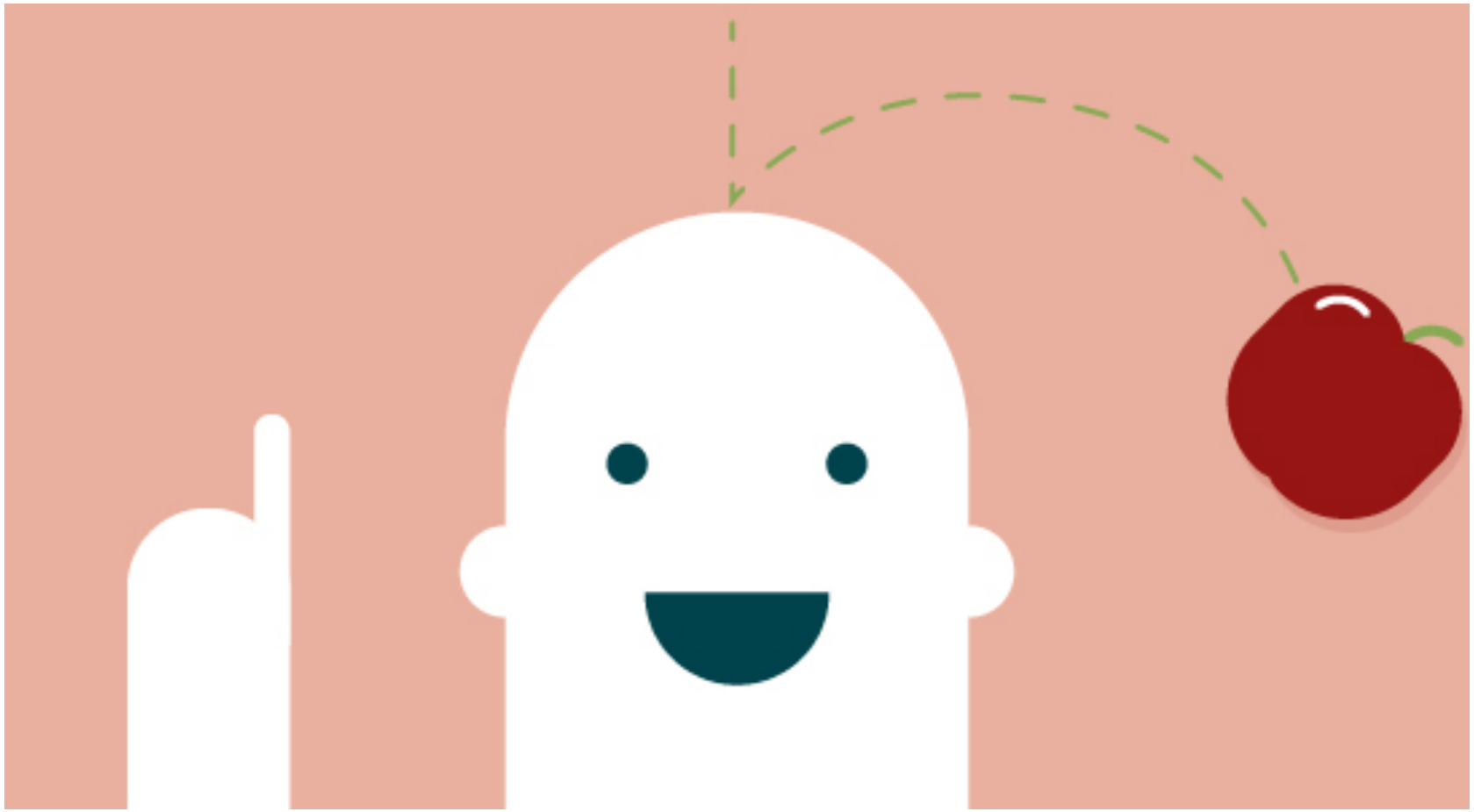
AI for Profiling and Targeted Behavior Modification

- Cambridge Analytica founded by a hedge fund billionaire Robert Mercer, a world-class computer scientist
- High profile clients: Nigel Farage and Steve Bannon

AI for Profiling and Targeted Behavior Modification

- Harvested 87M Facebook user data to generate voter profiles
- Purchased Facebook advertising targeted at the voter to ‘trigger’ that voter into making a desired voting choice
- Targets voters at their most persuadable moment and delivers via their newsfeed a stimulus to get them to vote (or not vote)

AI for Profiling and Targeted Behavior Modification

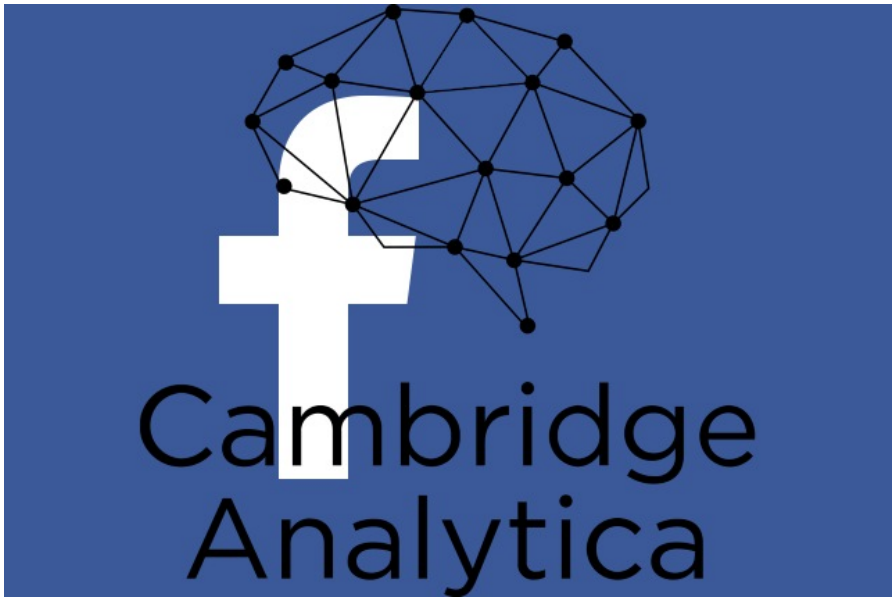


AI for Patient Profiling and Targeted Behavioral & Social Intervention

AI for Patient Profiling and Targeted Behavioral & Social Intervention

- Patient profiling to understand their disease better – trajectory, predicted response to interventions
- Targeted interventions to modify behavior and social circumstances

From



To

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Leo Anthony Celi

lceli@mit.edu