Health Innovation in Artificial Intelligence

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AI – YOU'RE SURROUNDED BY IT ALREADY

AI Improves Social Media
Makes it easier for users to locate and communicate with friends and business associates.

Chatbots
Recognize words and phrases in order to deliver helpful content to customers who have common questions.

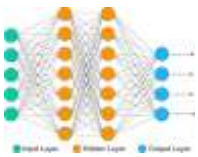
Maps and Directions
Apps like Google Maps calculate traffic and construction in order to find the quickest route to your destination.

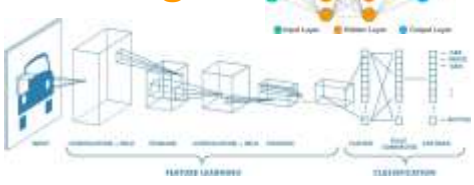
Product Recommendations
Online retailers use AI to gather information about your preferences and buying habits, then personalize your shopping experience.

Music Recommendations
Music services use AI to track your listening habits. They use the information to suggest other songs you might like to hear.

Financial Institutions Fraud Prevention
Banks use AI by sending mobile alerts to help prevent against fraud.

Deep Learning



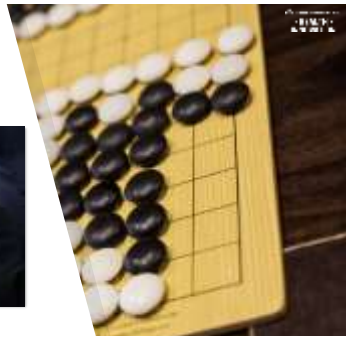


MAY 11, 1997

IBM'S DEEP BLUE DEFEATS **HUMAN CHAMPION** GARY KASPAROV

MAR 15, 2016

GOOGLE DEEPMIND'S ALPHAGO DEFEATS **HUMAN CHAMPION** LEE SEDOL



KAISER PERMANENTE'S **HEALTHCARE** DATASET

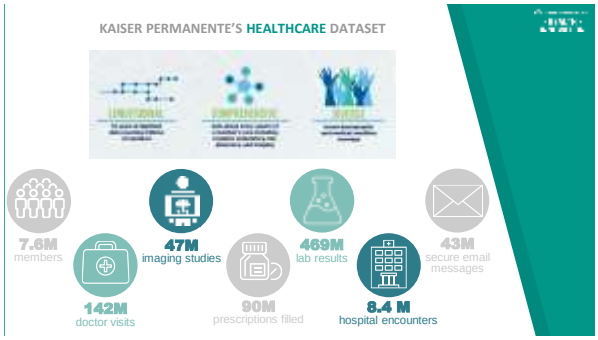
Kaiser Permanente has an astounding **44 petabytes** of rich health data.

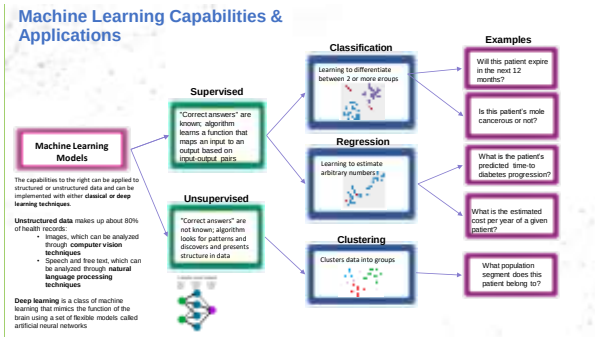
1.4 Million iPhones

30 stacks of CD-ROMS as tall as Mt. Whitney

Enough floppy disks to circle the globe 65 times!

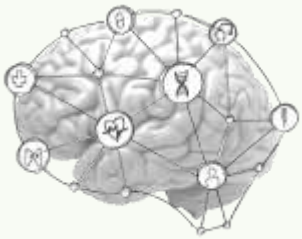
KP's health dataset records 170,000 years of physician experience


KAISER PERMANENTE'S HEALTHCARE DATASET
7.6M
members
47M
imaging studies
469M
lab results
43M
secure email messages
142M
doctor visits
90M
prescriptions filled
8.4 M
hospital encounters


Machine Learning Capabilities & Applications
Machine Learning Models
The capabilities to the right can be applied to structured or unstructured data and can be implemented with either classical or deep learning techniques.
Unstructured data makes up about 80% of health records:
Images, which can be analyzed through computer vision techniques
Speech and free text, which can be analyzed through natural language processing techniques
Deep learning is a class of machine learning that mimics the function of the brain using a set of flexible models called artificial neural networks
Supervised
"Correct answers" are known; algorithm learns a function that maps an input to an output based on input-output pairs
Unsupervised
"Correct answers" are not known; algorithm looks for patterns and discovers and presents structure in data
Classification
Learning to differentiate between 2 or more groups
Regression
Learning to estimate arbitrary numbers
Clustering
Clusters data into groups
Examples
Will this patient expire in the next 12 months?
Is this patient's mole cancerous or not?
What is the patient's predicted time-to diabetes progression?
What is the estimated cost per year of a given patient?
What population segment does this patient belong to?


Why use machine learning?
Factors: 7 x 2
Factors: 10s
Factors: 100s
Ankur Teredesai

AI for Health Care Delivery



1. Anticipating patients' current and future needs
2. Developing personalized care plans
3. Creating decision support tools and automation for clinicians

BIG DATA: MORE PERSONALIZED, PROACTIVE AND EFFICIENT CARE

Identify patients at risk of an adverse outcome and proactively intervene

- Predictive Analytics
- Population Management
- Personalization
- Automation

BIG DATA: MORE PERSONALIZED, PROACTIVE AND EFFICIENT CARE

Identify patients in greatest need of support and target screenings and interventions

- Predictive Analytics
- Population Management
- Personalization
- Automation

BIG DATA: MORE PERSONALIZED, PROACTIVE AND EFFICIENT CARE

Tailor treatment plans based on a patient's needs and preferences

- Predictive Analytics
- Population Management
- Personalization
- Automation

BIG DATA: MORE PERSONALIZED, PROACTIVE AND EFFICIENT CARE

Reduce non-clinical indirect work for physicians and enable self-care

- Predictive Analytics
- Population Management
- Personalization
- Automation

Health Care AI Hype

- A recent search identified over 5,000 papers related to applications of AI and Machine Learning in health care.
- Many of these papers claim that algorithms perform as well or better than human experts
- Only about a dozen of these studies include prospective validation and/or measurement of how use of the algorithm impacts health outcomes

"There has been remarkably little prospective validation for tasks that machines could perform to help clinicians or predict clinical outcomes that would be useful for health systems, and even less for patient-centered algorithms. The field is certainly high on promise and relatively low on data and proof"

Topol https://doi.org/10.1038/s41591-018-0300-7

FDA-Approved AI Tools

The FDA is focused on clearly defining and regulating "software-as-a-medical-device,".

On January 8, 2019, the FDA published a new Software Precertification Pilot Program and a regulatory framework explaining how it plans to regulate the next generation of digital health services, particularly those that leverage AI and ML to support decision-making.

This will allow companies to make "minor changes to its devices without having to make submissions each time."

Fast-track regulatory approval opens new commercial pathways for over 70 AI imaging & diagnostics companies that have raised equity financing since 2013, accounting for a total of 119 deals.

FDA-Approved AI Tools

In **2017** the FDA approved two AI devices:

Company	FDA Approval	Indication
Alivecor	November 2017	Afib detection via Apple Watch
Arterys	January 2017	MRI heart interpretation

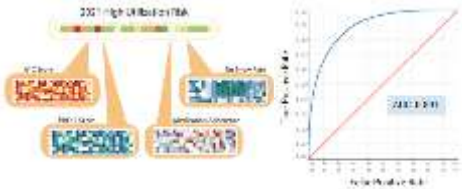
In **2018** there were 12 AI devices approved:

Company	FDA Approval	Indication
Apple	September 2018	Atrial fibrillation detection
Aidoc	August 2018	CT brain bleed diagnosis
iCAD	August 2018	Breast density via mammography
Zebra Medical	July 2018	Coronary calcium scoring
Bay Labs	June 2018	Echocardiogram EF determination
Neural Analytics	May 2018	Device for paramedic stroke diagnosis
Idx	April 2018	Diabetic retinopathy diagnosis
Icometrix	April 2018	MRI brain interpretation
Imagen	March 2018	X-ray wrist fracture diagnosis
Viz.ai	February 2018	CT stroke diagnosis
Arterys	February 2018	Liver and lung cancer (MRI, CT) diagnosis
MaxQ-AI	January 2018	CT brain bleed diagnosis

Topol https://doi.org/10.1038/s41591-018-0300-7

PREDICTIVE ANALYTICS: HIGH UTILIZERS

Identify DM2 Patients That Will Be in the Top 1% of hospital utilizers in 1-5 years



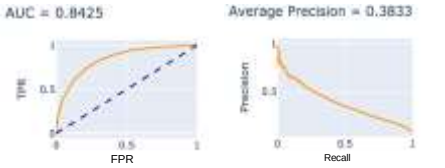
Pilot: Using the model to enroll patients into a Community Health Navigation program in West LA

PREDICTIVE ANALYTICS: END STAGE RENAL DISEASE

Patients may pass away after beginning dialysis prep but before receiving treatment benefit from dialysis.

Patients on dialysis may want to transition off of dialysis to preserve quality of life.

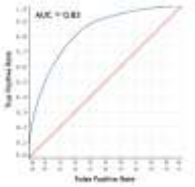
12-month outpatient mortality prediction for CKD Stage IV & V patients



POPULATION MANAGEMENT & PERSONALIZATION: HEALTHY STONES

POPULATION MANAGEMENT & PERSONALIZATION: HEALTHY STONES

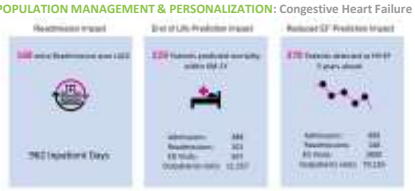
- Recurrence risk model identifies high risk patients to enroll in the healthy stones program
- Time to recurrence model prioritizes patients within the high risk group
- Recurrence Risk Model: AUCROC = 0.83
- Time to Recurrence Model: C-statistic: 0.79



Key Features

1. Ethnic Group - Non-Hispanic/Non-Latino (-)
2. Previous ED utilization (+)
3. Negative UA HGB in the last year (-)
4. 50-100 UA WBCS/HPF in the last year (+)
5. Irritable Bowl Disease
6. High BP (+)
7. UA Specific Gravity in the last year (+)
8. Most recent Cl level
9. Most recent K level
10. Age (-)

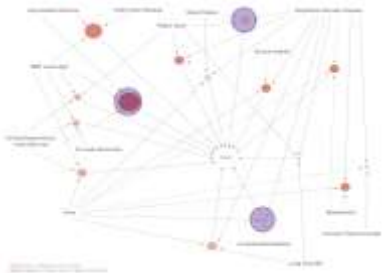
POPULATION MANAGEMENT & PERSONALIZATION: Congestive Heart Failure



Leverage a suite of predictive models that cover the HF care continuum to:

- Increase timely palliative care referrals
- Increase operational efficiency
- Decrease readmissions
- Increase preemptive outreach

POPULATION MANAGEMENT & PERSONALIZATION: Congestive Heart Failure



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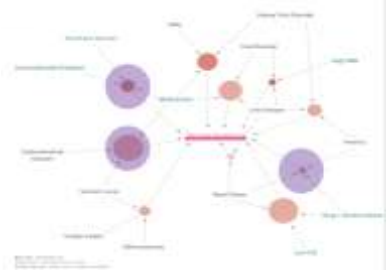
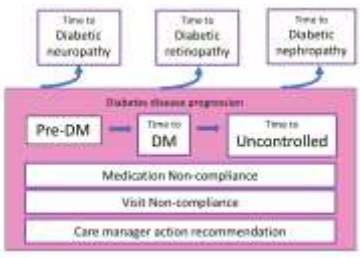
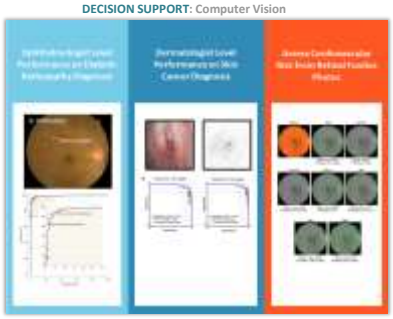


POPULATION MANAGEMENT & PERSONALIZATION: Congestive Heart Failure

POPULATION MANAGEMENT & PERSONALIZATION: Diabetes

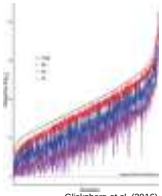


DECISION SUPPORT: Computer Vision



Algorithmic Justice

- Machine learning models predict exactly what they have been trained to predict, their forecasts are only as good as the data used for their training
- Data is not value free but rather a product of the systems that generate and collect the data



Glicksberg et al. (2016)

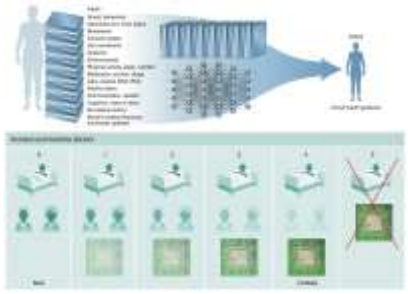
(Arpey et al. 2017)

Algorithmic Justice

- Identify the target population and select training and testing sets accordingly
- Build and test algorithms in socioeconomically diverse health care systems
- Ensure that key variables, such as race/ethnicity, language, and social determinants of health, are being captured and included in algorithms when appropriate
- Test algorithms for potential discriminatory behavior throughout data processing
- Develop feedback loops to monitor and verify output and validity

Gianfrancesco+ (2018)

The Future of AI in Health Care



Thank You!

Questions?