AI in Medicine: Technology and challenges

Julien Martel - CHUM
md, CCMF(mu)
Data Scientist

Disclosure

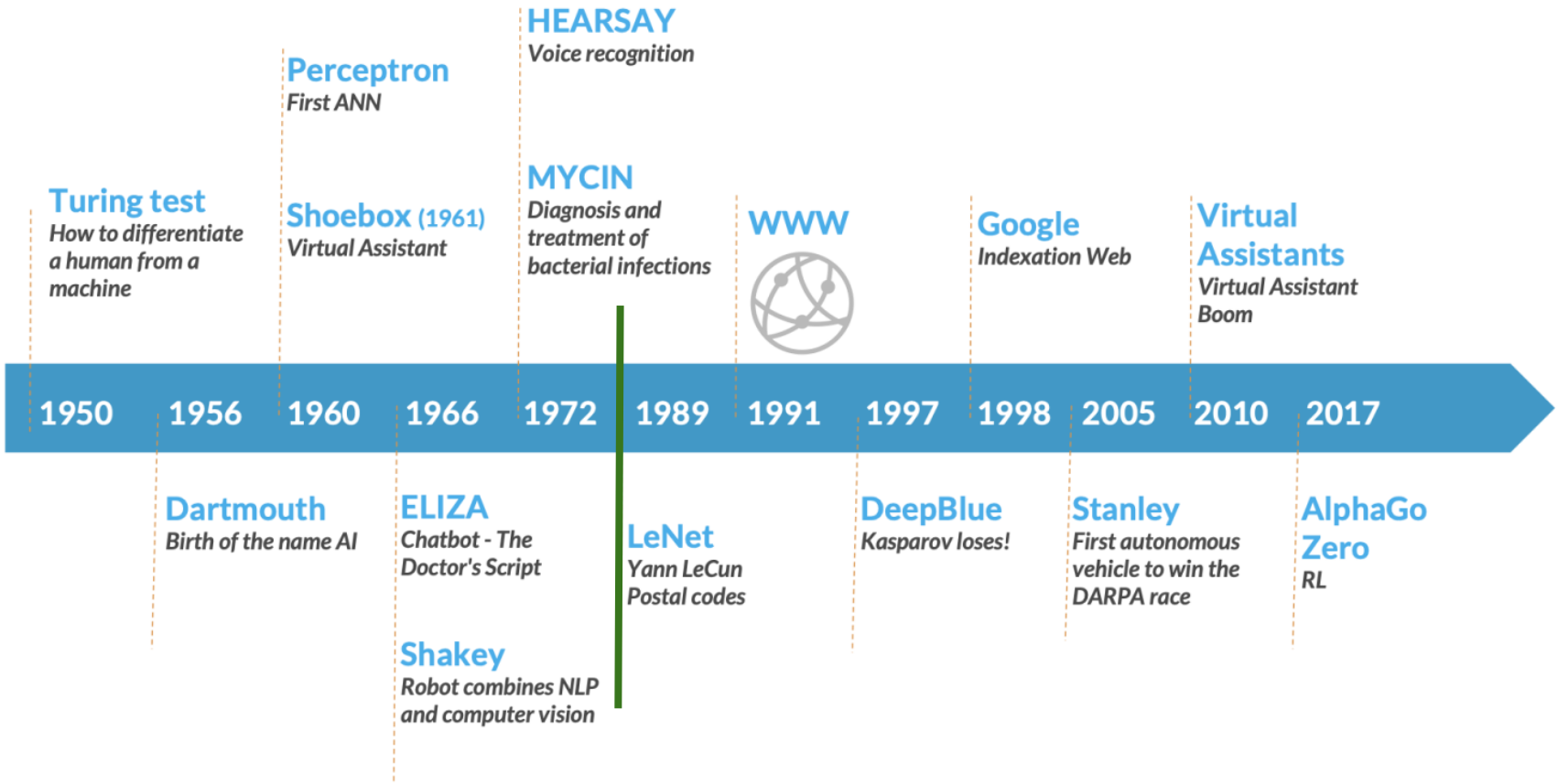
Speaker has no conflict of interest

Objectives

- Understand the basic principles of AI
- Review the applications of AI in medicine
- Understand the potential bias and limitations of AI

How does it work?

A five minutes crash course -- buckle up


HEARSAY
Voice recognition
Perceptron
First ANN
MYCIN
Diagnosis and treatment of bacterial infections
Turing test
How to differentiate a human from a machine
Shoebox (1961)
Virtual Assistant
WWW
Google
Indexation Web
Virtual Assistants
Virtual Assistant Boom
1950
1956
1960
1966
1972
1989
1991
1997
1998
2005
2010
2017
Dartmouth
Birth of the name AI
ELIZA
Chatbot - The Doctor's Script
LeNet
Yann LeCun Postal codes
DeepBlue
Kasparov loses!
Stanley
First autonomous vehicle to win the DARPA race
AlphaGo Zero
RL
Shakey
Robot combines NLP and computer vision

Types of AI

Specific

This is where we are, as of today. Very powerful but very narrow expertise.

i.e. : Hand written letters and digits recognition, play the game of Go.

General

Generalization of expertise across different fields, reasoning, arguing.

Human level intelligence.

Types of AI

Super

Reasoning capacity looks like magic to us

Combined intellect of the entire human race and more

Your guess is as good as mine


apple computer

Types of machine (self) learning

Supervised → The targets are known and labeled (common)

Unsupervised → The targets are determined by the algorithm

Reinforcement → Reward based (+ or -)

Deep learning → Uses multi layered and complex artificial neural networks architecture (this structure can be used for any form of learning*)

Others (semi-supervised, one-shot-learning, One-shot-semi-supervised, deep-RL …)

This is simply heartbreaking. I have a huge respect for Lee Sedol, not only one of the best Go players of all time, but also the one who accepted the challenge from Deepmind to play against AlphaGo not so long ago. He got beaten and it was a huge milestone in the history of artificial intelligence but his retirement from professional go comes as a surprise.

Thinking about loud here. Is this what we can expect to see in medicine too? When the first advanced algorithms using reinforcement learning start coming up with cures and new treatments without explanation, professors will just retire to avoid embarrassment?

#themedicalfuturist #digitalhealth #future #healthcare #medicine #technology #AI #artificialintelligence #chess #deeplearning #machinelearning #TMFchessjourney

Former Go champion beaten by DeepMind retires after declaring AI invincible

theverge.com

160 · 38 Comments

What can it do?

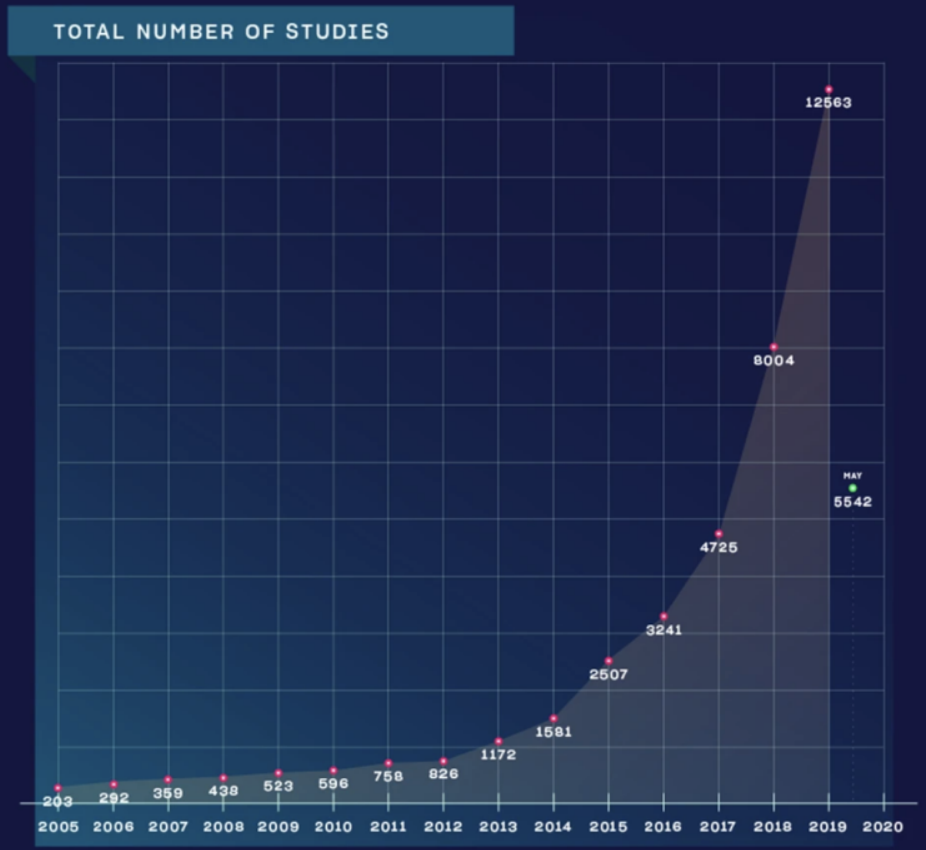
(other than Chess, Go and Atari)

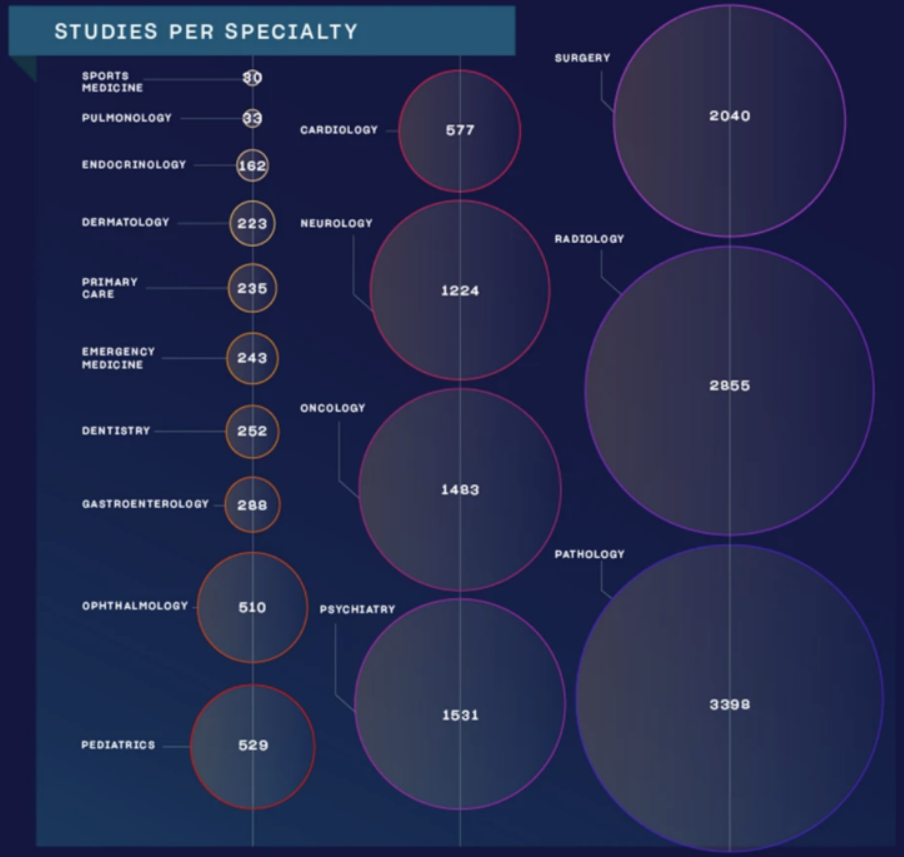
Current applications in medicine

a

b

MACHINE AND DEEP LEARNING STUDIES ON PUBMED.COM





Dermatology

Identification of melanoma with perfect NPV

Radiology

COVID detection in chest CT scans in China

Radio-oncology treatment planning - increase in efficiency

Laboratory

Cellular count and urine analysis

EMR (Epic)

Decision making in real time based on clinical notes and lab reviews using models and NLP

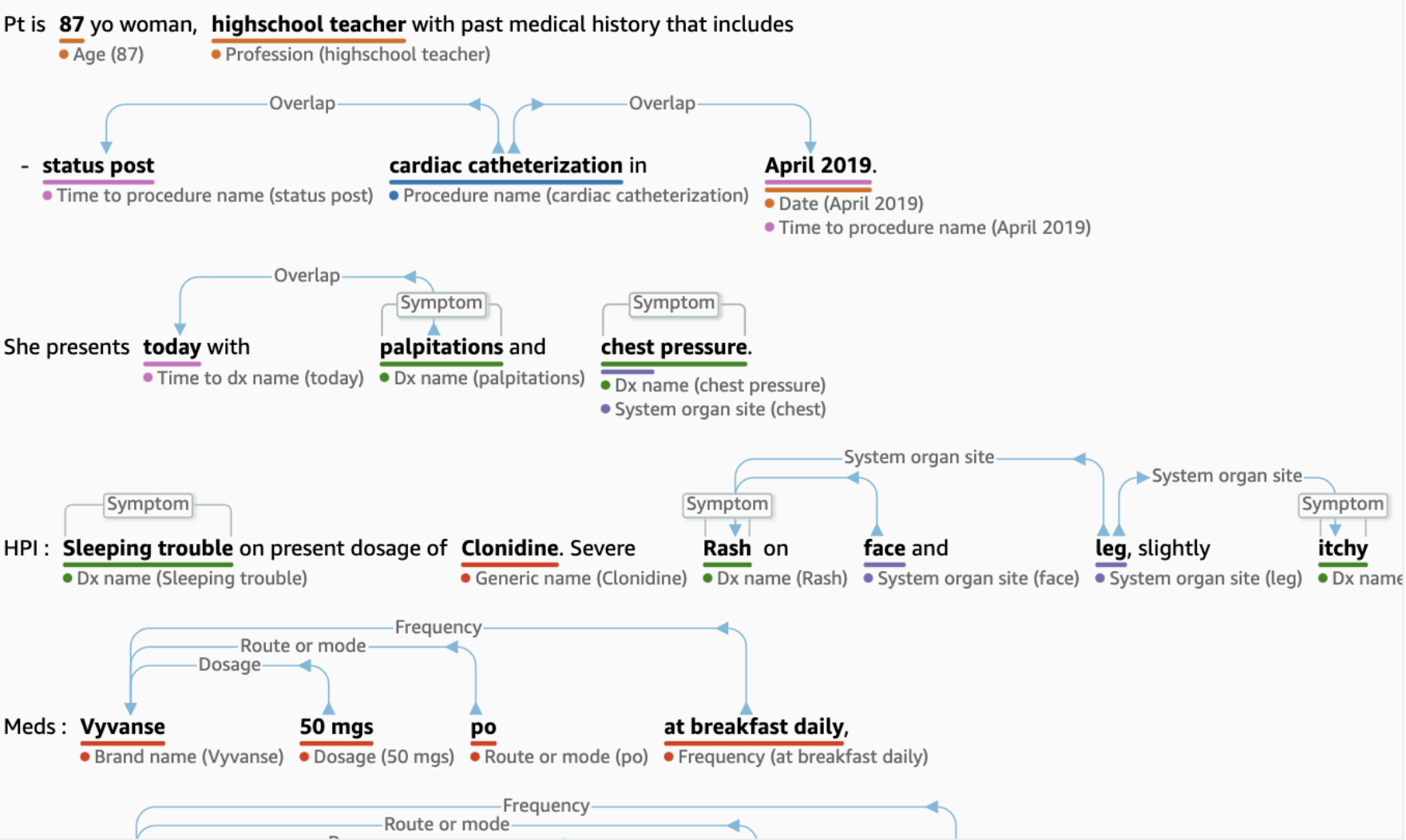
Pharmacology

Drug design (COVID designer particles)

Vaccine mRNA - protein folding prediction (1000x decrease in computation time)

Triage EMS --Predicting need for critical care:

The AI algorithm accurately predicted the need for the critical care of patients using information during EMS and outperformed the conventional triage tools and early warning scores.


Pt is 87 yo woman, highschool teacher with past medical history that includes
Age (87)
Profession (highschool teacher)
Overlap
Overlap
- status post
cardiac catheterization in
April 2019.
Time to procedure name (status post)
Procedure name (cardiac catheterization)
Date (April 2019)
Time to procedure name (April 2019)
Overlap
Symptom
Symptom
She presents today with
palpitations and
chest pressure.
Time to dx name (today)
Dx name (palpitations)
Dx name (chest pressure)
System organ site (chest)
System organ site
System organ site
Symptom
Symptom
Symptom
HPI : Sleeping trouble on present dosage of Clonidine. Severe
Rash on
face and
leg, slightly
itchy
Dx name (Sleeping trouble)
Generic name (Clonidine)
Dx name (Rash)
System organ site (face)
System organ site (leg)
Frequency
Route or mode
Dosage
Meds : Vyvanse
50 mgs
po
at breakfast daily,
Brand name (Vyvanse)
Dosage (50 mgs)
Route or mode (po)
Frequency (at breakfast daily)
Frequency
Route or mode

Dermatologist-level classification of skin cancer

An artificial intelligence trained to classify images of skin lesions as benign lesions or malignant skin cancers achieves the accuracy of board-certified dermatologists.

In this work, we pretrain a deep neural network at general object recognition, then fine-tune it on a dataset of ~130,000 skin lesion images comprised of over 2000 diseases.

FULL NATURE ARTICLE >

OPEN-ACCESS PDF >

What are the main challenges

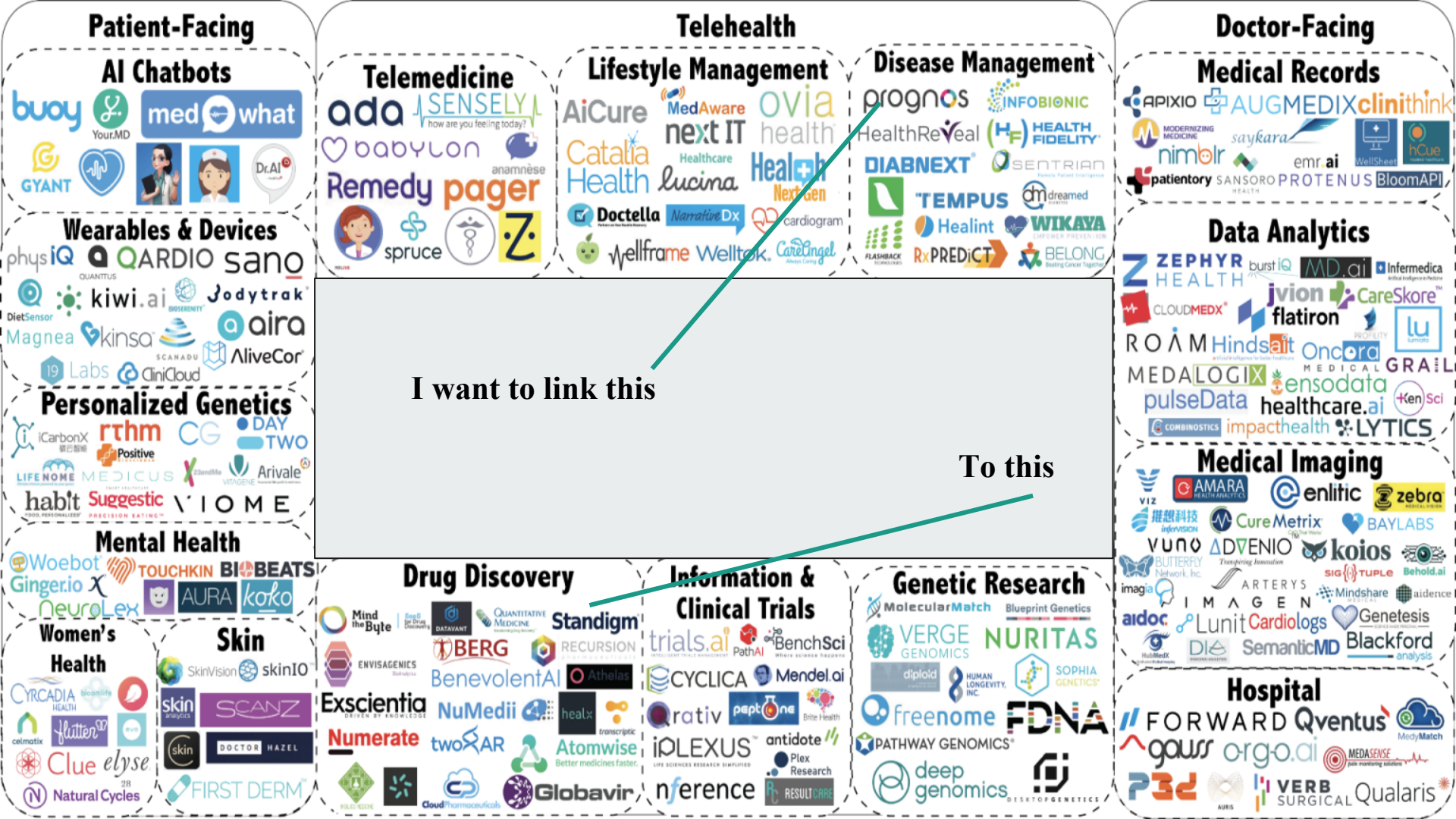
Top Challenges

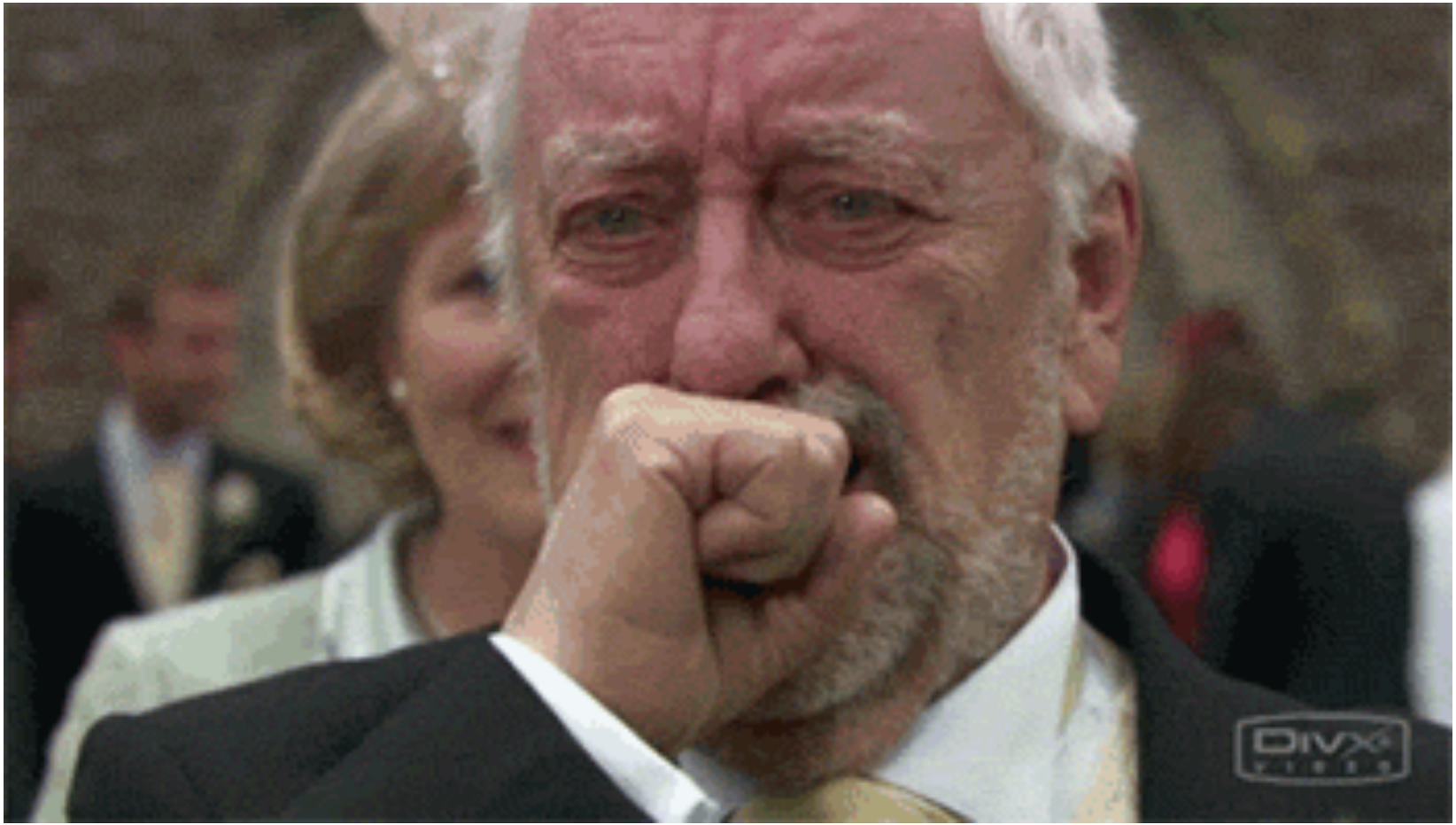
A challenge solved brings a new one to the table

5 important aspects, each a prior to the other

Especially true for algorithms using deep learning

Interoperability


Patient-Facing
AI Chatbots
buoy
Your.MD
medwhat
GYANT
Dr.AI
Wearables & Devices
physiQ
QARDIO
QUANTTUS
sano
DietSensor
kiwi.ai
BIOSERENITY
Jodytrak
Magnea
kinsa
SCANADU
aira
AliveCor
19 Labs
CliniCloud
Personalized Genetics
iCarbonX
rthm
CG
DAY TWO
Positive
LIFENOME
MEDICUS
ZbendMe
VITAGENE
Arivale
habit
Suggestic
VIOME
Mental Health
Woebot
TOUCHKIN
BIOBEATS
Ginger.io
AURA
koko
NeuroLex
Women's Health
CYRCADIA HEALTH
bloomlife
celmatix
flutter
evo
Clue
elyse
28
Natural Cycles
Skin
SkinVision
skinIO
skin analytics
SCANZ
skin
DOCTOR HAZEL
FIRST DERM
Telehealth
Telemedicine
ada
SENSELY
how are you feeling today?
BABYLON
anamnèse
Remedy
pager
spruce
Lifestyle Management
AiCure
MedAware
ovia health
next IT
Catalia Health
Healthcare lucina
Health Next Gen
Doctella
NarrativeDx
cardiogram
wellframe
Welltok
CareAngel
Disease Management
prognos
INFOBIONIC
HealthReveal
HEALTH FIDELITY
DIABNEXT
SENTRIAN
"TEMPUS
dreamed
FLASHBACK TECHNOLOGIES
Healint
WIKAYA
RxPREDICT
BELONG
I want to link this
To this
Drug Discovery
Mind the Byte
DATAVANT
Quantitative Medicine
Standigm
ENVISAGENICS
BERG
RECURSION
BenevolentAI
Athelas
Exscientia
NuMedii
healx
transcriptic
Numerate
twoXAR
Atomwise
Better medicines faster.
Globavir
CloudPharmaceuticals
Information & Clinical Trials
trials.ai
PathAI
BenchSci
CYCLICA
Mendel.ai
Qrativ
pepTone
Brite Health
iQLEXUS
antidote
Plex Research
nference
RESULTCARE
Genetic Research
MolecularMatch
Blueprint Genetics
VERGE GENOMICS
NURITAS
diploid
HUMAN LONGEVITY, INC.
SOPHIA GENETICS
freenome
FDNA
PATHWAY GENOMICS
deep genomics
DESKTOP GENETICS
Doctor-Facing
Medical Records
APIXIO
AUGMEDIX
clinithink
MODERNIZING MEDICINE
saykara
nimblr
emr.ai
WellSheet
hCue
patientory
SANSORO HEALTH
PROTENUS
BloomAPI
Data Analytics
ZEPHYR HEALTH
burstIQ
MD.ai
Infermedica
CLOUDMEDX
jvion
CareSkore
flatiron
ROAM
Hindsait
Oncora MEDICAL
GRAIL
MEDALOGIX
ensodata
pulseData
healthcare.ai
KenSci
COMBINOSTICS
impacthealth
LYTICS
Medical Imaging
VIZ
AMARA
enlitic
zebra
CureMetrix
BAYLABS
VUNO
ADVENIO
koios
BUTTERFLY Network, Inc.
SIGTUPLE
Behold.ai
imagia
ARTERYS
Mindshare
aidence
IMAGEN
aidoc
Lunit
Cardiologs
Genetesis
HealthMedX
DIA
SemanticMD
Blackford analysis
Hospital
FORWARD
Qventus
MedyMatch
gauss
orgo.ai
MEDASENSE
P3d
AURIS
VERB SURGICAL
Qualaris



Solving EHRs problem

Naming convention (FHIR, DICOM, HL7, SNOMED)

Should be part of the accreditation of EHR

APIs -- one rule to connect them all

Data Access and Privacy

Who and how?

AI is already commoditized by big corporations.

How will we give the power back to the patient?

What are the current data pipelines in place?

Who will benefit from the access to raw data?

Bias

MPW • AMAZON

Amazon Reportedly Killed an AI Recruitment System Because It Couldn't Stop the Tool from Discriminating Against Women

BY **DAVID MEYER**

October 10, 2018 6:00 AM EST

Is there a gold standard?

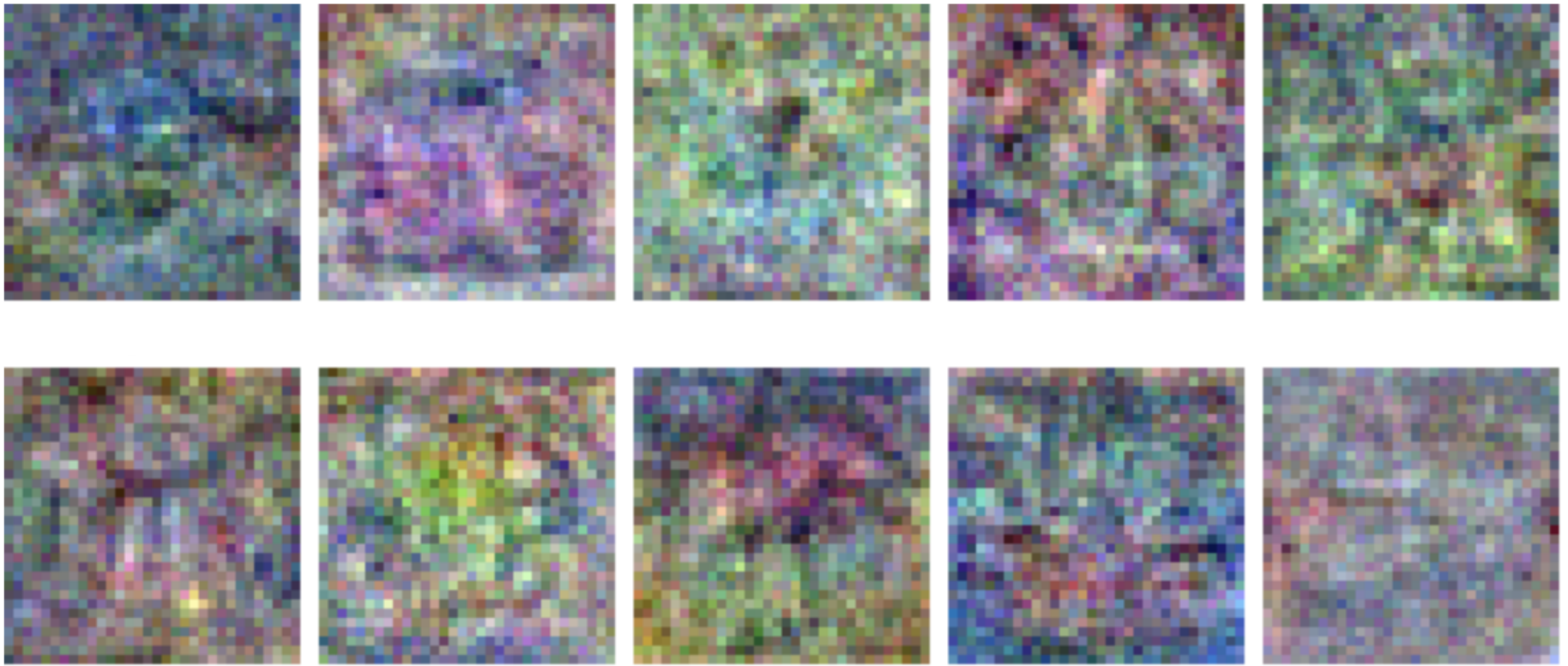
None-deterministic and complex outcomes are mostly biased

Culture bias, population bias, organizational bias → Supervised algorithms are only as good as the data provided.

Interobserver agreement and performance expectations

Explainability

Doctor, can you explain why I can go home now?



Visualizing the weights for 1-layer CIFAR-10 classifier

Major challenge

Mostly for deep learning algorithms

Lots of research in the field. The black box is more or less grey now.

Human mind is a perfect example of a black box - but we are self aware

Relevant in decision making

Liability

Liability issues

If there is no human in the decision process and a medical facility uses an algorithm, that facility would be liable if an harm causing mistake occurs.

Think of medical tools - they have performance metrics. Same goes with AI

Importance of validation studies

Augmented intelligence and human in the loop AI

AI team member concept

Summary

Many algorithms are used in artificial intelligence in order to solve a problem

We mostly use specific AI and we are far from general or super intelligence

AI is applied everywhere in our daily lives and is vastly used in medicine

Explainability will be a tough challenge to solve in medicine

Thanks!

References

Meskó, B., Görög, M. A short guide for medical professionals in the era of artificial intelligence. *npj Digit. Med.* 3, 126 (2020). https://doi.org/10.1038/s41746-020-00333-z

Kang, D. Y. et al. Artificial intelligence algorithm to predict the need for critical care in prehospital emergency medical services. *Scand. J. Trauma Resusc. Emerg. Med.* 28, 17 (2020).

Panch, T., Mattie, H. & Celi, L. A. The “inconvenient truth” about AI in healthcare. *npj Digit Med.* 2, 77 (2019).

World Health Organization. Big data and artificial intelligence. https://www.who.int/ethics/topics/big-data-artificial-intelligence/en/.

Fornell, D. Artificial intelligence greatly speeds radiation therapy treatment planning. itnonline.com. https://www.itnonline.com/article/artificial-intelligence-greatly-speeds-radiation-therapy-treatment-planning (2020).

Bzdok, D., Altman, N. & Krzywinski, M. Statistics versus machine learning. *Nat. Methods.* 15, 234–235 (2018).

Topol, E. J. High-performance medicine: the convergence of human and artificial intelligence. *Nat. Med*. 25, 44–56 (2019).