FINANCIAL OPPORTUNITIES FORUM

Mr. Raunak Onkar

Research Head & Fund Manager

PPFAS Mutual Fund

Today's topic:

AI Applications - AI in Medicine

Upcoming FOFs:

- 14th December, 2023 | Thursday
- 18th January, 2024 | Thursday
- 22nd February, 2024 | Thursday

All archives available at ppfasfof.com

AI in Medicine

Goals of Medical AI

- Early Detection
- Speed of Diagnosis
- Administrative Speed
- Wider Access
  - Cost
  - Geography
  - Time
- Mainstream Acceptance
- Consumerization of Medical Tech
- Patient Monitoring

Live Applications

- Radiology + Screening
  - Oncology, Ophthalmology, Cardiology, Neurology, Pulmonology, Dermatology, Orthopedics
- Medical Administration
  - Transcription
  - Patient Record Management
  - Medical Compliance & Continuous Monitoring
  - Mental Health
- Genomic Studies
- Drug Development

“Is AI going to replace medical professionals?”

*“We should stop training Radiologists.”**

Geoffrey Hinton - 2015

Andrew Ng

@AndrewYNg

Follow

Should radiologists be worried about their jobs? Breaking news: We can now diagnose pneumonia from chest X-rays better than radiologists. stanfordmlgroup.github.io/projects/chexn...

3:20 PM - 15 Nov 2017 from Mountain View, CA

1,401 Retweets **2,363** Likes

112 1.4K 2.4K

Technology will bring down workloads and shortage of radiologists

Given that radiologists in India are in short supply with only 20,000 or so for a population of 1.4 billion (a grossly inadequate ratio of 1:100,000) subspecialist radiologists who form a further fraction of this number are in even greater shortage. Technology in the form of teleradiology can play an important role in increasing the access of subspecialist radiologists by bringing images to them instead of vice versa.

Prathiba Raju • ETHealthWorld

Updated On Mar 25, 2023 at 06:08 PM IST

AI IN DIAGNOSTIC IMAGING

CENTRALIZED PLATFORM (IIOT)

IMAGE ACQUISITION	RADIOLOGY WORKFLOW	POST-PROCESSING	DIAGNOSTIC AIDS (CADx)	TRAINING RADIOLOGISTS
• Patient positioning for MRI • Optimal use of contrast agents • Faster MRI scan times through under-sampling and reconstruction	• Real time scan quality analysis • Post-acquisition assessment prioritization • Information management / Treatment planning • Coordination of AI applications	• Automatic labelling of anatomy (e.g. adjacent organs at risk) • Automatic identification of lesions • Additional measurements and metrics	• Identifying areas of concern for further investigation (e.g. U/S for fatty liver disease) • Identifying aggressive forms of tumour (e.g. in prostate cancer) • Suggesting relevant elements of patient history or clinically similar historic cases	• One highly skilled radiologist can only train a limited number of new radiologists in one location • If the skilled radiologist trains an AI tool, then that AI tool can be used to train many more radiologists all over the world
Philips, Healthineers, GE, academic researchers	*Philips, Healthineers, GE,Canon Sectra, TeraRecon, Start-ups (Quantib, MIM, Viz.ai)*	*Philips, Healthineers, GE, Start-ups (Aidoc, MIM, Nanox.ai)*	*Philips, Healthineers, GE, Sectra, Start-ups (Arterys, Aidoc, Viz.ai)*	*Philips, Healthineers, GE, Start-ups*

Source: Bernstein

Leading OEMs

PHILIPS

SIEMENS Healthineers

GE HealthCare

Canon

Challengers & Start-ups

TERARECON
A ConcertAI Company

ARTERYS

SECTRA

Google DeepMind

IBM Watson Health

Quantib

mim SOFTWARE

NANOXAI

viz.ai

HeartFlow

aidoc

Best placed for efficiency improvement tools, with some diagnostics aids

A focus on diagnostic aids, workflow and efficiency improvements

Source: Bernstein

Chest X-ray Pathology Detection

Pathology	Wang & Summers 2017	Rajpurkar & Ng 2017	Our method
Atelectasis	0.80 ± 0.00	0.8094	0.8143
Cardiomegaly	0.87 ± 0.01	0.9248	0.9129
Consolidation	0.80 ± 0.01	0.7901	0.811
Edema	0.88 ± 0.01	0.8878	0.922
Effusion	0.87 ± 0.00	0.8638	0.8884
Emphysema	0.91 ± 0.01	0.9371	0.9174
Fibrosis	0.78 ± 0.02	0.8047	0.8148
Hernia	0.77 ± 0.03	0.9164	0.8388
Infiltration	0.70 ± 0.01	0.7345	0.7265
Mass	0.83 ± 0.01	0.8676	0.8487
No Finding	-	-	0.7889
Nodule	0.75 ± 0.01	0.7802	0.7553
Pleural Thickening	0.79 ± 0.01	0.8062	0.8076
Pneumonia	0.67 ± 0.01	0.7680	0.7698
Pneumothorax	0.87 ± 0.01	0.8887	0.8884

Article | Open Access | Published: 15 September 2022

Expert-level detection of pathologies from unannotated chest X-ray images via self-supervised learning

Ekin Tiu, Ellie Talius, Pujan Patel, Curtis P. Langlotz, Andrew Y. Ng & Pranav Rajpurkar

Nature Biomedical Engineering **6**, 1399–1406 (2022) | Cite this article

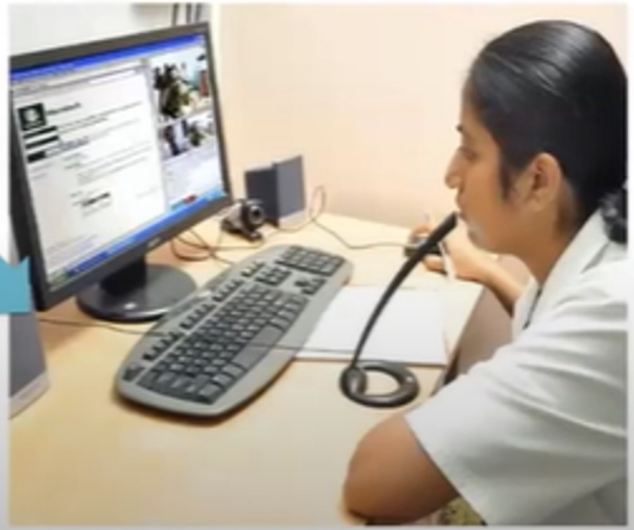
The Clinical Workflow

TEDx NapierBridge

x = independently organized TED event

In the Vision(Primary eye care center) Center

AI Tool



DR Tele-Screening

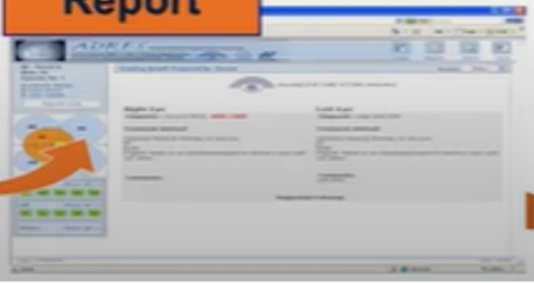
Diabetology Clinic

Counseling

Internet

Turn around time – 1 hour

Report



Internet

Challenges in Real time

- Environmental challenges
  - Ambient Light conditions
- Human challenges
  - Operator Skill
  - Frequently Changing technicians
  - Changing Priorities
- Patient factors
  - Very difficult to convince for every patient to get the fundus photo taken
  - Patient compliance
- Other factors
  - Ungradable Images (Presence of cataract, Small pupil)
  - Single field

AI algorithm for DR

- There are any number of AI algorithms for DR screening available today

Artificial Intelligence and Machine Learning (AI/ML)-Enabled Medical Devices

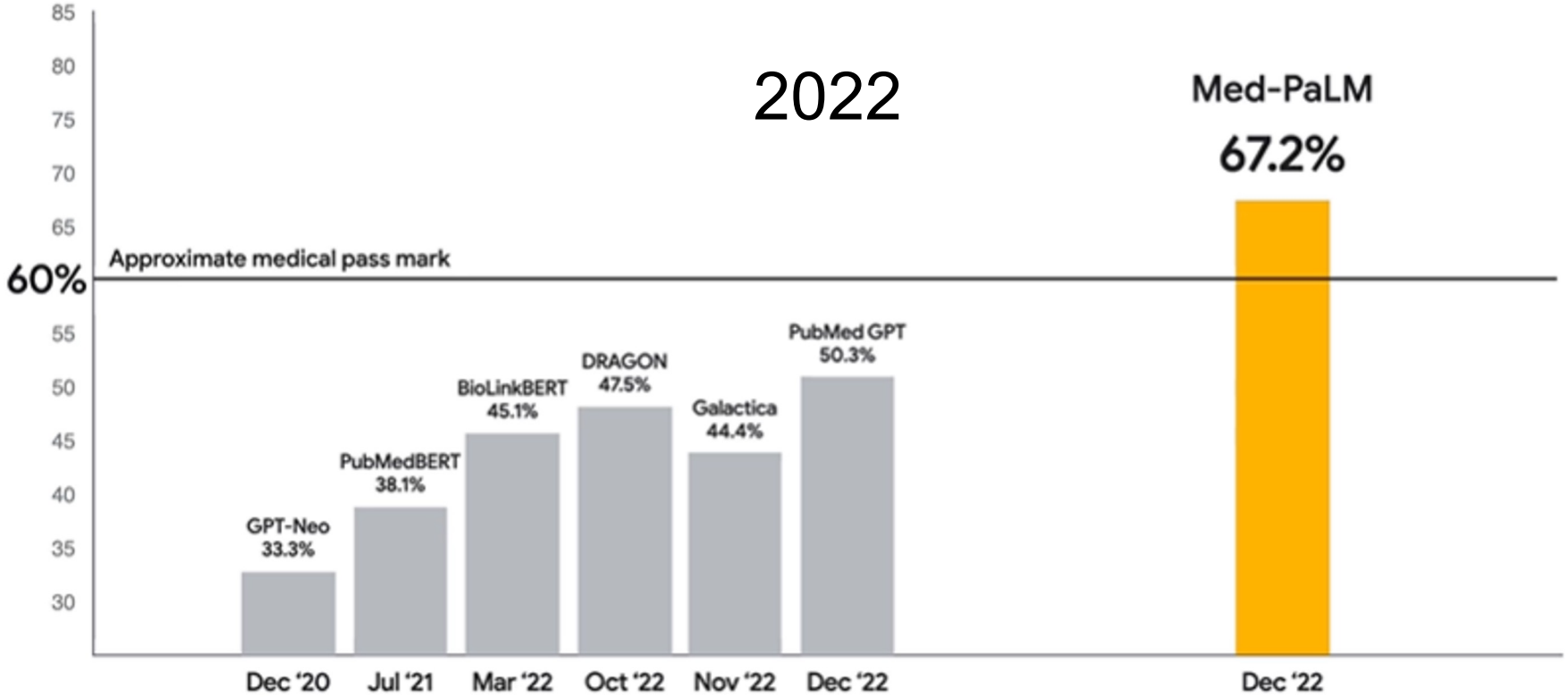
October 19, 2023 update: 171 Artificial Intelligence and Machine Learning (AI/ML)-Enabled Medical Devices were added to the list below. Of those newly added to the list, 155 are devices with final decision dates between August 1, 2022, and July 30, 2023, and 16 are devices from prior periods identified through a refinement of methods used to generate this list.

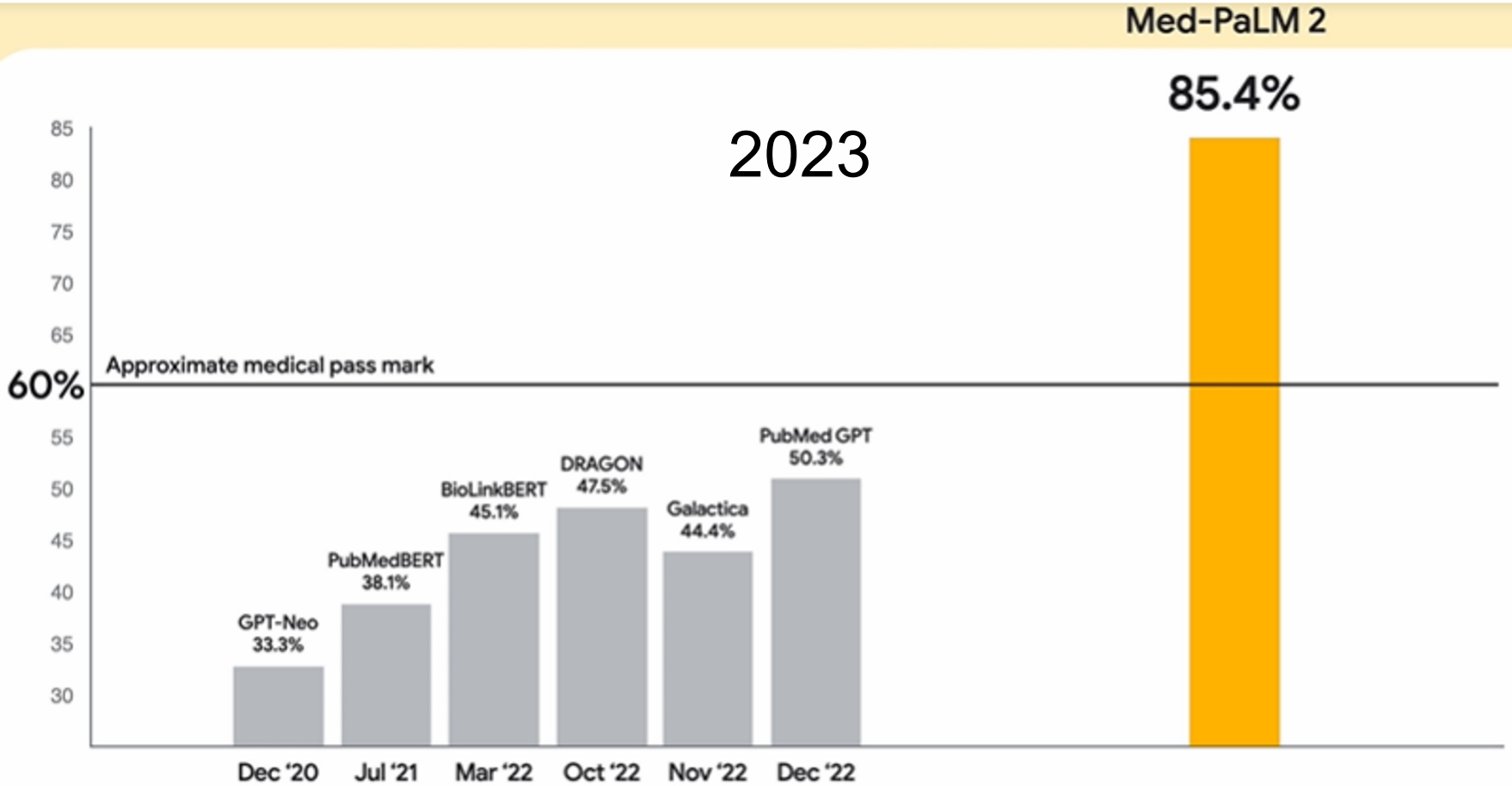
Quality Evaluation of AI in Clinical Practice

"To ensure a fair selection, the examination task *is the same* for all of you: Climb the tree!"

Auditing AI efficiency

- Total number of randomly selected 260 images were reviewed by the Retina Specialist
  - From 26 Centers
  - Using 3 types of non mydriatic cameras
- Missed Referral - 3.5%


2022
Med-PaLM
67.2%
85
80
75
70
65
60%
55
50
45
40
35
30
Approximate medical pass mark
GPT-Neo
33.3%
PubMedBERT
38.1%
BioLinkBERT
45.1%
DRAGON
47.5%
Galactica
44.4%
PubMed GPT
50.3%
Dec '20
Jul '21
Mar '22
Oct '22
Nov '22
Dec '22
Dec '22


Med-PaLM 2
85.4%
2023
85
80
75
70
65
60%
55
50
45
40
35
30
Approximate medical pass mark
GPT-Neo
33.3%
PubMedBERT
38.1%
BioLinkBERT
45.1%
DRAGON
47.5%
Galactica
44.4%
PubMed GPT
50.3%
Dec '20
Jul '21
Mar '22
Oct '22
Nov '22
Dec '22

AI For Medical Research

- Download publicly available labeled / unlabeled data from the web
- Download CNN code from github (for free) OR
- Use existing pre-trained transformer model **(New)**
- Perform Supervised Learning on your labelled data
- Publish Papers

AI in Drug Discovery

AI in Drug Discovery

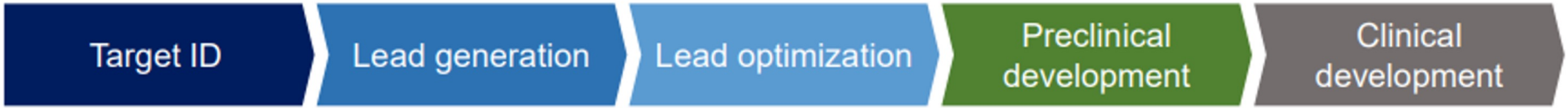
- [**OLD**] invitro > invivo > Human Trials > Approval
- [**NEW**] insilico > invitro > invivo > Human Trials > Approval
  - Identify Disease Targets
  - Simulate Molecules
  - Predict Drug’s Properties / Side Effects
  - Completely New Molecules
  - Prioritize Potential Drug Candidates
- Alphafold 1 (2019) - 3,33,000 protein structures
- Alphafold 2 (2022) - 200 Million protein structures

AlphaFold—for predicting protein structures

2023 Albert Lasker Basic Medical Research Award

Demis Hassabis
Google DeepMind

John Jumper
Google DeepMind



- Identify new targets using AI mining of genomics / omics / HER data
- Map novel disease pathways, protein / drug interactions using AI analysis of networks (knowledge graphs)
- Apply NLP to scientific/IP literature
- Mine proprietary wet lab data

- Protein modeling
- Virtual screening using in silico compound libraries
- Predicting structure-activity relationships
- Generating lead-like or drug-like molecules
- In silico design of large molecules

- Drug protein interactions
- Molecular motion dynamics
- Generative modeling
- Multi-parameter optimization (potency, solubility, specificity)
- Using AI to predict optimal synthesis path

- Analyze phenotypic data
- FIH dose prediction
- ADME/T DMPK prediction

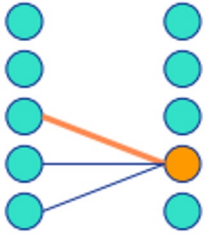
- Biomarker selection
- Patient response prediction
- Patient selection, trial size and recruitment
- Site selection
- Drug repurposing

Source: Bernstein

Company	AI Partnerships
Lilly	Atomwise, BiolojicDesign, Genesis Therapeutics, VERGE GENOMICS
Johnson & Johnson	ConcertAI, SRI International, TEMPUS
novo nordisk	dewpoint$_x$, HighRes biosolutions, Microsoft
MERCK	absci, Numerate
Roche	RECURSION, Shape^{TX}
abbvie	AnimaBiotech, cerebras
AstraZeneca	Benevolent^{AI}, BPG^{bio}, deepmatter, GATEHOUSE BIO, illumina, TEMPUS, THORNE
Pfizer	Alex Therapeutics, anumana, Atomwise, ConcertAI, CytoReason, GERO; IKTOS, Insilico Medicine, PostEra, TEMPUS, XtalPi
NOVARTIS	amazon, Dyno Therapeutics, Microsoft
Bristol Myers Squibb	ENVISAGENICS, evotec, Exscientia, PathAI, Sensyne Health, iz.ai
sanofi	Atomwise, Exscientia, Insilico Medicine
AMGEN	Generate:Biomedicines, Genus, VERANTOS

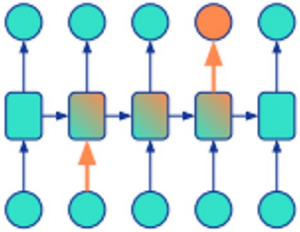
Source: Bernstein

Inductive Bias for Deep Learning Models



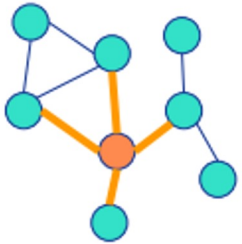
Convolutional Networks (e.g. computer vision)

- data in regular grid
- information flow to local neighbours



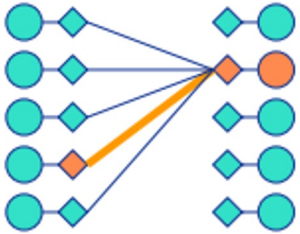
Recurrent Networks (e.g. language)

- data in ordered sequence
- information flow sequentially



Graph Networks (e.g. recommender systems or molecules)

- data in fixed graph structure
- information flow along fixed edges

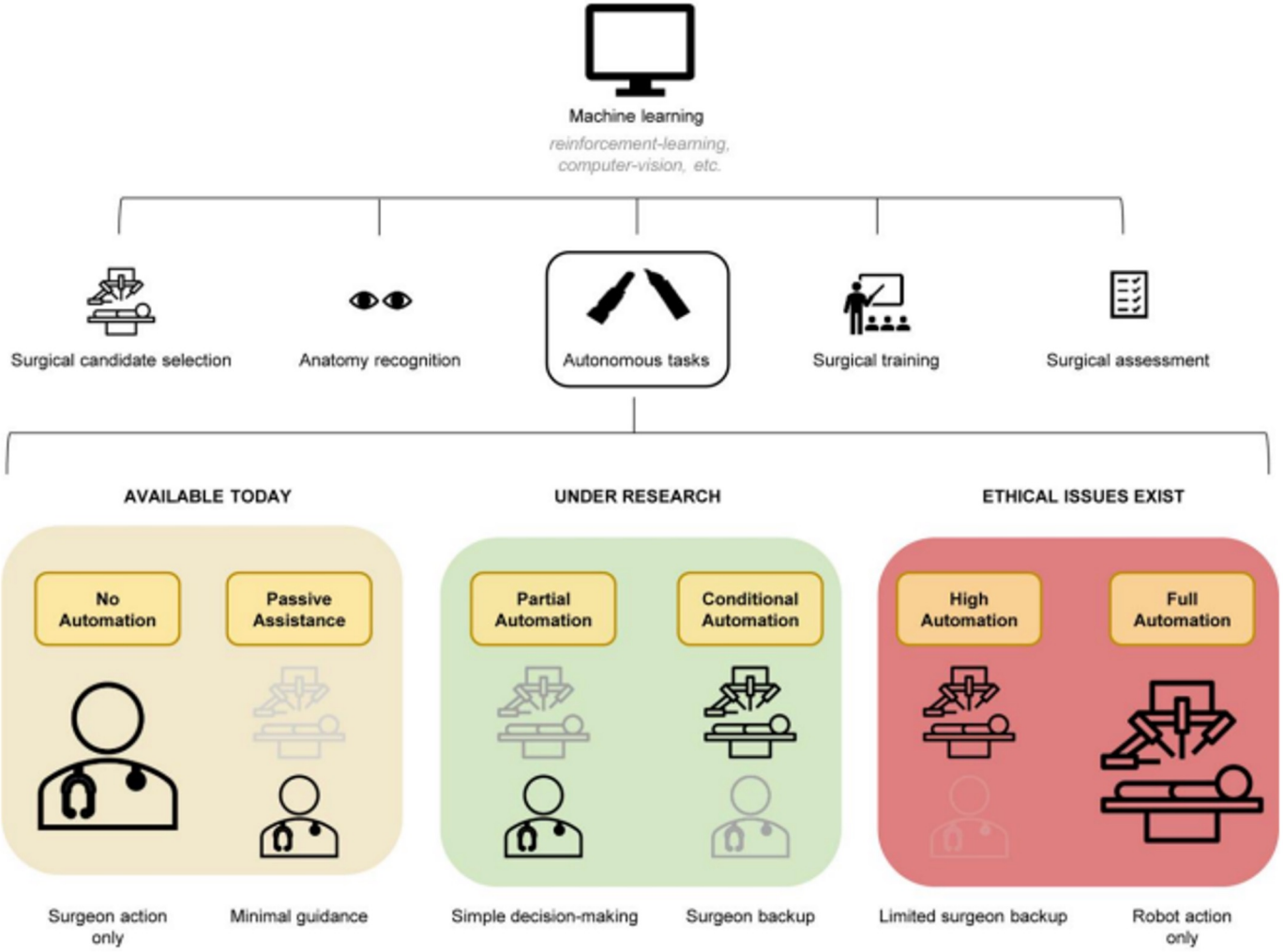


Attention Module (e.g. language)

- data in unordered set
- information flow dynamically controlled by the network (via keys and queries)

Turning a Biological Problem into a Computational Problem

AI in Surgery



Source: Bernstein

Prometheus (2012) - Pregnancy Scene
Med pod robotic surgery

Future of AI in Medicine (Clinical & Research)

- Need more unsupervised studies with reinforcement learning
- **Explainable AI:** The AI should explain how it reached the conclusion.
- Deploy AI tools to improve education, clinical processes & administrative activities.
- Improve Temporal Understanding of Patient Data
- Generalist Medical AI

Challenges in AI Adoption in Medicine

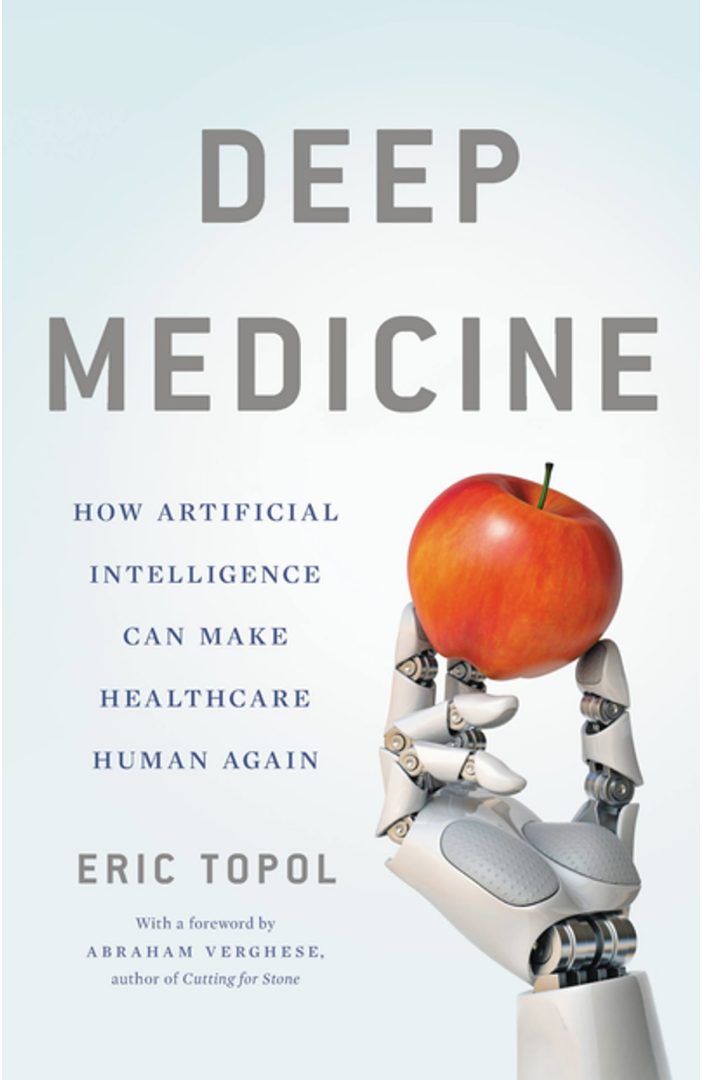
- Automating the process too soon (ignoring the people aspect)
- Mixed Results / Improper Implementation
- Prototype is not a product
- Poor Product Market fit
- Availability of Multi-Modal Data
- Data Ownership
- Incentives / Legal Liability / Safety
- ”Watson” Risk
- “Theranos” Risk

An investment case?

- Medical Equipment Manufacturers
- AI models
- Infrastructure Utilization
- Patient Care Improvement > Productivity Improvement?
- Diagnostics (more volume & lower costs?)
- Spend less on R & more on D
- SaaS products for medical professionals
- Better EHR systems

Deep Medicine

Dr Eric Topol



Thank you