

BRINGING DEEP LEARNING TO ENTERPRISE IMAGING CLINICAL PRACTICE

Esteban Rubens

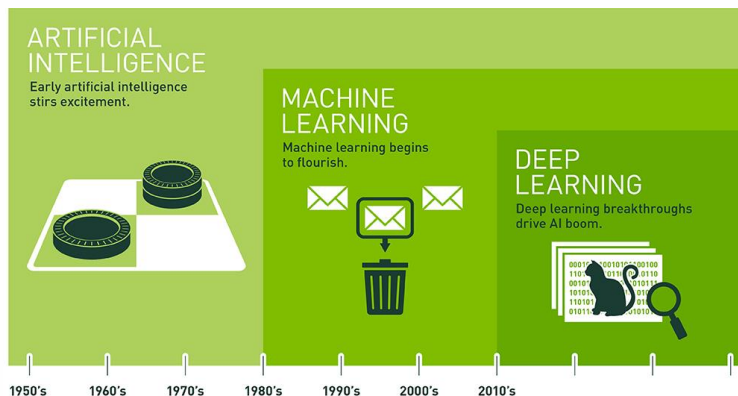
**Global Enterprise Imaging Principal
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@pureesteban

AI IN HEALTHCARE

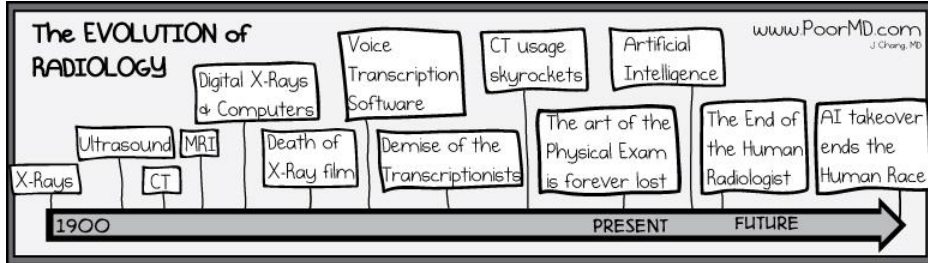
What is Artificial Intelligence (AI)?

How is AI different from Machine Learning (ML) and Deep Learning (DL)?

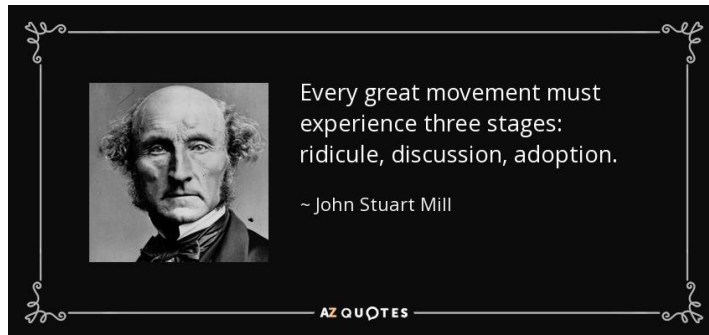


Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

AI IN HEALTHCARE: HYPE OR NOT?

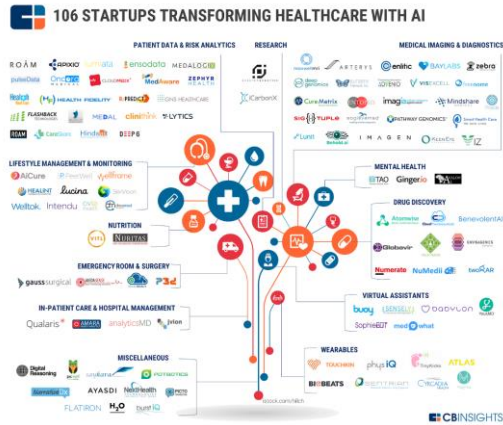


AI IN HEALTHCARE: HYPE OR NOT?



AI IN HEALTHCARE: HYPE OR NOT?

- Over 100 papers on ML at RSNA 2017
 - ML Showcase, a first in 103 years!
 - ML Showcase in 2018
 - Over 80 companies
- HIMSS 2018 & 2019
 - AI pre-conference event
- SIIM C-MIMI (3rd annual in 2018)
- MICCAI (Medical Image Computing and Computer Assisted Intervention Society)
 - 21st conference held in September 2018
 - 70 percent of the 400 papers to be featured at the conference use AI



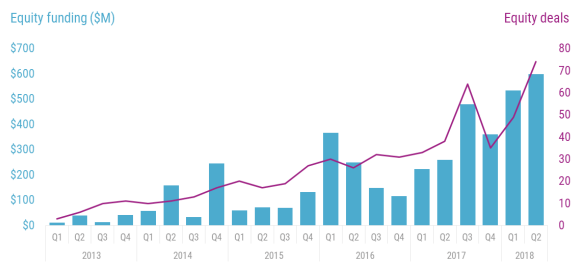
AI IN HEALTHCARE: HYPE OR NOT?

What is necessary for AI to become a reality in healthcare?

- Support by funding agencies
 - NIH is funding AI
- Recognition by regulators
 - FDA approvals for CADe & CADx
 - FDA *De Novo* process
- Investment by industry

AI in healthcare funding hit a historic high in Q2'18

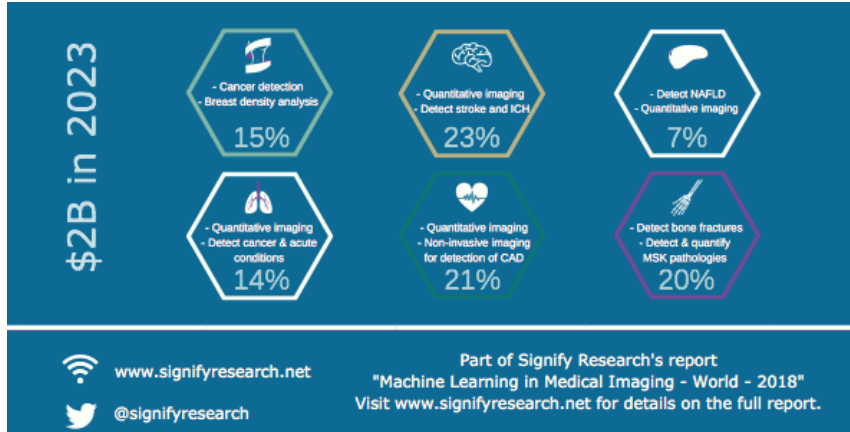
Disclosed equity funding, Q1'13 - Q2'18



Source: cbinsights.com

CBINSIGHTS

AI IN HEALTHCARE: HYPE OR NOT?



AI IN HEALTHCARE

- **Augment human abilities**
- **Give doctors time back to be doctors**
- **Almost endless opportunities**



INFRASTRUCTURE MATTERS

AI IN ENTERPRISE IMAGING

INFRASTRUCTURE MATTERS

- What is GPU starvation anyway?
- Why do we care?
- How is this related to AI in healthcare?



TRANSLATIONAL REQUIREMENTS

Solution: Increase amount of training data

Vast amounts of annotated data

+

Multiple training runs

Increase model inference accuracy

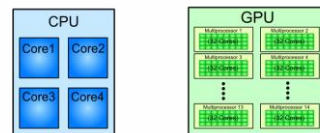


Microsoft

INCREASING INFERENCE ACCURACY

- Fast compute
 - GPUs for highly parallel workloads
- Fast networks
 - 100 Gbps!
- Fast storage
 - Highly-scalable, low-latency storage optimized for parallel access
 - Scale-out all-flash arrays

CPU/GPU Architecture Comparison



INFRASTRUCTURE MATTERS

- Bring AI from the lab to the bedside
- Is your IT infrastructure ready?
- What may have worked yesterday may not work tomorrow
- Retrofitting is not always a good idea



© Getty Images

INTEGRATING AI TO EXISTING WORKFLOWS

- Train models appropriately
- Clinical use requires:
 - High accuracy
 - Specificity & sensitivity depending on use
 - Low latency
 - Even under heavy load



WHERE DOES AI FIT IN ENTERPRISE IMAGING?

AI IN ENTERPRISE IMAGING

AI IN EI FILLS THE GAPS

DATA DELUGE

- The number of images that radiologists need to interpret is growing faster than the human resources needed to look at them
 - AI can bridge that gap, both in mature and in emerging economies
- Radiologists are measured on productivity, have SLAs
- Increased latency as a response to high concurrency is unacceptable
- Diagnostic radiology exceeds human limits



REAL-LIFE EXAMPLES OF AI IN EI

Point-of-Care Ultrasound

- Bringing imaging coverage to billions of people for whom imaging had never been available
- Who will interpret those images?
- Shortage of radiologists around the world, particularly in developing countries
- AI can bridge the gap



AI IN EI FILLS THE GAPS

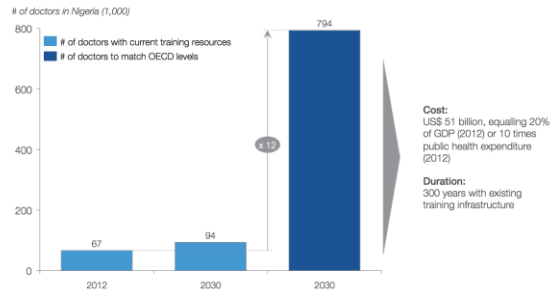
RADIOLOGIST SHORTAGE

Exhibit 1: Imitating Traditional Development Paths Is Impossible for Emerging Economies
Nigeria would need over 700,000 additional doctors to reach OECD levels by 2030

Sources: World Bank, WHO, Africa Health Workforce Observatory, BMI, IFC, BCG

Shortage of radiologists

- Technology is necessary to fill the existing gap in access to care
- AI can do that in EI
- Most countries in Africa have NO pediatric radiologists



HIMSS
transforming healthcare through IT

architects of change

AI IN EI FILLS THE GAPS

RADIOLOGIST SHORTAGE

Shortage of radiologists

- Radiologist coverage in less-populated areas
- No need to be beholden to a Nighthawk service
- Immediate access to subspecialty-level expertise

HIMSS
transforming healthcare through IT

architects of change

AI IN EI FILLS THE GAPS

RADIOLOGIST SHORTAGE

Shortage of radiologists

- Not just in the developing world

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Health

Radiologist shortage 'affecting cancer care' in the UK

By Hugh Pym
Health editor

22 August 2018

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Scotland

Radiologist shortage in Scotland 'red alert' warning

14 August 2018

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Amritsar

Posted at: Feb 9, 2017, 12:55 AM; last updated: Feb 9, 2017, 12:55 AM (IST)

Shortage of radiologists aggravates patients' misery

Shortages of radiologists and pathologists? Alberta Health Services responds.

AI IN EI FILLS THE GAPS

RADIOLOGIST SHORTAGE

Computers are not better than radiologists but they can improve patient care by doing things that they are better at doing – things that are often left undone

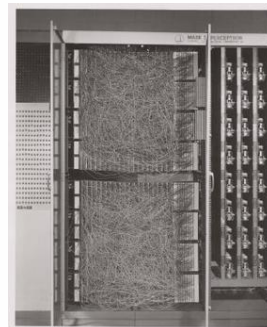
- Auto-alert for possible strokes (CT)
- Highlight nodules (CT, MR, US, XR)
- Portable device auto-referral to specialist
- Auto-segment with one-click override
- Highlight relevant changes between scans
- Show similar patient histories

AI IN EI FILLS THE GAPS

AUGMENTED INTELLIGENCE

“AI is just a fad”

- The first neural networks were developed in the 1950s
 - Perceptron in 1957
- They are finally starting to be useful
- GPU compute, fast storage and fast networks are making this possible



AI IN EI FILLS THE GAPS

AUGMENTED INTELLIGENCE

“AI will make radiologists sloppy”

Did ABS or traction control make drivers sloppy?

Did autopilot make pilots sloppy?

AI IN EI FILLS THE GAPS

AUGMENTED INTELLIGENCE

“Deep Learning is just another tool”

Not just another tool as it is now better than many other tools.

Deep Learning is mathematically provable to be able to approximate any function to an arbitrary precision

REAL-LIFE EXAMPLES

AI IN ENTERPRISE IMAGING

REAL-LIFE EXAMPLES OF AI IN EI

Digital Pathology

- A State University in the Midwest is digitizing their whole pathology slide archive (1.8 GB per slide) in order to do deep learning research on that data and apply it to patient care.
- Breast cancer: HER2 scoring from slides impacts treatment options
- Brain cancer: glioma characterization from MRI (non-invasive 1p/19q codeletion detection) impacts treatment options
- The first FDA-approved Pathology PACS, many others coming

Global Engage 

**4TH DIGITAL PATHOLOGY
& AI CONGRESS: USA**

JUNE 26-27 2018 - NEW YORK CITY, USA



REAL-LIFE EXAMPLES OF AI IN EI

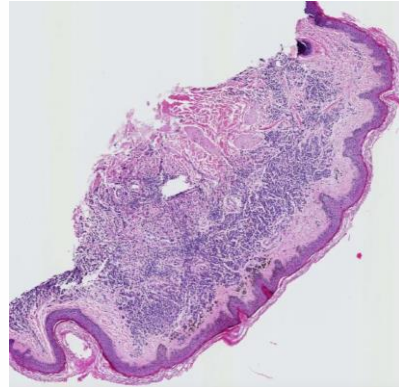
Digital Pathology

“ Data is the fuel driving the AI revolution. With access to one of the world’s largest tumor pathology archives, we needed the most advanced deep learning infrastructure to quickly turn massive amounts of data to clinically-validated AI applications.

The powerful combination of DGX-1 and FlashBlade accelerates our mission to catalyze the medical industry with AI. AIRI is architected with the same core technologies powering our AI infrastructure, and we’re thrilled to see what’s possible for other enterprises when they jumpstart their AI initiatives with AIRI.

Dr. Thomas Fuchs
Founder, Chief Science Officer
Twitter @ThomasFuchsAI

PAIGE

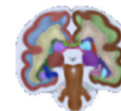


REAL-LIFE EXAMPLES OF AI IN EI

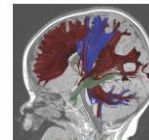
Neurology

- A research hospital has a radiology research team in conjunction with a world-class university that works with MRI vendors to get better images from the raw sensor (coil) data leading to unprecedented brain imaging detail
- Advances in understanding the causes of childhood epilepsy and finding the focus of seizures in patients
- In-utero fetal brain imaging, AI enhanced
 - Tissue segmentation

Fetal Brain Atlas



29 weeks gestational age



MR Tractography

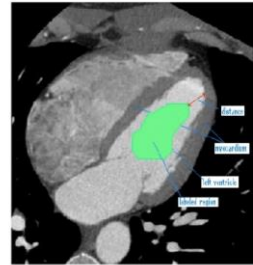
REAL-LIFE EXAMPLES OF AI IN EI

Cardiology & Radiology

[**simula** . research laboratory]

- Left ventricle segmentation from CT stacks
- Avoidance of thyroid nodule biopsies
- Lung nodule risk stratification
- High-throughput chest X-Ray interpretation (TB etc)

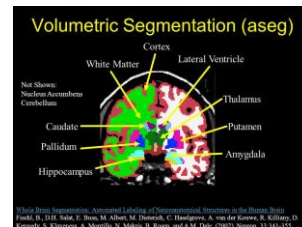
Heart Ventricle Segmentation



REAL-LIFE EXAMPLES OF AI IN EI

Auto-segmentation of cortical structures

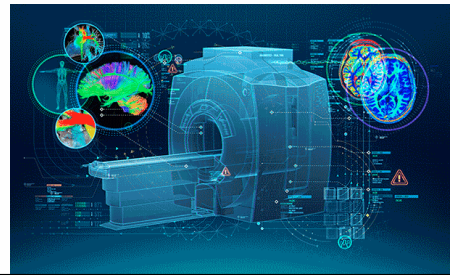
- Start with 8 deep structures
- Goal is to get to all 127 structures
- Mayo Clinic Computational Radiology Lab
 - Nvidia DGX-1



REAL-LIFE EXAMPLES OF AI IN EI

GPU integration into imaging modalities

- Scanners will do much more in the future
 - Nvidia collaboration with modality vendors starting with CT
- Much more will come out of modalities than image pixels
 - Segmentation
 - Quantification



REAL-LIFE EXAMPLES OF AI IN EI

FDA approvals for AI products

FDA permits marketing of clinical decision support software for alerting providers of a potential stroke in patients

For Immediate Release February 13, 2018

Transforming FDA's Approach to Digital Health

Remarks by Scott Gottlieb, M.D.,
Commissioner of Food and Drugs
Academy Health's 2018 Health Datapalooza
Washington, DC
April 28, 2018

We're expanding on our novel model for the pre-market review of digital health tools as medical devices, through our new pre-cert program. We're implementing a new approach to the review of artificial intelligence, and we're announcing today a new application of digital health tools to our own work – in this case the pre-market review of drug safety.

Artificial Intelligence

One of the most promising digital health tools is Artificial Intelligence, particularly efforts that use machine learning.

AI holds enormous promise for the future of medicine, and we're actively developing a new regulatory framework to promote innovation in this space and support the use of AI-based technologies. So, as we apply our Pre-Cert program—where we focus on a firm's underlying quality—we'll account for one of the greatest benefits of machine learning – that it can continue to learn and improve as it is used.

Capturing Patient Experience Through Deep Learning

CDER researchers are developing methods based on deep learning, a kind of artificial intelligence (AI), to capture patient experience of medical products in a way that allows essential information to be communicated, retrieved, and analyzed.

FDA News Release

FDA permits marketing of artificial intelligence-based device to detect certain diabetes-related eye problems

For Immediate Release April 11, 2018

FDA News Release

FDA permits marketing of artificial intelligence algorithm for aiding providers in detecting wrist fractures

For Immediate Release May 24, 2018

REAL-LIFE EXAMPLES OF AI IN EI

Beyond DL?

Data News Artificial Intelligence News News

Swarm AI that enables swarms of radiologists, outperforms specialists or AI alone in predicting Pneumonia

By Natasha Mathur · September 14, 2018 · 7:57 am · 384 · 0

REAL-LIFE EXAMPLES OF AI IN EI

Going from ~~bench~~ to bedside



good algorithms

THE FUTURE

What is the future of Radiology with AI?

It is whatever we make it!

- Radiologists
- Technologists
- IT
- Industry



THE FUTURE IS OURS TO CREATE.

THANK YOU!

QUESTIONS?