In the year 1968...
This was happening
Artificial Intelligence

- The science and engineering of creating intelligent machines that have the ability to achieve goals like humans via a constellation of technologies

Life can only be understood backwards; but it must be lived forwards.

Soren Kierkegaard
Definitions

• Neural Network (NN)
  Software constructions modeled after the way adaptable neurons in the brain were understood to work instead of human guided rigid instructions

• Deep Learning
  A type of neural network, the subset of machine learning composed of algorithms that permit software to train itself to perform tasks by processing multilayered networks of data

• Machine Learning
  Computers’ ability to learn without being explicitly programmed, with more that fifteen different approaches rather than predefined, hard rules-based methods

Definitions Continued

• Supervised Learning
  An optimization, trial-and-error process based on labeled data, algorithm comparing outputs with the correct outputs during training

• Unsupervised Learning
  The training samples are not labeled; the algorithm just looks for patterns, teaches itself

• Convolutional Neural Network
  Using the principle of convolution, a mathematical operation that basically takes two functions to produce a third one; instead of feeding in the entire dataset, it is broken into overlapping tiles with small neural networks and max-pooling, used especially for images

• Natural-Language Processing
  A machine’s attempt to “understand” speech or written language like humans

Definitions Continued

• Generative Adversarial Networks
  A pair of jointly trained neural networks, two processors and the other discriminative, whereby the former generates fake images and the latter tries to distinguish them from real images

• Reinforcement Learning
  A type of machine learning that shifts the focus from an abstract goal or decision making to technology for mapping and assessing actions in the real world

• Backpropagation
  An algorithm to indicate how a machine should change its internal parameters that are used to minimize the representation in each layer from that representation on the previous layer passing through background through the network

• Representation Learning
  A set of methods that allows a machine with raw data to automatically discover the representations needed for detection or classification
Definitions Continued

- **Transfer Learning**
  - The ability of an AI to learn from different tasks and apply its precedent knowledge to a completely new task

- **General Artificial Intelligence**
  - Perform a wide range of tasks, including any human task, without being explicitly programmed

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When in the forest you hear hoofbeats, Think **Horses NOT Zebras**

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A Perfect AI Story from Rady Children’s hospital San Diego

- Healthy newborn boy home on 3rd day of life
- On 8th day returned to Rady Hospital ER in status epilepticus
- ER work up found no infection, head and brain CT scan, labs all normal
- No response to any anti-seizure meds.
  - Seizures became more pronounced
  - Bleak prognosis → Brain damage and death before day 9
A Perfect AI Story from Rady Children's hospital - San Diego

- Blood sample sent to Rady's Genomic Institute for rapid whole genomic sequencing
- 5 million loci where his genome differed from more common ones
- AI natural language processing in 20 seconds devoured the boy's E.H.R. with 88 phenotypic features
- AI machine learning algorithm sifted 5 million genetic variants to 700,000 rare ones of which 962 are known to cause diseases

- Combining the above with the boy's phenotypic data, the system identified 1, in the gene called ALDH7A1 as most likely culprit defect
- Rare defect in less than 1/100 of 1 percent of people
- The defect causes metabolism deficits leading to seizures
- The defect can be overridden with vitamin B6 and arginine supplement with restriction of dietary lysine
- The seizures abruptly stopped and 36 hours later he was discharged

In follow up, the boy is perfectly healthy with no brain damage or signs of developmental delay
I often tell my students not to be misled by the name "artificial intelligence": there is nothing artificial about it. AI is made by humans, intended to behave by humans, and, ultimately, to impact human lives and human society.

- Fei-Fei Li

My ATM card and work perfectly in Outer Mongolia, but I can’t get my patient’s angiogram and discharge summary from the E.H.R. in Red Bluff, St. Elizabeth Hospital or Oroville Hospital.

- Peter Wolk, M.D.
How the Neural Network & the Human Brain are similar

Building blocks of AI in Medicine

Receiver Operating Characteristics Curve (ROC) & Area Under Curve (AUC)
Modern AI

Self Driving Cars

Gaming
(when I'm not on call)

Modern AI

Voice Language Translators

Google Maps

Modern AI

Patient wearable sensors
To AI, or Not to AI: Artificial Intelligence helps define Shakespeare
A Scientist used AI to determine where John Fletcher ends and William Shakespeare begins.

Danger Ahead

Garbage In, Garbage Out
Problems with Deep Learning & Deep Liabilities

- Bias is baked into medical research (gender, race, economics, genomic testing)

“We can build these models, but we don’t know how they work”

-Joel Dudley, Mount Sinai Icahn Institute

Electroshock Therapy
A Genetic Test Led Seven Women in One Family to Have Major Surgery. Then the Odds Changed.
The search giant has been pushing into health care, gaining access to millions of patient records. It's challenge: convincing the public that it can be trusted with our most personal data.

Hospitals Give Tech Giants Access to Detailed Medical Records
Deals with Microsoft, IBM and Google reveal the power medical providers have in deciding how personal sensitive health data is shared.

Problems with Deep Learning & Deep Liabilities
- Use of deep learning and patient data to predict timing of the onset of schizophrenia in 700,000 raw E.H.R. data
  - Joel Dudley, Head of Mount Sinai Icahn Institute
Problems with Deep Learning & Deep Liabilities

HACKING AND RANSOMS RISK

PRIVACY CONSIDERATIONS

ECONOMICS - LOSS OF JOBS

ETHICS AND LEGAL REALITIES FOR THE MEDICAL PROFESSION

A little knowledge is a dangerous thing.

So is a lot

What happens when your baby girl learns to say "Alexa"

Before she learns to say "Momma"
### Cardiology Applications

#### Imaging
- Nuclear
- MRI
- CTA
- ECG

#### Cardiology Applications

#### Diagnosing
- Patient sensors AliveCor and Smart watch
- Stress ECHO – BUTTERFLY NETWORK – to adjust echo probe for better imaging.

#### Cardiology Applications

#### CTA
- HeartFlow – to evaluate ischemia from CTA
- Which vessels need stenting and which don't and to avoid unnecessary angiograms
Cardiology Applications

• MRI — to predict MI in minutes vs hours with troponin, with blood flow and tissue changes on MRI during early minutes of STEMI

NVIDIA has released new details about its annual GPU Technology Conference (GTC), a four-day event dedicated to AI technology. GTC 2020 will be held in San Jose, California, and is scheduled to begin March 22. The conference is expected to draw more than 10,000 attendees and 250 exhibitors—including AI heavyweights such as AWS, Google and Microsoft—and the keynote address will be given by Jensen Huang, NVIDIA founder and CEO.

Artificial Intelligence to Predict Atrial Fibrillation

An artificial intelligence-enabled ECG algorithm for the identification of patients with atrial fibrillation during sinus rhythm: a retrospective analysis of outcome prediction
**AI to Predict AF**

- 454,789 ECG's in the training set, 64,340 in the validation set, 130,802 in the testing data set
- 3051 patients (8.4%) in the testing set had the AF ECG prior to the NSR ECG
- AUC 0.87 (if within 30 days of the first AF ECG the AUC ↑ to 0.90)

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**Artificial Intelligence to Screen for LV Dysfunction**

**Screening for cardiac contractile dysfunction using an artificial intelligence-enabled electrocardiogram**

**AI to screen LV Dysfunction**

- Asymptomatic LV dysfunction 3-6% of the general population and 9% in the elderly
- 625,326 pts with paired ECG and ECHO were screened
- 97,829 with paired tests within a 2 week window
- 35,970 training, 8,984 validation, 52,870 testing
  - 4,131 (7.8%) w/EF < 35%
  - 6,740 (12.7%) w/EF > 35% but < 50%
  - 41,999 (79.5%) w/EF > 50%
- AUC 0.93 for EF < 35% (0.98) for pts with no comorbidities
- AUC for BNP in comparison 0.60
AI to screen LV Dysfunction

- In pts w/EF > 50% but a positive AI screen they were 4x more likely to develop LV dysfunction over next 3 ½ years
- 10% over 15 years

Fig. 2 | Network ROC and sensitivity and specifically across age and gender subsets

Fig. 3 | Long-term incidence of developing an EF < 35% in patients with an initially normal EF stratified by AI classification
The play's the thing wherein I'll catch the conscience of the king
- Hamlet

AI, the thing wherein I'll catch the welfare of our kings
- Wolk

Our Patients are our Kings
The Virtual AI Assistant

**INPUTS**
- Social, behavioral
- Environment
- Immune system
- Gut microbiome
- Genomic
- Environmental
- Physical activity, sleep, nutrition
- Cognition, state of mind
- All medical history
- World's medical literature, continually updated

**OUTPUTS**
- Virtual health guidance
- Communication, speech
- Biosensors
- Immune system
- Gut microbiome
- Anatomical
- Environmental
- Physical activity, sleep, nutrition
- Cognition, state of mind
- All medical history
- World's medical literature, continually updated

Deep Learning

Deep Empathy

**Fin**