The World Has Changed

- Exponential growth of unstructured data
- Democratization of hardware
- Breakthroughs in machine learning

Transforming multiple industries… especially medicine

Trend 1: Exponential Growth Of Unstructured Data

Industry

- 80% of world's data is unstructured

- Medical knowledge & data*

  - 1950: 50 years to double knowledge

  - 1980: 7 years to double knowledge

  - 2015: <3 years to double knowledge

  - 1 Million GB of health data generated per person

* From IBM Computing, Cognition, & the Future of Knowing by Dr. John E Kelly III

Consequences

- Need for automatically analyzing & interpreting data

Unstructured data
Information that either does not have a pre-defined data model or is not organized in a pre-defined manner
Source: Wikipedia

How do we analyze & interpret all that data?

Trend 2: Democratization Of Hardware
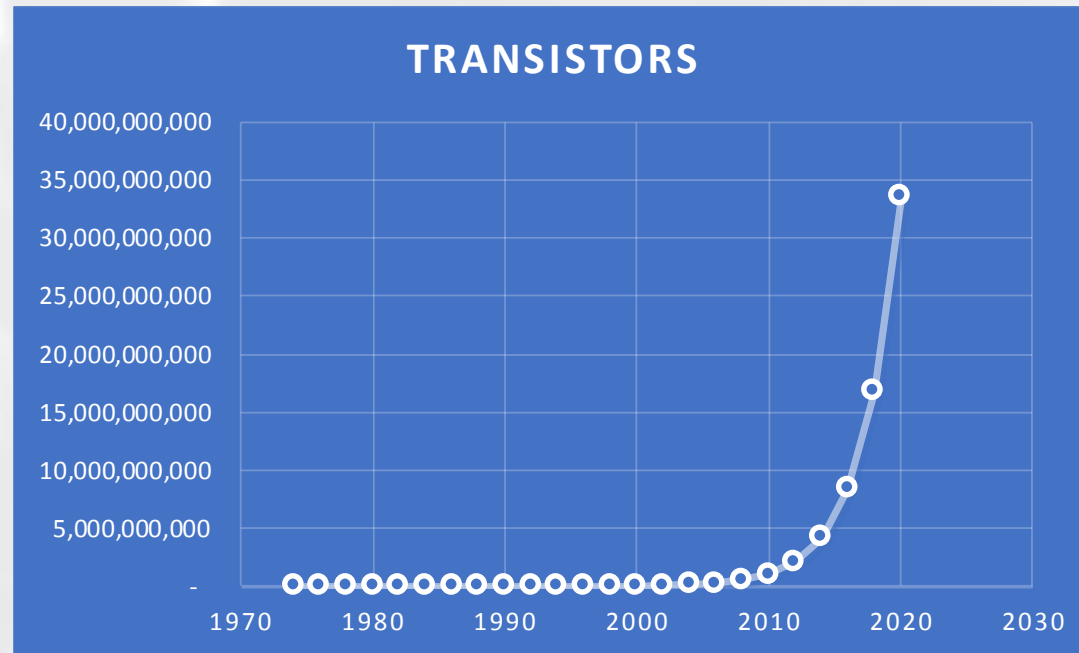
Industry

- Cloud computing

- Moore's Law

Consequences

- Vast amounts of compute are readily available to at very low cost

Enables everyone to have access to massive amounts of computing power

Trend 3: Start Of Cognitive Computing

Industry

- 1997: DeepBlue defeats Gary Kasparov at Chess
- 2011: Watson wins at Jeopardy!

- 2015: Microsoft wins ImageNet Computer Vision Challenge

- 2016: DeepMind's AlphaGo wins Go (4-1)

Why and how are computers suddenly beating experts in strategy, natural language, & "seeing"

Terminology

- Machine Learning: Class of algorithms where performance improves over time as more data is processed
  - Training: Model development to teach
  - Scoring: Using the model to evaluate a situation
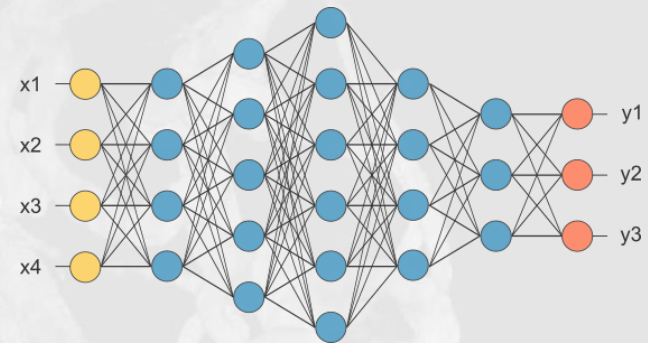
- Deep Learning: A subset of Machine Learning where there are multiple layers between the input and the output layers of a model

- Cognitive Computing: Ability to understand, reason, remember, learn, & act w/human-like intelligence using structured & unstructured data
  - Natural Language Processing (Siri, Amazon Echo)

"Goal of cognitive computing is to illuminate aspects of our world that were previously invisible—patterns & insight in unstructured data"
From IBM Computing, Cognition, & the Future of Knowing by Dr. John E Kelly III

Cognitive Computing & Medicine

Transformative opportunity to make sense of unstructured data

- Paradigm Shifts:
From algorithmic to statistical, probabilistic, & evidence-based

- Dataset increases → Accuracy improves

- Compute increases → Better/powerful ML → Accuracy improves

- Enables deeper human engagement, elevating expertise, & enhancing exploration and discovery

- Examples
  - IBM Watson—50+ cognitive areas, 35+ APIs
  - Alphabet DeepMind Health w/UK's National Health Services
  - Merck: Accelerate drug discovery
  - Startups: Enlitic (Radiographs, CT, MRI), Atomwise (drug), Freenome (DNA)

Intelligence = data + training/algorithms + compute

Implications

Where will we see machine learning in medicine?

- Clinical Decision Support / Business Intelligence

- Wellness/Prevention: "Supervisory Monitoring"

- (Deeper) Data Analysis & Image Recognition

- Predictive Diagnosis

Holy Grail

- Cognitive: "What is the optimal treatment?"

Solutions will be a hybrid of machine learning, traditional AI techniques, & human support

References & Further Reading

- IBM Watson Health: www.ibm.com/watson/health/
  - Overview of ML in CDS (Tanveer Syeda-Mahmood): www.youtube.com/watch?v=A4Uk88-DOBA

- IBM Computing, Cognition, & the Future of Knowing by Dr. John E Kelly III

- DeepMind Health: https://deepmind.com/applied/deepmind-health/

- Machine Learning Course: https://work.caltech.edu/lectures.html#lectures

- Ray Kurzweil: Future of intelligence on youtube