Artificial Intelligence in the World

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Fromm Institute
Spring Session, 2017
Lecture 8 agenda (1)

What’s happened this week
Deep Learning
Autonomous Vehicles
Computer Go
Ethics & legal issues
ANNs & brains
Other applications
Lecture 8 agenda (2)

• The future of AI
  • What to expect worldwide
  • Impacts of AI applications
  • Hardware & software of AI
  • Neuro-interfaces / human interactions
  • “Intuitive AI” tools

• What to watch out for

• Final comments
What happened in the past week? (1)

• Deep Learning

  • *Rock Stars of Machine Learning*/Deep Learning
    • *(seminar in September, Mountain View)*

  • “Deep Learning Takes on Translation” – CACM
What happened in the past week? (2)

• Autonomous Vehicles
  
  • “The future of artificial intelligence and self-driving cars” – Stanford Engineering
    
    • (summary of a radio program titled, “The Future of Everything”)

• McKinsey – Self-driving car technology – When will the robots hit the road?
What happened in the past week? (3)

• Computer chess & go
  
  • *NY Times -- Google’s AlphaGo Defeats Chinese Go Master in Win for A.I.*
  • *NY Times - Google’s A.I. Program Rattles Chinese Go Master as It Wins Match*
    • A small consolation for Mr. Ke was that he played a near-perfect game for the first hundred moves
    • Two Go professionals, each teamed with AlphaGo, are scheduled to play against each other on Friday.
    • “After this time, AlphaGo to me is 100 percent perfection, to me AlphaGo is the god of the Go game,” he said after the game on Thursday.
What happened in the past week? (4)

• Ethics & legal issues
  
  • *IEEE Computer Magazine -- Standardizing Ethical Design for Artificial Intelligence and Autonomous Systems* –
    
    • ensure every technologist is educated, trained, and empowered to prioritize ethical considerations in the design and development of autonomous and intelligent systems.

  • *(British Standard BS 8611:2016) Robots and robotic devices. Guide to the ethical design and application of robots* and robotic systems –
    
    • guidelines for the identification of potential ethical harm. Significant ethical hazards are presented for various robot applications.

  • When artificial intelligence *botches your medical diagnosis, who’s to blame?*
What happened in the past week? (5)

• ANNs and brains
  
  • *A step toward building a more brain-like computer* -- Stanford Engineering (synapse)

  • *MIT Technology Review – Curiosity may be vital for truly smart AI* (Will Knight)
What happened in the past week? (6)

• Other applications of AI / robotics
  • *Security Chiefs and Hackers Race to Benefit from AI Prize (for security)*
    • *(Financial Times)*
    • Note: “In 2015, 209,000 Cyber-Security Job Positions Went Unfilled in the US Alone”
  
  • *Waltzing robot teaches beginners how to dance like a pro*
    • *(New Scientist)*
The Future of Artificial Intelligence

• What to expect worldwide
• Impacts of AI applications
• Hardware and software of AI
• Neuro-interfaces / human interactions
• Design tools – “Intuitive AI”
• What to watch out for
The future -- What to expect worldwide

• The New AI Market – (O’Reilly) – top 18 companies investing in AI
• The Stanford 100-year study – 2016 report
• National AI R&D Strategic Plan
• 4 Ways AI Will Change About Everything (Salesforce)
• Impact of AI on China (McKinsey)
• AI Boom (Economist)
The New AI Market (O’Reilly)

1. Google
2. Facebook
3. Rocket Fuel
4. IBM
5. Amazon
6. Yahoo
7. Intel
8. Microsoft
9. Deloitte
10. MITRE
11. Baidu
12. LinkedIn
13. Apple
14. Cylance
15. Lockheed Martin
16. NASA
17. Sentient Corporation
18. Electronic Arts
The Stanford 100-year study – 2016 report

• Contrary to the more fantastic predictions for AI in the popular press, the Study Panel found **no cause for concern that AI is an imminent threat to humankind.**

• Instead, increasingly useful applications of AI, with **potentially profound positive impacts on our society and economy** are likely to emerge between now and 2030 At the same time, many of these developments will spur **disruptions in how human labor is augmented or replaced by AI**, creating new challenges for the economy and society more broadly.
Stanford – currently “hot” areas of AI research

- **Large-scale machine learning** concerns the design of learning algorithms, as well as scaling existing algorithms, to work with extremely large data sets.

- **Deep learning**, a class of learning procedures, has facilitated object recognition in images, video labeling, and activity recognition, and is making significant inroads into other areas of perception, such as audio, speech, and natural language processing.

- **Reinforcement learning** is a framework that shifts the focus of machine learning from pattern recognition to experience-driven sequential decision-making. It promises to carry AI applications forward toward taking actions in the real world.
• **Robotics** is currently concerned with how to train a robot to interact with the world around it in generalizable and predictable ways, how to facilitate manipulation of objects in interactive environments, and how to interact with people.

• **Computer vision** is currently the most prominent form of machine perception. It has been the sub-area of AI most transformed by the rise of deep learning. For the first time, computers are able to perform some vision tasks better than people.

• **Natural Language Processing**, often coupled with automatic speech recognition, is quickly becoming a commodity for widely spoken languages with large data sets. Research is now shifting to develop refined and capable systems that are able to interact with people through dialog, not just react to stylized requests. Great strides have also been made in machine translation among different languages, with more real-time person-to-person exchanges on the near horizon.

• **Collaborative systems** research investigates models and algorithms to help develop autonomous systems that can work collaboratively with other systems and with humans.
Stanford – currently “hot” areas of AI research (3)

- **Crowdsourcing and human computation** research investigates methods to augment computer systems by making automated calls to human expertise to solve problems that computers alone cannot solve well.

- **Algorithmic game theory and computational social choice** draw attention to the economic and social computing dimensions of AI, such as how systems can handle potentially misaligned incentives.

- **Internet of Things (IoT)** research is devoted to the idea that a wide array of devices, including appliances, vehicles, buildings, and cameras, can be interconnected to collect and share their abundant sensory information to use for intelligent purposes.

- **Neuromorphic computing** is a set of technologies that seek to mimic biological neural networks to improve the hardware efficiency and robustness of computing systems, often replacing an older emphasis on separate modules for input/output, instruction-processing, and memory.
Stanford study -- AI BY DOMAIN

• TRANSPORTATION
• HOME/SERVICE ROBOTS
• HEALTHCARE
• EDUCATION
• LOW-RESOURCE COMMUNITIES
• PUBLIC SAFETY AND SECURITY
• EMPLOYMENT AND WORKPLACE
• ENTERTAINMENT
(U.S.) National AI R&D Strategic Plan

• In 2015, the U.S. Government’s investment in unclassified R&D in AI-related technologies was approximately $1.1 billion.
  • Although these investments have led to important new science and technologies, there is opportunity for further coordination across the Federal government so that these investments can achieve their full potential.

• Recognizing the transformative effects of AI, in May 2016, the White House Office of Science and Technology Policy (OSTP) announced a new interagency working group to explore the benefits and risks of AI.
  • OSTP also announced a series of four workshops, held in the May-July 2016 time frame, aimed at spurring public dialogue on AI, and identifying the challenges and opportunities it entails.
4 Ways Artificial Intelligence Will Change Just About Everything -- Salesforce

• The Internet of Things
• Data & Analytics
• Machine Learning
• Prediction
Impact of AI on China -- McKinsey report

• With its biggest tech companies driving significant investments in R&D, China is one of the leading global hubs of AI development. Its advantages include a vast population and diverse industry mix that have the potential to generate huge volumes of data and provide an enormous market.

• [p.8 graphic – AI startups, M&A deals]
The United States has a more robust AI startup ecosystem than China

Number of promising AI startups, 2017

- Business intelligence and analytics
- Core AI
- AD, Sales, CRM
- Automotive technology
- Vision
- Conversational AI/bots
- Cybersecurity
- Financial technology
- Internet of Things
- Robotics
- Commerce
- Text analysis/generation
- Health care
- Others

Total: 39

United States: 39
China: 3
Major M&A deals, January 2011–February 2017

- Internet/tech giants

- Google: 11 deals
- Tencent: 5 deals
- Apple: 5 deals
- Baidu: 2 deals
- Intel: 5 deals
- Alibaba: 1 deal
- Microsoft: 4 deals
- JD: 1 deal
- Twitter: 4 deals
- iCarbonX: 1 deal

Total (including VC investments) = 55
AI Boom (Economist)

• Google, Microsoft and IBM are making AI services such as speech recognition, sentence parsing and image analysis freely available online, allowing startups to combine such building blocks to form new AI products and services.

• More than 300 companies from a range of industries have already built AI-powered apps using IBM’s Watson platform, doing everything from filtering job candidates to picking wines.

Impacts of AI applications

• Impacts of autonomous driving

• Medical applications – diagnosis *(The Motley Fool, Apr, 2017)*

• Finding a Voice *(Economist special report)*

• How AI Will Change Everything *(Baidu)*
Impacts of autonomous driving

• Reduced accidents
• Increased road capacity / decreased road congestion
• Decreased parking demand
• Increase in electricity demand / decreased gasoline consumption
• Change in land-use patterns
• Universal surveillance?

Medical applications – diagnosis

• Doctors at the University of North Carolina School of Medicine provided Watson with the records of 1,000 cancer patients, and it was able to provide treatment plans that concurred with oncologists' actual recommendations in 99% of cases.

• Additionally, Watson was able to provide additional options missed by its human counterparts in 30% of the cases, having been supplied with all the latest cancer research.

• This will provide effective cancer treatment to a wider variety of patients than ever before, while making every doctor with access to Watson a cancer expert.

  • *The Motley Fool, Apr, 2017*
Finding a Voice

• Machines cannot conduct proper conversations with humans because they do not understand the world.

• The more that machines talk, and the more that they seem to understand people, the more their users will be tempted to attribute human traits to them.

• That raises questions about what it means to be human. Language is widely seen as humankind’s most distinguishing trait. AI researchers insist that their machines do not think like people, but if they can listen and talk like humans, what does that make them?

• As humans teach ever more capable machines to use language, the once-obvious line between them will blur.

  • Economist special report
How AI Will Change Everything

• Artificial intelligence is shaping up as the next industrial revolution, poised to rapidly reinvent business, the global economy and how people work and interact with each other.
  • Andrew Ng, chief scientist at Chinese internet giant Baidu Inc. and co-founder of education startup Coursera, and Neil Jacobstein, chair of the artificial intelligence and robotics department at Silicon Valley think tank Singularity University

• ... In a few years everyone will be using speech recognition. It will feel natural. You’ll soon forget what it was like before you could talk to computers.

• ... a team at Imperial College London develop an AI that could diagnose pulmonary hypertension better than cardiologists typically do. Cardiologists have about 60% accuracy. This system does 80% accuracy.

• in January of this year, ... CMU developed a poker player called Libratus, which beat four of the world champion poker players, and not by just a little bit. They played 120,000 hands of poker, and Libratus ended up with $1.77 million in poker chips.

• [AI will cause displacement] over the next 10 to 15 years that is really significant. ... we need to make education affordable because there will be new jobs.
  • Wall Street Journal interview with Andrew Ng & Neil Jacobstein
Hardware and software of AI

• **Google develops a new AI chip (“Cloud TPU”)**
  • Based on Google’s Tensor Flow programming language
  • Faster processing; faster to train (machine learning)
  • “Cloud TPU pods” are clusters of these new TPUs with high-speed data connections → AI-first data centers

  • *MIT Technology Review*
Hardware and software of AI (2)

Behind your high tech digital assistant is a band of liberal arts majors. A trio of women shape the personality of Amazon’s Alexa, the AI-powered device used by tens of millions of consumers worldwide: Michelle Riggen-Ransom, who has an MFA in creative writing, composes the bot’s raw responses; Farah Houston, a psychology grad specializing in personality science, ensures that those responses dovetail with customers’ expectations; and Beth Holmes, a mathematician with expertise in natural language processing, decides which current events are woven into Alexa’s vocabulary, from the Super Bowl to the Oscars. “The commonality is that
Neuro-interfaces / human interactions

• *This app knows how you feel — from the look on your face*
  
  • What if a computer could recognize your facial expression, and react to how you feel? Rana el Kaliouby sees big possibilities in making technology emotionally aware.

  • *TED Women 2015*

  • [https://www.ted.com/talks/rana_el_kaliouby_this_app_knows_how_you_feel_from_the_look_on_your_face?language=en](https://www.ted.com/talks/rana_el_kaliouby_this_app_knows_how_you_feel_from_the_look_on_your_face?language=en)
Neuro-interfaces / human interactions (2)

- Consciousness Cloud ... would give the robots working in the factory “real-time shared access to the mental state of all humans in the workplace.”

  - Arizona State University – Yochan Group
The Consciousness Cloud
powered by Microsoft Azure

AEffective Robotics: ASU Yochan Group Submission to Microsoft Imagine Cup
Facebook is building **brain-computer interfaces**

- a **brain-computer interface** that will let you type with just your **mind** without invasive implants
  - collaborating with UC San Francisco, UC Berkeley, Johns Hopkins Medicine, Johns Hopkins University’s Applied Physics Laboratory and Washington University School of Medicine in St. Louis

- a way for humans to **hear through their skin**
  - let your skin mimic the cochlea in your ear that translates sound into specific frequencies for your brain. This technology could let deaf people essentially “hear” by bypassing their ears

  - *TechCrunch, April 19, 2017*
ARM Wants to Put Its Chips Inside Your Brain

• ARM will partner with the University of Washington’s Center for Sensorimotor Neural Engineering to help researchers there build chips that sit inside people’s skulls.

• The goal: to help people who are suffering from paralysis brought about by, say, stroke or spinal cord injury to move parts of their body again.
Neuralink, just started by Elon Musk
  • “neural lace”, a science-fictional concept invented by Iain M. Banks, a novelist, that is, in essence, a **machine interface woven into the brain**.

**Kernel**
  • **devices for the treatment of neurological conditions** such as strokes and Alzheimer’s disease
  • (and then) cognition-enhancing implants

  • aimed initially at medical applications, they also explicitly nod to the possible non-medical uses of this kind of **implant technology**

  • (no one understands the mechanism behind the natural equivalent of software—the way the brain encodes information)
Design Tools – “Intuitive AI”

• **Maurice Conti** – Generative Design

  • [https://www.ted.com/talks/maurice_conti_the_incredible_inventions_of_intuitive_ai](https://www.ted.com/talks/maurice_conti_the_incredible_inventions_of_intuitive_ai)
What to watch out for in the future

- **Will Democracy Survive Big Data and Artificial Intelligence?**
  - “Nudging” – encouraging us to do “the right thing”
  - Danger of vote-nudging by governments
  - “What can we do now?”
    - the basic rights of citizens should be protected
    - There should also be a right to get a copy of personal data collected about us; the unauthorised use of data would have to be punishable by law
  - ...

- from *Spektrum der Wissenschaft*, sister-publication of Scientific American
Will Democracy Survive Big Data and Artificial Intelligence?

Figure 2: At the digital crossroads. Source: Dirk Helbing
From McKinsey report on AI in China

• It is also an awesome responsibility to manage machines that can learn and make decisions without human direction. ... raise many ethical and legal issues

• ... questions about who owns personal data, how it may be shared, and how it should be protected from the increasing risk of cybersecurity breaches.

• AI may unintentionally discriminate in its decision making

• ... many legal implications. When accidents and even crimes happen due to AI decision making, who is held liable?

• the potential for weaponizing AI is a strong concern
  • Stephen Hawking, Elon Musk, and more than 1,000 AI and robotics researchers have signed a letter suggesting a ban on AI warfare
Yann LeCun (Facebook) on the future of AI

• Building intelligent machines is one of the greatest scientific challenges of our times, and it will require the sharing of ideas across countries, companies, labs and academia.

• Progress in AI is likely to be gradual—and open.
“The iBrain is Here and it’s already inside your phone”

• How AI and Machine Learning work at Apple
  • Article by Steven Levy / Backchannel
One more thing ...
What shall we tell our grandchildren to study?

• Grounding in STEM subjects
• Communication skills – including English writing & speaking
• Empathy / collaboration / teamwork skills
• Lifelong learning

• “The most important predictor of a team’s success is its communication patterns. Those patterns are as significant as all other factors—intelligence, personality, and talent—combined.” [HBR]
Additional recommended reading ...

• The Master and His Emissary: The Divided Brain and the Making of the Western World
  • by Iain McGilchrist
  • See handout
Artificial Intelligence in the World
Access to AIW course materials

- Includes
  - Handouts
  - Slides
  - Audio of lectures

- [http://fromm.usfca.edu/course-materials.html](http://fromm.usfca.edu/course-materials.html)