REDDS VIP Briefing on "AI Trends and SDGs"

Session: UNDESA--Action Line C1, C11: The Role of Private Sector in Mobilizing ICTs for SDGs

June 15, 2017
UN ITU Headquarters, Geneva
0900-1045 Room G1, ITU Varembe

AI Digital Quake-$40bn ’18 $50bn ‘20

VC ‘16 $5bn ~660 firms 60+% ‘15

10 MSs’ → $5 T market cap

China $337B

Mobile/Cloud first → AI first

WORLD ECONOMIC FORUM

AI top 6 trends

Gartner “perceptual smart machine age” top 3 trends

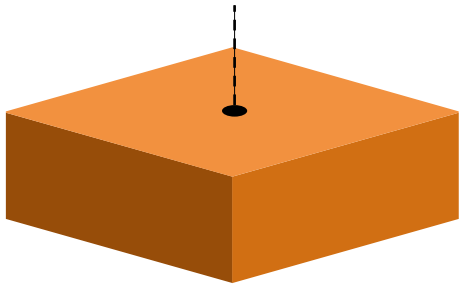
AI tools, hardware, open source (OpenAI)

FSR summit, $92.7 Trillion, AI key

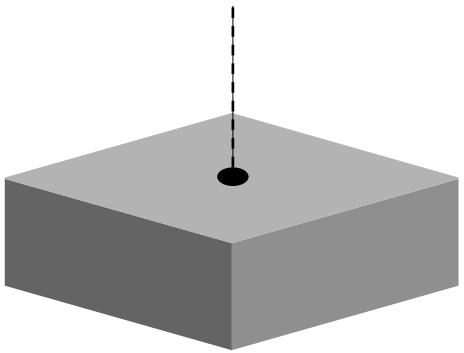
Data volumes driving AI

Only AI has the power to analyze this data to solve grand challenges and problems guiding our future.

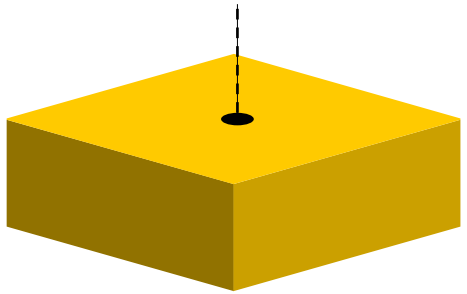
44 ZB 2020, 50x 2010



2015/16 entire human history



26 billion IoT devices 2020

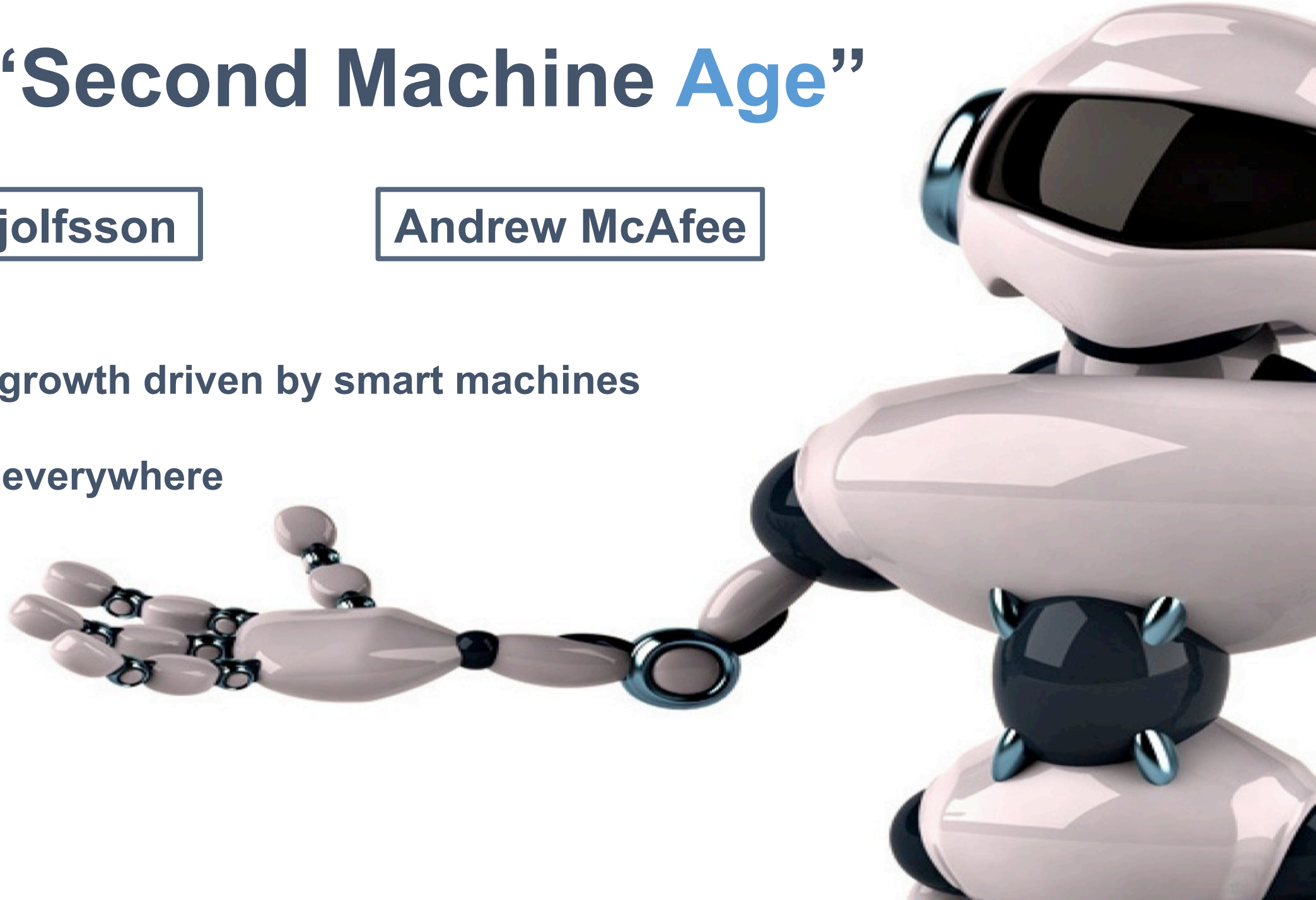


“Second Machine Age”

Erik Brynjolfsson

Andrew McAfee

- Dramatic growth driven by smart machines
- Evidence everywhere



4th Industrial Revolution

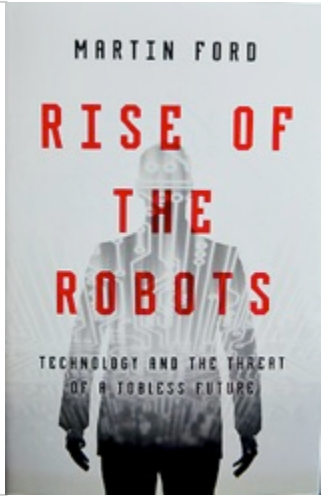
The Fourth Industrial Revolution
by Prof Klaus Schwab World Economic Forum;
Subject UBS paper

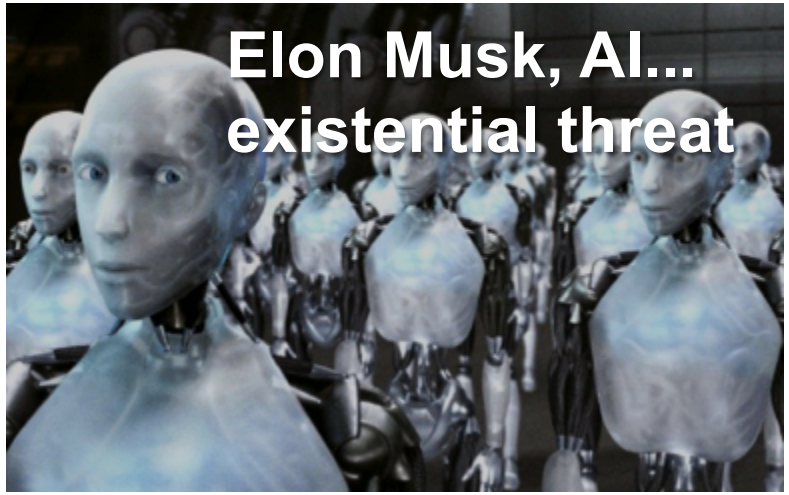
EXTREME automation, connectivity

Cyber-physical systems driven by AI and robots

AI Impact

Martin Ford,
Rise of
the Robots





AoE: AI of Everything

Is AI creating a digital quake where > 80 percent of companies and jobs will need to change or fail?

What are the implications to society, economic development, and path to prosperity?

AI technical standards achieve SDGs?

AI Driven Unprecedented Era

Hyper time compression

new disruptive innovations

Extreme convergence

of multiple domains

Exponential accelerating automation

– smart sensors and the 26 billion IoT devices by 2020

(11 trillion USD by 2025)

Universal connectivity linked by a digital AI mesh

AI Driven Unprecedented Era

AI of Everything (AoE)-the global AI mesh spawning a Digital Quake driving the Knowledge Synthesis of Everything (KSE), an inflection point
for humankind and the SDGs.

AoE: Evidence

Singapore self-driving Taxis
September 2016

Telefonica, BigML AI
selects startups

Norwegian Telenor AI
and Big Data Lab

Deep Knowledge Ventures,
AI votes on investments

Baidu, StockMaster
predicts market trends

Baidu, AskADoctor,
520 diseases, refers specialists

GE survival on software and AI

Controversy: AI bias

United Nations Sustainable Development Goals (SDGs): affordable, reliable, everywhere, safe, inclusive, fair, equal, resilient, sustainable, all ages

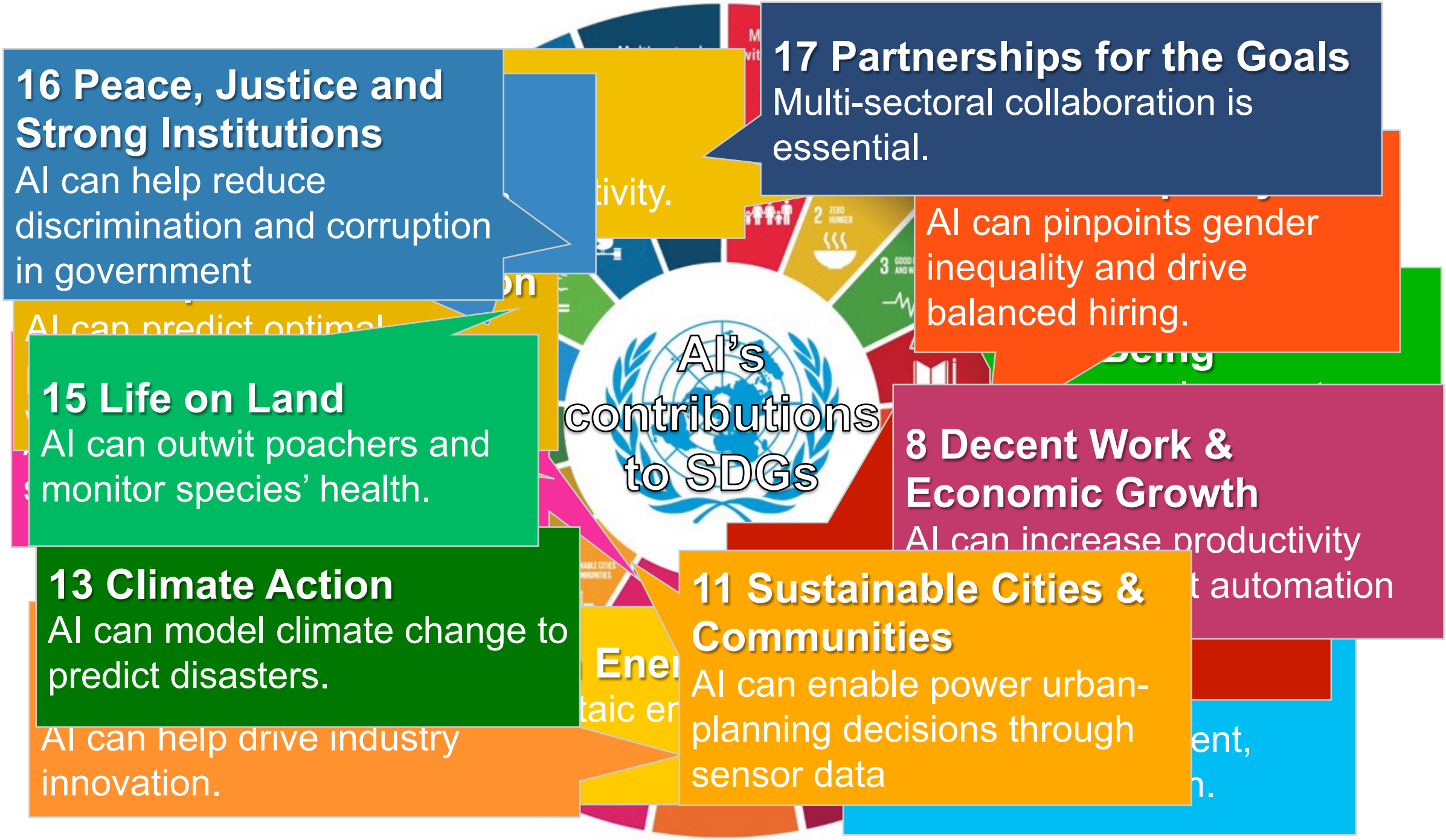
WSIS 11 Action Lines

AI

UN 8 MDGs 2000-2015

UN 17 SDGs 2015-2030


AI's contributions to SDGs
1 NO POVERTY
Map poverty with predictive Big Data analytics
2 ZERO HUNGER
Increase agricultural productivity
3 GOOD HEALTH AND WELL-BEING
Analyse vast amounts of healthcare data
4 QUALITY EDUCATION
Revolutionize classrooms with individualized learning
5 GENDER EQUALITY
Pinpoint gender inequity, drive balanced hiring
6 CLEAN WATER AND SANITATION
Improve efficient, clean water provision
7 AFFORDABLE AND CLEAN ENERGY
Improve photovoltaic energy capture
8 DECENT WORK AND ECONOMIC GROWTH
Increase productivity through intelligent automation
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
Help drive industry innovation
10 REDUCED INEQUALITIES
Build a more inclusive society (e.g. disability robotics)
11 SUSTAINABLE CITIES AND COMMUNITIES
Power urban-planning decisions through sensor data
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
Predict optimal production levels to reduce waste
13 CLIMATE ACTION
Model climate change to predict disasters
14 LIFE BELOW WATER
Track illegal fishing through pattern-recognition software
15 LIFE ON LAND
Outwit poachers and monitor species' health
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
Reduce discrimination and corruption in government
17 PARTNERSHIPS FOR THE GOALS
Multi-sectoral collaboration is essential


AI's contributions to SDGs
16 Peace, Justice and Strong Institutions
AI can help reduce discrimination and corruption in government
17 Partnerships for the Goals
Multi-sectoral collaboration is essential.
AI can pinpoints gender inequality and drive balanced hiring.
15 Life on Land
AI can outwit poachers and monitor species' health.
8 Decent Work & Economic Growth
13 Climate Action
AI can model climate change to predict disasters.
11 Sustainable Cities & Communities
AI can enable power urban-planning decisions through sensor data
AI can help drive industry innovation.

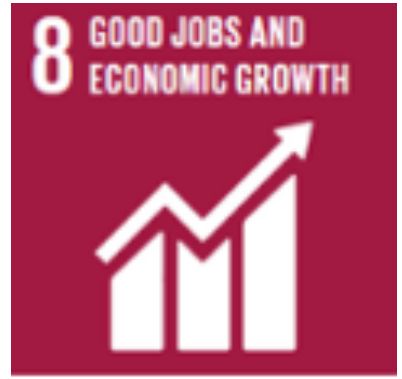
United Nations Sustainable Development Goals (SDGs): affordable, reliable, everywhere, safe, inclusive, fair, equal, resilient, sustainable, all ages

AI and SDGs

Tracking poverty (SDG1)

Diagnosis (SDG3)

Causal influences development programs education (SDG4)



Micro-finance (SDG8)

Greenhouse emissions and smart cities (SDG11&13)

Global partnerships (SDG17)

AI Support Programs

UN ITU partner
IBM Watson
AI XPRIZE

- ❑ $5 million prize
- ❑ Diverse and open sources
- ❑ Solving grand challenges

International standards?

IEEE ethics, Stanford project “100 Year Study”

BSI8611 ethics design and application robots

US Whitehouse 2 AI reports in Oct

Partnership on AI for People and Society

21 UN Agencies & XPRIZE AI FOR GOOD

Cybersecurity and AI Risks

What are the AI applications exposing risk?

- ❑ Email filtering: SPAM?
- ❑ Personalization: Amazon, Netflix?
- ❑ Fraud detection: Credit cards?
- ❑ Speech recognition: Chatbots, Robo Advisors?
- ❑ Image/video recognition: Airports, Policing, Social Media?
- ❑ Autonomous vehicles: Cars, trucks, drones?
- ❑ Robots: Factories and Consumer facing?
- ❑ Human/machine hybrids: Wearable, embedded?
- ❑ CASL – classic, augmented, synthetic Life?
- ❑ Data, security, privacy, trust?

Cybersecurity Questions

Do we need IT professionals?

- ❑ Who will protect us?
- ❑ What are the Cyber risks?
- ❑ Who will mange the risks of:

AI/ML, IoT, Big Data?

International Standards in trustworthy conduct mitigating risk?

Economy grow through safe e-commerce?

Benefit of IoT without the risk?

Where is AI of Everything providing risk exposure?

How do we ensure AI for Good?

How do we partner for ethical and trustworthy computing?

Discussions on AI

ACM Learning Center

IDG-IT World

ICSE 2016

Resources

Discussions with over 1000 experts, most here:
http://bit.ly/1mbO2MG

Computing Educators Oral History Project

http://www.southwestern.edu/departments/mathcompsci/OHProject/other-ohprojects.html

WE CALL FOR GLOBAL COOPERATION

#AIforGood

AI can help solve humanity's grandest challenges

THANK YOU

Appendix:
Added information

Resources—discussions with over 1000 experts, most here: **http://bit.ly/1mbO2MG**

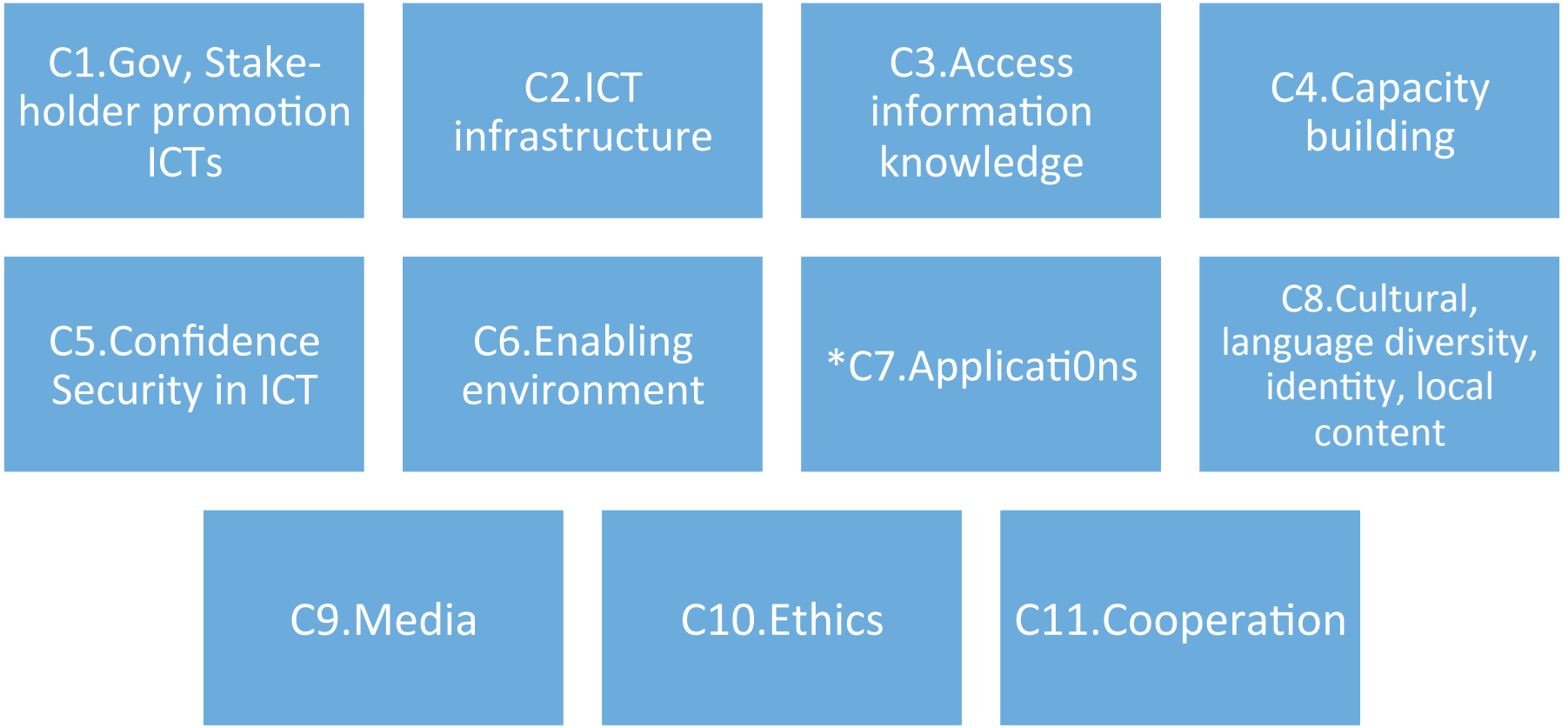
Computing Educators Oral History Project
http://www.southwestern.edu/departments/mathcompsci/OHProject/other-ohprojects.html

10 x Microsofts': Master Algorithm → $4T USD

	Development Phases →					
Types of Innovation ↓	**Concept**	**Research & Development (R&D)**	**Transfer Commercial**	**Production & Deployment**	**Usage**	***Key: 1-10 1 smartphone upgrade***
Products	10	1 + 10	1 + 10	1 + 10	1+ 10	**10 Master Algorithm**
Services	10	10	10	10	10	
Process	10	10	10	10	10	
Organization Model	10	10	10	10	10	
Business Model or 9 areas of the Business Model Canvas	10	10	10	10	10	
Social-mediated	10	10	10	10	10	
Machine-learning	10	10	10	10	10	

SRC: adapted from IT Innovation Foundation and OECD

AI supporting all United Nations/ITU World Summit on the Information Society (WSIS) Action Lines



*C7. e-gov, e-bus, e-learn, e-health, e-employ, e-environ, e-agri, e-sci

SRC: United Nations

ICT Innovation: Digital Libraries, Ex. ACM

- **World's largest scientific, educational and professional computing association**
- +110,000 members, +50% outside US
- Educators, researchers, developers, students
- +500 conferences / workshops / events
- +70 publications / newsletters
- +35 Special Interest Groups or SIGS (such as SIGGRAPH)
- Awards (such as Turing "Nobel Prize of Computing")
- **1.5 million worldwide users of the Digital Library**
  - **individuals, academic institutions, government research centers, corporations…http://dl.acm.org/**
- ACM Learning Center, webcasts, videos, books, courses,… **http://learning.acm.org/**

Daily AI News!

- AI assesses breast cancer risk 30 times faster
  http://www.forbes.com/sites/janetwburns/2016/08/29/artificial-intelligence-can-help-doctors-assess-breast-cancer-risk-thirty-times-faster/#7b717af556e2
- GE, reborn as a software startup using AI
  http://www.nytimes.com/2016/08/28/technology/ge-the-124-year-old-software-start-up.html?_r=0
- World leading 2025 China AI industry
  http://www.chinadaily.com.cn/business/tech/2016-08/27/content_26615174.htm
  - Global AI Market 2015: 127B; 2016: 165B; 2018: 200B
- Audrey--NASA's New Self-Learning AI Could Save First Responders
  http://motherboard.vice.com/read/this-nasa-ai-will-sense-danger-save-firefighters-and-learn-from-mistakes
- Voice recognition 3x faster than typing
  http://www.npr.org/sections/alltechconsidered/2016/08/24/491156218/voice-recognition-software-finally-beats-humans-at-typing-study-finds?utm_medium=RSS&utm_campaign=storiesfromnpr

SRC: News

Daily AI News!

- The world's first self-driving taxis will be picking up passengers in Singapore in September 1
  http://www.cbc.ca/news/technology/driverless-taxi-nutonomy-1.3735375
- AI bias http://motherboard.vice.com/read/its-our-fault-that-ai-thinks-white-names-are-more-pleasant-than-black-names

- Norwegian Telco creates AI and Big Data lab
  https://www.telecomtvtracker.com/insights/telenor-supports-norwegian-entrepreneurship-and-artificial-intelligence-research-6448/
- Telefonica and BigML using AI to select startups
  https://www.telefonica.com/es/web/press-office/-/telefonica-open-future_-and-bigml-create-preseries-a-joint-venture-for-early-stage-investment
- Deep Knowledge Ventures appoints AI like a board member to make investment decision
  http://www.itbusiness.ca/blog/hong-kong-vc-firm-appoints-ai-to-board-of-directors/48815
- Satellite images and machine learning can map poverty http://bit.ly/2bxEv3w

SRC: News

Examples: Robots, AI

- Baidu (O2O—online to offline): Medical voice-translation virtual robot, AskADoctor, knows 520 different diseases gives diagnosis with odds, links to nearby specialist
- Baidu: AI StockMaster analyses news, markets predicting sectors, stocks or markets changes
- Robot experiments shows signs of self-awareness (Rensselaer Polytechnic Institute NY)
  - 3 could speak
  - 2 muted
  - Asked to figure out who could speak; no one could solve the problem
  - Each tried to say “I do not know”, one heard itself and said, “Sorry, I know now" then saying more indicating it knew it could speak.

SRC: ACM, News releases

Examples: Robots, AI

- DARPA—Defense research (Defense Advanced Research Projects Agency)
  - **IBM SyNAPSE** neuromorphic chip—modelled on brains, 1 million neurons, 256 million synapses (human—100bn, 100 trn)
  - **ElectRX**—injected nano-chips acting as pacemakers to nervous system giving stimulating signals treating arthritis, mental illness, …
  - **BRAIN initiative-**-human brain modulation and recording
  - **RAM**--implantable neural device with the ability to record and stimulate neurons within the brain to help restore memory

SRC: ACM, News releases/stories

5 AI Megatrends: Pedro Domingos

1.The transition from computers that are programmed by us to computers that learn on their own. This is enabled by big data, and in turn enables the personalization of everything, from medicine to shopping, and the increasing automation of every function in an organization.

2.The automation of scientific discovery. Increasingly, each step of the scientific method, from gathering data to formulating hypotheses, is carried out by computers. This enables, for example, new drugs to be discovered at a much faster rate than before.

3.The replacement of white-collar workers by machines, not just blue-collar ones. Routine intellectual work can increasingly be done by AI; what's hard to replace is physical dexterity, common sense, and integrative intelligence.

SRC: News releases

5 Megatrends: Pedro Domingos

4.The transition from deterministic to probabilistic computing. From hardware to software, rigidly deterministic computations are giving way to probabilistic ones, **enabling faster, cheaper, lower-power, larger-scale, more ubiquitous, more flexible, data-driven information systems.**

5.The rise of evidence-based X, where X includes medicine, policy-making, development aid, and ultimately all important societal decisions. Instead of guesswork and mixed results, we have randomized controlled trials that quickly weed out what doesn't work from what does.

Book: The Master Algorithm, Sept 2015
Interview: http://www.itworldcanada.com/author/sibaraki

So How Do Computers Discover New Knowledge?

1. **Symbolists**--Fill in gaps in existing knowledge
2. **Connectionists**--Emulate the brain
3. **Evolutionists**--Simulate evolution
4. **Bayesians**--Systematically reduce uncertainty
5. **Analogizers**--Notice similarities between old and new

SRC: Pedro Domingos ACM Webinar Nov 2015 http://learning.acm.org/multimedia.cfm

Combining The Five Tribes of Machine Learning: Single algorithm or Master Algorithm (UL)

Tribe	Origins	Key Algorithm
Symbolists	Logic, philosophy	Inverse deduction
Connectionists	Neuroscience	Backpropagation
Evolutionists	Evolutionary biology	Genetic programming
Bayesians	Statistics	Probabilistic inference
Analogizers	Psychology	Kernel machines

SRC: Pedro Domingos ACM Webinar Nov 2015 http://learning.acm.org/multimedia.cfm

UL: Putting the Pieces Together

- Representation
  - Probabilistic logic (e.g., Markov logic networks)
  - Weighted formulas → Distribution over states
- Evaluation
  - Posterior probability
  - User-defined objective function
- Optimization
  - Formula discovery: Genetic programming
  - Weighted learning: Backpropagation

- OpenAI Gym, public beta: https://gym.openai.com/
- IBM Watson AI XPRIZE (TED2020): http://www.xprize.org/ai

SRC: Pedro Domingos ACM Webinar Nov 2015 http://learning.acm.org/multimedia.cfm
http://www.ibtimes.co.uk/elon-musks-1bn-non-profit-launches-gym-train-ai-atari-games-1557362

ML vs CRISPR/Cas9

- **Will the rapid exponential pace of parallel machine evolution realized by machine learning and human evolution spurred by CRISPR/Cas9 disrupt your world?**

Insights from FSR FIF Future Summit

- FIF (Financial Services summit) – top 150 experts and CEOs
- http://www.fintechideasfestival.com/
- Global industry $14 Trillion, 18% global GDP
- 10-20 years into the future
- Spotlighted trends being explored:
  - The Future of FinTech
  - Financial Inclusion
  - Big Data & Internet of Things
  - **Artificial Intelligence**
  - Biometrics, the Imminent Future
  - Blockchain, Cryptocurrencies, & Distributed Ledger
  - Cybersecurity
  - The Future of the FinTech Workforce

Megatrends (MT): “Second Machine Age”

“Second Machine Age”: Erik Brynjolfsson and Andrew McAfee

- Professors from MIT “global economy is on the cusp of a dramatic growth spurt driven by smart machines that finally take full advantage of advances in computer processing, artificial intelligence, networked communication and the digitization of just about everything.”
- Exponential growth: computing power, digital information, cheap IoT communicating, Big Data, unlimited speed, data recombination, ubiquity
- Evidence: Driverless cars, cell-reported traffic patterns, robots scanning and understanding environments, HoloLens, Skype language translation, computers writing reviews/resumes/ grading essays

SRC: Washington Post: Steven Pearlstein http://wapo.st/1bFeuMQ ;
http://blog.instagram.com/post/104847837897/141210-300million

Megatrends (MT): “Second Machine Age”

- Instagram: 400+ million/mthly users, 100+ million photos/ videos/daily; in 18 months sold for $1B to Facebook; Kodak declares bankruptcy same month
- FB Market Value ~$315B in top 5; ~$100B bigger than Walmart; 10 times Kodak at peak; FB 7 billionaires each 10x greater wealth than George Eastman
- WhatsApp $22B, 55 employees purchased by Facebook Feb 2014; $400 million value per person; new low capital business model

  Today: WhatsApp 1B users/mthly + Messenger 900 million = 60 billion mssgs/day

  VS

  United Airlines Dec 2015 $22B market cap, 82,300 employees

SRC: Washington Post: Steven Pearlstein http://wapo.st/1bFeuMQ ;
http://blog.instagram.com/post/104847837897/141210-300million ;
http://www.dogsofthedow.com/largest-companies-by-market-cap.htm ;

Megatrends (MT): “Second Machine Age”

“Second Machine Age” : Erik Brynjolfsson and Andrew McAfee

- First machine age (Kodak), rising and related together with jobs: productivity, employment and income

- Second machine age (FB), existing separately, productivity from jobs/income; with few employees, products/services for unlimited customers, at little cost

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- Future need: Driving greater demand for high-level programmers; education system focussed on skills for smart machines

SRC: Washington Post: Steven Pearlstein http://wapo.st/1bFeuMQ

Megatrends (MT): 4th Industrial Revolution

- *The Fourth Industrial Revolution*
  by Prof Klaus Schwab founder executive chairman World Economic Forum; subject UBS paper
- EXTREME automation, connectivity
- "ALL" dependent upon computing power
  - Examples:
    - CRISPR/Cas9 gene editing
      Jia Jia China, Boston Dynamics walking Robots, Hanson's Sophia

http://www.techrepublic.com/article/microsoft-envision-prepare-yourself-for-the-fourth-industrial-revolution/
https://www.weforum.org/pages/the-fourth-industrial-revolution-by-klaus-schwab/
https://www.ubs.com/global/en/about_ubs/follow_ubs/highlights/davos-2016.html
https://en.wikipedia.org/wiki/$1,000_genome

MT: 4th Industrial Revolution

- Three clusters merging in cyber-physical systems driven by AI and robots:
  - Physical (human world),
  - Digital (technosphere),
  - Biological (natural world)

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https://www.ubs.com/global/en/about_ubs/follow_ubs/highlights/davos-2016.html

MT: 4th Industrial Revolution

- **Impacts:** economic, cultural, social, … endless disruption
- **Labour** (McKinsey US 58% = 45% can be automated now, +13% NLP reaches avg human levels)
- **Cybersecurity risks** (Eurasia Group's cyber risk index of 1-100: US 77, China 88)
- **Geopolitical** (global reaction to US presidential process, populist movements, Zika virus concerns, terrorist acts, economic inequality)
- **Winning** by flexibility, mobility, and adaptability in: education, labour, infrastructure, legal IP

http://www.techrepublic.com/article/microsoft-envision-prepare-yourself-for-the-fourth-industrial-revolution/
https://www.weforum.org/pages/the-fourth-industrial-revolution-by-klaus-schwab/
https://www.ubs.com/global/en/about_ubs/follow_ubs/highlights/davos-2016.html http://techcrunch.com/2016/04/15/artificial-intelligence-and-racist/?ncid=rss

MT: 4th Industrial Revolution

- **Physical (human world):**
  - **Autonomous tech** (DARPA, Google, Tesla, Toyota,…)
  - **3D printing** of circuit boards, cells, organs, medical implants, industrial parts
    - **4D printing** products responding to environment later in time – time the 4D
  - **Advanced Robotics** (OceanOne, Jia Jia, Atlas/Boston Dynamics, Hybrid Delphi human and machine learning collaboration—Korea 4.5% GDP R&D)
  - **New Materials** (embedded electronics e-skin, self-repairing, Lotus Leaf-inspired nanotech, shape memory polymers, nanomaterials like quantum dot tech / new batteries)

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https://www.weforum.org/pages/the-fourth-industrial-revolution-by-klaus-schwab/
http://www.ibtimes.co.uk/sxsw-meet-sophia-female-humanoid-robot-that-says-she-wants-start-family-destroy-humans-1550695

MT: 4th Industrial Revolution

- **Biological:**
  - Genetic analysis
  - Synthetic human genome cell line (HGP-Write)
  - CRISPR/Cas9/Cpf1 for designer plants, animals, humans, embryo experimentation already happening
  - DARPA brain implants, Brain interfaces, Mind control of objects, EU Brain project, US Brain initiative, Consciousness understanding

http://www.techrepublic.com/article/microsoft-envision-prepare-yourself-for-the-fourth-industrial-revolution/
https://www.weforum.org/pages/the-fourth-industrial-revolution-by-klaus-schwab/

MT: 4th Industrial Revolution

- **Digital:**
  - Mobile growing + Sensors rising + IoT planetary nervous system + breakout of Chatbots, virtual assistants and intelligent agents, NLP = Big Data: real-time, findable, shareable, transparent, data patterns with data mining / analytics; processing costs falling, cloud rising, better user interfaces, machine learning / deep learning / recommender / prediction (problem solving)

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https://www.weforum.org/pages/the-fourth-industrial-revolution-by-klaus-schwab/
http://www.mckinsey.com/mgi/overview/in-the-news/by-2025-internet-of-things-applications-could-have-11-trillion-impact

MT: 4th Industrial Revolution

- **Digital:**
  - **IoT** (McKinsey 2025: $11.1 trillion per year)
    - IoT -> global digital mesh -> planetary nervous system -> ML -> Knowledge Synthesis of Everything (KSE)
  - **Smart sensors** (trillion+ 2025)
  - **Smart devices** (7B plus mobile subscriptions; 10B units; Artik chips; Maker movement-Edison, Arduino101,Curie; SOC; SOM; heterogeneous computing; $65 down to $5)
  - **Sharing Caring Economy (O to O**) and new disruptive business models (Uber, AirBnB, Alibaba, Facebook, Amazon Mechanical Turk)

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https://www.weforum.org/pages/the-fourth-industrial-revolution-by-klaus-schwab/
http://www.mckinsey.com/mgi/overview/in-the-news/by-2025-internet-of-things-applications-could-have-11-trillion-impact
KPCB
http://motherboard.vice.com/blog/inexpensive-small-computers-are-changing-the-maker-movement
http://www.cnet.com/news/samsung-artik-teases-smart-robots-light-switches-of-the-future/#ftag=CADf328eec

MT: 4th Industrial Revolution

- **Digital:**
  - **Blockchain** (shared distributed ledger for all kinds of transactions and registrations completed in seconds and not days, open source Hyperledger backed by 40 companies, R3 40+ banks + MS Azure & 45 “block-chain as-a-service providers”, NASDAQ private companies shares tracking, tagging with BC digital fingerprints [BlockVerify] reduce $1.77 tn counterfeit goods/50% online meds with no doctor name)
  - Rise of the **digital assistants and chatbots** (“HER” is here)
  - **Augmented reality and virtual reality** (Magic Leap, HoloLens, Oculus)

http://www.techrepublic.com/article/microsoft-envision-prepare-yourself-for-the-fourth-industrial-revolution/
https://www.weforum.org/pages/the-fourth-industrial-revolution-by-klaus-schwab/
http://www.mckinsey.com/mgi/overview/in-the-news/by-2025-internet-of-things-applications-could-have-11-trillion-impact
KPCB

CRISPR/Cas9

- CRISPR/Cas9: gene editing platform
  - clustered regularly-interspaced short palindromic repeats = from adaptive immune system in bacteria
  - Cas9 = enzyme guided by RNA programmed to locate DNA sequence; Cas9 serves as molecular scissors for DNA sequence cut-and-paste
  - Evolving with single letter DNA base-editing technique with 2/3 of genetic illness are single letter mutations; protein Cpf1 replaces Cas9 makes CRISPR simpler and more precise
  - U.S. Department of Agriculture won't regulate like GMO plants using foreign bacteria DNA

http://www.nytimes.com/2016/02/02/health/crispr-gene-editing-human-embryos-kathy-niakan-britain.html?_r=0

CRISPR/Cas9

- Created mini pet pigs, beagles with double the muscle mass
- Labs creating cures for types of late-onset Alzheimer's, breast cancer, hemophilia, cystic fibrosis, cervical cancer, blindness (retinitis pigmentosa), snip out HIV from immune cells; eliminate things like Lyme disease, Malaria and Zika virus by changing mosquitos; modifying pigs so they can act as organ donors, engineer crops that can survive in warmer climates produced by climate change, program yeast to create plastics, revive extinct species such as the Woolly Mammoth
- Create designer humans?

CRISPR/Cas9

- Cheap, versatile, precise and easy; getting more accurate
- International Summit on Human Gene Editing, US, UK, and China using viable human embryos should not be banned; altering embryos for clinical purposes unacceptable
- Experimentation on non-viable embryos conducted in China; UK approves providing no implantation

http://www.nytimes.com/2016/02/02/health/crispr-gene-editing-human-embryos-kathy-niakan-britain.html?_r=0

ML vs CRISPR/Cas9

- **Will the rapid exponential pace of parallel machine evolution realized by machine learning and human evolution spurred by CRISPR/Cas9 disrupt your world?**

Megatrends: ICT Usage

2014-2015:

3.2B Internet Users --+$4T Commerce

(USA: 29% e-commerce 2-1/tablet/phone)

~7B Mobile Subscriptions (10 sensors)

+81% Mobile Data Growth; video

36% Smartphones (+20% annual growth)

avg $318, -5% per year

25% Total Web Usage

+4 zettabytes data (4B TB)

34% useful, 7% tagged, 1% analyzed

*ICT ~20% GDP Growth

+10% high speed internet = up to 2% Economic Growth

to 2018:

>4B Internet users (USA: 54% e-comm 2-1/tablet/ph)

+60% Smart

+50% Total Web

Smart Internet

+1B Wearables (20 sensors)

20 ZB data (NELL)

***ICT = "Super Capital" 5x productivity gain**

$1 ICT = $5 return

SRC: KPCB, Wikipedia, UN, World Bank, IMF, ITU, ITIF, extrapolations from news releases (IDC, Gartner, Forrester,…)

MT: GIC 2020 Skills Assessment

- Changing environments:
  - **3D printing** – Driving changes in logistics management; what is intellectual property; new pricing models
  - **Data Equity** – The value of data internally, externally and the ways in which that information can be monetised. What are the right types of information and ways to get this information to enable business improvement
  - **The cloud** – The value that it can bring short term and the restrictions that it can bring longer term

SRC: GIC report http://ipthree.org/

http://www.techrepublic.com/article/how-ge-is-using-3d-printing-to-unleash-the-biggest-revolution-in-large-scale-

MT: GIC 2020 Skills Assessment

- Changing environments:
  - **Automation** – driving new self service capabilities
  - **Open source** – growing trend in providing support, customer service and consultancy
  - **Integration** – need for standards, reliable and trusted systems in healthcare integration in wearables, in car info-entertainment, smart metering, industrialising architectures, joining the supply chain together across suppliers, and buyers

SRC: GIC report http://ipthree.org/

MT: AI Innovation: Healthcare

- Costs, up to 17% of GDP
- $660K lifetime costs: http://bit.ly/1ppFLGc
- 52% consumers want web tools
  - 62% want to use email for health concerns
- Smart wearable's: Samsung, Apple, MS, …
- mHealth or Mobile Health
- Telemedicine, Curely, JioHealth
  - http://learning.acm.org/multimedia.cfm [podcasts]
- Research: Optogenetics, Epigenetics

SRC: KPCB, Wikipedia, News Releases … see URL Links to Web Site(s)

MT: AI Innovation: Healthcare

- Optogenetics/optoclamp (closed loop control)—activate cells (eg. Neurons) with light signals; optimize signals from feedback with continuous real-time adjustments
- **Epigenetics**: external or environmental factors that switch genes on and off
- **Precision genetic medicine**:
  - CRISPR/Cas9 gene editing: cheap, easy, snipping gene segments and replacing them
  - CRISPR, clustered regularly interspaced palindromic repeats—matches DNA sequences
  - Cas9 enzyme cut out the matched DNA, allows replacement

SRC: KPCB, Wikipedia, News Releases … see URL Links to Web Site(s)

MT: AI Innovation: Healthcare

- **Neuroscience:**
  - Neuroticism linked to creative genius
  - Insect brains controlling robots
  - Brain-to-brain networks (BRAIN-NETS) in primates, rodents working together for tasks, predict weather (better than working alone)
  - Transplanted embryonic GABA-expressing neurons increasing plasticity in the brains of adult mice, allowing for extensive rewiring and the creation of new neural connections -- comparable to that which occurs during important stages of brain development

SRC: KPCB, Wikipedia, News Releases/stories, news360, … see URL Links to Web Site(s)

MT: AI Innovation: Healthcare

- **Neuroscience:**
  - Passive frame theory—Consciousness—passive conduit rather than an active force that exerts control; more reflexive and less purposeful interpreter presenting information but is not the one making any arguments or acting upon the knowledge that is shared; “free will" "decider" does not exist, consciousness only relays information to control "voluntary" action, or goal-oriented movement involving the skeletal muscle system
  - Algorithm for Simplifying the Brain's Deep Complexity--Machine learning dimensionality reduction, interprets large-scale neural recordings
  - Brain signature predicts human emotions—90+% accuracy, neural activation pattern across brain, found by machine learning with neural imaging

SRC: KPCB, Wikipedia, News Releases/stories, news360, … see URL Links to Web Site(s)

MT Innovation: Blue Sky

EmDrive—electromagnetic space propulsion technology

Fusion—Lockheed announces compact design; prototype in under 10 years

AI and Quantum Learning: D-Wave 2X 1,000+ qubits—quantum computing 100 million times faster (Nasa, Google, Lockheed, Los Alamos National Laboratory). IBM Quantum Experience

Nanomaterials—nanorobots in medicine, extra capacity/life batteries, quantum dot solar windows, …

No limits

SRC: KPCB, Forbes, Wikipedia, News Releases/stories … see URL Links to Web Site

MT: AI Big Questions?

The Reality:

- Unlimited computational resources and connections
- Pervasive computational thinking
- Whatever the future, it will depend on computing
- Everything is recorded, nothing is forgotten
- Organizational, geographical boundaries disappearing
- Moving towards a master algorithm—universal learner

Digital quake – 2030 80% companies and jobs change?
What are the economic implications?
What is the social impact?
What will the world look like?
What are the intended and unintended consequences?
Is there a need for ICT accountability, ethical conduct, credentialing which EQUALS professionalism?

Inspired / adapted from assertions from Grady Booch keynote, NSF PACE Workshop August 21, 2014, Washington DC