
New Era of Computing. John Kelly III:

"Smart Machines: IBM's Watson and
the Era of Cognitive Computing"

Krzysztof Czarnecki, March 20, 2014



Instead of Introduction

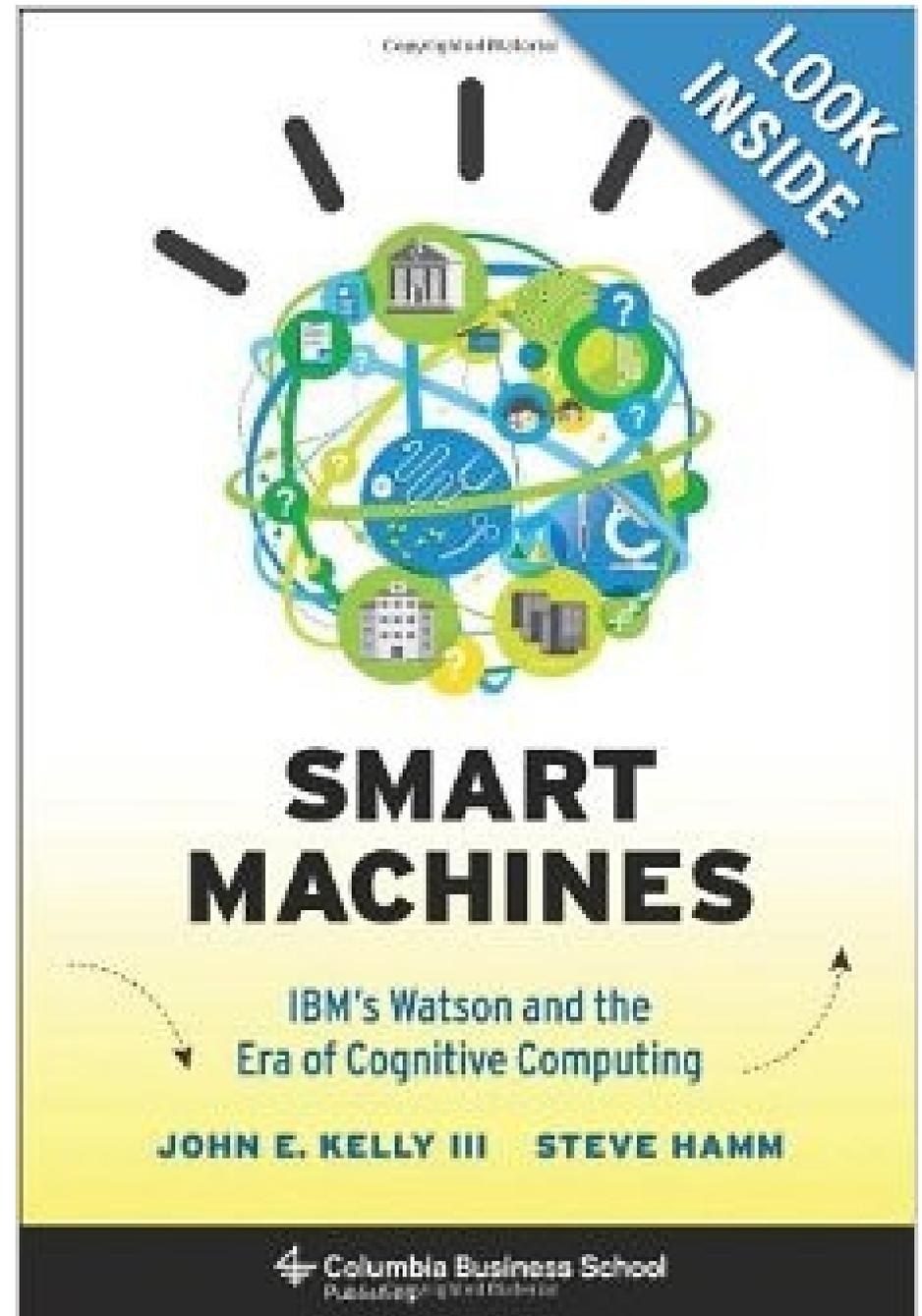
- BIG DATA
- SW: Self learning / cognitive systems
- HW: New architecture / technology

- “New Era of Cognitive Computing”: <http://www.youtube.com/watch?v=7ZXBqkEUZkU>
- Machine and Human Cognition are complementary
- We have different strengths and weaknesses
- Let use computers to help us reason,
 - not to play the same cognitive role in the universe,
 - nor to replicate Human cognition
- Dr Larry Norton at Memorial Sloan-Kettering:
 - “I envision situation where myself, the patient, the computer, my nurse, and my graduate fellow are all in the examination room interacting with one another”
- Effect on Human beings. Big shift is coming.

(Note: in parenthesis are the ideas or digressions not from the book)

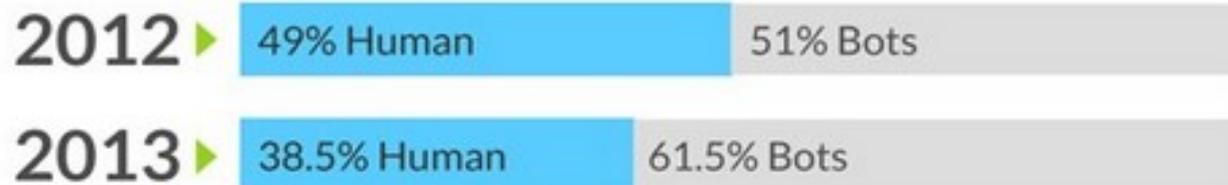
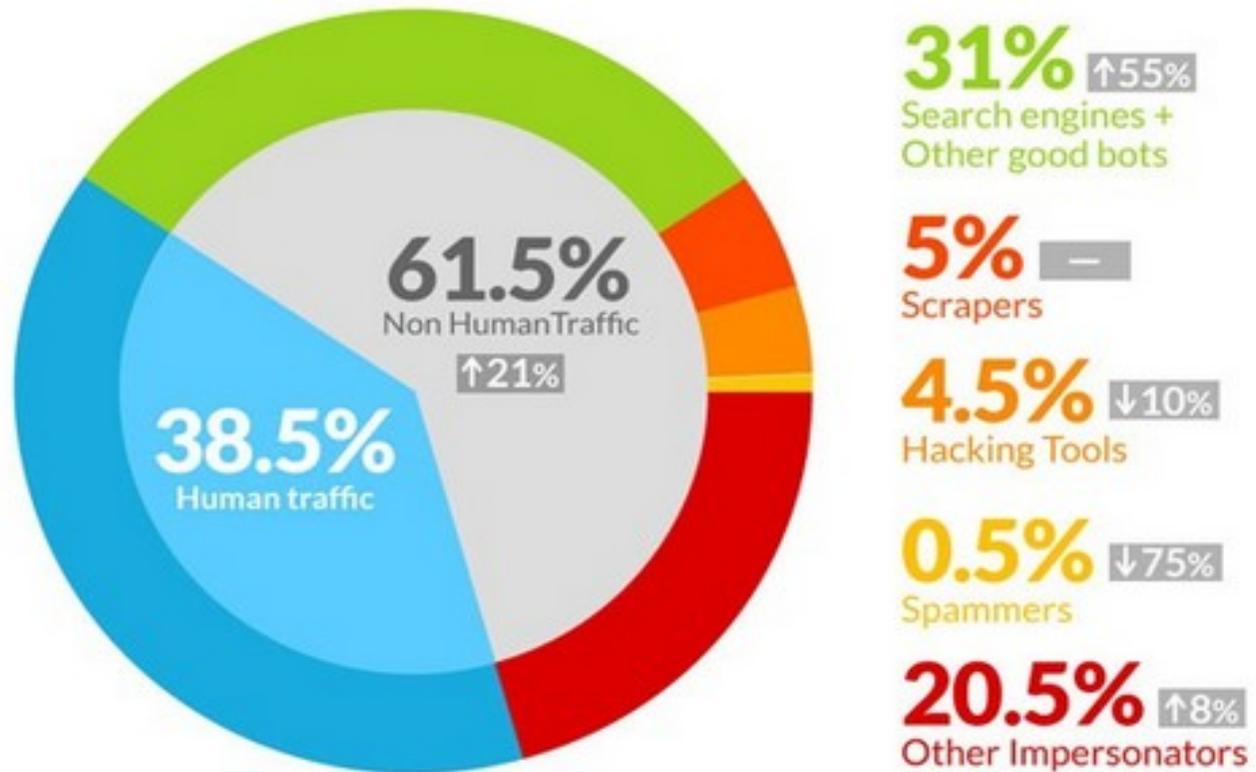
Agenda - Chapters of the book

1. **A new Era of computing**
2. Building learning Systems
3. Handling Big Data
4. Augmenting our senses
5. Designing Data-Centric Computers
6. Inventing a new physics of Computing
7. Imaging the cognitive City



Challenges

Bot/Human Traffic Distribution

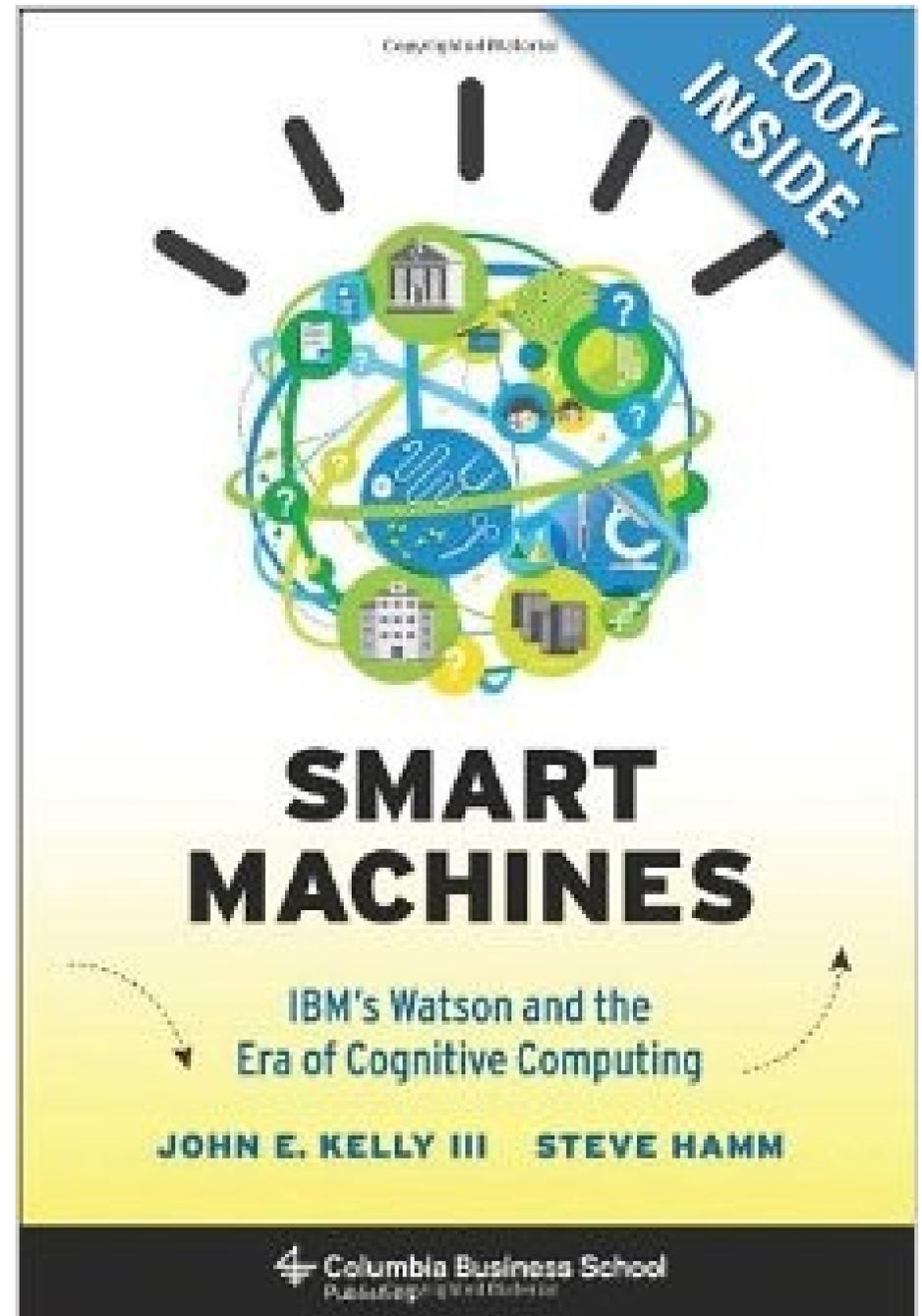


A new Era of computing - Challenges

- 61 % of traffic are non Human Traffic.
- 60% Y2Y grow of the information lot. Big data are the new natural resource.
- 15-20% medical diagnosis are inaccurate
- “IBM Research's John Kelly: The Three Eras of Computing”:
(<http://www.youtube.com/watch?v=e3fVSCYPLsU>)
 - Tabulating (40ties)
 - Programmable (or/and Transactional)
 - Knowledge handling/Cognitive technologies.
 - Learning systems – which does not require much programming
- Complexity:
 - Source: sensors, CCTV, Mobile phones
 - Scenarios: 1) Patrol officers; 2) Assist in personal decisions (house, car)
- Objectivity – many information are biased
- Cost of drug developing: 10-15 years: \$ 1 mld
- “Man Computer Symbiosis”: 1960 article by J.C.R Licklider
 - Explosion of creativity
- “Race against the machine” Erik Brynjolfsson, Andrew McAfee
 - Loosing the jobs http://www.ted.com/talks/andrew_mcafee_are_droids_taking_our_jobs
- “Human Brain Project” in Europe

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Jeopardy!



Watson



Building learning Systems (& Watson)

- “Jeopardy’ TV show: <http://www.youtube.com/watch?v=P18EdAKuC1U>,
http://www.ted.com/talks/ken_jennings_watson_jeopardy_and_me_the_obsolete_know_it_all
 - Vast amount and different format of text
 - probability

- Next area: Health Care
 - Recommend treatment
 - Cooperates with Cancer research centers
 - Cleveland Clinic,
 - Memorial Sloan-Kefler Cancer Center NY:
 - WESTMED Medical Group in Purchase, NY:
 - Interactive Care Insight for Oncology to access the latest information for oncology

- SCENARIO

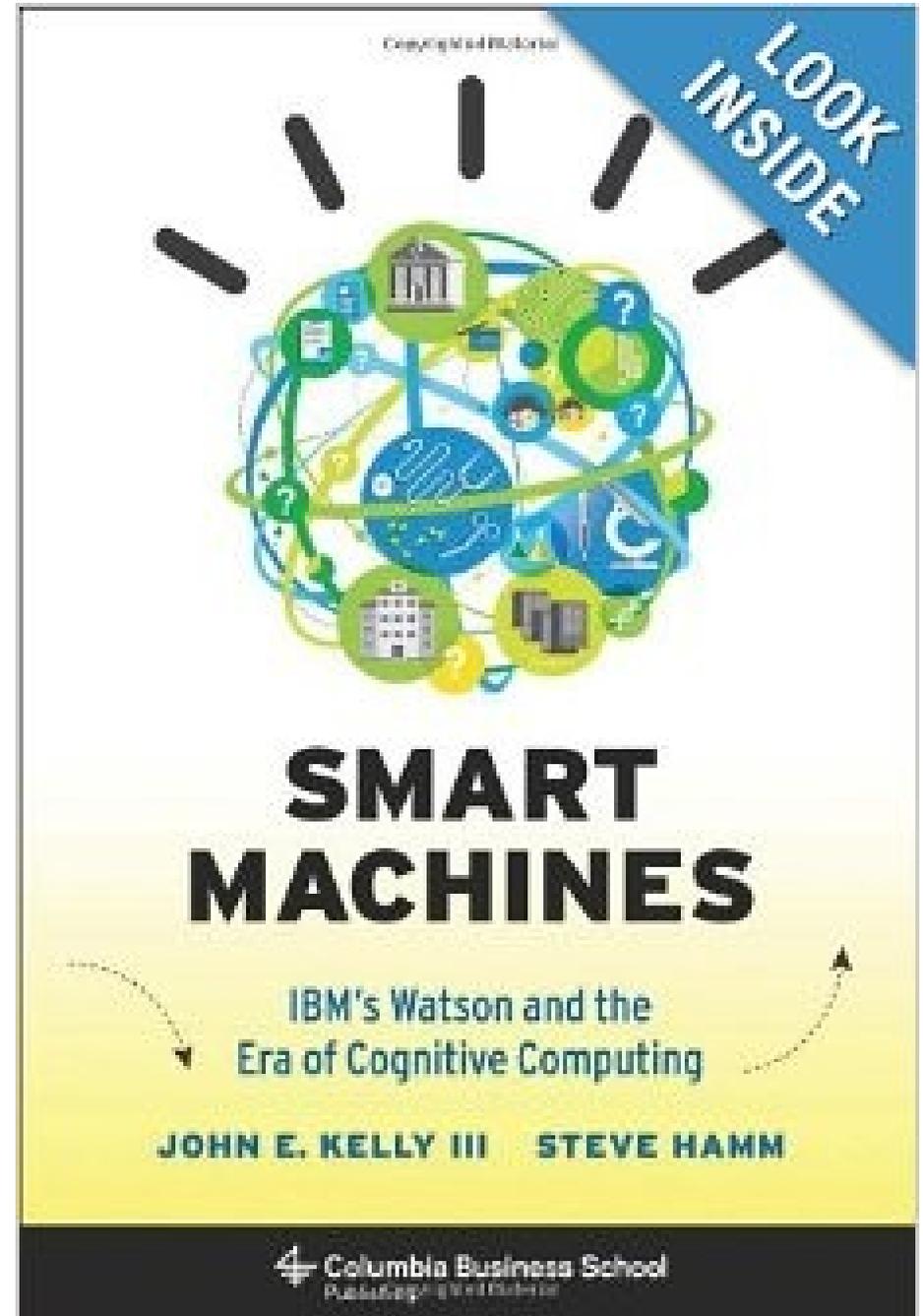
- User Interface WatsonPath - How physician solve the problems:
 - Review the evidence & interference
 - Ask for additional information and insight
 - He student will train the machine and. At the same time, the machine will help train the student

- Call Center – voice and context recognition

9 ▪ (Learning How to 'walk': http://www.youtube.com/watch?v=iNL5-0_T1D0)

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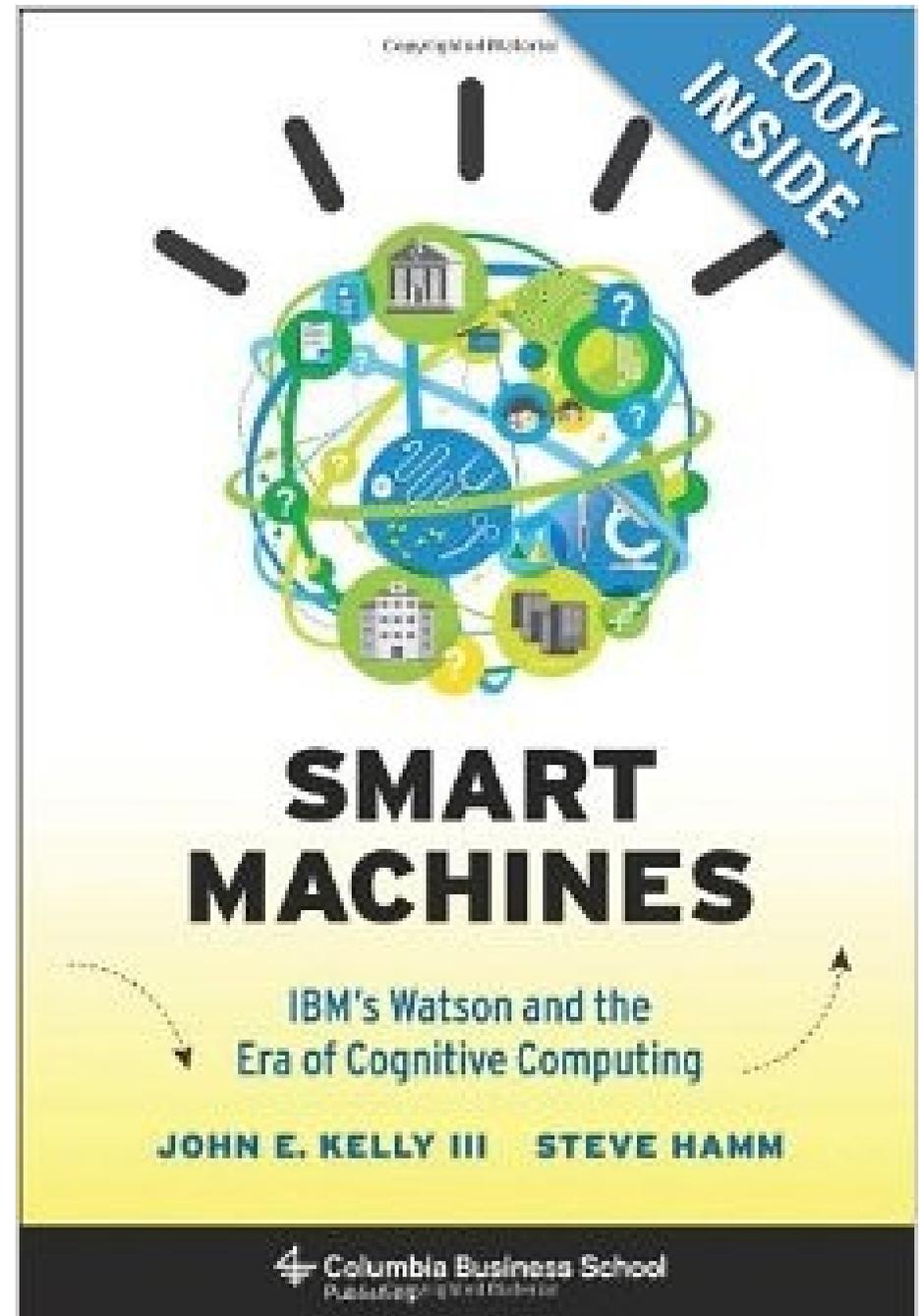


Handling Big Data - Challenges

- Big Data Challenges
 - Volume
 - Velocity (Streaming)
 - Variety
 - Veracity
- (Medical doctors
 - can know only ~2% of the knowledge
 - Pathologists should be reexamined every 5 years
 - Statistics of Diagnosis - Bayes theore)
- A lot of Data resources are already available on medical matters:
 - In articles on drugs
 - In medical records
 - In maintenance documentation
 - Let explore all of them: relations, ..
- SCENARIO
 - Ref medicine - was mentioned on previous slide ref Learning
 - Square Kilometre Array – Antenna,
 - ~Large Hadron Collider in Geneva
 - (Sentiment analysis Przemyslaw Biecek at TED at Krakow:
 - <http://www.youtube.com/watch?v=UEIcsVhFaSs>)

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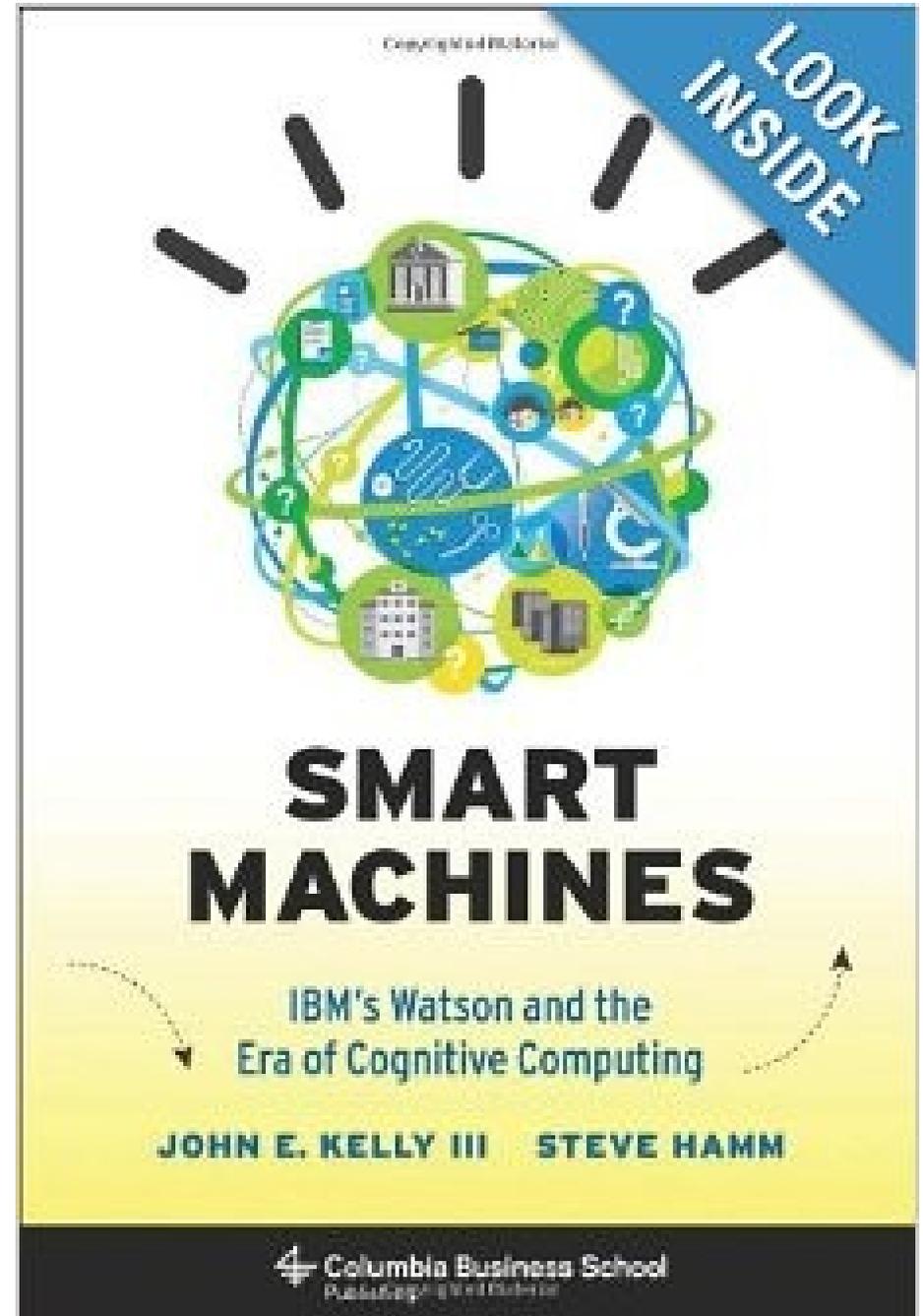


Augmenting our senses

- CO sensors
- RFID, CCTV, Hear, Smell
- 11% → 42% of data from sensors in 2020
- Brain 20 mld neurons 20 Watt
- “Cognitive Computing: The SyNAPSE Project” (Systems of Neuromorphic Adaptive Plastic Scalable Electronic) <http://www.youtube.com/watch?v=gQ3HEVeIBFY>
 - 2011, January 13 Dharmendra Modha received 1st chip
 - 200 experimental neurosynaptic computing chips. (Intelligence of a worm)
 - Non-von Neumann architecture – to simulate the functions of neurons and synapses.
 - Event-driven, distributed, parallel processing
 - 2013 TrueNorth chip; coming generation of brain boxes will be able to combine information from different sensors and draw conclusion from it.
- SCENARIO
 - Identify illness via smell sensor
 - Self Driving Vehicles.
 - The Mars rover Curiosity operates on the surface of the Red Planet - still must be programmed in advance by people
 - Brain like computer – reverse-engineer the Brain
 - Assistive vision
 - Tumbleweed, a robotics ball capable of rolling through a disaster scene
 - Conversation flower – a device that captures images and sound during Business meeting.

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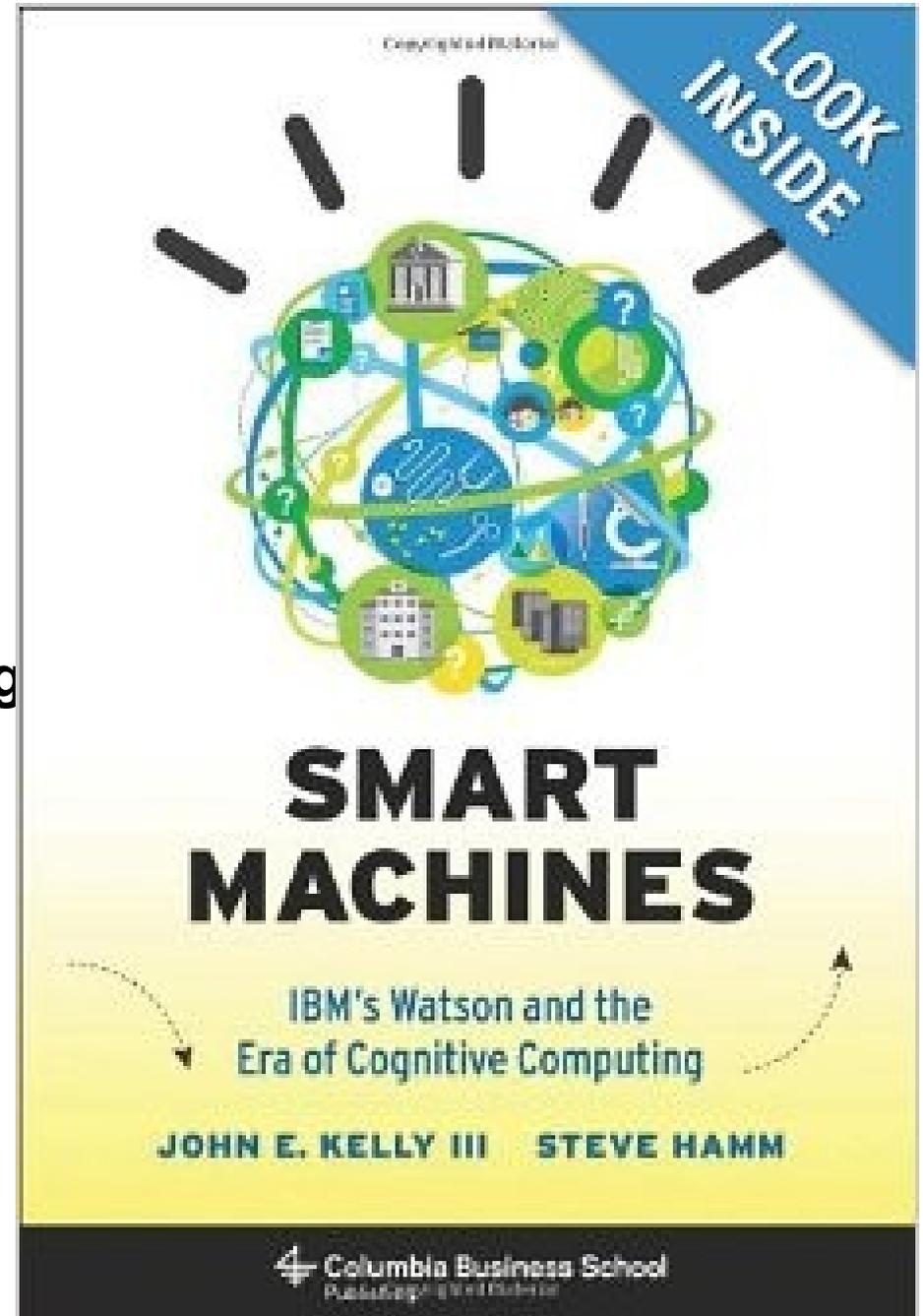
Designing Data-Centric Computers

- To avoid LAN/WAN traffic
- How much costs transferring 1 bit of data?
 - 800 - 6 000 picocents ($\times 10^{-12}$)
 - 6 - 27 picocents if within a single computer
- What processing should be close to data?
 - Service vs pure data (jpg, text, music)
- Change the CPU centric model of 40-ties by John Von Neuman
 - Architecture: CPU, RAM storage on the same chip
- Options
 - Use of FPGA (Field Programmable Gate Array)
 - Used in Cryptographic chips, compression / decompression, encryption on fly
 - Nanophotonic: CMOS integrated with photonic's functions at single silicon chip.
- DC2- Data Centric Deep Computing

- SCENARIO
 - Intelligence to the electricity Grid
 - AC, appliances;
 - Switch to electric vehicles: charging (and/or using as UPS in the office building)

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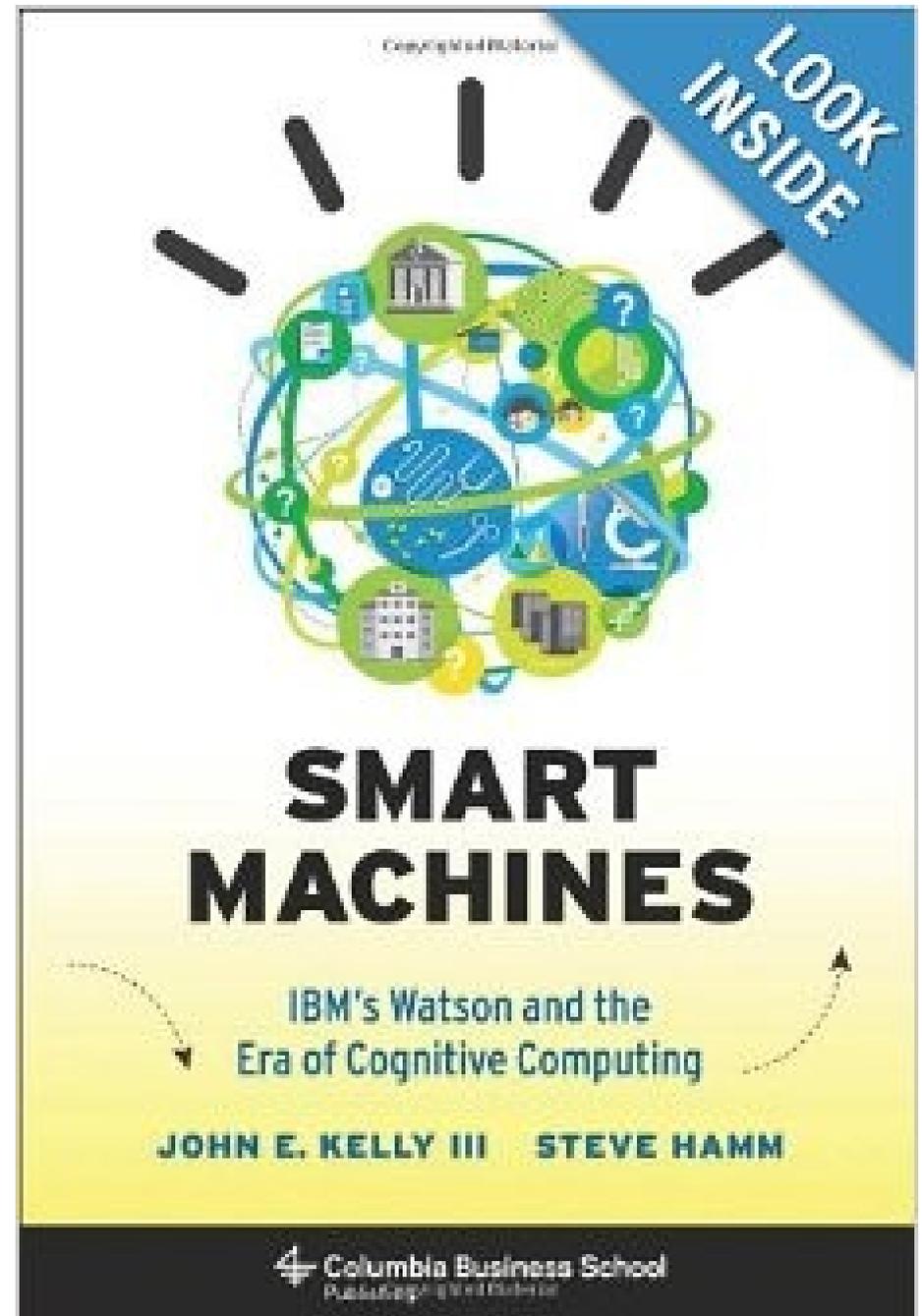


Inventing a new physics of Computing

- Moore Law: every 18 month CPU power doubles:
- Close to the limits
 - quantum limits of path width, (STM – Scanning Tunneling Microscope)
 - Density of Power consumption and cooling
- Quantum Computing
 - Cryptography of the WAN links
 - bits vs qbits ([0 or 1, probability] and/or four state logic [00, 01, 10, 11])
- Organic Solar Cell (with Chlorophyll? Much Cheaper than Silicon)
- Nanotechnology
- 1989 – moving the atoms
 - Smallest Movie (Youtube) “Boy and his atom”: <http://www.youtube.com/watch?v=oSCX78-8-q0>
 - 35 xenon atoms to spell out “IBM”
- 2011, March 2, 12 atoms to store 1 bit vs 1 Mio of atoms /bit
 - however at very low temperature,
 - Andreas Heinrich & Team IBM Research Almaden
- Gerd Binnig, Zurich (Atomic Force Microscope – AFM) . Nobel Price in Physics 1986
- SCENARIO
 - Molecule Chip?
 - ('DNA like' storage?)

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Imaging the cognitive City

- 1 Mio people move to cities every week; 6,5 Bio in 2050
- Need for “Scientific Theory of Cities”: to match demand and supply, ..
- Crime fighting COMSTAT Program: NY 1990 Commissioner William Bratton
 - 3000 cameras weekly reviews
 - Crime has been dropping for 20 years
- Holistic system
 - Smart meters, Grid
 - Twitters and issues
 - Use of many other sensors: CCTV, Microphones, pollution:
 - “You can't improve what you can't measure”
- SCENARIO
 - Rio de Janeiro: torrential rains & severe storms cause floods and landslides
 - Netherlands 20% of land under sea level vast network of dykes and sluices.
 - Learning system.
 - Operating System for the City to share information and coordinate functions.
 - City apps., Open-data initiatives and contents launched by Cities
 - Parking space locator in SF, LA. Sensors embedded in the pavement, smart phones
 - Indianapolis by Arizona State Univ: “Hestia”: Greenhouse gas emission,
 - (Krakow: potholes in the pavement)
 - Traffic jams. IBM Insight in Motion”. Cell- Phones record of track.
 - Dubuque, Iowa – use public buses. Istanbul.
 - To reduce ops expenses by 40%, meet 37% more demand, average commuter time by 60%

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