Computer Science and 21st Century Society

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The Diet
October 13, 2015

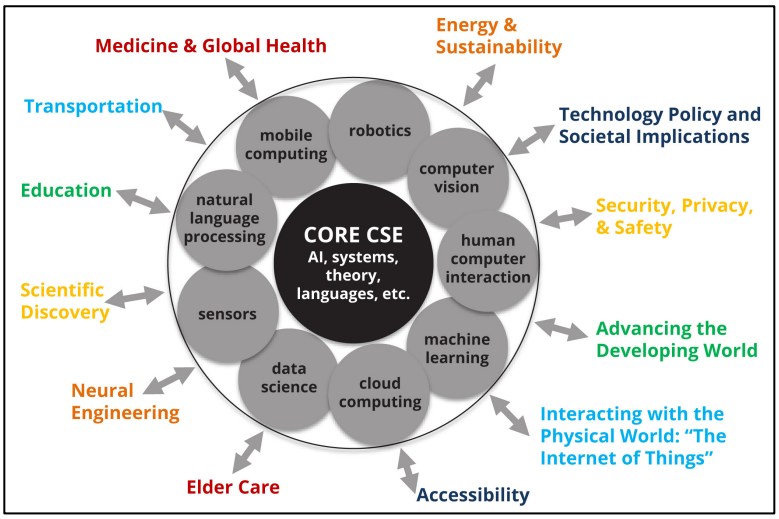
Background

- This is my fourth talk before The Diet
  - 2005-06: Stuck close to my knitting – Innovation policy
    - In my field – Information Technology – our nation's leadership is the result of a complex ecosystem involving universities, Federal investments in university research, and corporate R&D
    - You shouldn't be fooled, by the enormous magnitude of the corporate R&D investment, into believing that the relatively modest Federal investment is unimportant
    - The vast majority of corporate R&D is invested in engineering the next release of a product, rather than looking out 5, 10, or 15 years
    - Even at Microsoft, which invests more in fundamental research than any modern information technology company, the investment in Microsoft Research is only 5% of total R&D
  - 2008-09: Decided to venture far afield – "Metro Nation" – inspired by research studies from the Brookings Institution
    - America is increasingly a nation of "Metros" – Interconnected and interdependent urban and rural areas
    - By every measure except acreage, this is the "real America"
      - The Seattle-Tacoma-Bellevue metro area – Snohomish, King, and Pierce Counties – accounts for less than 9% of our state's land area, but 1/2 of the state's population, and 2/3s of our GDP
    - But we are still governed as if we are a nation of farmers
      - Our nation has well-articulated policies addressing rural America (from highways to farm subsidies)
      - But there's a policy vacuum related to urban America (metropolitan transportation and other forms of infrastructure)

- 2012-13: Again pretty far afield – "The manipulation of science" – inspired by the book "*Merchants of Doubt*"
  - Began with the theme of Tom Daniel's talk from the year before - Science skepticism / ignorance – for example, denial of evolution
  - Transitioned to the manipulation of science – a long and sorry history of a small group of individuals, companies, and politicians preventing action by sewing doubt, exploiting our nation's science skepticism and science ignorance:
    - The relationship of smoking and health
    - Acid rain
    - The ozone hole
    - Secondhand smoke
    - Global warming and climate change
      - *Today*, the platform on the website of one of Washington State's two major political parties says: "Climate change occurs naturally, and warming from human generated greenhouse gases has yet to be proven. At present climate change science does not provide sufficient basis to formulate public policy."
  - One reason people fall for this is the lousy state of science education – misunderstanding the basic processes of science, such as "what, exactly, is a scientific theory?"
- Tonight: I'm going to return to familiar turf, and talk about the interaction of computer science and 21st century society

The nature of the field *(see the chart)*

- We've had a great 50-year run focusing on the core of the field: making things faster, smaller, and cheaper
- But what matters to people today is a set of societal challenges:



education, health care, transportation, energy, the advancement of discovery, the future of work

- Advances at the core of computing are closely coupled to all of these societal challenges by a set of newer areas of the field: sensors, robotics, computer vision, natural language processing, data science
- In the next 50 years, the field will be judged based upon the impact it has on these societal challenges, and on our lives and our society
- Tonight I want to have a discussion of some of these issues
    - And I do mean a discussion – I've got far more questions than answers

Topic 1: Artificial intelligence, robotics, and the demise of our civilization

- Bill Gates, Stephen Hawking, and Elon Musk have recently joined a chorus of individuals suggesting that artificial intelligence will evolve to a point at which humanity will not be able to control its own creations, leading to the demise of our civilization
    - Musk referred to the advance of artificial intelligence as "our greatest existential threat" and called for "regulatory oversight … at the national and international level"
- There's the potential for a long philosophical discussion – and it would be an interesting and worthwhile discussion if it were led by someone smarter than I
- It's not that we shouldn't think about such things!
- But these comments by Gates, Hawking, Musk, and others strike me as dangerous alarmism – and subject to serious misinterpretation by the public
- We need to separate "automation" from "autonomy"
    - Our cars have automatic transmissions, and adaptive cruise control, and self-parking
    - This doesn't cause us to fear for the future of humanity
    - My concern is that the person on the street will misconstrue the comments of Gates, Hawking, and Musk as implying that before too long, our Teslas are going to get together in the Costco parking lot and decide to turn against us – run us all down
        - Let me tell you, we are a long way from needing to fear that!
    - This past summer, the DARPA Robotics Challenge put semi-autonomous humanoid robots – human guided robots that have

roughly the physical form of humans – through a battery of 8 tasks related to disaster relief
        - As John Markoff of the *New York Times* said ten days ago at the GeekWire Summit as he showed a video of the event, "If you're worried about Terminator, just close your bedroom door" – see https://www.dropbox.com/sh/780jfa3ilehp0mb/AAA3znYq31iHNAfEO84b1pdCa/A%20Compilation%20of%20Robots%20Falling%20Down%20at%20the%20DARPA%20Robotics%20Challenge.mp4?dl=0
- Andrew Ng (Stanford), said (paraphrased): "Working to prevent AI from turning evil is like disrupting the Space Program to prevent over-population on Mars"
- Here's an interesting policy question, though:
    - Technological advances create the potential for unintended consequences, and for accidents
    - What's the appropriate balance between innovation and safety?
    - Analogy: The introduction of high-pressure steam in England vs. the US
        - The US had looser regulations, more deaths, and a far more vibrant and rapid industrial revolution driven by high-pressure steam
    - My view of self-driving cars (and other things): the problem is too little artificial intelligence, not too much!
    - The Allen Institute for Artificial Intelligence, established by Paul Allen two years ago and led by my UW CSE colleague Oren Etzioni, has as its tagline "Artificial Intelligence for the Public Good" – there's huge potential!

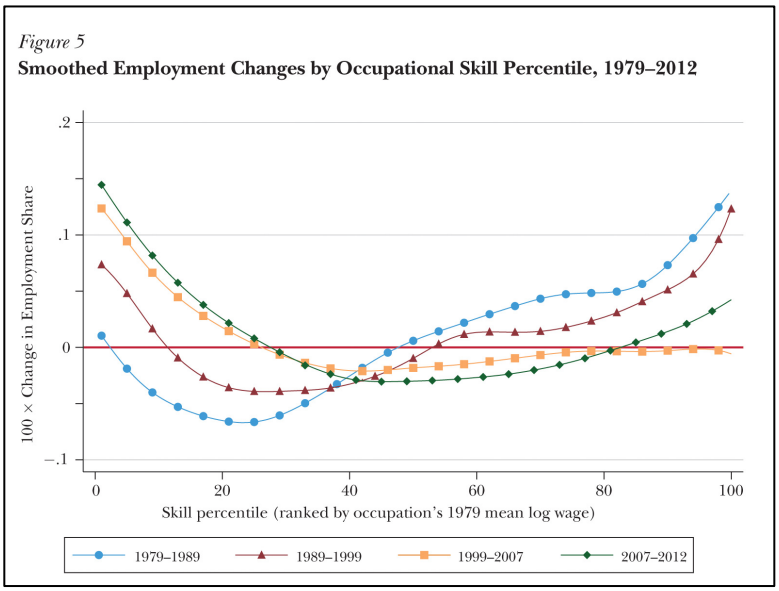
Topic 2: The impact of automation on the workforce

- At the time of the Civil War – about 150 years ago – somewhere between one-half and three-quarters of employed Americans worked on the farm
- Today, less than 2% of employed Americans work on the farm, and they produce enough to feed much of the rest of the world in addition to our own nation
- That's a dramatic change, but it took place at a leisurely pace – progressively, over the course of a century and a half – and during a period

when our nation had social safety nets in place to assist those who were displaced
    - So succeeding generations have been able to prepare themselves for alternative forms of employment
- Today, the pace of change is far faster – authors such as Ray Kurzweil argue that the overall rate of change in society must inevitably increase exponentially – and the social safety nets have largely been dismantled
- Concern regarding the impact of automation on employment goes back a long way:
    - The Luddite movement of the early 19th century, in which a group of English textile artisans protested the automation of textile production by seeking to destroy some of the machines
    - 1961 *Time Magazine* story:
        - "The number of jobs lost to more efficient machines is only part of the problem. What worries many job experts more is that automation may prevent the economy from creating enough new jobs."
- Recent prominence: MIT Business School faculty members Erik Brynjolfsson and Andrew McAfee in their 2014 book "*The Second Machine Age*":
    - "Rapid and accelerating digitization is likely to bring economic rather than environmental disruption, stemming from the fact that as computers get more powerful, companies have less need for some kinds of workers. Technological progress is going to leave behind some people, perhaps even a lot of people, as it races ahead."
- These 3 examples – the Luddites, *Time Magazine*, and the recent book by Brynjolfsson and McAfee – are cited by David Autor of the MIT Economics Department in a summer 2015 paper "*Why Are There Still So Many Jobs? The History and Future of Workplace Automation*" - http://pubs.aeaweb.org/doi/pdfplus/10.1257/jep.29.3.3 - in which he says:
    - "The past two centuries of automation and technological progress have not made human labor obsolete: the employment-to-population ratio rose during the 20th century"
- Autor points out that there often is a *complementarity* between automation and employment; he writes:
    - "Despite ATMs, US bank teller employment rose from 500,000 to 550,000 between 1980-2010. ATMs reduced the cost of operating a bank branch. The number of tellers per branch fell by 1/3 between

1988 and 2004. But the number of urban bank branches rose by more than 40%"

- He notes that while substitution takes place – machines for people – "But the scope for this kind of substitution is bounded because there are many tasks that people understand tacitly and accomplish effortlessly but for which neither computer programmers nor anyone else can enunciate the explicit 'rules' or procedures"
- Undeniably, there are structural changes taking place:
    - Employment loss has been the greatest at the lower end of mid-skill levels *(see the chart)*
    - There is employment growth at low skill levels, and at mid and high skill levels *(see the chart)*



- The positive view, though:
    - Overall employment has not decreased
    - Automation eliminates the more manual, less fulfilling tasks and allows society, on the average, to pursue more fulfilling tasks that really utilize human creativity

Topic 3: The "gig economy"

- Information technology has enabled specialization and outsourcing at the corporate level
    - Companies retain for themselves exactly what they're uniquely good at, and outsource the rest
        - For example, companies design computers, but don't manufacture them – which was not at all the case a few decades ago
    - The outsourcing is *global*

    - Can have huge impact because the cost of equivalent labor may differ dramatically, at least for interim periods
        - Electronics manufacturing moves from California to Central America to Asia
        - Routine software programming moves from America to India
- Information technology is enabling something else: Whether by economic necessity or by choice, our nation's workforce is increasingly composed of freelancers, independent contractors and the otherwise self-employed
    - It's estimated that as many as *one-third* of U.S. workers now find themselves piecing together two, three or more on-demand work opportunities to make a living
    - That is, they string together "gigs" rather than having permanent full-time jobs – enabled by digital channels for accessing freelance work
    - That's the "gig economy" – and it is clearly enabled by information technology
- Some examples:
    - Uber: effectively a limo service that's a federation of independent individuals – how many of you have used it?
    - Amazon Flex: 1-hour package delivery by freelancers
    - TaskRabbit: any sort of household task – assembling furniture, yard work, organizing your closet, waiting in line
    - UpWork: a market for freelancers of any kind – UpWork itself takes 10% for its trouble
    - Etsy: an online market for handmade or vintage items
    - Airbnb: room rentals
- Mark Warner, US Senator from Virginia, wrote in the *Washington Post* in June: "So these workers, even if they are doing very well, exist on a high wire, with no safety net beneath them. That may work for many of them — until the day that it doesn't."
- Whether or not you believe that this is a threat to our way of life, it's a true fact that it's a significant change, and that information technology enables it

Topic 4: Software that Cheats

- You're all familiar with the Volkswagen diesel emissions scandal – a story that broke several weeks ago

- I received two emails in the immediate aftermath that rubbed me the wrong way:
    - An old graduate school colleague, Dick Swenson: "We are at risk from the so-called prophets of machine intelligence who seem to have no morals"
    - Nick Wingfield of the *New York Times*: "I have been thinking about a story looking at how using software to cheat on tests goes far beyond the Volkswagen scandal"
- My response to them:
    - There was a related *New York Times* article today pointing out that the auto industry has been repeatedly caught cheating over many decades, from long before there were computers in our vehicles – "Volkswagen Test Rigging Follows a Long Auto Industry Pattern" (http://www.nytimes.com/2015/09/24/business/international/volkswagen-test-rigging-follows-a-long-auto-industry-pattern.html). The article says:
        - "Long before Volkswagen admitted to cheating on emissions tests for millions of cars worldwide, the automobile industry, Volkswagen included, had a well-known record of sidestepping regulation and even duping regulators."
        - "No matter the offense, penalties have often been fleeting. Executives are not jailed; fines are manageable."
        - "In the United States, automakers' lobbying has ensured that the statute giving powers to the National Highway Traffic Safety Administration 'has no specific criminal penalty for selling defective or noncompliant vehicles,' says Joan Claybrook, a former administrator of the agency and a longtime advocate of auto safety."
        - "'I don't see them changing this behavior unless criminal penalties are enacted into law that allow the prosecutor to put the executives in jail,' Ms. Claybrook said."
    - And the reader comments – which I usually totally ignore, but glanced at in this case – point out that this is nuthin' compared to the financial industry, and the reasons are the same: corporations get a wrist-slap (which they view as simply a cost of doing business), and individuals get off scot-free (at least those at the top do –

occasionally some poor shmoe way down the totem pole gets sacrificed)
    - So, yes, "intelligent systems" undoubtedly can make cheating harder to detect, but the heart of the problem is that there are no meaningful sanctions
    - As an analogy, this is the major issue with computer security:
        - The reason that people don't break into my house is not that it's an impenetrable fortress. Rather, it's that the likelihood of getting caught, multiplied by the magnitude of the penalty if you *do* get caught, provides sufficient deterrent
        - In the case of computer security, though, the likelihood of getting caught is low, and the likelihood of meaningful sanctions if you *do* get caught is low, so it's open season
            - An aside: The global nature of computer crime makes things even more complex: even when you can identify the perp, there will be jurisdictional issues
    - Undoubtedly, the folks at VW did a hard-nosed analysis: they looked at the likelihood of getting caught, and the impact of getting caught on the corporation and on individuals, and weighed it against the benefits of many years of being perceived of as the "clean Diesel" company

Topic 5 (and final): Security and Privacy

- Touched just now on some of the issues with computer security
- Another issue is that many of our systems were designed in the days before security was an issue
    - The Internet Protocols were designed in 1973, and deployed in 1982 – the user community was small, and they were all friends
    - The engineers who designed implantable pacemakers/defibrillators, and automobiles with telematics units, never dreamed that someone might try to hack them – for example the UW work featured on *60 Minutes* in February (http://www.cbsnews.com/news/car-hacked-on-60-minutes/)
- Privacy and security are related, and neither of them has a purely technological solution – they have technological, economic, legal, and social aspects

- Let's turn to privacy:
    - In 1999, Scott McNealy, CEO of Sun Microsystems, said: "You have zero privacy. Get over it!"
    - A decade later, in 2009, Pete Cashmore, founder of the blog Mashable, said: "Privacy is dead, and social media holds the smoking gun"
- It's more complicated than this suggests
- There are three actors:
    - Individuals
    - Corporations
    - Governments
- Individuals
    - There is a long history of individuals being willing to give up long-cherished rights – including the right to privacy – in return for convenience, or in response to some perceived threat
        - Think about the changes in our society after September 11 2001
            - That genie is not going back in the bottle!
    - In a world in which everyone uses online social networks there are some real issues with privacy
        - With data mining algorithms, everyone can know everything (age, gender, address, salary, number of children, or when is a good time to rob your home) on almost everyone
        - Even if someone decides not to publish any details about his/her personal life, his/her friends can still upload this information
    - Lovely video clip from 2012 (https://www.youtube.com/watch?v=F7pYHN9iC9I):
        - Dave is an extremely gifted clairvoyant who describes to clients detailed personal and financial information.
        - The video reveals the mechanism behind his magic – a set of people probing the web, making people aware of the fact that their entire life can be found online
- Corporations
    - There are many major corporations that have nothing to monetize except what they know about you

        - In the *New York Times* this past Sunday, Bruce Schneier, a leading computer security analyst, was quoted as saying "Surveillance is the business model of the Internet"
    - For example, that's how they sell you targeted ads
    - Companies that have something else that they can monetize tend to be leaders in advocating for privacy
        - Apple has taken particularly strong positions, as has Microsoft
            - These companies are also mature and principled – Microsoft under Brad Smith's influence is extraordinarily principled
    - Companies that don't have much else to monetize – companies such as Facebook – tend to be more on the loosey-goosie end of things
    - The *New York Times* article that I mentioned a minute ago (http://www.nytimes.com/2015/10/11/business/international/behind-the-european-privacy-ruling-thats-confounding-silicon-valley.html) concerned a privacy case decided last week in the European Court of Justice, related to individual control over personal data
        - "I am not a lawyer," and what I say here will not be precisely correct, but roughly:
            - Under European law, an individual has control over what data concerning him or her will be retained, and how it will be used
                - Privacy is a right equivalent to free speech
            - In the US, a company can take pretty much whatever approach it likes, and can change that approach whenever it likes
                - You, as the user, are asked to read and assent to an "End User Licensing Agreement"
- Governments
    - The US Government's surveillance practices in the wake of 9/11 have created enormous problems for American companies operating abroad – high-integrity companies such as Microsoft and Amazon
    - I'll give you an example:
        - I led an Amicus brief in a case in which Microsoft was directed by the US Government to turn over the emails of an Irish individual that were stored in a Microsoft datacenter in Ireland

        - My analogy: Hilton Hotels – if the US government wants access to the contents of an individual's room in a Hilton hotel in Ireland, the government can't simply direct Hilton to break into the room and filch the contents … there are some Irish laws that must be obeyed
    - My view: The issue is not what information can be collected – it's how that information can be used
- Individuals, corporations, and government all need to think carefully about this new world
    - We as individuals need to recognize that what is in our own best long-term interests may be in conflict with our own short-term behavior or expedience, and may be in conflict with what serves the needs of certain corporations and governments

Conclusion

- We've talked about 5 topics:
    - Artificial intelligence
    - Automation and the workforce
    - The gig economy
    - Software that cheats
    - Security and privacy
- There are lots of equally important topics that I could have addressed
- The bottom line
    - Computer science is a major force in shaping our society
    - Every major technology shift carries with it the potential for disruption, and the potential for abuse as well as use – for negative as well as positive consequences
    - Often, the technology is merely an amplifier of pre-existing human nature
    - It's up to us to decide in what direction our society is going head

Postscript

Martha Choe asked about the impact of digital interaction on personal interaction. There's a very nice recent book by my friend danah boyd: "*It's Complicated: the social lives of networked teens*" – http://www.amazon.com/Its-Complicated-Social-Lives-Networked/dp/0300199007/