Exploring the Foundations and Future of Computing

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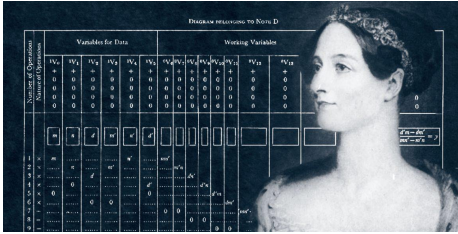11 April 2017

So little time, so much to do!

- **The Foundations of Computing**
  - **Did it really start with Aristotle?**
  - **A few other big names and ideas.**
- **The World of Computing**
  - **Only need five.**
  - **OK, maybe more than five, but does everybody need one?**
  - **Now I want more than the one in my lab, can I connect to yours?**
  - **Can I use all your workstations while you're using them?**
  - **Spare me the details.**
- **The Future of Computing**
  - **More devices, connections, data/information/knowledge**
  - **More people**
  - **More challenges**

So little time, so much to do!

- **The Foundations of Computing**
- **The World of Computing**
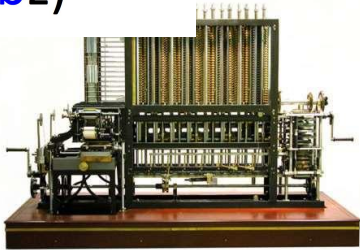- **The Future of Computing**

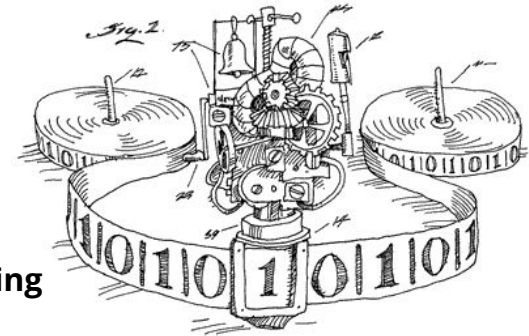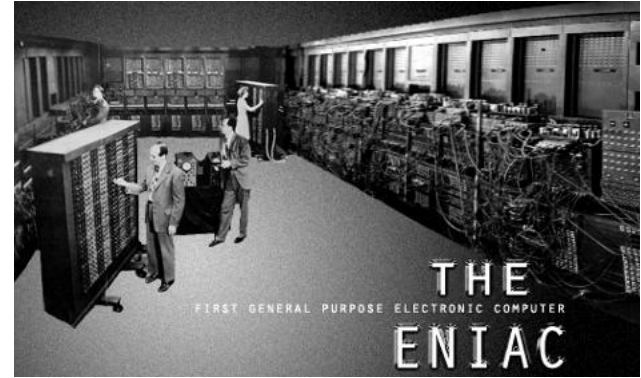Yeah Abstraction!

A (Brief) Tour of the World of Computing

That's great
With what we can automate
It's still up for debate
Our fate in the universe

Charles Babbage had the will
To build a computation mill,
Ada Lovelace understood
Babbage's machine was good,
About 100 years would pass,
Church's lambda-calculus,
Turing machine, intelligence
If it could pass the Turing Test,
Mark I, Z1, where to point a gun
Ask ENIAC.

$(\lambda y.x(yz))\ (ab)$

x(abz)

```
for i in range(3):
```
        It's a Tour of the World of Computing
In minimal time.

THE
ENIAC

FIRST GENERAL PURPOSE ELECTRONIC COMPUTER

The (Real) Foundation of Computing - Ideas

- **Did it really start with Aristotle?**
  - **Syllogism:** a schema for reasoning by the *structure*, no intuition needed
  - **Laws of Identity, Non-contradiction** and **the Excluded Middle**
- **A few other big names and ideas.**
  - **Shannon:** information theory
    - Read Boole's *The Laws of Thought* in undergraduate philosophy course @MIT
  - **Russell, Godel, Church & Turing:** self-reference as a limit of decidability
  - **von Neumann:** unifying machine, program and data **(Universal Turing Machine)**
- **Dixon, C. How Aristotle Created the Computer. *The Atlantic,* March 20, 2017 [link]**

The World of Computing: what we thought

- **Only need five.**
  - **"I think there is a world market for maybe five computers." T. J. Watson, President of IBM, 1946. [link] -- this quote is debated, see here.**
- **OK, maybe more than five, but does everybody need one?**
  - **"There is no reason anyone would want a computer in their home." Ken Olsen, Founder of Digital Equipment Corporation, 1977. [link]**
- **Now I want more than the one in my lab, can I connect to yours?**
  - **"The truth in no online database will replace your daily newspaper,...**
  - **... Yet Nicholas Negroponte ... predicts that we'll soon buy books and newspapers straight over the Internet. Uh, sure." Clifford Stoll, *Newsweek*, 1995.**
  - **BTW, *Newsweek* is available exclusively online since 2012] [link]**

  So what I predict today will likely be wrong or not bold enough.

The World of Computing: we we have now

- **Can I use all your workstations while you're using them?**
  - **High Performance/Supercomputing**
  - **Distributed/Parallel Computing**
  - **Cluster/Grid Computing**

- **Spare me the details.**
  - **Cloud Computing**
  - **Software/Data/Network/Desktop/ ... As a Service [link]**
  - **Mobile/Wearable/Embedded/Ubiquitous Computing**
  - **Self-driving automobiles**
  - **Deep Learning AI that matches best in the world**
    - Watson [link]
    - AlphaGo [link]

Watson 1 Humans 0

The Future of Computing

- **More devices, connections, data/information/knowledge**
  - **Data Science, Big Data, Machine/Deep Learning**
  - **Tablets, AppPhones, wireless/mobile networks**
- **More people**
  - **Accessibility**
  - **Diversity**
  - **Ubiquity**
- **More challenges**
  - **Privacy**
  - **Security**
  - **Ethics**

The Future of Computing will be driven by ideas!

Computing and the Liberal Arts

- **Critical thinking**
- **Multidisciplinary and interdisciplinary thinking**
- **Computational thinking**
- **Thinking**
  - **And behavior, motivation, persuasion**
  - **And psychology, cognition**
  - **And anthropology, sociology**
  - **And finance, business, investment**
  - **And political science, economics**

Case Study: Vaccines [link]

- *Lancet* **paper of causal relation between vaccines & autism [link] ...**
- **... is debunked, redacted as deemed fraudulent [link] ...**
- **... US CDC works to handle the consequences of this fraud [link] ...**
- **... still, many (informed?) people do not accept this conclusion! [link]**
- *Why does this happen?*
  - **Confirmation Bias:** impact of desire on belief [link]
  - **Backfire Effect:** when presented with evidence to the contrary, people often deepen their original, and mistaken, belief [link]
  - **Freedom:** it is a choice, no one (*i.e.*, government) should impose [link]
  - **Anecdotal Evidence:** a false negative is more dangerous than a false positive [link]

Data, Stats, Science and Computing are not enough!!!
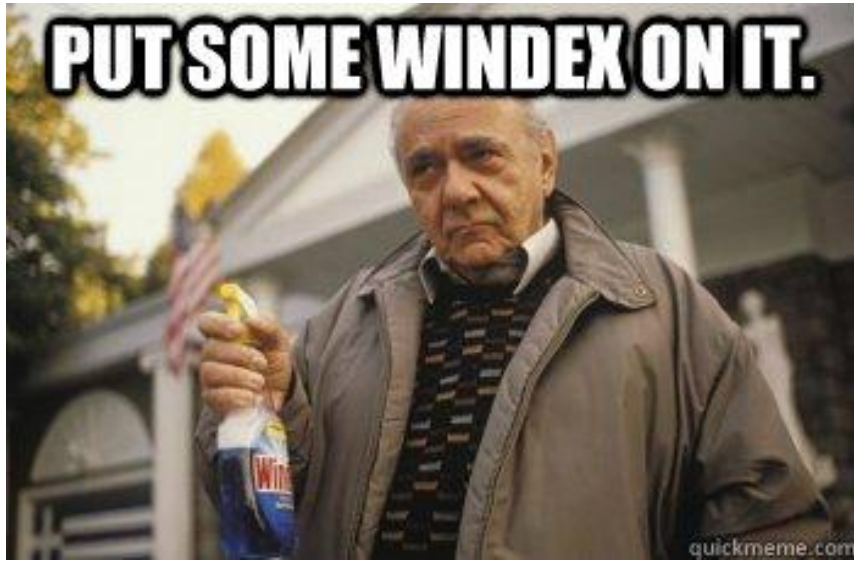
Computing is not a Hammer!

- **Computing contributes in many ways now ...**

- **... many more than we thought before ...**

- **.. so it is reasonable to expect even more in the future!**

- **However ...**

If the only tool you have is a hammer, **you tend to see every problem as a nail**

Abraham Maslow

Computing is not a Hammer (or Windex)!

Beware of a corollary of the Law of the Instrument

"It is also tempting to get comfortable with a hammer, and thus can only work on projects involving nails."

-- J.Dougherty, 2017

The Takeaway

- **Learn all the computing, mathematics, physics, statistics you can**
- **Get skills: programming, debugging, scripting, editing, writing**
  - **Contribute to an open source project, volunteer**
- **Leave your comfort zone**
  - **Take courses outside your major, college**
  - **Do the hard stuff**
  - **Take risks, make mistakes**
- **Help other to learn (since you will learn better!)**
- **Think big, solve big problems, make a difference …**

… Because you are the future of computing

Thank You

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