data-ppf.github.io mar 5, 2019

lecture 7 of 14: WWII, dawn of digital computation

chris wiggins + matt jones, Columbia

themes for today

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    - ‘secrecy’ ties into this power

historical & social context

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  - industrial data: role of Bell, NCR, and OSS/NSA

contemporary context/modern day relevance

student observations

capabilities

power

guided readings

guided readings

reminder: guiding questions

- scientific and intellectual networks

guided readings

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- hardware, labor, and valuing of skills

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- science v. engineering
- role of companies (where the “infra” and “data” are!)

secondary readings

- Sharon McGrayne

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- Janet Abbate

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  - "British Post Office electrical engineer Tommy Flowers"

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    - “British Post Office electrical engineer Tommy Flowers”
- Turing bio

McGrayne on Bayes

By 1939 Bayes' rule was virtually taboo, dead and buried as far as statisticians in the know were concerned. A disturbing question remained, though. How could wartime leaders make the best possible life-and-death decisions swiftly, without waiting for complete information? In deepest secrecy some of the greatest mathematical minds of the century would contribute to rethinking Bayes' role during the uncertain years ahead.

Figure 1: trading zone (1/2)

McGrayne on Bayes

Strangely enough, the Poles were the first to think otherwise. A few intelligence officers in Poland, sandwiched as they were between Germany and Russia, realized a full decade before the start of the Second World War that mathematics could make eavesdropping on their rapacious neighbors quite informative. The First World War had made the need for machines to encode radio messages painfully obvious. When an alphabet-scrambling machine was exhibited at an international trade show in 1923, Germany bought some and began introducing complexities to make their codes more secure. The machines were named Enigma.

Figure 2: labor, engineering, innovation

McGrayne on Bayes

Unlike the Poles, the British agency charged with cracking German military codes and ciphers clung to the tradition that decryption was a job for gentlemen with linguistic skills. Instead of hiring mathematicians, the Government Code and Cypher School (GC&CS) employed art historians, scholars of ancient Greek and medieval German, crossword puzzlers, and chess players. Mathematicians were regarded as "strange fellows."[2]

The British government and educational systems treated applied mathematics and statistics as largely irrelevant to practical problems. Well-to-do boys in English boarding schools learned Greek and Latin but not science and engineering, which were associated with low-class trade. Britain had no elite engineering schools like MIT or the École Polytechnique. Two years into the war, when government officials went to Oxford to recruit men proficient in both mathematics and modern languages, they found only an undergraduate mathematics major teaching himself beginning German. The government did not even plan to exempt mathematicians from combat. Knowing that their skills would be needed eventually, mathematicians quietly spread word to their colleagues to register with the government as physicists because they at least were considered vital to the nation's defense.

McGrayne on Bayes

With applied mathematicians and statisticians in short supply, wartime data were often analyzed not by statisticians but by actuaries, biologists, physicists, and pure mathematicians—few of whom knew that, as far as sophisticated statistics was concerned, Bayes' rule was unscientific. Their ignorance proved fortunate.

Figure 4: trading zone (2/2)

McGrayne on Bayes

In a fundamental breakthrough, Turing realized he could not systematize his hunches or compare their probabilities without a unit of measurement. He named his unit a ban for Banburismus and defined it as "about the smallest change in weight of evidence that is directly perceptible to human intuition."[13] One ban represented odds of 10 to 1 in favor of a guess, but Turing normally dealt with much smaller quantities, decibans and even centibans. The ban was basically the same as the bit, the measure of information Claude Shannon discovered by using Bayes' rule at roughly the same time at Bell Telephone Laboratories. Turing's measure of belief, the ban, and its supporting mathematical framework have been called his greatest intellectual contribution to Britain's defense.

named by Tukey

Figure 5: technology and corporate resources

McGrayne on Bayes

In operation, Banburismus used 5- or 6-foot-long strips of thin cardboard printed in Banbury. Decoders look for repetitions and coincidences, so Wrens, technicians from the Women's Royal Naval Service, punched each intercepted message by hand, letter by letter, into a Banbury sheet. Then they slipped one strip on top of others so that any two messages could be compared. When enough letter holes showed through both Banburies, the number of repeats was recorded.

Figure 6: labor, unseen and/or erased

McGrayne on Bayes

Kolmogorov became the world's authority on probability theory. In 1933 he demonstrated that probability is indeed a branch of mathematics, founded on basic axioms and far removed from its indecorous gambling origins. So fundamental was Kolmogorov's approach that any mathematician, frequentist or Bayesian, could legitimately use probability. Kolmogorov himself espoused the frequentist approach.

Figure 7: 'Russian' mathematics, trading zone

see also "No Bayesians in foxholes" 1997, Breiman

"a strongly anti-Bayesian position which used to be common in statistics" – Gelman

McGrayne on Bayes

Turing spent at least one afternoon in Dayton, where the National Cash Register Company planned to manufacture 336 bombes. He was dismayed to discover that the U.S. Navy was ignoring Banburismus and its ability to economize on bombe usage. The Americans seemed uninterested in the Enigma outside of their obligation to supply bombes for it.

Figure 8: contractor mindset @ NCR

McGrayne on Bayes

Max Newman, formerly Turing's mathematics instructor at Cambridge, wanted to automate the British attack on Tunny-Lorenz's codes, and he, Michie, and Good were already working on new machines to do it. Michie had refined Turingismus, but it soon became obvious that mechanical switches would be far too slow. The process would have to be electronic; engineer Thomas H. Flowers suggested using glass vacuum tubes because they could switch current on and off much faster. With backing from Newman, Flowers built the first Colossus at the Post Office Research Station, which ran Britain's telephone system. Installed at Bletchley Park, Colossus decrypted its first message on February 5, 1944. Flowers's car broke down that day but not his Colossus.

Figure 9: UK ‘post’ (telecommunications too)

McGrayne on Bayes

By 1945 U.S. cryptanalysts were writing memos to one another about Bayes' theorem. Whether the Americans learned about Bayes from Bletchley Park or discovered its usefulness on their own is not known; 65 years after the war, the British government still refuses to declassify many documents about wartime cryptography. A young American mathematician, Andrew Gleason, who was working on Japanese naval codes and who looked after Turing during his stay in Washington, almost certainly knew about Bayes during the war. He, Good, and Alexander continued to work on top-secret cryptography for decades after the war. Gleason helped establish a postwar

Figure 10: behind the fence; Bayes and data science

Abbate on “Women at the Dawn”

I was a Colossus operator, which we considered to be the crème de la crème. We felt we were “at the sharp end,” where there was a great tension and flow of adrenaline . . . operating those incredible machines.

—Jean Beech, Colossus operator[1]

I don’t know if you can picture how exciting the ENIAC was to all of us. And we didn’t talk socially or any other time about anything else. It was—we discussed it almost all the time.

—Jean Jennings, ENIAC programmer[2]

Figure 11: motivation: in their own words

Abbate on “Women at the Dawn”

Computer Work and the Gendered Division of Labor

By the time I reached my third year of college, I started looking around for some type of occupation that could use a math major. I didn’t want teaching. Insurance companies’ actuarial positions required a master’s degree (and they seldom hired women, I later found out). . . . Just after graduation, I happened to see an ad in the daily paper. The Army was looking for women with a degree in mathematics—right here in Philadelphia.

—Kay McNulty, ENIAC programmer[19]

Figure 12: ‘labor shortage’

Abbate on “Women at the Dawn”

manageable for women, assuring them, “If you’ve used an electric mixer in your kitchen, you can learn to run a drill press.”[23] At the same time,

Figure 13: forced models of labor

Abbate on "Women at the Dawn"

In the scientific world, women had been employed in large numbers to do calculations by hand. These human computers generally, although not always, had some training in mathematics, and it was from the ranks of such mathematically trained women that the ENIAC project drew its first corps of programmers. However, even women with college degrees were relegated to subprofessional job classifications. As Kay McNulty recalled, "The girls were told that only 'men' could get professional ratings."[25] The ENIAC programmers were not promoted from computer to mathematician—a professional rating—until January 1946.[26]

Figure 14: prior labor dynamics, and power dynamics

Abbate on "Women at the Dawn"

computer. Dividing the task this way was meant to conserve the scarce labor of trained mathematicians. It also reproduced a gender hierarchy: all of the cryptographers working with Colossus were men, and all of the operators were women.[27] As B. Jack Copeland notes in his history

Figure 15: org chart as weapon of oppression

Abbate on “Women at the Dawn”

in favor of original thought and good work.”[31] While men’s supposedly more creative work excused them from military exercises, Colossus operator Catherine Caughey described how the Wrens were forced to do drills and marches after working all night on the machine: “They made us do an hour’s squad-drill on the gravel in front of the Abbey every morning. . . . We were all being killed by the constant changes of shift. Church Parade on a Sunday was compulsory. On my first Sunday, when I was on nights, I had to assemble with the others. We had to march two miles each way to the village church, along an icy road.”[32] The arduous and seemingly unnecessary demands placed on the Colossus operators reveal their superiors’ unspoken presumption that women’s work is by nature mundane and does not require one’s full energies. Such gender stereotyping can be destructively self-fulfilling. With their work seen as less important, women are loaded down with extra chores such as military drills (or in the present day, housework or low-level administrative tasks). These burdens, in turn, make it harder for women to perform up to their potential, reinforcing the idea that they are less capable than men. In the Bletchley

Figure 16: ‘destructively self-fulfilling’

Abbate on “Women at the Dawn”

Occasionally, the six of us programmers all got together to discuss how we thought the machine worked. If this sounds haphazard, it was. The biggest advantage of learning the ENIAC from the diagrams was that we began to understand what it could and what it could not do. As a result we could diagnose troubles almost down to the individual vacuum tube. Since we knew both the application and the machine, we learned to diagnose troubles as well as, if not better than, the engineer.

—Jean Jennings, ENIAC programmer[36]

Figure 17: depth of nuderstanding

Abbate on "Women at the Dawn"

Initial Assumptions about Computing Work

The selection criteria and job training for Colossus and ENIAC indicate that these tasks were believed to require at least some mathematical ability and that the best available female workers were assigned to the computers. Wrens were placed in Max Newman's mechanical codebreaking section based on an eclectic mix of technical and social qualifications: "Wrens were chosen by interview. . . . No fixed qualifications were required, though a pass in mathematics in School Certificate or apparently 'good social recommendations' was normally considered essential. . . . None had studied mathematics at the university."[37] Newman gave prospective operators a two-week course covering binary math, the teletype alphabet code, and machine operation, after which they were given a written exam. Those with the highest scores were given the most challenging assignments, including Colossus.[38] The first Colossus operators were presumably trained by Newman himself to use the machines, but after that experienced operators took on the responsibility of training new recruits, adding another dimension to their duties.

Qualifications were higher for ENIAC. The six programmers all had

Abbate on "Women at the Dawn"

To be a successful Colossus operator therefore required physical endurance, mechanical aptitude, attention to detail, and the ability to memorize codes and do mental arithmetic. Female operators were also entrusted with a certain amount of initiative. They did some runs without supervision, evaluating the results to determine if the correct wheel setting had been found.[50] They were also trained by the engineers to do routine testing of the machines, and they solved some minor mechanical problems,

Figure 18: skill mix

Abbate on “Women at the Dawn”

cords, Ruth Lichterman was quick to correct him.

Q: When you say you programmed the machine, did that mean physically that you took these plugs from one place and plugged them into another place?
[Ruth Lichterman]: Well, now, program means several things. . . . You got a problem, and you started with pencil and paper, and you decided how you were going to do this problem and which numbers went where. . . . [Y]ou drew a diagram of all this stuff and then you actually went on the machine, and we call that “plugging in” rather than “program.”[59]

Figure 19: programming and plugging

Abbate on “Women at the Dawn”

Constructing Opportunities for Women in Computing at War’s End

We had to sign the Secrets Act when we left, and we had to take all these machines down. My parents never knew what I did, and neither did my husband. I never told anybody at all. None of us ever did.

—Eleanor Ireland, Colossus operator[67]

Figure 20: secrecy

Abbate on “Women at the Dawn”

One common experience for the Colossus and ENIAC women was that neither group received public recognition for their work, either during the war or for many decades afterward. At Bletchley Park, there was complete secrecy: not even the Wrens’ families found out what they had been doing until the 1980s. At Penn, however, the ENIAC was given a

Figure 21: secrecy and un-history

Abbate on "Women at the Dawn"

I wasn't included on any of the pictures of the entire stupid thing." Kay McNulty noted ruefully, "None of us girls were ever introduced [at the press conference]; we were just programmers."[79] It was not until the fiftieth anniversary of the ENIAC that historians rediscovered and began to publicize the ENIAC women's contribution.[80]

Figure 22: erasure

Turing on Turing

Turing on Turing

sooner or later, do so. But in the meantime, the Poles had used the duplicated transmission to identify which wheels were being used and their relative positions, using giveaways known to the British codebreakers as ‘females’. Females happened when the same letter appeared in both versions of the enciphered triplet in the same place – for example, if CIL was transmitted as ABN MRN.

Figure 24: polish engineering

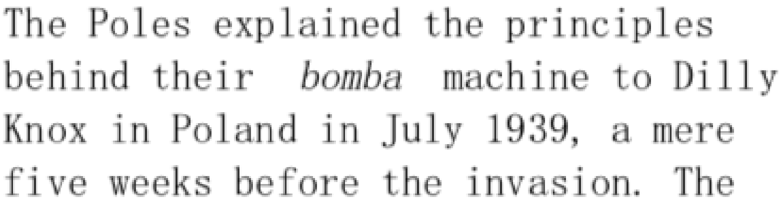
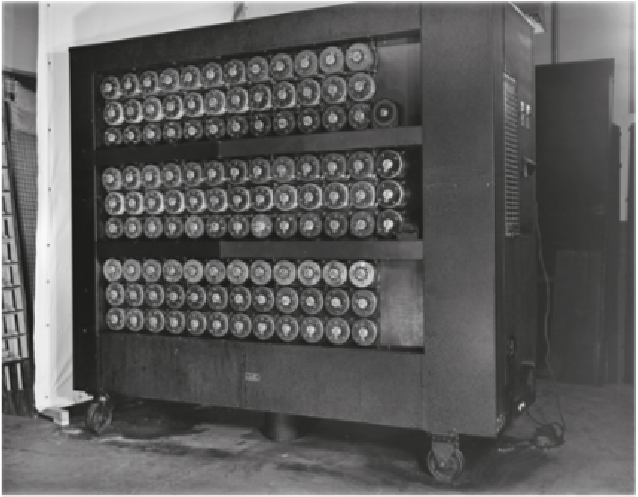

The Poles explained the principles behind their *bomba* machine to Dilly Knox in Poland in July 1939, a mere five weeks before the invasion. The

Figure 25: knowledge transfer



Not a computer. The Bombe, designed by Alan Turing and Gordon Welchman, found logically plausible Enigma settings which were worth testing further.

ALAN TURING' S TRIP to America was so secret that, nine years later, in writing to his friend Norman Routledge Alan said that the job he had had during the war 'certainly did not involve any travelling' . In fact, his

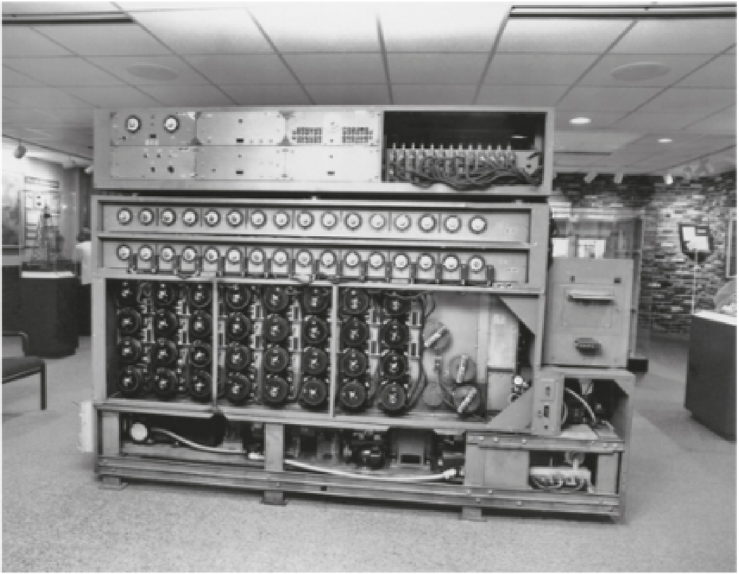
Figure 27: secrecy

Washington

November 28, 1942

REPORT BY DR A.M. TURING, Ph. D.

Alan was next due to visit Bell Laboratories, the research division of the telephone company AT&T. In many ways this was the counterpart to the Post Office Research Establishment where Tommy Flowers was based, and it was where they were building Bombes for the US Army. Getting into Bell Labs was difficult. For one thing the



Very substantial equipment: the US
Navy's four-wheel Bombe (above), and

primary readings

- Turing

contemporary article(s) on the theme

- Mitchell + Jordan piece

power and principles

how did this capability rearrange power? who can now do what, from what, to whom?

- gender and professional roles

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- gender and professional roles
- need for engineering resources: only certain countries, companies

how did this capability rearrange power? who can now do what, from what, to whom?

- gender and professional roles
- need for engineering resources: only certain countries, companies
- secrecy

role of rights, harms, justice?

foreshadowing data for Thursday

reminder of themes/big main takeaways

changes

- Real data:

changes

- Real data:
  - labor and hierarchy in work practice Vs.

changes

- Real data:
  - labor and hierarchy in work practice Vs.
  - labor and hierarchy in ideological justification

changes

- Real data:
  - labor and hierarchy in work practice Vs.
  - labor and hierarchy in ideological justification
- Power of data to reinforce hierarchy

changes

- Real data:
  - labor and hierarchy in work practice Vs.
  - labor and hierarchy in ideological justification
- Power of data to reinforce hierarchy
- Math vs. implementation

Programming and gender

Forms of history around women, around gender

1. Recovery of unheralded women

Programming and gender

Forms of history around women, around gender

1. Recovery of unheralded women
2. Statistical recovery of mass phenomena

Programming and gender

Forms of history around women, around gender

1. Recovery of unheralded women
2. Statistical recovery of mass phenomena
3. Constitution of gender binaries

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Forms of history around women, around gender

1. Recovery of unheralded women
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4. Structural stories of exclusion

Programming and gender

Forms of history around women, around gender

1. Recovery of unheralded women
2. Statistical recovery of mass phenomena
3. Constitution of gender binaries
4. Structural stories of exclusion
5. Ideological apparatus sustaining that exclusion

up next:

next weeks: Erasure of labor à mech Turk and curation in AI

- see, e.g., FB content moderators article

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- see, e.g., FB content moderators article
- see, e.g., Jill Lepore New Yorker article