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Regarding the Constants of Nature and of Art

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Abstract:
In 1832, Charles Babbage proposed the collection of “The Constants of Nature and of Art”, a list of diverse phenomena organised into twenty categories to be counted and measured, ranging from atomic weights and the conductive power of electricity, to the quantity of air consumed per hour by humans, and the number of books in public libraries at given dates. During the same period, he was also developing the difference engine, a machine for computing and printing tables of numbers. Babbage’s constants and engines exemplified a rationality which emphasised counting and measurement as essential means for legitimate knowledge production, also evidenced by the Statistical Society of London’s interest in the establishment of regular censuses throughout the 1800s.

Moving to the present, methodological developments in official statistics such as big data analytics have once again led to an interest in making use of data from diverse sources such as social media and mobile phones. Several European National Statistical Institutes have established groups studying big data methods, and started recruiting data scientists.

By reading these two moments in the history of official statistics in parallel, I build on the understanding that methods enact subjectivities and populations. In other words, counting a population does not merely reflect what already exists “out there”, but actively engages in its enactment by bringing it into being. Drawing on material collected through a collaborative ethnography of five European National Statistical Institutes as part of the ARITHMUS project, I argue that changes in official statistics methods have social and political implications for those being counted, and that analyses of past census methodology can help guide social studies of contemporary quantification methods.

Keywords: census, Charles Babbage, constants, difference engine, big data

Regarding the Constants of Nature and of Art

Introduction

In 1832, Charles Babbage proposed the collection of "The Constants of Nature and of Art", a list of diverse phenomena organised into twenty categories to be counted and measured, ranging from atomic weights and the conductive power of electricity, to the quantity of air consumed per hour by humans, and the number of books in public libraries at given dates. During the same period, he was also working on the difference engine, a machine for computing and printing tables of numbers. Babbage's constants and engines exemplify a rationality which emphasised counting and measurement as essential means for legitimate knowledge production, also evidenced by the Statistical Society of London's interest in the establishment of regular censuses throughout the 1800s.

Moving to the present, methodological developments in official statistics such as big data analytics have once again led to an interest in making use of data from diverse sources such as social media and mobile phones. Several European National Statistical Institutes have established groups studying big data methods, and started recruiting data scientists.

The initial question that started this work—a question not currently supported by the historical record—is whether Babbage imagined using his difference engines to count people, and whether the Statistical Society of London discussed such applications prior to the deployment of Herman Hollerith's tabulating machines for data analysis in the US census of 1890. While the initial question remains unanswered at the time of writing, in the following sections I suggest a method for viewing contemporary practices of big data analytics through the lens of Babbage's seemingly arbitrary "constants of nature and art". The purpose of this short paper is to introduce a potential line of inquiry for further consideration; it does not provide a detailed examination of the method itself.

Background

Royal Statistical Society archives

In 2015, I visited the Royal Statistical Society archives in London to investigate whether the meeting minutes of the Statistical Society of London contained any links pointing to considerations of using Charles Babbage's difference engines for the censuses conducted by members of the Society throughout the 1800s. As Babbage was a well-known and prolific statistician who played an important role in the early history of computing, I imagined that his work could provide a potential entry point for social studies of methods. While there were no indications of such discussions in the council minute books, I continued to follow Babbage's own writings and correspondence, documented in a variety of primary and secondary sources (Lindgren 1990; Agar 2003; Bromley 1982; C. Babbage [1889] 2010; M. L. Jones 2016b; Hacking 1990).

In the following sections, I describe the significance of Babbage's list of constants for understanding contemporary statistical methods, and I chart a course for the stage of investigating possible links between population census methods and the development of machines for counting and tabulating.

A note on theory

Throughout the report, I build on the understanding that methods enact subjectivities and populations. In other words, counting a population does not merely reflect what already exists "out there", but actively engages in its enactment by bringing it into being (Ruppert 2011). Drawing on material collected through a collaborative ethnography of five European National Statistical Institutes as part of the ARITHMUS project, I argue that changes in official statistics methods have social and political implications for those being counted, and that analyses of statistical methods of the past, such as lists of constants or machines to sort punch cards, can help guide social studies of contemporary quantification methods.

The Big Data Project at the UK Office for National Statistics

Between 2014 and 2016, I conducted ethnographic fieldwork at the UK Office for National Statistics where I followed the work of a group of statisticians who worked with big data and other new data sources to supplement traditional data sources in the making of official statistics. They experimented with new methods for counting populations, for example through geo-located twitter posts, smart meter logs, aggregated mobile phone data, prices of groceries sold over the Internet, and so on. They investigated methods for using new data sources, and worked in ways they defined as "data-driven", that is, they collected the data first and designed their studies later. To work with new data sources, they needed to acquire new skills, such as learning to build their own computing clusters within the statistical institutes, as well as modifying existing statistical methods to handle larger datasets. The background to my interpretation of Babbage's work was formed by my engagement with the ONS Big Data Project whose work I followed over a period of about one year.

The Constants of Nature and of Art

Born in 1791, Charles Babbage is recognised as a statistician, philosopher, and an inventor. He designed but failed to construct the difference engine[1], a machine for calculating and printing logarithm tables[2]. Babbage also corresponded with Ada Lovelace who is often credited with writing the first program. Lovelace's program was written for the analytical engine, also designed and never constructed by Babbage, but usually recognised as the first programmable computer. In short, Babbage built machines for computation that were precursors to computers as we recognise them today, and these machines came into being around the same time the Statistical Society of London[3] was formed by Babbage, Thomas Malthus, and Richard Jones in 1834.

In 1832, Babbage composed a letter to his friend David Brewster, where he called for a collaboration between scientists in Britain, France, and Germany, to collect what he called the Constants of Nature and of Art. He described this list as a collection of "all those facts which

[1] Some of his Swedish contemporaries, Per Georg Scheutz and Edvard Scheutz did manage to build it later, as described in the previously mentioned book Glory and Failure by Michael Lindgren (Lindgren 1990).

[2] These tables were used to speed up calculation and reduce the number of errors in mathematical operations.

[3] Renamed the Royal Statistical Society in 1887.

can be expressed by numbers in the various sciences and arts". Items in this collection were supposed to include, among others, the period of revolution for planets, the atomic weights of bodies, the length of all rivers, power of steam engines in Cornwall, the speed of light, the speed of birds, the frequency of different letters in different languages, the number of books in great public libraries, the number of students at various universities, etc.

My first reading of the list was accompanied by a strong sense of incredulity. I felt the pull of a progressive narrative along the lines of "Babbage is wrong because his science has not advanced to 'our' level", which is clearly incorrect on multiple levels, and needs to be resisted and questioned. A more productive inquiry can start with the question "how is today's science and technology quaint, and how can we see it?"

We can look at past technological artefacts as a foregrounding exercise for the present, an exercise that indicates paths not followed. Babbage's list of constants may appear arbitrary or whimsical, and those parts that seem quaint, disconnected, or incoherent today, while clearly having been coherent to Babbage at the time of writing, hold clues to our own understanding, and our own unquestioned assumptions about science and technology today. In other words, we can ask, how does contemporary science and technology look when viewed from hundred fifty years into the future, or, if the past looks incoherent at first glance, how does the present look incoherent to future observers?

As big data discourses become more dominant in census discussions among European National Statistics Institutes, it is productive to look back at a time when quantification was beginning to assert its dominance as a method for ordering the world. Charles Babbage's lists of things to be counted is accompanied by statements about the power of numbers and the importance of counting and quantifying everything which mirror many statements made by computer scientists and statisticians speaking about big data today.

The ideas underlying big data analytics are not new, they draw on a rich history of collecting and counting things to further science[4]. Contemporary claims around big data are remarkably similar to Babbage's constants and engines, both exemplifying a rationality which emphasises counting and measurement as essential means for legitimate knowledge production.

As mentioned earlier, I build on the understanding that methods do not only observe an external, already present reality, but engage in its production and create new possibilities. The production of official statistics has social and political implications for those being counted, and analyses of previous methods can help guide social studies of contemporary quantification practices.

Epilogue: Revisiting the initial question

I conclude with a brief history of Babbage's work on the difference engine that contextualises the initial and unresolved question of whether Babbage imagined using his difference engines to count people, and whether the Statistical Society of London discussed such applications

[4] See Beer (2016) for a discussion of the old and the new in big data discourses.

prior to the deployment of Herman Hollerith's tabulating machines for data analysis in the US census of 1890.

During his lifetime Babbage worked on various calculating machines, and constructed parts of them, but never managed to conclude his two major projects: Difference Engine No.2, which was finally constructed in 1991, and the Analytical Engine, which remains unconstructed to this day. Babbage's critics pointed out that he received enough money from the UK government to build two battleships, but did not manage to build the machine he promised[5]. As noted earlier, a Swedish inventor called Pehr Georg Scheutz did manage to build a slightly simplified version together with his son Edvard Scheutz in 1850s.

The Difference Engine No.2 was designed to solve polynomials using the 'method of differences', which is a way of calculating complex multiplications by using only addition. However, Babbage's goal was not only computation of tables with results of solved equations, but automation of the full production, from the layout of the tables to the printing. It was an early example of a machine that replaced work that could only be performed by humans previously, as it included a printing unit for printing the results of the calculation.

Later on, Herman Hollerith built a machine along the same lines, but one that could accept instructions on punch cards. He formed The Tabulating Machine Company in the US in 1896. He then sold his company, which was merged with three others to form a larger company, which changed its name in 1924 to International Business Machines (IBM). We know that Hollerith visited and spoke the Royal Statistical Society in 1894 (Truesdell 1965), but I have not yet located earlier considerations of the use of such machines in census by the members of the Society.

The initial question, of whether Babbage and his contemporaries imagined difference engines to assist in the counting of people remains interesting as it points to a shift in epistemology: Machines are constructed to manipulate symbols while the dream of knowing things without human intervention continues to grow. The imaginary of the so-called 'strong AI', a term used to denote sentient artificial intelligence, continues to build on that same foundation to this day, and the question remains: If methods do not simply reflect an already existing reality but engage in its production, what are the potentialities of their product?

[5] Hacking (1990) also notes that Babbage was famous for a machine that he never managed to build.

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Appendix: Timeline of significant events for census machines

1725 – Basile Bouchon designs a loom controlled by a perforated paper tape.
1745 – Jacques de Vaucanson designs a fully automated loom based on Bouchon & Jean-Baptiste Falcon's work.
1805 – Joseph Marie Jacquard designs the Jacquard loom, eliminating the paper tape from Vaucanson's, instead using Falcon's chain of punch cards.
1822 – Babbage's first difference engine design.
1823 – Babbage brings in Joseph Clement to construct the machine.
1831 – Clement stops working on the machine due to an argument about costs.
1835 – Babbage starts designing the Analytical Engine.
1837 – Per Georg Scheutz designs the Scheutzian Calculation Engine, based on Babbage's design.
1843 – Ada Lovelace translates Menabrea's article on the engine, and supplements it with notes including an algorithm.
1847 to 1849 – Babbage designs Difference Engine No 2.
1853 – Per Georg & Edvard Scheutz build an improved calculation engine, which is exhibited at the World's Fair in Paris in 1855.
1857 – British government commissions a full-scale difference engine based on Per Georg & Scheutz and Edvard Scheutz's design, to be built by Paul Donkin's company, estimated to cost £1200.
1859 – Donkin's company delivers the machine several weeks late and £615 over budget.
1864 – General Register Office publishes life tables produced by William Farr using the difference engine built in 1859.
1871 – Babbage dies.
1875 – Martin Wiberg improves on Scheutz's design to produce a machine that can print complete tables.
1878 – British Association for the Advancement of Science recommends against constructing the Analytical Engine due to high costs and uncertainty about whether it would work.