Two Computer Sciences: a Branch of Physics and Naur’s Dataology

1. Introduction

This paper argues that there is a science of computing separate from the study of computers as tools and separate from designing and constructing computers. I am using the term science in a broad sense following the ancient Greek view of science as learning about the universe or the early 20th century modern physics view of science as natural philosophy.

Currently, computing is studied as engineering in EECS (electrical engineering and computer science) departments. Originally from the invention of computers after World War II, various types of studies involving computers were viewed as physics. Both the original Stanford CS department and the UC Berkeley CS departments were split off from physics in the 1960s. Projects such as developing languages to operate computers as tools were usually also part of physics. For example, Niklaus Wirth developed the early Pascal computer language at SLAC (Stanford Linear Accelerator).

A result of studying only the engineering aspects of the computer as a tool is that progress is seen as developing new types of computers, for example quantum computers, or importing formal mathematics into the study of computing without methodological debate or scientific experimentation. Also, P=?NP as a measure of abstract mathematical problem difficulty was adopted as mathematical truth without any methodological debate or experimentation because engineering simply applies mathematics, it does not test or question it. Even books seemingly aimed at computing as physics tend to be broad surveys conveying assumed truth instead of testing scientific theories (for example Aaronson[2013]).

There are alternative conceptions of mathematics that "prove" results opposite to those currently believed. The best know examples are from the work of Paul Finsler who denied the validity of Zermelo Frankel set theory and proved the continuum hypothesis is true (Breger[1995], Finsler[1969], Finsler[1996]). Computing may allow methodological testing of the alternatives.

One result of only studying the tool called computers is that many academic areas give priority to the tool and assume human though is the same as computing without debate or testing. The situation is very much like ancient Roman progress and innovation as for example building aqueducts in comparison to Greek study of Zeno’s paradox.

CS as part of physics was envisaged by Richard Feynman in the early 1960s (Feynman[1963], in particular discussion of calculation for physics versus calculations for engineering). I know this from taking Mathew Sand’s philosophy of education seminar and discussing computing with him as a Stanford undergraduate. However, Feynman changed by 1987 to describe EECS as limited to studying computers as tools and as engineering development (Feynman[1996] p. Xiii, but see also Feynman[1987] that expresses the earlier view).

This paper can be read as filling in the details of what science of computing should be as outlined by Roger Penrose (Penrose[1987], Penrose[1989], Penrose[1994]).

2. Dataology as the Study of Data

Professor Naur coined the term dataology (Naur[2005], Naur[2007) for problems that involve computing abstracted from computing machines. The "big data" area is an example. Since data gets its meaning from human interpretation, dataology would probably fit into the area of social sciences or maybe library sciences. Study of data is very much like developing better library book catalog systems.

The significant discovery of Professor Naur is that the study of universal computing (Turing machines) probably fits into the dataology scientific area because universal computing is not just mathematics but requires empirical testing. Turing machines as related to the mind may also be part of physics (natural philosophy) because physics has always involved theoretical questions on the nature of calculating, and because quantum physics brought the observer into study of physical reality. I do not understand exactly the role of universal computing in either dataology or physics or in which of the two computing sciences it should fit in.

3. Computing as a Branch of Physics

The reason that computing academic departments arose from physics is that progress in physics has involved studies of calculating. There is a current view that physics progresses by becoming more like formal mathematics, but that was not true at least until the latter part of the 20th Century. Opposition to the formalist view of physics is probably best expressed by the recently available Einstein lecture on Geometry (Einstein[1921], also Finsler[1996]).

It seems to me the main reason for studying computing as a part of physics (students trained also as physicists) is that there is quite a bit of evidence that the universe is somehow discrete and irregular (for example Noyes[2001]). It is possible to imagine a physical theory that does not involve differential equations but divides space (and time?) into discrete and irregular and probably tiny discrete objects as was almost certainly considered by Max Planck and Ludwig Boltzmann in the 19th century (Kuhn[1978], pp. 76-91).

The study of the physics subarea of CS was perhaps already envisioned by Max Planck (maybe along with Carl Runge and Albert Einstein) (Kuhn[1978] p. 111). The problem was calculating behavior of individual particles in kinetic gases along with the black body radiation problem. Plank’s work involved questions of calculations and logic. Planck’s original result was dependent on the countable characterization of tiny oscillators and how to view thermodynamics because Planck believed in some kind of particle reality by opposing the energists (Kuhn[1978], p. 21). Also Planck understood the importance of studying calculating outside of pure mathematics because he hired Ernst Zermelo as his Humboldt assistant in 1895. Zermelo proved that reversible processes were impossible which is obviously wrong physics from thermodynamics (Kuhn[1978], p. 26). A more modern work by a physicist studying calculating is David Bohm’s ideas of the "qualitative infinity of the universe" and "chance and necessity" (Bohm[1957]).

4. References

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