John von Neumann the First Post Hilbert Programme Philosopher of Computation

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John von Neumann (JVN) as anti-Carnapian philosopher

- In the early 1950s JVN studied philosophy as part of his efforts to understand computation while building an early computer.
- JVN had abandoned formal logic in particular Hilberts programme that all knowledge could be coded as a giant array of logic formula. Truth is determined by evaluating formal sentences.
- The process of JVN abandonment of formalism started with Godel's incompleteness and inconsistency proofs and continued with his collaboration with physicists during and after WWII. JVN stated he was spending an unreasonable amount of time on philosophy of computation and in the late 1940s wrote letters calling himself a philosopher.

JVN criticism of Rudolf Carnap

- Eckehart Kohler's paper *Why von Neumann rejected Carnap's Dualism of Information Concepts* documents JVN's philosophy. JVN along with physicist Wolfgang Pauli wrote to Rudolf Carnap convincing Carnap to abandon publication of his study of information.
- Kohler argues that JVN criticism was incorrect because he wrongly assumed information was a purely physical concept. Kohler claims information involves both physical and logical aspects.
- I believe Kohler does not understand JVN's total abandonment of the very idea that logic is part of reality. That Hilberts programme failed.
- JVN also wrote to Claude Shannon suggesting he use the physical term entropy for Shannon's mathematical codes. Shannon did not accept JVN's suggestion.

JVN abandonment of the Hilbert programme - Einstein quotation

- Next part of this paper discusses JVN transition to anti-formalist
- Rejection of formal logic goes back at least to Einstein's lecture on geometry in 1921.
- Einstein believed that formal mathematics was incomplete and disconnected from physical reality. Einstein writes:
- **This view of axioms, advocated by modern axiomatics, purges mathematics of all extraneous elements. ... such an expurgated exposition of mathematics makes it also evident that mathematics as such cannot predicate anything about objects of our intuition or real objects.**

1930s transition to philosopher of computation

- Both JVN and Niels Bohr attended the 1938 *New Theories in Physics* conference in Warsaw. Proceedings have a brief exchange between Bohr and JVN. JVN agreed that his no hidden variable proof was problematic. They almost certainly had other discussions during the conference.
- By the late 1930s Von Neumann had given up on the Hilbert Programme. He embraced the natural philosophy based empiricism of the founders of modern physics. In 1939 Von Neumann writes to R. Ortvay (from Miklos Redei's selected JVN letters):
- **Godel's results mean that there is no "complete" axiomatic system, not even in mathematics, and I believe that there is actually no other consistent interpretation of this complex of questions.**

Before computers were built

- Rest of talk attempts to reconstruct JVN's computation thinking. I am claiming he understood modern concepts in computational philosophy.
- JVN's terminology made sense before it was known if computers could be constructed.
- Before computers were constructed, it was naively assumed that a computer would explain and be the same as human brains. As an applied mathematician and founder of game theory, JVN rejected this.
- Modern names for anti-formalist alternative methods. Polya Heuristic, Lakatos quasi-empirical mathematics, Finsler alternative continua. Alternative 3 value logic evaluation rules.

Building the first computers

- JVN as main government adviser in applied mathematics during and after WWII knew of the computation projects.
- There is a question how much Turing Machines (TM) influenced JVN. The main influence of TMs was that Turing first formalized the idea of step by step calculating. Alternatives were ideas such as propositional logic. Formulas are evaluate using mathematical rules and theorems. Discussed in Cassirer session at this HOPOS conference.
- JVN, as the best pre-computer human calculator was skeptical of TMs because there were too primitive. TMs are actually very weak machines because they lack random access memory, lack multiplication and use unary versus binary encoding. .

Building continued ...

- JVN's computer architecture used in the first computers. ENIAC and EDVAC used a model now called MRAM.
- There is dispute of JVN contribution to design of the first two computer ENIAC and EDVAC. He supervised building the IAS computer at the Institute for Advanced Study. JVN was the only theoretician of computation involved. All early and most modern computers his computer architecture named the von Neumann architecture.

Pre computer computation experience

- Physicists working on the Manhattan project "programmed" human calculating machine operators. The people were very accurate at running fancy adding machines. The physicists then combined the results.
- WWII code breaking involved algorithms. William Tutte's programs for the later in WWII Colossus machine is very close to modern algorithms. Colossus had random access memory except is was set up by operators connectng jumpers on plug "memory" boards.
- North Atlantic submarine searching was perhaps the first artificial neural network game playing competition algorithmic searching before computers or small radar existed.

JVN terminology has modern computational meaning

- I think one needs to read JVN various contributions to computer terms using modern terms from computer science. Currently they are usually read as relating to robot building and to justify the possibility of artificial intelligence.
- JVN thinking are writing occurred before it was even know if computers could be built.
- JVN term **automaton** should be read as **computer**. JVN term **self reproducing automata** should be read as computer program that generates other computer programs. Such programs are usually called compilers. **Axiomatics** should be read as **algorithm**. If these changes are made, JVN writing reads like modern computer science.

Skepticism of neural networks

The insight that a formal neuron network can do anything which you can describe in words is a very important insight and simplifies matters enormously at low complication levels. It is by no means certain that it is a simplification on high complication levels. It is perfectly possible that on high complication levels the value of the theorem is in the reverse direction, namely, that you can express logics in terms of these efforts and the converse may not be true. (quoted in Aspray[1990], note 94, p. 32)

Skepticism toward genetic algorithms from Heisenberg book

"He (Neumann) led the biologist to the window of his study and said: 'Can you see the beautiful white villa over there on the hill? It arose by pure chance. It took millions of years for the hill to be formed; trees grew, decayed and grew again, then the wind covered the top of the hill with sand, stones were probably deposited on it by a volcanic process, and accident decreed that they should come to lie on top of one another. And so it went on. I know, of course, that accidental processes through the eons generally produce quite different results. But on this one occasion they led to the appearance of this country house, and people moved in and live there at this very moment'(Heisenberg, Physics and Beyond, 1971, p. 111). "

Probably forged letter from Godel to JVN on computation

- A 1956 dated letter was found in the JVN Library of Congress papers from Kurt Godel to JVN stating the importance of modern problem called P=?NP.
- The letter is almost certainly a forgery for two reasons. First JVN understood that TMs are weak and was using this in has von Neumann architecture. The model is now called the MRAM model. If JVN and Godel discussed computation hardness, JVN would have explained his model.
- In the MRAM model, there is no need for guessing and no P=?NP problem because MRAMs can simulate non deterministic machines (if any path solves a problem in polynomial time, it is solved) using a deterministic MRAM.
- Second, there is a letter probably from late 1940s in JVN's collected correspondence recommending against Godel's appointment because Godel's psychological problems effected his work (p. 276).

Added from Feyerabend Conference - why JVN philosophy ignored

- I claim founders of modern physics worked with JVN because they believed philosophy of computation was needed for advances in physics.
- Flavio Del Santo in his 2017 paper *Genesis of Karl Popper's EPR-Like Experiment and its Resonance among the physics community in the 1980s* explains.
- Del Santo's explanation of post WWII physics applies to why JVN philosophy of computation is ignored and why its study is needed for progress in computing and physics.
- In my view, too many quantum mechanic results such as entanglement and instantaneous wave collapse are accidents of the formal mathematics.

Del Santo on problem with Post WWII philosophy of physics

We have to remember that, besides a few exceptions, physics in 1960s and 1970s was conducted within a completely pragmatic framework. Heavily influenced by the Cold War (military) demands, research in physics was focused mainly on those fields which could have had an immediate practical application (this gave birth to the notorious expression —shut up and calculate!), whereas genuine theoretical research was completely dominated by high energy physics. Philosophy and physics (read computation here**) had never been more far apart.**