Menshevising Idealism: or why the Soviet Union didn't develop the first computers

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Overview

- let’s start with some context
- 1946 - first modern digital computers announced
  - ENIAC – USA – University of Pennsylvania – in use
  - ACE – UK – National Physical Laboratory - design
- 1948 - many early US & UK computers running
- 1951 - commercial computers

Overview

- 1951 - first comparable Soviet computer running
  - MESM – Sergey Lebedev
- why...?
- USSR had theoretical/technical capability
  - control theory
  - analogue computing
  - sequence control systems
- computers key to economic planning & automation

Overview

- digital computers not secret
- long history of mechanical computation
- mechanical calculators
  - 1642 - Pascal - France - adder/Pascaline
  - 1694 - Leibniz - Germany – multiplier
  - 1822 - Babbage – UK - difference engine – generate tables
- analogue computers
  - WWI - Great Powers - naval fire control
  - 1928 – Vannever Bush – USA - differential analysers
  - 1936 – Lukyanov - USSR- water integrator

Overview

- proto digital computers
  - 1936 – Zuse - Germany - Z1 - patents 1937
  - 1939 – Atanasoff – USA - ABC
  - 1944 - USA - ASCC/Harvard Mark 1
- secret proto digital computers
  - 1943 - Colossus – UK
  - used to crack German Lorenz cipher
  - not public until 1980s
  - techniques relevant to analysing streamed data

Overview

- 1945 - von Neumann *Report on the EDVAC*
  - described stored program design – key to digital computers
  - widely distributed
- all subsequent general purpose digital computers stored program
- why didn’t USSR pick up on this?
  - anecdotally, Lebedev read about digital computers in 1948 in foreign popular magazines
- why didn’t USSR prioritise acquiring US/UK designs?
  - c.f. atomic weapons – 1940s

What's special about computers?

- computers are machines that execute instructions to transform data
- program – sequence of instructions
- two components
  - Central Processing Unit
    - carries out instructions
  - memory – holds data
    - include peripherals (e.g. mouse, keyboard, screen) & network
- instructions to
  - move data from memory to CPU
  - change data in CPU – arithmetic & comparison
  - move data from CPU to memory

What's special about computers?

- usually instructions are carried out in a linear sequence
- also instructions to change the sequence depending on properties of data
  - choose between optional sequences
  - repeat a sequence until some property is satisfied
- proto digital computers instruction sequences fixed
- had to be physically changed for each program
  - ENIAC – Electronic Numerical Integrator and Computer
    - functional components wired together
  - Colossus
    - instructions set on switches and jack panels

What's special about computers?

- modern digital computers store instructions in memory
  - as well as data
  - easy to change what computer does
  - computer can modify its own programs
- stored program attributed to John von Neumann
  - modified ENIAC – 1946/47
- von Neumann got idea from Alan Turing - 1936/7

What's special about computers?

- Turing was working on *mathematical logic*
  - theoretical foundations of mathematics
- concerned with *computability*
  - what are limits to mechanical rule following?
- NB well before digital computers
- let's now survey mathematical logic before considering its implications for philosophy

Logic and computability

- propositional calculus
- Aristotle - 384-322 BC - Greece
- values: true & false
- variables over values: x y z...
- operators
  - conjunction – logical and – x AND y - true only if both x and y true
  - disjunction – logical or – x OR y - true if either x or y or both true
  - negation – logical not – NOT x - true if x false
  - implication – x implies y or if x then y

Logic and computability

- expressions – built up using truth values, variables and operators
- theorem – expression that is true for all values of variables
- axiom – basic true expression
- rule of inference
  - syllogism
  - connects premises to conclusion
  - implication

Logic and computability

- proof – establish something is a theorem
  - start with axioms as premises
  - apply rules of inference
  - until expression is conclusion
- deductive logic
- NB
  - pure calculus – doesn’t matter what variables represent
  - form of logic Hegel, Marx & Engels familiar with

Logic and computability

- predicate calculus
- Augustus De Morgan - 1806-1871 - UK
- extends propositional calculus
- predicates – over truth variables
  - properties that may be true or false – P Q R...
- quantifiers
  - universal – for all
  - existential – there exists
- more axioms and rules of inferences
- NB still a pure calculus – doesn’t matter what predicates represent

Logic and computability

- set theory
- Cantor – 1845-1918 – Germany
  - set is a collection of things
  - symbols or other sets
- operators
  - member – some thing a member of a set
  - union – join two sets – no duplicates
  - intersection – common elements of two sets
  - difference – between two sets

Logic and computability

- apply propositional & predicate calculus to set theory
  - predicates are properties of sets
  - quantify over sets
  - e.g. model arithmetic
- but
  - countable infinite sets
    - Engels unhappy
    - mocks Cantor’s ideas in Anti-Duhring
  - paradoxes
    - Russell’s
    - set of all sets that aren’t members of themselves
    - is this set a member of itself?

Logic and computability

- can logic capture all of mathematics?
- 1910-27 - Russell & Whitehead – *Principia Mathematica* – UK - Cambridge
  - heroic failure
- David Hilbert – 1862-1943 - Germany
- Hilbert's Programme
- can we prove for mathematics
  - consistency - no provable contradictions
  - completeness – no unprovable theorems
  - decidability – systematic way of establishing whether or not an expression is a theorem

Logic and computability

- Kurt Gödel – 1906-1978 – Austria/USA
  - 1931 - mathematics can’t be both consistent and complete
- Alan Turing – 1912-1954 – UK - Cambridge
  - 1936 - mathematics can’t be decidable
- proofs by contradiction

Logic and computability

- Turing's distinctive approach
  - most logical models of maths require an implicit human to do the proofs
  - Turing invented a class of machines based on how humans do mathematics
- tape
  - unbounded but finite sequence of symbols
- rules
  - in current state
  - depending on current symbol
    - change symbol
    - move tape one symbol left or right
    - change state

Logic and computability

- NB machine - no implicit human
- Turing showed
  - any mathematical expression can be represented on the tape
  - Turing machines can be represented on the tape
  - can make a Universal Turing machine to execute Turing machines

➔ Von Neumann’s stored program

Logic and computability

- what is the ontological status of logic?
- logicism/logical atomism e.g. Russell
  - mathematics is reducible to logic
  - truth is out there
  - Platonic realism i.e. idealism
- formalism e.g. Hilbert
  - mathematics is applying rules to symbols – language game
  - no necessary meanings

Logic and computability

- intuitionism e.g. Brouwer - Netherlands
  - only accept mathematical entities that can be constructed from first principles
  - rejects actual infinities
  - rejects proof by contradiction
- led to constructivism e.g. Markov (Jnr) – USSR
- let’s now look at how this all played with Marxist philosophy

Menshevising idealism

- mathematical logic seen as contrary to dialectical materialism
  - mechanical materialism
  - formalist
- roots in Engels on logic and mathematics
- dialectical materialism == logic + dialectics
  - pure dialectics == Hegelian idealism
  - pure logic == mechanical materialism

Menshevising idealism

- 1878 - *Anti-Dühring*
  - philosophy of nature is empirical, abstracted from reality
  - dialectics goes beyond “narrow horizon” of formal logic
- 1883 - *Dialectics of Nature*
  - formal logic enumerates “forms of motion of thoughts”
  - dialectics derives higher forms from lower
  - formal logic is not nonsense
  - but pure maths is abstractions which becomes nonsense at extremes
- 1886 - *Ludwig Feuerbach and the End of Classical German Philosophy*
  - all that’s left of philosophy “expelled from nature and history” is theory of laws of thought –logic and dialectics

Menshevising idealism

- struggle over philosophy of science in USSR after October Revolution
- 1920s - mechanist tendency gained ascendency
  - down played dialectics
  - reductionist
- Abram Deborin
  - dialectical materialism is a synthesis of Hegelian dialectic and Feurbach materialism
  - anti reductionist

Menshevising idealism

- 1929 – mechanists discredited as revisionist
  - purge of Academy of Sciences
- 1930 – New Turn
  - V. P. Mitulin accused Deborin of formalism in approach to dialectics
  - not relevant to practical needs
- Stalin coined “menshevising idealism” for Deborin
- by 1931, mechanism & MI conflated with political orientation
  - mechanism == right deviation – Bukharin
  - MI== left deviation - Trotsky

Menshevising Idealism

- made career progression difficult...
- led to Soviet focus on applicable mathematics
- subsequent Soviet mathematical logic based on intuitionism/constructivism

Menshevising Idealism

- international implications
- e.g. UK
- CPGB had leading scientists as members
- 1931 - Second International Congress of History of Science & Technology
  - London
  - paper by Hessen on Soviet line

Menshevising Idealism

- David Guest - 1911-1938
  - mathematician – Cambridge & Southampton
  - killed in Spain
  - supported Hessen at Congress
- 1934 - *Machian Tendency in Modern British Philosophy*
  - orthodox Soviet position
  - attacked logicists and formalists
  - promoted intuitionism as revolutionary

Menshevising Idealism

- 1934 – collection - *Aspects of Dialectical Materialism*
- two papers by communist scientists
- Hyman Levy - 1889-1975
  - mathematician- Imperial College
  - friend of David Guest
  - laws of dialectics add nothing to science
  - subsequently criticised as mechanist
- J. D. Bernal - 1901-1971
  - X-Ray crystallographer - Cambridge & Birkbeck
  - dialectic is not applicable to experimental science

Menshevising Idealism

- J. B. S. Haldane – 1892-1964
  - geneticist/physiologist - UCL
- 1938 - *Marxist Philosophy and the Sciences*
  - orthodox Soviet position
  - reiterated Engels' disquiet with infinite sets
  - Marxists sceptical of "more ambitious logical theories"
    - logical systems only work in highly abstract contexts
  - knew about calculating machines – differential analysers
    - said may herald a "new epoch" in mathematics

Menshevising Idealism

- Maurice Cornforth – 1909-1980
  - logician/philosopher
- 1946 - *Science Versus Idealism*
  - orthodox Soviet critique of pure empiricism and modern logic
  - tribute to David Guest
  - helped by Haldane

Menshevising Idealism

- these British communists all knew each other...
- ... and had
  - close contact with USSR
  - strong links to currents in logic and mathematics
    - especially Cambridge
- none seem to have noticed Turing's papers

Conclusions

- lost opportunity for USSR
- compounded by 1940s critique of cybernetics
- e.g. 1950 Boris Agapov - editor Literary Gazette
  - capitalists want to replace class conscious workers & soldiers with compliant robots
  - computers no use for planning
- but Soviet military & scientists wanted computers
- two secret design programs
  - Academy of Sciences - MESM
  - Ministry of Machine-Building and Instrument Construction - Strela

Conclusions

- easier after 1953 “thaw”
- mid 1960s - USSR could build world class computers e.g. BESM 6
  - west worried by progress
  - CIA report suggested USSR might overtake
- too many competing projects
  - from different organisations – ministries, academia, military
  - no standardisation of hardware and software
  - couldn’t ramp up to meet demand
- late 1960s - own designs abandoned for IBM 360 clones

Conclusions

- Turing not ideological/political
  - irony that approach was materialist in Engels' terms
  - from observation to theory to practice
- Turing's results constrain computation
  - constrains reach of logic
- Turing also argued that thought is computational
- so we might conclude that dialectics as a component of thought is constrained
- worth exploring implications for dialectical materialism
  - relationships between computation, logic and dialectics

Further reading

- Helena Sheehan, *Marxism and the Philosophy of Science: A Critical History*, Humanities Press, 1985, 1993, Verso Books, 2017.
- Paul Cockshott, Louis Mackenzie and Greg Michaelson, *Computation and its Limits*, Oxford University Press, 2012