



UNLOCKING
CONSCIOUSNESS



BRIAN MIND FORUM

Appendix 015

Quest for Artificial (or Machine) Intelligence

'Give us a definition and we will program the world'.

After Archimedes C100 BC

Human Enhancement

Down through history communities have sought to improve their ability to feed themselves and their dependents, to learn from their elders, to defeat their competitors, to remember more knowledge, to make better decisions. Children learned as apprentices to their parents and peerhood. The priests and the war lords competed to teach the brighter youth. Few parents could teach reading and writing thus the first schools were established. There are references to the first schools in Mesopotamia in 2,000BC. [Archaeologists have found a tablet with the inscription *"My teacher said my handwriting was no good so he caned me"*] The Greeks established the first academies, and the great library at Alexandria around 300 BC. Islam established the first universities. The first Christian University was in Bologna. Printing led to the establishment of Libraries. The spread of ideas stimulated the Renaissance. Memory has always been a prize attribute and many great thinkers and orators have devised 'systems' to aid their recollection. We list many such systems from around the Fifth century BC to the present day at appendix 5.

There has been a long history of trying to bring all known information together, and to ensure everything we know is passed on to, and preserved by each generation. The community could only afford the resources to keep less than 10% of the population in full time education till sixteen or so. The Industrial revolution created the need for an army of literate and numerate staff to run the factories and offices, and it generated the wealth to fund universal basic education, leading to the first of a series of education Acts in the late nineteenth century.

Into the twentieth century bright youngsters who could pass the examinations into the grammar schools were often unable to take up their places as their families needed the wages they could earn. In 1944 full time basic education for both sexes equally was provided free by the state – so also was further education for those with the appropriate aptitude. In 2011 this policy was reversed. The younger generation are now expected to fund their own further education, arguably when they need the most comprehensive education more than at any time in history. Civilisation does not always move forward!

The industrial Revolution

Increasingly throughout the nineteenth century the need for improved ways of keeping records of commercial and financial transactions generated the invention of improved writing machines – typewriters, and improved calculating machines. The abacus could go so far, but soon accounting machines could extend the typewriter’s mechanical technology to adding and subtracting. Storing numbers led to the invention of the punched card, and reels of paper tape which linked in the telegraph, and the thermionic valve replicated the concept of a hole or not a hole to enable electronics to progressively replace cards and cog wheels and relays. All the components were in place.

The stored program computer

The demands of the Second World War witnessed the fast development of the world’s first computer. Colossus was built at Bletchley Park by a team led by Max Newman, Tommy Flowers and Alan Turing. However ‘Colossus’ was only designed to execute one program. After the war, Newman set up the Computer Machine Laboratory at Manchester. Alan Turing went first to the National Physical Laboratory then joined Newman, Frederic Williams and Tom Kilburn in Manchester, where Turing wrote the world’s first program for the Manchester ‘baby’ which went live in the Spring of 1948.

In the USA, John Mauchly and J Presper Eckert built a fully functioning machine at the University of Pennsylvania in 1946. It was a step forward from Colossus because different programs could be run by manually plugging in wires and setting switches. However, although President Clinton claimed ENIAC as the world’s first computer it did not have a stored program.

Working with Mauchly and Eckert, John Von Neumann published a draft report for a machine called EDVAC, which has become known as the ‘von Neumann architecture’. EDVAC eventually went operational in 1950.

Maurice Wilks and his Team at Cambridge University built EDSAC which was switched on in the summer of 1948. Later in 1948 CSIRAC was up and running at the University of Sydney, Australia.

The idea of storing the instructions in the programs and the information (data) to be processed, interchangeably in the same medium was the great breakthrough. The information was just one long stream of ‘0’s and ‘1’s. Five, and later eight ‘digit’ ‘words’ based on the Morse coding system represented the letters, numbers, and later pictures and sounds. In the same way the program was also stored as one long stream of ‘0’s and ‘1’s, grouped in ‘instructions’ to indicate the operation, the operand and the location of the next instruction. The information code was standardised – the American Standard Code for Information Interchange or ASCII was soon set up and remains the world standard to this day.

This remarkably simple concept gave birth to the ‘*stored program computer*’, where one program can call into operation another program, without human involvement; while programs can amend existing programs (learn), and programs can input information from a multitude of sources; process, store and recall information, then output that information to screens, loudspeakers, the internet, or to control other machines, all in the same format.

This is the first machines that humans have invented that have a degree of self-control and can change their own behaviour. They can learn. They can process literature, mathematics, music, pictures and other programs.

It would be an understatement to say the result is dynamic.

Birth of Artificial (or machine) Intelligence AI.

The computing community soon identified the potential. If intelligence could be programmed then computers could replace boring jobs and release people for more interesting occupations. More intelligent processing of information could lead to better decision making and a more efficient community. Could intelligent programs be written to control robots?

The thrust of Alan Turing's 1936 paper to the Royal Society, on '*computable numbers*' was that if we could 'define precisely the way a problem could be solved, write out the formula, list the steps in the algorithm, then a 'computer' could solve that problem'.

Building on this insight, a group of leaders in computing research met in Dartmouth College in the USA in 1956, funded by the Rockefeller foundation. Marvin Minsky, information theorist, who later coined the term 'artificial intelligence' while at the Media Lab at Harvard, Claude Shannon, famous for his work on the technology of the transmission of information over telephone circuits, Herbert Simon and John Nash, both later Nobel Prize Winners, wrote in their funding application "*every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it*". In other words: "*if...intelligence can be precisely defined then a machine can be made to simulate it*". They went on to ask for funding for a ten man group to spend six months to specify intelligence, including making machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans and improve themselves.

Sixty years, and many millions of dollars later we have successfully written programs that can beat chess masters, win quiz competitions and learn to play the game 'Go'. However, neither the cognitive neuroscientists, nor the biogeneticists, nor the cognitive psychologists nor the scientific community generally, have been able to specify a definition of 'intelligence'.

Lord Kelvin argued that the first step to knowledge was description, plus measurement leading to a definition verifiable by experiment. The software community paraphrase Archimedes by saying '*give us a definition and we will program the world*'.

Hardware and Software

The computing world is two industries. Hardware is very definitely in the world of Science, but software is not. Some programmers like to call themselves software engineers, but many have a more humanist background. A minority have little or no formal education. Some of the best programmers did not even take 'O' level (or GCSE, or GCE). Many early games programs were written by fourteen-year olds. Geography, (or at least map reading) and philosophy are far more useful than mathematics. Unless one is going to write mathematical programs the two times table and an understanding of percentages is usually quite sufficient. Logic has been at a premium.

Logic

The history of the development of logic goes right back to Euclid. George Boole published '*An investigation into the Laws of Thought on which he founded the Mathematical Theories of Logic and Probabilities*' in 1847. There is no record of any cooperation with Babbage or Linda Lovelace. Charles Pierce, Gottlieb Frege built on this work and Bernard Russel and Alfred Whitehead published *The Principia Mathematica* c 1910. It is illuminating to our investigation of 'Intelligence' that T.S.Eliot argued that '*the Principia made as great a contribution to language as to mathematics*'.

At the turn of the Twentieth century Hilbert published his famous 'Questions for mathematicians' including the notorious 'halting problem', listed at appendix 9 (see also 33). In 1931 Kurt Gödel contradicted Hilbert and the ensuing debate led to Alan Turing publishing '*On computable numbers and a solution to the halting problem*': the first half of his paper was the starting gun of the computing revolution. The second half is largely forgotten!

Results of the Dartmouth Conference

While the Brits were concentrating on the hardware, Marvin Minsky co-founded the Artificial Intelligence Laboratory at MIT. Substantial resources were devoted to this promising subject, but AI proved to be orders of magnitude more difficult than anyone expected and progress slowed right down. A new wave of activity was directed at programming early robots to navigate mazes. These experiments had the advantage that demonstrations were visually interesting to potential funders.

Programs reproducing 'neural networks' and then 'feedback loops' seemed to offer breakthroughs and led Norbert Wiener to coin the word 'cybernetics', and Hollywood dreamed of 'automata' and 'robots'. These words proved very useful in concentrating people's minds and helped initiate another wave of enthusiasm.

After winning a Nobel Prize for his work on the Immune system Gerald Edelman devoted his efforts to building automata that could learn to navigate around each other. He published *Neural Darwinism: Theory of Natural Group Selection* in 1987. *Consciousness*, in 2000: and *Bright Air, Brilliant Fire* in 1992, which had a considerable influence on the groups that were trying to emulate 'reactive intelligence'.

AI Successes.

Turing suggested that one way of measuring our success in building 'sentient' systems was to set up a conversation. A person on one side and either another a human or a computer on the other. Could the person distinguish who they were talking to. As soon as it became impossible to tell everyone more or less lost interest. 'Very clever, but so what?' Inventors have a hard life!

IBM took a different route and concentrated on solving specific problems with very clearly defined boundaries and rules. The game of chess was ideal, and a great deal of excitement was generated by the successful programming of massive computers to beat chess masters and then win quizzes like *Jeopardy*. Both programs analysed very large accumulations of information (databanks) and used sophisticated mathematical algorithms to identify patterns.

This area of 'artificial' or machine intelligence is making significant progress. It is not as 'exciting' as some of the more glamorous systems but it is producing a growing raft of successes. Pattern recognition is a key part of the basic definition of information. Pattern recognition is a component of the controversial IQ test. Identifying patterns of an opponent's behaviour is a key part of winning chess matches. Building up patterns of behaviour is how the program was written to learn to play the game 'go'.

However, the programmes that achieve these prodigious feats can do nothing else. We are a long way from what Christof Koch calls 'general intelligence', or 'superintelligence'.

Other Factors

Historically, research into intelligence has concentrated on studying and mapping neuro behaviour – internal processing, as it were. Perhaps intelligence is also about recognising external processing: the patterns in the outside world.

In the quest to understand 'intelligence' people have suggested that there is a form of intelligence associated with each of the five sensory organs and systems, then added emotional intelligence to cover human relationships.

More recently there has been a tendency to include learning into a wider context of intelligence, and in so doing conflating the acquisition of new skills with the execution of existing skills.

In some ways we have substantially lowered our ambitions for artificial intelligence.

Perhaps we should ask ourselves whether designing systems that can emulate a human – the ‘Turing test’, compares with actually being able to identify valuable information out of massive volumes of data, like medical data to help solve health and medical problems. Do we really expect to design robots that can debate the finer points of Marxism and Capitalism with us and, hopefully, offer us a better economic settlement for the world? Nobody is going to stop trying!

References: *Intelligence Reinvented*. Nello Cristianini. Professor of Artificial Intelligence University of Bristol. Review NS 29 Oct 2016 p38

2018 // Book Final // Appendices NEW // 015 Quest for AI v2 2017 01 Jan