Chapter 5
Computation, Cybernetics and Control

> "We are living in a computer program reality" P. K. Dick 1977 (@ Metz conference in France)

Introduction

The following section covers the topics of Computation, Cybernetics, and Control and how they can be used in Neuroweapons that are automated and fully autonomous. To begin it is important to go over the history of computers and how it directly relates to weapons research and how it is a direct outcome of war time needs and demands for fast and efficient mechanisms of execution and plan formulation.

The great advances in computer science that have occurred since the 1940s were greatly enhanced by the war effort in the Allied countries, specifically the Anglo allies: US, Canada, Australia, New Zealand and Great Britain. The race for computational superiority, which I would argue actually went to the Germans, could have been the deciding factor in the war if the German military had continued access to raw materials such as Oil to run their industries and machines. The early pioneers in this field were in the Allies: Alan Turing, and in Germany Konrad Zuse. Some of the first examples of computer controllers are found in the German military industrial production plants. Some of the first examples of "Machine Intelligence" were a direct outcome of the work of Alan Turing for the predecessor of GCHQ. However, before going into Turing and Zuse it is important to look at some of the more basic and predecessors to more advanced operations of computation in the form of management of the Holocaust by the Germans using IBM tabulating machines.

Everyone is familiar with the numbers written on Nazi inmates of Labor and Death camps. Those numbers were an index for the tabulation machines created by IBM for the German Government in 1937. International Business Machines (IBM), an American company founded by German Herman Hollerith and managed by American supporter of fascism, Thomas J. Watson, now popularly the name of the IBM Artificial Intelligence platform 'IBM-Watson' also IBM is involved in the development of Quantum Computing. IBM manages the extermination camps and mass categorization of Germany through a subsidiary in Germany:

> Dehomag and other IBM subsidiaries custom-designed the applications. Its technicians sent mock-ups of punch cards back and forth to Reich offices until the data columns were acceptable, much as any software designer would today. Punch cards could only be designed, printed, and purchased from one source: IBM. The machines were not sold, they were leased, and regularly maintained and upgraded by only one source: IBM. IBM subsidiaries trained the Nazi officers and their surrogates throughout Europe, set up branch offices and local dealerships throughout Nazi Europe staffed by a revolving door of IBM employees, and scoured paper mills to produce as many as 1.5 billion punch cards a year in Germany alone. Moreover, the fragile machines were serviced on site about once per month, even when that site was in or near a concentration camp. IBM Germany's headquarters in Berlin maintained duplicates of many code books, much as any IBM service bureau today would maintain data backups for computers.

> ...IBM Germany's census operations and similar advanced people counting and registration technologies. IBM was founded in 1898 by German inventor Herman Hollerith as a census tabulating company. Census was its business. But when IBM Germany formed its philosophical and technologic alliance with Nazi Germany, census and registration took on a new mission. IBM Germany invented the racial census-listing not just religious affiliation, but bloodline going back generations. This was the Nazi data lust. Not just to count the Jews — but to identify them.

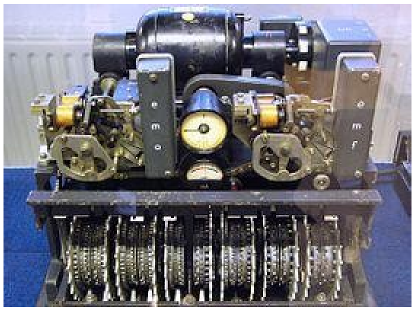
As was seen in the section on the Science of Neuroweapons regarding Eugenics and tracing tribes and clans along genetic bloodlines, we see how the IBM tabulators were used to keep track, index and exploit these data points for the mass extermination of Jews, Poles, Gypsies, Homosexuals, and Leftists, among others. The diabolical methods created by such a Totalitarian regime are truly mind bending. The more scientific and military applications of the German Computer Scientists followed a more technical rather then sociological route in comparison to this utilization of IBM to manage the Holocaust.

Konrad Zuse is not known to be a devoted Nazi, rather he was known as a dedicated computer engineer who happened to be German and was later conscripted into service. However, it is known that one of his collaborators was a dedicated Nazi, Helmut Schreyer, who later went on to leave Germany like many former Nazis and resettled in Brazil where he set up a computing institute. Zuse began his development of his famous Z-series computers in the spare rooms of his parent’s apartment. In 1938 he attempted to create his first computer, which never actually worked due to fabrication problems with the mechanical systems of his machine. The construction of the Z-series computers was oriented exclusively towards the mathematics of statics and Zuse's encryption engine was never built, it was the S1, a special computer which was used in the Henschel factory between 1942 and 1944 to calculate wing measurements for remote control flying bombs, a predecessor to modern drones. Previously, in 1940, Zuse was able to complete his first working computer, the Z-2. In, 1941 he built the first programmable computer, the Z-3. After the war he also developed the first algorithmic programming language, Plankukul (Calculus Plan) in 1945-6.

Meanwhile, in Britain, the more famous Alan Turing, started working on his computational ideals, some of which were done in collaboration with Von Neumann, a Germanic Hungarian that taught at Princeton who was respected as one of the greatest mathematicians of his time. Turing became most famous for his breaking of the German Military encryption Enigma machine. Although, this work was actually pioneered by a Polish Intelligence decryption engineer at the Biuro Szyfrów (Cipher Bureau) , Marian Rejewski, who created the first version of the ‘cryptologic bomb’ (bomba kruptologiczna) before the Nazis defeated the Polish military and work had to be stopped in Poland. The computer as it became known was the ‘Bombe’. The bombe was an electro-mechanical device used by British cryptologists to help decipher German Enigma-machine-encrypted secret messages during World War II. The US Navy and US Army later produced their own machines to the same functional specification, albeit engineered differently both from each other and from the British Bombe itself.

The initial design of the bombe was produced in 1939 at the UK Government Code and

Cypher School (GC&CS), now known as GCHQ, at Bletchley Park by Alan Turing, with an important refinement devised in 1940 by Gordon Welchman. The engineering design and construction was the work of Harold Keen of the British Tabulating Machine Company. It was a substantial development from the first bombe, code-named Victory, installed in March 1940 while the second version, Agnus Dei or Agnes, incorporating Welchman's new design, was working by August 1940. Another significant contribution from the British war effort was the development of the Colossus machines in 1944. Designed by British engineer Tommy Flowers working at Bletchley Park, the Colossus is designed to break the complex Lorenz ciphers used by the Nazis during World War II. A total of ten Colossi were delivered, each using as many as 2,500 vacuum tubes. A series of pulleys transported continuous rolls of punched paper tape containing possible solutions to a particular code. Colossus reduced the time to break Lorenz messages from weeks to hours. Most historians believe that the use of Colossus machines significantly shortened the war by providing evidence of enemy intentions and beliefs. The machine’s existence was not made public until the 1970s.



Lorenz messages created by a cypher machine

Another important German computer engineer that came to attention shortly after the war, was Heinz Billing. Billing was heavily involved in the development of magnetic drum memory. This eventually converged in a meeting between British computer engineers and German computer engineers shortly after the war:

> "This paper discusses the question of an unknown potential meeting between the computer pioneers Alan Turing and Konrad Zuse. It is said to have taken place at Gottingen in 1947. Most historians of computing have no knowledge of Zuse's interrogation by Turing. So far, only one source is available which mentions this event, Heinz Billing's memoirs." [other participants include on the German side: Zuse, Heinz Billing, Helmut Schreyer who eventually went to Brazil, and Alwin Walther. On the English side, interrogators, Arthur Porter, Alan Turing, and John Womersley] After which electronic magnetic drum computing entered English computation designs.
> Billing one of the inventors of the magnetic drum and designer of the first German sequence-controlled electronic digital computer as well as of the first German program-stored electronic digital computer.
>
> Turing worked at NPL developing the modern stored-program electronic digital computer called 'ACE' (automatic computing engine). Oct. 1945

> Porter visits Germany in March 1946 to identify German scientists of interest. Zuse and Schreyer visited the National Physical Laboratory in London 15 Feb 1948 - 4 March 1948 'Did Allan Turing Interrogate Konrad Zuse in Gottingen in 1947?' (Bruderer 2013)

It is interesting that Britain was able to take the work of Billing after the war and create advances to computational abilities. Heinz Billing, he researched and worked at the Institute for Instrumentation in the Max Planck Society , which was located on the grounds of the AVA in Göttingen and where he developed in 1948 a magnetic drum memory and program-controlled computing machines. Billing mainly used amplifier tubes for this purpose . During this time he learned about the novel electronic computing machine ENIAC in the USA and its performance. In 1947, an exchange with senior English scientists and computer scientists from the National Physical Laboratory (NPL) took place in Teddington , where John Roland Womersley (1907-1958), Arthur Porter and Alan Turing were involved. In the form of a colloquium, the British experts interviewed German scientists such as Heinz Billing, Konrad Zuse , Alwin Walther and Helmut Schreyer . Billing was confronted for the first time with the idea of binary numbers and data storage. In contrast to the English, who worked with acoustic storage, Billing from 1948 intended for music recordings and glued on a rotating drum tapes for magnetophones to save numbers. Later, Billing was interested in Physics and was part of the research which was cited to disprove the discovery of Gravitational Waves by American Physicist, Weber. [See Ch. 6 Physics of Neuroweapons]. Also, later in life, 1967, Zuse became interested in Physics and created what was known as Digital Physics. Zuse suggested that the universe itself is running on a cellular automaton or similar computational structure (digital physics); in 1969, he published the book Rechnender Raum (translated into English as Calculating Space). This idea has attracted a lot of attention, since there is no physical evidence against Zuse's thesis.

One of the tragic stories of the development of computer technology involves that of Alan Turing after the war. After the war, Turing made great strides in developing proto-Artificial Intelligence ideals. In 1950, he created the Turing test which was a theoretical test to see if a human could tell if they were interacting with a computer or a person, if the computer could fool the human it had passed the test, as passing as human. He also was involved in researching new computational hardware to support his ideals in Artificial Intelligence. However, Turing was a homosexual, which at the time was a criminal offence in Great Britain.   Whether, he was set up to cover up a burglary at his residence and where he conducted his research is an open question in conspiracy theories. Nonetheless, it was charged that his lover burgled his house leading to discovery of his homosexuality. Turing's conviction led to the removal of his security clearance and barred him from continuing with his cryptographic consultancy for GCHQ. He was denied entry into the United States after his conviction in 1952, but was free to visit other European countries. Turing was never accused of espionage but, in common with all who had worked at Bletchley Park, he was prevented by the Official Secrets Act from discussing his war work. On 8 June 1954, Turing's housekeeper found him dead. He had died the previous day. A post-mortem examination established that the cause of death was cyanide poisoning. When his body was discovered, an apple lay half-eaten beside his bed, and although the apple was not tested for cyanide, it was speculated that this was the means by which a fatal dose was consumed.

As can be seen by this brief history of the development of computing from out of the need to break encryption during World War 2, we see the convergence of computation and Intelligence work. Jumping forward, we will see how the British Secret Intelligence Services used computers in the war with the Irish Republican Army.

History of British Computing in Intelligence

Building on the earlier work of such great Intelligence computer engineers as Turing in Britain. The United Kingdom started turning to computers for active surveillance and tracking of Irish Republican Volunteers during the 'Troubles in Northern Ireland' which ended some 20 years ago as Neuroweapon computerized Thought Injection was becoming a viable platform for conducting irregular warfare, ironically Lockheed-Martin engineers used the IRA as an example in their early 2000s research on Game Theoretic Reflexive Control. It is interesting that in 1966, which was also the year that saw the creation of the Ulster Volunteer Force (UVF) in Northern Ireland which openly attacked Native Irish Catholics starting the 'Troubles', Great Britain developed it's first Intelligence Satellite, later, 1969, a series of satellites were launched ironically named 'Skynet', which is also a electronic surveillance system used by the NSA. Though this ironic in a chapter on Artificial Intelligence and Automated Systems, it does reveal a frame of mind in the British Intelligence Community, of desiring information. The question then becomes how to manage such information.

In Northern Ireland, MI-5, developed some of it's first surveillance systems based in visual data: cctv; and managing that data using Statistical Learning algorithms and computer networks. It is easy to see why they would want to use computers for surveillance and tracking with this brief account of what is involved in surveillance and the mass numbers of human agents involved:

> The branch of MI5 in charge of static and mobile surveillance is and is A4, part of A branch (Operations & Intelligence) in a fast-growing empire that has at least fourteen main departments and many sub-units. The field officers of A4 are dedicated expert people who are often treated as a lesser breed by the desk analysts and policy-makers. Foot surveillance is taught to students of MI5 and military Intelligence officers using a drill known as the A-B-C system. At least three people are used to follow the target: A (for adjacent, also known as the 'Eyeball') is nearest; B (Back-up) is further back, preferably concealed from the quarry. Both usually stick to the same side of the road. C (Control) has a wide field of vision on the opposite side of the road, guiding the other two with concealed throat microphone and/or discreet hand signals. A guide for novice trackers suggests: 'Behave naturally; have a purpose for being there; be prepared with a cover story (ensure that it fits the situation); remember you are most vulnerable when coming from cover.' The guidance deals with distance from the target, anticipation, body language, local knowledge, concentration and teamwork.
>
> Means by which the target is kept off-guard including 'boxing' and 'paralleling'. 'The subject is allowed to proceed on a route where there are a minimal number of surveillance officers. The idea is to let the subject 'run' from point to point to be checked

> at various places [like polling in a video game] by surveillance officers on parallel routes or ahead.' Even if new faces are introduced into the surveillance team, close control deteriorates in this form of play. However, 'the most important factor about surveillance is the need to be honest about exposure. It is better to have a controlled loss rather than to hang on to the subject too long.'
> The MI5 technique is manpower-intensive. Up to fifty Watchers might be needed to maintain twenty-four-hour cover on a single target. The result was a drive to recruit a large number of officers in a short time. (Geraghty,144-5)

In the early 1970s to track movements of vehicles in Northern Ireland, the British military used a system of logs which recorded the drivers and vehicle tags. As technology developed in CCTV, the system became more and more computerized. Initially, the logs were replaced with computer terminals and a database. Then in the mid-1990s, the computer system started switching to Machine Intelligence to analyze data. They developed a system of hidden cameras deployed covertly, called Glutton.

> Second only to the informer is the computer or, rather, the array of computers which act as the collating brains of this new style of warfare. In Northern Ireland, for example, the army uses two systems: 'Vengeful', dedicated to vehicles, and 'Crucible', for people. Crucible, one source explained, 'will hold a personal file containing a map/picture showing this is where a suspect lives as well as details of family and past.' Vengeful is linked to the Northern Ireland vehicle licensing office. The two systems provide total cover of a largely innocent population, the sea within which the terrorist fish still swim. Information management is handled by yet another Intelligence Corps team, the Joint Surveillance Group." (Geraghty, 158-9)

Later, a new AI system was introduced called Caister, which was a knowledge based system to analyze IRA movements and personnel, this system replaced an earlier system, known as Crucible. Later, Caister was replaced by a system known as Calshot, which included AI analysis of data, bypassing human interaction, an automated autonomous system, which replaced. An earlier attempt at using AI for automated analysis was called Effigy, which was replaced in 1998 with a system known as 'Mannequin'.

Geraghty writes:

> Another new Intelligence computer was 'Caister', a knowledge-based system (KBS) to replace the earlier Crucible [mid-90s] in sifting personal information about terrorists and their associates. Caister or its later variant 'Calshot', it was hoped, would be part of a process of analysis where the computer, rather than human mind, identified significant links between one suspect and another. The generic name given to this technique is Artificial Intelligence. Laden with personal files Caister, according to one document, would 'provide dual central processing suites at Theipval (military HQ) and Knock (RUC HQ) interconnected by megastream support up to 350 terminals over secure communications bearers. Data up to 'Secret'. Average response time of ten seconds for a single enquiry with 192 concurrent references.'

> Artificial Intelligence was trialled and failed at an earlier stage under the code-name ‘Effigy’, but by 1997, under the code-name ‘Mannequin’, plans were virtually complete to have a second shot at this project, regarded as vital to a successful counter-terrorist campaign in the future. The key was integration, and an electronic spring-clean of the Military Intelligence cupboard in which, in 1994, there were no fewer than thirty-seven separate computer programs, virtually none of which was compatible with any other. “ (Geraghty, 160)

Obviously, this reveals the nature of surveillance to Secret Intelligence, in that it is not specific to known suspects but is a wide net cast across all sectors of a society, which was later confirmed in the Snowden NSA leaks. As Geraghty notes:

> By 1996, the new culture of directed Intelligence had proliferated like some exotic plant inside a greenhouse in Bedfordshire, new home of the Defence Intelligence and Security School. The system could run effective surveillance on an entire population and, through the use of psychological warfare (reserved, so far, for use in Bosnia), shape popular perceptions of events to suit a military strategy. It gave enormous power to those in charge of the system in Northern Ireland… (Geraghty, 131-2)

It is interesting to note that at that time, the mid-90s, that psychological warfare could be run through their computer systems and it’s AI. Although the claim of psyops being limited to Bosnia and not employed in Northern Ireland is contradicted by historical accounts of such psychological warfare in Northern Ireland (Lethal Allies, 328, 348). Additionally, there is a cavalier attitude with such powers by those in authority. As exhibited by Michael Mates, Northern Ireland Secretary 1991-2:

> “I never had to go looking for power. This is where Northern Ireland is different. You could have more than you could use…. There’s no bloody democracy down there. That’s why it works so well. I’ve never been happier. I had power. But one keeps very quiet about it.” (Geraghty, 132)

Indeed, it is noted by the author Richard Aldrich that the European Convention on Human Rights was viewed by the British secret state as a threat to it’s viability (Aldrich, 485). That adhering to international treaties and laws, not to mention domestic laws would be a ‘threat’. To what extent this attitude remains to the human administrators of the security establishment in Great Britain, it remains an interesting question as to whether the AI analysis also considers such laws a ‘threat’ and what it’s automated responses to such a threat might be. Clearly, when it comes to security agencies the law is not implemented against their own Intelligence. Professor Bill Rolston in his paper ‘An Effective Mask for Terror: Democracy, Death Squads and Northern Ireland’: ‘Although the law was sometimes used against state forces, it was used leniently, even when they acted independently outside of their special units.’ (Rolston, 21). It is recorded that the Military Intelligence during the Troubles viewed those in civil authority with contempt as they referred to oversight as being ‘betrayed and maligned’ by ‘flabby-faced men with pop-eyes and fancy accents'. (Lethal Allies, 322). Even going further then contempt for the legal oversight is the outright applying fuel to the fire to achieve objectives:

> If loyalist paramilitaries could not shoot the fish, they would poison the water. Eventually, they reasoned, this would ineluctably drive the nationalist community to pressurise the IRA to stop its campaign'. A spokesman explained the UVF strategy at that time: 'We believed, rightly or wrongly, that the only effective way to beat the terror machine was to employ greater terrorism against its operative … By bombing the heart of Provisional enclaves we attempted to terrorize the nationalist community into demanding that the Provisionals either cease their campaign or move out … we hoped to crack their morale and destroy their chain of command.' (Lethal Allies, 323)

This notion of using terrorism by members of the security state are echoed by Evelegh:

> A third military strategist with experience in Ireland was Robin Evelegh, who served in Cyprus during the late 1960s. After service in Northern Ireland he wrote Peace-Keeping in a Democratic Society: The Lessons of Northern Ireland, which influenced later security operations. In his book, Evelegh bemoaned 'shortcomings in the laws governing the operation of the Security Forces [in Northern Ireland] to suppress terrorism and disorder' which –if only they could be corrected –could 'succeed in ending these horrors'. Echoing Kitson [directed psyops], he thought such limitations necessitated civil, policing and military powers being united to 'weld all the efforts of the Government into a machine directed at one end, the defeat of the insurrection' –a call, in effect, for martial law. Evelegh supported Kitson's lead on turning paramilitaries into allies who 'have to be consciously created' and then indemnified with immunity 'for the crimes he will have to commit'. On agents provocateurs infiltrating enemy ranks, Evelegh says openly that the agent should 'clearly play his part in terrorist activity which will almost inevitably involve him in committing further crimes'. He quotes Lord Widgeryad in a 1974 High Court appeal as also acknowledging this fact.(Lethal Allies, 352)

To what extent surveillance systems and it's management through Artificial Intelligence could go toward enforcing martial law, or of enabling Military Intelligence of running around oversight is an open question. Clearly, there is a very big opening for abuse for such systems. It is worrisome that the NSA does not consider passive automated systems of surveillance as 'surveillance', would this mean that an automated system of thought injection is also not 'neuroweapons' or 'mind control'? As journalist Jakob Applebaum explains:

> According to Appelbaum, the NSA is running a two-stage data dragnet operation. The first stage is TURMOIL, which collects data traffic passively via satellite and cable taps and stores it – in some cases for up to 15 years – for future reference. The NSA does not consider this surveillance because no human operator is involved, just automatic systems." [3]

If it the NSA can collect data passively without a warrant what is to stop them from collecting passive neural data using automated systems? Is full automation just a legal workaround, but one which opens up unforeseen complex engineering problems?

Tracking and Surveillance are not the only areas in military operations that are automated and utilizing Artificial Intelligence. Information Operations is also an area that is utilizing automated and Machine Intelligence to achieve the aims of secret Intelligence organizations. Many are now familiar with the Cambridge Analytica data breach and exploitation story. An Influence Operation, a sub-specialty of Information Operations are becoming more and more automated. Cambridge Analytica, a British defense contractor, with many connections to far-right American business interests, such as billionaire Robert Mercer, who made his fortune in Image Recognition in Artificial Intelligence Systems, was owned by SCL Group. SCL Group conducted Information and Influence Operations research for the British Ministry of Defence. As explained by this news article:

> The SCL project was carried out by the MoD's Defence Science and Technology Laboratory (DSTL), which is focused on maximising "the impact of science and technology for the defence and security of the UK".
>
> According to a heavily redacted document released under freedom of information rules, Project Duco was part of the government's "human and social influence" work, and SCL was paid £150,000. The company was also paid £40,000 for work carried out in 2010-11.
>
> The government team, which included psychologists and analysts, worked with SCL in 2014 to assess how "target audience analysis" could be used by the British government. (Watt 2018)

It is easy to see how such a company could be used to further a Secret Intelligence Agency's goals and plans, goals and plans which need not be the same as the democratically elected government. Another troubling aspect of Cambridge Analytica was it's complicity in influence operations during the UK's plans to exit the European Union, which as noted before Secret Intelligence viewed EU laws on human rights, such as the equality of the Irish with the British in Northern Ireland, as a 'threat'. Indeed, another company connected to Cambridge Analytica and SCL Group, Harris Media, conducts influence operations for far-right political organizations such as the AFd in Germany, and has a common cause with other far-right political causes.

The Defence Science and Technology Laboratory has as it's component areas of expertise such areas as counter-terrorism, under which category in America research into 'Thought Injection' was conducted as a counter-terrorism tactic. Another area of DSTL research and promotion of automation and machine autonomy is Influence Operations, and Cognitive Science. Recently it has offered financial support to researchers using machines in this endeavor.[1]

It is not just the 5 Eyes nations, such as the UK and USA, that have automated influence operations, virtually any well organized intelligence department of any nation could easily deploy such a system, and not just the bogeymen of Russia and China. So with such a plethora of potential operatives in Influence Operations one would think the United States would have developed counter-measures to such operations as Maj. Christopher Telley reminds us:

> ...the transformation of one industry in particular has grave implications for U.S. national security: influence. AI-guided information operations (IO) utilize tools that can shape a target audience's perceptions through the rapid and effective mimicry of human empathy with that audience. Machine speed influence operations are occurring right now, but future IO systems will be able to individually monitor and affect tens of thousands of people at once. Though the threat of automated influence exists quite literally on the smartphone in front of you, the Pentagon's current efforts to integrate AI do not appear to include any reasonably resourced IO response. (Telley, 2018)

It is noteworthy that the Defense Department tried to create a counter-measures department for Influence Operations, but it was closed down in 2002 by Donald Rumsfeld, SECDEF under George Bush, citing public outcry, which itself may have been an influence operation. Maj. Telley, calls the automated machine intelligence implementation of Influence Operations, the Influence Machine, he elaborates on the problem with such Influence Machines:

> The crux of the Influence Machine's value is the inherent vulnerability of Western democracy, that decision makers are beholden to a malleable selectorate. as senator Mark Warner noted, "We're increasingly in a world where cyber vulnerability, misinformation and disinformation may be the tools of conflict." By affecting the cognition —the will—of enough people, this machine can prevent or delay a democratic government's physical response to aggression; it is a defeat mechanism. The Influence Machine's objective comes down to changing the value of the target's strategic goal. Clausewitz knew that the political object, the original motive, in a conflict was the essential factor in any deterrence equation. The smaller the value demanded of an opponent, the less that competitor would be willing to try to deny it. This is the inverse of Fearon's "tying hands" findings that the increase of the perceived costs for an audience, a national population, tends to prevent a country from backing down when attempting to coerce an opponent. With automated influence, that opponent attempts to lower the expected benefits, on the part of the competitor's audiences, for the intervention action. The Influence Machine enables defeat before any shots are ever fired by removing "the physical means or the will to fight." in this condition, a defeated state's executive is unwilling or unable to respond to a threat action, thereby yielding to the opponent's will as fake news becomes frighteningly competitive with real news, the emergence of the Influence Machine presents a novel way to "hack" the unchanging human nature of war. (Telley, 2018, 7)

As we have learned Influence Operations are an integral part of any Intelligence Agency's strategic goals and policies. Another area that has developed directly out of Intelligence work is that of Operations Research, which is most closely identified with the development of Cybernetics, which is a direct outgrowth of Operations Research.

Cybernetics

Before discussing Cybernetics we need to understand the parent concept of Operations Research (OR).

> According to the Operational Research Society of Great Britain (OPERATIONAL RESEARCH QUARTERLY, I3(3):282, I962), Operational Research is the attack of modern science on complex problems arising in the direction and management of large systems of men, machines, materials and money in industry, business, government and defense. Its distinctive approach is to develop a scientific model of the system, incorporating measurements of factors such as change and risk, with which to predict and compare the outcomes of alternative decisions, strategies or controls. The purpose is to help management determine its policy and actions scientifically. (Anonymous, year unknown)

Operations Research began in Great Britain just before the war and was involved in the development of British Radar defenses. The Operational Research department was eventually placed under the command of Lord Dowding, in charge of Air Defenses and credited with saving Britain in the ‘Battle of Britain’ [he also believed in UFOs]. It is easy to see how this is important to a National Intelligence infrastructure. As it is also the task of the IC to monitor it’s nations fiscal and economic output and intakes, every IC has a department related to these affairs. Hence, the creation of a mathematically based scientific discipline for analysis of these most important aspects of national Intelligence.

Norbert Weiner coined the term ‘Cybernetics’ as a participant in the Macy Conferences, an early academic colloqia on automation and machine learning held at Dartmouth College in the 1950s. Weiner, who worked on controllers for Radar systems, during World War 2 for the United States Government. Later, he was interested in how controllers work in not just radar but in general terms. Cybernetics is a transdisciplinary approach for exploring regulatory systems—their structures, constraints, and possibilities. Norbert Wiener defined cybernetics in 1948 as "the scientific study of control and communication in the animal and the machine." In the 21st century, the term is often used in a rather loose way to imply "control of any system using technology." In other words, it is the scientific study of how humans, animals and machines control and communicate with each other. A colleague of Weiner was Stafford Beers, who during World War 2 he worked for British Military Intelligence in the area of Operations Research was a prominent figure in the development of Cybernetics. Eden Medina provides a digest of the interactions between Military Intelligence and Cybernetics:

> British cybernetics, as practiced by Beer, differed from the U.S. approach in significant ways. In his book the Cybernetic Brain, Andrew Pickering distinguishes British cybernetics (as represented by the careers of Beer, Ashby, Grey Walter, Gregory

> Bateson, R.D. Laing, and Gordon Pask) from the better-known story of cybernetics in the United States, which is often tied to the career of Norbert Wiener and Wiener's military research at MIT during the Second World War. Pickering notes that British cybernetics was tied primarily to psychiatry, not military engineering, and focused on the brain. (Medina, 36)
>
> psychiatry and military engineering were not separate domains in the postwar era, and work in cybernetics spanned both fields in the U.S. and British contexts. For example, the British cybernetician Gordon Pask received fifteen years of funding for his work on decision making and adaptive training systems from the U.S. Office of Navy Research. Military funding also supported the work of psychologists such as George Miller, who promoted the use of cybernetic ideas and information theory in psychology. (Medina, 36, Note 45)

The modeling of cybernetics on the Nervous System of vertebrate animals was done explicitly by Stafford Beers. In the sense of the Brain as commander of the body. This is a biological C2 system (command and control: C2). USAF Colonel Scherrer delineates the relationship of cybernetics to C2 [for similarity to discussion on Semiotic Cybernetics see 'Lessons from an American Weapons Designer']:

> The cybernetic-system model is the dominant C2 paradigm for nearly all researchers and systems builders and either explicitly or implicitly informs all C2 models (see Figure 5). A cybernetic system is composed of three fundamental components: sensors that accept input from the environment, processors that accept the input and transform it, and output mechanisms that take the processed information and use it to change the behavior of the system. The cybernetic aspect of military operations is readily apparent given these operations are a process by which a commander (sensor and processor) directs forces (people, processes/ors, and technology organized into a system to produce output) to achieve comparative advantage over an adversary (interaction with the environment) through maneuver and the application of firepower (output and feedback). The science of cybernetics studies internal and external interactions "guided by the principle that numerous different types of systems can be studied according to the principles of feedback, control, and communications." Also key to understanding the concept of cybernetics is the idea of self-regulation. When a system senses a change in the environment, that information is used to adjust the behavior according to the goal of the system. The system then monitors the environment to ascertain if either the internal or external change has successfully aligned with the system's goal. (Scherrer, 2009, 34)

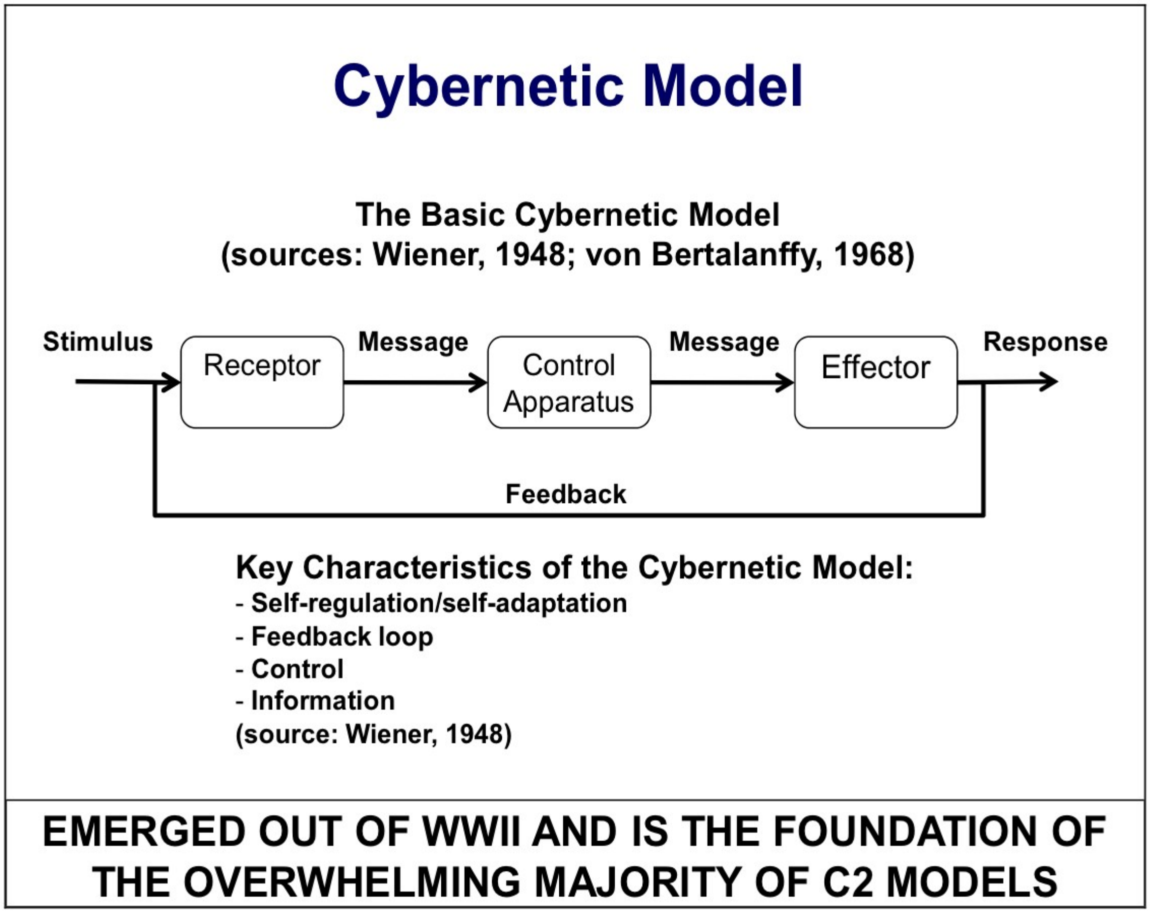


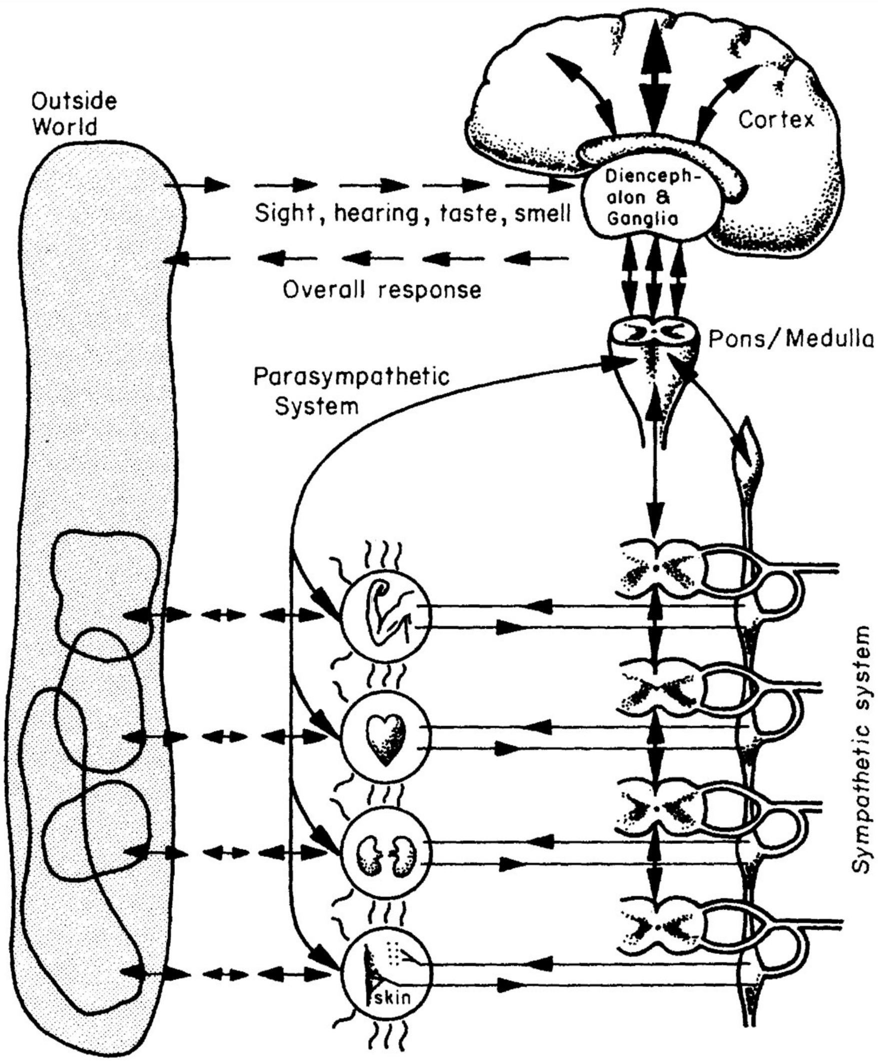
Figure 5: The Cybernetic Model. (Sources: Wiener, 1948 and Bertalanffy, 1968).

With this we see how similar and intrinsic the study of cybernetics is to military and intelligence command and control.

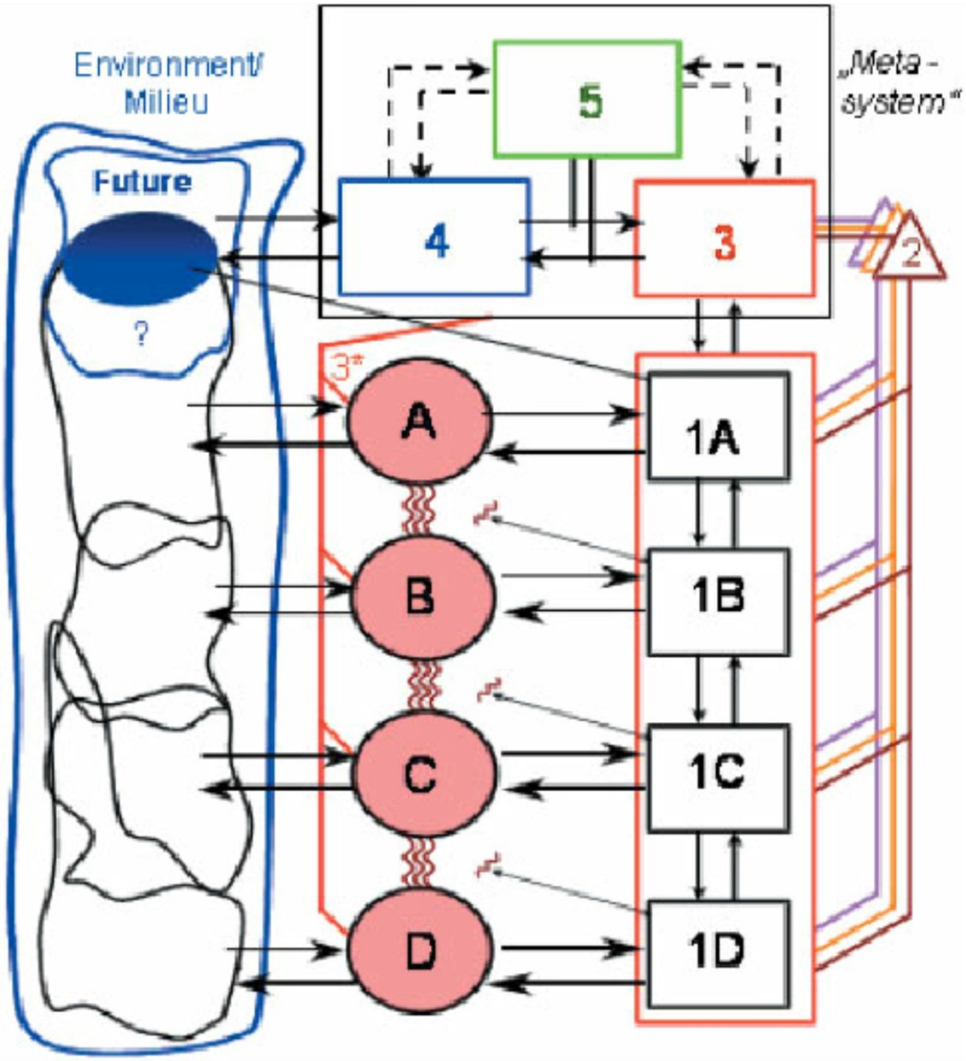
Stafford Beers, however, took this in a more interdisciplinary direction. Eventually, creating a cybernetic system that regulated the industries of Chile in 1972-73, with Project Cybersyn. Beers is the creator of what he termed the Viable Systems model, which was first postulated in 1972 in Beer's book, 'The Brain of the Firm'. Medina offers the following on the Viable System Model of Beers:

> Beers defines a viable system as 'a system that survives. It coheres; it is integral. It is homeostaticaly balanced both internally and externally, but has none the less mechanisms and opportunities to grow and to learn, to evolve and to adapt—to become more and more potent in its environment.' …a system that is 'capable of independent existence.' (Medina, 50)

The Viable Systems model was based on Beers notion of the central nervous system.



Central Nervous System



Beers Viable System Model

Andrew Pickering explains Beers' view:

> The spirit of the [Viable System Model] VSM is nicely expressed in the juxtaposition of two figures from Brain of the Firm: one a schematic of the human body; the other of the firm. Very briefly, Beer argued that one needs to distinguish, at minimum, five levels or system of control in any viable system. In this figure, System One consists of four subsidiaries of a larger organization, labelled A,B,C,D, analogous to arms and legs, the heart, kidneys, etc. System Two, the equivalent of the sympathetic nervous system, connects them to one another and to System Three, and seeks to damp out destructive interactions between the subsidiaries. System Three-- the pons and medulla of the VSM-- consists of a set of Operation Research (OR) models of production that enables management to react to fluctuations in Systems One and Two--by reallocating resources, for example. System Four--the base of the brain itself--was envisaged as a decision-making environment for higher management, modeled on the World War II

> operations room. It would collect and display information from the lower systems and from the outside world and, very importantly, it would run a set of computer programs that higher management could consult on the possible future effects of major decisions. At the same time, this operations room was intended to function as a club-room for senior management--a place. To hang out, even when major decisions were not at stake. Finally System Five, was the location of the most senior management whom Beer regarded as the cortex of the firm. Their vision of the firm and its future, whatever it was, was to be negotiated into reality in reciprocally vetoing homeostatic interactions with System 4. (Pickering, 16)

As noted, cybernetics, and controllers or control are intrinsically linked. For Beer he defined control in a more open sense then, for Beer control is self-regulation, or the ability of a system to adapt to internal and environmental changes and self-sustain itself. This was an important distinction for Beer, rather then trying to create a hierarchical system of total control, he was trying to create a system that is much more fractal in nature (Medina, 37). Indeed, for Beer an integral component of control is what he called 'variety', citing Ashby's Law of Requisite Variety: for a system to be stable, the number of states that its control mechanism is capable of attaining (its variety) must be greater than or equal to the number of states in the system being controlled, only variety can control variety. Medina has observed that "it is impossible to truly control another unless you can respond to all attempts at subversion." (Medina, 39).

Another important aspect of Beer's cybernetics was the creation of inter-connected components within the system:

> Beer emphasized creating lateral communication channels among the different subsystems so that the changes in one subsystem could be absorbed by changes in the others. This approach, he argued, took advantage of the flexibility of each subsystem. Instead of creating a regulator to fix the behaviour of each subsystem, he found ways to couple subsystems together so that they could respond to each other and adapt. Such adaptive couplings helped maintain the stability of the overall system. (Medina, 39)

He viewed managers as system designers rather then as part of the system, he looked for ways to restructure systems so that it would tend toward homeostasis and desired behaviors. (Medina, 40). Another aspect of the interconnectedness was the creation of horizontal and vertical forms of communication and control. This allowed changes in one subsystem to be reacted to by other subsystems rather then waiting for a directive from the top (C2). Thus, cybernetic management approached the control with degrees of freedom and autonomy of subsystems, while preserving the overall system (Medina, 40).

Development of Computation Timeline

19th Century: The idea of formal logic can be traced back to the philosophers of ancient Greece, but its mathematical development really began with the work of George Boole (1815–

1864), who worked out the details of propositional, or Boolean, logic (Boole, 1847). In 1879, Gottlob Frege (1848–1925) extended Boole's logic to include objects and relations, creating the firstorder logic that is used today. Alfred Tarski (1902–1983) introduced a theory of reference that shows how to relate the objects in a logic to objects in the real world. (Russell and Norvig, 7-8)

1925 Vannevar Bush and colleagues develop the first analogue computer, capable of solving differential equations.

1931- proto-Genetic Algorithm Work by Sewall Wright (1931) on the concept of a fitness landscape was an important precursor to the development of genetic algorithms. In the 1950s, several statisticians, including Box (1957) and Friedman (1959), used evolutionary techniques for optimization problems, but it wasn't until Rechenberg (1965) introduced evolution strategies to solve optimization problems for airfoils that the approach gained popularity. In the 1960s and 1970s, John Holland (1975) championed genetic algorithms, both as a useful tool and as a method to expand our understanding of adaptation, biological or otherwise (Holland, 1995). The ar tificial life movement (Langton, 1995) takes this idea one step further, viewing the products of genetic algorithms as organisms rather than solutions to problems. Work in this field by Hinton and Nowlan (1987) and Ackley and Littman (1991) has done much to clarify the implications of the Baldwin effect. For general background on evolution, we recommend Smith and Szathm´ary (1999), Ridley (2004), and Carroll (2007).

1936 the Church–Turing thesis, which states that the Turing machine (Turing, 1936) is capable of computing any computable function, is generally accepted as providing a sufficient definition. Turing also showed that there were some functions that no Turing machine can compute. For example, no machine can tell in general whether a given program will return an answer on a given input or run forever. (Russell and Norvig, 8)

1937 - IBM begins business in Nazi Germany directly with the Reich, to categorize using census, all Germans, with special categories that later became used in the Concentration Camps, they were aiding in Nazi Eugenics.

1938 Z1 Computer Beginning in 1935 he experimented in the construction of computers in his parents' flat on Wrangelstraße 38, moving with them into their new flat on Methfesselstraße 10, the street leading up the Kreuzberg, Berlin.[12] Working in his parents' apartment in 1936, he produced his first attempt, the Z1, a floating point binary mechanical calculator with limited programmability, reading instructions from a perforated 35 mm film.[10] In 1937, Zuse submitted two patents that anticipated a von Neumann architecture. He finished the Z1 in 1938.

1939 - Von Nuemann was interested in Turing's work in continuous groups.

1939 - Turing [Allies], builds the first prototype of the Bombe, an electro-mechanical device, to decrypt Nazi messages based on earier version in Poland.

1940 The first operational computer was the electromechanical Heath Robinson,8 built in 1940 by Alan Turing's team for a single purpose: deciphering German messages. In 1943, the same group developed the Colossus, a powerful general-purpose machine based on vacuum tubes.9 The first operational programmable computer was the Z-3, the invention of Konrad Zuse in Germany in 1941. Zuse also invented floating-point numbers and the first high-level programming language, Plankalk¨ul. The first electronic computer, the ABC, was assembled by John Atanasoff and his student Clifford Berry between 1940 and 1942 at Iowa State University. Atanasoff's research received little support or recognition; it was the ENIAC, developed as part of a secret military project at the University of Pennsylvania by a team including John Mauchly and John Eckert, that proved to be the most influential forerunner of modern computers. (Russell and Norvig, 14)

1940b Norbert Wiener begins working with engineer Julian Bigelow on the problems involved in effective automatic range finders for anti aircraft guns

1941-45 Zuse Guidance Systems Zuse built the S1 and S2 computing machines, which were special purpose devices which computed aerodynamic corrections to the wings of radio-controlled flying bombs. The S2 featured an integrated analog-to-digital converter under program control, making it the first process-controlled computer. These machines contributed to the Henschel Werke Hs 293 and Hs 294 guided missiles developed by the German military between 1941 and 1945, which were the precursors to the modern cruise missile

1941b U of Iowa Computer Atanasoff and his graduate student, Clifford Berry, design a computer that can solve 29 equations simultaneously. This marks the first time a computer is able to store information on its main memory. 1942 Macy Proposal Warren McCulloch proposes to Macy Foundation executive Frank Fremont-Smith that a series of conferences be convened on the circular causality / teleological mechanism themes presented at the Cerebral Inhibition Meeting. Fremont-Smith, concurs, but says this would have to await the end of the war.

1941c Bombe Built as an electro-mechanical means of decrypting Nazi ENIGMA-based military communications during World War II, the British Bombe is conceived of by computer pioneer Alan Turing and Harold Keen of the British Tabulating Machine Company. Hundreds of allied bombes were built in order to determine the daily rotor start positions of Enigma cipher machines, which in turn allowed the Allies to decrypt German messages. The basic idea for bombes came from Polish code-breaker Marian Rejewski's 1938 "Bomba."

1943 The first work that is now generally recognized as AI was done by Warren McCulloch and Walter Pitts (1943). They drew on three sources: knowledge of the basic physiology and function of neurons in the brain; a formal analysis of propositional logic due to Russell and Whitehead; and Turing's theory of computation. They proposed a model of artificial neurons in which each neuron is characterized as being "on" or "off," with a switch to "on" occurring in response to stimulation by a sufficient number of neighboring neurons. The state of a neuron wasconceived of as "factually equivalent to a proposition which proposed its adequate stimulus."

They showed, for example, that any computable function could be computed by some network of connected neurons, and that all the logical connectives (and, or, not, etc.) could be implemented by simple net structures. McCulloch and Pitts also suggested that suitably defined networks could learn. Donald Hebb (1949) demonstrated a simple updating rule for modifying the connection strengths between neurons. His rule, now called Hebbian learning,remains an influential model to this day. (Russell and Norvig, 16)

1943b Alan Turing pursues his 'child machine' concept - using knowledge of how humans acquire intelligence to design a trainable intelligent machine or computer.

1943-1944 ENIAC Two University of Pennsylvania professors, John Mauchly and J. Presper Eckert, build the Electronic Numerical Integrator and Calculator (ENIAC). Considered the grandfather of digital computers, it fills a 20-foot by 40-foot room and has 18,000 vacuum tubes.

1944 John von Neumann and Oskar Morgenstern publish their book The Theory of Games and Economic Behavior (1944).

1944b Colossus Designed by British engineer Tommy Flowers, the Colossus is designed to break the complex Lorenz ciphers used by the Nazis during World War II. A total of ten Colossi were delivered, each using as many as 2,500 vacuum tubes. A series of pulleys transported continuous rolls of punched paper tape containing possible solutions to a particular code. Colossus reduced the time to break Lorenz messages from weeks to hours. Most historians believe that the use of Colossus machines significantly shortened the war by providing evidence of enemy intentions and beliefs. The machine’s existence was not made public until the 1970s.

1945 Zuse Plankalkül While working on his Z4 computer, Zuse realised that programming in machine code was too complicated. He started working on a PhD thesis containing groundbreaking research years ahead of its time, mainly the first high-level programming language, Plankalkül ("Plan Calculus") and, as an elaborate example program, the first real computer chess engine

1946 John von Neumann formulates concept of a stored 'program', setting the stage for flexible programming of computers.

1946b Macy Conferences Convened The first of ten Macy conferences is held under the initial title "Feedback Mechanisms and Circular Causal Systems in Biological and Social Systems". This series of conferences (actually motivated by excitement from the 1942 Cerebral Inhibition meeting) will become the birthplace of cybernetics as a field.

1947 Turing debriefs Zuse** in Gotingen, Germany Arthur Porter, Alan Turing, and Alwin Walther debrief Konrad Zuse, Heinz Billing, Helmut Schreyer in the form of a symposium on developments in Computer Engineering in Germany during WWII. In 1948 Zuse and Schreyer visits the National Physical Laboratory in London where Turing was working on the 'ACE' computer (automatic computing machine).

1947b W. Ross Ashby's paper "Principles of the self-organizing dynamic system" introduces the term 'self-organizing' into cybernetics parlance.

1948 The central figure in the creation of what is now called control theory was Norbert Wiener (1894–1964). Wiener was a brilliant mathematician who worked with Bertrand Russell, among others, before developing an interest in biological and mechanical control systems and their connection to cognition, in his personal life he, as a Jew, was ironically married to an avowed Nazi. Like Craik (who also used control systems as psychological models), Wiener and his colleagues Arturo Rosenblueth and Julian Bigelow challenged the behaviorist orthodoxy (Rosenblueth et al.,1943). Theyviewedpurposivebehaviorasarising from a regulatory mechanism trying to minimize “error”—the difference between current state and goal state. In the late 1940s, Wiener, along with Warren McCulloch, Walter Pitts, and John von Neumann, organized a series of influential conferences that explored the new mathematical and computational models of cognition. Wiener’s book Cybernetics (1948) became a bestseller and awoke the public to the possibility of artificially intelligent machines. Meanwhile, in Britain, W. Ross Ashby (Ashby, 1940) pioneered similar ideas. Ashby, Alan Turing, Grey Walter, and others formed the Ratio Club for “those who had Wiener’s ideas before Wiener’s book appeared.” Ashby’s Design for a Brain (1948, 1952) elaborated on his idea that intelligence could be created by the use of homeostatic devices containing appropriate feedback loops to achieve stable adaptive behavior. (Russell and Norvig, 15) 1948b Shannon Information Theory Claude Shannon´s "The Mathematical Theory of Communication" showed engineers how to code data so they could check for accuracy in transmission. Defines 'bit' as fundamental information unit.

1948c von Neumann oversees construction of the first stored-program computer at Princeton.

1948d Grey Walter creates autonomous machines called Elmer and Elsie that mimic lifelike behavior with very simple circuitry.

1948e Stored Program University of Manchester researchers Frederic Williams, Tom Kilburn, and Geoff Toothill develop the Small-Scale Experimental Machine (SSEM), better known as the Manchester "Baby." The Baby was built to test a new memory technology developed by Williams and Kilburn -- soon known as the Williams Tube – which was the first high-speed electronic random access memory for computers. Their first program, consisting of seventeen instructions and written by Kilburn, ran on June 21st, 1948. This was the first program in history to run on a digital, electronic, stored-program computer.

1948f - Heinz Billing, After the Second World War, he researched and worked at the Institute for Instrumentation in the Max Planck Society , which was located on the grounds of the AVA in Göttingen and where he developed in 1948 a magnetic drum memory and program-controlled computing machines. Billing mainly used amplifier tubes for this purpose . During this time he learned about the novel electronic computing machine ENIAC in the USA and its performance. In 1947, an exchange with senior English scientists and computer scientists from the National Physical Laboratory (NPL) took place in Teddington , where u. a. John Roland Womersley

(1907-1958),Arthur Porter and Alan Turing were involved. In the form of a colloquium, the British experts interviewed German scientists such as Heinz Billing, Konrad Zuse , Alwin Walther and Helmut Schreyer . Billing was confronted for the first time with the idea of binary numbers and data storage. In contrast to the English, who worked with acoustic storage, used Billing from 1948 intended for music recordings and glued on a rotating drum tapes for magnetophones to save numbers. https://de.wikipedia.org/wiki/Heinz_Billing [need to find information on his wartime years]

1949- Helmut Schreyer flees to Brazil along with other Nazis. Schreyer, during the war worked on technology to convert the radar signal into an audio signal which the pilot of a fighter aircraft might recognize. He also worked on the V-2 project. Helmut Schreyer advised Konrad Zuse to use electrical circuit technology to implement computers, but he first considered it practically infeasible and then could not get the necessary funding. Up to 1942 Schreyer himself built an experimental model of a computer using 100 vacuum tubes, which was lost at the end of the war. In 1944 he built an electrical circuit to convert decimal to binary numbers. He worked with Zuse on the Z-Series computers after befriending him in college. In Brazil he became professor at the Instituto Militar de Engenharia in Rio de Janeiro, no doubt of service to Brazil's Fascist leaders. An interesting note is that he was taken to Britain to study the latest computer architectures at the National Physical Laboratory before fleeing, perhaps MI-5 missed the note about him being a committed Nazi.
http://v3.espacenet.com/publicationDetails/originalDocument?CC=DE&NR=1224364B&KC=B&FT=D&date=19660908&DB=EPODOC&locale=en_EP

1949 Hebbian Learning Donald Hebb demonstrates how simple neural elements and operations could explain complex observed psychological phenomena such as learning.

1950 Two undergraduate students at Harvard, Marvin Minsky and Dean Edmonds, built the f irst neural network computer in 1950. The SNARC,asitwascalled,used3000vacuum tubes and a surplus automatic pilot mechanism from a B-24 bomber to simulate a network of 40 neurons. Later, at Princeton, Minsky studied universal computation in neural networks. (Russell and Norvig, 16)

1950b Alan Turing addressed the problem of artificial intelligence, and proposed an experiment that became known as the Turing test, an attempt to define a standard for a machine to be called "intelligent". The idea was that a computer could be said to "think" if a human interrogator could not tell it apart, through conversation, from a human being.[105]

1950c Sperry Rand builds the first commercially-available data processing machine, the UNIVAC I

1950d Based on ideas from Alan Turing, Britain´s Pilot ACE computer is constructed at the National Physical Laboratory. "We are trying to build a machine to do all kinds of different things simply by programming rather than by the addition of extra apparatus," Turing said at a symposium on large-scale digital calculating machinery in 1947 in Cambridge, Massachusetts. The design packed 800 vacuum tubes into a relatively compact 12 square feet.

1951 First Simulator During World War II, the US Navy approaches the Massachusetts Institute of Technology (MIT) about building a flight simulator to train bomber crews. Under the leadership of MIT's Gordon Brown and Jay Forrester, the team first built a small analog simulator, but found it inaccurate and inflexible. News of the groundbreaking electronic ENIAC computer that same year inspired the group to change course and attempt a digital solution, whereby flight variables could be rapidly programmed in software. Completed in 1951, Whirlwind remains one of the most important computer projects in the history of computing. Foremost among its developments was Forrester's perfection of magnetic core memory, which became the dominant form of high-speed random access memory for computers until the mid-1970s.

23 January 1952 - Turing's house was burgled leading to an investigation into his homosexuality:
Turing's conviction led to the removal of his security clearance and barred him from continuing with his cryptographic consultancy for the Government Communications Headquarters (GCHQ), the British signals intelligence agency that had evolved from GC&CS in 1946 (though he kept his academic job). He was denied entry into the United States after his conviction in 1952, but was free to visit other European countries. Turing was never accused of espionage but, in common with all who had worked at Bletchley Park, he was prevented by the Official Secrets Act from discussing his war work.[130]

8 June 1954, Turing's housekeeper found him dead. He had died the previous day. A post-mortem examination established that the cause of death was cyanide poisoning.[131] When his body was discovered, an apple lay half-eaten beside his bed, and although the apple was not tested for cyanide,[132] it was speculated that this was the means by which a fatal dose was consumed.

1956 McCarthy convinced Minsky, Claude Shannon, and Nathaniel Rochester to help him bring together U.S. researchers interested in automata theory, neural nets, and the study of intelligence. They organized a two-month workshop at Dartmouth in the summer of 1956. The proposal states:10 We propose that a 2 month, 10 man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that 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. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer. There were 10 attendees in all, including Trenchard More from Princeton, Arthur Samuel from IBM, and Ray Solomonoff and Oliver Selfridge from MIT. Two researchers from Carnegie Tech,11 Allen Newell and Herbert Simon, rather stole the show. Although the others had ideas and in some cases programs for particular applications such as checkers, Newell and Simon already had a reasoning program, the Logic Theorist (LT), about which Simon claimed, “We have invented a computer program capable of thinking non-numerically, and thereby solved the venerable mind–body problem.”12 Soon after the workshop, the program was able to prove most of the theorems in Chapter 2 of Russell and Whitehead’s Principia Mathematica.RussellwasreportedlydelightedwhenSimon showed him that the program had come up with a proof for one theorem that was shorter than the one in Principia.TheeditorsoftheJournal of Symbolic Logic were less impressed; they rejected a paper coauthored by Newell, Simon, and Logic Theorist. (Russell and Norvig, 17-18)

1956 At IBM, Nathaniel Rochester and his colleagues produced some of the first AI programs. Herbert Gelernter (1959) constructed the Geometry Theorem Prover, which was able to prove theorems that many students of mathematics would find quite tricky. Starting in 1952, Arthur Samuel wrote a series of programs for checkers (draughts) that eventually learned to play at a strong amateur level (Russell and Norvig, 18)

1957 The work of Richard Bellman (1957) formalized a class of sequential decision problems called Markov decision processes, (Russell and Norvig, 10)

1958 John McCarthy moved from Dartmouth to MIT and there made three crucial contributions in one historic year: 1958. In MIT AI Lab Memo No.1, McCarthydefined the high-level language Lisp,whichwastobecomethedominantAIprogramminglanguageforthenext30 years. With Lisp, McCarthy had the tool he needed, but access to scarce and expensive computing resources was also a serious problem. In response, he and others at MIT invented time sharing. Also in 1958, McCarthy published a paper entitled Programs with Common Sense, in which he described the Advice Taker, a hypothetical program that can be seen as the first complete AI system. Like the Logic Theorist and Geometry Theorem Prover, McCarthy’s program was designed to use knowledge to search for solutions to problems. But unlike the others, it was to embody general knowledge of the world. For example, he showed how some simple axioms would enable the program to generate a plan to drive to the airport. The program was also designed to accept new axioms in the normal course of operation, thereby allowing it to achieve competence in new areas without being reprogrammed.TheAdvice Taker thus embodied the central principles of knowledge representation and reasoning: that it is useful to have a formal, explicit representation of the world and its workings and to be able to manipulate that representation with deductive processes. It is remarkable how much of the 1958 paper remains relevant today. (Russell and Norvig, 19)

1958b Heuristic Search- The use of heuristic information in problem solving appears in an early paper by Simon and Newell (1958), but the phrase “heuristic search” and the use of heuristic functions that estimate the distance to the goal came somewhat later (Newell and Ernst, 1965; Lin, 1965). Doran and Michie (1966) conducted extensive experimental studies of heuristic search. Although they analyzed path length and “penetrance” (the ratio of path length to the total number of nodes examined so far), they appear to have ignored the information provided by the path cost g(n).

1958c Early experiments in machine evolution (now called genetic algorithms)(Friedberg, 1958; Friedberg et al.,1959)werebasedontheundoubtedlycorrectbeliefthatby making an appropriate series of small mutations to a machine-code program, one can generate a program with good performance for any particular task. The idea, then, was to try random mutations with a selection process to preserve mutations that seemed useful. Despite thousands of hours of CPU time, almost no progress was demonstrated. Modern genetic algorithms use better representations and have shown more success. (Russell and Norvig, 21)

1959 Dijkstra directed graph search (DAGs)- The two-point shortest-path algorithm of Dijkstra (1959) is the origin of uniform-cost search. These works also introduced the idea of explored and frontier sets (closed and open lists).

1959b Stafford Beer publishes Cybernetics and Management, considered the seminal work in management cybernetics.

1960 Heinz von Foerster and the University of Illinois host a conference entitled 'Principles of Self-organization' - drawing McCulloch, von Bertalanffy, Pask, Beer, Ashby, and many others. Ross Ashby comes to Illinois to work at the BCL (ca 1960 or 1961)

1961 IBM´s 7000 series of mainframe computers are the company´s first to use transistors. At the top of the line was the Model 7030, also known as "Stretch." Nine of the computers, which featured dozens of advanced design innovations, were sold, mainly to national laboratories and major scientific users. A special version, known as HARVEST, was developed for the US National Security Agency (NSA). The knowledge and technologies developed for the Stretch project played a major role in the design, management, and manufacture of the later IBM System/360--the most successful computer family in IBM history.

1962 Atlas A joint project of England's Manchester University, Ferranti Computers, and Plessey, Atlas comes online nine years after Manchester's computer lab begins exploring transistor technology. Atlas was the fastest computer in the world at the time and introduced the concept of "virtual memory," that is, using a disk or drum as an extension of main memory. System control was provided through the Atlas Supervisor, which some consider to be the first true operating system.

1963 In 1963, McCarthy started the AI lab at Stanford. His plan to use logic to build the ultimate Advice Taker was advanced by J. A. Robinson's discovery in 1965 of the resolution method (a complete theorem-proving algorithm for first-order logic; see Chapter 9). Work at Stanford emphasized general-purpose methods for logical reasoning. Applications of logic included Cordell Green's question-answering and planning systems (Green, 1969b) and the Shakey robotics project at the Stanford Research Institute (SRI). (Russell and Norvig, 19)

1964 First major artificial intelligence laboratories established at MIT, Stanford, SRI, and University of Edinburgh

1965 Belief State Problems The idea of transforming partially observable problems into belief-state problems originated with Astrom (1965) for the much more complex case of probabilistic uncertainty. Erdmann and Mason (1988) studied the problem of robotic manipulation without sensors, using a continuous form of belief-state search. The belief-state approach was reinvented in the context of sensorless and partially observablesearch problems by Genesereth and Nourbakhsh (1993). Additional work was done on sensorless problems in the logic-based planning community (Goldman and Boddy, 1996; Smith and Weld, 1998). This work has emphasized concise representations for belief states. Bonet and Geffner (2000) introduced the first effective heuristics for belief-state search; these were refined by Bryce et al. (2006). The incremental approach to belief-state search, in which solutions are constructed incrementally for subsets of states within each belief state, was studied in the planning literature by Kurien et al. (2002); several new incremental algorithms were introduced for nondeterministic, partially observable problems by Russell and Wolfe (2005).

1966 first launch of British Intelligence satellite. [coincidentally UDA is created in N. Ireland same year]

1966b IBM 360 System/360 is a major event in the history of computing. On April 7, IBM announced five models of System/360, spanning a 50-to-1 performance range. At the same press conference, IBM also announced 40 completely new peripherals for the new family. System/360 was aimed at both business and scientific customers and all models could run the same software, largely without modification. IBM’s initial investment of $5 billion was quickly returned as orders for the system climbed to 1,000 per month within two years. At the time IBM released the System/360, the company had just made the transition from discrete transistors to integrated circuits, and its major source of revenue began to move from punched card equipment to electronic computer systems.

1967 Zuse Cellular Automaton Zuse also suggested that the universe itself is running on a cellular automaton or similar computational structure (digital physics); in 1969, he published the book Rechnender Raum (translated into English as Calculating Space). This idea has attracted a lot of attention, since there is no physical evidence against Zuse's thesis. Edward Fredkin (1980s), Jürgen Schmidhuber (1990s), and others have expanded on it. [Perhaps, inspired by the notion that a Machine Intelligence is in operation in the psychological space, others have speculated on this, such as P.K. Dick in 1977]

1969 Minsky and Papert’s book Perceptrons (1969) proved that, although perceptrons (a simple form of neural network) could be shown to learn anything they were capable of representing, they could represent very little. In particular, a two-input perceptron (restricted to be simpler than the form Rosenblatt originally studied) could not be trained to recognize when its two inputs were different. Although their results did not apply to more complex, multilayer networks, research funding for neural-net research soon dwindled to almost nothing. Ironically, the new back-propagation learning algorithms for multilayer networks that were to cause an enormous resurgence in neural-net research in the late 1980s were actually discovered first in 1969 (Bryson and Ho, 1969). (Russell and Norvig, 22)

1969 DENDRAL was powerful because All the relevanttheoretical knowledgeto solve these problemshas been mappedoverfrom its general form in the [spectrum prediction component] (“first principles”) to efficient special forms (“cookbook recipes”). (Feigenbaum et al.,1971) (Russell and Norvig, 23)

1970 The most famous microworld was the blocks world, which consists of a set of solid blocks placed on a tabletop (or more often, a simulation of a tabletop), as shown in Figure 1.4. Atypicaltaskinthisworldistorearrangetheblocksinacertainway,usingarobothand that can pick up one block at a time. The blocks world was home to the vision project of David Huffman (1971), the vision and constraint-propagation work of David Waltz (1975), the learning theory of Patrick Winston (1970), the natural-language-understanding program of Terry Winograd (1972), and the planner of Scott Fahlman (1974). (Russell and Norvig, 20)

**1971- Bidirectional search ** , which was introduced by Pohl (1971), can also be effective in some cases.

1971b Nilsson, STRIPS Stanford Research Institute Problem Solver (STRIPS) new problem solver called STRIPS that attempts to find a sequence of operators in a spcce of world models to transform a given initial world model into a model in which a given goal formula can be proven to be true. STRIPS represents a world n,~del as an arbitrary collection of first-order predicate calculus formulas and is designed to work with .models consisting of large numbers of formulas. It employs a resolution theorem prover to answer questions of particular models and uses means-ends analysis to guide it to the desired goal-satisfying model. This system was an early precursor to GOAP in Game and Simulation AI

1971b Cybersyn Stafford Beer is commissioned by the Allende government in Chile to integrate a management structure for the national economy, and the CyberSyn project is born.

1972- 'A' Search ** The A∗ algorithm, incorporating the current path cost into heuristic search, was developed by Hart, Nilsson, and Raphael (1968), with some later corrections (Hart et al., 1972). Hart developed A as part of the Shakey Robot project at Stanford Research Institute, which also developed early Planning Systems. Hart later developed the first expert system which was used for resource extraction or mining purposes. Peter Hart’s early research at SRI, with Dick Duda, led to the world’s first use of context in optical character recognition and to the development of one of the most widely used algorithms in image analysis. Their book, Pattern Classification and Scene Analysis, is the ninth most-cited reference in the field of computer science. Dechter and Pearl (1985) demonstrated the optimal efficiency of A∗.The original A∗ paper introduced the consistency condition on heuristic functions. The monotone condition was introduced by Pohl (1977) as a simpler replacement, but Pearl (1984) showed that the two were equivalent. Pohl (1977) pioneered the study of the relationship between the error in heuristic functions and the time complexity of A∗. A∗ and other state-space search algorithms are closely related to the branch-and-bound techniques that are widely used in operations research (Lawler and Wood, 1966).

1972b Stafford Beer publishes Brain of the Firm: The Managerial Cybernetics of Organization (1972)

1973 Failure to come to grips with the “combinatorial explosion” was one of the main criticisms of AI contained in the Lighthill report (Lighthill, 1973), which formed the basis for the decision by the British government to end support for AI research in all but two universities. (Oral tradition paints a somewhat different and more colorful picture, with political ambitions and personal animosities whose description is beside the point.). (Russell and Norvig, 22)

1974 Science fiction author John Brunner introduces the notion of an individual or small group affecting an entire society by exploiting networked computer systems in his novel Shockwave Rider [suggestive of automated psyops]

1975 Gordon Pask publishes his massive two-volume work on conversation theory, influential on chatbot development and natural language processing

1976 Cray Supercomputer The fastest machine of its day, The Cray-1's speed comes partly from its shape, a "C," which reduces the length of wires and thus the time signals need to travel across them. High packaging density of integrated circuits and a novel Freon cooling system also contributed to its speed. Each Cray-1 took a full year to assemble and test and cost about $10 million. Typical applications included US national defense work, including the design and simulation of nuclear weapons, and weather forecasting.

1978 Planning and Acting The unpredictability and partial observability of real environments were recognized early on in robotics projects that used planning techniques, including Shakey (Fikes et al., 1972) and FREDDY (Michie, 1974). The problems received more attention after the publication of McDermott’s (1978a) influential article, Planning and Acting

1979 Stafford Beer's The Heart of the Enterprise, outlining his Viable System Model (VSM), is published.

1982 The first successful commercial expert system, R1, began operation at the Digital Equipment Corporation (McDermott, 1982). The program helped configure orders for new computer systems; by 1986, it was saving the company an estimated $40 million a year. By 1988, DEC’s AI group had 40 expert systems deployed, with more on the way. DuPont had 100 in use and 500 in development, saving an estimated $10 million a year. Nearly every major U.S. corporation had its own AI group and was either using or investigating expert systems. (Russell and Norvig, 24)

1986 In the mid-1980s at least four different groups reinvented the back-propagation learning algorithm first found in 1969 by Bryson and Ho. The algorithm was applied to many learning problems in computer science and psychology, and the widespread dissemination of the results in the collection Parallel Distributed Processing (Rumelhart and McClelland, 1986) caused great excitement. (Russell and Norvig, 24)

1987 Connection Machine Daniel Hillis of Thinking Machines Corporation moves artificial intelligence a step forward when he develops the controversial concept of massive parallelism in the Connection Machine CM-1. The machine used up to 65,536 one-bit processors and could complete several billion operations per second. Each processor had its own small memory linked with others through a flexible network that users altered by reprogramming rather than rewiring. The machine´s system of connections and switches let processors broadcast information and requests for help to other processors in a simulation of brain-like associative recall. Using this system, the machine could work faster than any other at the time on a problem that could be parceled out among the many processors.

1988 Judea Pearl's (1988) Probabilistic Reasoning in Intelligent Systems led to a new acceptance of probability and decision theory in AI, following a resurgence of interest epitomized by Peter Cheeseman's (1985) article "In Defense of Probability." The Bayesian network formalism was invented to allow efficient representation of, and rigorous reasoning with, uncertain knowledge. (Russell and Norvig, 24)

1990 Intel Touchstone Reaching 32 gigaflops (32 billion floating point operations per second), Intel's Touchstone Delta has 512 processors operating independently, arranged in a two-dimensional communications "mesh." Caltech researchers used this supercomputer prototype for projects such as real-time processing of satellite images, and for simulating molecular models in AIDS research. It would serve as the model for several other significant multi-processor systems that would be among the fastest in the world.

1992 Genetic Programming Interest in genetic programming was spurred by John Koza's work (Koza, 1992, 1994), but it goes back at least to early experiments with machine code by Friedberg (1958) and with finite-state automata by Fogel et al. (1966). As with genetic algorithms, there is debate about the effectiveness of the technique. Koza et al. (1999) describe experiments in the use of genetic programming to design circuit devices. The field of genetic programming is closely related to genetic algorithms. The principal difference is that the representations that are mutated and combined are programs rather than bit strings. The programs are represented in the form of expression trees; the expressions can be in a standard language such as Lisp or can be specially designed to represent circuits, robot controllers, and so on. Crossover involves splicing together subtrees rather than substrings. This form of mutation guarantees that the offspring are well-formed expressions, which would not be the case if programs were manipulated as strings.

1994 'Vengeful' computer based tracking system deployed by British in N. Ireland. Caister a knowledge based system is used to monitor suspected IRA members, associations, movements, etc. Caister is later replaced by the automated AI system, 'Calshot' relied on machine interpretation rather then human interpretation.

1994b Stafford Beer introduces 'team syntegration' in his book Beyond Dispute: The Invention of Team Syntegrity (1994)

1994c Neuroevolution Neuroevolution, or neuro-evolution, is a form of artificial intelligence that uses evolutionary algorithms to generate artificial neural networks (ANN), parameters, topology and rules.[1] It is most commonly applied in artificial life, general game playing and evolutionary robotics. The main benefit is that neuroevolution can be applied more widely than supervised learning algorithms, which require a syllabus of correct input-output pairs. In contrast, neuroevolution requires only a measure of a network's performance at a task. For example, the outcome of a game (i.e. whether one player won or lost) can be easily measured without providing labeled examples of desired strategies. Neuroevolution can be contrasted with conventional deep learning techniques that use gradient descent on a neural network with a fixed topology.

1997 Deep Blue Deep Blue versus Garry Kasparov was a pair of six-game chess matches between world chess champion Garry Kasparov and an IBM supercomputer called Deep Blue. The first match was played in Philadelphia in 1996 and won by Kasparov. The second was played in New York City in 1997 and won by Deep Blue. The 1997 match was the first defeat of a reigning world chess champion by a computer under tournament conditions.

1998 British Intelligence deploy the AI system 'Mannequin' based on an earlier system 'Effigy' developed for fighting the insurgency in N. Ireland. Later deployed further afield such as in Bosnia.

By 1996, the new culture of directed Intelligence had proliferated like some exotic plant inside a greenhouse in Bedfordshire, new home of the Defence Intelligence and Security |School. The system could run effective surveillance on an entire population and, through the use of psychological warfare (reserved, so far, for use in Bosnia), shape popular perceptions of events to suit a military strategy. It gave enormous power to those in charge of the system in Northern Ireland. (Geraghty, 1998, 132-133)
2000s Despite these successes, some influential founders of AI, including John McCarthy (2007), Marvin Minsky (2007), Nils Nilsson (1995, 2005) and Patrick Winston (Beal and Winston, 2009), have expressed discontent with the progress of AI. They think that AI should put less emphasis on creating ever-improved versions of applications that are good at a specific task, such as driving a car, playing chess, or recognizing speech. Instead, they believe AI should return to its roots of striving for, in Simon’s words, “machines that think, that learn and that create.” They call the effort human-level AI or HLAI; their first symposium was in 2004 (Minsky et al.,2004).Theeffortwillrequireverylargeknowledgebases;Hendleret al. (1995) discuss where these knowledge bases might come from. ArelatedideaisthesubfieldofArtificial General Intelligence or AGI (Goertzel and Pennachin, 2007), which held its first conference and organized the Journal of Artificial General Intelligence in 2008. AGI looks for a universal algorithm for learning and acting in any environment, and has its roots in the work of Ray Solomonoff (1964), one of the attendees of the original 1956 Dartmouth conference. Guaranteeing that what we create is really Friendly AI is also a concern (Yudkowsky, 2008; Omohundro, 2008), one we will return to in Chapter 26. (Russell and Norvig, 27)

2001 RTS Research Academic Interest in Game AI One of the seminal articles on game AI was John Laird and Michael van Lent's article Human-Level AI's Killer Application Interactive Computer Games published in a 2001 issue of AI Magazine. This was a significant article, because it was one of the first publications by AAAI that recognized real-time games as an excellent environment for AI research. It also helped change the mentality of academic researchers from trying to apply existing approaches to games, and instead think about building new and specialized approaches for games. https://towardsdatascience.com/a-history-of-rts-ai-research-72339bcaa3ee

2002 Earth Simulator Developed by the Japanese government to create global climate models, the Earth Simulator is a massively parallel, vector-based system that costs nearly 60 billion yen (roughly $600 million at the time). A consortium of aerospace, energy, and marine science agencies undertook the project, and the system was built by NEC around their SX-6 architecture. To protect it from earthquakes, the building housing it was built using a seismic isolation system that used rubber supports. The Earth Simulator was listed as the fastest supercomputer in the world from 2002 to 2004.

2003 GOAP in Game AI Jeff Orkin, Goal-Oriented Action Planning (aka GOAP, rhymes with soap) refers to a simplfied STRIPS-like planning architecture specifically designed for real-time control of autonomous character behavior in games. I originally implemented GOAP for F.E.A.R. while working at Monolith Productions. This A.I. architecture simultaneously powered Monolith's Condemned: Criminal Origins. (Brian Legge was responsible for the A.I. in Condemned). My GOAP implementation was inspired by conversations within the A.I. Interface Standards Committee's (AIISC) GOAP Working Group, as well as ideas from the Synthetic Characters Group's C4 agent architecture at the MIT Media Lab, and Nils Nilsson's description of STRIPS planning in his AI book.

2009 IBM Roadrunner The Roadrunner is the first computer to reach a sustained performance of 1 petaflop (one thousand trillion floating point operations per second). It used two different microprocessors: an IBM POWER XCell L8i and AMD Opteron. It was used to model the decay of the US nuclear arsenal, analyze financial data, and render 3D medical images in real-time. An offshoot of the POWER XCell8i chip was used as the main processor in the Sony PlayStation 3 game console.

2009b Jaguar Originally a Cray XT3 system, the Jaguar is a massively parallel supercomputer at Oak Ridge National Laboratory, a US science and energy research facility. The system cost more than $100 million to create and ran a variation of the Linux operating system with up to 10 petabytes of storage. The Jaguar was used to study climate science, seismology, and astrophysics applications. It was the fastest computer in the world from November 2009 to June 2010.

2010 Tianhe Supercomputer (China) With a peak speed of over a petaflop (one thousand trillion calculations per second), the Tianhe 1 (translation: Milky Way 1) is developed by the Chinese

National University of Defense Technology using Intel Xeon processors combined with AMD graphic processing units (GPUs). The upgraded and faster Tianhe-1A used Intel Xeon CPUs as well, but switched to nVidia's Tesla GPUs and added more than 2,000 Fei-Tang (SPARC-based) processors. The machines were used by the Chinese Academy of Sciences to run massive solar energy simulations, as well as some of the most complex molecular studies ever undertaken.

2011 Sequoia Built by IBM using their Blue Gene/Q supercomputer architecture, the Sequoia system is the world's fastest supercomputer in 2012. Despite using 98,304 PowerPC chips, Sequoia's relatively low power usage made it unusually efficient. Scientific and defense applications included studies of human electrophysiology, nuclear weapon simulation, human genome mapping, and global climate change

2013 IBM Watson Watson is a question-answering computer system capable of answering questions posed in natural language, developed in IBM's DeepQA project by a research team led by principal investigator David Ferrucci. Watson was named after IBM's first CEO, industrialist Thomas J. Watson. The computer system was initially developed to answer questions on the quiz show Jeopardy! and, in 2011, the Watson computer system competed on Jeopardy! against legendary champions Brad Rutter and Ken Jennings winning the first place prize of $1 million.

2013b AutoML Automated machine learning (AutoML) is the process of automating the end-to-end process of applying machine learning to real-world problems. In a typical machine learning application, practitioners must apply the appropriate data pre-processing, feature engineering, feature extraction, and feature selection methods that make the dataset amenable for machine learning. Following those preprocessing steps, practitioners must then perform algorithm selection and hyperparameter optimization to maximize the predictive performance of their final machine learning model. As many of these steps are often beyond the abilities of non-experts, AutoML was proposed as an artificial intelligence-based solution to the ever-growing challenge of applying machine learning. Automating the end-to-end process of applying machine learning offers the advantages of producing simpler solutions, faster creation of those solutions, and models that often outperform models that were designed by hand.

2014 Generative adversarial networks (GANs) are a class of artificial intelligence algorithms used in unsupervised machine learning, implemented by a system of two neural networks contesting with each other in a zero-sum game framework. They were introduced by Ian Goodfellow et al. in 2014. This technique can generate photographs that look at least superficially authentic to human observers, having many realistic characteristics (though in tests people can tell real from generated in many cases).

2015 OpenAI OpenAI is a non-profit artificial intelligence (AI) research organization that aims to promote and develop friendly AI in such a way as to benefit humanity as a whole. Founded in late 2015, the San Francisco-based organization aims to “freely collaborate” with other institutions and researchers by making its patents and research open to the public. The founders (notably Elon Musk and Sam Altman) are motivated in part by concerns about existential risk from artificial general intelligence.

2015b Tensorflow TensorFlow is an open-source software library for dataflow programming across a range of tasks. It is a symbolic math library, and is also used for machine learning applications such as neural networks.

2016 AlphaGo AlphaGo versus Lee Sedol, also known as the Google DeepMind Challenge Match, was a five-game Go match between 18-time world champion Lee Sedol and AlphaGo, a computer Go program developed by Google DeepMind, played in Seoul, South Korea between 9 and 15 March 2016. AlphaGo won all but the fourth game; all games were won by resignation.The match has been compared with the historic chess match between Deep Blue and Garry Kasparov in 1997.

2019 DeepMind Real Time Strategy AI Deepmind releases its development environment to run AI in the Real Time Strategy game, Starcraft II.

Notes:

[1] https://www.gov.uk/government/news/100000-for-research-into-automation-and-machine-intelligence (accessed 11/26/18)

[2] Rumsfeld shuts down Pentagon Influence Ops and Countermeasures, https://m.govexec.com/defense/2002/02/pentagon-shuts-down-controversial-information-office/11149/ (accessed 3/13/19)

[3] https://www.theregister.co.uk/2013/12/31/nsa_weapons_catalogue_promises_pwnage_at_the_speed_of_light (accessed 6/11/19)

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