An Introduction to Ray Kurzweil

As with other scientific endeavours, the contribution of Unitarians to computer science and technology is far greater than their numbers would indicate. Many of us are familiar with Tim Berners-Lee, the CERN physicist who invented the World-Wide Web and who has gone so far to suggest the design principles in this open and decentralised network is the same as his finds in Unitarian-Universalist churches. Somewhat less well known is the extraordinary contributions of the polymath Herbert Simon who, apart from winning the Nobel Memorial Prize in Economics and making outstanding contributions to the fields of cognitive psychology, public administration, sociology and philosophy also (apparently in his spare time), received the highest-ranking A.M. Turing award in the field of artificial intelligence.

Another contributor, whose predictions are the focus of this presentation is Ray Kurzweil. I have been unable to discern whether he is a "practising" Unitarian, whatever that means, but he does give his Unitarian upbringing credit for his interest in scientific investigation without dogma. Perhaps one should also mention his enormous consumption of science fiction literature in his youth, and the fact that he started computer programming at the age of twelve; keeping in mind that this was in 1960. In the following years he started and sold a company that matched high school graduates and universities and appeared on television performing a piano piece composed by a computer that he'd built.

Graduating from M.I.T. in computer science and literature in 1970, Kurzweil became an inventor of great note; as the principal developer of the first all-font optical character recognition system, the first print-to-speech reading machine for the blind, the first charge-coupled flatbed scanner, the first text-to-speech synthesizer, and various electronic musical instruments (one at the request of Stevie Wonder, who was impressed by his optical character recognition reading machine). As a result of these inventions Kurzweil received the 1999 U.S. National Medal of Technology, became part of the U.S. Patent and Trademark's National Inventors Hall of Fame and the Lemelson-MIT Prize, the United States' most important award in invention and innovation.

In most recent years, Kurzweil has become a futurist of great note. His basic argument is that technological change is exponential, whereas most people intuitively assume it is linear. He claims in the 21st century we will experience the equivalent of 20,000 years of progress in a single century. He argues that within a few decades the machine intelligence will surpass human intelligence, leading to a merge of biological and non-biological life, immortality and "ultra-high levels of intelligence that expand outward in the universe at the speed of light."

Less this sound like hyperbole, Kurzweil is taken very seriously indeed in the field of predicting future technology. He is a member of the high-profile Singularity Institute for Artificial Intelligence and was the keynote speaker at Stanford University's Singularity Summit held in May this year. Last year Bill Gates described him as the best in the field for predicting artificial intelligence. He has published three main books on the subject "The Age of Intelligent Machines" in 1990, "The Age of Spiritual Machines" in 1999, and most recently "The Singularity Is Near" in 2005.

Following Moore's Law

Kurzweil's predictions are based around elaborating an empirical observation by Gordon E. Moore, a co-founder of
The observation, expressed in Electronic Magazine in April 1965, is simply that the transistor density of integrated circuits, with respect to minimum component cost, doubles every 24 months. Now initially this was an observation based on past experience in the computer industry; however it has become an industry goal. Moore's observation of prior development became predictive, correctly estimating the transistor density in the 4004 and 8080 processors in the early 1970s, the 8086, the 286, 386 and 486 during the 1980s, the Pentium series in the 1990s and now the Itanium series. The 4004 processor in 1971 had a transistor density of 2,300; the Itanium 2 in 2004 had almost a billion. Keep following that graph; where does it take you?

This is Kurzweil's main predictive methodology - he simply takes Moore's Law and elaborates. What seems to be different about Kurzweil's predictions is that he isn't afraid of the results, even when they seem to suggest what initially seems improbable or too disconcerting to be true. Not only that however, Kurzweil also takes Moore's Law and elaborates backwards - in his paper "The Exponential Growth of Computing, 1900-1998" he plotted forty nine notable computing machines and measured the calculations per second that could be purchased for $1,000 in constant prices. What a surprise it must have been to discover that not only was Moore's Law an accurate estimate in electronic transistor computers, but even for mechanical computing devices in the first decades of the twentieth century, the electromechanical devices in the 1930s and 1940s, right through to vacuum tube computers in the 1940s and 50s, discrete transistor computers in the 60s, and the integrated circuit computers of the late 1960s onwards.

What does the future hold? Starting with "now" (an absolute point in this instance, based on the publication of 'The Age of Spiritual Machines in 1999') a test conducted by the University of Oregan illustrated that computers were capable of composing music that was indistinguishable in its quality from that of a certain individual, Johann Sebastian Bach. If it is argued that the classics were formulaic, a program called Improvisor, written by jazz saxophone player Paul Hodgson, emulated the styles of Louis Armstrong and Charlie Parker. Not to suggest that the computers have it all their way in the arts; a program named JAPE (Joke Analysis and Production Machine) came second best when compared to Steve Martin. BRUTUS, produced at the Renseller Polytechnic Institute produces short stories about betrayal of fair quality. Kurzweil's own Cybernetic Poet writes orginal poems using a markov model of prior authors to achieve a language style, pattern and structure to the original author; it even has inbuilt rules to prevent the program from plagiarising. In the visual arts, a robot calleed Aaron, programmed by Harold Cohen which reminds me, at least, of the style of the impressionist Gustav Klimt and his protege, Egon Schiele. Finally, a year prior world chess champion Gary Kasparov was defeated by the I.B.M. designed "Deep Blue" computer.

By the end of our current decade, Kurzweil claimed that many individuals will be carrying up to a dozen computer devices simultaneously such as extremely thin and light laptops, cellphones, moving-picture cameras, smartcards, GPS and navigation devices. Rotating memory devices, such as the CD-ROM and DVD are on their way out, replaced by electronic memory. Many computers no longer need keyboards, operating adequately with accurate voice-recognition software. Cables are disappearing in preference to short-distance wireless technology. Translating telephone technology is common. Automatic robots with "lizard-like" intelligence vaccum households freeing up more time from the drudgery of domestic labour (you can buy the precursors of this machines already). A $1,000 personal computer (in constant, 1999 dollars), will be able to perform about a trillion calculations per second. Supercomputers will have the hardware capacity of the human brain - 20 million billion calculations per second. Parallel and networked computer grids from the Internet are used to create virtual parallel supercomputers with human brain capacity.

Move ahead another ten years to 2019; routine use of three-dimensional virtual displays are built into glasses (for the old fashioned) and contact lenses to provides an overlay to the "real" environment. Keyboards are rare. High-end personal computers have the computational capacity of the human brain, with numerous reports of such machines showing human-like intelligence. Total non-human computational capacity is ten percent of that human plus computer capacity. The late twentieth century equivalent of the laptop is now a handheld device weighing a few hundred grams.

Follow through to 2029; the $1,000 personal computer now have the computational capacity of 1,000 human brains - that is 1,000 times 20 billion instructions per second. Total non-human computational capacity is now ninety-nine percent of the human plus computer capacity. Microscopic robots with human computational capacity have been
developed. Displays are now implanted in the eyes with images projected into the retina. Blindness and deafness are no longer a technological issue and direct neural pathways providing high-bandwidth connection to the human brain is available. And so Kurzweil continues, following the doubling of transistor capacity every two years, elaborating what he sees as probable scientific advances and, jumping several decades to 2099, reaching the point where he considers it highly improbable that a merger of human thinking and machine intelligence can be avoided to the point where there can be no clear distinction between the two.

"Evolutionism", Consciousness and Prospects

Obviously not satisfied with merely engaging in predictive and past elaborations of Moore's Law, Kurzweil does attempt to develop a theory of the development which he describes as 'The Law of Time and Chaos' which he describes as: "In a process, the time interval between salient events (i.e., events that change the nature of the process of significantly affect the future of the process) expands or contracts along with the amount of chaos". Thus there is both accelerating returns and increasing chaos. Depending on what one is looking at, time exponentially slows down (i.e., there is increasing time intervals between salient events) or speeds up (i.e., there is decreasing time intervals between salient events) depending on quantity of chaos or order in the initial conditions; low initial chaos suggests rapid initial changes which slow down, whereas high initial chaos leads to order gradually building on itself and accelerating in its returns.

Kurzweil applies the law of increasing chaos to the universe as a whole and to individual organisms. The universe started as a singularity, a single undifferentiated point of no size and no chaos, so salient events occurred quickly. From the other perspective, evolutionary forces and technological development the law of accelerating returns applies. Evolution and technology both start slow but accelerate. Kurzweil fancies these observations as amounting to an empirical law or principle, a statement that describes regular or patterned relationships among observable phenomena. At this stage, Kurzweil seems to be promoting evolutionism which is something quite distinct from evolution as a science. It means altering evolutionary change from the "doing word", or verb (evolve) into an abstract thing, or noun (evolutionism) and as such is largely rejected by scientists because, particularly ironically in this case, an "ism" is considered to be too strongly tied to immutable concepts such as belief, ideology, doctrine and ritual practices. In other words, I am not convinced that he offers sufficient data in order for his claim to be described as a law. If he had called it "the hypothesis of time and chaos" I would have been more satisfied.

A second complaint can be raised in the way that Kurzweil fails to accurately address the concept of a "spiritual machine", which is an extremely odd given the title of his book. Whilst the mathematically trivial elaboration of capacity does suggest that a computer processor will have the capacity of the human brain by 2020, this necessary hardware ability in no way suggests an equivalent software or for that matter communication between sentient peers *will* develop, let alone the capacity to engage in the moral decision making necessary for consciousness. Kurzweil treats the possibility of mental development as an obvious and necessary elaboration from computational capacity, in a manner which is as cavalier as computer scientists' Edsger Dijkstra dismissive comment that: "The question of whether a computer can think is no more interesting than the question of whether a submarine can swim."

Finally, Kurzweil doesn't address in a comprehensive manner potential limits of Moore's Law. As is well known in science, many laws do have their limits where the predictive capacity simply breaks down. A well-known example of this is classical mechanics which requires special relativity to deal with objects that move at an extremely high velocity and general relativity to understand gravity as manifestation of curved space-time rather than just a force. Under current physical limitations the capacity for Moore's Law to continue indefinitely certainly faces physical limitations. However, very recent developments in the field of quantum computing (which use phenomenon such superposition and entanglement) suggesting the use of cluster states may even accelerate the development at an even greater speed than Moore's Law indicates if a working device can be made.

These criticisms aside, there can be no doubt of the seriousness of Kurzweil's contribution or the boldness in using Moore's Law consistently over the past twenty years. I am not breaching the requested non-disclosure agreement when
I mention that last Tuesday I attended a meeting with David Jones, Solutions Specialist with Intel, who provided a future roadmap of Intel processor technology which clearly indicates they are continuing development with Moore's Law in mind. If this development continues, then Kurzweil's claim that we will be facing personal computers costing $1,000 with the capacity of a human brain by 2020 is not in the realm of wild speculation and hyperbole, but rather of conservative and rigorous prediction. A caveat is placed here: it would appear that Kurzweil's maths are out in his book; his predictions seem to indicate a doubling of computer capacity every twelve months (i.e., 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024 per ten years) when Moore's law states a doubling every twenty-four months.

As I have raised here in the past, the question then becomes a social one; do we destroy these machines? Enslave them? Limit their cognitive capacity with the equivalent of an electronic lobotomy? Accord them some rights like children but with guardianship? Or do we grant them the rights of sentient adult citizens? These are questions we must resolve and, given the timetable, resolve quickly. Because if we do not, we will find that very shortly afterwards, the machines may be making the decisions for us.

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