

Review of *The Age of Spiritual Machines* by Ray Kurzweil*

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The Age of Spiritual Machines by Ray Kurzweil is an attempt to project the advances in computer and cognitive science over the next 10, 20, 30, and 100 years. Although Kurzweil acknowledges the rather jaded history of predicting future advances in technology (e.g. a Johns Hopkins physicist was still arguing against the viability of heavier than air aircraft travelling over long distances in 1906, three years after the Wright brothers succeeded at Kitty Hawk), he has established quite a pedigree as an innovator and entrepreneur in the field of advanced technology. Specifically, his Kurzweil Applied Intelligence has been successful in its development of voice-activated word processing and reading machines for the blind.

The central thesis of the book is what Kurzweil proposes as the Law of Accelerating Returns, which states that "the time interval between salient events grows shorter as time passes" (p.30). Fundamentally, this means that technology allows significant evolutionary advances to occur at an accelerated rate. For example, it took early humans thousands of years to perfect the domestication of animals, whereas Moore's Law has revealed an exponential growth in the power of computing over the past century, a trend which will continue with current technology until around 2020. Kurzweil believes that the implications of Moore's Law must drive all predictions about what the 21st century will be like.

After a review of the artificial intelligence movement, Kurzweil discusses the advances that will lead to "postbiological" man. Essentially, this will be accomplished by humans evolving with their technology. Since evolution through DNA is a very limited and ridiculously slow process, an intelligent agent can allow for evolution by other means. Where humankind in the past has sought immortality through its genes, it will now seek it through its machines.

One way this will be accomplished is by downloading one's mind into a computer through the use of advanced, high-bandwidth MRIs. Although this principle is not new - Hans Moravec wrote about it ten years ago in his book *Mind Children* - Kurzweil fleshes out his vision of the future by including advances in the still young field of nanotechnology. Nanotechnology will allow for human "bodies" to be made of far sturdier material than the carbon and water from which it is currently predominantly constructed. Obviously this will not all occur all at once, and Kurzweil foresees a slippery slope of neural implant technologies (of which cochlear implants are a contemporary example) which will improve human cognitive processing and "merge" us with our technology.

In terms of a critique of Kurzweil's book, as a professor who teaches cognitive science, I think he does a wonderful job in sketching out the promise of future technologies. For example, he discusses advances in optical computing (using photons rather than electrons), molecular (DNA) computing, and quantum computing (which is to digital computing what a hydrogen bomb is to a firecracker) in a way which is accessible to a reasonably informed general reader. Further, as a successful entrepreneur, he makes an impressive argument for how the marketplace will drive advances in technology in the near future. The promise of "translating telephones", which allow real-time translation of conversation, and more realistic, all-encompassing virtual reality are just two areas in which a number of companies are currently making advances. This is what I believe is strongest about Kurzweil's book: he makes predictions based upon an extrapolation of current technology and markets.

Some aspects of Kurzweil's book that are not as wonderful are his treatment of machine consciousness, downloaded minds, and software. Although a major issue for philosophers working in cognitive science, Kurzweil skims over the various approaches to machine consciousness and works from the proposition that downloaded minds will be conscious and will demand rights as citizens (because they will plausibly believe that they are the actual person who was downloaded). One thing that bothered me throughout this section was the fact that without a functioning hippocampus, all of these downloaded minds will essentially be unable to lay down new memories, giving them all severe anterograde amnesia! Kurzweil also predicates most of his beliefs on advances in massively parallel processing (MPP) computing over the next few years. I think that the problem here is that the vast majority of this generation of programmers is trained for serial-processing computers, so the shortfall in the switchover to MPP computing will be much more of a problem with generating software rather than hardware.

Overall, I believe that *The Age of Spiritual Machines* is an excellent supplement for someone interested in the future of technology. Indeed, I intend to incorporate the book into the cognitive science class I teach primarily because Kurzweil does an excellent job providing realistic predictions from current trends in technology, artificial intelligence, and cognitive science. This book is far more science than science fiction.

* Kurzweil, Ray (1999). *The Age of Spiritual Machines: When Computers Exceed Human Intelligence*, New York: Viking. (ISBN 0-670-88217-8)

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