BOOKS & ARTS

When computers take over

What if the current exponential increase in information-processing power could continue unabated?

The Singularity is Near: When Humans Transcend Biology
by Ray Kurzweil
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I recall reading a statistic from my student days to the effect that if physics journals continued to grow at the same rate, then by the end of the twentieth century, library bookshelves would have to expand at the speed of light to accommodate them. This absurdity is an illustration of what one might call the exponential-growth fallacy. Examples drawn from technology are legion. The Moon landing in 1969 was widely touted as the first small step on an escalator to the stars, with Arthur C. Clarke predicting huge lunar bases and a Jupiter expedition by 2001. The rapid uptake of robotics in the manufacturing industry after the Second World War led to predictions of cyborg servants and android armies within a few decades. In the event, these technologies became stuck or even slid backwards.

The key point about exponential growth is that it never lasts. The conditions for runaway expansion are always peculiar and temporary (with the possible exception of the expanding Universe). But this sobering fact has not stopped futurologist and author Ray Kurzweil from invoking exponential, and even hyper-exponential, growth in the realm of information processing. There is no doubt that the rise and rise in computing power has dazzled us all. Gordon Moore, co-founder of Intel, famously predicted about 30 years ago that computer processing power would double every 18 months, and so far his prediction has come true. Kurzweil invokes 'Moore's law' as if it were a law of nature, and extrapolates from it into a not-so-distant future in which burgeoning information processing transforms and transcends life as we know it. He refers to his culmination point, at which familiar human culture is obliterated by a tidal wave of unrestrained computation, as the 'singularity'. The word is loosely analogous to the mathematician's singularity, at which the rate of change of a quantity becomes infinite.

If the sky's the limit when it comes to processing information, it isn't hard to think of startling applications. Tired of deciding what to eat? Let a swarm of sensors patrol your innards and order the right nutrients automatically through your personal wireless network. Concerned about dying? Then achieve immortality by flooding your body with smart nanobots to monitor and maintain your failing biosystems. Or better yet, 'upload' your mind into cyberspace, where you can have more fun, untrammelled by a material body.

RONALD GRANT ARCHIVE

A giant leap: will increased computing power allow machines to take over, as in films like *The Matrix*?

The question is not whether these wild ideas should be taken seriously, but whether the premise on which they are founded — unbounded exponential growth in information-processing power — somehow escapes the strictures that eventually curtail all other cases of headlong expansion. One obvious reason why accelerating growth in computation might stall concerns the availability of resources. What happens when the Earth's entire surface has been converted into a gigantic information-garnering, bit-churning system? Kurzweil is ready with the answer: we move into space. ("We" here is a generic term. The sentient beings that will soon wrest control from humans, and which are destined to supervise the cosmic phase of development, will be some sort of superdupercomputers.) But by the remorseless logic of exponentiation, pretty soon thereafter the resource-hungry system will find itself spreading across the galaxy so fast it hits the speed of light. Like the physics journals on the bookshelves, exponential growth stops here. Or does it? Kurzweil toys with the idea that the speed-of-light barrier is there to be broken, which opens up the giddy prospect of the entire Universe being taken over by an omniscient superintelligence within just a few centuries.

Such exhilarating speculation is great fun to read, but needs to be taken with a huge dose of salt. The biggest lacuna in Kurzweil's argument is the tacit assumption that if we liberate enough information-processing power, then nature will succumb to all our desires. Control the Solar System? Just double the bit rate a few times and it will be within our grasp. Create life? Simulate consciousness? It all boils down to making a cheaper, faster processor. Unfortunately, the laws of physics may well dictate otherwise. Technology can harness physical laws but it can't bend them. No amount of information processing will suspend the law of gravity or create perpetual-motion machines.

When it comes to discussing the physics that underpins his predictions, Kurzweil is apt to be vague or even misinformed. The stupendous power demands implied by the rampant growth in computation and nanotechnology will be met by a concomitant 'law of accelerating returns' in power-generation technologies, such as fuel cells and high-temperature superconductors. And if these run into technical