

The Dawn of the Age of Artificial Intelligence

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Reuters

The advances we've seen in the past few years—cars that drive themselves, useful humanoid robots, speech recognition and synthesis systems, 3D printers, *Jeopardy!*-champion computers—are not the crowning achievements of the computer era. They're the warm-up acts. As we move deeper into the second machine age we'll see more and more such wonders, and they'll become more and more impressive.

How can we be so sure? Because the exponential, digital, and recombinant powers of the second machine age have made it possible for humanity to create two of the most important one-time events in our history: the emergence of real, useful artificial intelligence (AI) and the connection of most of the people on the planet via a common digital network.

Either of these advances alone would fundamentally change our growth prospects. When combined, they're more important than anything since the Industrial Revolution, which forever transformed how physical work was done.

Thinking Machines, Available now

Digital machines have escaped their narrow confines and started to demonstrate broad abilities in pattern recognition, complex communication, and other domains that used to be exclusively human. We've recently seen great progress in natural language processing, machine learning (the ability of a computer to automatically refine its methods and improve its results as it gets more data), computer vision, simultaneous localization and mapping, and many other areas.

We're going to see artificial intelligence do more and more, and as this happens costs will go down, outcomes will improve, and our lives will get better. Soon countless pieces of AI will be working on our behalf, often in the background. They'll help us in areas ranging from trivial to substantive to life

changing. Trivial uses of AI include recognizing our friends' faces in photos and recommending products. More substantive ones include automatically driving cars on the road, guiding robots in warehouses, and better matching jobs and job seekers. But these remarkable advances pale against the life-changing potential of artificial intelligence.

To take just one recent example, innovators at the Israeli company OrCam have combined a small but powerful computer, digital sensors, and excellent algorithms to give key aspects of sight to the visually impaired (a population numbering more than twenty million in the United States alone). A user of the OrCam system, which was introduced in 2013, clips onto her glasses a combination of a tiny digital camera and speaker that works by conducting sound waves through the bones of the head. If she points her finger at a source of text such as a billboard, package of food, or newspaper article, the computer immediately analyzes the images the camera sends to it, then reads the text to her via the speaker.

Reading text 'in the wild'—in a variety of fonts, sizes, surfaces, and lighting conditions—has historically been yet another area where humans outpaced even the most advanced hardware and software. OrCam and similar innovations show that this is no longer the case, and that here again technology is racing ahead. As it does, it will help millions of people lead fuller lives. The OrCam costs about \$2,500—the price of a good hearing aid—and is certain to become cheaper over time.

Digital technologies are also restoring hearing to the deaf via cochlear implants and will probably bring sight back to the fully blind; the FDA recently approved a first-generation retinal implant. AI's benefits extend even to quadriplegics, since wheelchairs can now be controlled by thoughts. Considered objectively, these advances are something close to miracles—and they're still in their infancy.

Billions of Innovators, Coming Soon

In addition to powerful and useful AI, the other recent development that promises to further accelerate the second machine age is the digital interconnection of the planet's people. There is no better resource for improving the world and bettering the state of humanity than the world's humans—all 7.1 billion of us. Our good ideas and innovations will address the challenges that arise, improve the quality of our lives, allow us to live more lightly on the planet, and help us take better care of one another. It is a remarkable and unmistakable fact that, with the exception of climate change, virtually all environmental, social, and individual indicators of health have improved over time, even as human population has increased.

This improvement is not a lucky coincidence; it is cause and effect. Things have gotten better *because* there are more people, who in total have more good ideas that improve our overall lot. The economist Julian Simon was one of the first to make this optimistic argument, and he advanced it repeatedly and forcefully throughout his career. He wrote, "It is your mind that matters economically, as much or more than your mouth or hands. In the long run, the most important economic effect of population size and growth is the contribution of additional people to our stock of useful knowledge. And this contribution is large enough in the long run to overcome all the costs of population growth."

We do have one quibble with Simon, however. He wrote that, “The main fuel to speed the world’s progress is our stock of knowledge, and the brake is our lack of imagination.” We agree about the fuel but disagree about the brake. The main impediment to progress has been that, until quite recently, a sizable portion of the world’s people had no effective way to access the world’s stock of knowledge or to add to it.

In the industrialized West we have long been accustomed to having libraries, telephones, and computers at our disposal, but these have been unimaginable luxuries to the people of the developing world. That situation is rapidly changing. In 2000, for example, there were approximately seven hundred million mobile phone subscriptions in the world, fewer than 30 percent of which were in developing countries.

By 2012 there were more than six billion subscriptions, over 75 percent of which were in the developing world. The World Bank estimates that three-quarters of the people on the planet now have access to a mobile phone, and that in some countries mobile telephony is more widespread than electricity or clean water.

The first mobile phones bought and sold in the developing world were capable of little more than voice calls and text messages, yet even these simple devices could make a significant difference. Between 1997 and 2001 the economist Robert Jensen studied a set of coastal villages in Kerala, India, where fishing was the main industry.¹⁰ Jensen gathered data both before and after mobile phone service was introduced, and the changes he documented are remarkable. Fish prices stabilized immediately after phones were introduced, and even though these prices dropped on average, fishermen’s profits actually increased because they were able to eliminate the waste that occurred when they took their fish to markets that already had enough supply for the day. The overall economic well-being of both buyers and sellers improved, and Jensen was able to tie these gains directly to the phones themselves.

Now, of course, even the most basic phones sold in the developing world are more powerful than the ones used by Kerala’s fisherman over a decade ago. And cheap mobile devices keep improving. Technology analysis firm IDC forecasts that smartphones will outsell feature phones in the near future, and will make up about two-thirds of all sales by 2017.

This shift is due to continued simultaneous performance improvements and cost declines in both mobile phone devices and networks, and it has an important consequence: it will bring billions of people into the community of potential knowledge creators, problem solvers, and innovators.

'Infinite Computing' and Beyond

Today, people with connected smartphones or tablets anywhere in the world have access to many (if not most) of the same communication resources and information that we do while sitting in our offices at MIT. They can search the Web and browse Wikipedia. They can follow online courses, some of them taught by the best in the academic world. They can share their insights on blogs, Facebook, Twitter, and many other services, most of which are free. They can even conduct sophisticated data analyses using cloud resources such as Amazon Web Services and R, an open source application for statistics.¹³ In short, they can be full contributors in the work of innovation and knowledge creation, taking advantage of what Autodesk CEO Carl Bass calls “infinite computing.”

Until quite recently rapid communication, information acquisition, and knowledge sharing, especially over long distances, were essentially limited to the planet's elite. Now they're much more democratic and egalitarian, and getting more so all the time. The journalist A. J. Liebling famously remarked that, "Freedom of the press is limited to those who own one." It is no exaggeration to say that billions of people will soon have a printing press, reference library, school, and computer all at their fingertips.

We believe that this development will boost human progress. We can't predict exactly what new insights, products, and solutions will arrive in the coming years, but we are fully confident that they'll be impressive. The second machine age will be characterized by countless instances of machine intelligence and billions of interconnected brains working together to better understand and improve our world. It will make mockery out of all that came before.

This post is adapted from Erik Brynjolfsson and Andrew McAfee's *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*.

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