

March of machines to rule the world

Digital technology is advancing so fast that computers could soon solve every problem, writes **James Dean**

The secrets of human life are quietly being transferred to the digital brains of machines. Every second, they learn more about our foibles by digesting the vast amounts of personal information we put online.

Social networks, smartphone apps and countless internet-connected services are helping machines to learn about us so quickly that by 2025 we will be able to talk to artificially intelligent personal assistants as if they were humans.

The evolution is being catalysed by a process known as "machine learning", whereby a computer is fed huge amounts of data from which it is able to draw its own meanings. Machine learning will be central to spurring advances in robotics for hospitals, home care and transport over the next decade, according to experts polled by *The Times*.

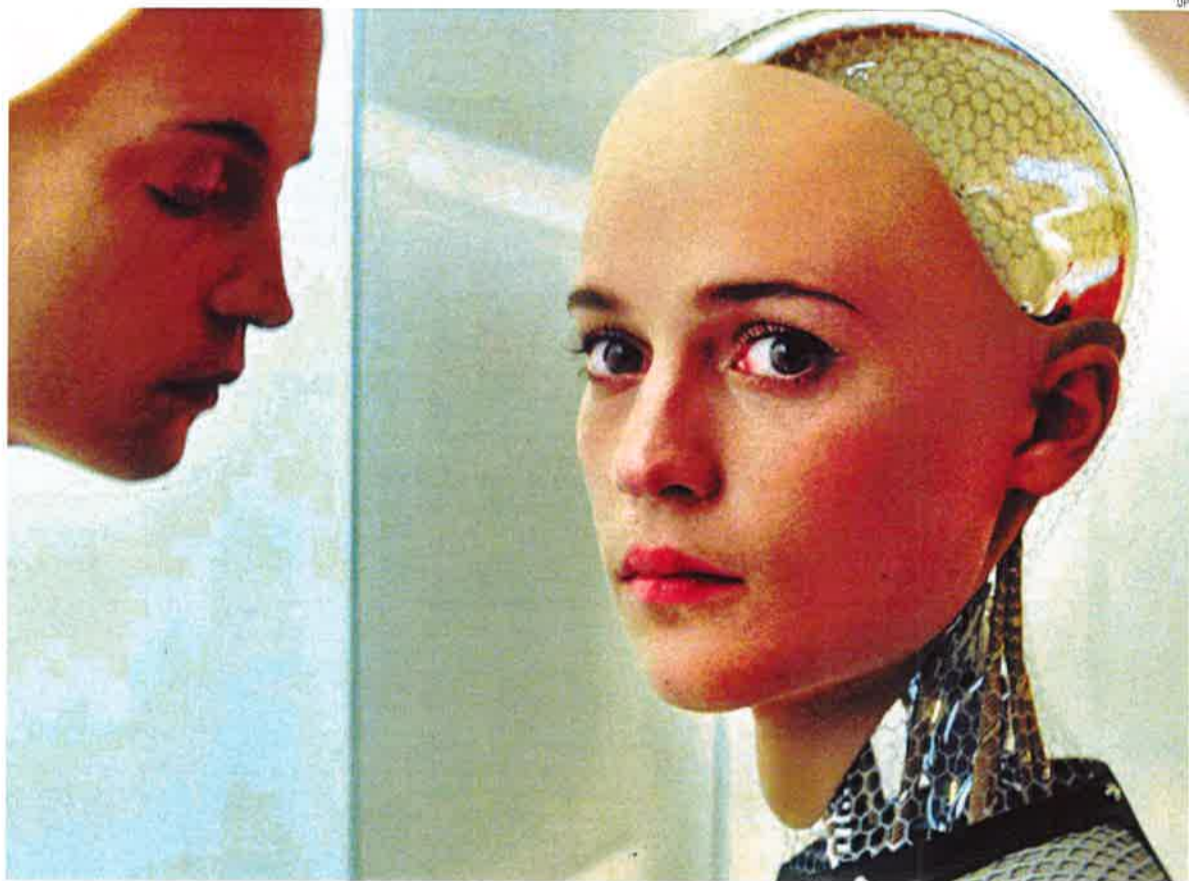
Such is the perceived importance of the field that last month the Royal Society created a machine-learning working group, comprising several leading thinkers, to explore its likely benefits and pitfalls.

"Twenty years ago, a computer programmer would have to work out a problem and then type out the code that allowed the computer to solve it," said Peter Donnelly, chairman of the working group and professor of statistical science at the University of Oxford. "With machine learning, they programme the steps that allow the computer to learn the solution to the problem. You can't programme a computer in a car and tell it what to do in every circumstance, because you can't possibly conceive of them all."

Professor Donnelly said that the expansion of the internet and the increased power of computers had revolutionised the field since the first forays were made about 20 years ago, and that ten years from now we would be using and relying on complex apps beyond our current imagination.

The power of machine learning is expected to accelerate rapidly in the coming years as computers digest more information about us from the internet, and the algorithms that power them become more advanced. This will help to create powerful virtual assistants that are able to pre-empt the needs of their human masters.

Zoubin Ghahramani, a professor of information engineering at the University of Cambridge, said: "A lot of



Alicia Vikander in last year's *Ex Machina*, a thriller about artificial intelligence. We may be conversing with machines by 2025

these algorithms are already affecting our lives, but most people don't think about the fact that they are all forms of robot intelligence.

"Every aspect of your activity on Facebook is controlled by this intelligence — what appears in your news feed, what adverts it shows you."

Professor Ghahramani predicted that smartphone assistants would be "superintelligent" in ten years' time. "We can already talk to them in a primitive way but we can't have conversations with them," he said. "By 2025 we will, and they'll be much more natural. If you were to allow it, the assistant would know things about you — your priorities, what it should remind you about, clever recommendations it could make."

There will be limits to the progress, however. Paul Newman, principal investigator at the University of Oxford's mobile robotics group, said: "We're not going to have something that helps us around the house. I don't see the generalist robot coming for a long time."

"Intelligent robots will first appear in places where they have a clearly defined role — that's why there are already so many robots on car production lines. We have evolved extraordinary capabilities as humans, but look at how long it took us to evolve. I think the idea of a humanoid robot is jaundiced by science fiction, and at the moment, it is just that."

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How technology is transforming our lives

Vehicles

A single digital ticket will buy an automated journey across land, sea and air, taking passengers from driverless private taxis to autonomous trains, buses and other public transport systems.

Fully autonomous vehicles will begin to cut road accidents, and private car ownership will plummet.

Phil Williams, a government robotics adviser, said that the money currently being poured into driverless car programmes across the world — such as those run by Google, Apple and Uber — suggested that driverless cars would be a reality in the next decade. "Technically, it's perfectly possible —

there's nothing holding us back," he said. "We're actually very close already. It's more about getting the public outside and fine-tuning road rules. People are worried about what happens when the first accident comes."

Zoubin Ghahramani, a professor at the University of Cambridge, predicted that commuting to work in an autonomous vehicle service would be common by 2025.

"One thing that will certainly change is the sense of what's safe on a public road," he said. "As vehicles get more sensors and begin to talk to one another, being in an autonomous vehicle will become safer. Cars driven by humans will become the

weak link. Safety needs to improve, the cars need to be tested in real conditions and the rules and regulations need to change significantly."

The Department for Transport estimates that road accidents cost the economy £15 billion a year in emergency services, road repairs, congestion and days taken off work. It is hoped that autonomous vehicles' computer "brains" will be linked together, helping to avert accidents caused by human error.

Drones

Medical supplies will be delivered by drone as a first response to emergencies in remote areas. In urban areas, light goods will be dropped off by delivery

drone within minutes of being bought online.

Amazon, the online retailer, is developing a fleet of drones with the aim of delivering books, gadgets and other consumables to customers once air regulations allow. Google has experimented with package drops in the Australian outback.

Hospitals

Robot assistants will increase surgeons' ability to carry out precision operations. Robot-controlled medical tools will operate on delicate tissue with a light touch beyond the capability of a human. As they watch surgeons

carry out operations, the machines will learn how to do them better, and guide the human's hand accordingly.

Robots that can be swallowed will perform precision operations inside patients, finding their way to the right part of the body and releasing drugs or carrying out simple surgery. Automated porters will transport patients

between wards and deliver their meals, as robot cleaners work to combat infection.

Home care

As the western population ages, companion robots for the elderly will become normal.

They will alert an elderly relative's family if they fall or if the person in their care is acting out of character.

They might be able to do basic household tasks, if not washing the dishes or doing the laundry. Children will grow up with robot toys without thinking they are strange, just as children today are growing up with smartphones.



Japan's answer to Eric and Ernie brings sunshine to the elderly

Richard Lloyd Parry Tokyo

At the Shintomi care home, 40 elderly people gather in the main hall to watch a comedy double act. Palro, the little straight man, has just led everyone in a dance and Pepper, the taller funny guy, is making old ladies cackle by trying, and failing, to guess their ages.

They are no Morecambe and Wise and, when they pipe up with an old Japanese folk song, some members of the audience look unimpressed — but let's make allowances. Palro and Pepper are humanoid robots using artificial intelligence to soothe, stimulate and entertain the elderly.

Indeed, Palro and Pepper are not the only electronic members of staff at the



Experts in Japan say that dementia patients find it easier to talk to robots

home. Since embarking two years ago on a subsidised experimental programme, it has acquired 18 robots, with names such as LR-2, Action Glove and Exo-Muscle. As well as helping patients

to walk and monitoring their health, they ease the burden on staff.

The robotic revolution has happened because of the convergence of two forces: robot technology and human ageing. By 2050, 27 per cent of the UK population is expected to be 65 or older; in Japan, with a shrinking population, the proportion will be 36.4 per cent.

A year ago the Japanese government unveiled its "new strategy for robots", which aims to quadruple the size of the industry by 2020. Few sectors offer greater opportunity than that of elderly care. There is the Honda Walking Assist Device, a lightweight apparatus of belt and leg braces buckled to a stroke patient who otherwise would hobble awkwardly with a stick. With the Honda

strapped on to her like an exo-skeleton, measuring her own exertions and compensating with its own movements, she manages a steady walk.

Some of the most useful technology is aimed not at the home's patients but at its staff. Many of those who care for the elderly are afflicted by back injuries, from the effort of repeatedly lifting and lowering immobile patients. An exosuit relieves this burden.

Powered by compressed air and operated hands-free through a mouth-piece, it is an early version of the mechanical loader that Sigourney Weaver used to vanquish her extra-terrestrial adversary in *Alien*. It adds 30kg to the amount that a user can lift.

Similar devices are being used by

construction workers and airport baggage handlers to reduce the burden of their loads. Elderly workers are taking part in trials to see if such devices can extend their working lives.

Then there are the humanoid robots. "Some people with dementia like talking to people," Tomiko Kuge, of Fujisoft, which makes Palro, said. "They feel self-conscious, because they fear that they're repeating themselves or not making sense. Sometimes, they get angry with their carers, but a robot soothes them and they can talk to it easily."

Palro costs about £4,000, but is available to rent for £180 a month. About 300 are at work, mostly in care homes but some as receptionists in banks.