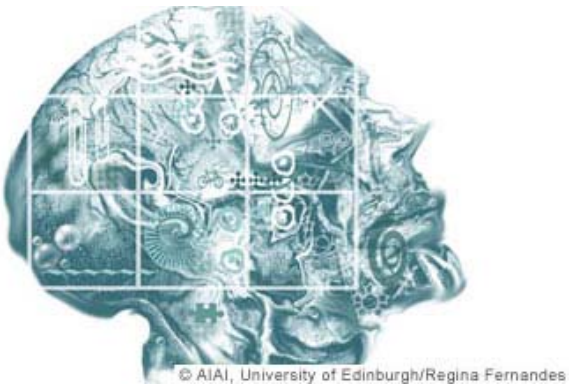

Artificial intelligence – from fantasy to reality

Professor Austin Tate, Director of the Artificial Intelligence Applications Institute (AIAI) at the University of Edinburgh, discusses progress made in AI and what could be in store...

The field of artificial intelligence (AI) has been characterised by some very optimistic projections, coupled with an under-estimation of the time and effort needed to produce intelligence in machines. The impression many have of AI is gleaned from science fiction where it may be portrayed in a human-like robot such as ‘David’ in Spielberg's *A.I.*, the crazed ‘HAL’ in Kubrick's *2001*, or super human (and often malevolent) entities such as ‘Skynet’ in Cameron's *Terminator* movies. Given such a fantasy portrayal it is not surprising that reality may seem a little out of step with expectations.

Physical and reasoning aspects of robots both require much work. Interacting with the world in a useful way is a big challenge. Though we are a still a long way from realistic biped bodies with humanistic movement, great strides have been made in this direction at a number of labs in the last decade. A car has driven across the US “hand-free” using sophisticated AI visual processing and vehicle control software and the state of Nevada has now licensed autonomous cars. In some US Grand Challenges, autonomous vehicles have driven at high speed over rough terrain. Biped robot exoskeletons with AI adaptive systems technology are becoming available and have assisted disabled people in walking again.

The intelligence in an AI is normally in the software which runs on a computer. There are many very clever, knowledgeable or intelligent programs working on well-defined problem domains and helping people in their everyday lives without them even being aware of it. However, brute force systems like the core of IBM's Deep Blue (the chess playing program/computer) do not strike me as very intelligent. Rather, they are powerful and able to search many possibilities in a short space of time. I would describe as more intelligent the software on board the Deep Space One spacecraft which employed autonomous intelligent planning and control software as it performed its mission.

In terms of the synergy between increasingly capable computer systems and AI, AI has influenced general programming language design from the very earliest days of computers (e.g., via LISP in the 1950s), and continues to do so, for example in the design of Java. AI has always been a computation intensive activity, and some techniques have come into their own as computing power has grown.

This applies very directly to tasks such as speech understanding, visual processing, and other aspects of robotics. Improvements in raw computing power also facilitate headline catching AI such as IBM's Watson computer having enough knowledge and information to win over previous champions in the *Jeopardy* TV quiz in the USA.

Game playing was an early focus for some AI researchers for decades. The attempt to get computers to play chess allowed us to begin to understand the different mechanisms involved in intelligent reasoning and planning, a problem which is considered "solved" since Deep Blue won a series of games at grand master level. Perhaps a more interesting example is that AI planning technology is embedded in a low-cost consumer device to play bridge – the "Bridge Baron".

There are some general purpose AI methods that are frequently used or embedded in many deployed systems. These include heuristic search, constraint solving, rule-based reasoning, and adaptive techniques such as genetic algorithms. Areas of application include:

- Finance (insurance underwriting, fraud detection)
- Supply chain management
- Crew and equipment planning and scheduling
- Advanced manufacturing and assembly
- Oil exploration
- Many uses in aerospace, defence and telecommunications

In the USA, the Defense Advanced Research Projects Agency (DARPA or ARPA) has provided a stimulus to the advancement of AI techniques in many fields over the years. They were instrumental in setting up competitions which drove natural language and speech processing systems, such that they are capable enough for use in many on-line assistance and personal mobile devices. In one DARPA initiative in the 1990s to develop AI planning and scheduling technology, an early focus created a system to improve the scheduling involved in moving materials for military missions. A US Department of Commerce report in 1994 stated that the deployment of this single logistics support aid during Operation Desert Shield paid back all US government investment in AI and knowledge-based systems research over a 30 year period.

In my own field of AI planning and collaboration, an example of a deployed application of our results is in the flexible re-planning of the assembly, integration and testing of the payload bay of Ariane rockets for the European Space Agency. This sort of application of AI can be found in many engineering sectors.

When you pick up a copy of the “Yellow Pages” in the UK, its layout has been done using AI constraint-based layout methods developed jointly by industry and my research institute which allows for immediate feedback on placement of adverts to generate increased sales opportunities with potential advertisers, improves the layout to keep customer information close to adverts, and uses significantly less paper resources in the final products.

The growth of the web has been a recent driver for work on semantic representations and using reasoning facilities to create the so called “Semantic Web”. Data mining and extraction or classification of large data sets from science and engineering in fields such as drug discovery and particle physics, as well as from commercial operations such as advertising and banking, have been very productively used to scan and classify vast quantities of data, e.g., from astronomical observations.

The successes of AI to date (and only some are widely recognised) have formed a solid basis for realistic exploitation and excellent prospects for future development. The “knowledge bottleneck” which needed to be addressed to make intelligent systems a reality is being solved through the growth of the web, on-line social networking, and knowledge sharing for professional uses.

I am an optimist and believe that AI methods (in particular knowledge-based systems) will allow us to make much better use of information in support of the tasks we wish to carry out, such that the processes involved will be more transparent, open and explainable. This will profoundly affect the ways in which verification of compliance with standards, legislation, safety rules and so on will be possible for individuals, organisations and governments.

It is in the nature of any technology that it can be used for good or for bad. If AI systems are seen as agents of their creators or the groups that deploy them, then accountability must reside with those that put such systems into use. That is a general concern we all should have whether we are talking about tools such as a hammer, a car, a computer controlled train or elevator, an automated financial stock dealing system or an unmanned autonomous vehicle

In future I believe we will see deep space probes and rovers with advanced automation and AI travel out from our planet sending back home exciting discoveries. Autonomous sea, land and airborne vehicles will explore parts of our own planet too inhospitable for people to travel there. Humans and robots will work alongside one another in emergency and rescue situations, and protect building occupants. We will be able to have a personal assistant or co-worker who will work alongside us, get to know our tasks, processes and preferences. It will do those things you wish you had time to do yourself but which are never at the top of your agenda. The same systems will adapt themselves to become an active aid as you and your family age.

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