The Dream of Human Level Machine Intelligence

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Abstract

This editorial letter presents a brief review on the history of artificial intelligence (AI) and current methodology. The aim and scope of this new journal will also be explained. Through many ups and downs, the path of AI seems to regain its momentum in recent years. This revival comes from the discovery of many new techniques such as evolutionary algorithm and nonlinear dynamics. The advancement of high-speed computers and our increased understanding of human brain mechanism also contribute to this breakthrough. However, researchers tend to form “small circles” and there are not enough communications between them. This new journal aims at providing a friendly platform for researchers to exchange their ideas. If more researchers around the world can come together and cooperate, then the dream of human level machine intelligence will come true very soon.

1 A Brief History

The ultimate goal of artificial intelligence (AI) is to produce a machine which is clever enough to solve problems and complete tasks like human beings do, or even perform better than humans. This dream started in 1950s. Pioneers such as Herbert Simon were very optimistic and claimed that “machines will be capable, within twenty years, of doing any work a man can do.” (Simon, 1965), but progress was slow throughout the decades. In 1980s, Japan launched a fifth generation computer project aiming at producing a machine capable of casual conversation (Crevier, 1993). Unfortunately, it turned out that AI research was much more difficult than people had anticipated. Many researchers had given up hope in 1990s.

Recently, however, the original AI dream has been revived. First we should thank the advancement of high-speed computers that enable researchers to test sophisticated algorithms. Second we need to thank those researchers who focused their AI technology on specific applications (such as handwriting recognition and language translation). These commercial applications turned out to be very successful. Investors are willing to fund AI research again because they can see the market. Third, the most important of all, researchers get many new ideas from brain science, physics and mathematics. Many sticky difficulties have been resolved. Research progress is steady and promising.

Now AI researchers are optimistic once again. Ray Kurzweil thinks that a machine, which is intelligent enough to improve its own intelligence, will become available before 2045 (Kurzweil, 2005). Although many researchers are more conservative about this opinion, the consensus is that AI research is now on the right track, and fruitful results can be expected.

Around the world there are many research groups devoting to the study of general-purposed AI. The following is a list of projects which are now under active development:

- ACT-R (http://act-r.psy.cmu.edu/)
- AIXI (http://www.hutter1.net/ai/index.htm)
- Cyc (http://www.cyc.com/)
- HTM (http://www.numenta.com/)
- LIDA (http://ccrg.cs.memphis.edu/projects.html)
- NARS (http://nars.wang.googlepages.com/)
- Novamente (http://www.novamente.net/)
- Polyscheme (http://act-r.psy.cmu.edu/)
• SNePS (http://www.cse.buffalo.edu/sneps/)
• Soar (http://sitemaker.umich.edu/soar/home)
There are also many other projects pursued by various research teams which are not listed above.

2 Methodology
In terms of overall methodology, there are 3 main research styles (Wang, 2010):

• Hybrid, or we call it LEGO style: To start with a basket of AI techniques, and then try to connect them together into a complete system. The problem is, the resulting system can be messy, redundant, ugly, and full of errors.

• Integrated, or we call it Creator style: To start with an architecture, and then to insert modules built with various techniques. The problem is that, it is very difficult to decide the overall architecture of the intelligent system. The researchers need a philosophical hypothesis about what generates intelligence.

• Unified, or we call it Growth style: To start with a core system built with a single technique, and then to add optional tools built with auxiliary techniques. The resulting system will be less messy than the LEGO style, but if the core technique is chosen wrongly, the system will never grow (the performance will never improve).

In terms of techniques, there are 5 main approaches:

1. Symbol-based. Entities and their relationships are represented as symbols, trees, and graphs. A large knowledge database with a particular structure is usually constructed. Logical algorithms are also constructed to process the symbols.

2. Connectionist. A blank neural network is being trained to represent the desirable entities and relationships. Rather than constructing an explicit model of the world, the neural network is shaped by the world by modifying internal structure.

3. Bayesian. Evidences keep being collected and the probability of a hypothesis keeps being updated based on some inference rules.

4. Evolutionary. This is inspired from nature, where genes recombine during reproduction, and the fitter offspring have higher chance of next reproduction. In a similar way, old algorithms breed new algorithms and they evolve towards the desirable goal.

5. Dynamical. The complex behaviour of an intelligent agent can be mapped to a chaotic trajectory in a multi-dimensional space.

In our opinion, there is one important factor which has been neglected by many AI researchers. This is the marriage between AI and brain science. Recent advancement of brain science allows us to get a better understanding of what is going on in our brain when we learn abstract knowledge and do complex tasks. This understanding is extremely important for us to construct intelligent machines. Our brain is smarter than a computer in terms of flexibility and creativity:

• Example 1: If a red traffic light is ON for more than 10 minutes, we’ll guess the traffic light is not working properly, so we may “break the law” and cross the road when the junction ahead is clear.

• Example 2: You can listen to your dad even if many other people are also speaking and your dad’s voice is changed due to a cold.

• Example 3: We invented airplanes, helicopters, and balloons. They can all fly, but fly differently from birds (no need to flap wings).

The above examples show that there is still a big difference between the intelligence of human beings and that of computers. Computers can only follow algorithms designed by programmers. They cannot handle uncertainty and sudden accident. They cannot imagine. They cannot invent. Therefore, if we want to build a machine capable of human level intelligence, it may need a completely new design.

First, the new intelligent machine should develop its own belief system instead of strictly follow a set of if-then-else. The machine should also “dare to dream”. When the system learned 1+1=2, it would automatically imagine the possibilities of 1+1=1, 1+1=3, 1+1=11, etc. Genetic Programming (GP) is usually used for searching and optimization. However, we guess that this evolutionary approach may also be useful for generating im-
agination and creativity. All possibilities, no matter how bizarre it sounds, can be assigned for a non-zero belief value.

Attention is another issue that should be addressed. All animals are able to filter their sensory signals and focus only on the most important object (you may try to use a cake to distract a cockroach while trying to hit it from the back). The brain mechanism of attention may involve synchronization among neurons (Borisyuk et al., 2009), which should be incorporated in the intelligent system.

An intelligent system should also be self-evolve, self-aware, and have a sense of the world around it. It should not only passively learn from the data, but also actively consider the possibility of hidden and unknown factors (Dundas & Chik, 2010).

What listed above is only a small sample of ideas and approaches. The ultimate machine of human level intelligence may require a combination of different methods, or need a completely new technique.

3 About this Journal

An unhealthy phenomenon is that, individual researcher works on his own, and there are not enough communications between researchers. There are many “small circles” which are either within one country or within one academic field. We need a community which is international as well as multi-disciplinary (including computer science, engineering, physics, biology, mathematics, and so on).

iConcept Pocket Journal Series: Human Level Intelligence aims at providing a friendly platform for researchers to exchange their ideas. We invite both practical as well as theoretical papers from all areas of Artificial General Intelligence, Machine Learning, Humanoid Robotics, Computational Neuroscience, Brain studies that relate to intelligence and consciousness, as well as Philosophy of Mind. Different from other journals, we welcome new ideas or frameworks of models that stimulate discussion in a new direction. If more researchers can come together and cooperate, then the dream of human level machine intelligence will come true very soon.

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References


