Why human brains hold the key to smarter artificial intelligence

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Credit: AI-generated image (disclaimer)

Understanding how our brains sustain 'internal evolution' – and help us to adapt and learn complex skills such as language – could one day lead to smarter robots.

Why is it that humans are capable of learning complex languages from

such an early age? And why does the solution to an 'insight problem' (such as connecting nine dots on a rectangular grid with four contiguous straight lines without lifting the pencil) suddenly pop into your head first thing the morning after?

INSIGHT, a ground-breaking EU project led by one of the current pioneers of theoretical evolutionary biology, has achieved a better understanding of exactly how we solve problems, by examining how ideas in our brains could evolve throughout our lives. The findings could have implications for programming problem-solving robotics that think for themselves and advance our knowledge of how human language developed.

'Open-ended human problem solving and open-ended learning remain far superior to what can currently be achieved by machines,' explains Professor Eörs Szathmáry, Director of the Parmenides Centre for the Conceptual Foundations of Science at the Parmenides Foundation in Munich, Germany and Professor of Biology at Eötvös University in Budapest, Hungary. 'In particular, robots lack adequate algorithms for insight problem solving in various contexts, which is vital in human understanding.'

By insight, we mean the ability that we humans can create new and more useful representations of a problem, in order to allow for solutions other than by 'brute force', and guide future actions. This enables us to tackle problems that are not routine in a highly creative manner, something that artificial intelligence has difficulty in doing.

For example, over several years we learn through experience and play how to walk, talk and socialise, while the development of complex, knowledge-expanding ideas such as Einstein's theory of relativity can take one decade or more. Often a 'eureka' solution can pop into your head without prior warning, suggesting that unconscious processing plays

a crucial role in insight.

The evolution of thought

'The deep similarities between thought and evolution led us to hypothesise that cognitive adaptations – achieved by 'neuronal' natural selection – run in real-time in the neuronal networks of the human brain during its lifetime,' explains Szathmáry. 'This process we call Darwinian neurodynamics.'

The INSIGHT project provided evidence to support this theory by using computer simulations, robots, examinations of cell cultures and human psychology experiments and neuroimaging. For example, rat neurons were stimulated to learn temporal patterns of activity, which were recorded and then played back to a naive network to see if the learnt information could be copied. Robots were fed natural selection algorithms designed to create open-ended creative autonomous exploration, and tested to see if they could, in effect, create their own objective.

'Unlike artificial selection, which says 'here is your function, this is what you've got to evolve', we found that a robot could develop its own game,' explains Szathmáry. 'Ultimately, robots could be able to generate their own values and desires, and in a sense have minds of their own.' In order to test this hypothesis, the project developed new evolutionary robotics toolkit, called Robogen, which allows anybody with a computer to evolve robot bodies and brains in physics-based simulations, 3D print evolved body parts, assemble the entire robot and observe its behaviour in the real world. The project has also made progress in mapping how Darwinian dynamics in the brain are crucial to language processing.

The implications of this research are far-reaching. One interesting twist might be that the evolutionary processes going on in the brain could even

be more powerful than in the wild, as they are modified and guided by learning. While much of this remains speculative – and further refinement of models required – the INSIGHT project has begun to put flesh on the bones of a theory that could one day lead to self-learning machines, smarter language translation and transform teaching and problem solving.

More information: INSIGHT project website: www.insightproject.eu/ ROBOGEN website: www.robogen.org/

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