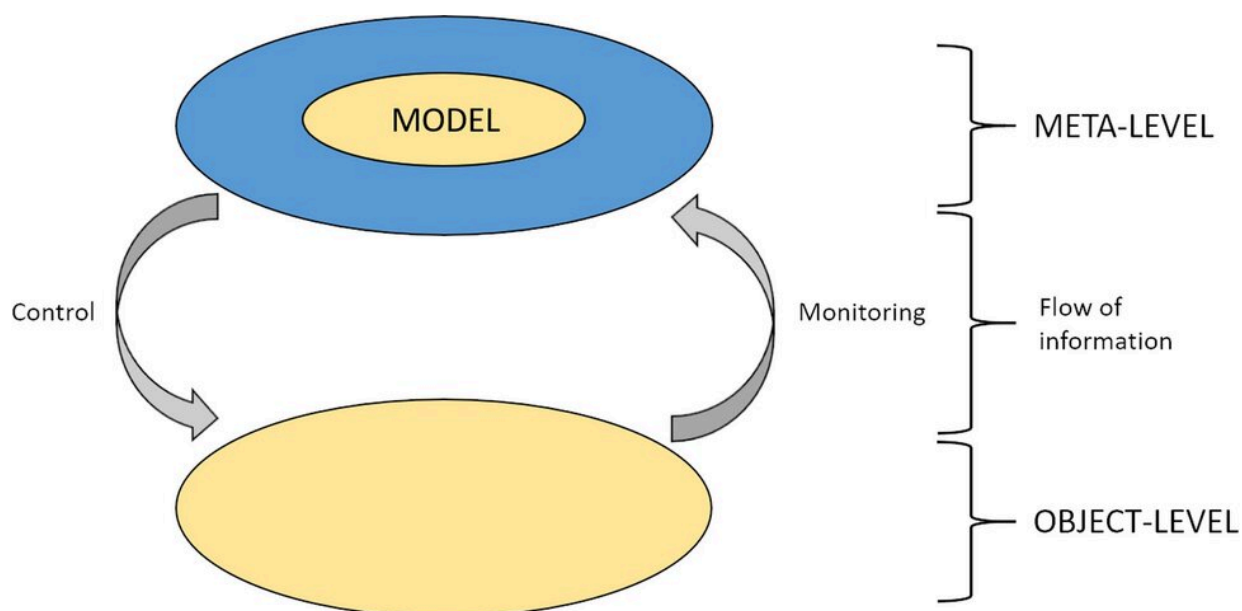


Creating artificial intelligence that acts more human by 'knowing that it knows'

June 2 2022



Nelson and Narens' formulation of a meta-level/object-level theoretical comprising consisting of two structures (meta-level and object-level) and two relationships in terms of the direction of the flow of information between the two levels. The meta-level contains an imperfect model of the object-level. Credit: *Scientific Reports* (2022). DOI: 10.1038/s41598-022-10173-4

A research group from the Graduate School of Informatics, Nagoya University, has taken a big step towards creating a neural network with metamemory through a computer-based evolution experiment. Their paper appears in *Scientific Reports*.

In recent years, there has been rapid progress in designing [artificial intelligence](#) technology using neural networks that imitate brain circuits. One goal of this field of research is understanding the evolution of metamemory to use it to create artificial intelligence with a human-like mind.

Metamemory is the process by which we ask ourselves whether we remember what we had for dinner yesterday and then use that [memory](#) to decide whether to eat something different tonight. While this may seem like a simple question, answering it involves a complex process. Metamemory is important because it involves a person having knowledge of their own memory capabilities and adjusting their behavior accordingly.

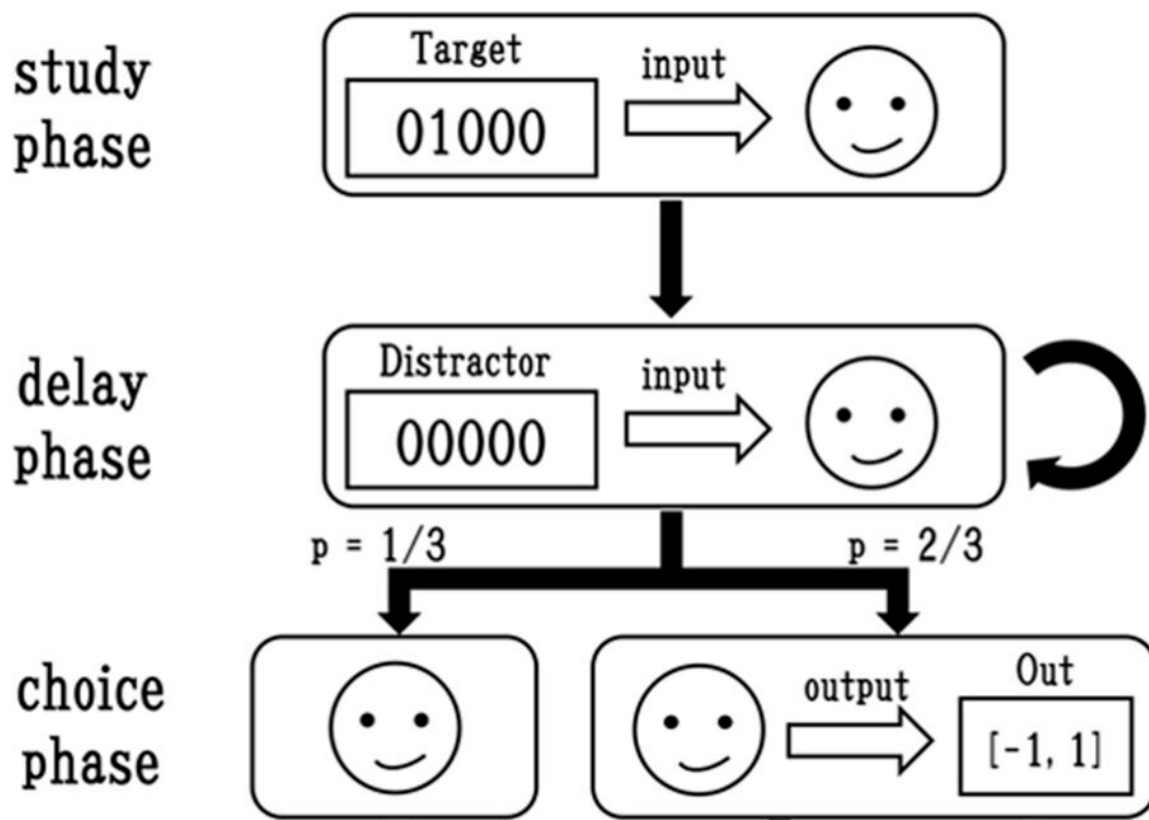
"In order to elucidate the evolutionary basis of the human mind and consciousness, it is important to understand metamemory," explains lead author Professor Takaya Arita. "A truly human-like artificial intelligence, which can be interacted with and enjoyed like a family member in a person's home, is an artificial intelligence that has a certain amount of metamemory, as it has the ability to remember things that it once heard or learned."

When studying metamemory, researchers often employ a "delayed matching-to-sample task." In humans, this task consists of the participant seeing an object, such as a red circle, remembering it, and then taking part in a test to select the thing that they had previously seen from multiple similar objects. Correct answers are rewarded and wrong answers punished. However, the subject can choose not to do the test and still earn a smaller reward.

A human performing this task would naturally use their metamemory to consider if they remembered seeing the object. If they remembered it, they would take the test to get the bigger reward, and if they were

unsure, they would avoid risking the penalty and receive the smaller reward instead. Previous studies reported that monkeys could perform this task as well.

The Nagoya University team comprising Professor Takaya Arita, Yusuke Yamato, and Reiji Suzuki of the Graduate School of Informatics created an artificial [neural network](#) model that performed the delayed matching-to-sample task and analyzed how it behaved.



The delayed match-to-sample task that introduced the escape option. Credit: *Scientific Reports* (2022). DOI: 10.1038/s41598-022-10173-4

Despite starting from random [neural networks](#) that did not even have a

memory function, the model was able to evolve to the point that it performed similarly to the monkeys in previous studies. The neural network could examine its memories, keep them, and separate outputs. The intelligence was able to do this without requiring any assistance or intervention by the researchers, suggesting the plausibility of it having metamemory mechanisms. "The need for metamemory depends on the user's environment. Therefore, it is important for artificial intelligence to have a metamemory that adapts to its environment by learning and evolving," says Professor Arita of the finding. "The key point is that the artificial intelligence learns and evolves to create a metamemory that adapts to its environment."

Creating an adaptable intelligence with metamemory is a big step towards making machines that have memories like ours. The team is enthusiastic about the future, "This achievement is expected to provide clues to the realization of artificial [intelligence](#) with a 'human-like mind' and even consciousness."

More information: Yusuke Yamato et al, Evolution of metamemory based on self-reference to own memory in artificial neural network with neuromodulation, *Scientific Reports* (2022). [DOI: 10.1038/s41598-022-10173-4](#)

Provided by Nagoya University

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