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Scuola Internazionale Superiore di Studi Avanzati

PRESS RELEASE

Rat Vision: A Lesson for Artificial Intelligence

A new SISSA study reveals that rats possess visual recognition capabilities that challenge neural networks.

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Rats perceive the world with a complexity that modern artificial neural networks struggle to match. This is the finding of a recent study published in the journal *Patterns* by the Visual Neuroscience Lab of the Scuola Internazionale Superiore di Studi Avanzati (SISSA), led by Davide Zoccolan. Using a convolutional neural network (CNN), a type of artificial intelligence particularly effective at recognizing image content, researchers attempted to replicate rats' ability to recognize objects under various conditions, altering the objects' sizes, positions, rotations, and partially obscuring them.

The results reveal that, even compared to advances in artificial intelligence, rat vision is extremely efficient and adaptable. As the complexity of image manipulations increases, the neural network requires more resources to compete

with rat discrimination ability. Additionally, rats and artificial intelligence employ different image processing strategies, suggesting that neural networks have still something to learn from neuroscience.

Convolutional Neural Networks (CNN) are the most advanced tools for image recognition and are inspired, at least in part, by the functioning of the mammalian visual cortex. A CNN consists of multiple layers, each playing a specific role in the visual analysis process. The initial layers process simple image features, such as edges and contrasts, while the intermediate and final layers combine this information to recognize more complex structures and identify objects within images.

For this study, SISSA researchers carried out behavioral experiments, training rats with a reward to recognize and discriminate objects under increasingly challenging conditions. For instance, objects were rotated, resized, or partially obscured to assess both the animals' and the neural networks' ability to recognize them despite these transformations. In simpler scenarios, such as changes in position, the neural network managed to replicate the rats' accuracy using only half of the layers; however, as complexity increased, rats maintained a quite high success rate in all tests, while the network needed increasingly more layers and resources to compete, achieving comparable results only by utilizing the entire depth of the convolutional architecture.

In addition, the study found considerable differences in how the neural network and the rat visual system process visual information, despite the biological inspiration of the former. Unlike the CNN, which relies on specific patterns for each image, rats appear to have more flexible and generalizable strategies that remain stable even when an object appearance changes across various contexts. "Rats, often considered poor models of vision, actually display sophisticated abilities that force us to rethink the potential of their visual system and, simultaneously, the limitations of artificial neural networks," explains Davide Zoccolan. "This suggests that they could be a good model for studying human or primate visual capabilities, which have a highly developed visual cortex, even compared to artificial neural networks, which, despite their success at replicating human visual performance, often do so using very different strategies."

The study also suggests that understanding better the mechanisms by which rats and, more generally, mammals recognize objects through vision in complex or ambiguous settings could inspire improvements in artificial intelligence models. Simultaneously, it underscores that even the visual systems of rats, nocturnal animals that prefer other highly developed senses such as smell to explore the world, is quite advanced.

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Scuola Internazionale
Superiore di Studi Avanzati
Via Bonomea 265, Trieste
W www.sissa.it

Facebook, Twitter
@SISSAschool

CONTATTI
Alessandro Tavecchio
M atavecch@sissa.it
T +39 3341468174

Donato Ramani
M ramani@sissa.it
T +39 3428022237