How maggots are influencing the future of robotics

2 September 2016

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What can software designers and ICT specialists learn from maggots? Quite a lot, it would appear. Through understanding how complex learning processes in simple organisms work, EU scientists hope to usher in an era of self-learning robots and predictive computing.

Animals—no matter how simple or complex—display a remarkable capacity for learning. Even with limited brain power, an organism can choose the right thing to do in response to external stimuli, which is something that current computational learning theory cannot fully account for.

Learning from maggots

The EU-funded MINIMAL project, launched in 2014, has focused on the learning processes in a relatively simple animal, the fruit fly larva (maggots). Despite having fewer than 10 000 neurons, this creature is capable of learning quickly and flexibly certain cues that lead them towards good things and away from bad things.

"Understanding the specific mechanisms behind this learning process could have important applications for technology, such as the development of self-learning small robotic devices," explains MINIMAL project coordinator Professor Barbara Webb from the School of Informatics at Edinburgh University in the UK.

"This could mean, for example, being able to develop small, cheap robots for use in precision agriculture, which are able to learn which plants need fertiliser or irrigation. This can then be delivered only where and when needed. Our key idea is that small but active systems can, like animals, locally discriminate and remember only the effective cues needed for the ongoing task."

The humble maggot was selected by Webb and her team because they were able to closely monitor and control both the animal's behaviour and brain processes in remarkable detail. They were able to track the entire process by which these animals are capable of learning new odours that lead them to good food (such as sugar) and away from bad food (such as quinine).

"We discovered that some specific single brain cells are sufficient, when activated, to make the larva learn that a particular odour is good," says Webb. ' We plan to explore this further using a new method developed through the MINIMAL project, which shows the activity of specific brain cells lighting up, which we can track even when the larva moves around freely. We really did not expect this last method to work so it is perhaps one of the most satisfying elements of the project so far."

Information opportunities

The project team's work on the learning process of the maggot could benefit other fields as well. "Although our main aim has been to demonstrate such capabilities in real world robot systems, there may be parallels in the information environment," says Webb.

For example, whilst current trends in computing often rely on big data, it is notable that in nature, animals often learn with very little data to predict associations (such as the maggot's ability to detect good food). Understanding how this works could have ramifications for the development of software and computer interfaces that anticipate a user's next action.

Looking even further into the future, it might one day even be possible that the larvae themselves could become engineered computational devices, capable of performing critical signal processing tasks.

"The next step is to consolidate our findings into a model of the neural learning mechanism of the larva and test this out on a robot," says Webb. "We have also developed a soft robot maggot, but it has been difficult to control its movement. Biologically-based learning could be the answer, and we firmly believe that such robots have potential for a range of applications."

The MINIMAL project is due for completion at the end of December 2016.

More information: Project website: blog.inf.ed.ac.uk/minimal/contact/

Provided by CORDIS
APA citation: How maggots are influencing the future of robotics (2016, September 2) retrieved 24 February 2021 from https://phys.org/news/2016-09-maggots-future-robotics.html