Q&A: Animals and robots develop an unlikely scientific partnership

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Collaborations between robotics specialists and biologists have never been so successful. The former draw their ideas from animal morphology while the latter have found in technology a useful tool for studying nature. Francesco Mondada, robotics engineer at EPFL, and Laurent Keller, specialist in evolutionary genetics at the University of Lausanne (UNIL), exchange their points of view. The latest issue of

Flash presents their entire interview together with a special "robots-animals" section (in French).

One of them deals with life, the other with electronics and mechanics. Yet biologists and robotics specialists are having an increasing necessity to collaborate and share their knowledge. This results in different kinds of achievements, especially in the field of biomedicine. Additionally, such exchanges have also given rise to bio-inspired robotics, with a growing parade of robots imitating the morphology of animals. The ones engineered at EPFL have been inspired in cats, salamanders and insects.

There is a third type of feat: design robots that are capable of mingling amidst animal populations with the purpose of studying their behavior. This has become the specialty of Mondada's team at EPFL. At first they were engaged in a project involving cockroaches and then continued their adventure with chickens and fish. For his part, Laurent Keller, an expert in ants and evolutionary genetics at UNIL, has conducted a number of studies using robots developed at EPFL. Flash magazine presents a special "robots- animals" section together with an exchange of opinions between the biologist and the robotics engineer.

At first glance, when it comes to robotics and biology one could not imagine two more different fields of study. What were you interested about during these exchanges?

Francesco Mondada: As an engineer, I saw an opportunity to address new challenges and to answer questions that do not necessarily arise in more traditional engineering applications. For instance, when we worked on robotic cockroaches, there were chemical and miniaturization aspects that proved very interesting. When we do this kind of work we acquire knowledge that leads us to having new ideas for designing the robots'

mechanisms and for developing new types of applications.

Laurent Keller: The use of robots can be useful in situations where you cannot directly employ real animals, mainly when we want to study social interactions or a particular aspect of behavior. In the project that I am conducting with Professor Dario Floreano at EPFL, we only work with robots. The aim is to study the evolution of cooperation among individuals, specifically to see the conditions under which they become more or less altruistic according to their degrees of relationship and the benefits they receive. The advantage with robots is that they can observe such evolution on a number of generations, while it would take years with real animals. In addition, we have also been able to test some theoretical biological models quantitatively for the first time.
- In practice, how does this interdisciplinary work and collaboration take place?

LK: In our case, robotics engineers had specific questions of a technical nature. On the other hand, our questions dealt with evolution and neural networks and were more complex. Therefore there is the matter of a language and concepts to be defined, which takes a little time. There are also differences in the approaches of the analysis. For example, as biologists we try to understand the behavior of all the individuals in a population as a whole, whereas engineers will tend to take only the best specimens into account.

FM: We engineers are concerned with design and biologists with analysis. Thus, there is a difference of method, vision, language. For example, to you, Laurent, what would be a significant temperature difference for an animal?

LK: Well, about two degrees.

FM: In electronics, the allowable temperature ranges are much wider.

You begin to worry at the moment when you can no longer touch a component, when there's a difference of 20-30 degrees. For us, if we light a bulb and it heats, it's normal. For biologists, if they want light, it is normal for them to not to want heat. This is a typical example of the kind of difficulty or misunderstanding that may happen.

Laurent Keller, what made you think about the possibility of using robots?

LK: One of my students was interested in issues related to artificial intelligence and I put him in contact with people from EPFL. This is where the idea came to establish further collaboration. What interested me was the possibility to make machines capable of evolving and to observe group behaviors such as the evolution of sociability, which we are not able to study in isolation with real animals.

And you, Francesco Mondada, how did you become aware of the interest in using robots as a tool for biologists?

FM: When I was working on bio-inspired robotics projects, I had the opportunity to come across biologists who brought us the elements of behavior or animal morphology that we lacked. One day, we thought it would be nice to be able to, in turn, bring to robots to their labs. That proved quite a success! Then, I received requests from biologists who were interested in using such a tool to conduct their research. And for us, this constitutes an interesting testing ground.

More and more inventions are combining technology and life sciences. How do you see the future? Do you think biologists and robotics specialists are going to

have to collaborate even more?

LK: That's true; collaborations of this kind are more frequent. But personally, I prefer to stick to the concrete reality and I do not like to speculate on what might happen, which eventually never does as imagined.

FM: At EPFL there are good examples of inventions of this kind, particularly in the fields of neuroprosthetics and biomedicine. Then again, we are not specialized in these disciplines. Essentially, what we are doing is "tricking" living organisms by copying some significant biological aspects. Unlike bio-inspired robotics, we are not concerned with imitating or copying living beings' mechanisms in their complexity. In short, we do not want our robot fish to look like a real fish; we just need it to have the required features for the real fish around it to think it is.

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