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New artificial intelligence and robotic tools for enhancing high throughput ethology and ethomics

ABSTRACT:
At the crossroads of distributed artificial intelligence and animal social cognition, animal and machine social collaboration is an emergent research field that has still been barely explored. Here, we discuss the long-term vision of the concept of mixed societies of both living and artificial agents. Such mixed groups would be composed of animals and robots whose social interactions produce shared and emergent collective behaviours. In these social bio-hybrid systems, animals and machines would cooperate to make decisions. We propose a general-purpose, automated, quantitative and high-throughput system for measuring the behaviour of interacting animals and robots. Our system use machine vision techniques to automatically track large groups of unmarked individuals while maintaining their distinct identities. Such research is part of a novel field of research in biology at the crossroad of genomics and ethology called ethomics. The aim is to produce automated ethograms by combining real-time high-throughput data mining by machine learning techniques and to classify and quantify the link between individual behaviour and social behaviour. This approach is relevant both for biology and for collective robotics. In this context, we present experimental results we have obtained for cockroaches (*P. americana*), chicks (*G. gallus*) and zebrafish (*D. rerio*) in mixed groups with autonomous robots. To invent social bio-hybrid system, we need to further investigate the mechanisms producing emergent collective intelligence in group-living animals. This also requires clarifying the link between individual cognitive capabilities and social structures. Mathematical models of animal social behaviour have to be developed both for progress in ethology and to guide the design of the robots and to serve as robotic behavioural modules.