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Procedia Computer Science 7 (2011) 130–132

Procedia Computer Science

The European Future Technologies Conference and Exhibition 2011

First Steps Toward Artificial Culture in Robot Societies☆

A.F.T. Winfield[a,*], A.G. Sutcliffe[b], F.E. Griffths[c], J.L. Bown[d], R. Durie[e], J. Tennant Jackson[f], M.D. Erbas[a], D. Wang[b], S. Bhamjee[c], A. Guest[d]

[a] *Bristol Robotics Laboratory, UWE Bristol, BS16 1QT, UK*
[b] *Manchester Business School, University of Manchester, Manchester M15 6PB, UK*
[c] *Warwick Medical School, University of Warwick, Coventry CV4 7AL, UK*
[d] *SIMBIOS Centre, University of Abertay Dundee, Dundee DD1 1HG, UK*
[e] *Department of Politics, University of Exeter, Exeter EX4 4RJ, UK*
[f] *Leeds School of Contemporary Art and Graphic Design, Leeds Metropolitan University, Leeds LS1 3HE, UK*

Abstract

This poster abstract outlines initial results from a multi-disciplinary research project called 'the emergence of artificial culture in robot societies' whose overall aim is to investigate the processes and mechanisms by which protocultural behaviours, better described as traditions, might emerge in a free running collective robot system. We accept, as a working hypothesis, the idea that mimesis and embodiment are essential pre-requisites for cultural evolution [1]. It follows that since our aim is to demonstrate artificial culture we need a system of embodied artificial agents, i.e. robots, in which robots are able to learn socially from each other, by imitation. This group of robots, which we call 'Copybots' (after [1] pp106-107), require an environment in which behaviours can be copied, by imitation, from one robot to another and we refer to this environment as the 'artificial culture lab'.

Selection and peer review under responsibility of FET11

1. The Copybots

The Copybots (Fig. 1) implement a form of embodied imitation in which one robot can copy another's behaviours only by observing with its physical senses and then transforming that sequence of sense-data (perceptions) into actions. We do not allow the robots to transmit behaviours (i.e. sequences of actions) directly from one to another. This means that the Copybots have to overcome essentially the same problems of inferring each others' behaviours from possibly unreliable firstperson perceptions as any embodied agents (robots, animals or humans), yet at same time the Copybots implement a minimal model of social learning by imitation. We argue that this embodied yet abstract model of social learning, by imitation, provides both a degree of biological plausibility and opportunities for unexpected emergence that would not be present in an agent-based simulation.

Dawkins coined the term 'meme' to describe a unit of cultural transmission [2], and we use this terminology here. We propose a definition of a robot meme as follows: *a contiguous sequence or package of behaviours copied from one robot to another, by imitation*. In the artificial culture lab we seed each Copybot with initial behaviours which, in this poster, are selfcontained sequences of movement or sound. We then free-run the Copybots so that robots alternate between

☆ http://sites.google.com/site/artcultproject/.

* Corresponding author.
E-mail address: alan.winfield@uwe.ac.uk (A.F.T. Winfield).

Selection and peer review under responsibility of FET11 doi:10.1016/j.procs.2011.09.063

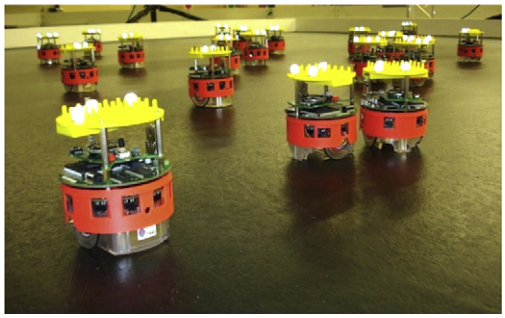

Figure 1. Artificial culture lab showing 20 Copybots in the experimental arena. Note the red skirts which makes it easier for robots to see each other.

enacting and watching (and learning) those sequences. The first-generation copy (child) of the initial seed behaviour may then itself be copied giving a second generation copy in an iterative process that means we have behavioural heredity. The errors that occur in embodied robot–robot imitation, due to noisy sensors, imperfect observation and the estimation process of inferring actions, gives rise to variation in imitated behaviours. If, furthermore, we allow robots to select which socially learned behaviour to enact, then we have the three evolutionary operators necessary for behavioural (i.e. memetic) evolution. The artificial culture lab provides us with the infrastructure and tools needed to track and record these possibly complex sequences of interactions for later analysis.

2. Experimental Results

We have to date conducted real-robot trials with 2 - 8 robots, limiting ourselves initially to a small number of robots in order to focus on understanding the fidelity of imitation (variation) observed in embodied imitation, and the effect of different simple selection operators. We present in this poster representative results of two trials, one of embodied movement-imitation and the other simulated sound-imitation. Fig. 2 shows a trajectory plot of two robot movement-meme evolution generated from the tracking data (robot x,y positions); this experiment is described in detail in [3].

We also investigate meme-gene co-evolution and Fig. 3 shows a Bayesian network for a single agent (or robot). Inputs at the top are either attributes of the individual agent i.e. genes in this case – predisposition to become obese, or information and environmental influences (memes such as food promotions and healthy life style messages). The agent reasons about which decisions to take (Act, React to change diet and life style) from a combination of all the inputs. The model scales with many BN based agents exchanging information in a network with different characteristics (social networks, spatial topologies or random diffusion models), so we can simulate a wide range of artificial societies using robots as agents in physical worlds, or simulations in virtual worlds.

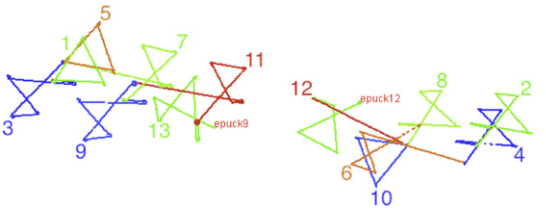

Figure 2. Trajectory plot: two robot movement-meme evolution in which all observed memes are stored and meme selection is random, with equal probability. The experiment starts with robot epuck9 (left) in teacher mode, following a movement trajectory that describes a triangle with sides of 15 cm (meme 1). Robot epuck12 (right) then enacts meme 2, a copy of meme 1. Note the emergence of a new meme 'species': the figure-of-eight meme (e.g. 2,3,4,7,8 and 9).

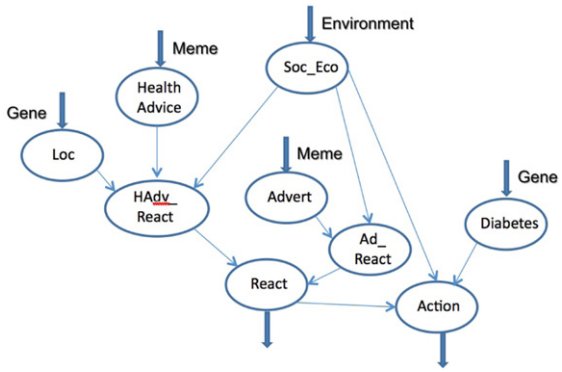

Figure 3. A computational model of gene-meme co-evolution (Bayesian network) with competing memes (Health advice and Advertising) co-evolving with genes for Diabetes and Self-control.

3. Discussion

This project is ongoing and it would be premature to draw any general conclusions. However, we can at this stage claim that embodied imitation does indeed give rise to meme variation 'for free', in the sense that those variations arise from embodiment. Initial trials demonstrate – we believe for the first time – promising openended embodied memetic evolution. Although methodologically controversial, we argue that this project offers a promising constructionist approach to modelling, not just how traditions emerge and evolve in social agents, but more general societal questions.

References

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