

Swarm Cognition Workshop

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Introduction

What do ants and neurons have in common? A bit of reasoning reveals that they share much more than one would intuitively think. An ant is part of a colony, much as a neuron is part of the brain. An ant cannot do much in isolation, but a colony is a highly resilient adaptive system. Similarly, a neuron is individually able just of limited interaction with other neurons, but the brain displays highly complex cognitive processes. In other words, both ants and neurons behave/act in perfect harmony with other conspecifics/cells to accomplish tasks that go beyond the capability of a single individual. Self-organisation is the common mechanism that allows simple units—e.g., ants and neurons—to display complex spatio-temporal patterns. As a consequence, colony behaviour and cognitive processes can be explained in terms of self-organising rules of interaction among the low-level units and their environment.

“Swarm Cognition” is the juxtaposition of two relatively unrelated concepts that evoke, on the one hand, the power of collective behaviours displayed by natural swarms, and on the other hand the complexity of cognitive processes in the vertebrate brain. With this premise, the Swarm Cognition Workshop aims at promoting synergies between diverse disciplines such as cognitive neurosciences, psychology, ethology and swarm intelligence. Research work in Swarm Cognition aims at identifying the operational principles of cognitive behaviour by calling upon the underlying mechanisms of self-organising systems, i.e., systems whose internal organisation changes without being guided by an outside source.

Self-organising systems can be found in living and non-living matter. Examples of biological self-organising systems are animal societies such as ant colonies, bird flocks or fish schools (Camazine et al., 2001; Sumpter, 2006). Self-organisation refers to a spatio-temporal pattern (i.e., a collective behaviour or a physical structure) that is not explicitly programmed in each individual component of the system, but emerges from the numerous interactions between these components, which only follow simple individual rules that are performed on the basis of local information only, without any global map or representation. In a self-organised system, while no individual is aware of all the possible alternatives, and no individual possesses an explicitly programmed

solution, all together they reach an “unconscious” agreement. In other words, the relevance or the meaning of the self-organised behavioural pattern is not found at the individual level, but at the collective one.

In recent years, scientists from various disciplines have been suggesting that, at a certain level of description, operational principles used to account for the behaviour of natural swarms may turn out to be extremely powerful tools to identify the neuroscientific basis of cognition (i.e., the explanatory principles). Generally speaking, these studies claim that the massively parallel animal-to-animal interactions which operationally explain cognitive processes of natural swarms are functionally similar to neuron-to-neuron communication which underlie the cognitive abilities of living organisms, including humans (Couzin, 2008; Visscher & Camazine, 1999). For example, the work of Passino et al. (2008) points out numerous similarities in the functional organisation of vertebrate brains and the mechanisms underlying nest site selection in honeybees. On the other hand, recent neuro-computational models emphasise the dynamical aspects of cognition as the result of complex spatio-temporal interactions among neural populations (see, for instance, Deco et al., 2008; Thelen et al., 2001; Schöner., 2002).

The workshop aims at enhancing collaborations between cognitive (neuro)scientists with different backgrounds by nurturing cross-disciplinary initiatives, confrontation and constructive discussions on the epistemological basis of Swarm Cognition. The workshop is also an opportunity to develop cross-disciplinary methodological tools that strengthen the scientific soundness of research in Swarm Cognition.

The workshop stimulates the interaction between biologists, ethologists, psychologists, neuroscientists, computer scientists, cognitive scientists on the issue of Swarm Cognition. In particular we invite scientists to submit innovative research work which highlights the importance of the mechanisms of self-organisation as operational principles to explain cognitive processes displayed by individuals or collectives, both natural and artificial. We also welcome the submission of already published research, to be reconsidered under a Swarm Cognition perspective. In the latter case, contributions should necessarily provide: (i) an introductory section that explains how the presented research fits within the Swarm Cognition approach, (ii) a summary of the most significant results obtained and (iii) a conclusion section in which that outlooks future swarm cognition studies.

Topics and goals

The originality of this workshop is marked by the following: (i) addressing cutting edge Swarm Cognition research issues; (ii) involving a truly interdisciplinary cooperation; (iii) hosting world leading keynote speakers in the field.

This workshop is envisioned as being a first meeting on Swarm Cognition. As such, the issues which the workshop will raise are of interest to a surprisingly diverse array of specialities. In no particular order, the following come to mind:

- Cognitive science
- Neurosciences
- Situated agents
- Bounded rationality
- Neuroeconomics
- Evolutionary game theory
- Cognitive ethology
- Neural computation and distributed representations
- Distributed computation
- Population biology
- Swarm intelligence
- Reinforcement learning
- Adaptive control
- Cultural evolution
- Cognitive sociology

Format

The workshop will be a full-day event, that features invited talks, contributed presentations with time for discussion, and a panel. Consistent with the workshop format, we expect and encourage contributed talks to present either work in progress, or final results. Additionally, already published work recast into the Swarm Cognition framework are also eligible for presentation at the workshop, provided that the authors opportunistically motivate in the paper the relevance of their work with respect to Swarm Cognition. Submitted papers will be selected on the basis of a peer-review process by referees highly confident with the workshop topics.

Keynote speakers will have 45 minutes each to present their work. The keynote speakers will be invited to submit a short paper, that will be made available on the workshop web site before the beginning of the workshop. Each invited talk will be followed by 15 minutes discussion. There will be at least 4 speakers that will have 20 minutes for presentation followed by 10 minutes discussion. The remaining time, excluding the breaks, will be allocated to panel discussion.

Dissemination

The material presented at the workshop will be fully accessible through the workshop web site. Authors of papers accepted for the “Swam Cognition” workshop will be invited to submit in September/October 2009 an extended version for review for publication on a special issue on Swarm Cognition of the Swarm Intelligence Journal (Springer Verlag, see <http://www.springer.com/11721>).

Web Site

For up to date information, please refer to the conference web site: <http://laral.istc.cnr.it/swarm-cognition>. Notice that the web site is also intended as an open place for discussion, thanks to a wiki implementation. These pages are meant to be a pre-workshop place for the authors/participants to propose relevant issues that, conveniently selected by the workshop committee, will be subjected to the attention of the workshop participants during the panel discussion.

References

- Camazine, S., Deneubourg, J.-L., Franks, N., Sneyd, J., Theraulaz, G., & Bonabeau, E. (2001). *Self-organization in biological systems*. Princeton University Press, Princeton, NJ.
- Couzin, I. (2008). Collective cognition in animal groups. *Trends in Cognitive Sciences*, 13(1), 36–43.
- Deco, G., Jirsa, V., Robinson, P., Breakspear, M., & Friston, K. (2008). The dynamic brain: From spiking neurons to neural masses and cortical fields. *PLoS Computational Biology*, 4(8).
- Passino, K., Seeley, T., & Visscher, P. (2008). Swarm cognition in honey bees. *Behavioral Ecology and Sociobiology*, 62, 401–414.
- Schöner, G. (2002). Timing, clocks, and dynamical systems. *Brain and Cognition*, 48, 31–51.
- Sumpter, D. (2006). The principles of collective animal behaviour. *Philosophical Transactions of the Royal Society of London: Series B*, 361, 5–22.
- Thelen, E., Schöner, G., Scheier, C., & Smith, L. B. (2001). The dynamics of embodiment: A field theory of infant perseverative reaching. *Behavioral and Brain Sciences*, 24(1), 1–34.
- Visscher, P., & Camazine, S. (1999). Collective decision and cognition in bees. *Nature*, 397, 400.