

A survey of Collective self-awareness in multiple robot systems

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1 self-reconfiguration

Queralta and Westerlund (2019)

2 collective self-awareness

Diaconescu et al. (2017) Kephart et al. (2017) https://en.wikipedia.org/wiki/Collective_consciousness Landauer and Bellman (2015)

3 Nodes and networks

Agne et al. (2016)

4 Definition

“Information about the global state of the system, which feeds back to adaptively control the actions of the system’s low-level components. This information about the global state is distributed and statistical in nature, and thus is difficult for observers to tease out. However, the system’s components are able, collectively, to use this information in such a way that the entire system appears to have a coherent and useful sense of its own state (Mitchell, 2005). Schmickl et al. (2011) showed that a group of robots with simple behavioral rules and local interactions may achieve collective awareness of a global state, distributed across the individual units.

The emphasis here has been added, to highlight that a system which behaves in a self-aware manner is not necessarily required to possess a single component which has access to system global knowledge. Indeed, in many cases, e.g., ant colonies, immune systems and humans themselves, the entire system appears self-aware, despite the knowledge available at constituent parts being only local. The appearance of self-awareness is an emergent effect Mitchell (2005).

This is a key observation which can contribute to the design of self-aware systems: one need not require that such a system possesses a global omniscient controller. Indeed, many natural systems appear to have been favored by evolution which do not have such a central point of control, and rely upon relevant knowledge being available at required locations within the system. It is highly likely that this can improve the robustness and adaptability of such systems; these are desirable properties for natural and artificial systems alike Mitchell (2005).

WORKING DEFINITION FOR SELF-AWARE COMPUTING SYSTEMS

This definition is based on the idea of a conceptual component called a self-aware node. A node in this context need not physically exist as a hardware or software component of a computing system, but provides a conceptualisation of locality within a global system, particularly in relation to what is considered self in the context of self-awareness. This distributed nature of conceptual components is particularly relevant to the idea of distributed self-awareness, as expounded by Mitchell (2005). The definition is as follows.

To be self-aware a node must:

- Possess information about its internal state (private self-awareness).
- Possess sufficient knowledge of its environment to determine how it is perceived by other parts of the system (public self-awareness).

Optionally, it might also:

- Possess knowledge of its role or importance within the wider system.
- Possess knowledge about the likely effect of potential future actions / decisions.
- Possess historical knowledge.
- Select what is relevant knowledge and what is not.

5 Self expression

Lewis et al. (2011)

6 In nature

fish, bees, ants, immune systems

7 The rest

Kernbach (2011) Selvaggio et al. (2017) Celentano and Röning (2016) CoCoRo - The Self-aware Underwater Swarm Schmickl et al. (2011)

8 Surveys

Lewis et al. (2011) starting from section II-C.

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