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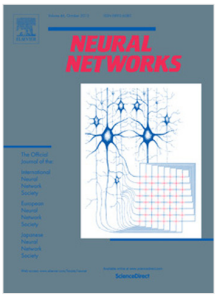

Information-theoretic decomposition of embodied and situated systems

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Information-Theoretic Decomposition of Embodied and Situated Systems

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Abstract

The embodied and situated view of cognition stresses the importance of real-time and nonlinear bodily interaction with the environment for developing concepts and structuring knowledge. In this article, populations of robots controlled by an artificial neural network learn a wall-following task through artificial evolution. At the end of the evolutionary process, time series are recorded from perceptual and motor neurons of selected robots. Information-theoretic measures are estimated on pairings of variables to unveil nonlinear interactions that structure the agent-environment system. Specifically, the mutual information is utilized to quantify the degree of dependence and the transfer entropy to detect the direction of the information flow. Furthermore, the system is analyzed with the local form of such measures, thus capturing the underlying dynamics of information. Results show that different measures are interdependent and complementary in uncovering aspects of the robots' interaction with the environment, as well as characteristics of the functional neural structure. Therefore, the set of information-theoretic measures provides a decomposition of the system, capturing the intricacy of nonlinear relationships that characterize robots' behavior and neural dynamics.

Keywords: `Embodied cognition, Situated cognition, Evolutionary robotics, Information theory, Antireductionism`

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