# Redefining robustness

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The concept of robustness in the context of most work in Alife and complex systems implies that the results of a given model remain consistent despite unexpected variation. For example, homeostatic coupling between an animat and the environment is one possible simple form of robustness which we have demonstrated in simple simulation models (Ikegami et al., 2008, BioSystems, 91, p. 388), in which we defined robustness as a dynamic that sustains variability. However, these models still were situated in simple virtual environments. We are currently using this simulation as a basis for developing a real-world robot experiment with "virtual" sound scape setups. Developing this link between real and simulated methodologies has led us to an examination of robustness in a broader sense.

We argue that robustness as commonly defined in Alife is no longer adequate for producing real insight into the functions of biological life. Robustness in one methodology or virtual world does not imply robustness in another, and likewise does not imply that we can develop a robust explanation of the behaviour of interest.

Robustness analysis as a concept is credited to Richard Levins who was the first to truly address pragmatic concerns important to biological modellers (1966, Conceptual Issues in Evolutionary Biology, p. 18, MIT Press). Levins argued that the construction of robust theorems from models involves studying similar but conceptually different models of the same phenomena and attempting to discern the common structures between them. Levins' pragmatic concerns about modelling illuminate similar tradeoffs made by modellers in the Alife community, leading some models to become mired in modelling for its own sake, creating simulations with little relation to the natural world (Silverman et al., 2008, forthcoming).

With this perspective in mind, a reevaluation of the concept of robustness within Alife is needed. While Alife can contribute to the search for common structures in biological systems which can drive behaviour, producing robust theorems about those behaviours also involves confirming that such structures are instantiated in the system of interest (Weisberg, 2005, Phil. Sci., 73, p. 730). A unified framework under which to search for common structures is central to these concerns. Without a clear common relationship between conceptually related models, performing Levinsian robustness analysis becomes an impossible task.

Thus, we argue that finding robust theorems in Alife which demonstrate common structures is made difficult by the lack of common environments between models. A more critical analysis of what constitutes a useful environment for simulation and robotics is needed, and without such analysis, our concept of robustness falls short of Levins' requirements for developing true robust theorems about the natural world. In essence, crafting a robust explanation of a behaviour using a model requires a robust demonstration of that behaviour through a suitable combination of modeling and experimentation. We contend that combining simulation and robotics with an approach using common methodologies and related environments as described above will allow us to develop a new definition of robustness in Alife.