Learning to evolve: With a little help from my ancestors

Learning to fly is easy, if you are a bird. But why is it that birds learn so easily how to fly" It is well known that birds learn through practice, and that they gradually refine their innate ability into a finely tuned skill. According to a new theory by Dr Stone of Sheffield University, skills such as flying are easy to refine because the innate ability of today's birds depends indirectly on the learning that their ancestors did, which leaves a genetically specified latent memory for flying.

The theory has been tested on simple models of brains called artificial neural networks, which can be made to evolve using genetic algorithms.

Whilst these networks do not fly, they do learn associations, and these associations could take the form of a skill such as flying. Using computer simulations, Stone demonstrates in a study, publishing in the open access journal *PLoS Computational Biology*, that the ability to learn in network models has two surprising consequences.

First, learning accelerates the rate at which a skill becomes innate over generations, so it accelerates the evolution of innate skill acquisition. For comparison, evolution is slow if a network simply inherits its innate ability from its parents, but is not allowed to learn in order to improve this innate ability.

Second, learning in previous generations indirectly induces the formation of a latent memory in the current generation, and therefore decreases the amount of learning required. It matters how quickly learning occurs, because time spent learning is time spent not eating, or time spent being eaten, which incurs the ultimate penalty for slow learners. These effects are especially pronounced if there is a large biological 'fitness cost' to learning, where biological fitness is measured in terms of the number of offspring each individual has.

Crucially, the beneficial effects of learning depend on the unusual form of information storage in neural networks, a form common to biological and artificial neural networks. Unlike computers, which store each item of information in a specific location in the computer's memory chip, neural networks store each item distributed over many neuronal connections. If information is stored as distributed representations then evolution is accelerated. This may help explain how complex motor skills, such as nest building and hunting skills, are acquired by a combination of innate ability and learning over many generations.

The new theory has its roots in ideas proposed by James Baldwin in 1896, who made the counter-intuitive argument that learning within each generation could guide evolution of innate behaviour over future generations. It now seems that Baldwin may have been more right than he could have guessed, even though concepts such as artificial neural networks and distributed representations were not known in his time.

Citation:

A previous version of this article appeared as an Early Online Release on June 8, 2007 (doi: 10.1371/journal.pcbi.0030147.eor).

Stone JV (2007) Distributed representations accelerate evolution of adaptive behaviours. PLoS Comput Biol 3(7): e147. doi:10.1371/journal.pcbi.0030147

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