# Self-adaptation of Cultural Learning Parameters

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## 1. INTRODUCTION

A number of researchers have analysed the interactions between learning and evolution, where individuals within a population of artificial organisms are capable of evolving genetically and also of acquiring knowledge during their lifetime. The aim of this paper is to examine the effects of allowing certain cultural learning parameters to self-adapt as the experiment progresses.

## 2. RELATED WORK

Hinton and Nowlan employed a genetic algorithm to study the effects of lifetime learning on the performance of genetic evolution [2]. Each agent in the model possesses a genome, comprised of a string of characters which can be one of 1, 0 or *?*. Each agent is allowed a number of rounds of lifetime learning where for each *?* in the genotype they 'guess' its value, assigning it either a 1 or a 0.

The experiments compared the performance of a population endowed with learning and one without. Results showed that, once learning was applied, the population converged on the problem solution, showing that individual learning is capable of guiding genetic evolution. Hinton & Nowlan's model was modified by Best to replace individual learning with social, or cultural, learning[1].

## 3. MODEL

Our model follows the structure of the experiments performed by Best[1]. The model employs the NK fitness model as the fitness landscape for the experiments[3]. The NK fitness model alters the ruggedness of a fitness landscape by tuning the level of epistasis present within a chromosome.

### 3.1 Cultural learning

Cultural learning is implemented by allowing individuals to acquire values for the their *?* loci from teachers selected from the population. Each pupil is stochastically assigned a teacher and, for each *?* locus in the pupil's genecode the corresponding value is copied from the teacher with a certain *imitation probability*. This process is repeated for a number of *teaching rounds* and the best fitness result is taken as the agent's final fitness.

### 3.2 Self-adaptation of cultural parameters

The model employed by Best used fixed cultural parameters (imitation probability and number of teaching rounds). In our implementation we allow both parameters to evolve in a similar manner to the evolution of the solution itself. Each agent carries three genomes: one containing the solution to the NK landscape, one encoding imitation probability and, finally, one encoding teaching rounds. All three genomes are allowed to undergo the processes of crossover and mutation.

## 4. EXPERIMENTS

The experiments employed two populations: one using evolutionary learning alone, and the other using both evolutionary and cultural learning. Results show that the addition of cultural learning to evolutionary learning has beneficial effects in terms of fitness, as seen in previous work. Furthermore, results obtained from the examination of the self-adaptive parameters illustrate the relative quality of teachers at different stages in the experiment.

Once teaching rounds attain an initial high value, the benefits of imitation become more pronounced and the population responds by beginning to increase imitation probability. However, once probability of imitating a teacher increases, less learning rounds are required in order to achieve imitation, and the teaching rounds values begin to fall. This process continues throughout the experiment, with the fall of teaching rounds values being mirrored by a corresponding rise in imitation probability.


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