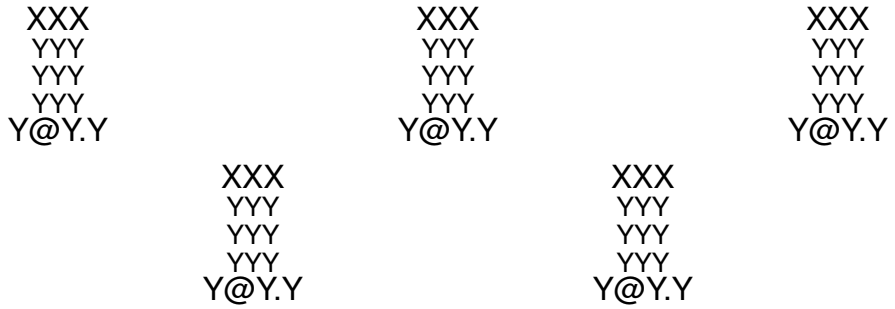
Heterogeneous Cellular Automata Evolution in a Fluctuating Environment



ABSTRACT

The importance of environnemental fluctuations in the evolution of living beings by natural selection have been widely noted by biologists and have been linked to many important characteristics of the living such as: modularity, plasticity, size of the genotype, mutation rate, epigenetic adaptations. However, in artificial life simulaions, environmental fluctuations are usually seen as a problem to be solved rather than as an essential characteristic of evolution. We propose in this paper to use HetCA, an heterogeneous cellular automata characterized by its ability to generate open ended long-term evolution and evolutionary progress, to measure the impact of different forms of environmental fluctuations. Our results indicates environnemental fluctuations induce mechanisms analogous to epigenetic adaptations in HetCA.

CCS Concepts

•**Computer systems organization** → **Embedded systems;** *Redundancy;* Robotics; •**Networks** → Network reliability;

Keywords

ACM proceedings; LaTeX; text tagging

1. INTRODUCTION

If early population genetics theory assumed the environment to be constant, since Richards Levins works [2] in the 70 to Evolution in Four Dimensions by Eva Jablonka and al. [1] the importance of environnemental fluctuations in the evolution of living beings by natural selection have been widely noted. Through those works and others, environmental fluctuations have been linked to many important questions about the mechanisms of evolution such as: modularity, plasticity, size of the genotype, mutation rate and through this the evolvability. Recently Jablonka[1] have developed the idea that epigenetic mechanisms controlling the rate of changes in certain genes have evolved to counter frequent environmental changes. Environmental changes can include introduction of new predator or new potencial food, radical environment modifications such as climate change inducing environmental stress but also cyclic changes such as daily cycle of light and darkness, seasons...

In [**?**] Lachemann model the consequences of such cycling variations on phenotypical inheritances. Their model predict that, when those cycles are longer than the reproductive cycle but relatively short heritable variations produced by non-DNA inheritance systems are likely to be observed.

Beaucoup de traveaux en vie artificielle s'intÃl'ressent aux variations environementales mais la pluspart les envisage essentiellement sous l'angle de variation locales et comme un problÃÍmes Ãă rÃl'soudre. NÃl'anmoins quelques traveaux s'y intÃl'ressent critÃl'r A Artificial life works focus on

plasticity, fluctuation environment, structural inherance

This paper is organized as follows. Section 2 highlights consequences of variable environment in biological evolution. In Section 3, we explain the mecanisms of HetCA simulation. The implementation of environmental fluctuation in HetCA is then explained in Section 4. Section 5 details the computer experimental setup while we reports experimental results in Section 6. We discuss the implications of these results in Section 7. Finally, Section 8 concludes the paper.

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2. BACKGROUND

3. HETCA

The eukaryotic chromatin remodeling machinery, the cell cycle regulation systems [**?**], the nuclear envelope, the cytoskeleton, and the programmed cell death (PCD, or apoptosis) apparatus all are such major eukaryotic innovations, which do not appear to have direct prokaryotic predecessors

4. EXPERIMENTAL SETUP

5. RESULTS

6. DISCUSSIONS

7. CONCLUSIONS

8. REFERENCES

[1] Eva Jablonka, Marion J Lamb, and Anna Zeligowski. *Evolution in Four Dimensions, revised edition: Genetic, Epigenetic, Behavioral, and Symbolic Variation in the History of Life*. MIT press, 2014.

[2] Richard Levins. *Evolution in changing environments: some theoretical explorations*. Number 2. Princeton University Press, 1968.