Framsticks – Artificial Life

Maciej Komosinski Szymon Ulatowski

Institute of Computing Science,
Poznan University of Technology
Piotrowo 3A, 60-965 Poznan, Poland

www.frams.alife.pl

This paper was published as: M. Komosinski, Sz. Ulatowski, Framsticks – Artificial Life. In: *European Conference on Machine Learning '98 Demonstration and Poster Papers* (Ed. by C. Nédellec, C. Rouveirol), Chemnitzer Informatik-Berichte, Chemnitz, 1998, 7-9.

This paper describes the Framsticks system as it was in 1998.

Abstract

The objective of the Framsticks project is to study the evolution process in a computer-simulated artificial world. We hope that – like in the real world – despite randomness and aimlessness of basic evolution mechanisms, it will lead to creation of more and more efficient "artificial organisms", still better and better adapted to the "artificial world" conditions. The project includes evolution of physical structure, control system (neural network) structure and its knowledge. Evolutionary algorithms are used to implement selection, crossovers and mutations. Simulation takes place in a three-dimensional world; finite elements method is used.

1 Introduction

For many years, people have been using computers to simulate the nature. This field of science has been named "Artificial Life" (AL). The name is obviously connected with "Artificial Intelligence" (AI) – both fields partly cover. AL, compared to AI, has to do more with biology and physics, and tends to be more practical than theoretical. It might be called a branch of biology, as we study "living" organisms in an environment. No matter that the environment is an artificial world inside a computer: philosophers have not yet decided whether our world is real and, nevertheless, biologists keep examining its living organisms. In addition, our made-up worlds let us (until we explore other life forms) study signs of life which have nothing to do with proteins.

Artificial Life experiments may have various applications, from explanation of behavior of animals to television advertisements. Group behaviors is studied (fish shoals, bird herds) and that has been used in filmmaking (computer control of animals models). More sophisticated models include learning and self-improving creatures. Artificial organisms (i.e. carriages with engines) can be learnt to avoid obstacles, seek energy spots, follow targets, escape enemies etc. Such experiments are directly connected with real robots control – the robots alone may perform useful actions. Some simulation models may have unreal simulation rules, but then they cannot be compared directly with reality.

It is evolution which controls improvements – awards better-adapted (fit) organisms. It works similarly to genetic algorithms. For the evolution process to go so far, organisms should be under control of this process. In the real world it is possible because of genes as the way of formal description of construction plans. Such descriptions can be then mutated and crossed over. The same situation takes place with our world simulator, where genes describe the structures (physical and neural) of organisms. Full freedom in creating genotypes means theoretically ability for creation of creatures of any complexity.

Such experiments make us ask whether self-improvement of artificial organisms can lead to founding consciousness, intelligence, and feelings? Not in our simple model, perhaps. However, the evolution has once showed what it is up to!

2 Simulation model – Framsticks

Biological evolution started from simple components. Much time passed until the first creatures were able to reproduce. In our artificial world, we skip this "chemical evolution" stage. We supply our creatures with basic functions: notation of their features in their genotypes, reproduction, and energy management. We also state the rules of organism building.

It would be difficult to simulate a world with quarks, atoms or even proteins as its basic elements. That is why the basic element of our organisms is much bigger – it is a rod (segment, stick, bar). Such an element can be assigned various functions depending on its genetic description. It can be just a "standard" stick, or can specialize in assimilation, ingestion, muscle speed, friction, etc. It can contain receptors (detecting stick position, ground or energy sources) and neurons, and it can also transmit and process signals if it contains parts of a "brain". It can have "muscles" and cause moves. A group of connected sticks makes up an independent organism.

Physical simulation module computes interaction of each organism with the world, analyzes forces influencing particular sticks and computes their new positions. Creatures can destroy each other. The simulation takes place in a three-dimensional space, and uses finite elements theory and rigid body dynamics. The artificial world's ground can be flat or made of blocks of different height (with possible smooth "slopes"). Water environment can be simulated.

Neural module computes excitations in neural nets, collects data from receptors and sends signals to muscles. Neural nets are synchronous and deterministic, and may have any topology.

Energetic module analyzes gains and losses of energy. An organism can gain energy by assimilation or food ingestion (food may be a part of another organism). The work of muscles and neurons results in energy losses. An organism dies after using up all of its energy.

Creation module creates new organisms by mutating and crossing over ancestors' genotypes according to their fitness. Users can define the fitness function (by adjusting weights of elementary criteria, like average velocity, average life span, distance, genotype size). For selection, the fitness value can be scaled using the sigma truncation method or linearly.

3 Experiments

A few experiments have been conducted, mainly with fitness defined to maximize horizontal velocity during life span on a flat ground. Interesting creatures were evolved, but just a small part of the simulator features was used so far. The project is in progress and there are still many experiments to be performed (seeking food, following, group behavior, mutual dependencies, coevolution, etc.). Please visit the web site to learn about current results, download applications, see sample movies etc.