

**Alain Lioret**

**Paper : Galatema : A Framework for Generative Cinema**



**Abstract:**

Galatema is a new generative project about making some pieces of generative cinema. All films begin with a story or a script. So, Galatema propose a framework to generate 2D or 3D films, from a story and a study with a mind map software for the basic architecture of the film.

Then, the Galatema software propose to build the architecture directly as a nodal representation for the entire production, mixing nodes for characters, props, lights, actions, etc.

Some generative methods (using Genetic Algorithm, Content Based Image Retrieval, Machine Learning, Principal Component Analysis, etc.) are used to make the film.

The artist can produce different kinds of film, controlling the generative methods involved to make the shots. So with this framework, we can make some nearly classic reels (animatics) or some new experimental cinema.

**Topic: Art**

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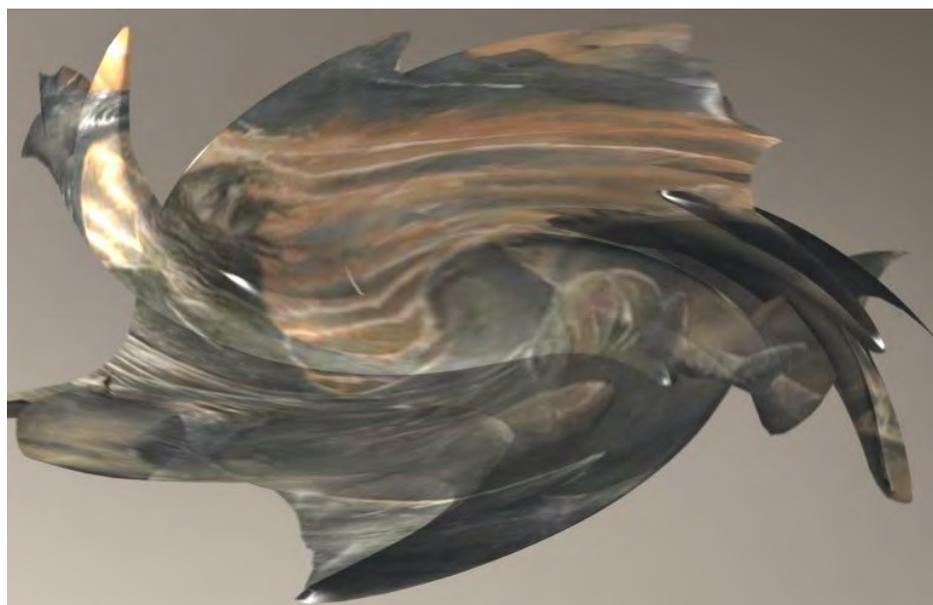
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*Image of Eriol I made with Galatema.*

All the assets are controlled by artificial beings (as the Painting Beings, the Light Beings, the Plant Beings, the Sound Beings, the Time Beings, etc.).

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## GALATEMA : A Framework for Generative Cinema

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Galatema is a project for making some kind of new cinema, using Artificial Life Creatures. The idea is to let a complex ecosystem of artificial beings working together, in their own world, making some images in real time or not. These creatures are different from other artificial life creatures, as they are involved in some special tasks, as making lights, making sounds, making camera shots, etc. This world works with some rules, based on cellular automaton, evolved by genetic algorithm, and in constant mutation with machine learning.

### Calculated Cinema

Generative Cinema is not very well-known today. But, we can tell about Calculated Cinema, made at the beginning of the computer animation. You can read the excellent article by Eugeni Bonet at the *Verbindingen/Jonctions* 5 [1], relating the effect of the work back in 1916 from artists such as Arnaldo Ginna and Bruno Corra, the Italian futurists who made the first abstract film “Vita Futurista” [2]. (See Fig. 1).



*Fig 1 : Vita Futurista. Ginna – Corra. 1916*

Since this first film, many artists worked on making cinema with some process, automatic, or semi-automatic, with computer algorithms or just computed rules. We can't mention here all these people, but among us, just some important names : Oskar Fischinger, László Moholy-Nagy, Alexandre Alexeieff with Claire Parker, Norman McLaren for the first experiments of new cinema (with animation), and then Ben F. Laposky, Mary Ellen Bute, Karl Otto Götz and some few others who have produced the first machine-generated graphics and animation between 1940 and 1960.

To know more about “calculated cinema”, you can read the Malcom Le Grice book : “Experimental Cinema in the Digital Age” [3].

Let's just mention here the first important artists using computer generated animations : Charles Csuri, Stan Vanderbeek (Fig.2), Lillian Schwartz, James and John Whitney, and Larry Cuba among the most well known.



Fig.2 : Movie-Drome. Stan VanDerBeek. 1963

## Algorithmic Cinema

A very important work was also made by Barbara Lattanzi, who is involved in algorithmic cinema. She has produced many experimental films and the software tools used to make them. She has been working on video improvisation, remediation of structuralist films, etc. [4]. You can find her art and software on her web-page, her courses, and some very interesting papers too.

Jim Andrews had made one of the most important experience of generative cinema, called dbCinema [5]. (Fig 3).



Fig .3 : Jim Andrews. DbCinema.

DbCinema is an online graphic synthesizer able to produce a real-time painterly cinema. It's a very good work, with experiences based upon Kandinski paintings, and many others. We can compare this work with some experiments made by Lev Manovich (especially the Soft Cinema) [6]. You can find some good papers about new kind of cinema on his web site.

Jon Pettigrew has also made some prototype of generative cinema [7] but he is rather working on generative music.

We can also read the good writing by Iain Lobb : « Generative Cinema and Dialogue » [8] where he tries to explain how generative cinema can be considered as a cinematic language. His essay contains an interesting part on algorithms for storytelling, and refers to the work of Sheldon Klein , James Meehan and Mazoud Yazdani. Yazdani is the first person trying to use generated storytelling.

Lobb says about Tale-Spin, the software made by Meehan :

*“Developed in the 1970s, Tale-Spin is typical of early artificial intelligence work in that it tries, and largely fails, to recreate aspects of human intelligence. There is now some consensus that this approach to AI is fatally flawed, and new approaches have now emerged in reaction to this, for example ‘A-Life’, which focuses on the interactions of groups of simple simulated organisms. The ‘microworld’ approach to generative cinema uses ideas from A-Life to create a cinematic experience”.*

Galatema is one experience using A-Life in response to this idea.

## Painting Beings

Painting Beings [12] [13] are artificial creatures, living in a “microworld”, evolving, in space, forms, colors, trying to make a painting world in their own artistic ecosystem. In fact, they are a kind of abstraction for characters that we can find in virtual worlds, such as The Sims or in Second Life universe. But, they are artificial life characters, with some very simple geometric forms, and some cellular automaton rules evolved by genetic algorithm.

The Painting Beings are working together to produce some digital paintings, always animated, always evolved. We can see another work similar to this, made by Tara Krause[14].(see Fig.4).

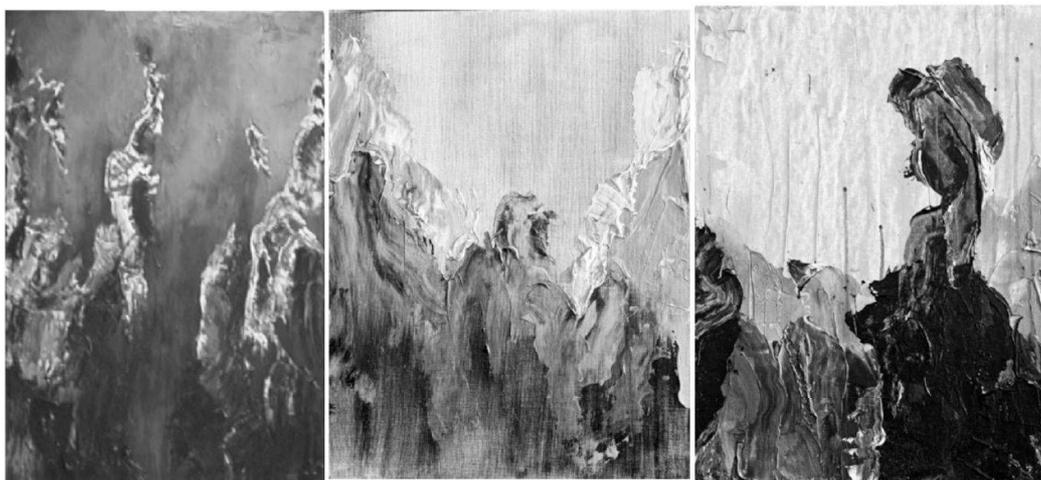


Fig 4 : Cellular Automaton Painting by Tara Krause.

Painting Beings can organize themselves, to produce abstract art figures, or they can also try to mimic some real images, seen by a web-cam or using an internet research (via Google Search for example). (see Fig 5).

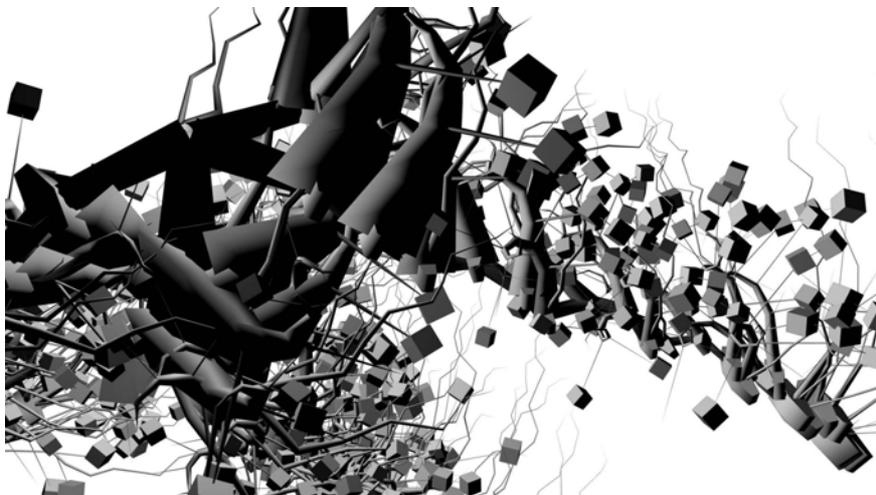


*Fig 5 : Painting Beings in Action. Alain Lioret 2006.*

Painting Beings give life to the pixels, and they are working like some artificial impressionists , seeing our world from their point of view. They are one of the most important parts of the Galatema ecosystem for making artificial cinema.

## **Plant Beings**

Plant beings are artificial plants, made with genetically evolved L-Systems. These plants were first generated for a special piece of Art, at the “Espace EDF Electra” in 2002. These Plants Beings are constructed in a similar way as Christian Jacob's works[9]. Simple rules for classic L-Systems are used, and evolved by genetic algorithms. The plants beings are alive : they can grow, move, die, can be ill, and some can even eat other beings... (see Fig 6). They also use the “Divine Proportion” rules (see later in this paper).



*Fig. 6 : One example of Plant Beings. Alain Lioret. 2002.*

## Light Beings

Light Beings are some strange artificial creatures, who's major work is to produce the lights in their world. Derived from the plant beings, they also have shape, based on fractal L-System, with other more abstract rules than the plants. The Light Beings were first created for the exhibition "Les Passeurs de Lumières" in the "Centre International du Vitrail" in Chartres (2003)[10].

All the light produced in the Galatema System is made by these beings. (See Fig 7).



*Fig.7 : Some Light Beings (with 3 Plant Beings). Alain Lioret. 2003.*

## Sound Beings

Sound Beings are a new kind of artificial creatures, made specially for Galatema Systems. Sound Beings are some entities, producing generative music, using fractal rules, such as cellular automaton, strange attractor formulas, and few other methods. Python Source code for the Sound Beings is inspired by the software FractMus, written by the composer Gustavo Diaz-Jerez[11].

The music produced by the Sound Beings use special rules that evolve within the Fibonacci Numbers as explained in [20] and [21].

## Eyes Beings

The role of Eyes Beings is to see many different things. They can of course see their own world, the 3D world where the Galatema artificial beings live. They take the work of the virtual camera inside this world. But, they can do more : they can read some texts (with simple words or short sentences) and consider them as a screenplay for making some films. How can they understand what they see ? Simply by using Internet, and especially the Google Image Search engine. For example, if they can read the word "Dinosaur", they automatically see this page : (Fig 8).

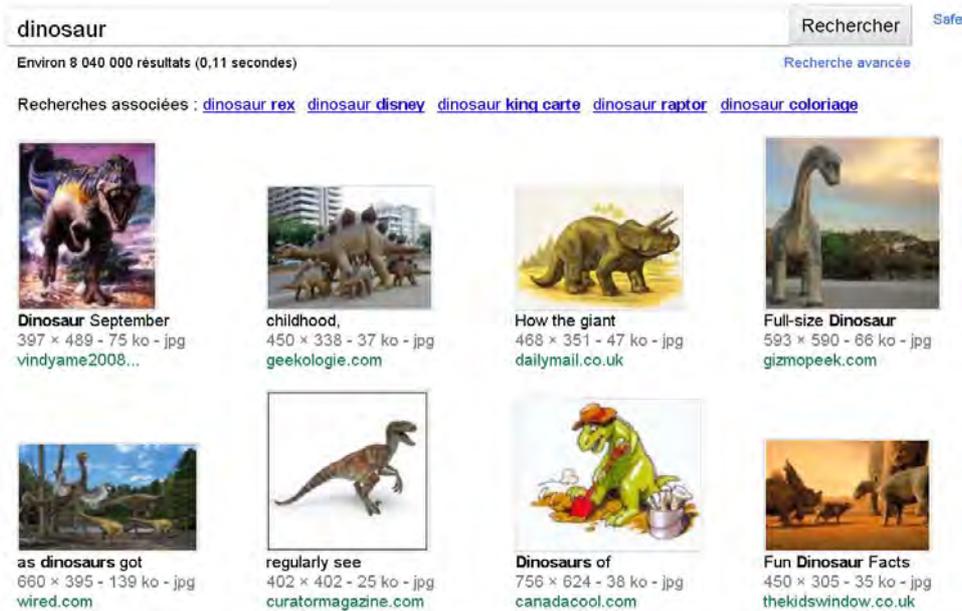


Fig 8 : Result of a Google Image Search, for the word "Dinosaur".

So, Eyes Beings can load these images (randomly or entirely), pass them on to the Painting Beings, who will give their own interpretation .

Eyes Beings can also look at us through a web-cam or a digital camera, in real time, so they are able to insert some interpretations of pictures instantly.

## Cut Beings

Cut Beings are artificial creatures whose task is to make the montage of the film. They can work in real time, pointing out the correct Eyes Being and putting them to work. They can also make a metric montage for one or many produced films after producing series of numbers in time and collaboration with Eyes Beings

The first rules they use are inspired by Eisenstein theory [15], about arithmetical montage, which we can see also in some Peter Kubelka films.

## Implementation of Galatema System

Galatema System uses Open Source Software, especially Blender[16] for the 3D world and Python[17] for programming. Blender 2.5x is a very good software for making artificial cinema, because all the necessary elements are included.

Painting Beings, Eyes Beings, Light Beings and Plant Beings are involved directly in the 3D scenes. See Fig 9.

Sound Beings and Cut Beings are working together in the Sequencer for the final montage of the film. See Fig 10.

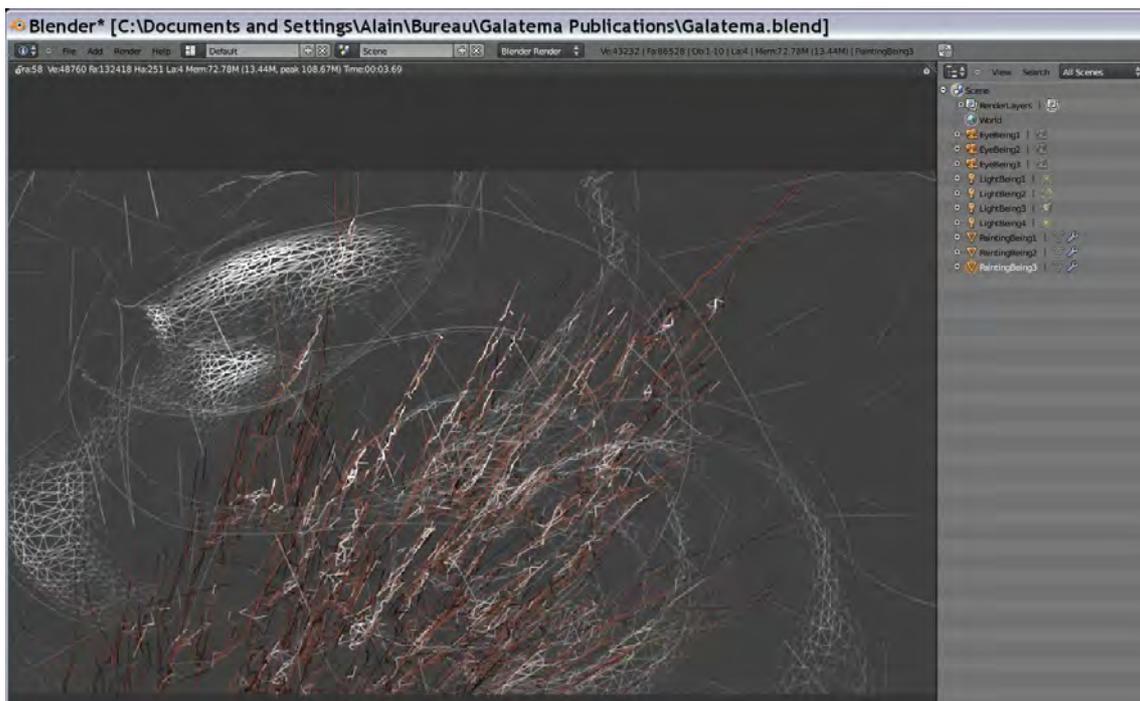


Fig 9 : Some Eyes Beings with Light Beings and Painting Beings in the Galatema System under Blender.

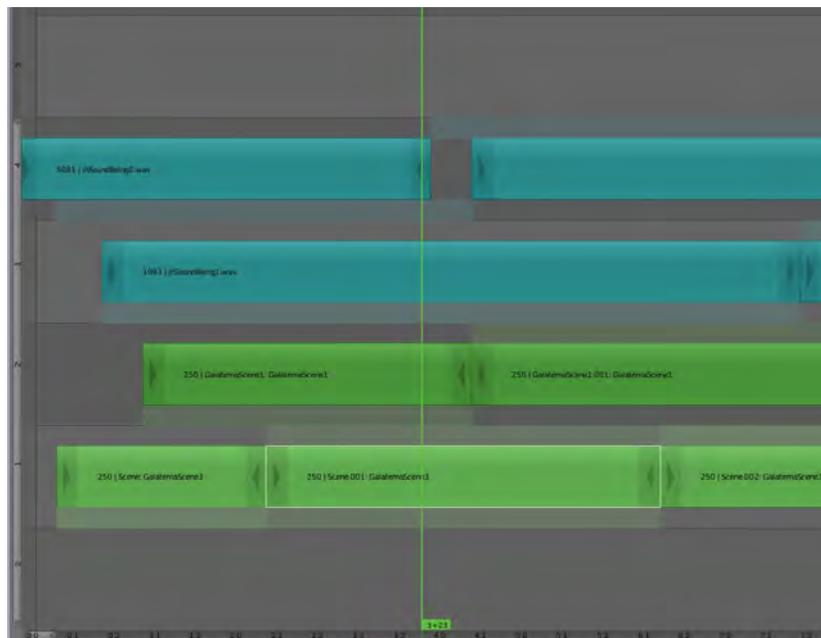


Fig 10 : Sound Beings and Cut Beings for Galatema Scenes in Blender.

## An Evolving World

How do these artificial beings work together ? They are all parts of a huge genetically evolved ecosystem. All these beings have many parameters (colors, positions, rotations, velocity, etc.). The amount of parameters is too big to use all of them in the system. So, we are using a factor P, which sets up the correct amount of parameters to be included

in the genome for the entire ecosystem.

This factor P can change with time, during the production of a film.

Then, the system makes a random choice of P parameters among all parameters in the entire system. Then, a special procedure, called “Proportion” runs to assemble parameters by groups, of 2 parameters, or 3, 4, 5 until 10 parameters together.

So, Galatema System stores lists such as :

*Plist = [(PaintingBeing1.TranslateX, LightBeing2.intensity), (EyesBeings9.positionZ, PaintingBeing6.rotationX, SoundBeing4.timeEnd), (PaintingBeing4.velocityY, CutBeing3.timeStart)]*

(In Python language, Plist is a list of tuples).

## Rules of Divine Proportion

With the Plist of parameters, Galatema System is based on a Genetic Algorithm, and the fitness function is build upon the “Divine Proportion Rules”. Following the major work of Luca Pacioli (See Fig 11), Divine Proportion[18][19] use some key numbers, such as the Golden Ratio, called Phi ( $\varphi$ ), which is equal to :

$$(1 + \sqrt{5}) / 2 = 1.6180339... \text{ (Rule Factor 1)}$$

But also, the inverse of  $\varphi$ ,  $\Phi$  which is equal to

$$1 / \varphi = 1 / 1.6180339... = 0.6180339... \text{ (Rule Factor 2)}$$



Fig 11 : Luca Pacioli, and his major work about the Divine Proportion.

Galatema's beings are also using the Golden Angle, which value is calculated as followed :

$$360 * (1 - 1/\varphi) = 137.51^\circ, \text{ or about } 2.399963 \text{ radians. (Rule Factor 3).}$$

The Rule Factor 4 is used for all the combinations of more than two parameters. It is based on the Fibonacci numbers, which are :

*0, 1, 1, 2, 3, 5, 8, 13, 21, 34, etc... (Rule Factor 4)*

These simple rules are used by the artificial beings to evolve their proportions of parameters during time (two by two or more), and the fitness function is calculated as below :

*For each tuple of parameters:*

*If number of elements == 2:*

*fit = random (rule1, rule2, rule 3)*

*Else:*

*n = number of elements*

*fit[1] = 1*

*For i = 2 to n:*

*fit[i] = fit[i-1] + element[i]*

So, the global fitness function for evolving the population of artificial beings in the Galatema System is :

$FIT = \sum fit(all\_tuple)$

## **Experimentation**

The first experience made with the Galatema System, was the GalaBoids creations. GalaBoids were presented at the Genetic and Evolutionary Computing Conference (Gecco) [22]. Boids are living in their world, all making their own paths. They use additional rules which gives them strange behaviors especially some trajectories, based on hyper-complex fractals formula (such as polynomial functions, for example  $z = z^p + z + c$  in the complex plan numbers). Boids were based on the Craig Reynolds works as described in [24].

These Boids are using Genetic Algorithm applied to their trajectories, grouped by similar colors, so they can find a better way with other boids which have nearest colors. [23]. (See Fig 12).

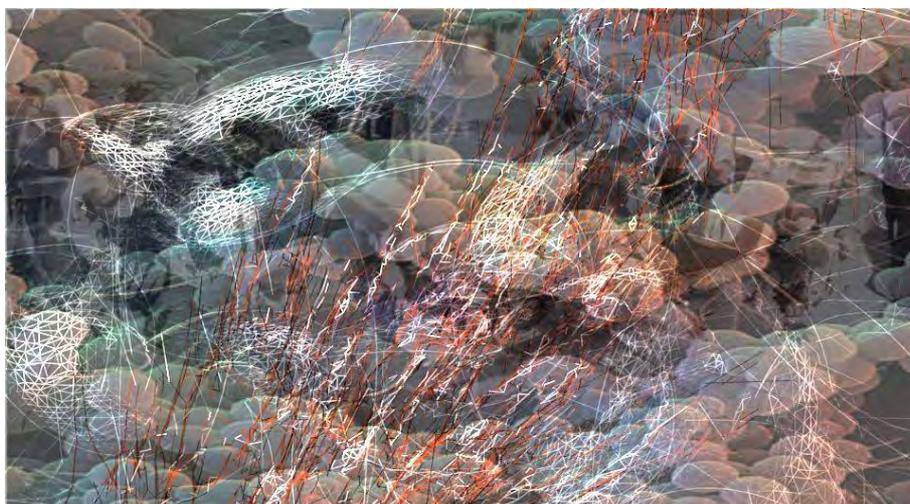


*Fig 12 : GalaBoids, first experience with the Galatema System.*

The second experience is a short film, called “Galaone“, and produced upon a very simple screenplay, given to the Eyes Beings :

*“Big bang universe  
Earth at the beginning  
Beginning of life  
Bacteria  
Seashell  
Dinosaur  
Australopithecus  
Mother Earth  
Passion of Christ  
Science history”*

Galaone is the first completely artificial film, made by the Galatema System Beings. (See Fig 13)



*Fig 13 : One frame of the Galaone film. 2010.*

## Future Work

There is a lot of work still being processed in the development of Galatema System. The first of them is to produce more and more films, to test the artistic abilities of this artificial world to make interesting cinema. Then, we have to include new rules for fitness evaluation of genetic evolution in the Galatema world (for example, more advanced cellular automaton rules, more fractal rules, other rules, etc.).

We plan to introduce some machine learning algorithms, in order to the system to learn how to make more interesting pieces of art. Galatema System will learn by himself as well as from other users' interactions.

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