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Data Gardens : An Artistic Proposal Towards the Representation of Distributed and Dynamic Data Using Multiagent Systems

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Abstract

We suggest a new paradigm for the representation of data, which is best suited for the real-time representation (visual and sonorous) of complex systems, real or simulated. The basic idea lies in the use of the garden metaphor to represent the dynamic evolution of interacting and organizing entities. In this proposal, multiagent systems are used to map between given complex systems and their *garden-like* representation, which we call *Data Gardens (DG)*. The evolution of these *Data Gardens* is driven both by the real-time arrival of data from the system to represent and by the endogenous reaction of the multiagent system, immersing the user within a visual and sonorous atmosphere from which he can gain an intuitive understanding of the system. The principles exposed may ultimately be applied to the representation of multiagent systems themselves.

1. Principles

Let's imagine a virtual garden whose visual and sonorous aspects continuously change to reflect the passing of time and the evolution of weather conditions in a distant place. Connected to real meteorological data, it functions as a virtual window, opened on a distant reality. This is what the computer-art project called *The Garden of Chances* (*GoC* to make it short) [1] is all about, and it inspired the concept of *Data Gardens* (*DG*), designed to address the issue of the representation of complex systems by means of visual and sonorous metaphors.

Keeping a close watch on meteorological data in order to secure airplanes landings is an example of a situation where decisions are subjected to the real-time understanding of a complex, dynamic system. For artificial systems also, such as multiagent systems, real-time representation is fundamental to provide insight into the inner mechanisms of the system at the agent level, or "topsight" over the functioning of the system as a whole. Visualization in Scientific Computing (ViSC) has proven very efficient to represent huge sets of data, by the use of statistical techniques to synthesize and class hierarchically the data, and extract relevant attributes from those sets, before presenting them to the user. But it has not been so successful when dealing with distributed and dynamic systems since it is based, among other things, on a delayed treatment of the data.

The basic proposal is to consider any complex system one wish to represent as a metaphorical garden, the evolution of which reflects in real-time the evolution of the system. In this paradigm, the measures made on the system are not only stored, waiting for a further statistical processing, but they are also immediately transmitted to a *Data Garden*, a virtual ecosystem with the same global dynamics as the system to represent but with a stronger visual and sonorous appeal. Indeed, the garden metaphor has the interesting property to be both very complex in its functioning, and still completely familiar to anybody, enabling a very fast and intuitive perception. Moreover, it doesn't require a sustained attention, since it relies for the most part on peripheral perception mechanisms, following the same principles as those that make us perceive weather conditions effortlessly. Finally, the *Data Garden* paradigm doesn't reduce the complexity of the system to represent but transforms this complexity to integrate it into a meaningful environment, creating a visual and sonorous ambient atmosphere from which to gain a continuous understanding of the studied system.

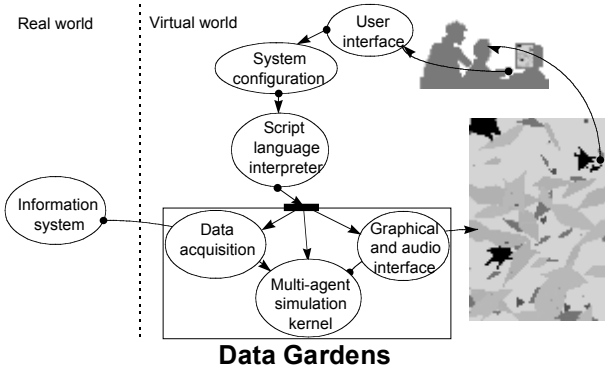
2. The Garden of Chances

Data Gardens are being built using the tools developed for the *GoC* artistic project. Designed as an ecosystem simulation system, the *GoC* is a kind of virtual garden in which plants grow, reproduce and die according to real world meteorological conditions, and also to interactions with other plants, this evolution being transcribed graphically. To achieve this, each plant is modeled as an autonomous agent which is characterized by sets of *parameters* and *behaviors*, and by a graphical representation, an abstract colored shape. Parameters are either internal (private resources of the plant) or external

(signals propagated in their environment). Behaviors specify how those parameters are supposed to evolve, as time goes by, in conjunction with meteorological data, or as signals emitted by other friendly or hostile plants are perceived. Changes in parameters then result in changes of shape, size, color, position, movement, etc. The plant may also reproduce itself or die as a consequence. A little scripting language has been written to specify all this characteristics dynamically.

3. Data Gardens

In *DGs*, data of any type may be acquired and injected into a multi-agent system whose function is to dynamically organize the data flux so that most important data can be perceived instantaneously. The aim is also to make interactions between data (correlations, mutual dependencies, etc.) become visible through the representation. The organization of the multiagent system itself must therefore be able to express those interactions through the cooperation and communication of the agents. Moreover, the visual representation of the data (or of the multiagent system that represents the data) must also make those relationships immediately perceptible. Finally, the user must be able to make the current representation evolve until he finds one that is the most strongly evocative to him, and be able to evaluate its efficiency.



Data Gardens

3.1. Dynamic organization

Dynamic organization of graphical elements has several purposes: reflect the dynamic evolution of individual data, make their interactions become visible, and provide a global vision of the whole data-set at a glance. This associates constraints related to the interactions between data, which can be of any type and constraints linked to the perception of pictures or sound, which are for the most part of a hierarchical nature. The idea is to take inspiration from different kind of complex systems, physical, biological, or even sociological to design distributed mechanisms for the hierarchical organization of agents. Once agents are hierarchically organized, based on social insects models for example, the graphical transcription can be made using simple considerations on size, color contrasts, position in the screen, etc.

3.2. Evaluation and adaptation

If the representation is to be efficient, the user must get the greatest amount of information in the shortest time, and with the best precision. This cannot be achieved with a normalized representation suitable for anyone, because this doesn't care for individual sensitivities. On the contrary, the proposal is to integrate the user as a component of the system, with the possibility to affect directly the evolution of the system. By so doing, a coevolution of representations (that of the user and that of the computer) is expected.

4. Conclusion

Data Gardens must be imagined as "meaning operators" between a flow of data, and a user, who is supposed to identify and follow, in the evolution of the system, that of the outside world. However, *DGs* are not intended to replace existing environments used to track and trace data. They are to be viewed as complementary tools that allow an instantaneous and natural perception of complex situations and propose a global perspective on them. *The Garden of Chances* is the first of such systems and it should now be studied in a systematic way, and with an experimental perspective, in order to develop operational design and evaluation methodologies.

5. References

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