**PROJECT AMOREIRAS (MULBERRY TREES): AUTONOMY AND ARTIFICIAL LEARNING IN AN URBAN ENVIRONMENT**

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Abstract

This artist’s writing discusses Project Amoreiras, developed by the Poéticas Digitais Group. The proposal is an urban intervention involving art, technology and environment, configured as an interactive installation of mulberry trees on the Paulista Avenue (São Paulo, Brazil). The article highlights its poetic and technological elements as critical positioning on pollution in the metropolitan environment, the processes of autonomy and artificial learning, the emergent behavior of the trees, the application of John Conway’s neighborhood principles to the project as well as the positive reception of the proposal by the pedestrians during the exhibition.

**Keywords:** interactive installation; art media; artificial learning; autonomy; environment; urban intervention.

With the first morning sounds, a tree responds to the pollution that has already started to collect on its leaves, moving to rid itself of the dirt. The louder the noise—the roar of the engines, the honking of car horns, the voices of people passing on the street, or not-so-perceptible noises like the rumble of the subway—the more the tree swings. The younger, smaller trees do not know how to deal with this environment of noises and moods. They do not know how to shake off the grime of the city—they are newcomers. However, they are able to learn how to respond to the environment and survive.

Amoreiras is an artistic project about autonomy, artificial learning, nature and environment. The main characters are five young trees on the Paulista Avenue, the cultural and economic center of São Paulo: five small, recently planted red mulberry trees, with cylindrical composite drupes and juicy infructescence with an acidulated and pleasant taste that matures in the spring. They have heart-shaped, serrated leaves that serve as food to the silkworm, flowers in catkins and dark-red-to-almost-black fruit that is edible *au naturel* and often used in jams. This kind of tree is forbidden on city avenues because they pollute the roads with leaves that fall into the culverts and bear fruit that attracts small birds and leaves indelible stains on the sidewalks and clothes of the passersby [1].

Planted in boxes, each mulberry tree is fitted with a prosthesis that aims to provide, correct or increase an impaired natural function and therefore ensure its survival. Metal, rubber and acrylic prostheses connected to small motors and an Arduino card are inserted in the young stem, which vibrates as if in dialogue with the factors related to the pollution. The swaying of the branches is caused by that “motor-driven prosthesis,” connected to the trunks of the trees (Fig. 1). Each one has a similar prosthesis, which varies, however, according to its peculiarities and anatomy. In this way, the interactive installation establishes its proposal for artificial learning, involving art, environment and new technologies, in a dance of leaves and a shaking of trunks, making the swaying of the branches at times apparent and poetic, at others mechanical, sometimes caused by the wind itself blowing against the leaves.

The choice of the mulberry trees as elements of the artwork and their focus on their leaves can be explained by Biondi and Reissmann’s study [2] on how trees react to pollution in big cities, including the criteria of their evaluation and maintenance:

According to Harris [3], the problems with air pollution are observed in the leaves themselves because they are the parts that most evidence the symptoms caused by this factor. The symptoms vary greatly, depending on the species and state of growth, type and concentration of pollutants, extent of exposure to humidity, light, temperature and other factors [4]. . . . *The parameters used to evaluate urban trees are still very subjective.* In agriculture and forestry, evaluation of the performance of trees is determined by their respective productions, based on the criteria referring to quality and quantity, according to their objectives. *While in urban areas, the criteria used transcend these qualitative and quantitative values because the involvement with aesthetic values is much greater and much more difficult to quantify, due to sentimental and psychological factors.* Currently, the monitoring of urban trees has been conducted to observe and measure variables that may not be informing the good performance of trees. Thus, it is urgent to search for other practical and accurate parameters to facilitate the urban trees maintenance (Emphasis added).

One of the parameters for maintenance of the urban trees in the project Amoreiras could be the notion of autonomy, present in the learning process of those *cyborg-trees*, with their copper rods and poetic anti-pollution prostheses.

Throughout the day, the *learners*, initially clumsy, start reacting more autonomously to incoming pollution data, swaying when there is too much noise (an indicator of the level of pollution) and lying at rest when the threat is smaller. By the late afternoon, differences in their behavior are noticed, which shows they are learning and possibly dialoguing with each other, exchanging data in a dance of mechanical prostheses, rods, rubbers and leaves.

The behavior of each tree is autonomous and occurs in response to the intensity of the ambient sound, also being influenced by each tree’s *personality*. In a process of emergency, the “pollution” is captured through a microphone: The system measures the noise variations and discrepancies as a symptom of several polluting and pollutant factors of the metropolitan environment that affect the urban trees. The artwork promotes observation and maturation of the trees’ behavior, which are enabled from an artificial learning algorithm. The sound is captured directly by a patch written in Pure Data, which sends the information to the main application, developed in Java via
The personality of each tree is defined by two variables (drawn from a lottery at the beginning of each day) that define how much each tree will try to imitate its companions and how much its behavior will be randomly disturbed.

An algorithm is attributed to each tree that determines how to turn its engine (via Arduino) according to the sound activity. In general, the louder the noise is, the greater the activity. It is important to emphasize additional rules, such as the intensity and extent of vibration, so that the movement is smooth, or to limit time period so that the trees can swing without being damaged. Initially, the algorithm is unaccustomed, which leads to senseless behavior (for example: the trees shake even in the absence of noise). A learning algorithm monitors the database and constantly observes the behavior of each tree, comparing the sound activity and trying to adapt the algorithm to act similarly. That is, the learning algorithm tries to get each tree’s algorithm to reach the same level of activation as the others for a given sound intensity.

There is a great variety of learning algorithms; some are so complex that they can be applied to the simulation of human mental processes, for instance. For this project, a simplified algorithm suffices, as it leads to an adequate level of complexity for the final result in which an emergent behavior is observed. The project basically works as follows: The five learning trees have similar equations to guide their behaviors, and each one is attributed to only one additional variable. The learning would be the process of changing the value of this variable until the equations are similar in reaction to the excess of pollution. According to the practical result of this approach, the parameters can be regulated in order to obtain the desired behavior, but a priori undetermined for each one of the different trees, creating a spontaneous and collective dance of rain.

To obtain the Amoreiras’ algorithm, we took John Conway’s game of life principles as a guide. That is, we have a set of simple rules with a complex result. However, we must remark that the final behavior is not specified by the rules, despite being derived from them, once “the rules should be such as to make the behavior of the population unpredictable” [5]. So, what we do is apply neighborhood principles to the self-evaluation process of the mulberry trees. The behavior of two adjacent mulberry trees (or only one, if it is at an extremity of the installation) is more relevant than the behavior of the more distant one. This procedure can facilitate the occurrence of behaviors with possible combinations of motor activation.

In practice, the expected result is the following: The trees will sway separately, sporadically, according to the ambient noise, so as to rid themselves of the pollution in their leaves. The action of the trees will be arbitrary at first, and during the day they will start to dialogue among themselves, becoming more and more synchronized.

Note that, although all are young, each tree is an individual. Their motors and prosthesis-boxes are similar, but not identical, so as to suitably adapt to each without hurting it.

At the end of each day, the personalities of the trees are altered at random, so as to restart the learning process. This prevents the trees from being in tune already as of the first day, so that a change in behavior will not occur, allowing them to build emerging cycles and rhythms and to continue seeking different approximations among themselves, as in a dance of leaves and trees, with their poetic prostheses rebelling against the soot, amidst the urban barbarity: It is as if the trees of the city shook to denounce the dirt in the air [6], also reminding us of the danger we live in and the situation we helped to create.

The environmental proposal of the artwork was very well perceived by neighbors and pedestrians (Fig. 2). In almost three months in public space, despite the delicate trees and coupled mechanisms, no depredation or damage was done to the installation. Pedestrians reacted very pleasantly to that unexpected visit on a so-busy avenue in São Paulo. During the exhibition period, the trees, allowed provisory as an artistic urban intervention, were full of fruit, turning the surroundings into an enchanted area and people stopped to see, touch, pick fruits, interrupting their automated walk. The red fingers of the fruit pickers and the act of removing the dust from the shoulders by those passers-by constituted an urban dance, recompising their routine, now touched by an affective factor: A memory of our forgotten yards, forgotten gardens and seemingly endless childhood times.

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