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When artists met EvoSpace-i

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***Abstract*—This paper presents a new step towards a hard goal: establishing a stronger collaboration between the art world and the field of Evolutionary Algorithms, so that both can benefit. Two were the main reasons for pursuing this goal: on the one hand the aim of studying human creative processes that may allow in the future improving computer based creativity; on the other hand we wanted to both improve available software tools and also propose a methodology allowing artists to develop collective evolutionary based artistic experiences. This paper focuses in the second goal, and shows a new addition to EvoSpace-i software tool, as well as to the methodology applied, and how it was employed by a team of artists when creating a new collective artwork.**

I. Introduction

The interests of Evolutionary Algorithms researchers in artistic and design applications can be traced back to the years when these methods became the mainstream when facing optimization problems. The book by P. Bentley was published in the nineties, the decade when EAs got public attention and recognition [1]. Although sometimes naive approaches, the variety of chapters reports applications from several domains far from the optimization arena: art, design, creativity, etc.

Since then, a plethora of works have been developed in the area, and several books [9], [8], international conferences [1] and tracks within the main ones, and even a competition [2], focus nowadays in this specific research area. Yet, all of these efforts belong to the area of Computational Intelligence, and to the best of our knowledge few works and events in the Arts world focus on Evolutionary Algorithms. Although computer science researchers are aware of the possibilities in connecting EAs and the Arts, few traditional artists seriously consider the need or opportunity for applying EAs in their daily work. A stronger collaboration is thus required: the evolutionary art equation lacks one of the main components, the artists, and one of the reasons maybe the difficulty for employing software tools that are traditionally developed by Evolutionary Algorithms researchers. Secondly, this lack of collaboration may hinder a better comprehension of artistic processes and a deeper understanding of human creativity.

This paper describes a new initiative developed in a wider context, which tries both to improve software tools so that they can be autonomously used by artists, while we learn from the artists' way of working. The synergies that arise may benefit both worlds at once.

The paper is organized as follows: Section II reviews the literature. Section III shows the software tool initially conceived for interactive EAs while section IV presents the methodology applied by the artists team. Secion V describes the improvement and changes in the software tool so that it can fit in the way artists work. Section VI shows the results obtained and finally we present our conclusions and future work in section VII.

II. The artists and the Evolutionary Algorithms

During the last decades a number of optimization software tools have been developed with Evolutionary Algorithms as the main component, some of them reaching success among EA researchers, such as ECJ [7]. Although these tools are quite useful for this community, one of the main problems for outsiders, is the difficulty for properly selecting the main parameters when a specific problem is to be solved. The problem becomes a nightmare when a non-scientist lands on any of the available tools and tries to apply it to something different, which may be the case for most traditional artists.

Computer based art has been present since computers exists: artist soon discovered how easily computers could be useful in generative art projects, and generative art, referred at the beginning to any autonomous system capable of generating art [3], is nowadays considered by many as associated to computer programs capable of generating art.

EA researchers also saw the opportunity for providing artists with new and specifically tuned algorithms and tools. Thus Interactive Evolutionary Algorithms entered the stage [13] and some easy to use web-based tools for evolutionary art were deployed, such as Picbreeder [11].

The idea of evolution within the art context is not new, and a number of artists and theorists already considered the

[1] EvoMusart

[2] GECCO art, design and creativity competition

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possibilities long ago. William Latham described an evolutionary approach to art creation [6], and the evolutionary process behind art processes was suggested by Thomas Wallas, as reported by D. Sapp in [10]. However, few traditional artists -those with a background in fine arts- employ the available software tools in their everyday activity or are even aware of evolutionary algorithms as an available method.

During the last couple of years, a new proposal based on *unplugged evolutionary algorithms* was presented and applied in a collective artwork developed by a team of five traditional artists [2]. The aim was to both study artistic creativity from the Evolutionary Algorithm point of view, while also trying to test the algorithm as a new methodology for collective artistic creation. The process developed showed the need for a specific software tool to better coordinate artists, while offering also the possibility of storing information about the evolutionary process useful for future analysis: such as the relationship among individuals in the population, the genealogy for each of the individual artwork, information on artistic preferences, etc. This led the team to tune and improve a software tool previously developed with the idea of supporting both traditional optimization processes as well as interactive approaches to evolutionary art: EvoSpace [4] and its interactive version [16]. The idea was thus to provide artists with a software tool allowing them to collaboratively apply the unplugged version of Evolutionary Algorithms. Next sections describe the EvoSpace tool, and how it has been tuned to this specific goal: making traditional artists new users of evolutionary algorithms.

III. EvoSpace and EvoSpace-i

A common approach employed when EA systems are applied to art or design projects is the use of interactive evolutionary algorithms (IEAs), where users interact with the evolving population in a specific way: evaluating the artistic value of individuals generated [14], [12].

Although several models and software tools have been developed in the past few years, we have been particularly interested in providing cloud services for evolutionary algorithms in both models, the standard and the interactive version. To the best of our knowledge, EvoSpace and EvoSpace-i where the first integrating all these features. We include below a summary of the tool considered as our starting point. Interested readers can obtain a whole picture of the tool in [4] and [16].

EvoSpace-i is a platform for the implementation of IEAs. Build over the Django web framework and EvoSpace population storage, it implements authentication of users, a rating interface, integration with the Facebook social network, folders where users can store collections of artifacts and share them with their Facebook friends and browsing of ancestors of artifacts. EvoSpace-i takes a collaborative approach, as the preferences of multiple users are considered and integrated into the evolutionary process. This is done by exploiting the use of social networking and using a distributed computing model. EvoSpace-i follows current trends in software and system development where computational resources are shared across the web and applications are available on heterogeneous computational devices. This is known as the *cloud computing model*, where infrastructure, platforms and applications are shared across the Internet. EvoSpace-i provides a platform that easily integrates into the the cloud model, and can be used to develop EvoArt services that reside on the cloud. EvoSpace-i also attempts to integrate design tools that can be used by both artists and EA researchers. In particular, EvoSpace-i exploits the Processing programming language to generate artistic designs, since Processing allows for easy representation of images, animations, audio, and data processing procedures that are intuitive to the nonprogrammer.

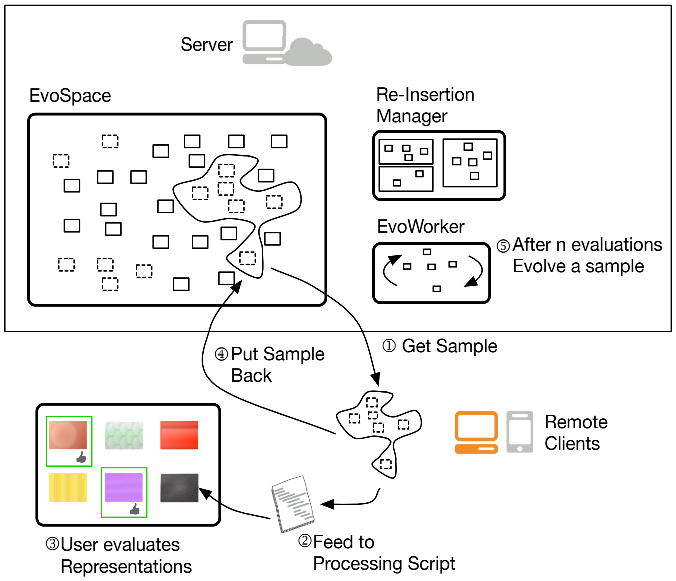
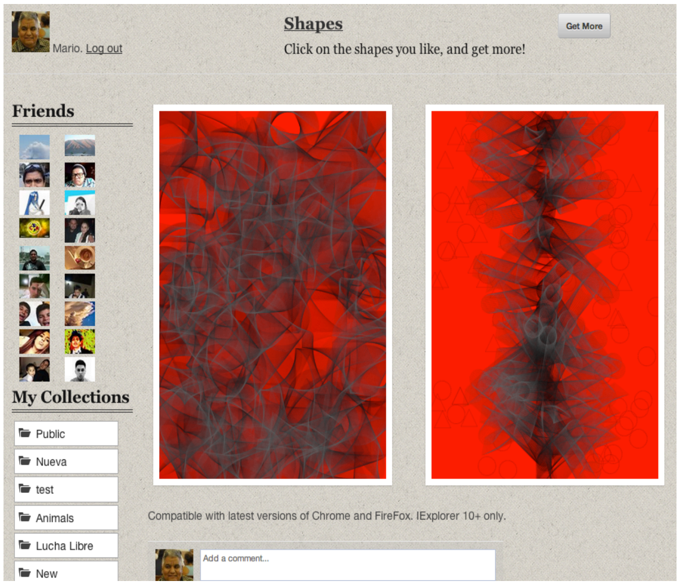

Server
EvoSpace
Re-Insertion Manager
EvoWorker
⑤After n evaluations Evolve a sample
④Put Sample Back
① Get Sample
Remote Clients
③User evaluates Representations
②Feed to Processing Script

Fig. 1. Evaluation process in EvoSpace-i

Figure 1 shows the components of EvoSpace-i and the evaluation process. EvoSpace-i is based on the EvoSpace population storage. Based on the tuple space model, EvoSpace is a service which decouples the population from the rest of the operations of the EA. In a basic configuration, EvoWorkers take a random population sample from EvoSpace, and use it as the initial population for a local EA executed on the client machine. After a certain number of local generations, the evolved population is returned to EvoSpace to replace the sample. For EvoSpace-i, a new type of Worker is needed: Human users. Users are responsible for evaluating the quality of individuals: (i) first a random sample of individuals are taken from EvoSpace, (ii) the chromosome of each individual parameterizes a Processing script, that renders a painting to the user, (iii) users select those individuals they like, this is stored in each individual's data, (iv) finally the sample is returned to EvoSpace. The fitness assigned to each individual can depend on the ratings given by a certain number of users. In this case the EvoWorker process is replaced by an Evolve() method, that is executed after a certain number of samples have been returned. Unlike the normal operation of EvoSpace, when a user takes a sample of individuals, these are returned with their identity unchanged, other than the rating added by the current user.

The graphical user interface of an IEA application implemented using EvoSpace-i is shown in Figure 2, in this case two artifacts are presented to the user; when the user is finished selecting those he liked, another two can be retrieved from the server. Several IEA experiments have been developed with EvoSpace-i (such as the one described in [15]), modifying



Click on the shapes you like, and get more!

Compatible with latest versions of Chrome and FireFox. IExplorer 10+ only.

Fig. 2. EvoSpace-i GUI

only the processing script, chromosome representation and evolutionary operators.

Nevertheless, a recently presented approach to evolutionary art by means of unplugged evolutionary algorithms, in which the whole algorithm is developed by the artists (not just the fitness evaluation process [2]) pushed us towards tuning Evospace-i to this particular way of working, while still relaying upon the cloud and the interactive nature of the tool. Therefore, we propose a new module for EvoSpace-i to enable the execution of unplugged evolutionary algorithms in an artistic context.

For a better understanding of the new requirements for EvoSpace-i, we include below a summary for the unplugged version of the Evolutionary Algorithms when run by artists, and the new project the team has faced, then describing the new version of tool and how it was employed within the project.

IV. Unplugged Evolutionary Algorithms and Collective Art

When the unplugged version of EAs is applied in an artistic context, the artist team is in charge of applying every operation within the EA, including mutation, crossover, reproduction, etc. The idea is to remove the computer, providing freedom to artists when applying the algorithm. This allows us to learn and understand the creative process from an evolutionary point of view. The Evolutionary Algorithm is thus a model that defines a methodology for a team of artists to work cooperatively when creating a collective work.

A summary of the main steps and the process to be performed within the methodology is the following one:

- Goal: Create a series of evolutionary artworks generated by a number of human agents -artists/designers- employing an adapted version of the Evolutionary Algorithm.
- Initial Population: Every artist provides an initial image with comments on the artist's personal work. Thus, the initial population is filled.
- Generations: Every artist must produce every generation -every week- a non signed artwork, so that a blind process is maintained.
- Individuals: Every artwork is the result of the application of any kind of mutation and crossover over two images selected from the previous generation.
- Coordination: Artists send by email to the hub, a digital version -photographed or scanned 2MB file- of the work together with a form filled with subjective and objective information of the images selected as parents of the new one, numerical assessment of different parameters, and a whole description on the kind of mutation and crossover operations applied.
- The hub, after receiving the whole new generation, share it with the artists team by means of a dropbox shared folder, so that every artist can analyze it and begin the next generation.
- The process is repeated for a number of generations decided by the whole team.
- The final output may be both, a single selected work, or the whole art work, as a collective indissoluble work generated.

This methodology was successfully applied in a first application and the artwork generated was shown in several cities around the world: Cancún, Madrid, Amsterdam, etc. According to the feedback provided by artists this methodology applied for artistic creation was considered of interest as new way for improving collaborative working.

We thus saw the interest in generalizing the model and providing a software tool that both easily allowed artists to work under the model, while providing information on the genealogy of the works, so that further analysis of the evolutionary process would be easily developed with the software tool.

Therefore the tool should allow any interested team of artists to define and begin a new artistic project with the parameters desired (number of artists-individuals per generation, number of generations, elitism, etc) without the need of complex operations for installing and managing a software tool by non-specialists. The cloud concept that EvoSpace-i embodies nicely fits in this idea.

We thus decided to add EvoSpace-i with the components required to allow a new artistic experience. We describe below the technical changes included, that allowed a team of artists to directly use EvoSpace-i and develop a project including some changes in the methodology (when compared with the previous experiment described in [2]):

- Individuals: A new artist joined the team, so we would have 6 individuals per generation (six new artworks every week).
- Elitism: We decided to add elitism. Thus, the best individual (most frequently selected work to act as a

parent from a generation) would remain available f the new one. Therefore a total of 7 individuals wou conform every generation: 6 new works + the best o from the previous generation.

V. New module for EvoSpace-i

The new module was designed according to the requir ments for the unplugged EA described in the previous sectio aimed to be used by an artist team. Additional design decisio are described next:

- Cloud Based: The application must run in a clou platform without dependencies of other EvoSpace modules. This will allow other researchers or artis the installation of the web service. Also depending o the platform certain level of scalability can be easi achieved.
- Open Source: The source must be open, and use on open source libraries. This will ensure that there a not additional costs for running experiments.
- Standard Based: In order to be easily extensible, t project must use open standards.
- Interactive Gallery: After the experiment, users a researchers can browse the resulting work. Users mu be able to interact with the work, browsing generatio and following inheritance trees.
- Different *Apps* would be developed for making t process even easier for artists.

The Data Model for the proposed module is shown Figure 3, a Painting class models the artwork uploaded b a single User, also in this version with a single image, an one or two parents. A Painting instance could be a memb of one or more generations. Each Generation instance ha a range of time where it could receive members. Only th generation instance with a next_generation property s to True can receive new members. Also, when a generatio is receiving new members (artworks) these are not yet visib to other artists until a new generation is created.

The module was designed using the cloud based arch tecture shown in Figure 4. The chosen hosting platform f the web application and database was Heroku, for the storag of images Amazon's Simple Storage Service (S3) was use These two services are used by the client-side code usin javascript and the JQuery library. In the remaining of th section a more detailed description of these components a presented.

A. Heroku Platform and Django Web Framework

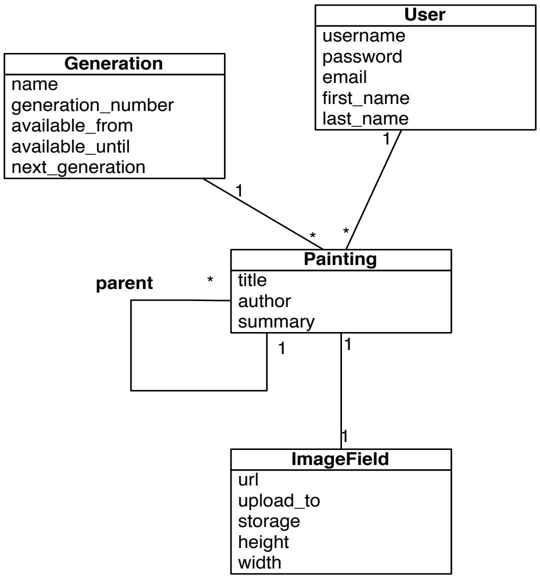


Fig. 3. Model for the unplugged version

Heroku is a multi-language PaaS (Platform as a Service supporting among others Ruby, Python and Java application The basic unit of composition in Heroku is a lightweig container running a single user-specified process. These co tainers, which they call dynos, can include web (only thes can receive http requests) and worker processes (includin systems used for database and queuing, for instance). Thes process types are the prototypes from which one or more dyn can be instantiated; if the number of requests to the serv increases more instances can be assigned on-the-fly. In our case, our Django application uses the Gunicorn application server running in one web process This model is very different from a Virtual Private Server (VPS) where users pay for the whole server; in a process based model, users pay only for the processes they need. For the current experiment only one dyno

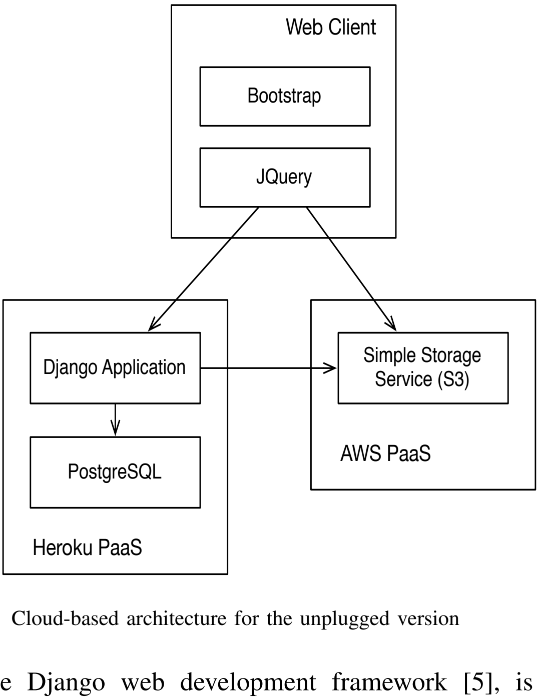
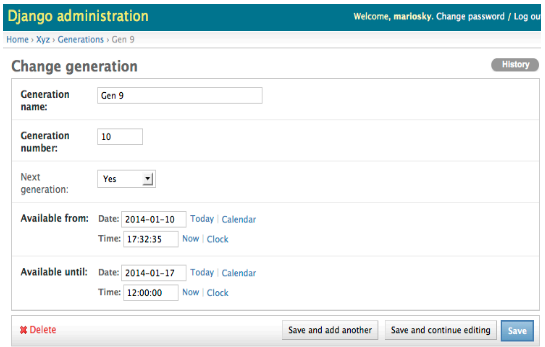


Fig. 4. Cloud-based architecture for the unplugged version

The Django web development framework [5], is a set of Python libraries, that provide high-level abstractions of common web development patterns. In Django a web application consists of different Python scripts following a Model-View-Controller (MVC) design pattern. Using a separation of concerns design principle, the application logic is separated mainly in four scripts:

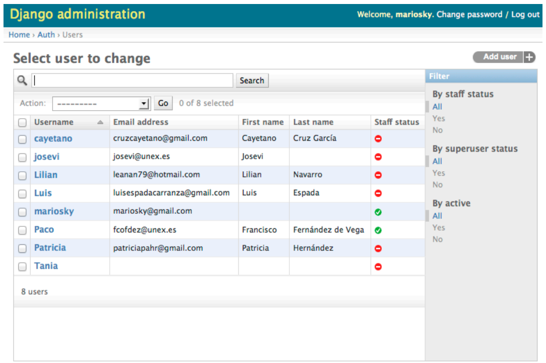
- The models.py script contains a class based description of the database schema. These classes are Object-Relational mappers with methods to create, retrieve, update, and delete records in the database system using Python code instead of SQL.
- The views.py file contains the business logic for each web page defined as special View functions. These functions receive as parameters http request data, do operations on the model (database) , and return the data through HTML generator templates.
- The urls.py file specifies which view is called for a given URL pattern.
- Various HTML template files that describes the design of the page.
- The settings.py file is where the configuration of the project is stored.

The Django framework also generates a web administration application for each model, this functionality saved development time, and the functionality offered by the application was adequate for the current experiment. Example administrative forms are: Generations in Figure 5, Users and Paintings in Figures 6 and 7 respectively.



Generation name: Gen 9
Generation number: 10
Next generation: Yes
Available from: Date: 2014-01-10 Time: 17:32:35
Available until: Date: 2014-01-17 Time: 12:00:00

Fig. 5. Administration form for Generations

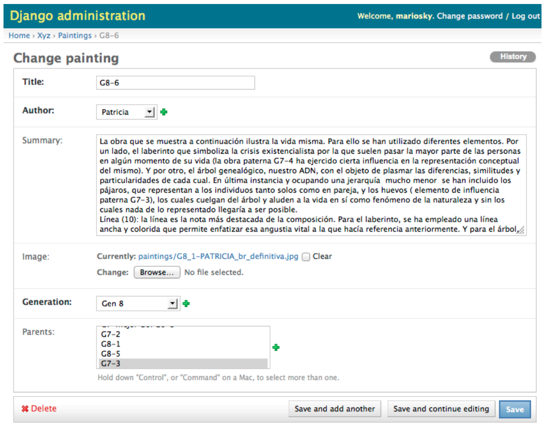


Username	Email address	First name	Last name	Staff status
cayetano	cruzcayetano@gmail.com	Cayetano	Cruz García	⊖
josevi	josevi@unex.es	Josevi		⊖
Lilian	leanan79@hotmail.com	Lilian	Navarro	⊖
Luis	luisespadacarranza@gmail.com	Luis	Espada	⊖
mariosky	mariosky@gmail.com			✓
Paco	fcofdez@unex.es	Francisco	Fernández de Vega	✓
Patricia	patriciapahr@gmail.com	Patricia	Hernández	⊖
Tania				⊖

8 users

Fig. 6. Administration form for Users

Client-side scripting is used extensively by the module. As mentioned earlier, JQuery is used in the selection of parents, sending and retrieving of images and together with other libraries the image preview functionality. Also Modal Windows, Lists, Buttons are also implemented using the JQuery-UI library. Finally the bootstrap front end framework was used resulting in a responsive Web interface. This means that the style of the web pages is automatically adapted to the screen size of the device.


Django administration
Welcome, mariosky. Change password / Log out
Home › Xyz › Paintings › G8-6
Change painting
History
Clear
Browse...
Delete
Save and add another
Save and continue editing
Save

Title: G8-6

Author: Patricia

Summary: La obra que se muestra a continuación ilustra la vida misma. Para ello se han utilizado diferentes elementos. Por un lado, el laberinto que simboliza la crisis existencialista por la que suelen pasar la mayor parte de las personas en algún momento de su vida (la obra paterna G7-4 ha ejercido cierta influencia en la representación conceptual del mismo). Y por otro, el árbol genealógico, nuestro ADN, con el objeto de plasmar las diferencias, similitudes y particularidades de cada cual. En última instancia y ocupando una jerarquía mucho menor se han incluido los pájaros, que representan a los individuos tanto solos como en pareja, y los huevos (elemento de influencia paterna G7-3), los cuales cuelgan del árbol y aluden a la vida en sí como fenómeno de la naturaleza y sin los cuales nada de lo representado llegaría a ser posible.
Línea (10): la línea es la nota más destacada de la composición. Para el laberinto, se ha empleado una línea ancha y colorida que permite enfatizar esa angustia vital a la que hacía referencia anteriormente. Y para el árbol,

Image: Currently: paintings/G8_1-PATRICIA_br_definitiva.jpg ☐ Clear
Change: Browse... No file selected.

Generation: Gen 8

Parents:
G7-2
G8-1
G8-5
G7-3

Hold down "Control", or "Command" on a Mac, to select more than one.

Fig. 7. Administration form for Paintings

B. *Amazon S3*

Amazon S3 (Simple Storage Service) is an online file storage web service offered by Amazon Web Services. S3 stores arbitrary objects (files) up to 5 terabytes in size, each accompanied by up to 2 kilobytes of metadata. Objects are stored and retrieved using standard interfaces *SOAP, REST and BitTorrent*. Amazon S3 is used by high demand services like DropBox and MineCraft, and to store images by Tumblr and Pinterest. All images and static files for the module are stored in S3, using the s3boto Django storage backend.

VI. Results

The new tool was successfully employed in the experiment we described below, developed by six artists, Cayetano Cruz, Lilian Navarro, Patricia Hernández, Tania Gallego, J. Vicente Albarrán and Luis Espada together with the coordinator, in charge of parameterizing the tool and checking the functionality, given that this was the first time the tool was employed by traditional artists. Actually, some bugs were detected and fixed along the experiment, such as that due to different images (individuals) being uploaded with the same name. Given that all of the images were stored in a single Amazon cloud folder, it was required to use different names for every image.

The artists worked in different towns without directly exchanging information along the experiment. The only place to meet was EvoSpace: every week they uploaded their new work and checked their peers' ones, to receive inspiration for the next generation.

The experiment began the last week of October 2013, and ended in the last week of January 2014. Sixty artworks were produced in the period, six per week. We describe below how the experiment was developed, some of the images created and screen-shots with the tool as employed by the artists. The elitism parameter was included in this experiment, so that the work with highest number of selections every generation was the only one surviving to the next generation. The remaining ones would be replaced by the new works created by artists every week. Therefore, every generation would include the best individual from the previous one together with the six new works.

A. *First steps: Login and uploading individuals*

As described above, the first step artist must perform every generation, and once the previous one is ready, is to login into the system. Then, they can check available individuals, evaluate them and decide which to use as parents for a new creation.

The person in charge of the coordination was responsible for uploading the initial generation (works selected by artists according to the rules described in previous section). Figure 8 shows a screen-shot of this first generation, that was then automatically shown at the beginning of the experiment to each of the artists just after login into EvoSpace. The six works selected for the initial generation were the following ones: Persistence of Memory, by Dali; A heroic feat! With dead men!, Goya; Impossible Lov3, Marc Brunet; The Kiss, Klimt; The Garden of Earthly Delights by Bosch; El locutorio de San Bernardo, Ressendi.

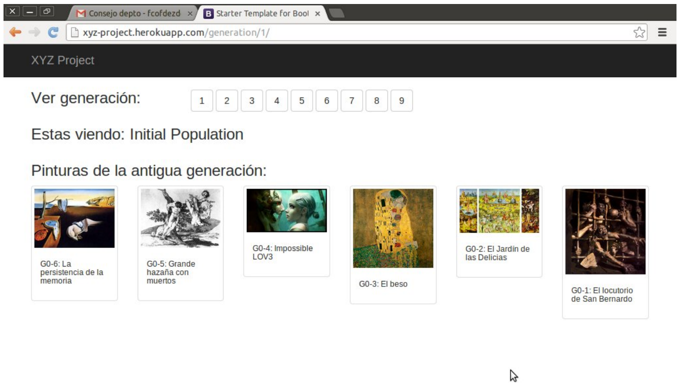

Consejo depto - fcofdezd
Starter Template for Bool
xyz-project.herokuapp.com/generation/1/
XYZ Project
Ver generación:
1 2 3 4 5 6 7 8 9
Estas viendo: Initial Population
Pinturas de la antigua generación:
G0-6: La persistencia de la memoria
G0-5: Grande hazaña con muertos
G0-4: Impossible LOV3
G0-3: El beso
G0-2: El Jardin de las Delicias
G0-1: El locutorio de San Bernardo

Fig. 8. Initial population in the cloud

Once the initial population was uploaded, artists had the opportunity to check it and take inspiration, deciding which two works would act as parents and proceeding with the creative process. The tool allowed artists to check enlarged versions of the images for a proper evaluation. Figure 9 shows how an image is shown when selected. This specific image was produced in the experiment described in generation #8.

Once an artist has produced a new work, he upload it to EvoSpace. The tool allows the artists to specify the parents, by selecting them before uploading the new child (see Figure 10). Once the parents have been selected and the new work is to be uploaded, the tool provides the artist with a form to be completed, so that he can specify why the images acting as parents have been selected, which elements have been considered from each of the parents, and how mutation and crossover operators were applied (see figure 11).

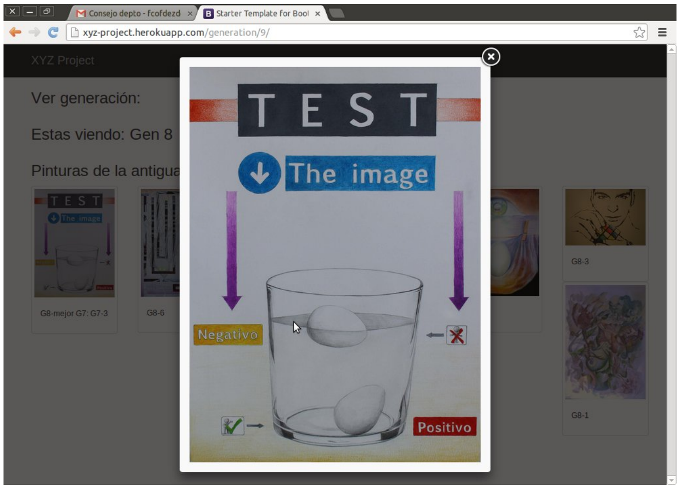


Fig. 9. Checking an Individual

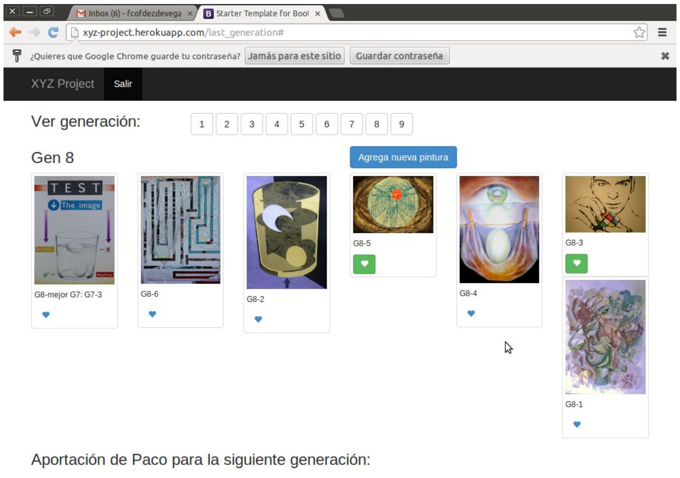

Inbox (6) - fcofdezdevega
Starter Template for Bool
xyz-project.herokuapp.com/last_generation#
¿Quieres que Google Chrome guarde tu contraseña?
Jamás para este sitio
Guardar contraseña
XYZ Project
Salir
Ver generación:
1 2 3 4 5 6 7 8 9
Gen 8
Agrega nueva pintura
G8-mejor G7: G7-3
G8-6
G8-2
G8-5
G8-4
G8-3
G8-1
Aportación de Paco para la siguiente generación:

Fig. 10. Selecting parents for the new work

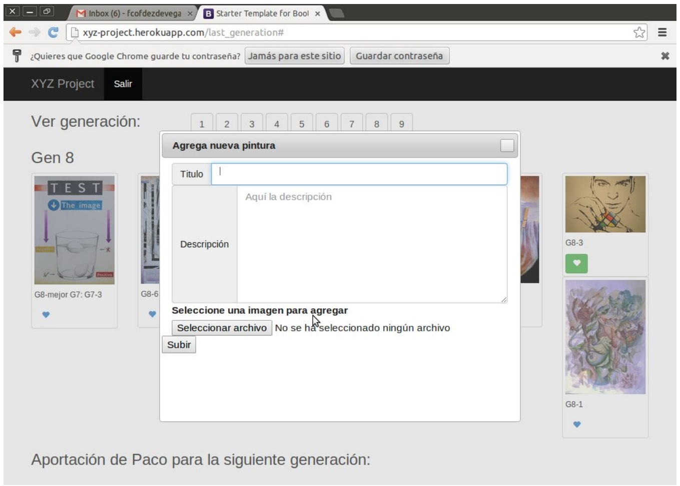

Inbox (6) - fcofdezdevega
Starter Template for Bool
xyz-project.herokuapp.com/last_generation#
¿Quieres que Google Chrome guarde tu contraseña?
Jamás para este sitio
Guardar contraseña
XYZ Project
Salir
Ver generación:
1 2 3 4 5 6 7 8 9
Gen 8
Agrega nueva pintura
Titulo
Descripción
Aquí la descripción
Seleccione una imagen para agregar
Seleccionar archivo
No se ha seleccionado ningún archivo
Subir
G8-mejor G7: G7-3
G8-6
G8-3
G8-1
Aportación de Paco para la siguiente generación:

Fig. 11. Uploading a new individual and reporting how it was produced

Although we don’t try here to perform an analysis of the results for this specific experiment, as a sample of the dynamics behind the process that the tool allows, we can see how the genetic operators were applied by artists. For instance, figures 12 and 13 both from generation #4 include a shared motif: the egg. Nevertheless, no direct translation of messages or ideas in a specific generation were allowed between artists, nor direct encoding of shapes in chromosomes. Actually no explicit chromosomes were employed in the experiment. Instead, genetic operators influenced the spread of the information that artist generated through their works. In this specific case, the origin was in an individual from the very first generation (see figure 14), that suggested the concept that was later spread along generations, even surviving up to generation 8 (see figure 9).

In order to make things even easier for artists, EvoSpace-i uses a responsive web front end that allows artists to directly take a photo of their work with their Android smartphone and upload it from there (see Figure 15).

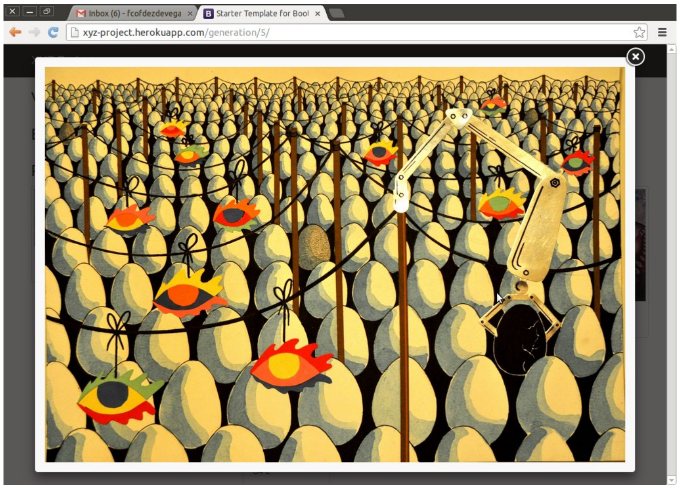

Inbox (6) - fcofdezdevega
Starter Template for Boot
xyz-project.herokuapp.com/generation/5/

Fig. 12. Individual G4-3, from generation 4 including a particular motif: the egg

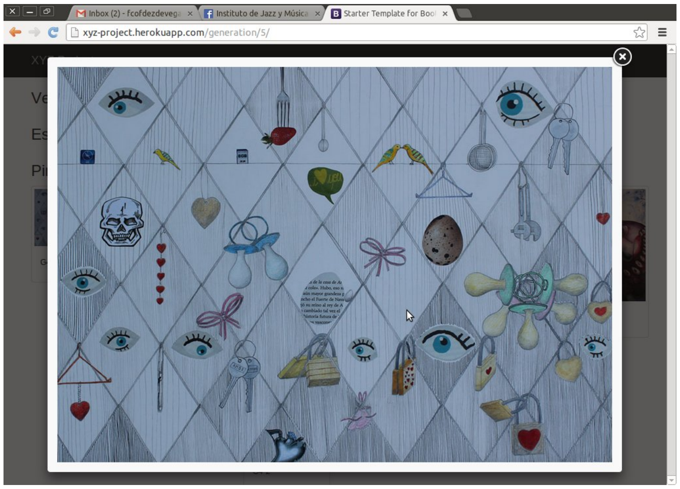

Inbox (2) - fcofdezdevega
Instituto de Jazz y Música
Starter Template for Boot
xyz-project.herokuapp.com/generation/5/

Fig. 13. A second individual in the same generation, G4-2, employing the “egg” in a different context.

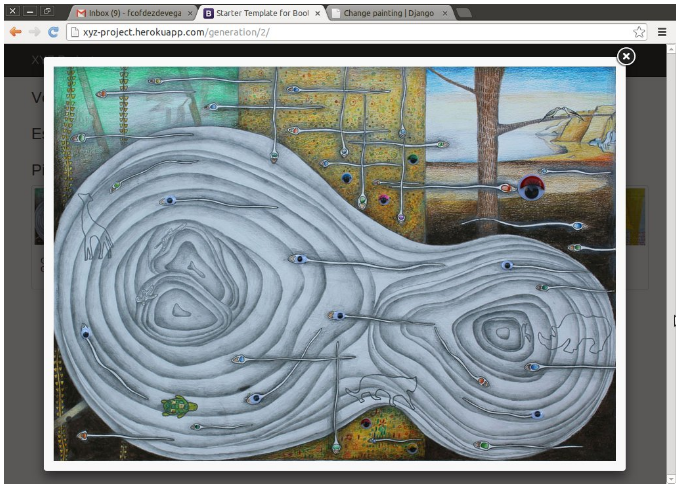
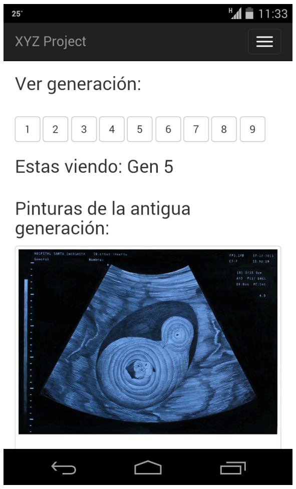

Inbox (9) - fcofdezdevega
Starter Template for Boot
Change painting | Django
xyz-project.herokuapp.com/generation/2/

Fig. 14. Individual G1-3.



Ver generación:

Estas viendo: Gen 5

Pinturas de la antigua generación:

Fig. 15. The Android App.

The work performed by artists, when properly developed, allows an interesting study of genealogy of works, procedures of interest, understanding of genetic operations from the artists point of view, etc. Although this concepts were already analyzed in our previous work [2], we stated there that a large number of *runs* of the experiment were required to assess the conclusions reached. This tool aims at providing a context allowing a number of artists teams to apply the methodology for artistic creation while also providing us with raw data to be analyzed. The specific results shown above are a sample of what the tool allows, and hope will help awakening other artists’ interest in Evolutionary Algorithms based methodologies. If an increasing number of artists meet evospace-i, we’ll have enough data to perform statistical analysis of the conclusions that may be drawn from processes that involves human creativity to be later applied within computer based Evolutionary Algorithms.

VII. Conclusion

This paper describes the improvement over Evospace-i tool and the experiment that allowed to test its functionality.

By tunning the previous version of the Evospace-i, we provide a cloud based software tool that allows teams of artists to cooperatively work applying *Unplugged Evolutionary Algorithms* when developing collective art works.

The tool allows to manage a population of artistic works for a number of generations, maintaining the genealogy of individuals, while providing artists with the opportunity to express how genetic operations have been considered and applied during the creative process.

A team of six artists have participated in a 10-weeks-long experiment, creating 60 paintings that embody genetic relationships. The tool allowed the artists to express the source of inspiration -parents- for each of the new artworks while providing insights from their creative process.

The specific results are a sample of what the tool allows, and may awake other artists' interest in Evolutionary Algorithms based methodologies.

We hope that the new tool will enhance the collaboration among artists and researchers, providing the opportunity for collecting enough data that may help to understand human creative processes and eventually translate them into better EAs devoted to art and design.

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References

[1] P. Bentley, *Evolutionary Design by Computers.* Morgan Kaufmann: Springer-Verlag, 1999.

[2] F. Fernandez de Vega, L. Navarro, C. Cruz, F. Chavez, L. Espada, P. Hernandez, and T. Gallego, "Unplugging evolutionary algorithms: On the sources of novelty and creativity," in *2013 IEEE Congress on Evolutionary Computation (CEC).* IEEE, 2013, pp. 2856–2863.

[3] P. Galanter, "What is generative art? complexity theory as a context for art theory," in *In GA2003–6th Generative Art Conference*. Citeseer, 2003.

[4] M. Garcia, L. Trujillo, F. Fernández-de Vega, J. Merelo, and G. Olague, "Evospace: A distributed evolutionary platform based on the tuple spacemodel," *Proceedings from EvoApplications 12*, pp. 499–508.

[5] A. Holovaty and J. Kaplan Moss, "Introduction to django," in *The Definitive Guide to Django*. Apress, 2008.

[6] W. Latham, "Form synth: The rule-based evolution of complex forms from geometric primitives," in *Computers in art, design and animation*. Springer, 1989, pp. 80–108.

[7] S. Luke, L. Panait, G. Balan, S. Paus, Z. Skolicki, J. Bassett, R. Hubley, and A. Chircop, "Ecj: A java-based evolutionary computation research system," *Downloadable versions and documentation can be found at the following url: http://cs. gmu. edu/eclab/projects/ecj*, 2006.

[8] J. MacCormack and M. d'Inverno (eds), *Computers and Creativity*. New York: Springer-Verlag, 2012.

[9] J. Romero and P. Machado, Eds., *The Art of Artificial Evolution: A Handbook on Evolutionary Art and Music*, ser. Natural Computing Series. Springer Berlin Heidelberg, November 2007.

[10] D. D. Sapp, "The point of creative frustration and the creative process: a new look at an old model," *The Journal of Creative Behavior*, vol. 26, no. 1, pp. 21–28, 1992.

[11] J. Secretan, N. Beato, D. B. D'Ambrosio, A. Rodriguez, A. Campbell, J. T. Folsom-Kovarik, and K. O. Stanley, "Picbreeder: A case study in collaborative evolutionary exploration of design space," *Evol. Comput.*, vol. 19, no. 3, pp. 373–403, 2011.

[12] Y. Semet, "Evolutionary computation: a survey of existing theory," University of Illinois, Tech. Rep., 2002.

[13] H. Takagi, "Interactive evolutionary computation," in *Proccedings of the 5th Int'l Conf. on Soft Computing*, 1998, pp. 41–50.

[14] ——, "Interactive evolutionary computation: fusion of the capabilities of ec optimization and human evaluation," *Proceedings of IEEE*, vol. 89, no. 9, pp. 1275–1296, 2001.

[15] L. Trujillo, M. García-Valdez, F. Fernández-de Vega, and J.-J. Merelo, "Fireworks: Evolutionary art project based on evospace-interactive," in *2013 IEEE Congress onEvolutionary Computation (CEC).* IEEE, 2013, pp. 2871–2878.

[16] M. G. Valdez, L. Trujillo, F. F. de Vega, J. J. Merelo, and G. Olague, "Evospace-interactive: A framework to develop distributed collaborative-interactive evolutionary algorithms for artistic design," in *Proceedings EvoMusart 2013*, 2013.