EvoEvo Project
FP7-ICT FET Proactive EVLIT program
Project reference: 610427

Deliverable 6.5
Mid-term dissemination report
Version 1.6

EvoEvo Deliverable 6.5

Mid-term dissemination report

Due date:	M18 (May 2015)
Person in charge:	Guillaume Beslon
Partner in charge:	INRIA
Workpackage:	WP6 (Management)
Deliverable description:	Mid-term dissemination report. This report should prepare the final dissemination workshop, select conferences where to present the results and journal where to publish position papers to disseminate the results and concepts of the project.

Revisions:

Revision no.	Revision description	Date	Person in charge
1.0	Definition of dissemination policy	28/04/15	G. Beslon (INRIA)
1.1	Draft of the dissemination report	12/05/15	G. Beslon (INRIA)
1.2	Corrections by Dominique Schneider	21/05/15	D. Schneider (UJF)
1.3	Corrections by Santiago Elena	23/05/15	S. Elena (CSIC)
1.4	Corrections by Paulien Hogeweg	23/05/15	P. Hogeweg (UU)
1.5	Corrections by Susan Stepney	23/05/15	S. Stepney (UoY)
1.6	Final corrections by Guillaume Beslon	23/05/15	G. Beslon (INRIA)

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1. Introduction

The purpose of deliverable 6.5 is to present the dissemination plan for the results of the EvoEvo project. It comes complements the deliverable 6.2 (project communication media) that presented the communication material of the project.

Dissemination is considered as a key activity for the EvoEvo project and all partners are encouraged to get involved in all aspects of dissemination activity. Indeed, the objective of EvoEvo dissemination is to trigger a new line of research in evolutionary biology and evolutionary computation and to show its potential as a route toward "living technologies". This report presents the dissemination activities of the project in direction of academics, industrials and the general public. This dissemination plan is based on an analysis of the characteristics of the project (highly risky proactive interdisciplinary research). This analysis is presented in section 2 (dissemination policy). Note that this document is intended to evolve along the course of the project to account for the scheduling and preparation of the main dissemination activities (in particular the EvoEvo workshops).

2. Dissemination policy

EvoEvo (Evolution of Evolution) is a project within the Seventh Framework Programme of the European Community under the Information and Communication Technologies work programme. The EvoEvo project is by nature an interdisciplinary project in which at least two disciplines closely interact:

- Evolutionary microbiology and experimental evolution
- Computational biology and artificial life
- Computer science and evolutionary algorithms

Moreover, during the project, interactions between the disciplines are intended to increase as interactions between workpackages increase. All members of the project are used to such interdisciplinary interactions. They are also aware that an efficient dissemination strategy must take into account the specificity of the dissemination target. That is why, in the EvoEvo project, the dissemination strategy targets different media depending on the scientific message.

The second characteristic of the EvoEvo project that must be taken into account to design the dissemination policy is that EvoEvo is a proactive activity that intends to explore unknown or almost unknown scientific domains. As stated in the Description of Work document (section B1.1.3), *nobody really knows what living technologies will look like, how they will be implemented nor what they will be useful for. EvoEvo aims at a better understanding of what living technologies could be in a near future and how they could be used in a real context*. In other words, we consider that the mark of success of EvoEvo will not be its results but its ability to trigger new research in the different domains covered by the project. In particular, we will not seek direct industrial applications of the project results. We will rather propose visible demonstrators illustrating the potential of the ideas developed in the project to create evolving technologies that evolve continuously while interacting with their users.

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Taking into account both aspects of the project, we propose a dissemination plan organized in 4 areas:

1. Dissemination of the results in life sciences (including computational biology)
2. Dissemination of the results in computer science (including artificial life[1])
3. Dissemination of the "EvoEvo" concepts, ideas and potential
4. Dissemination of the "living technologies" concepts, ideas and potential

Note that areas 1 and 2 are targeting specific scientific communities and intend to communicate results. Thus the dissemination strategies for these two areas are quite classical. On the other, hand, areas 3 and 4 are intrinsically interdisciplinary and intend to communicate concepts. We thus adopt here more proactive dissemination strategies. Indeed, targeted audience and communication media used in these different areas must be suited to their specific objectives. The following sections describe the dissemination policy proposed for these four areas.

3. Area1: Dissemination in life science

3.1. Objective

A large part of the project consists of *in vivo* (WP1) and *in silico* (WP3) experimental evolution. The objectives are to unravel EvoEvo properties in real and simulated systems and to understand how these properties are selected depending on the evolutionary conditions. WP1 and WP3 will produce results of great interest for the life science community that will be disseminated independently of their use in workpackages 4 and 5.

3.2. Target audience

The main target audience covers the whole life science academic community with a specific focus on evolutionary biologists, microbiologists (virologists and bacteriologists) and computational biologists. A secondary target audience is composed of actors of public health (politicians, physicians, industrialists…) who may be interested in our results and tools to better understand and cure infectious diseases.

3.3. Dissemination strategy

The two target audiences require different media. In life sciences, the audience is composed of academics, and the dissemination strategy is clearly based on publications in scientific journals. High potential impact results will be submitted to generalist journals (*Nature*, *Science*, *Proc Natl Acad Sci USA*, *PLoS Biology, eLife*). Medium impact results will be submitted to more specialised journals depending on the domain of interest. Targeted journals include (but are not limited to):

- *Genome Biology and Evolution,*

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[1] Artificial life and computational biology are close fields with similar research objectives and similar methods. However they strongly differ in the disciplinary backgrounds. Computational biology is rooted in life science and uses the same publication and communication strategy (e.g., results are published in scientific journals ranked by Impact Factor). On the other hand, artificial life is rooted in computer science. Results in artificial life are mainly published in conferences (ranked by their historical reputation). Journals are often used to publish long versions of conference communications. Although, in the EvoEvo project, we do not distinguish computational biology from artificial life, these specificities must be taken into account to design the dissemination policy.

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- *Molecular Biology and Evolution,*
- *PLoS Computational Biology, PLoS Genetics and PLoS Pathogens*
- *BMC Evolutionary Biology,*
- *Evolution,*
- *Journal of Evolutionary Biology*
- *Journal of Virology,*
- *…*

Finally, low impact but still interesting results will be submitted to the open-access generalist journal such as *PLoS One* or *Scientific Reports*.

As far as actors of public health are concerned, the dissemination strategy requires more direct communication. INRIA communication and translational services are in charge of organizing joint meetings with industrialists, politicians and physicians to disseminate the results of the project. It is of course impossible to present here a long-term schedule of such meetings. However, it is worth noting that the project and its results (including the simulator of antibiotic resistance evolution) have been recently presented to a panel of start-ups and physicians during a Lyon BioPôle meeting on infectious diseases (December 10th 2014), at the French senator chamber (February 11th 2015), to a panel of young researchers in computer science (March 12th 2015) and to the pharmaceutics company Biomerieux (June 9th 2015).

4. Area 2: Dissemination in computer science

4.1. Objective

The ultimate objective of the EvoEvo project is to propose new evolutionary algorithms able to self-adapt by exploiting the EvoEvo strategies unravelled by the biology/computational biology side of the project. The project thus follows the research agenda laid out in [Banzhaf *et al.,* 2006]: that for the development of computational evolution, we need a form of artificial evolution that integrates more ideas from biology and evolutionary biology.

4.2. Target audience

New bioinspired metaheuristics classically take more than ten years to diffuse in the machine learning community and finally be used on real world problems. We thus consider that targeting some potential "final users" would be at best a waste of time, at worst a mistake. Rather, we will communicate our results to the evolutionary algorithms community, including the artificial life community.

4.3. Dissemination strategy

4.3.1. Conference communications

In computer science, the publication delays in scientific journals are often unbearable. That is why, although we do not reject *a priori* the possibility of publishing in journals (e.g., *Evolutionary Computation, Artificial Life, Unconventional Computing…*), we will preferentially target computer science conferences specialized in evolutionary computation, artificial life or natural computing. The list of targeted conferences includes but is not limited to:

- The Genetic and Evolutionary Computation Conference (*GECCO*)

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- The International Conference on the Synthesis and Simulation of Living Systems (*ALife*)
- The European Conference on Artificial Life (*ECAL*)
- The IEEE Conference on Evolutionary Computation (*IEEE CEC*)
- IEEE International Conference on Self-Adaptive and Self-Organizing Systems (*SASO*)
- The International Conference on Unconventional Computation and Natural Computation (*UCNC*)
- …

Beside these conferences that are the most prestigious in the domain, we will also target more specialized workshops. These workshops will enable us to directly disseminate our results in the specialized community of self-adaptive metaheuristics and bioinspired algorithms. The list of such workshops is impossible to draw here but one can cite, for instance, the International Workshop on Information Processing from Cells and Tissues (*IPCAT*).

4.3.2. Software, demonstrators and benchmarks

Beside conferences communications, all software developed in the project will be made available on the project website (http://www.evoevo.eu/software/). In particular models developed during WP2, frameworks developed during WP4 and applications developed during WP5 will be made available. Moreover, for all domains for which benchmarks are available (e.g. subspace clustering [Muller *et al.*, 2009]), our software and algorithms will be tested on these benchmark and the results will be published in conference communications and made available as demonstrators on the project website.

5. Area 3: Dissemination of the "EvoEvo" concepts, ideas and potential

5.1. Introduction

The term "EvoEvo" stands for "Evolution of Evolution". Partners 1 (INRIA) and Partner 2 (UJF) coined the term in 2012 in a joint publication [Hindré *et al.*, 2012]. One of the objectives of the EvoEvo project is to unravel the research potential of this concept and possibly to launch new research directions and create an academic community gathering biologists and computer scientists to study them. To this aim, it is essential to widely disseminate the *concept*, explain its power and potential, and position it in the global framework of Darwinian and neo-Darwinian theory. It is important to stress the fact that, contrary to the two first dissemination objectives, the idea here is not to widely disseminate the *results* but rather to create a scientific community willing to develop the EvoEvo concept and to explore its potential. Thus, the dissemination strategy must be different from the two previous ones. Indeed, the objective here is not to present scientific results to a large community but to orient scientists' sight in a new direction.

5.2. Target audience

The target audience is the academic community and more precisely every scientist interested in evolution, either from the evolutionary biology side or from the evolutionary computation side. This may also cover mathematicians, physicists or computational biologists developing models in evolutionary biology.

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5.3. Dissemination strategy

Due to the specific objective of this dissemination activity, the strategy must be more complex than the "simple" publication of the results of the project in scientific journals or conferences (although we will of course use these results to reinforce our message). We will follow three complementary lines of dissemination:

- Position paper(s) will present the general ideas and explain the EvoEvo concept,
- Workshops will gather the core of the scientific community interested by EvoEvo to explore the concept more thoroughly,
- Special issues in scientific journals will present the community's opinion and work on EvoEvo.

5.3.1. Position papers

In the course of the project several position papers will be submitted to scientific journals. These position papers will cover different topics and will be written by different collections of authors. Three position papers are planned at this stage but others may result from the EvoEvo workshops:

- At least one position paper will be submitted to a renowned journal in evolutionary biology. This position paper will be signed by the researchers directly contributing to the EvoEvo project. It will present the core of the EvoEvo concept. In particular, this position paper will argue for a unified analysis of several lines of research that are currently isolated and dispersed (e.g. researches on evolution of variability [Lynch, 2010], evolution of robustness [[van Nimwegen et al., 1999; Wagner, 2007], evolution of evolvability [Pigliucci, 2008] and evolution of epistasis [Phillips, 2008]). It will propose EvoEvo as this unified view. This position paper will be submitted to a highly visible journal in evolutionary biology. Our main target will be *Trends in Ecology and Evolution* (IF: 18.987) but depending on the final format of the paper, another journal of interest could be *Nature Reviews Genetics* (IF: 39.794).
- Following the open-endedness evolution workshop held in July 2014, a position paper is under progress to present the results of the workshop. The researchers who attended the workshop will collectively sign this paper. The paper will be submitted to an interdisciplinary journal like *Journal of the Royal Society Interface* (IF: 3.856). Note that, depending on the final content of the paper, a long version may be submitted to an open digital repository like *arXiv* and a condensed version submitted to a scientific journal.
- The two first position papers will mainly target the evolutionary biology and the artificial life academic communities respectively. The opportunity of writing a position paper targeting the evolutionary computation community will be discussed when the first results of WorkPackages 4 and 5 have provided sufficient justification for our approach. Note, however, that the objective of this paper will not be to present the results of the project but rather to try to convince the community to follow the EvoEvo approach while diversifying it. Note also that, depending on the results obtained during the project, this paper will not only present the "Evolution of Evolution" concept but also the "living technology" approach followed in the EvoEvo project. The targeted media will be discussed later. An interesting choice would be *Evolutionary Computation* (IF: 3.733) or *IEEE Transactions on Evolutionary Computation* (IF: 5.545) but, as claimed above, publication delay may be unacceptable. A more viable choice could be sending a position paper in a highly visible conference like *GECCO*.

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5.3.2. EvoEvo workshops

The position papers are not enough to create a scientific community. As proposed in the Description of Work document of the EvoEvo project, we will organize workshops to foster discussions and gather different views from the academic community. Two workshops are planned in the course of the project and other will follow if the two first ones are clear success.

- The first EvoEvo workshop is being organized as a satellite workshop of the ECAL 2015 conference in York (UK). It will be a one-day-long workshop (to be held on July 24th 2015). Eight submissions have been received for the workshop and the program is currently under discussion (reviews are due by the end of may). Due to the context of the conference, this workshop will mainly gather scientists from the artificial life community, which is not sufficient in our objectives[2]. That is why we will organize a second workshop during the third year of the project.
- The second EvoEvo workshop will be organized in fall 2016. To ensure a large audience, it will last two days and the program will be composed of invited conferences and short presentations selected upon abstract submission (a classical format in life science, although unusual in computer science). Invited speakers will comprise life scientists studying evolution through experimental evolution of microorganisms and computer scientists working on the "digital evolution" models [Adami, 2006]. As for the first EvoEvo workshop, the scientific committee will comprise the 5 PIs of the EvoEvo project (G. Beslon, S. Elena, P. Hogeweg, D. Schneider and S. Stepney). The list of invited speakers is currently being discussed and will include, among others:
  - Richard Lenski (Michigan State University, USA)
  - Santiago Elena (CSIC, Spain)
  - Gregory Velicer (ETH, Switzerland)
  - Paul Rainey (Massey University, New Zealand)
  - Charles Ofria (Michigan State University, USA)
  - Carole Knibbe (Université Claude Bernard, France)
  - Lee Altenberg (KLI, Austria)
  - Nobuto Takeuchi (University of Tokyo, Japan)

5.3.3. Special issue in scientific journals

Following the second EvoEvo workshop, we will edit a special issue of a scientific journal[3]. This special issue will constitute a forum for researchers interested by the EvoEvo concept and provide a unified view of the field at the end of the EvoEvo project. The targeted journal will be *BMC Evolutionary Biology* which exactly covers the scope of the workshop. A second journal may be targeted specifically for ICT results: the *International Journal of Unconventional Computation*.

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[2] Note that another workshop was proposed as a satellite of the *Mathematical Models in Ecology and Evolution* conference (Paris, July 2015). Unfortunately, this proposal was accepted by the organisers of the conference.

[3] The opportunity to propose a special issue after the first EvoEvo workshop will be discussed after the workshop depending on the quality of the discussions and oral contributions.

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6. Area 4: Dissemination of the "living technologies" concepts, ideas and potential

6.1. Introduction

As stated in the Description of Work (section 1.1.3), "*creating "living technologies" is a will that is sustained by the extraordinary capacities we observe in the living kingdom (far above the capacities of our artificial systems). However, the roadmap toward this will still contains too many* terrae incognitae *to efficiently draw a path toward living technologies. Actually, nobody really knows what these technologies will look like, how they will be implemented (will it be software, hardware, "wetware" technologies?) nor what they will be useful for (will they complement extant technologies or replace them?). […] EvoEvo also aims at a better understanding of what living technologies could be in a near future and how they could be used in a real context*". Indeed, one of the motivations of the project is to create a proof of concept showing the potential of living technologies. However, the DoW also states "*the route towards real living technologies is clearly longer than a three-year project [and that the project aims at] providing important insights on what living technologies could be, how they could be integrated to extant technologies and, ultimately, how they could serve humans and societies*". The objective of this fourth dissemination area is to communicate the potential of living technologies – as shown by the project results – and to trigger the use of such technologies by other actors than the project partners.

6.2. Target audience

Contrary to area 2 (section 4) that may seem similar at first sight, the target audience here is not composed of academics (though academics may also be interested) but rather of technological companies and developers that may be interested in integrating – or simply testing the integration of – evolving/living bricks in their technological solution. At a lower level, computer science undergraduate or graduate students may also be targeted since launching their own project using living technologies can interest them. Partners 1 (INRIA) and 4 (University of York) are involved in computer science departments of universities or engineering schools. Both partners will be in charge of communicating in direction of their respective students.

6.3. Dissemination strategy

The dissemination strategy of area 4 must take into account the specificities of the target audience. That is why it will not be based on academic publication but rather on demonstrators and on their diffusion.

6.3.1. Demonstrators

Workpackage 5's objective is to develop proofs of concept of the applicability of living technologies using the EvoEvo concepts. Two proofs of concept are planned, one is a data-stream classifier (task 5.1) and the second one is the evolution of a personal companion (task 5.2). Both will be designed to enable easy distribution of the demonstrators, either directly (the code being freely available on the project website) or indirectly (through public demonstration videos available on the project website). The proposed demonstrators are the following ones:

- **EvoWave**. In task 5.1, the data-stream classifier will be applied on classification of Wi-Fi signals and the result of the classification will be used as a context signal to help computer

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users by reorganizing all or part of their desktop depending on the context of use (e.g. propose shortcuts to the files previously opened in the same context). Indeed, any mobile device receives almost permanently a very complex combination of Wi-Fi signals provided by many different other devices. Our population of virtual evolving cells will be used to classify these signals and the resulting classes will be interpreted as the working context of the mobile devices. This application does not need any specific material and can be easily tested on any (modern) computer. Thus it can be made available on the project website for testing by the community.

- **EvoMove**. In task 5.2, we propose to classify sensor signals and use the classification models to generate actions that are likely to change the signals themselves, *i.e.* to change the world sensed by the sensors. This will create the classical enaction loop [Varela et al., 1993]. At first glance this could be done using robotic devices, but it is difficult to imagine a robot with no goal while having no explicit goal is one of the conditions for open-endedness to emerge. To overcome this difficulty, we propose to use the sensors that measure body movements, to classify them using our algorithms and to use the resulting classes to produce sounds or, ideally, music. Two demonstrators can be derived from this idea. One will be a new kind of electronic instrument that will evolve as the musician plays with it (in other words, an instrument that adapts its sound and gesture as the musician uses it). The second demonstrator will be a dance creation. More precisely, we propose that one or a few dancers be equipped with body sensors and that the stage be also equipped with sensor networks. Our virtual cells will evolve in the data generated by the sensors and use them to produce sounds and/or lights that will in turn influence the dancer movements. The system will thus have to learn to interact with the dancers in a true open-ended way[4]. Both demonstrators will need specific sensors and sensor-networks and will thus be difficult to use outside of the project. Their dissemination power will clearly depend on the quality of the results and on their use by artists in their plays and performances. Partner 1 (leader of WP5) will use the resources of its sub-contractor partner (INSA-Lyon) to test these applications and disseminate them. Indeed, INSA-Lyon is an engineering school that offers to the student the possibility to study music, dance or theatre in parallel with their technical studies (in structures called "artistic sections"). Thus this institution is strongly involved in art-science interactions that are at the heart of these demonstrators. Students of INSA-Lyon studying electronic music and dance will be our first beta-testers and depending on the first results, the artistic sections will serve as dissemination actors towards professional artists.

6.3.2. Media and video

As stated above, only our first demonstrator will be easily usable without specific material[5]. The following ones (music instrument and dance play) will be disseminated directly (through real performances) but also indirectly through media available on the project website and possibly on social networks. These media will include music and video of the performances as well as interviews of artists and scientists to explain the specifics of the technology and the interest of interacting with it.

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[4] The possibility of including simple robotic devices (Sphero [sphero]) in the system and to have dancers playing with them is under study but cannot be guarantied so far.
[5] The use of more easily available sensing devices (e.g., smart-phone accelerometers, smart watches) to produce music will be envisaged depending on the results obtained. This possibility would considerably enlarge the dissemination power but its outcome clearly depends on the simplicity to use the application. That is why it cannot be firmly proposed at that point.

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6.3.3. Software toolbox

The software developed during the project will be made available as components to be re-used for other applications. These components will be proposed to computer science departments for the students to be able to test them and develop their own use of the system. This will trigger innovative use of living technologies and – if successful – will reinforce considerably its dissemination[6].

6.3.4. Communication in technological journals and blogs

Finally, depending on the conclusion of the project and on the outcomes of the proof-of-concept applications, we will propose communications in technological journals or blogs such as *wired*. These communications are not intended to disseminate the results of the project (which is the objective of dissemination area 2) but rather to explain what living technologies could be. Note that, as for dissemination area 1, this activity will be relayed by the communication services of our institutions.

7. Conclusion

The EvoEvo project is a high-risk proactive project. From the very beginning of the project, it has been stated that nobody could foresee the outcome of the project for the very simple reason that nobody really knows what living technologies will be, will serve to or even if they will really emerge in the near future. This high risk renders the planning of dissemination activities difficult since they will of course depend on the outcomes of the project. To avoid these difficulties we have divided the dissemination activities in four areas of growing interest and growing uncertainty.

At the mid-term of the project, we are proud that dissemination areas 1 (Dissemination in life science) and 2 (Dissemination in computer science) are already progressing well, with paper published or to be published in renowned journals (*eLife*, *Molecular Biology & Evolution*, *mBio*, *Journal of Mathematical Biology*…) or conferences (ALife 2014, GECCO 2015, ECAL 2015). Dissemination area 3 (Dissemination of the "EvoEvo" concepts, ideas and potential) has already started with the first EvoEvo workshop to be held as a satellite workshop of the upcoming ECAL 2015 conference (York, UK) in July. Dissemination area 4 (Dissemination of the "living technologies" concepts, ideas and potential) could not start before the mid-term of the project since it strongly relies on WP5 that starts at M18. However, it has already been actively discussed and the final demonstrators to be developed in WP5 have been designed to facilitate dissemination of the project core ideas. Of course, at that point, the outcome of the project is still wide open but, if successful, all tools to organize an efficient communication plan will be ready.

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[6] As an example of such collaboration, a group of five undergraduate students of the computer science department of the INSA-Lyon (France) is already interested in using living technologies to develop an alarm-clock able to adapt to its user.

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