SICSA Distinguished Visiting Fellow Award – REPORT

Prof. Enrique Alba

August 26th, 2021

This is a summary of the activities performed by Prof. Enrique Alba (Univ. of Málaga, Spain) in collaboration with Robert Gordon University (RGU) in Aberdeen and the University of Stirling. This visit has been funded by SICSA, and happened in the time frame lapsed since July 11th and August 15th 2021.

This visit has been subject to present regulations during the COVID pandemic, and then the travel and stay in the UK was adapted to the needed timing for flights, tests, and rules governing physical meetings. As a global outcome, we can clearly declare it as a SUCCESSFUL large set of many activities relating research, teaching, and international collaborations between the three universities involved, plus a direct benefit also to researchers from other Scottish universities participating in them (Edinburgh and Glasgow).

The list of activities developed while visiting Scotland is as follows:

A. Numerous weekly meetings with Prof. John McCall (RGU), either remote and in person. The outcome is a higher understanding on the scientific problems at RGU and the new Subsea Center, plus concrete proposed advances with RGU researchers and PhD students.
B. Two long meetings in person with Dr. Alexander Brownlee (U. Stirling), plus other shorter remote meetings along the visit. In addition, various other meetings with PhD students of Dr. Brwonlee took place, with discussions on future research steps and papers.
C. Three plenary seminars on Evolutionary Computation, Smart Cities, and Industry 4.0, respectively. They were attended by a considerably large number of researchers, leading to fruitful discussions and potential new collaborations between Scottish groups as a result.
D. Other meetings and interactions with local staff, like Dr. Chris Pearson (Director of the Subsea Center in RGU) and Prof. Gabriela Ochoa (researcher at U. Stirling).

We hope to have benefitted a large number of teachers and researchers at as least two Scottish universities, with ramifications for collaborations with the visitor and between themselves also in the near future. Here follows the detail on every block of activities.

As to meetings and research at RGU (A), we have discussed on extensions of existing algorithms in the domains of multiobjective problems, dynamic environments, parallel versions of metaheuristics, and theory of landscapes. We have also met to address existing issues in deep learning and applications to industry, in combination with optimization techniques. Profs. Alba and McCall have had numerous in person meetings with local researchers (both postdoc and PhD students) to go over present research topics at RGU and potential improvements coming from the expertise of Prof. Alba in similar fields. Besides that, several meetings took place in order to talk on conference publication and organization, links to industry, new ways of structuring the future work at the Subsea Center, and future collaborations between the teams at RGU and Univ. of Málaga.

As to the collaborations with Dr. Brownlee (B), we had the opportunity of having fruitful discussions with researchers at U. Stirling in topics related to multiobjective optimisation, surrogate models for time-consuming real applications, and floating point optimisation with advanced techniques. We had also the opportunity to discuss on new ways for building modern research groups that interact with industry, promoting not only good research but innovation from the university to the market.

As to the series of seminars (C), we held three of them with considerable success in terms of meaningful scientific discussions and number of attendees. In particular, the three seminars where offered through Zoom to a wide audience coming from different Scottish universities, being the titles the following ones:

1. Perspectives on Evolutionary Computing: Achievements and Challenges (July 28th 2021)
2. Intelligent Systems for Smart Cities (August 4th 2021)
3. Artificial Intelligence and Industry 4.0 (August 11th 2021)

Please, find more details on these seminars at the end of this report in the Appendix.

Finally, as to the various other scientific interactions (D), Prof. Alba had the opportunity to discuss on scientific and organizational matters with Dr. Pearson, in relation of the new Subsea Center, the challenges and different ways of organization for it. There is a big potential of future collaborations of this center and the research team in Spain because of the scientific topics in common and the already going on relationship in terms of publication in similar conferences and journals, plus the will to improve human resources in making future visits between fellows in both countries. In a similar line of work, Prof. Alba had the opportunity to interact with Prof. Ochoa (U. Sitirling) on ACM SIGEVO issues, the organization of GECCO, future research in visualization of problem landscapes, and potential extensions to industry products and new grants.

In brief: the work, interactions, benefits, and future collaborations (with already planned journal papers, visits, joint participation in grants) between the groups in Spain and in Scotland have been clearly targeted and advanced in this visit. The funds received from SICSA have then been used for the good of science and a higher quality of the involved universities, thanks in particular to the great disposition to interact and collaborate of every single Scottish researcher met by Prof. Alba.

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Appendix – Open Seminars for Scottish Universities

1. Perspectives on Evolutionary Computing: Achievements and Challenges

Among the many modern and effective techniques for search, optimization, and machine learning, Evolutionary Computing represents a family of exceptionally important algorithms whose natural inspiration has led them to solve open problems in science and industry.

After their initial proposal, many years of development produced genetic algorithms, evolution strategies, genetic programming and many new types of evolutionary algorithms that were first seen as black boxes ready to allow researchers solve with accuracy their problems in virtually every domain of knowledge: medicine, logistics, software, telecoms, and a long etcetera. Soon after, theory and computational extensions came, digging into their nature and the way of solving real problems. Thus, hybrids, ensembles, new operators, new representations, and new search landscape analyses appeared, to transform them not only into precise but also into efficient techniques well beyond the early results needing considerable computation times.

Nowadays, evolutionary algorithms represent a healthy and large field of research, development and innovation in actual companies. They are reaching our cities (reduction of pollution, smart mobility, circular economy…), our agriculture (watering intelligent systems), our skies (drone management), and our seas (energy, conservation, unmanned vehicles…).

This talk will present several past achievements, new challenges, and some latest advances such as dynamic resolution of problems, distributed techniques, many-objective optimization, neuro-evolution, edge computing, and quantum optimization, to name a few.

2. Intelligent Systems for Smart Cities

The concept of Smart Cities can be understood as a holistic approach to improve the level of development and management of the city in a broad range of services by using information and communication technologies.

It is common to recognize six axes of work in them: i) Smart Economy, ii) Smart People, iii) Smart Governance, iv) Smart Mobility, v) Smart Environment, and vi) Smart Living. In this talk we first focus on a capital issue: smart mobility. European citizens and economic actors need a transport system which provides them with seamless, high-quality door-to-door mobility. At the same time, the adverse effects of transport on the climate, the environment and human health need to be reduced. We will show many new systems based in the use of bio-inspired techniques to ease the road traffic flow in the city, as well as allowing a customized smooth experience for travelers (private and public transport).

This talk will then discuss on potential applications of intelligent systems for energy (like adaptive lighting in streets), environmental applications (like mobile sensors for air pollution), smart building (intelligent design), and several other applications linked to smart living, tourism, and smart municipal governance.

3. Artificial Intelligence and Industry 4.0

In the present era of digitalization of our society, the automatic and then intelligent management of Industry has a prominent place. The different past revolutions in industry have taken factories and production processes to their limit, with increasing needs of reducing their costs, being sustainable, and adapting to dynamic markets

These needs are now being approached by using, not just computers and their hardware customized companions (e.g., sensors and actuators), but also artificial intelligence (AI), to boost their efficiency and maximize their adaptability. As a consequence, a plethora of new techniques is now out there, and is continuously enlarged with advanced solvers using AI to design, manage, predict, and act on industry processes. Distributed intelligence, dynamic problem solving, multi-objective modelling, federated learning, deep neuro-evolution, and many other assorted families of techniques allow our businesses to fully enter the requirements of this 21st century.

This talk will revise some of these techniques in the context of design of machines/processes, fault prediction, planning, scheduling, circular economy, and the cohort of software/hardware technologies and vehicles, with a goal in mind: that of inspiring new research, development, and innovation for the near future in our developing industry.