SN Computer Science (2021) 2:433
https://doi.org/10.1007/s42979-021-00816-0

EDITORIAL

Editorial for the Topical Issue "Evolution, the New AI Revolution"

Anikó Ekárt[1] · **Anna Isabel Esparcia-Alcázar**[2]

Published online: 28 August 2021

25 years after the IEEE Expert Special Issue edited by Peter J Angeline, with the title "Evolution Revolution", we consider it very timely to proudly assert that Evolution ***is*** the AI Revolution. We are inspired by Risto Miikkulainen's keynote talk at the Evo*2019 conference, where he famously stated that *"Evolution is the new deep learning"*.

This topical issue evolved from EvoStar, the leading European event on Bio-Inspired Computation held between 15 and 17 April 2020, which for the first time in its nearly 25 years of history was held fully online due to the COVID-19 pandemic. It is, therefore, befitting it is dedicated to how Evolution is revolutionising AI.

For this topical issue, authors of selected papers from Evo* 2020 were invited to submit extensions of their work. Additionally, submissions of new original works on applications of evolutionary computation addressing a broader computer science audience were solicited.

The special issue comprises eight articles. To begin with, we were honoured to count on strategic futurist Peter J Angeline, who in **The Revolution continues** reflects on the journey of evolutionary computation in the past 25 years and the broad applicability of evolutionary techniques. He concludes that "The EC future is bright, as it has a unique place in science and business, and will evolve, naturally, with the times."

We then continue with **Creative AI through Evolutionary Computation: Principles and Examples** by Risto Miikkulainen. We are immersed into a discussion on how the power of artificial intelligence is in the creation of solutions that are new. Evolutionary computation variants are employed successfully for finding creative solutions to practical and hard real-world problems. Miikkulainen provides us with compelling evidence why evolutionary computation can be seen as the "next deep learning."

The six articles that are extensions of Evo*2020 contributions follow.

Lilla Beke, Michal Weiszer and Jun Chen conduct **A comparison of genetic representations and initialisation methods for the multi-objective shortest path problem on multigraphs.** Multigraphs are used for modelling practical transportation problems with multiple conflicting objectives. Given the complexity of the multigraph problem, only approximate solution methods can lead to good solutions over a limited time period. The authors extend popular genetic representations from simple graph to multigraph multi-objective shortest path problem (MSPP) and additionally consider two heuristic initialisation methods. They conduct their comparison over a diverse set of bi- and triple objective problems and conclude that given the good quality and the shorter time compared to an exact algorithm, their method has a future in the application to the time-constrained multigraph MSPP.

Pedro A. Castillo, Raneem Qaddoura, Hossam Faris and Ibrahim Aljarah introduce us to **EvoCluster: An Open-Source Nature-Inspired Optimization Clustering Framework.** EvoCluster is an open source and cross-platform framework aimed to perform partitional clustering tasks, which are very relevant in big data applications. In their article, the EvoCluster framework is extended with various distance measures for the objective function, various techniques of detecting the k value, and an option for supervised or unsupervised datasets. As the title suggests, the source code of EvoCluster is publicly available, at http://evo-ml.com/evocluster/.

Ferrante Neri and Shahin Rostami introduce **Generalised Pattern Search based on Covariance Matrix Diagonalisation.** They propose a fitness landscape analysis to lead to selection of suitable search directions for high performing pattern search for numerical optimization problems. Following the fitness landscape analysis, the sampled points whose

✉ Anikó Ekárt
a.ekart@aston.ac.uk

Anna Isabel Esparcia-Alcázar
aesparcia@ieee.org

[1] Computer Science, College of Engineering and Physical Sciences, Aston University, Birmingham, UK

[2] http://species-society.org

objective function values are below a threshold are selected. Then, the search directions for the pattern search are chosen as the eigenvectors of the covariance matrix of this distribution. The authors demonstrate the competitiveness of their method via numerical results.

Takfarinas Saber, David Brevet, Goetz Botterweck and Anthony Ventresque tackle **Reparation in Evolutionary Algorithms for Multi-objective Feature Selection in Large Software Product Lines.** Feature models are used in software engineering to express possible alternative products. Engineers select suitable subsets of features from these feature models. The authors propose combining genetic algorithms with mixed-integer linear programming into a novel hybrid algorithm for multi-objective feature selection in software product lines. Their method not only succeeds at modifying less features from the original infeasible solutions and in a shorter time than the currently used method, but can also handle software evolution.

Muhammad Sheraz Anjum and Conor Ryan propose **Seeding Grammars in Grammatical Evolution to Improve Search Based Software Testing.** For the improvement of code coverage analysis, they enhance Ariadne, a grammatical evolution-based system for generating test data, with a capability to include constants. They achieve this by seeding Ariadne's grammar with constants extracted from the programme under test. They demonstrate that the proposed seeding leads to substantial improvement in code coverage and reduced search budget.

We conclude the topical issue with **The X-Faces behind the Portraits of No One** by João Correia, Tiago Martins, Sérgio Rebelo, João Bicker and Penousal Machado. The authors explain how they computationally created photorealistic face images, transforming their generative and evolutionary system X-Faces into the interactive Media Art installation entitled Portraits of No One. The ingenious recombination of facial parts extracted from real face images led to composite faces of remarkable photorealism. Visitors to the exhibition could engage with X-Faces, become part of them, and observe the portraits synthesised by AI displayed in the installation space.

This topical issue showcases the success of evolutionary computation in a broad range of practical application problems, from transport to software engineering, big data, software testing and media art. Evolutionary computation is the solution method often integrated with ingenious representations and heuristics or established AI and optimization techniques. New solutions and great improvements over previously known solutions are achieved through this creative AI method fast becoming "the new deep learning".

We hope you enjoy this very first topical issue resulting from the partnership between SPECIES, the Society for the Promotion of Evolutionary Computation in Europe and its Surroundings, which organises the EvoStar conferences, and SN Computer Science. Stay tuned for the series of topical issues that will follow.