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INTRODUCTION

Introduction to the peer commentary special section on "Jaws 30" by W. B. Langdon

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1 Introduction

In 1992, John R. Koza published his first book on Genetic Programming (GP): "Genetic Programming: On the Programming of Computers by Means of Natural Selection" [1]. This ground-breaking book paved the way for the establishment of a new field of study. Building on the seminal work by John Holland and others in the nascent research community of evolutionary computation, Koza showed how evolution can be applied also to problems related to programming, learning and design. Koza influenced the work of thousands of researchers and practitioners worldwide, many of whom aimed to continue the exploration, formalization and improvement of the original formulation of GP. Another aspect of the research derived from Koza's work has been the application of GP to challenging problems, producing a long list of human-competitive solutions. In this special issue, we celebrate the 30th anniversary of [1] with a position paper written by William B. Landgon, titled "Jaws 30", that focuses on the multiple impacts of the book on the GP field. The authority and prospective of W. B. Langdon is unique and unquestioned in this research field, with his work over the years covering a large subset of the core principles and components of GP. The paper has received the peer commentaries of Giovanni Squillero and Alberto Tonda, Mauro Castelli, Malcolm Heywood, Alberto Bartoli, Luca Manzoni and Eric Medvet, Jason Moore and Colin Johnson, all of them core contributors to the state-of-the-art in GP. W. B. Langdon responded to the commentary, giving rise to a very interesting and insightful discussion about the past, the present and the future of GP.

W. B. Langdon's paper starts with a summary of the contents of the book [1] and a description of the author, J. R. Koza, followed by a chronological discussion of the

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development of the GP field, from its very origins to the present and beyond. Interesting points for the discussion, among many others, are the first historical applications of GP, the first important research topics and challenges, like for instance GP theory and bloat, more recent trends such as implementations of GP on GPUs, deep learning and hardware accelerators, and a very insightful discussion of the many GP variants that extend and complement the proposal of [1], like for instance Grammatical Evolution, Cartesian GP and many forms of linear GP. The paper concludes with a stimulating discussion about the future of GP. The message that appears between the lines of this final part of W. B. Langdon's paper is that the lessons of the past are fundamental to understand the future and influence it positively.

The commentaries focus on a variety of issues covered by W. B. Langdon, and highlight important areas of promising lines of inquiry for the future developments of the field. Topics include the usefulness of the biological abstraction that underpins the origins of GP, the always promising but mostly underused strategy of co-evolving populations, the link of GP and explainable Artificial Intelligence (XAI), the contrast between the use, or lack thereof, of GP relative to other machine learning approaches in industrial and commercial applications, and the introduction of new ways in which to measure fitness and drive evolution in GP.

W. B. Langdon's reply focuses on some important points. He establishes areas where GP is competitive, such as the design of ensembles of other artificial intelligence generated models and recent successes in automatic bug fixing and genetic improvement of software. He points out the importance of human-interpretable solutions. He identifies parallelization and coevolution as key factors for the development of GP. He discusses numerous available GP tools. He focuses on the importance of the representation used to define the programs and the variation operators. Finally, he discusses several possibilities for improving the fitness function.

In conclusion, we consider the work of W. B. Langdon reviewing and discussing J. R. Koza's seminal book a noteworthy contribution to our field. The paper preserves the essence of Koza's work while updating it to reflect the latest advancements in the field. This balance between tradition and innovation is crucial for the continued growth and relevance of GP. Furthermore, the paper distills complex ideas into clear and accessible language, serving as an invaluable resource for both newcomers to the field and seasoned researchers. Moreover, the commentaries, and subsequent reply by W. B. Langdon, highlight some of the most important areas of current and future developments. This scientific discussion presented in this Peer Commentary will surely help revitalize a classic work, and add significant value to the GP field by showing that many ideas contained in the book are still extremely relevant today, and will probably continue to be so in years to come.

Reference

1. J.R. Koza, *Genetic Programming: On the Programming of Computers by Means of Natural Selection* (MIT Press, Cambridge, 1992)