Leaving the Trees (the evolution of alternative representations in GP)

The talk aims to provide a comprehensive overview of the various representations used in Genetic Programming, dispelling the notion that "GPs evolve expressions as trees". It will discuss the advantages and disadvantages of these representations, and suggest potential future directions. Additionally, the talk will provide references to modern implementations of GPs and demonstrate how nowadays GP can be a relevant option for creating "original" solutions.

Outline

Despite the potential of Koza's original implementation, since the 1990s most of the GP community abandoned the goal of evolving programs in favor of symbolic regression, substituting the original lisp s-expressions with explicit tree-based data structures. However, over the years, more complex and powerful representations have been proposed, including Cartesian GP, Linear GP, and, more recently, new GPs that exploits full graphs.

While some of the alternative encodings had the sole goal of speeding up the evaluation of individuals, other increased the expressiveness or changed the nature of the evolution processes, again allowing to evolve, or tweak, Turing-complete programs. Over a 35-year seamless path, GP helped scholars and practitioners to evolve lisp programs, expressions, circuits, generic structures, and, then again, programs in typed, high-level languages.

- Brief history of GP
- Different representations and their potential usage
 - S-expressions
 - High-level Expression (eg. TinyGP, gplearn)
 - Java Bytecode GP
 - Cartesian Genetic Programming (CGP, including CGP++)
 - Linear Genetic Programming (LGP)
 - Graph-Based Genetic Programming (GGP)
 - Grammatical Evolution (GE)
 - Grammar-Guided Genetic Programming (GGGP)
- Conclusions and future directions

Details

- Expected length: 2h
- Level: introductory

Presenter

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Short Bio

I am a full professor of computer science at Politecnico di Torino, Department of Control and Computer Engineering. My research combines artificial intelligence and soft computing, in particular bio-inspired meta-heuristics and multi-agent systems; I also design approximate optimization techniques able to achieve acceptable solutions with a reasonable amount of resources. The industrial applications of my work range from electronic CAD to bioinformatics, to the cultural sector. As of December 2024, I am credited as an author in 3 books, 42 journal articles, 11 book chapters, and 170 papers in conference proceedings; I am also listed among the editors in 14 volumes. So far I have presented 12 tutorials at top conferences, I have been invited to speak at 4 international events and 2 national ones. As an entrepreneur, I co-founded Ominee, S.r.l. in 2014, Bactell, Inc. in 2019, and Ai · Culture, S.r.l. in 2024.

I have been an IEEE Senior Member since 2014; currently, I serve on the technical committee of the IEEE Computational Intelligence Society Games and on the editorial board of Genetic Programming and Evolvable Machines. I was the program chair of the European Conference on the Applications of Evolutionary Computation in 2016 and 2017, and I am now a member of the steering committee of EvoApplications. Last year I co-organized GGP, the workshop on Graph Genetic Programming at GECCO; in 2018, EvoML, the workshop on Evolutionary Machine Learning at PPSN; in 2016 and 2017, MPDEA, the workshop on Measuring and Promoting Diversity in Evolutionary Algorithms at GECCO; and from 2004 to 2014, EvoHOT, the Workshops on Evolutionary Hardware Optimization Techniques.

Updated and complete data can be found at: https://staff.polito.it/giovanni.s quillero/cv.html