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Bio: I am research professor at the Technical Institute of Tijuana in Mexico (ITT), working at the Department of Electric and Electronic Engineering, and the Engineering Sciences graduate program, of which I am co-founder and where I am involved in interdisciplinary research within the fields of evolutionary computation, computer vision, machine learning, pattern recognition and autonomous robotics. My work focuses on Genetic Programming (GP) and developing new learning and search strategies based on this paradigm. I received an **Electronic Engineering degree (2002)** and a **Masters in Computer Science (2004)** from ITT, as well as a **Doctorate in Computer Science from CICESE research center in Mexico (2008)**. I have developed research collaborations with a variety of institutions, such as CINVESTAV-IPN and CITED-IPN in Mexico, the University of Bordeaux and INRIA in France, University of Lisbon and NOVA-IMS in Portugal and the University of Extremadura in Spain. I have published over 70 journal papers, 60 conference papers, 18 book chapters, and have edited several books related to evolutionary computation, including some derived from the NEO workshop series, of which I am series co-chair, and the Genetic Programming Theory and Practice workshop which I helped co-organize from 2019 to 2023. I am also Associate Editor of the Genetic Programming and Evolvable Machines journal and the AI Communications journal, and have been PI or Co-PI for various national and international research grants.

Students

1. **Masters students:** a total of 14 students have worked under my supervision (12 graduated and 2 in process)
2. **Doctoral students:** a total 12 doctoral students have worked under my supervision (7 graduated and 5 in process)

Recent Journal Papers

1. Cárdenas Florido L, Trujillo L, Hernandez DE, Muñoz Contreras JM. M5GP: Parallel Multidimensional Genetic Programming with Multidimensional Populations for Symbolic Regression. *Mathematical and Computational Applications*. 2024; 29(2):25.
2. Illya Bakurov, José Manuel Muñoz Contreras, Mauro Castelli, Nuno Rodrigues, Sara Silva, Leonardo Trujillo, Leonardo Vanneschi. Geometric Semantic Genetic Programming with Normalized and Standardized Random Programs, accepted to appear in *Genetic Programming and Evolvable Machines* (Springer), 2024
3. Vanneschi, L., Trujillo, L. Introduction to the peer commentary special section on “Jaws 30” by W. B. Langdon. *Genet Program Evolvable Mach* 24, 18 (2023).
4. Cristian Sandoval, Oliver Cuate, Luis C. González, Leonardo Trujillo, Oliver Schütze, Towards fast approximations for the hypervolume indicator for multi-objective optimization problems by Genetic Programming, *Applied Soft Computing*, 2022, 109103, ISSN 1568-4946.
5. Leonardo Trujillo, Jose Manuel Muñoz Contreras, Daniel E. Hernandez, Mauro Castelli, Juan J. Tapia. GSGP-CUDA — A CUDA framework for Geometric Semantic Genetic Programming in SoftwareX, Volume 18, June 2022, 101085.

Edited Books

1. Genetic Programming Theory and Practice XX. (2024). In **L. Trujillo**, Stephan Winkler, Leonardo Trujillo, Charles Ofria, Ting Hu (Eds.), *Genetic and Evolutionary Computation*. Springer Singapore. <https://doi.org/10.1007/978-981-99-8413-8>
2. Genetic Programming Theory and Practice XIX. (2023). In **L. Trujillo**, S. Winkler, S. Silva & W. Banzhaf, (Eds.), *Genetic and Evolutionary Computation*. Springer Singapore. <https://doi.org/10.1007/978-981-19-8460-0>
3. Genetic Programming Theory and Practice XVIII. (2022). In W. Banzhaf, **L. Trujillo**, S. Winkler, & B. Worzel (Eds.), *Genetic and Evolutionary Computation*. Springer Singapore. <https://doi.org/10.1007/978-981-16-8113-4>
4. Genetic Programming Theory and Practice XVII. (2020). In W. Banzhaf, E. Goodman, L. Sheneman, L. Trujillo, & B. Worzel (Eds.), *Genetic and Evolutionary Computation*. Springer International Publishing. <https://doi.org/10.1007/978-3-030-39958-0>

Description of the Research Group

We work at Tecnológico Nacional de México/Instituto Tecnológico de Tijuana (ITT), in the Engineering Sciences Graduate Program (<http://www.pcitectijuana.mx/>). Our research group at ITT focuses on research related to Genetic Programming, Evolutionary Computation and Machine Learning applications. Currently, we have 2 master students and five doctoral students working in our team, either locally or in other parts of Mexico. A quick overview of the topics covered by these theses will convey the type of work we do:

- Transfer Learning with Genetic Programming Feature Construction
- ML applications for GP
- GPU and FPGA implementations of GP and GSGP
- Industry 4.0 in Tijuana and Mexico
- Localization and Dispatching of ambulances in Tijuana

We have also developed several projects with local industry, in:

- EEG classification of mental states
- Computer Vision inspection of production lines
- Prediction of faults in production lines
- Time series analysis and classification

Our students come from diverse backgrounds, including Computer Engineering, Electronic Engineering and Mechanical Engineering; our goal is always to put the student in an optimal position to make a significant contribution in these fields. We also have a long history of collaborations with research groups all over the world, including Mexico, France, Spain, Portugal, Ireland, USA, and others.

We are not a “high-tech” lab, but have a decent amount of equipment for data intensive Computer Science research. We have several Dell Xeon Workstations with NVIDIA GPUs (RTX 4060, 4070 and 4080), a Dell R430 Xeon server, an HP ProLiant Xeon server, and our “crown jewel” an IBM Power 8 server with 512 GB RAM and 2 Tesla P100 GPU Cards (soon to be fully equipped with 4 cards) for Machine Learning research. We also collaborate with other labs at ITT that have a variety of other computing platforms, including state-of-the-art FPGA development boards and DACs for specialized application development.

Description of the Work to be Carried Out

For the Species program, we want to propose four possible projects for a student:

1. **Transfer Learning and Feature Construction with Genetic Programming:** We are currently developing CUDA and FPGA implementations of GP, namely based on M5GP and GSGP [2,3,5]. Both of them use a linear genome representation and a stack-based interpreter, greatly improving execution times. Our goal is to continue to expand these systems, and to characterize their behavior in a principled manner. Therefore, we are looking for students interested in:
 - **Extending our implementations of M5GP (CUDA) and GSGP (VHDL).** The former using GPU-based processing for regression and classification tasks in Python and Numba, while the latter would focus on extending our VHDL-based implementation of GSGP for FPGAs for real-world use.
 - We want to facilitate **transfer learning in GP by using M5GP** [1] to match the feature space representation of two problems, and do so with interpretable models. For this, we need to develop, implement and test a fitness function that considers both problem similarity and interpretability to guide the search [4].
 - **Visualization techniques of “problem space” and “solution space and/or semantic space”**, both of which are relevant for transfer learning in general and GP in particular.

REFERENCES:

1. Muñoz, L., Trujillo, L. & Silva, S. Transfer learning in constructive induction with Genetic Programming. Genetic Programming and Evolvable Machines, 1–41, 2019.
2. Muñoz, L., Trujillo, L., Silva, S., Castelli, M., Vanneschi, L. Evolving multidimensional transformations for symbolic regression with M3GP. Memetic Comp., vol. 11, no. 2, pp. 111-126, 2019.
3. Leonardo Trujillo, Jose Manuel Muñoz Contreras, Daniel E.Hernandez, Mauro Castelli, Juan J.Tapia. GSGP-CUDA — A CUDA framework for Geometric Semantic Genetic Programming in SoftwareX, Volume 18, June 2022, 101085.
4. Aldeia, G.S.I., de França, F.O. Interpretability in symbolic regression: a benchmark of explanatory methods using the Feynman data set. Genet Program Evolvable Mach, 2022
5. Cárdenas Florido L, Trujillo L, Hernandez DE, Muñoz Contreras JM. M5GP: Parallel Multidimensional Genetic Programming with Multidimensional Populations for Symbolic Regression. Mathematical and Computational Applications. 2024; 29(2):25.

Reasons to accept our invitation:

1. **We are working on innovative GP research:** As I hope the list of topics presented above reveals, we are really interested in pushing GP forward within the wider ML ecosystem that is currently all over the computer science landscape.
2. **Accommodation:** Unfortunately the ITT does not offer special rooms for visiting study or faculty, so we would need to find a proper room for rent, which are available near by the institution, since there are several higher learning institutions in the area.
3. **Additional funding:** It may be possible to offer a travel grant for the student that visits us, but we cannot guarantee this at the moment. For now, I would leave it as 50% (yes)/50% (no) chance we have it, but are working to guarantee it.
4. **Tijuana:** The city is a unique experience for sure, the cross-cultural border town is unlike most cities, the border between Mexico and the USA is at the center of many macro-economic and macro-social phenomena, making its culture and society quite special. There are also great places to visit nearby (https://www.tripadvisor.com/Attractions-g499403-Activities-Valle_de_Guadalupe_Ensenada_Municipality_Baja_California.html). Another interesting aspect is the food, good gracious the food, it is just excellent! (<https://www.10news.com/news/tijuana-reinventing-itself-through-food>), nobody can deny this (<https://www.sandiegouniontribune.com/entertainment/dining-and-drinking/sd-me-tj-visit-20170105-story.html>), what can you expect from the home of the Cesar Salad (<https://www.withlovetopaperandwine.com/food/original-ceasars-salad-tijuana-casears-restaurant-bar>) .