Short CV (Wolfgang Banzhaf)

Citizenship: German (by birth) and Canadian (naturalized), US Permanent Resident

Education: PhD in Physics, 1985, from the Karlsruhe Institute of Technology, Germany
Diploma in Physics (MS equ), 1982, from Ludwig-Maximilian University, Munich, Germany

Work Experience: Since 2016: John R. Koza Endowed Chair in Genetic Programming, Michigan State University, East Lansing, Michigan, USA
2003-2016: Professor of Computer Science, Memorial University of Newfoundland, Canada
2003-2009 and 2012-2016: Head of Department of Computer Science, Memorial University of Newfoundland, Canada
1993-2003: Associate Professor of Applied Computer Science, Technical University of Dortmund, Germany
1989-1993: (Senior) Research Scientist at Mitsubishi Electric, Japan and USA
1985-1989: Postdoc, Institute of Theoretical Physics I, University of Stuttgart, Germany

Visiting scholar at ICSI, Univ. Berkeley, USA, Univ. of New South Wales, Australia, Univ of California, Irvine, USA, INRIA, Orsay, France, Institute des Systemes Complexes, Paris, France, Louis Pasteur Univ, Strasbourg, France, Victoria Univ, Wellington, New Zealand, Univ of Toulouse Capitole, France, Hanoi Univ of Science and Technology, Vietnam

Author of more than 200 scholarly contributions, 3 books and more than 10 edited volumes.

Research Interests
Bio-inspired computing, Neural Networks, Evolutionary Computing, Genetic Programming, Self-organization, Artificial Life, Artificial Chemistries

Honors
2010-2018 University Research Professor, Memorial University of Newfoundland, Canada
2018-2023 Honorary University Research Professor, Memorial University of Newfoundland, Canada
2016- current, Endowed Chair, Michigan State University, USA
2003 Senior Fellow, ISGEC
2007 EvoStar 'Croc' Award
2022 Lifetime Achievement Award, ISAL
2023 SIGEVO Outstanding Contribution Award, ACM

Organization
Founding EiC, Journal of Genetic Programming and Evolvable Machines
First EiC, GECCO 1998, first program co-chair EuroGP
Treasurer, ACM SIGEVO, SPECIES, Chair, ACM SIGEVO

Description of Research Group

Wolfgang Banzhaf is endowed chair (the only endowed chair dedicated to evolutionary computation in the US) for genetic programming in the department of Computer Science and Engineering at Michigan State University. He is a member of the BEACON Center for the Study of Evolution in Action, which consists of a group of approximately 10 faculty members across the colleges of Engineering and Natural Science. There is also non-local membership in Beacon, consisting of hundreds of faculty members from across the country.

The smaller BEACON Lab has four faculty members, Prof. Charles Ofria, the director of Beacon, Dr. Emily Dohlson, an assistant prof in CSE, Dr. Kevin Liu, and associate prof in CSE and myself. We further have Dr. Nathan Haut, fixed term assistant prof in the department of Computational Math and Engineering, as well as Dr. Iliya Miralavy, in CSE. All in all, the group is publishing well over 20 papers a year, and has been one of the most active groups in Evolutionary Computation in the United States.

The Banzhaf lab, within Beacon, has currently 6 members: Five PhD students and Dr. Haut. Research topics cover a range, AutoML, CGP, Self-modifying GP, Images and Uncertainty Quantification, and Evolutionary Machine Learning for the PhD students, with a much broader portfolio for Dr. Haut. Myself as a group leader am involved in many different research projects that go even beyond the research group, but center on GP.

The current research activity includes a new book on Linear Genetic Programming, the yearly GPTP workshop held in Michigan, as well as a book on Time, Life and Self-Reference. I also have a strong interaction with the group of Prof. Zhang in New Zealand which has resulted in many publications. Research projects currently range from biological applications (peptide function prediction) to modeling equations in Nuclear Physics. I also have a strong interest in exploring fundamental aspects of GP, including its features of explainability and interpretability of models.

Description of Work to be Carried out by the Student

The study we work on right now is to better characterize certain new fitness functions for Genetic Programming , in particular fitness functions that show additional degrees of neutrality. Neutrality in GP has had a checkered history, with some scholars claiming it is ultimately detrimental to the search effects of GP, while others (including me) claiming that there is a good type of neutrality that can be used to help make search in GP fitness landscapes more efficient [1].

We have so far mostly considered symbolic regression tasks for examination of fitness functions [2], but now want to broaden this study to include classification tasks. The idea is to examine fitness functions based on Pearson correlation, properly adapted to classification tasks [3], and study their effect on classification outcomes, first in binary but then also in multi-class classification.

The suspicion is that correlation will offer a good type of neutrality for classification as well, so that the search landscape and the search efficiency are considerably improved [4]. The student should work on classification tasks and benchmark a number of new variants of fitness functions on binary and multi-class classification.

The expected outcome of the work is improved efficiency for classification tasks, and at least one paper in a conference and/or journal.

References

[1] Banzhaf, W., Genotype-phenotype-mapping and neutral variation—a case study in genetic programming." In *International Conference on Parallel Problem Solving from Nature*, 1994 (pp. 322-332) Springer Berlin Heidelberg
[2] Haut, N., Banzhaf, W. and Punch, B., Correlation versus RMSE loss functions in symbolic regression tasks. In *Genetic Programming Theory and Practice XIX 2023* (pp. 31-55) Springer Nature Singapore.
[3] Matthews BW. Comparison of the predicted and observed secondary structure of T4 phage lysozyme. *Biochim Biophys Acta (BBA) Protein Struct.* 1975;405(2):442–451
[4] Banzhaf W, Hu T, Ochoa G. How the combinatorics of neutral spaces leads genetic programming to discover simple solutions. In: *Genetic Programming Theory and Practice XX* 2024 (pp. 65-86) Springer Nature Singapore.
[5] Hu, T, Banzhaf, W and Ochoa, G., How Neutrality Shapes Evolution: Simplicity Bias and Search, in *Proceedings of the Genetic and Evolutionary Computation Conference* 2025 (pp. 1008-1016) ACM Press

Other Relevant Information

The US visa system is somewhat complicated, so the student needs to apply early for a visa for the United States. She/he will the receive an office desk in our Beacon lab to work in and access to our HPC center for numerically demanding tasks. Each year, the GPTP workshop takes place in the first week of June, which would be an opportunity for the student to take part of.

We shall try to help with accommodation, which, if taken in the summer months (from May to August) should be easy to find, either in town or in a university dormitory.

East Lansing is the neighboring city to Lansing, the capital of Michigan, with all amenities that a state capital can offer, eg. in regard to culture and outdoor experiences. East Lansing is dominated by its student population (approx. 60,000 students are here during the academic year). During summer, there are a number of festivals in town. Overall, the city is relatively small (<150,000) and does not give the feeling of a big city. The university is close to the center of town, but has a large campus. Sometimes, it makes sense to take a bus or ride a bike, rather than walking. Used bikes can be easily bought over the summer from our university bike shop.

The Beacon Lab is located in the Interdisciplinary Science and Technology Building (ISTB) on Service Road which is one of the newest buildings on campus. MSU is one of the larger, state-funded universities in the USA, and there are many events taking place on campus over the summer. The ground floor of the ISTB is populated by graduate students of the Beacon lab (approximately 15) and 4 faculty members.

Travelling to East Lansing is best done via bus from-to Detroit International Airport (about 2 hours), or via train from-to Chicago International Airport (about 4.5 hours from Chicago Union Station). There is also a local airport – Lansing Capital Airport, but it is less connected to international destinations. Michigan is one of the greenest states in the US, enclosed from 3 sides by the Great Lakes.