Hitoshi Iba

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Evoart portrait collection

Biography

Hitoshi Iba received his Ph.D. degree from the University of Tokyo, Japan, in 1990. From 1990 to 1998, he was with the Electro Technical Laboratory (ETL) in Ibaraki, Japan. He has been with The University of Tokyo, Japan since 1998. He is currently a Professor at Dept. of Information and Communication Engineering, Graduate School of Information Science and Technology, The University of Tokyo. His research interest includes evolutionary computation, genetic programming, bioinformatics, foundations of artificial intelligence, and robotics. He is a founding associate editor of the Journal of Genetic Programming and Evolvable Machines (GPEM). He used to be a funding associate editor of IEEE transactions on Evolutionary Computation. He is also an underwater naturalist and experienced PADI divemaster having completed more than a thousand dives.

Research interests

- Evolutionary system
- Evolutionary computation
- Genetic programming
- Swarm intelligence
- Meta-heuristics
- Emergence

Recent publication

He published many journal papers in various international journals, leading to an *h-Index* of 52. He is also a (co-)author of many books as listed below:

- Iba,H., "Swarm Intelligence and Deep Evolution: Evolutionary Approach to Artificial Intelligence," ISBN-10: 1032009152, CRC Press, 2022.
- Iba,H., Noman,N. (eds.), "Evolution: Deep Learning with Evolutionary Computation", Springer, 2020.
- Iba,H., "AI and Swarm: Evolutionary approach to emergent intelligence," ISBN-10: 0367136317, CRC Press, 2019.
- Iba,H., "Evolutionary Approach to Machine Learning and Deep Neural Networks -- Neuro-Evolution and Gene Regulatory Networks," Springer, 2018.
- Iba,H., Noman,N. (eds.), "Evolutionary Computation in Gene Regulatory Network Research," Wiley Series in Bioinformatics, ISBN-10: 1118911512, Wiley, 2016.

Education and profession

- Bachelor of Science from Dept. Science of University of Tokyo in 1985
- Ph.D. degree from Dept. Engineering of University of Tokyo in 1990.
- Researcher at ETL (Electro-Technical Lab.) from 1990 to 1998.
- Visiting researcher at Stanford University from 1996 to 1997.
- Associate Professor of Department of Electronical Engineering at the University of Tokyo, from 1998 to 2004.
- Professor of Graduate School of Frontier Sciences at the University of Tokyo, from 2004 to 2008.
- Professor of Department of Electrical Engineering and Information Systems at the University of Tokyo, from 2008 to 2014.
- Professor of Department of Information and Communication Engineering, Graduate School of Information Science and Technology at the University of Tokyo, from 2015 to present.

Research group

Keywords

Emergence of Intelligence
Evolutionary computation
Genetic programming
Nature-inspired computation and optimization
Swarm intelligence

Overview

In our laboratory, we study computation and systems with the keywords of evolution and emergence. Let us consider the following questions:

- Why are the peacock's feathers so incredibly beautiful?
- Why did the giraffe's neck become so long?
- If a worker bee cannot have any offspring of its own, why does it work so hard to serve the queen bee?

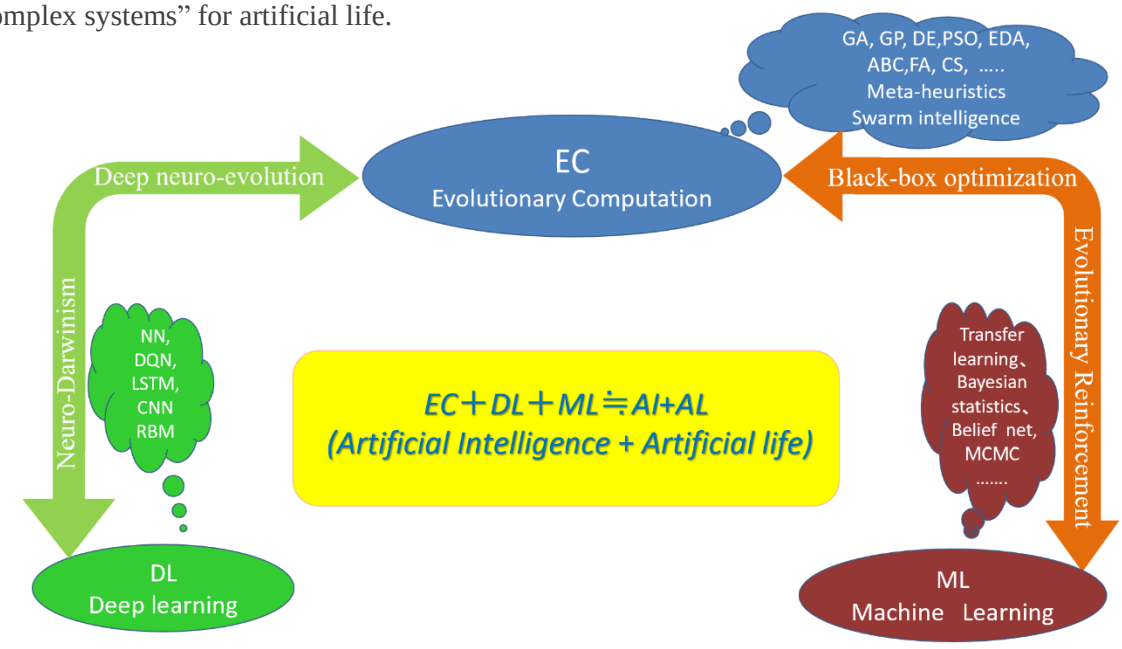
When exploring the answers to these questions, we see that biological organisms are solving certain types of optimization problems through the process of evolution. It is the objective of the evolutionary method to exploit this concept to establish an effective computing system (an evolutionary system).

Research topics

We study the integration of EC (Evolutionary computation) with ML (Machine learning), which is widely applied not only in engineering optimization but also in financial engineering, art and design. For instance, we have applied evolutionary reinforcement learning to robotics and game AI.

We also research on neuro-evolution, which is a framework that integrates DL (Deep leaning) and EC. The main feature of neuro-evolution is that it genetically searches for the optimal network and its learning parameters, thereby eliminating the time and effort (e.g., network construction by trial and error) associated with conventional neural network search.

These methods aim to integrate engineering and life sciences, and to realize the main concepts of life phenomena, such as “symbiosis” and “diversity.” In addition, it will lead to the elucidation of the phenomena of “emergence” and “complex systems” for artificial life.



Project Description

Deep neural evolution

We study a framework of deep learning (DL) methods hybridized with evolutionary computation (EC). Over the last decade, DL has dramatically reformed many domains: computer vision, speech recognition, healthcare, and automatic game playing, to mention only a few. All DL models, using different architectures and algorithms, utilize multiple processing layers for extracting a hierarchy of abstractions of data. Their remarkable successes notwithstanding, these powerful models are facing many challenges, and we try to solve some of the problems in DL by means of EC methodologies. More precisely, we will work on the following integration of EC with DL: (1) EC for hyper-parameter optimization in DNN; (2) EC for DNN architecture design; and (3) Deep neuroevolution. We also research on the interesting applications of DL with EC in real-world problems, e.g., X-ray based medical imaging and dangerous object detection.

Ref. Iba,H., Noman,N. (eds.), "Evolution: Deep Learning with Evolutionary Computation", Springer, 2020.

Swarm intelligence and meta-heuristics

We study a methodology for EA (evolutionary algorithm)-based approach for complex adaptive systems with the integration of several meta-heuristics, e.g., ACO (Ant Colony Optimization), ABC (Artificial Bee Colony), and PSO (Particle Swarm Optimization), etc. These developments contribute towards better problem-solving methodologies in AI. We also research on emerging uses of swarm intelligence in applications such as complex adaptive systems, reaction-diffusion computing, and diffusion-limited aggregation, etc. As for the real-world applications, our research concerns are upon swarm robotics, ant simulation, silicon traffics, image understanding etc.

Ref. Iba,H., "AI and Swarm: Evolutionary approach to emergent intelligence," ISBN-10: 0367136317, CRC Press, 2019.

Genetic Programming : Theory and application

On this theme, we specifically propose a workplan based on the study and transformation of feature spaces by using GP (Genetic Programming) as an embedded feature construction method for different types of classifiers (decision trees, neural networks, support vector machines, etc.). By evolving new features as combinations of the original ones, intuition tells us that the complexity of the classification problem should be "transferred" from the feature space to the evolved features, producing a less complex space and therefore an easier classification problem. Intuition also tells us that the amount of transferred complexity will depend on the type of classifier used. The plan is to verify this expected behavior by using precise measures of complexity (of the feature spaces and of the features themselves) found in the literature, or even developing new ones that better represent the observed phenomena.

Additional Information

- Unfortunately, there is a very small chance for providing additional financing for the award winning candidates. SPECIES scholarship may cover some of the live expenses in Tokyo. The candidates are expected to finance their own needs in addition to the scholarship for housing accommodation.

- It is possible to start a collaboration to be continued remotely after the visit.

- Speaking Japanese is not compulsory. The supervisors and the direct collaborators are all fluent in English.