# A New Intelligent Optimization Paradigm to Solve Complex Optimization Problems

MengChu Zhou, Ph.D. and Distinguished Professor
Fellow of IEEE, IFAC, AAAS, CAA and NAI

## Abstract

High-dimensional computationally expensive problems (HEPs) in which a single fitness evaluation consumes hours or even days have attracted increasing attention from both academia and industry. Exponentially expanding search space and complex landscape make HEPs extremely challenging to be solved by traditional algorithms with limited computational resources. Therefore, an Autoencoder-embedded Evolutionary Optimization (AEO) framework is invented to deal with them. To be specific, high-dimensional search space can be compressed to informative low-dimensional space by using an autoencoder as a dimension reduction tool. The search operation conducted in this low-dimensional space facilitates the population in convergence towards the optima. To balance the exploration and exploitation ability during optimization, two sub-populations are adopted to coevolve in a distributed fashion, wherein one is assisted by an autoencoder and the other undergoes a regular evolutionary process. Dynamic information exchange is conducted between them after each cycle to promote sub-population diversity. Moreover, surrogate models can be incorporated into AEO (SAEO) to further boost its performance by reducing unnecessary fitness evaluation. Both AEO and SAEO are validated by testing benchmark functions with dimensions varying from 30 to 200. Compared with the state-of-the-art algorithms for HEPs, AEO shows extraordinarily high efficiency for these challenging problems while SAEO can greatly improve the performance of AEO in most cases, thus opening new directions for various evolutionary algorithms under AEO to tackle HEPs and greatly advancing the field of high-dimensional computationally expensive optimization.