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Self-Adaptive Teaching-Learning-Based Optimizer with Improved RBF and Sparse Autoencoder for Complex Optimization Problems

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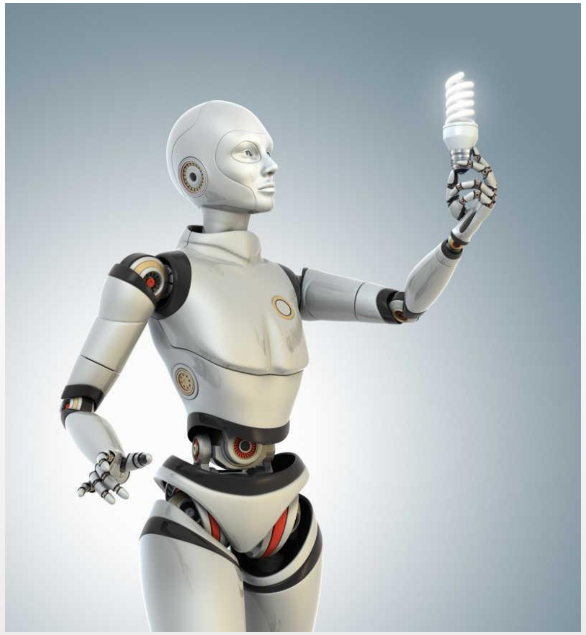
1 Introduction

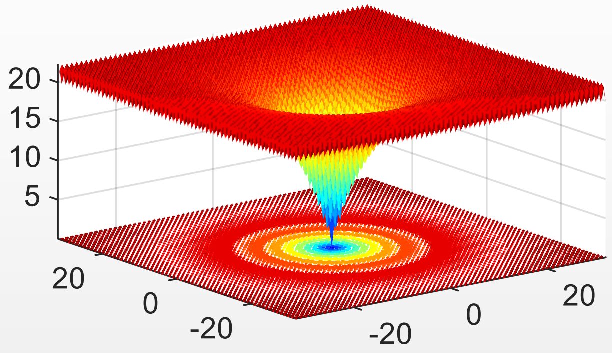
Introduction

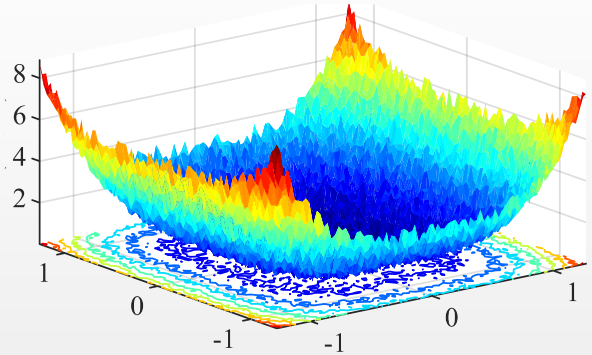
- Evolutionary algorithms
  - Robots
  - Computer vision
  - Cloud computing
  - Manufacturing scheduling problems



Introduction

❑ High-dimensional problems





➢ They have large search spaces

➢ They need a large number of function evaluations (FEs) to yield satisfactory solutions

➢ FEs in many real-world problems can be highly costly

➢ Some traditional EAs may easily trap into local optima

2 Motivation

Motivation

- High-dimensional complex optimization problems

Contributions

Goal: Solve high-dimensional complex optimization problems with fewer computational resources

1. This work proposes a Self-adaptive Teaching-learning-based Optimizer with an improved Radial basis function model and a sparse Autoencoder (STORA)

2. STORA includes
   - Self-adaptive Teaching-learning-based Optimizer (STO)
   - Dimension reduction tool – Sparse autoencoder (SAE)
   - Surrogate model – Improved radial basis function model (IRBF)

3 Proposed Framework

Proposed Framework

Self-adaptive Teaching-learning-based Optimizer (STO)

➢ Balance exploration and exploitation

- Learning factor that dynamically and linearly decreases as iterations continue
- Step size of individual j in iteration t: $S^j(t)$

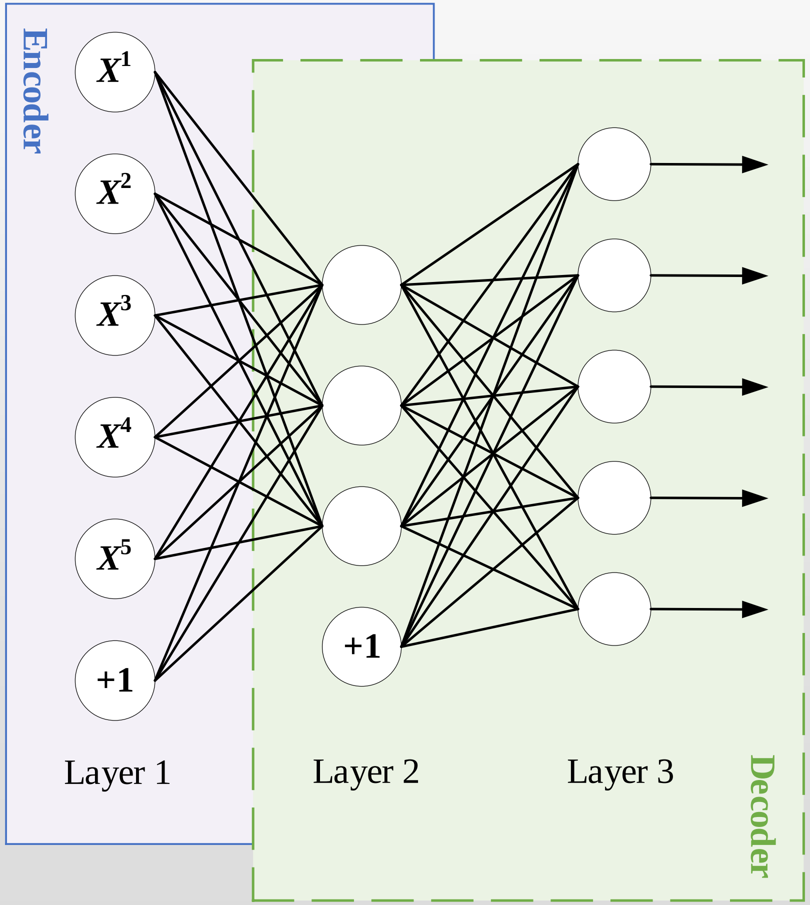
➢ Prevent falling into local optima

- Knowledge acquisition factors (A_1 and A_2) in teaching and learning phase, respectively
- Disturbance of the teacher

Proposed Framework

Sparse autoencoder (SAE)

- ➢ Compress a high-dimensional space into a reduced one for facilitating evolution

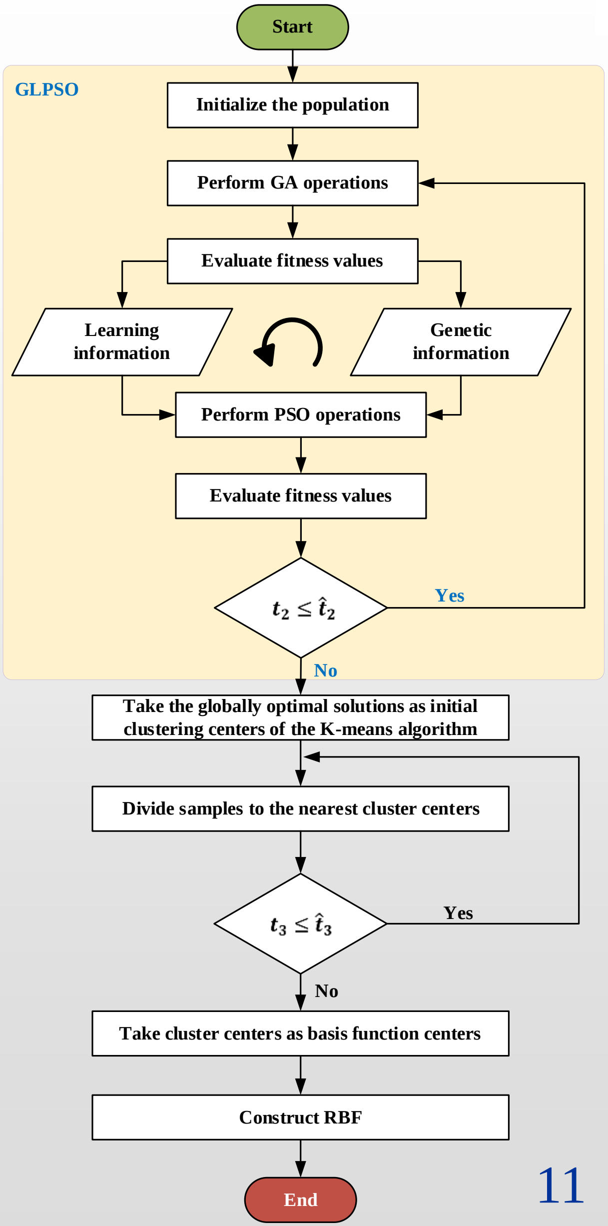


Proposed Framework

Improved radial basis function model (IRBF)

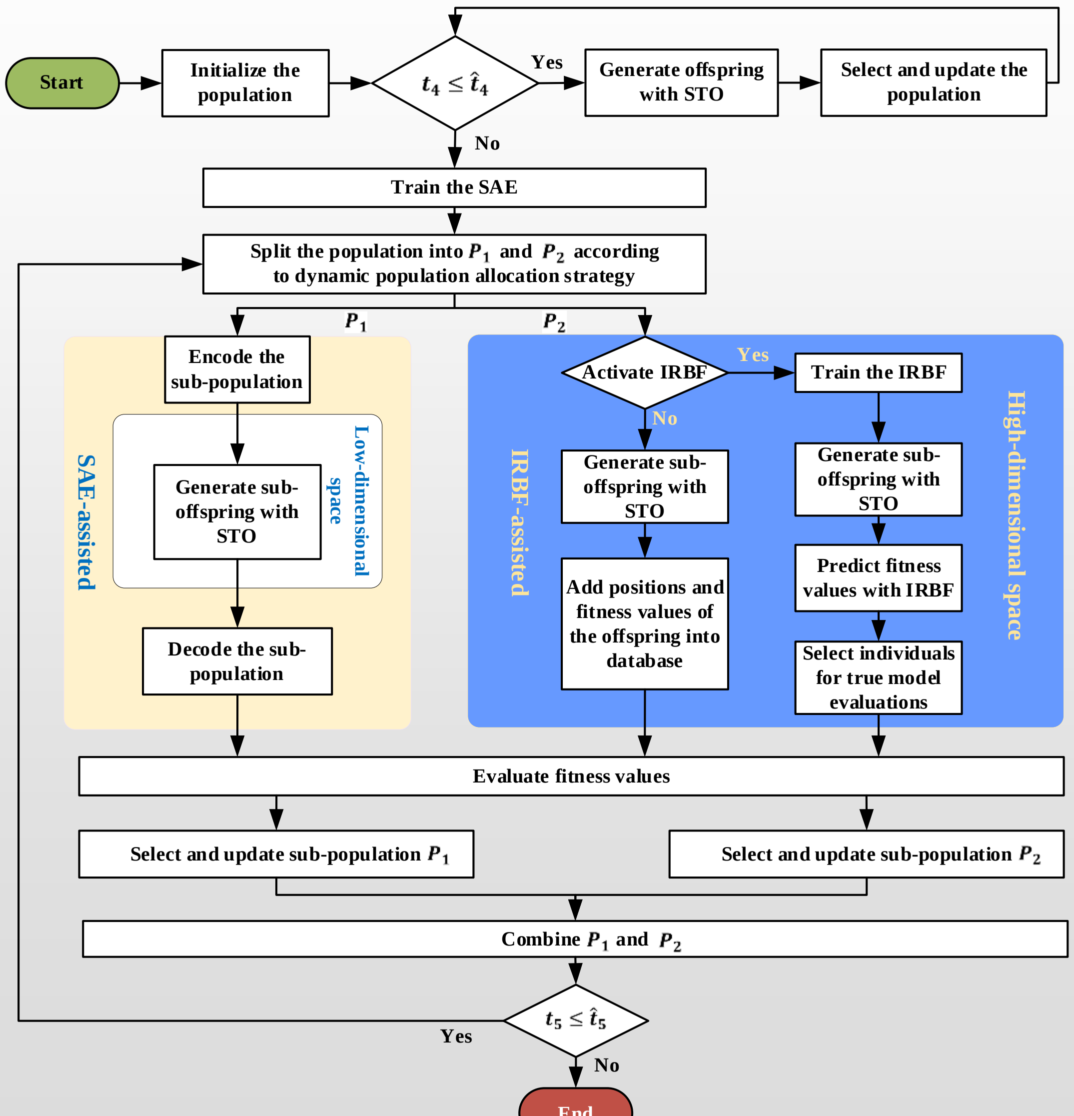
- Discover main characteristics of a true model and then substitute a part of the true model
- Use fewer computational resources to evaluate individuals
- Balance prediction accuracy and training time

1. K-means algorithm selects centers of a basis function
2. Genetic Learning Particle Swarm Optimization (GLPSO) finds initial clustering centers



Proposed Framework

Self-adaptive Teaching-learning-based Optimizer with an improved Radial basis function model and a sparse Autoencoder (STORA)



5 Experimental Results and Discussion

Experimental Results and Discussion

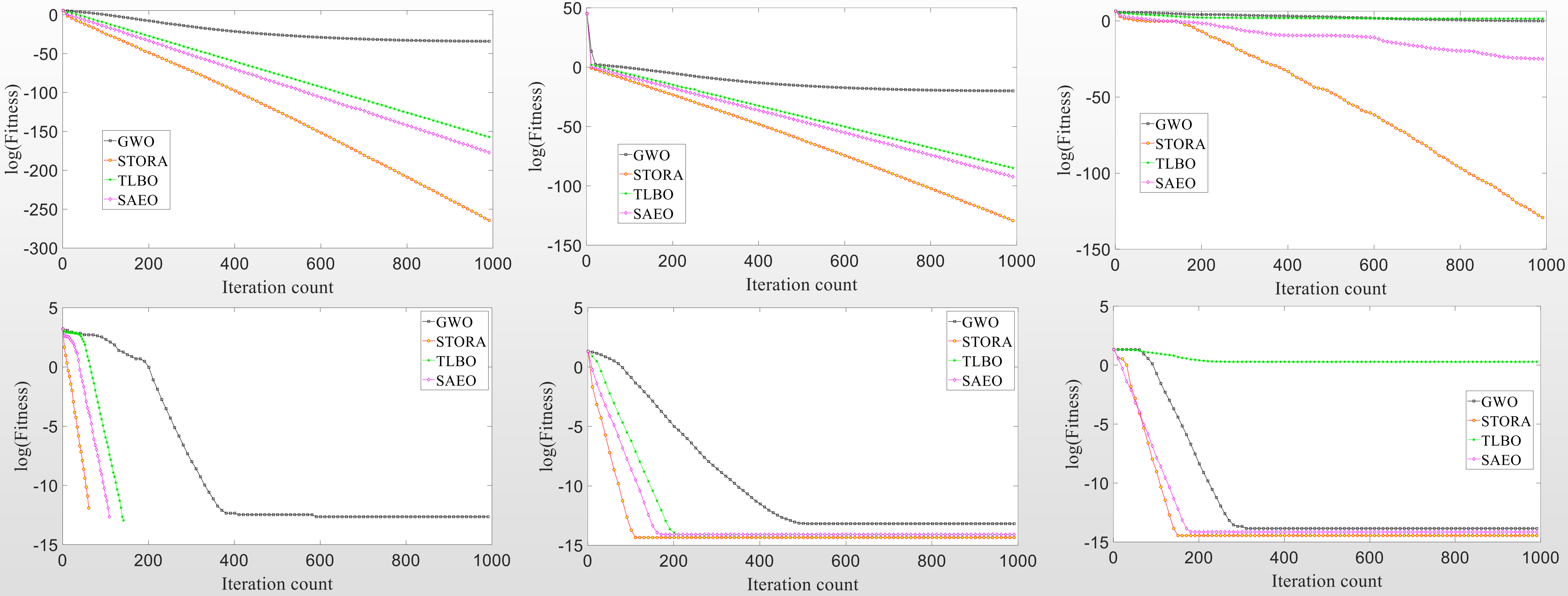
❑ Benchmark functions

BENCHMARK FUNCTIONS

Functions	D	Range
$F1(x)=\sum_{i=1}^{N}(\lvert x_i+0.5\rvert)^2$	100	[-100,100]
$F2(x)=\sum_{i=1}^{N}\lvert x_i\rvert+\prod_{i=1}^{N}\lvert x_i\rvert$	100	[-10,10]
$F3(x)=\max_i\{\lvert x_i\rvert, 1\leq i\leq N\}$	100	[-100,100]
$F4(x)=\sum_{i=1}^{N}[x_i^2-10\cos(2\pi x_i)+10]$	100	[-5.12,5.12]
$F5(x)=-20\exp\left(-0.2\sqrt{\frac{1}{N}\sum_{i=1}^{N}x_i^2}\right)-\exp\left(\frac{1}{N}\sum_{i=1}^{N}\cos(2\pi x_i)\right)+20+e$	100	[-32,32]
$F6(x)=418.9829D-\sum_{i=1}^{N}x_i sin\sqrt{\lvert x_i\rvert}$	100	[-500,500]

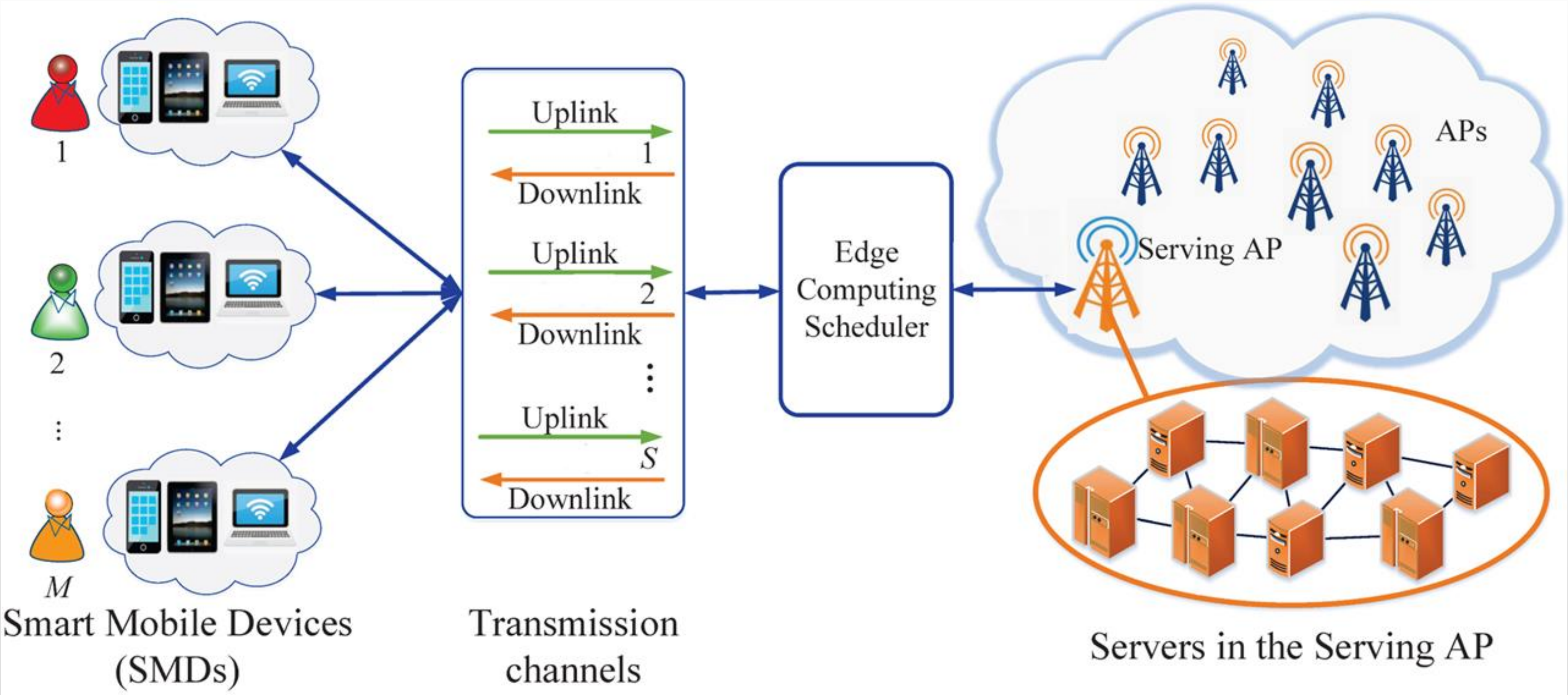
Experimental Results and Discussion

❑ Results of benchmark functions



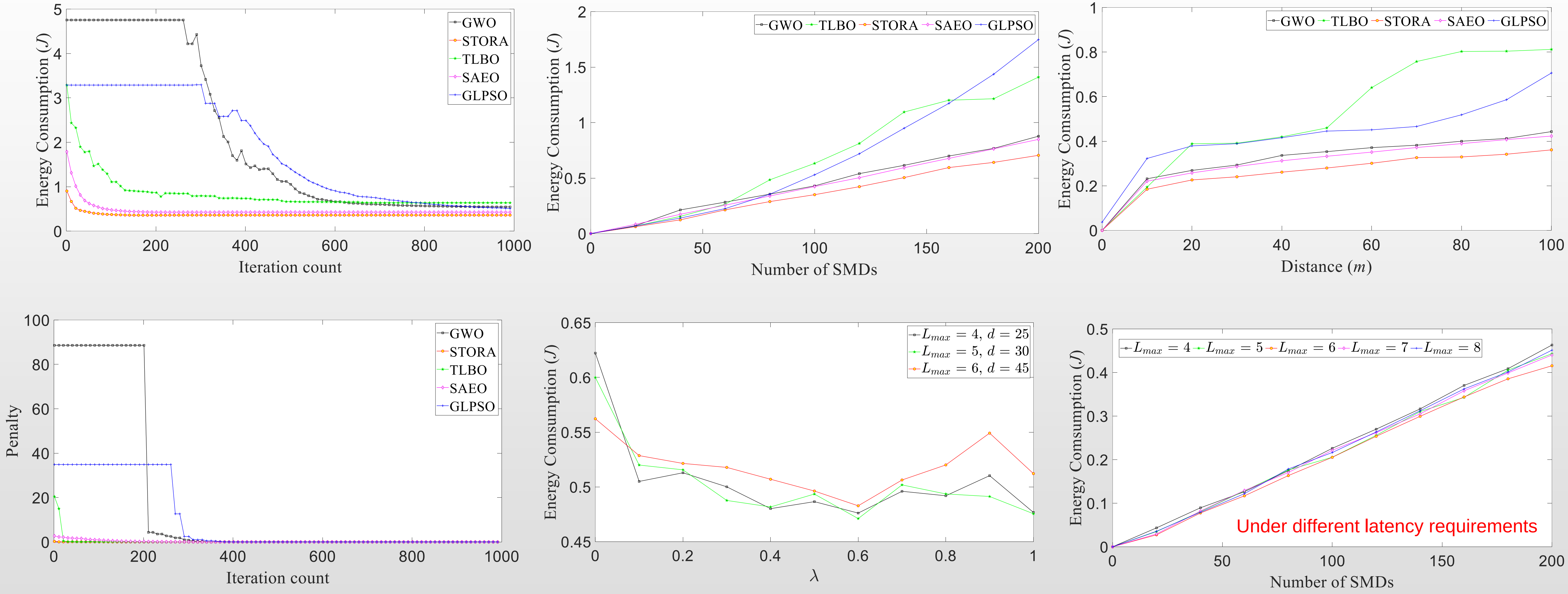
STORA has stable performance and it achieves the best search result over its peers

- Real-world Computation Offloading Problem



Experimental Results and Discussion

❑ Real-world Computation Offloading Problem



STORA finds the best solution with least iteration counts under different latency requirements

6 Conclusions

Conclusions

- Self-adaptive Teaching-learning based Optimizer with an improved Radial basis function model and a sparse Autoencoder (STORA) for complex optimization problems
- STORA yields the best search result with the least time among all compared algorithms for benchmark functions
- STORA yields higher-quality solutions meeting all constraints than its typical peers for a real-world computation offloading problem

Q & A

Thank you for your attention!

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