

The Peoples Democratic Republic of Algeria
Ministry of Higher Education and Scientific Research University of
Ferhat Abbas 1 –Setif



Faculty of Science
Departement: Computer Science
Domain: Mathematics and Computer Science
Specialty: Foundations and Engineering of Information and Imaging

Theme

Recent Advances in Bioinspired Algorithms

Presented by:

MADANI Laid
MEHENNI Youcef Aimen

Supervised

by: Moussa
Dr.SEMCHEDINE

Promotion 2024/2025

Contents

Abstract ii

Resume ii

Dedication iii

Dedication iv

Acknowledgment v

General Introduction 2

1 Bio-inspired Optimization Algorithms 3

1.1 Introduction	3
1.2 Definitions	3
1.2.1 Optimization	3
1.2.2 Combinatorial Optimization	4
1.2.2.1 Local Optimum	4
1.2.2.2 Global Optimum	5
1.3 Optimization problem	6
1.3.1 Definition	6
1.3.2 Modeling an Optimization Problem	6
1.3.3 Types of Optimization Problems	7
1.3.3.1 Problem of Class P	7
1.3.3.2 Problem of Class NP	7
1.3.3.3 Problem of Class NP-hard	7
1.3.3.4 Problem of Class NP-complete	8
1.4 Optimization Approaches	8
1.4.1 Deterministic Approaches	8
1.4.2 Approximate Approaches	8
1.4.2.1 Heuristic Methods	8
1.4.2.2 Metaheuristic Methods	9
1.4.2.3 Heuristics vs Metaheuristics	9
1.4.2.4 Key Properties of Metaheuristics	9
1.4.2.5 Exploration and Exploitation	9
1.4.3 Classification of Metaheuristics	10
1.5 Bio-inspired Optimization	11
1.5.1 Advantage Bio-Inspired	11
1.5.2 Process of Creating a Bio-Inspired Algorithm	11
1.5.3 Application Areas of Bio-Inspired Optimization	12
1.5.4 Conclusion	12
2 Related work on recent bio inspired algorithms	13
2.1 Introduction	13
2.2 Taxonomy of Bio inspired approaches	13
2.2.1 Evolution-Based Algorithms	13
2.2.2 Swarm Intelligence-Based Algorithms	14
2.2.3 Ecology-Based Algorithms	14
2.3 Well-known bio inspired algorithms:	15
2.3.1 The Genetic Algorithm (GA)	15
2.3.1.1 Core Concepts	15
2.3.1.2 Applications	17

2.3.1.3 Advantages	17
2.3.1.4 Disadvantages	18
2.3.2 Particle Swarm Optimization (PSO)	18
2.3.2.1 Core Concepts	18
2.3.2.2 Applications	19
2.3.2.3 Advantages	20
2.3.2.4 Disadvantages	20
2.3.3 The Firefly Algorithm (FA)	20
2.3.3.1 Core Concepts	20
2.3.3.2 The Attractiveness of the Firefly	21
2.3.4 The Grey Wolf Optimizer (GWO)	22
2.3.4.1 Social Hierarchy	23
2.3.4.2 Hunting Mechanism	23
2.3.4.3 Mathematical Model	24
2.3.4.4 Applications	25
2.3.5 The Whale Optimization Algorithm (WOA)	26
2.3.5.1 Algorithm Mechanism	26
2.3.5.2 Encircling Prey	26
2.3.5.3 Bubble-Net Attacking Method	28
2.3.5.4 Searching for Prey (Exploration)	29
2.3.5.5 Advantages of WOA	29
2.3.5.6 Disadvantages of WOA	29
2.3.6 Ant Colony Optimization	30
2.3.6.1 Working Principle of ACO	30
2.3.6.2 Mathematical Relationships	31
2.3.6.3 Applications of ACO	32
2.3.6.4 Advantages to ACO	32
2.3.6.5 Disadvantages of ACO	32
2.3.7 Harris Hawks Optimization (HHO)	33
2.3.7.1 Algorithm Mechanism	33
2.3.7.2 Applications	33
2.3.8 Cuckoo Search (CS)	33
2.3.8.1 Algorithm Mechanism	33
2.3.8.2 Applications	34
2.3.9 Bat Algorithm (BA)	34
2.3.9.1 Algorithm Mechanism	34
2.3.9.2 Applications	34
2.3.10 Artificial Bee Colony (ABC)	34
2.3.10.1 Algorithm Mechanism	34
2.3.10.2 Applications	35
2.3.11 Biogeography-Based Optimization (BBO)	35
2.3.11.1 Core Concept	35
2.3.11.2 Mathematical Relationships	36
2.3.11.3 Applications	36
2.3.11.4 Advantages	36
2.3.11.5 Disadvantages	37

2.4 Review of Recent Nature-Inspired Algorithms	37
2.4.1 Pufferfish Optimization Algorithm (POA)	37
2.4.1.1 Core Concepts	37
2.4.1.2 Mathematical Relationships	38
2.4.1.3 Applications	40
2.4.1.4 Advantages	40
2.4.1.5 Disadvantages	40
2.4.2 Mountain Gazelle Optimizer (MGO)	41
2.4.2.1 Core Concepts	41
2.4.2.2 Mathematical Relationships	42
2.4.2.3 Applications	45
2.4.2.4 Advantages	46
2.4.2.5 Disadvantages	46
2.4.3 Recent Algorithms	47
2.5 Conclusion	50
3 Methodology, Experiments, and Results	51
3.1 Introduction	51
3.2 Description of the Proposition	51
3.2.1 Steps for Using the GUI	51
3.2.2 Notes	52
3.3 Development Environment	53
3.3.1 Hardware	53
3.3.2 Software	53
3.3.2.1 Programming Language	53
3.4 Validation	54
3.4.1 Description	54
3.4.2 Benchmark Functions	54
3.4.2.1 Schwefel Function	54
3.4.2.2 Sphere Function	55
3.4.2.3 Ackley Function	55
3.4.2.4 Sum-Diff-Pow Function	55
3.4.2.5 Griewank Function	56
3.4.2.6 Rastrigin Function	56
3.4.2.7 Dixon-Price Function	56
3.4.2.8 Rosenbrock Function	57
3.4.2.9 Levy Function	57
3.4.2.10 Cross-in-Tray Function	57
3.4.2.11 Holder Table Function	58
3.4.3 Parameters	58
3.4.4 Evaluation Criteria	59
3.4.5 Results and Analysis	59
3.4.6 Parameters Used	59
3.4.6.1 General Parameters	59
3.4.6.2 Algorithm-Specific Parameters	60
3.4.6.3 Analysis of Results Table	60
3.4.6.4 Overview of Results	60

3.4.6.5 Performance of Best Optimum Values	60
3.4.6.6 Execution Time Performance	61
3.4.6.7 Stability of Results	61
3.4.6.8 Analysis of Best Optimum Charts	62
3.4.6.9 Analysis of Convergence Charts	63
3.4.6.10 Analysis of Execution Time Bars	64
3.5 Conclusion	64
General conclusion	65

ABSTRACT

Bio-inspired algorithms have gained increasing attention in the past decade due to their wide range of applications across various fields. Motivated by their growing importance, we have developed a user interface designed to simplify the process of testing these algorithms

using standard benchmark functions to evaluate their performance. The interface presents the results in a comprehensive manner through tables, graphs, and bar charts, facilitating easier analysis and interpretation. It is user-friendly and supports the addition of new algorithms and benchmark functions, making it a valuable tool for students and researchers in mathematics and computer science to obtain results efficiently and with minimal effort.

Keywords: Optimization, nature-inspired algorithms, benchmark functions, Particle Swarm Optimization, Firefly Algorithm, Grey Wolf Optimizer, Whale Optimization, Biogeography-Based Optimization, Gazelle Optimization Algorithm, Puffer Fish Optimization Algorithm.

Résumé

Les algorithmes bio-inspires ont suscité un intérêt croissant au cours de la dernière décennie en raison de leur large éventail d'applications dans divers domaines. Motivés par leur importance croissante, nous avons développé une interface utilisateur conçue pour simplifier

le processus de test de ces algorithmes à l'aide de fonctions de référence standard afin d'évaluer leurs performances. L'interface présente les résultats de manière complète à travers des tableaux, des graphiques et des diagrammes en barres, facilitant ainsi l'analyse et l'interprétation. Elle est conviviale et permet l'ajout de nouveaux algorithmes et de fonctions de référence, ce qui en fait un outil précieux pour les étudiants et les chercheurs en mathématiques et en informatique, leur permettant d'obtenir des résultats de manière efficace et avec un minimum d'effort.

Mots clés: Optimisation, algorithmes inspirés de la nature, fonctions de référence, Optimisation

par essaim particulaire, Algorithme des lucioles, Optimiseur de loup gris, Optimisation par baleine, Optimisation biogéographique, Algorithme d'optimisation de la gazelle, Algorithme d'optimisation du poisson-globe.

