Lion Optimization Algorithm (LOA): A nature-inspired metaheuristic algorithm

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Abstract

During the past decade, solving complex optimization problems with metaheuristic algorithms has received considerable attention among practitioners and researchers. Hence, many metaheuristic algorithms have been developed over the last years. Many of these algorithms are inspired by various phenomena of nature. In this paper, a new population based algorithm, the Lion Optimization Algorithm (LOA), is introduced. Special lifestyle of lions and their cooperation characteristics has been the basic motivation for development of this optimization algorithm. Some benchmark problems are selected from the literature, and the solution of the proposed algorithm has been compared with those of some well-known and newest meta-heuristics for these problems. The obtained results confirm the high performance of the proposed algorithm in comparison to the other algorithms used in this paper.
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Keywords: Lion Optimization Algorithm (LOA); Global optimization; Metaheuristic

1. Introduction

Many engineering optimization problems are usually quite difficult to solve, and many applications have to deal with these complex problems. In these problems, search space grows exponentially with the problem size. Therefore, the traditional optimization methods do not provide a suitable solution for them. Hence, over the past few decades, many meta-heuristic algorithms have been designed to solve such problems. Researchers have shown good performance of meta-heuristic algorithms in a wide range of complex problems such as scheduling problems [1–6], data clustering [7,8], image and video processing [9–12], tuning of neural networks [13–15] and pattern recognition [16–18], etc.

For many years, human have utilized the guidance of nature in finding the most appropriate solution for problems. Hence, during the last decades, there has been a growing attempt in developing algorithms inspired by nature [19–21]. For example, Genetic algorithm was proposed by Holland [22], and

simulates Darwinian evolution concepts. Artificial Immune Systems [23], simulate biological immune systems for optimization. Ant Colony Optimization [24] was inspired by behavior of ants foraging for food. Particle Swarm Optimization [25] mimics the social behavior of a flock of migrating birds trying to reach an unknown destination. Marriage in Honey Bee Optimization Algorithm (MBO) was proposed by Abbass [26], and mimics processes of reproduction in the honey bee colony. Bacterial Foraging Algorithm [27] simulates search and optimal foraging of bacteria. The Shuffled Frog Leaping algorithm [28] was inspired by a frog population searching for food. The Cat Swarm algorithm [29] was developed based on the behavior of cats. Invasive weed optimization was proposed by Mehrabian and Lucas [30], and mimics the ecological behavior of colonizing weeds. Monkey Search [31] simulates a monkey in search for food resources. Water flow-like algorithm [32] was inspired by water flowing from higher to lower levels. Biogeography-based optimization algorithm was introduced by Simon [33], and inspired by biogeography which refers to the study of biological organisms in terms of geographical distribution (over time and space). The Fish

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Duc Truong Pham,Natalia Hartono

Lion Optimization Algorithm Loa A Nature Inspired:

Natural Computing for Unsupervised Learning Xiangtao Li,Ka-Chun Wong,2018-10-31 This book highlights recent research advances in unsupervised learning using natural computing techniques such as artificial neural networks evolutionary algorithms swarm intelligence artificial immune systems artificial life quantum computing DNA computing and others The book also includes information on the use of natural computing techniques for unsupervised learning tasks It features several trending topics such as big data scalability wireless network analysis engineering optimization social media and complex network analytics It shows how these applications have triggered a number of new natural computing techniques to improve the performance of unsupervised learning methods With this book the readers can easily capture new advances in this area with systematic understanding of the scope in depth Readers can rapidly explore new methods and new applications at the junction between natural computing and unsupervised learning Includes advances on unsupervised learning using natural computing techniques Reports on topics in emerging areas such as evolutionary multi objective unsupervised learning Features natural computing techniques such as evolutionary multi objective algorithms and many objective swarm intelligence algorithms **Intelligent Production and Manufacturing Optimisation—The Bees Algorithm Approach** Duc Truong Pham,Natalia Hartono,2022-11-19 This book is the first work dedicated to the Bees Algorithm Following a gentle introduction to the main ideas underpinning the algorithm the book presents recent results and developments relating to the algorithm and its application to optimisation problems in production and manufacturing With the advent of the Fourth Industrial Revolution production and manufacturing processes and systems have become more complex To obtain the best performance from them requires efficient and effective optimisation techniques that do not depend on the availability of process or system models Such models are usually either not obtainable or mathematically intractable due to the high degrees of nonlinearities and uncertainties in the processes and systems to be represented The Bees Algorithm is a powerful swarm based intelligent optimisation metaheuristic inspired by the foraging behaviour of honeybees The algorithm is conceptually elegant and extremely easy to apply All it needs to solve an optimisation problem is a means to evaluate the quality of potential solutions This book demonstrates the simplicity effectiveness and versatility of the algorithm and encourages its further adoption by engineers and researchers across the world to realise smart and sustainable manufacturing and production in the age of Industry 4 0 and beyond **Computational Intelligence** Dinesh C.S. Bisht,Mangey Ram,2020-08-10 Computational intelligence CI lies at the interface between engineering and computer science control engineering where problems are solved using computer assisted methods Thus it can be regarded as an indispensable basis for all artificial intelligence AI activities This book collects surveys of most recent theoretical approaches focusing on fuzzy systems neurocomputing and nature inspired algorithms It also presents surveys of up to date research and application with special focus on fuzzy systems as well as on applications in life sciences and neuronal computing *Soft*

Computing for Problem Solving Jagdish Chand Bansal,Kedar Nath Das,Atulya Nagar,Kusum Deep,Akshay Kumar Ojha,2018-12-14 This two volume book presents outcomes of the 7th International Conference on Soft Computing for Problem Solving SocProS 2017 This conference is a joint technical collaboration between the Soft Computing Research Society Liverpool Hope University UK the Indian Institute of Technology Roorkee the South Asian University New Delhi and the National Institute of Technology Silchar and brings together researchers engineers and practitioners to discuss thought provoking developments and challenges in order to select potential future directions The book presents the latest advances and innovations in the interdisciplinary areas of soft computing including original research papers in the areas including but not limited to algorithms artificial immune systems artificial neural networks genetic algorithms genetic programming and particle swarm optimization and applications control systems data mining and clustering finance weather forecasting game theory business and forecasting applications It is a valuable resource for both young and experienced researchers dealing with complex and intricate real world problems for which finding a solution by traditional methods is a difficult task

Hybrid Intelligence for Social Networks Hema Banati,Siddhartha Bhattacharyya,Ashish Mani,Mario Köppen,2017-11-28 This book explains aspects of social networks varying from development and application of new artificial intelligence and computational intelligence techniques for social networks to understanding the impact of social networks Chapters 1 and 2 deal with the basic strategies towards social networks such as mining text from such networks and applying social network metrics using a hybrid approach Chaps 3 to 8 focus on the prime research areas in social networks community detection influence maximization and opinion mining Chapter 9 to 13 concentrate on studying the impact and use of social networks in society primarily in education commerce and crowd sourcing The contributions provide a multidimensional approach and the book will serve graduate students and researchers as a reference in computer science electronics engineering communications and information technology *Advances in Swarm Intelligence* Ying Tan,Yuhui Shi,2021-07-07 his two volume set LNCS 12689 12690 constitutes the refereed proceedings of the 12th International Conference on Advances in Swarm Intelligence ICSI 2021 held in Qingdao China in July 2021 The 104 full papers presented in this volume were carefully reviewed and selected from 177 submissions They cover topics such as Swarm Intelligence and Nature Inspired Computing Swarm based Computing Algorithms for Optimization Particle Swarm Optimization Ant Colony Optimization Differential Evolution Genetic Algorithm and Evolutionary Computation Fireworks Algorithms Brain Storm Optimization Algorithm Bacterial Foraging Optimization Algorithm DNA Computing Methods Multi Objective Optimization Swarm Robotics and Multi Agent System UAV Cooperation and Control Machine Learning Data Mining and Other Applications **The Nature of Business Transformation** Richard Kelly,2022-03-17 This book is a practical guide for business professionals to develop and improve business intelligence and collective decision making within their organisation It proposes a progressive reconfiguration of the traditional business operating system using a nature inspired framework called swarm facilitation that

enables and facilitates collective decision making Organisations have followed the same rigid formula of problem solving and decision making for over 100 years It is dominated by centralised governance and pyramid decision making Such an approach is no longer fit for purpose in an environment of employee disengagement artificial intelligence AI superintelligence and Covid 19 fallout By the end of this book readers will be able to solve organisational problems and challenges collectively using swarm intelligence upgrade and future proof business operating systems to reflect a more collective decision making approach fit for the new connected economy and Industry 4 0 embrace mindset quotients that support people working in a more networked self organising and collective environment The book is important reading for leaders and managers who are focused on building organisational capital and engagement and gaining value from the emerging technology by evolving their business operating system into a digital ecosystem as part of an ongoing digital transformation strategy It will also appeal to experts working in the field of organisational change and development both within the organisation and as consultants   *Advances in Nature-Inspired Computing and Applications* Shishir Kumar Shandilya,Smita Shandilya,Atulya K. Nagar,2018-08-29 This book contains research contributions from leading global scholars in nature inspired computing It includes comprehensive coverage of each respective topic while also highlighting recent and future trends The contributions provides readers with a snapshot of the state of the art in the field of nature inspired computing and its application This book has focus on the current researches while highlighting the empirical results along with theoretical concepts to provide a comprehensive reference for students researchers scholars professionals and practitioners in the field of Advanced Artificial Intelligence Nature Inspired Algorithms and Soft Computing

Nature-Inspired Optimization Algorithms Vasuki A,2020-05-31 Nature Inspired Optimization Algorithms a comprehensive work on the most popular optimization algorithms based on nature starts with an overview of optimization going from the classical to the latest swarm intelligence algorithm Nature has a rich abundance of flora and fauna that inspired the development of optimization techniques providing us with simple solutions to complex problems in an effective and adaptive manner The study of the intelligent survival strategies of animals birds and insects in a hostile and ever changing environment has led to the development of techniques emulating their behavior This book is a lucid description of fifteen important existing optimization algorithms based on swarm intelligence and superior in performance It is a valuable resource for engineers researchers faculty and students who are devising optimum solutions to any type of problem ranging from computer science to economics and covering diverse areas that require maximizing output and minimizing resources This is the crux of all optimization algorithms Features Detailed description of the algorithms along with pseudocode and flowchart Easy translation to program code that is also readily available in Mathworks website for some of the algorithms Simple examples demonstrating the optimization strategies are provided to enhance understanding Standard applications and benchmark datasets for testing and validating the algorithms are included This book is a reference for undergraduate and

post graduate students It will be useful to faculty members teaching optimization It is also a comprehensive guide for researchers who are looking for optimizing resources in attaining the best solution to a problem The nature inspired optimization algorithms are unconventional and this makes them more efficient than their traditional counterparts

Advanced Optimization by Nature-Inspired Algorithms Omid Bozorg-Haddad,2017-06-30 This book compiles presents and explains the most important meta heuristic and evolutionary optimization algorithms whose successful performance has been proven in different fields of engineering and it includes application of these algorithms to important engineering optimization problems In addition this book guides readers to studies that have implemented these algorithms by providing a literature review on developments and applications of each algorithm This book is intended for students but can be used by researchers and professionals in the area of engineering optimization *Nature-Inspired Optimizers* Seyedali Mirjalili,Jin Song Dong,Andrew Lewis,2019-02-01 This book covers the conventional and most recent theories and applications in the area of evolutionary algorithms swarm intelligence and meta heuristics Each chapter offers a comprehensive description of a specific algorithm from the mathematical model to its practical application Different kind of optimization problems are solved in this book including those related to path planning image processing hand gesture detection among others All in all the book offers a tutorial on how to design adapt and evaluate evolutionary algorithms Source codes for most of the proposed techniques have been included as supplementary materials on a dedicated webpage

Handbook of Nature-Inspired Optimization Algorithms: The State of the Art Ali Mohamed,Diego Oliva,Ponnuthurai Nagaratnam Suganthan,2022-08-31 The introduction of nature inspired optimization algorithms NIOAs over the past three decades helped solve nonlinear high dimensional and complex computational optimization problems NIOAs have been originally developed to overcome the challenges of global optimization problems such as nonlinearity non convexity non continuity non differentiability and or multimodality which traditional numerical optimization techniques had difficulties solving The main objective for this book is to make available a self contained collection of modern research addressing the general bound constrained optimization problems in many real world applications using nature inspired optimization algorithms This book is suitable for a graduate class on optimization but will also be useful for interested senior students working on their research projects Nature-Inspired Optimization Algorithms Xin-She Yang,2014-02-17 Nature Inspired Optimization Algorithms provides a systematic introduction to all major nature inspired algorithms for optimization The book s unified approach balancing algorithm introduction theoretical background and practical implementation complements extensive literature with well chosen case studies to illustrate how these algorithms work Topics include particle swarm optimization ant and bee algorithms simulated annealing cuckoo search firefly algorithm bat algorithm flower algorithm harmony search algorithm analysis constraint handling hybrid methods parameter tuning and control as well as multi objective optimization This book can serve as an introductory book for graduates doctoral students and lecturers in

computer science engineering and natural sciences It can also serve a source of inspiration for new applications Researchers and engineers as well as experienced experts will also find it a handy reference Discusses and summarizes the latest developments in nature inspired algorithms with comprehensive timely literature Provides a theoretical understanding as well as practical implementation hints Provides a step by step introduction to each algorithm   Handbook of Nature-Inspired Optimization Algorithms: The State of the Art Ali Wagdy Mohamed,Diego Oliva,Ponnuthurai Nagaratnam Suganthan,2022-09-03 This book presents recent contributions and significant development advanced issues and challenges In real world problems and applications most of the optimization problems involve different types of constraints These problems are called constrained optimization problems COPs The optimization of the constrained optimization problems is considered a challenging task since the optimum solution s must be feasible In their original design evolutionary algorithms EAs are able to solve unconstrained optimization problems effectively As a result in the past decade many researchers have developed a variety of constraint handling techniques incorporated into EAs designs to counter this deficiency The main objective for this book is to make available a self contained collection of modern research addressing the general constrained optimization problems in many real world applications using nature inspired optimization algorithms This book is suitable for a graduate class on optimization but will also be useful for interested senior students working on their research projects

Design and Applications of Nature Inspired Optimization Dipti Singh,Vanita Garg,Kusum Deep,2023-01-02 This book gives a detailed information of various real life applications from various fields using nature inspired optimization techniques These techniques are proven to be efficient and robust in many difficult problems in literature The authors provide detailed information about real life problems and how various nature inspired optimizations are applied to solve these problems The authors discuss techniques such as Biogeography Based Optimization Glow Swarm Optimization Elephant herd Optimization Algorithm Cuckoo Search Algorithm Ant Colony Optimization and Grey Wolf Optimization etc These algorithms are applied to a wide range of problems from the field of engineering finance medicinal etc As an important part of the Women in Science and Engineering book series the work highlights the contribution of women leaders in nature inspired optimization inspiring women and men girls and boys to enter and apply themselves to the field   Introduction to Nature-Inspired Optimization George Lindfield,John Penny,2017-08-10 Introduction to Nature Inspired Optimization brings together many of the innovative mathematical methods for non linear optimization that have their origins in the way various species behave in order to optimize their chances of survival The book describes each method examines their strengths and weaknesses and where appropriate provides the MATLAB code to give practical insight into the detailed structure of these methods and how they work Nature inspired algorithms emulate processes that are found in the natural world spurring interest for optimization Lindfield Penny provide concise coverage to all the major algorithms including genetic algorithms artificial bee colony algorithms ant colony optimization and the cuckoo search algorithm among others This book provides a

quick reference to practicing engineers researchers and graduate students who work in the field of optimization Applies concepts in nature and biology to develop new algorithms for nonlinear optimization Offers working MATLAB programs for the major algorithms described applying them to a range of problems Provides useful comparative studies of the algorithms highlighting their strengths and weaknesses Discusses the current state of the field and indicates possible areas of future development   *Nature Inspired Metaheuristic Optimization Algorithms and Applications* Samuel Gaxiola,2020 Regarding optimization methods there is much inspiration to be found in nature and biology There has been much effort in recent years to further and develop new methods and algorithms for approaching optimization problems with the inspiration for the logic for these algorithms coming from biology and nature in general Broadly speaking there are three categories of algorithms with respect to the logical structures Swarm intelligence algorithms operate with a logic that utilizes multiple instances in the search space to find an optimal solution by emulating the way lifeforms search for food or shelter in swarms Evolutionary algorithms operate in such a way that an initial set of instances referred to as the initial population will have certain characteristics used to measure fitness which are then passed on to the subsequent offspring instances in each iteration of the algorithm until some predetermined stop condition is met Population based stochastic algorithms utilize an element of randomness when creating instances and analyzing the search space which make the logic less susceptible to converging to an undesirable solution Because these categories are so broad in their definitions and characteristics there are many algorithms that fall within multiple categories In this work three algorithms are analyzed and characterized The Invasive Weed Optimization IWO algorithm utilizes the concept of unwanted weeds in a garden spreading and serves as the basis for a population based stochastic algorithm The Imperialist Competitive Algorithm ICA emulates the observed relationships between imperialist and colony states in history and utilizes a logic that encapsulates some features of evolutionary algorithms while also being stochastic and population based A hybrid algorithm comprised of population based stochastic characteristics taken from the IWO and swarm intelligence from the Particle Swarm Optimization PSO algorithm provides a more comprehensive and robust method of traversing the search space benefiting from the strengths of both algorithms These algorithms were characterized using benchmark test functions They were then applied to an antenna pattern optimization problem and comparisons between performances were analyzed This work outlines the individual strengths and weaknesses of each algorithm while demonstrating that they outperform the Genetic Algorithm GA with respect to computation time and results for the antenna optimization problem   **Nature-inspired Methods for Stochastic, Robust and Dynamic Optimization** ,2018   **Frontiers in Nature-Inspired Industrial Optimization** Mahdi Khosravy,Neeraj Gupta,Nilesh Patel,2021-09-15 The book provides a collection of recent applications of nature inspired optimization in industrial fields Different optimization techniques have been deployed and different problems have been effectively analyzed The valuable contributions from researchers focus on three ultimate goals i improving the accuracy of these techniques ii

achieving higher speed and lower computational complexity and iii working on their proposed applications The book is helpful for active researchers and practitioners in the field   **Prediction-based Nature-inspired Dynamic Optimization** Almuth Meier,2020 Dynamic optimization problems typically appear in real world systems underlying environmental influence Solving this kind of problems requires algorithms considering relationships between problem instances at different points in time Nature inspired optimization is frequently used to solve dynamic problems as they store information about past environments in the population by a natural means In order to circumvent the premature convergence of nature inspired meta heuristics in dynamic optimization problems prediction is one among other approaches In this thesis we show that neural networks are a reasonable alternative to commonly used prediction models suggest variants extending particle swarm optimization by prediction and propose a new strategy to take into account predictive uncertainty during optimization In addition we construct a benchmark generator and a convergence measure that are tailored to the characteristics of prediction based optimization algorithms

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