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NATURE-INSPIRED TECHNIQUES FOR OPTIMIZATION: A BRIEF REVIEW

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ABSTRACT

Nature plays a very important role to solve problems in a very effective and well-organized way. Few researchers are trying to create computational methods that can assist human to solve difficult problems. Nature inspired techniques like swarm intelligence, bio-inspired, physics/chemistry and many more have helped in solving difficult problems and also provide most favourable solution. Nature inspired techniques are well-matched for soft computing application because parallel, dynamic and self organising behaviour. These algorithms motivated from the working group of social agents like ants, bees and insect. This paper is a complete survey of nature inspired techniques.

Keywords: Bio-inspired, Metaheuristic search, Physics/chemistry algorithms, Swarm Intelligence, Other algorithms.

I. INTRODUCTION

Nature inspired computing is a technique that is inspired by nature. Nature has constantly served an inspiration for numerous scientific and technological developments. These nature inspired techniques are used to build numerous algorithms to solve optimization problems and find global optimal solution [1]. In this paper we classified different types of nature inspired techniques as follow:

a) Swarm Intelligence
b) physical and chemistry based
c) Bio-inspired
d) Other techniques. [2]

II. LITERATURE REVIEW

In this section we explain the different types of nature inspired techniques used for optimization and their types:

1.1 Swarm Intelligence Based

All SI-based algorithms make use of multi-agents, motivated by the collective actions of social insects, like ants, bees, and wasps, as well as from other animal societies like group of birds or fish [2]. There are numerous types of swarm intelligence based algorithms as follows:

1.1.1Cuckoo Search

A new metaheuristic search algorithm, called Cuckoo search is an optimization technique developed by Xin-she Yang and Suash Deb in 2009. This algorithm is motivated by obligate brood parasitism. Some cuckoo species lay their eggs in the nests of other host bird. There are three basic types of brood parasitism: intraspecific brood parasitism, cooperative breeding, and nest take over. Some species of cuckoo birds lay their egg in common nests, If a host bird founds the egg are not their own, they will either throw these eggs away or else simple discard its nest and build a totally new nest.[3]

1.1.2 Krill Herd

Krill Herd (KH) proposed by Gandomi in 2012 to solve optimization problems. [5] It is based on the herding activities of the krill individuals. The main purpose of krill movement is distance of each krill from the food source. The herding of the krill is multi objective method including two main targets i.e. increasing krill density and reaching food. The time dependent position of individual krill in 2D surface is ruled by the following three main activities: 1. Movement induced by other krill individuals. 2. Foraging activity 3. Random diffusion. [4]

1.1.3 Monkey search

Monkey algorithm (MA) is a fresh swarm intelligence algorithm. It was put forward by Ruiqing and Wansheng in 2008 which is used in solving important, multimodal optimization problem. [6] The process obtains from the simulation of mountain-climbing of monkeys. It consists of three processes: climb process, watch-jump process, and somersault process. The purpose of climb process is to search local most favourable solutions. The purpose of the somersault process is to make monkeys discover new search area and this action avoids running into neighbourhood search. [7]

1.1.4 Eagle Strategy

Eagle strategy is a metaheuristic scheme for optimization, proposed by Xin-She Yang and Suash Deb in 2010. [9] The two-stage approach of an eagle's foraging performance. Firstly, we assume that an eagle will achieve the L´evy walk in the entire area. Once it discovers a prey it changes to a chase strategy. Secondly, the chase strategy can be considered as an serious local search using any optimization technique such as the steepest descent method, or the downhill simplex or Nelder-Mead method. [8]

1.1.5 Cat Swarm

Cat Swarm is an optimization algorithm that describes the common behaviour of cats. Cats have concentration about objects in action and have a great tracking skill. [10] It might be thinking that cats spend most of the time resting, but in fact they are always attentive and moving gradually. This action corresponds to the seeking mode. Moreover, when cats notice a prey, they waste lots of energy because of their fast movements. This actions match to the tracing mode. [11]

1.1.6 Firefly Algorithm

The Firefly Algorithm was developed by Yang in 2008, and Yang in 2009 and it was based on the act of the flashing qualities of fireflies. For ease, we can idealize these flashing qualities as the following rules : all fireflies are unisex so that one firefly is attracted to other fireflies regardless of their sex, pleasant appearance is proportional to their brightness, thus for any two blinking fireflies, the less brighter one will travel towards the brighter firefly. The pleasant appearance is proportional to the brightness and they both reduce as their distance

increases. If no one is brighter than a particular firefly, it moves randomly. The intensity of a firefly is strong-minded by the landscape of the objective function to be optimized. [12]

1.1.7 Fish Swarm/School

Fish can discover the region with more nutritional in water by individual explore or following other fish. Consequently, the water region where the amount of fish is the most is generally the most nutritional. According to this quality, Artificial Fish model is presented the three types of behaviour i.e. preying behaviour, swarming behaviour and following behaviour. Preying behaviour is a basic biological behaviour that tends to the food. In Swarming behaviour Fish will gather in groups naturally in moving. While swarming, they obey the following three principles: Compartmentation principle, Unification principle approximately, Cohesion principle. Following behaviour: In moving process of the fish swarm, when a single fish or several ones find food, the neighbourhood fellows will follow and get to the food quickly.[14]

II. BIO-INSPIRED AGORITHM

SI-based algorithms belong to bio-inspired algorithms and while bio-inspired algorithms are a subset of nature-inspired algorithms. Some bio-inspired algorithms are: [2]

2.1 Atmosphere Cloud Model

ACMO is novel optimization Reverse Search Method which is completely dissimilar from traditional optimization method. The central part of ACMO algorithm is given as follows: 1) the total search space is separated into many disjoint regions according to the certain rules, and each area has its personal moisture value and atmospheric pressure value. 2) Another important concept in ACMO algorithm is that the behaviour of the cloud must follow the rules below: a) Cloud can only be produced in the areas where the moisture value is superior than a certain threshold value; b) Under the action of wind, clouds move from areas with higher atmospheric pressure to areas with worse atmospheric pressure; c) In the move process, the droplets of one cloud would spread or gather according to the difference of the atmospheric pressure between the areas. d) One cloud is regarded to disappear when meeting some criteria. [15]

2.2 Dolphin Echolocation

The term ‘‘echolocation’’ was developed by Griffin. Echolocating animals include some mammals and a few birds. [16] A dolphin is able to produce sounds in the form of click. Frequency of these clicks is superior than that of the sounds used for communication and differs among species. When the sound hits an object, some of the energy of the sound-wave is reflected back towards the dolphin. As quickly as an echo is received, the dolphin generates s another click. The time fall between click and echo enables the dolphin to calculate the distance from the object. By constantly emitting clicks and receiving echoes, the dolphin can follow objects. [17]

2.3 Biogeography-based Optimization:

Biogeography-based optimization (BBO) was developed Dan Simon in 2008. BBO is a new population-based evolutionary algorithm (EA) based on the theory of island biogeography. [18] Every island characterize one solution, where the good problem solution means that the island has lots of good biotic "living: diversity of prey, trees etc" and a biotic "non-living: distance of isolation, wind, temperature, humidity, water, area, etc" factors, which attracts additional species than the other islands. Each feature is called suitability index variable (SIV), which represents the independent variable of such a problem in BBO. As these features changes, the island suitability index (ISI) changes too, thus in BBO, ISI is the dependent variable. [19]

2.4 Flower Pollination Algorithm

The main purpose of a flower is finally imitation via pollination. Flower pollination is normally coupled with the transfer of pollen, and such transfer is over and over again linked with pollinators like insects, birds, bats and other animals. [20] Abiotic and biotic pollination are two types of pollen in pollination process. Basically 90% of flowering plants belong to biotic pollination. In this pollen is transmitted by a pollinator such as bugs and animals. About 10% of pollination takes abiotic which does not need any pollinators. Wind and diffusion help pollination and grass is a best example of abiotic pollination.

2.5 Japanese Tree Frog Calling

This technique has shown that male Japanese tree frogs calling to catch the attention of females. Actually, females of this family of frog can identify the source of calling in order to verify current locality of the corresponding male. A difficulty occurs when two of these males are too close in space and speak with each other. In this case female are not capable to properly identify both calls and enable to detect where the calls came from. This activity is example of self-organization in environment. [26]

III. PHYSICS AND CHEMISTRY BASED ALGORITHM

These algorithms have been developed by definite physical and chemical rule, containing electrical charges, gravity, River system etc. Some physics and chemistry based Algorithms are as follows: [2]

3.1 Big-Bag Big-Crunch

The BB–BC method invented by Erol and Eksin and it consists of two phase: a Big Bang phase, and a Big Crunch phase. In the Big Bang phase, applicant solutions are arbitrarily distributed over the search space. Erol and Eksin linked the random nature of the Big Bang to energy dissipation or the makeover from a convergent solution to a new set of solution applicants. The Big Ban phase is tracked by the Big Crunch which has many inputs but only one output known as centre of mass. The only result has been attained by calculating the centre of mass. [23]

3.2 Black Hole

In 1967, John Wheeler the American physicist first named the phenomenon of mass collapsing as a black hole. When star becoming unseen to the eye, however, during that stage it was not known as a black hole. In the

proposed BH algorithm the evolving of the population is done by moving all the candidates towards the best candidate in each iteration, namely, the black hole and changes those candidates that enter within the range of the black hole by recently generated candidates in the search space. The black hole terminology has been used for the first time in solving standard functions. [24]

3.3 River Formation Dynamics

River formation dynamics finds short paths in graphs and good solutions for TSP. RFD associate altitude values to nodes. Drops erode the ground (they reduce the altitude of nodes) or leave the sediment (increase it) as they move. The probability of the drop to take a given edge in its place of others is proportional to the gradient of the down slope in the edge, which depends on the difference of altitudes between both nodes and the distance. At the beginning, a flat environment is provided same altitude. The exception is the destination node, which is a gap or hole. Drops are unleashed at the origin node, which spread around the flat environment until some of them fall in the destination node. After some steps, excellent paths from the origin to the destination are established. [25]

IV. OTHER ALGORITHMS

Sometimes, it is not easy to put some algorithms in the above three groups because, these algorithms have been developed by different characteristics from different Sources, such as social, emotional etc

4.1 Backtracking Optimization Search

BSA, a new evolutionary algorithm (EA) used for solving real-valued numerical optimization problems. BSA can be explained by dividing its functions into five processes as is done in other EAs: initialization, selection-I, mutation, crossover and selection-II. [29]

4.2 Artificial Cooperative Search

ACS is an algorithm developed for solving real valued numerical optimization problems. In ACS algorithm, a super organism consisting of random solutions of the associated trouble correspond to an artificial super organism migrating to extra useful feeding areas. ACS algorithm holds two super organisms: α and β that include artificial sub-super organisms equal to the dimension of the population (N). The number of individuals within the correlated sub-super organisms is equal to the dimension of the problem (D). In ACS algorithm, α and β super organisms are used for the detection of artificial Predator and Prey sub-super organisms. [28]

TABLE : List of some Algorithms

SWARM INTELLIFENCE BASED ALGORITHM	
Name of Algorithm	**Author**
1. CUCKOO SEARCH	Yang and Deb
2. KRILL HERD	Gandomi and Alavi
3. MONKEY SEARCH	Mucherino and Seref
4. EAGLE STRATEGY	Yang and Deb
5. CAT SWARM	Chu et al.
6. FIREFLY ALGORITHM	Yang
7. FISH SWARM/SCHOOL	Li et al.

BIO-INSPIRED ALGORITHMS	
Name of Algorithm	**Author**
1. ATMOSPHERE CLOUD MODEL	Yan and Hao
2. DOLPHIN ECHOLOCATION	Kaveh and Farhoudi
3. BIOGEOGRAPHYBASED OPTIMIZATION	Simon
4. FLOWER POLLINATION ALGORITHM	Yang
5. JAPANESE TREE FROGS CALLING	Hern´andez and Blum
PHYSICS AND CHEMISTRY BASED ALGORITHM	
Name of Algorithm	**Author**
1. BLACK HOLE	Hatamlou
2. BIG-BAG BIG-CRUNCH	Zandi et al.
3. RIVER FORMATION DYNAMICS	Rabanal et al

OTHER ALGORITHMS	
Name of Algorithm	**Author**
1. BACKTRACKING OPTIMIZATION **2.** ARTIFICAL COOPERATIVE SEARCH	Civicioglu Civicioglu

Table1. List of some algorithms

V. CONCLUSION

The nature inspired algorithms perform in highly complex problems and can show very good a result when problem is not correctly defined. These have a tendency to find the best accessible solution in change environment and good decision maker. Due to extremely dynamic behaviour of some networks must be disable to evaluating the shortest path as fast as possible. As the complexity and bulk of the network raises, time requirement to find the shortest path is to be very huge. Some nature based approaches which can replace "best for sure" solutions with "good enough" solutions.

REFERENCE

[1] Shilpi Gupta, Shweta Bhardwaj, Parul Kalra Bhatia, A Reminiscent study of nature inspired computation, International Journal of Advances in Engineering & Technology, Vol. 1, Issue 2, pp.117-125. May 2011.

[2] Iztok Fister Jr, Xin-She Yang, Iztok Fister, Janez Brest, Dusan Fister, A Brief Review of Nature-Inspired Algorithms for Optimization, Elektrotehniski vestnik, 80(3), PP. 1–7, July 2013.

[3] X.-S. Yang, and Deb. S, Engineering Optimisation by Cuckoo Search, Int. J. Mathematical Modelling and Numerical Optimisation, Vol. 1, No.4, pp. 330–343, 2010.

[4]Amir Hossein Gandomi, Amir Hossein Alavi, Krill herd, A new bio-inspired optimization algorithm. Communications, Nonlinear Science and Numerical Simulation, 2012, PP. 4831–4845

[5] Prabhneet kaur, Taranjot kaur, A Comparative Study of Various Metaheuristic Algorithms, International Journal of Computer Science and Information Technologies, Vol. 5 (5) , PP. 6701-6704, 2014.

[6] Z. Ruiqing and T. Wansheng, Monkey algorithm for global numerical optimization, Journal of Uncertain Systems, vol. 2, no. 3, pp. 164–175, 2008.

[7] Xin Chen,Yongquan Zhou and Qifang Luo, A Hybrid Monkey Search Algorithm for Clustering Analysis , Scientific World Journal Volume 2014, Article ID 938239, pp. 1-16

[8] Yang, X. S. and Deb, S., "Eagle strategy using Levy walk ´ and firefly algorithm for stochastic optimization" Nature Inspired Cooperative Strategies for Optimization (NICSO 2010) (Eds. J. R. Gonzalez et al.), SCI Vol. 284, PP. 101-111

[9] X. S. Yang, S. Deb , X. He, Eagle strategy with flower algorithm, Advances in Computing, Communications and Informatics (ICACCI), International Conference, PP. 1213 – 1217, Aug 2013.

[10] Broderick Crawford, Ricardo Soto, Natalia Berríos, Franklin Johnson, Fernando Paredes, Carlos Castro, and Enrique Norero' A Binary Cat Swarm Optimization Algorithm for the Non-Unicost Set Covering Problem, Hindawi Publishing Corporation Mathematical Problems in Engineering Volume 2015, Article ID 578541, PP. 1-8.

[11] S.-A Chu, P-W Tsai, and J.-S Pan, Cat swarm optimization. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 4099 LNAI:854–858, 2006. Cited By (since 1996) 8.

[12] Xin-She Yang, Firefly algorithm, stochastic test functions and design optimisation, International Journal of Bio-Inspired Computation, 2(2), PP. 78–84, 2010.

[13] Adil Hashmi, Nishant Goel, Shruti Goel, Divya Gupta, Firefly Algorithm for Unconstrained Optimization, IOSR Journal of Computer Engineering (IOSR-JCE), e-ISSN: 2278-0661, p- ISSN: 2278-8727Volume 11, Issue 1 (May - Jun. 2013), PP. 75-78**.**

[14] X.-L. Li, Z.-J Shao and J.-X Qian, Optimizing method based on autonomous animats: Fish-swarm algorithm, Xitong Gongcheng Lilun yu Shijian/System Engineering Theory and Practice, 22(11):32, 2002.

[15] GAO-WEI YAN and ZHAN-JU HAO, A novel optimization algorithm based on atmosphere clouds model, International Journal of Computational Intelligence and Applications, 2013.

[16] A Kaveh and N Farhoudi, A new optimization method: Dolphin echolocation, Advances in Engineering Software, 59:53–70, 2013.

[17] K. Lenina, Dr. B. Ravindranath Reddyb, Dr. M. Surya Kalavathic, Dolphin Echolocation Algorithm for Solving Optimal Reactive Power Dispatch Problem, International Journal of Computer (IJC), Volume 12, No 1, pp 1-15, 2014.

[18] Dan Simon, Biogeography-based optimization. Evolutionary Computation, IEEE Transactions on, 12(6):702–713, 2008.

[19] Ali R. Alroomi , Fadhel A. Albasri and Jawad H. Talaq, Solving the associated weakness of Biography-Based Optimization Algorithm, International Journal on Soft Computing (IJSC) Vol. 4, No. 4, November 2013.

[20] Xin-She Yang, Flower pollination algorithm for global optimization, Unconventional Computation and Natural Computation, VOL 7445, pages 240–249, 2012.

[21] Xin-She Yang, Mehmet Karamanoglu, and Xingshi He, Multiobjective flower algorithm for optimization, Procedia Computer Science, 18:861–868, 2013.

[22] Z Zandi, E Afjei, and M Sedighizadeh, Reactive power dispatch using big bang-big crunch optimization algorithm for voltage stability enhancement, In Power and Energy (PECon), 2012 IEEE International Conference on, pages 239–244, IEEE, 2012.

[23] Z. Zandi, E. AFJEI, and M.Sedighizadeh, Hybrid Big Bang–Bag Crunch Optimization Based optimal reactive power dispatch for voltage stability enhancement, Journal of Theoretical and Applied Information Technology 20th January 2013, Vol. 47 No.2, PP. 537-546.

[24] Abdolreza Hatamlou, Black hole: A new heuristic optimization approach for data clustering, Information Sciences, 2012. PP. 175-184.

[25] Pablo Rabanal, Ismael Rodr´ıguez, and Fernando Rubio, Using river formation dynamics to design heuristic algorithms, In Unconventional Computation, PP. 163–177, Springer, 2007.

[26] Hugo Hern´andez and Christian Blum, Distributed graph coloring: an approach based on the calling behavior of japanese tree frogs. Swarm Intelligence, 6(2):117–150, 2012.

[27] Pinar Civicioglu, Backtracking search optimization algorithm for numerical optimization problems, Applied Mathematics and Computation, 219(15):8121–8144, 2013.

[28] P. Civicioglu, Artificial cooperative search algorithm for numerical optimization problems, Information Sciences, 229:58–76, 2013.

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