Evolution of Bio-inspired Routing Algorithms: A Survey

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***Abstract* - Nature tremendously exhibits some robust, diverse, dynamic and charming phenomena to solve complex problems in computer science. Bio-inspired routing algorithms are the nature inspired algorithms for solving the optimization problems opening a new era in computing. They are classified into three categories: Evolutionary based, Swarm Intelligence based and Ecology based routing algorithms. In this paper it is tried to overview the bio-inspired routing algorithms with their scope and viability developed in the past decades.**

***Index Terms* – Bio-inspired Routing Algorithm, Optimization Algorithm.**

I. INTRODUCTION

Optimization problems are wide, numerous and commonly encountered in computer science. Basically it means finding out the best possible solution or desirable solution. Therefore, for finding the solution of these problems ought to be an active research topic. Also for solving optimization problems it requires vast computational efforts which may tend to fail as the problem size increases. Nature is the perfect example for solving optimization problems because it always finds the optimal strategy ranging from micro-organism to human beings to balance the ecosystem, maintain diversity and physical phenomena adaptation like rain, cloud, river etc. Nature describes it designs and capabilities which are extremely enormous, mysterious and interesting that researchers are trying to find possibility in easy mapping between nature and technology. In last few decades, Bio-inspired routing has come up as new era in computing covering various application areas like Computer Networks, Security, Robotics, Medical Engineering, Power Systems, and Production Engineering etc. Bio-inspired routing algorithms are the nature inspired algorithms for solving the optimization problems opening a new era in computing. They are classified into three categories: Evolutionary based, Swarm Intelligence based and Ecology based routing algorithms as shown in figure 1. In this paper it is tried to overview the bio-inspired routing algorithms with their scope and viability developed in the past decades.

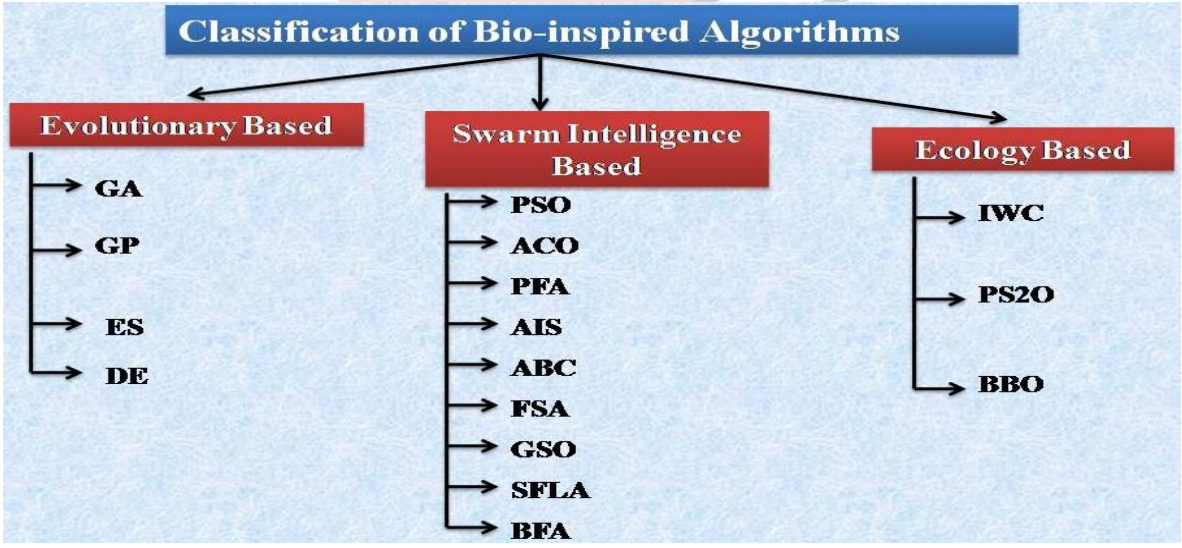

Fig.1: Classification of Bio-inspired Routing Algorithms

II. LITERATURE SURVEY

Evolutionary Based

Evolutionary based Bio-inspired algorithms are well known classical algorithms which are based on biological evolution in nature **[1].** They adopt the strategies to interact to solve the hard problems.

GAs stands for Genetic Algorithms based on evolutionary based bio-inspired algorithms proposed by J.H. Holland in 1973 **[2].** They follow the principles of Charles Darwin Theory of survival of the fittest. GAs begins with initialization of population of chromosome, then for each chromosome an appropriate fitness function is evaluated where they undergo cross over and mutation thus giving new set of solutions (offspring).

GP stands for genetic programming proposed by Koza, John R in 1992 **[3].** GP is the extension of GAs which differs only in terms of representation of solution. The population in GP generates diversity in values of genes as well as structure of individuals.
ES stands for evolution strategies proposed by Bienert, Rechenberg and Schwefel in 1964 **[4]** to optimize aerodynamic design problem robotically. This algorithm is inspired by theory of adaptation and evolution by means of natural selection. It utilizes the self-adaptive mechanism for controlling the application of mutation which is the main feature of such algorithms.
DE stands for differential evolution proposed by R. Storn and K. Price in 1995 **[5].** DE differs from GAs, in GAs mutation is the result of small pre combination to the genes of an individual while in DE , mutation is the result of arithmetic combination of individuals. DE automatically adapts the mutations increments to the best value during evolutionary process stage.

Swarm Intelligence Based
Swarm Intelligence based bio-inspired routing algorithm is a recent and emerging paradigm for implementing adaptive systems proposed by E. Bonabeau, M. Dorigo and G. Theraulaz in 1999 **[6]**. Swarm Intelligence (SI) is based on collective social behavior of real world insect swarms as a problem solving tool.
PSO stands for particle swarm optimization which is intelligence oriented, stochastic and population-based global optimization technique proposed by Kennedy and Eberhart in 1995 **[7]**. PSO is inspired by the social behavior of bird flocking searching for food. It has unique searching mechanism, simple concept, and computational efficiency and ease implementation, hence it is applied in many engineering optimization areas.
ACO stands for ant colony optimization proposed by Dorigo and Di Caro in 1999 **[8].** It is the most powerful swarm intelligence based bio-inspired routing algorithms. It is inspired by foreign behavior of ants in the wild, the phenomenon is known as stigmergy. The main aspect of ACO is that several ant species find shortest path between ant's nest and the food by tracing pheromone trails, strong pheromone trail indicates higher desirability.
ACS stands for ant colony system introduced by M.Dorigo,V.Maniezzo, & A. Colorni in 1996 **[9]** to improve performance of ant systems. It is based on four modifications applied to an ant system namely different transition rule, different pheromone trail update rule, local update of pheromone trail to favor exploration and use of candidate list to restrict the choice.
AIS stands for artificial immune system algorithm proposed by D. Dasgupta in 1999 **[10]** which is based on clone selection principle in human beings. It is inspired by human immune system which is highly adaptive systems having numerous strengths like immune recognition, reinforcement learning, feature extraction, immune memory, diversity and robustness. In AIS searching power is efficient and mutation operation can be uniform, Gaussian or exponential.
ABC stands for artificial bee colony algorithm proposed by XS Yang **[11**] in 2009. In ABC , an individual entity like bee in bee colony exhibit a simple set of behavior policies such as migration, replication, death, but a group of entities like bee colony exhibit complex set of behavior policies such as scalability and adaptability.
FSA stands for fish swarm algorithm proposed by X. Li, Z.Shao, J.Qian in 2002 **[12]** which is a new population based swarm intelligence evolutionary computation technique. It is inspired by natural instructional behavior of fish. FSA simulate three typical behavior namely searching for food, swarming in response to a threat and following to increase the chance of achieving a successful result.
GSO stands for group search optimizer algorithm proposed by S.He, Q.H.Wu in 2006 **[13]** which is a population based optimization algorithm. It is inspired by animal foraging behavior which adopts the producer-scrounger (PS) for designing optimum searching strategies. It constitutes three types of members namely Producers, Scroungers and Rangers. The task of producing strategies & searching for food is done by Producers, the task to perform scrounging strategies & joining uncovered resources is done by Scroungers and the task to perform random walk motion is done by Rangers.
SFLA stands for shuffled frog-leaping algorithm proposed by Muzaffar Eusuff and Kevin Lansey in 2003**[14].**It has efficient mathematical function and global search capability which is population based heuristic algorithm. It is inspired by interactive exchange of information of frogs searching for food laid on isolated stones randomly located in a pond. Some characteristics of SFLA are simple concept, fewer parameter adjustment, prompt formation, great capability in global search and easy implementation.
BFA stands for Bacterial Foraging Optimization Algorithm introduced by K.M. Passino in 2002 **[15].** It consist three mechanisms namely chemo taxis, reproduction and elimination-dispersal. In chemo taxis, a cell-to-cell communication mechanism is established to simulate the biological behavior of bacterial movement. In reproduction, only the best adapted bacteria tend to survive and transmit their genetic characters to succeeding generations. In elimination-dispersal, randomly selects part of the bacteria population to diminish and disperse into random positions in the environment.

Ecology Based
There can be numerous and complex types of interactions among the species of ecosystem. An Ecosystem provides rich source of mechanisms for designing and solving difficult engineering and computer science problems. It comprises with the biotic and non-biotic organisms which interacts with ecological entities like soil, water, air etc.
IWC stands for invasive weed colony algorithm proposed by A.R. Mehrabian and C. Lucas in 2006 **[16].** It is a stochastic search algorithm which is inspired by ecological process of weed colonization and distribution. IWC solves complex problems with appreciable efficiency including linear and non-linear optimization problems.
PS2O is a multi-species optimizer which extends the dynamics of the canonical PSO algorithm proposed by Hanning Chen and Yunlong Zhu in 2008 **[17]**. It is inspired by evolution of symbiotic species in natural ecosystems and heterogeneous interaction between species. In PS2O cooperation occurred in two levels, i.e., species level (interaction between species) and individual level (interaction within species).

BBO stands for Biogeography-Based Optimization algorithm proposed by Dan Simon in 2008 **[18]**. It is inspired by mathematical models of biogeography by Robert MacArthur and Edward Wilson. In BBO, there are two main operators: migration (which includes both emigration and immigration) and mutation. Mutation is used to increase the diversity of the population to get the good solutions.

III. CONCLUSION

Bio-inspired routing algorithms have opened a new era of research for next generation computing and engineering. In computer science, such algorithms may useful for solving complex problems with optimized solution. In this paper it is tried to summaries some bio-inspired algorithms with their working method and inspiration drawn for those algorithms. They are categorized into three namely; Evolutionary based, Swarm intelligence based and Ecology based bio-inspired algorithms. There still remain challenging task for research community for realization of such algorithms and mapping into in technology form, for this purpose it requires collaboration of researchers from different communities like artificial intelligence, medical engineering, chemistry, computer science, ecology etc. At the end, it is suggested that bio-inspired algorithms are most powerful algorithms to get optimized solution for complex problems which may helpful for future generation computing..

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