Aging Theories and the Aging Leader Algorithm with Challenger

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Abstract: **Aging is an inevitable process in nature. Almost each and every organism grows older with time. This process of being older makes the population grow at a normal pace and maintain the balance among species. This Aging mechanism can be applied on various problems and optimal solutions can be found. If a leader has a good leading power, it can live longer serve its population in a better way, else if a leader does not have the much needed capability to lead its population and it grows older, some new particles may come up to challenge and claim the leadership and this process can bring diversity in the population. This paper presents the aging theories related to the aging mechanism and an Aging leader algorithm is presented.**

Keywords**: Particle Swarm Optimization, Aging Leader, Lifespan, Population, Performance, Challenger, Leader, Aging, global search, premature convergence.**

I. INTRODUCTION

1) Aging:

Aging is a universal, intrinsic, progressive and deleterious process.[5]Every organism grows older with time. The process of being older is known as aging. With aging, the organisms become weak and become unable to lead the population, with this; other young organisms make themselves available for becoming the new leader and they rise up as the challengers for the older leaders in a population. Aging is essential to maintain the diversity. There may be number of challengers available for taking up the leadership but out of them only one can lead the specific population. [1]

a) Why aging?

There are three main theories: – Simple Deterioration (wear and tear theories)

– Non-Programmed Aging (non-adaptive aging)

– Programmed Aging [6]

b) Important Terms used:

i.) Population

The members of same species make up the population.

ii.) Challenger

The member of the population which presents itself for the position of the leader is called the challenger.

iii.) Leader

The member of the population which has all the capabilities of leading the population, and proves itself the best one for this position, becomes the leader of the population.

The selection of the new leader is done using some parameters. There are two main things which are checked to select the new leader. These are: lifespan and performance.

a) Lifespan:

Lifespan can be defined as the life time of the leader of a population, that means for how long a leader can live actively; leading that population. The lifespan of the leader can be elongated or can be shortened, according to the situation.

b) Performance:

The performance of a leader is defined as its capability to lead a population. If a new particle tries to enter the population, its performance is compared with the performance of the leader. The one with better leading power capability or performance can become the new leader.

II. BACKGROUND OF AGING THEORIES

Different theories of aging has been proposed by the biologists from time to time . Different classifications of these theories have been done according to the evidences the biologists get from researching in the field of

aging. Some of these theories include:

a) Classification 1:

According to this classification, the two categories of the aging theories have been proposed. These are: programmed theories and error theories.

1) *Programmed Theories*:

According to programmed theories, every human body will age and there is a certain biological timeline that the body has to follow. Some terms in programmed theory include:

a) *Programmed Longevity*: Certain genes switches on and off over time and it cause aging.

b) *Endocrine Theory*: Certain changes in hormones can control aging.

c) *Immunological Theory*: The immune system declines over time resulting, people more susceptible to diseases.

2) *Error Theories:*

Error theories say aging is caused by environmental damage to our body's systems, which increases with time.

a) *Wear and Tear:* Cells and tissues simply wear out with time.

b) *Rates of Living*: The faster the consumption of oxygen by an organism, the shorter it lives.

c) *Cross-Linking*: Cross-linked proteins accumulate and slow down body processes.

d) *Free Radicals*: Free radicals damage the cells.

e) *Somatic DNA Damage*: Genetic mutations results in malfunctioning of the cells.

b) Classification 2:

These two major theories explain the psychosocial aspects of aging in older adults:

1. *Disengagement theory:*

Disengagement theory views aging as a process of mutual withdrawal in which the capability of older adults slows down and they retire, as expected by society. Proponents of disengagement theory hold that mutual social withdrawal benefits both the individuals and the society.

2. *Activity theory:*

The activity theory sees a positive correlation between keeping active and aging well. The activity theory say that mutual social withdrawal runs counter to traditional American ideals of activity, energy, and industry. Individuals who led active lives as young and middle adults will probably remain active as older adults, while the ones who were less active may become little disengaged as they get aged.

A) *Aging Theory and Its Connection with Evolutionary Computation:*

The biologists have been working on aging theories for about 150 years. Nowadays the aging theories can be divided into two main categories:

1) Non-programmed theories:

According to the non-programmed theories, aging is not evolved but is an inescapable biological reality that causes increasing deterioration over time.

2) *Programmed theories:*

According to the programmed theories , aging is a genetically programmed characteristic which is beneficial to animal species. Both the non-programmed and programmed theories have their unsolved problems . According to different theories it has been accepted that aging is able to increase genetic diversity and is helpful for the evolution of a species. An optimal lifespan plays an important role in improving the effectiveness of evolution. Moreover, for intelligent species which are able to learn from experience, aging helps to avoid the adverse effects of excessive experience accumulation of older individuals. Without the aging mechanism, there are no physical and functional differences between younger and older animals. Because older animals accumulate more knowledge and skills than younger ones, they are always the superior competitors. The outcome of this situation:

1. The older animals always have more chances to survive and breed as they are superior competitors in natural selection.

2. In social animal colonies, it is common that superior individuals are selected as the leaders of the colonies.

3. Without aging, the older animals are always the leaders, being in-charge of the activities, knowledge and skills of the colonies for a very long time.[3]

In genetic algorithm design, each individual is assigned an age. The individual is removed from the population when its age reaches a predefined longevity. The fitness of an individual is evaluated by considering not only the objective function but also the age . In nature, when the leader of a colony gets too old to lead, new individuals emerge to challenge and claim the leadership. In this way, the community is always led by a leader with adequate leading power. The study of effect of aging on more evolutionary computation techniques is still in progress.[4]

III. AGING LEADER ALGORITHM

This algorithm works on the members of a population. Whenever the leader of the population becomes weak or grows older and inefficient to lead, a new leader is needed. The challengers rise up to lead the population and using the algorithm, the one with best qualities, becomes the new leader of the population An efficient best solution is found by comparing the leaders of different population.

1. Consideration's

i) A database consisting of the members of the population

ii) a new particle $^{\theta}$

iii) A population having a leader with lifespan b and performance p.

2. Working:

A new particle $^{\theta}$ enters the database containing the leader having lifespan b and performance p. The lifespan of the previous leader is checked, when it expires, a new challenger comes up to challenge former's leading power. The best is found and leads the population.

The algorithm works as follows:

Step 1: Initialization

In an n- dimensional search space, the initial positions of all the particles are initialized randomly with their velocities be set to zero. Among the swarm, one best particle is found and it is selected as the leader with its age and lifespan both initialized to zero.

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Step 2: Updating Leader

For every particle, present in the swarm, new positions are found. If the newly generated position is better than the leader, then the new generated particle is made the new leader of that population.

Step 3: Lifespan Control

The leading power of the leader for improving the entire swarm is found, after the positions of all the particles are updated.

The globally best solution (gbest) found and accordingly three cases are defined:

a.) If gbest<0 (good leading power) , lifespan b is increased by 2, b=b+2.

b.) If gbest=0 (fairly leading power), lifespan b is increased by 1, b=b+1.

c.) If gbest>0 (poor leading power), lifespan b is decreased by 1, b=b-1.

Step 4: Generating a Challenger

A newly generated particle challenges the previous leader whose lifespan is expired. If the performance of particle θ is greater than the leader, or if lifespan of leader expires (b=0), then the challenger is generated and the leader is updated, reporting the best solution.

Step 5: Evaluating the Challenger

The leading power of the challenger and the previous leader are compared:

a.) If the challenger has more leading power, it will replace the leader.

b.) If challenger has less power, the leader will lead the swarm as it is.

Step 6:

Best solution for the population is found and report is generated.

Step 7:

Best solutions found by other population are compared and more optimal solution in multi-population is generated. [2]

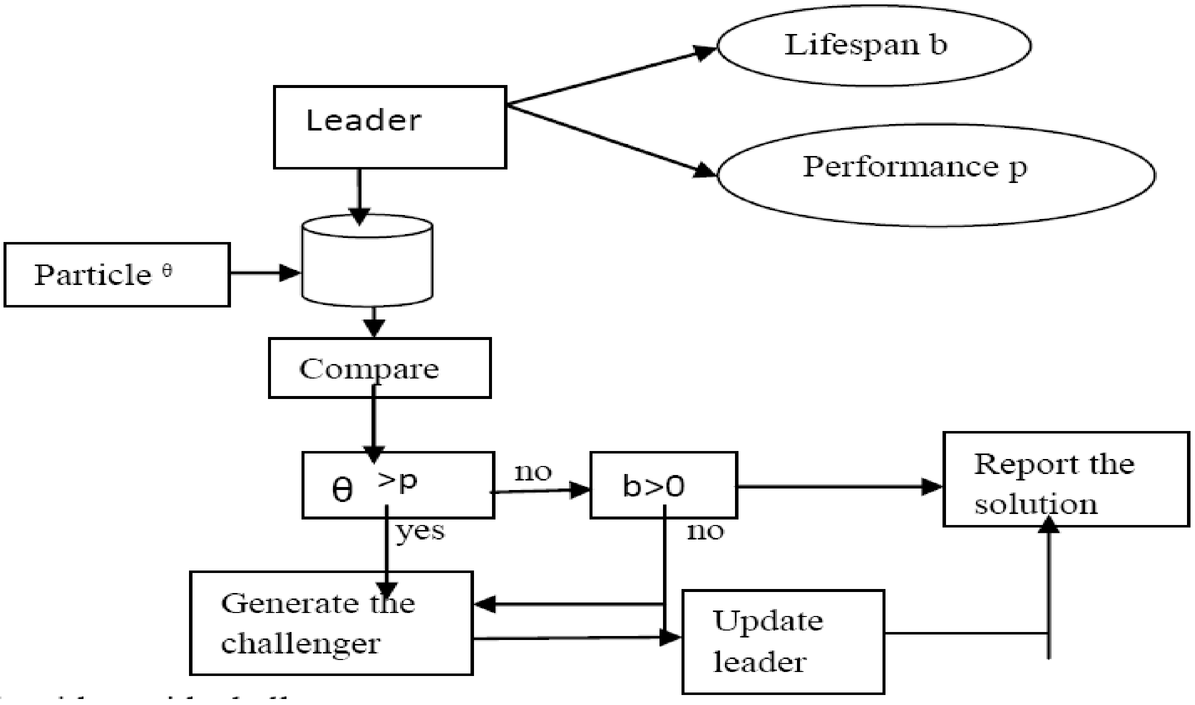

Figure: Aging Leader Algorithm with challenger

IV. RELATED WORK DONE

[1] *Wei-Neng Chen , Jun Zhang, Ni Chen, Zhi-Hui Zhan , Henry Shu-Hung Chung , Yun Li , Yu-Hui Shi "Particle Swarm Optimization with an Aging Leader and Challengers"* In nature, almost every organism ages and has a limited lifespan. . In a social animal colony, aging makes the old leader of the colony become weak, and thus it provides opportunities for the other individuals to challenge the leadership position. This paper presents the aging mechanism applied to particle swarm optimization (PSO) and proposes a PSO with an aging leader and challengers (ALC-PSO). ALC-PSO is designed to overcome the problem of premature convergence without significantly impairing the fast-converging feature of PSO.

[2] *S.Vijayalakshmi, D.Sudha, S.Mercy Sigamani, K.Kalpana Devi, "Particle Swarm Optimization with Aging Leader and Challenges for Multiswarm Optimization"* In reality every organism ages and has a limited life span. Aging is important for maintaining diversity. In nature the aging leader become weak which leaves opportunities to the other individuals to challenge the leadership position. This paper transplants the aging leader and challengers (ALC-PSO) by taking its advantages and proposes Aging leader and challengers (ALC-PSO) in multiswarm. The leader which shows the long leading power attracts the swarm towards the best position, else if the leader of the swarm fails to improve the swarm towards better position, the new challengers claim the leadership. This concept ALC-PSO in multiswarm serves as a mechanism for upgrading a suitable leader to lead the swarm and provides the best optimal solution.

[3] *Theodore C. Goldsmith "The Evolution of Aging How New Theories"* It provides a review of theories of biological aging including underlying evolution and genetics issues and describes recent discoveries and theories that overwhelmingly favor programmed aging and therefore suggest that increased research on aging mechanisms would be highly beneficial to public health.

[4] *A. Ghosh, S. Tsutsui, and H. Tanaka, "Individual aging in genetic algorithms"*A concept of age of individuals for measuring their suitability for participation in genetic operations for steady state GAs is introduced. Effective fitness of an individual depends both on its functional value and age. Age of a newly generated individual is taken as zero and every iteration is increased by one. As in nature, adult individuals are considered more fit for genetic operations, compared to young and old ones. The model aims to emulate the natural genetic system in a more natural way. The effectiveness of this concept is demonstrated by solving complex function optimization problems. The results have shown that the scheme provides enhanced performance and it maintains more diversity in the population thereby allowing the species to be robust to trace the changing environment

V. CONCLUSION

The aging leader algorithm presented here can be implemented to some optimization problems to have the optimal solutions for those problems. Some of these problems include: particle swarm optimization, task assignment problem , elections etc. It is a simple algorithm which can be easily implemented using any high level language like: C/C++, Java, .net and in MATLAB too.

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