Altruism as a Tool for optimization: Literature Review

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***Abstract*— Altruism is the opposite of selfishness. Altruism is a powerful force and is unique in the animal environment. Some individuals are heterogeneity and interact between altruists and selfish. The simplest form of altruism can be explained by usefulness of protecting ones genetic investment in relatives other than direct offspring. Reciprocal altruism is the idea that if you behave kindly to a person or help them in the past, that individual will be inclined to help you in the future .Altruism can be hedonistic or natural altruism in empathy, affection, sympathy, emotional contagion, pity and compassion; or normative altruism of the moral, non-moral social, and rational types. Altruism exists in families and among the diverse motives of the political and public sector. We have to turn to game theory for complicated models of altruism. Using game theory shows that altruistic behavior can be optimal but the conditions under which it is so are delicate .When we can estimate average behavior over trials we do the better. We can also use altruism with genetic algorithm. Altruism favored over natural selection – built in genetic algorithm. Altruism optimizes solution of multiobjective optimization problems. in this paper, definitions of altruism, types of altruism, benefits of altruism, altruism and fitness ,evolution of altruism, are discussed and analyzed . The survey investigates how to cultivate altruism as well as advantage and disadvantage of genetic algorithm with altruism. To add to this, several future improvements are suggested.**

***Keywords*— Altruism; genetic algorithm; optimization; Multiobjective optimization.**

I. INTRODUCTION

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Some people risk their lives to help others and its altruistic behavior. This does not mean that humans are more altruistic than selfish; they can act in either direction.

A truly altruistic deed must not be motivated by the desire to gain some personal benefit, either in the short or long term. Our action is not considered altruistic if the sole aim of our behaviour is to ease the personal distress that we feel when faced with the suffering of another.

There is much confusion of the ideal that a person ought to be allowed to pursue his own aims with the belief that, if left free, he will or ought to pursues solely his selfish aims. (Hayek, 1960). In my view the ideal society would be one in which each citizen developed a real split personality, acting selfishly in the market place and altruistically at the ballot box.(meade,1973). Though some believe that humans are fundamentally self-interested, recent research suggests otherwise: Studies have found that people's first impulse is to cooperate rather than compete; that toddlers spontaneously help people in need out of a genuine concern for their welfare; and that even non-human primate's display altruism [1-4] .

Crook (1980) has suggested that altruism may be linked to consciousness. Crook explained that consciousness helps us to distinguish between other people and ourselves and to imagine ourselves if we were put into the situation that a certain individual is in. A study done by Rushton (1984) suggested that parental models and other forms of social support are essential factors in the development of altruistic behavior. there exist several factors that may affect the way in which a person behaves altruistically. Isen, Daubman and Nowicki (1987) have founded that if a person is in a good mood, they are more likely to help others. However, people are less likely to help when in a good mood if they think that helping, may spoil that good mood. Genetic algorithms are a family of computational models belonging to the class of evolutionary algorithms, part of artificial intelligence [5]. Multiobjective optimization involves minimizing or maximizing multiple objective functions subject to a set of constraints. Biological phenomena are mimicked in various modern day technologies. The field of optimization is no exception. Many recent optimization algorithms like simulated annealing (SA), ant colony optimization, etc. have been inspired by nature [6]. A similar inspiration from evolutionary biology for solving optimization problems led to genetic algorithm. In natural evolution, altruism (unselfishness) is a commonly observed phenomenon, too [6-7].by adding altruism to genetic algorithm and solving multiobjective optimization problems, solutions are better than genetic algorithm without altruism, so altruism is a tool for optimization. Altruism increases fitness of recipient and decrease fitness of donor. The fitness of donor still decrease until the donor dies. Altruism improve solution because by adding altruism to genetic algorithm, population divides into altruistic group,(which contains the smallest fitness chromosomes)and population group contains the remaining chromosomes (have the heights fitness) and by doing altruistic operation between two groups the fitness of population group will increase and fitness of altruistic group will decrease ,and remains only in the population, the highest fitness chromosomes .after previous step ,crossover and mutation apply on population after altruistic process, and solutions will be better than genetic without altruism. Altruism has a great influence on multiobjective optimization problems.by biomimicking altruistic behavior of honey bees

in multiobjective genetic algorithm, altruism favored over natural selection-built in genetic algorithm and improved results. The concept of altruism can be used in simulating monkey behavior and ant colony, etc.

A. *Several definitions of altruism*

- Altruism: Feelings and behavior that show a desire to help other people and a lack of selfishness
- The principle of unselfish concern for or devotion to the welfare of others
- Behavior by an animal that, May be to its disadvantage but that benefits others of its kind.
- Altruism: Willingness to do things that bring advantages to others, even if it results in disadvantage for yourself.
- Altruism: Promotes the survival chances of others at a cost to one's own.
- Altruism: Self-sacrifice for the benefit of others.
- Altruism: Unselfish regard for or devotion to the welfare of others.
- Altruism: Behavior by an animal that is not beneficial to or may be harmful to itself but that benefits others of its species.

B. Benefits of altruism

Evolutionary scientists speculate that altruism has such deep roots in human nature because helping and cooperation promotes the survival of our species. Research suggests that practicing altruism enhances our personal well-being emotionally, physically, romantically and perhaps even financially [1-2]. It's also crucial. To stable and healthy communities and to the well-being of our species as a whole. Altruism makes us happy: researchers have consistently found that people report a significant happiness boost after doing kind deeds for others. Some studies suggest giving to others makes people feel happier than spending money on them.

- Altruism is good for our health: Older people who volunteer or regularly help friends or relatives have significantly lower chance of dying.
- Altruism is good for our bottom line: Across the animal kingdom, animals that cooperate with each other are more productive and survive longer.
- Altruism is good for our love lives: When researcher David buss surveyed more than 10,000 people across 37 cultures, he found that kindness was their most important criterion for a mate and the single universal requirement for a mate across all cultures.
- Altruism fights addiction: Studies have shown that addicts who help others even in small ways can significantly improve their chances of staying sober and avoiding relapse.
- Altruism promotes social connections: When we give to the others, they feel closer to us and we also feel closer to them.
- Altruism is good for education: When students complement their classroom learning with real world community service, improve academic performance and make students feel more connected to their school.

C. How to cultivate altruism?

Studies show that kids behave altruistically even before they've learned to talk. But too often, we don't act on our propensities for kindness as we get older. Here are ways research suggests we can nurture our own altruistic instincts and help motivate altruism in others. The steps of cultivate altruism are:

Step 1: Get connected
Step 2: Get personal
Step 3: See yourself in others
Step 4: Give thanks
Step 5: Put people in a good mood.
Step 6: Fight inequality.
Step 7: Lead by example: people who consistently display altruism encourage others to follow suit.
Step 8: Encourage collaboration and emphasize shared goals.
Step 9: Help in building a supportive community.

D. Is altruism a revolution?

No it's more of an evolution. It's not about forcing anyone to do anything. Capitalistic and altruistic citizens can coexist within a society just as employed and unemployed people can coexist within a family. Altruism is a gradual letting go of the old value 'what is best for me?' and an embracing of a new one 'what is best for us?'

E. What is necessary for an altruistic society?

Legislation can only go so far to shape public life, and usually follows rather than leads social change. Laws will mean nothing if people aren't willing to change the aims of their lives and if they are; it won't be pieces of paper that inspire them to change their approach to life. We have a vision of redressing the balance of economic factors over social ones. The more people share this, the sooner it will come about.

By thinking altruistically .we welcomes all efforts to contribute to and to share these ideas. Our ultimate goal is a world where everyone has the chance to work not for money but for love of the work, their fellow man and this wonderful life which we have been given [1-3].

F. Models of altruism

The most effective counter to the spread of altruism is the modern money system since it is responsible for an unnatural transactional mentality. The inherent conflict in conventional money establishes zero-sum (competitive) relationships

between people and organizations so that those who help others necessarily disadvantage themselves.

- *Weak altruism*: benefits more the other individual than the altruist.
- *Strong altruism*: benefits other individuals at altruist's own cost.

G. Fitness and altruism

Altruistic process as optimization tool, increase fitness of a randomly chosen chromosome (recipient), and decreases fitness of randomly chosen chromosome with altruistic allele (donor).

From the point of view of traditional evolutionary theory the altruistic chromosomes must die out during evolution because their fitness is systematically decreased.

Multi-level selection theory explains the evolution of altruism by considering the action of natural selection not on an individual but on a group level [4].

Evolution of cooperation in nature is usually explained by kin selection, group selection, reciprocal altruism ("tit for tat") or moralism.

The rest of this paper is organized as follows: In Section 2 we review the genetic algorithm. The genetic algorithm with altruism is presented in Section 3 respectively. In the last section we conclude this paper and point out some future research directions.

II. GENETIC ALGORITHM

- Genetic algorithms are a family of computational models belonging to the class of evolutionary.
- These algorithms encode a potential solution to a specific problem on a simple chromosome like data structure.
- Using techniques inspired by natural evolution such as inheritance, mutation, selection and crossover.
- They are often viewed as function optimizers.
- First appeared in 1950s and early 1960s while biologists were explicitly seeking to the model of natural evolution [7-8].
- Idea of inheritance and mutation introduced by Ingo Rothenberg which is termed as evolution strategy (1965).
- M.j.walsh introduced evolutionary programming (1966).
- Later versions introduced population which leads to the genetic algorithms.
- In 1975 John Holland published book adaptation in natural and artificial systems .this was the first book to represent concept of adaptive digital systems using mutation, selection and crossover.
- Evolution is very powerful theory since biological principles like common descent and selective breeding have been used for the benefit of humans.
- Most organisms evolve by means of two primary processes: natural selection and sexual reproduction. The first determines which members of population survive and reproduce and the second ensures mixing and recombination among the genes of their offspring.
- Similar analogy is used in GA.
- Search space/state space; the space of all feasible solutions.
- Chromosome: a set of genes; chromosome contains the solution in form of genes.
- Population: a set of solutions (or individuals/chromosomes).
- Generation: the process of evaluation, selection, recombination and mutation.
- Fitness: the value assigned to an individual based on how far or close it is from the solution; greater the fitness value better the solution it contains.

Selection types: -

- Roulette wheel selection (RWS): The chance of a chromosome being selected is proportional to its fitness value.
- Elitism selection: The idea here is to arrange the chromosomes in the decreasing order according to their fitness values .then apply the selection with each two chromosomes in the arranged set. In this way, genetic algorithm will be applied between strong chromosomes or between weak chromosomes. This means there is no chance to apply genetic algorithm between weak and strong chromosome.
- Rank selection: The rank values can be distributed through the set of chromosomes according to their fitness values can be distributed through the set of chromosomes according to their fitness values, after that, the new fitness values can be calculated using another fitness function .finally the roulette wheel can be used to choose the selected chromosomes.
- Binary tournament selection: For n times do the following :
  - Choose two chromosomes randomly.
  - And select the chromosome with the highest fitness value.
  - The problem is to know the suitable types of selection and crossover parameters to be worked together to perform better within less time when applied in intrusion detection system.

B. Types of crossover

- Single point.
- Two points.
- Uniform.

C. Types of mutation

- Flip Bit (used for binary represented genes).
- Boundary (used for integer and float represented genes).
- Uniform (used for integer and float representation).

D. Parameters of genetic algorithm

There are three basic parameters of genetic algorithm

- Crossover probability
- Mutation probability
- Population size
  - Crossover probability represents how often crossover is performed.
    Constraint: if the crossover rate is too high, high performance strings are eliminated faster than selection can produce improvements, low crossover rate may cause stagnation due to the lower exploration rate.
    Solution: crossover rate generally should be high, about 80%-95%
    Some results show that for some problems crossover rate about 60% is the best.
  - Mutation probability represents how often mutation is performed.
    Constraint: A very small mutation rate may lead to convergence to local optima areas, mutation rate that is too high results in almost random search.
    Solution: best rates reported are about 0.5%-1%.
  - Population size number of chromosomes in population (in one generation).
    Constraint: Too few chromosomes implies GA has a few possibilities to perform crossover and only a small part of search space is explored.
    Too many chromosomes implies GA slows down.
    Solution: Good population size is about 20-30, however sometimes size 50-100 is reported as best.

E. Advantage of genetic algorithm

- Implicit parallelism solution space is explored in multiple directions.
- Nonlinear problems- large solution space, but GA is ideal.
- Work on complex landscape.
- Dilemma of global optimum vs. many local optima.
- GA can manipulate many parameters simultaneously.
- GA doesn't have specific knowledge of problem. All possible search pathways are considered in GA.

F. Disadvantage of genetic algorithm

- Computationally expensive.
- Time consuming.
- Proper writing of fitness function.
- Proper values of size of population, crossover and mutation rate.
- Deceptive fitness function.
- Premature convergence.
- No one mathematically perfect solution since problems of biological adaptation doesn't have this issue.

G. Pseudopod of genetic algorithm

Step 1: Choose the initial population of individuals.
Step 2: Evaluate the fitness of each individual in population.
Step 3: Repeat until termination condition satisfied
Step 4 :(Selection): select the individuals with greater fitness for reproduction.
Step 5 :(Crossover): breed new individuals through crossover.
Step 6: (Mutation): apply probabilistic mutation on new individuals.
Step 7: Form a new population with these offspring.
Step8: Terminate.

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III. ALTRUISM WITH GENETIC ALGORITHM

Genetic algorithm with altruism composed of two steps that are repeated, reproduction with replacing a parental population by a new one and altruism.

By adding altruism to genetic algorithm the result algorithm will be stronger and faster than genetic without altruism. Altruism helps in increasing fitness of recipient chromosome and decreasing fitness of donor chromosome .From this the fitness of donor will decrease and then donor chromosome will die. And remains only in the population the chromosomes with the greater fitness [10]

1. Specification of chromosomes

$\alpha = (\alpha_a, \alpha_s, \alpha_f)$

. Each chromosome consists of three entries (Altruism, Similarity and Fitness) [7-8].

The first 1-bit entry determines presence (1) or absence (0) of altruism.

The second nonnegative integer entry describes a similarity (belonging to a clan, kinship relation); two chromosomes are more similar, if an absolute value of the difference of their similarity descriptor is smaller, in the limit case of zero difference the chromosomes belong to the same clan.

The third nonnegative real number entry determines a fitness of the chromosome.

2. Population is a multiset of finite number of chromosomes

P={α,β,α`,β`,….}

3. Selection of chromosomes

A quasirandom selection of chromosome α is specified by a probability that is determined by a rescaled fitness

$$\text{Prob}_{qr}(\alpha) = \frac{F(f(\alpha))}{\sum F(f(\beta))}$$

Where α, β two chromosomes in the population, F is a mapping that "rescales"chromosome fitness so that the following condition is fulfilled

$$f(\alpha) < f(\beta) \rightarrow F(f(\alpha)) < F(f(\beta))$$

A quasirandom selection can be expressed as an application of stochastic operator onto the whole population

$\alpha = O_{qr,sel}(P)$

Rescaling function

$$F(f(\alpha)) = MIN + \frac{(MAX - MIN)\cdot(rank(f(\alpha)) - 1)}{p-1}$$

Where MIN is a small number(equal to 1/p),MAX =1,p is a cardinality of a population P,and rank(f(α)) is an index number of a place of f(α) in a sequence of fitness of all chromosomes arranged in increasing order.

Fully random selection of a chromosome α is specified by a probability

$$Prob_{fr}(\alpha) = \frac{1}{|P|}$$

This means that in the framework of this type of selection a chromosome α is selected with a probability specified as an inverse value of the population P.

4. Reproduction process

Assign to a pair of chromosomes a new pair of chromosomes. Reproduction process include crossover and mutation operator.

- A Crossover operator assigns to a pair of chromosomes α , β (parents) another pair of chromosomes $\tilde{\alpha},\tilde{\beta}$ (offspring).
  $(\tilde{\alpha}, \tilde{\beta}) = O_{cross}(\alpha,\beta)$
  Let $\alpha=(\alpha_a,\alpha_s,\alpha_f)$, $\beta = (\beta_a,\beta_s,\beta_f)$ are parents chromosomes and by doing crossover operator on parents yield offspring ,$\tilde{\alpha}=(\tilde{\alpha_a},\tilde{\alpha_s},\tilde{\alpha_f})$, $\tilde{\beta}=(\tilde{\beta_a},\tilde{\beta_s}$, $\tilde{\beta_f})$
  Altruistic entries remain unchanged, similarity entries of offspring are determined by the parent-mother similarity entry of chromosome α and fitness entries are determined as arithmetic means of parent values.
  $\tilde{\alpha_a} = \alpha_a$, $\tilde{\beta_a} = \beta_a$
  $\tilde{\alpha_s} = \alpha_s$, $\tilde{\beta_s} = \alpha_s$
  $\tilde{\alpha_f} = \frac{1}{2}(\alpha_f + \beta_f)$, $\tilde{\beta_f} = \frac{1}{2}(\alpha_f + \beta_f)$
- Mutation operator assign stochastically to each chromosome $\tilde{\alpha}$ another chromosome α`. Mutation operator affects all three parts of the chromosome α[10].

$$\alpha`_a = \begin{cases} 1-\tilde{\alpha_a} \text{ (if random}<P_{mut}) \\ \tilde{\alpha_a} \text{ (otherwise)} \end{cases}$$

Where P_{mut} is the probability of mutation

$$\alpha`_s = \begin{cases} 1+\text{random (m)) } \dagger\tilde{\alpha_s} \text{ (if random}<P_{mut}) \\ \tilde{\alpha_s} \text{ (otherwise)} \end{cases}$$

Where m is the number of chromosome classes

$\alpha`_f = \tilde{\alpha_f} + r(0,\sigma_{mut})$

Where $r(0, \sigma_{mut})$ is a random number with normal distribution, zero mean and standard deviation σ_{mut}

5. Altruism

Altruism mean an interaction between chromosomes so that their fitness is for one of them (donor) decreased and for another (recipient) is increased.

Let α be an altruistic chromosome (donor), thus αa=1.

We introduce with respect to this altruistic chromosome a distance of chromosomes from this equation

$d(\alpha,\beta)=|\alpha a - \beta a| + |\alpha s - \beta s|$

Where d is the distance between chromosomes,

a and s are altruism and similarity for each chromosome.

An altruistic operator O_{alt} which acts on a donor α (α_a=1) and a recipient β randomly chosen from the whole population is determined by

$(\alpha`, \beta`)=O_{alt}(\alpha , \beta)$

Where

$\alpha`_a = \alpha_a$ , $\alpha`_s = \alpha_s$,

$\alpha`_f = \alpha_f - e^{-\xi . d(\alpha,\beta)} |r(0,\sigma_{alt})|$

and

$\beta`_a = \beta_a$, $\beta`_s = \beta_s$,

$\beta`_f = \beta_f + e^{-\xi . d(\alpha,\beta)} |r(0,\sigma_{alt})|$

Where ξ is a real positive number and $r(0,\sigma_{alt})$ is a random number with a normal distribution and a standard deviation σ_{alt} .the parameter ξ controls the "strength" of relatedness relevant for an amount of fitness donation. If this parameter is small, then an altruistic process is applied strongly even for recipient ,which are in relatedness very far from donor ,in the other case if this constant is sufficiently big ,then an altruistic transfer of fitness is realized substantially only for closely related couple donor-recipient. The "canonical" genetic algorithm is modified in such a way, that an operation of altruism is included before a reproduction process .This operation is repeated for prescribed number of times for a randomly chosen donor with an altruistic chromosome and for totally randomly chosen recipient[10].

A. GA with altruism parameters:

T_{max} = maximal number of generations
P_{mut}=probability of mutation
P_{cross}=probability of crossover
p=cardinality of the population
m=number of chromosome classes
u=number of altruistic acts
ξ= A measure of similarity between donor and recipient relevant for an amount of fitness donation
σ_{cross} = Standard deviation of random modifications of fitness in the reproduction
σ_{alt} =standard deviation of random modifications of fitness in the altruism

B. The pseudo code of the genetic algorithm with altruism

Step 1: Generate P, Multiset of randomly generated chromosomes;
Step 2: Set *t*=0;
Step 3: While $t < T_{max}$ do

Step 4: Set *t=t+1*;
Step 5: For *i=1* to u do
Step 6: Do fully random selection of x from p, and do fully random selection of y from P_{alt} (contains the lowest fitness chromosomes); x, y are two parents
Step 7: Apply altruistic operator O_{alt} on x, y
Step 8: Set new population equal old population without old value of x,y ,then add to the new population the new value of x,y
Step 9: End for
Step 10: Do reproduction process (crossover and mutation) on p after altruism
Step 11: Keep chromosomes after reproduction in Q
Step 12: Terminates when goal achieved

C. Optimization

Finding an alternative with the most cost effective or highest achievable performance under the given constraints, by maximizing desired factors and minimizing undesired ones.

D. multiobjective optimization

Finding a vector of decision variables which satisfies constraints and optimizes a vector function whose elements represent the objective functions. These functions form a mathematical description of performance criteria which are usually in conflict with each other.

E. Illustrates altruism of honey bee colony

Each honeycomb has one queen, large population of daughter-worker bees and a very small number of son –drones. A large population of the daughter-worker bees prefers to rear the queen's offspring (sibling sisters; altruistic behaviour) rather than produce their own offspring (selfish behaviour).this maximizes the inclusive fitness of the population[11].

F. Altruism in multiobjective optimization problems

Altruism improves solution of multiobjective optimization problems .by biomimicking altruistic behaviour of honey bees in multi-objective genetic algorithm researchers found that altruism favored over the natural selection built-in genetic algorithm. Altruism used for solving optimization problems in science and engineering, used for describing complex phenomena like carcinogenesis and performs better than genetic algorithm without altruism.

IV. Conclusions and Future Work

Altruism is a tool for optimization. Biomimicking biological phenomena can be done using the concept of altruism. Altruism can be studied further in models in economy. Altruism favored over natural selection built-in genetic algorithm.an altruism could also prove efficient, when a solution emerges from cooperation of more individuals, like in optimization by a kind of ant colony.

However, there are many future works that can be done, such as:

- Integrate altruism with genetic algorithm and solve all types of multi-objective optimization problems.
- Compare solutions of multi-objective optimization problems with and without altruism to study the effects of altruism.
- Using altruism in objectives that are mutually exclusive and optimizing them requires tradeoff.
- Study altruism by game theory and modeling problems in game theory by altruism.
- Study the effects of adding altruism before and after reproduction in genetic algorithm.
- Adding altruism to neural networking.
- Adding altruism to gravitational search algorithm.
- Adding altruism to intelligent water drops.
- Adding altruism to river formation dynamics.
- Using the concept of altruism in making a simulation of cancer.
- Study the concept of altruism in ants' colony.
- Using altruism in aeronautics.
- Using altruism in multiple objective genetics algorithm to design wing shape for supersonic aircraft.
- Using altruism in major consideration for wing design.
- Using altruism with fuzzy logical

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