

## Mosquito Attack Optimization

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Abstract

**Ant Colony Optimization and Swarm Optimization are the classical areas of researches in the field of Computer Science. Computer Scientists are trying to map the Biological and Natural Solution with the Artificial one, since last 2 decades. Finally, Genetic Algorithm (GA), Genetic Programming (GP) and Artificial Neural Network (ANN), ACO[13], etc were derived from the Biological, Genetical and Natural characteristics of the living organisms.**

**We have developed a population based stochastic optimization technique inspired by social behavior of Mosquito (Female). This research will open a new side of 'Particle Swarm Optimization', in future.**

**Keywords:** GA, PSO, DMTIM, critical value and Chi-Square.

## 1. Introduction

Population based stochastic optimization technique is a new research area originated from social behavior of bird flocking or fish schooling. Particle swarm optimization[12] (PSO) shows maximum similarities with GA (Genetic Algorithm)[10,11], where initial population generated from random solution and searches for optima by updating generations [Dr. Eberhart and Dr. Kennedy in 1995]. PSO has no evolution operators, like crossover, mutation, etc.

Background of Artificial Life is important in this research. Here in this case human made system must possess some necessary features of life. This type of research bifurcated into a) how computational techniques can help when studying biological features and b) how biological techniques can help out with computational problems. Our focus is on the second one. In both the cases Genetic Behaviors, natural characteristics and Environmental studies are mandatory.

Sufficient numbers of population based stochastic optimization techniques are proposed for optimal / near optimal solutions of problems.

Genetic Algorithms are inspired in Darwin's theory of evolution by natural selection and are powerful tools in difficult search and optimization problems [Holland, 1975; Goldberg, 1989].

## 2. Earlier Works

A group of Mosquitoes are randomly searching the host (object) to attack. All of the Mosquitoes have fitness values that are evaluated by the fitness function to be optimized, and have velocities that direct the flying of the Mosquitoes[4, 8].

Mosquitoes use visual, thermal, and olfactory stimuli to locate a host. Of these, olfactory (connected with sense of smell) signals are most important[3]. For mosquitoes that feed during the daytime, movement of the host and the wearing of dark-colored clothing may initiate orientation toward a person. Visual signals seem to be important for in-flight orientation, particularly over long ranges, whereas olfactory stimuli become more important as a mosquito nears its host[6]. Using sensors on its antennae, a mosquito picks up animals' body heat, odor and carbon dioxide from exhaled breath. The female mosquito follows the trail upwind to its source[4]. Once mosquitoes get closer, they're attracted to other signals such as dark colors, moisture in the air, and

silhouettes of potential victims. Mosquitoes responded to the body signals of an animal standing 45 feet away. The female mosquito (only the female feeds on blood--the males prefer plant juices) tracks its quarry by a "sniffing" mechanism, which monitors heat, moisture and carbon dioxide content in the air. This is why mosquito repellents work[4]. It is not that they smell bad to the insect--it is because the molecules, which they contain, block the sensing mechanisms that the mosquito carries in its antennae to detect heat, moisture and carbon dioxide. In other words, if an effective repellent is in the air, the mosquito gets lost on its track to the target, Willis (1947).

Mosquitoes do not become active until temperatures reach about 45 F. Mosquito activity increased with increasing temperature to about 68 degrees. Above 68, mosquitoes become less active, and the pests take cover at the upper threshold temperature of about 82 degrees. Wind speed higher than six meters a second will ground mosquitoes[5].

Mosquito can flap its wings about 500 times per second to fly in a reasonable speed equals three miles per hour[5, 6, 3].

### 3. Our Work

Considering the following data – which will feed at the daytime and worked as a signal sensing during attack [Rudolfs,1922] :-

CO<sub>2</sub> Concentration (carries in it's a antennae)

Temperature sensing

Dark Color (Vision)

Humidity

Peptone / Hemoglobin (For Long distance search)

If any thing changes in the above learning factor then Mosquito changes its orientation and repelled.

Sensor technology and communication have led to the concept of a sensor network. A sensor network is a network of local sensor nodes which have sensing, processing, and communication capabilities. Sensor networks have received growing interest in a variety of applications that fully exploit the capability of sensor networks, algorithms for sensor networks should be *scalable, i.e.,* adding/deleting sensors or targets into a sensor network can be handled efficiently, and *distributed, i.e.,* the algorithm can be implemented in individual sensors. In this paper, we propose a scalable distributed multiple-target tracking and identity management (DMTIM) algorithm which can keep track of multiple maneuvering targets and their identities in a sensor network.

### **3.1 General Host-Attach Algorithm :-**

Step 1 : Selection of Mosquitoes

(Fitness and Sex Selection)

Step 2 : for each mosquito

Step 3 : Calculate the Fitness Value

Step 4 : If the fitness value is better than  
the best fitness value in history  
set current value as the new Best  
value

Step 5 : for each mosquito  
Initialize : CO<sub>2</sub> , Temperature,  
Color, Humidity and  
Hemoglobin

Step 6 : Calculate Mosquito velocity

Step 7 : Update Mosquito Position

Step 8 : Mutation for each mosquito if  
failed to attach host

### **3.2 Genetic Fitness Algorithm (GFA) – Considering Natural Genetic behavior : -**

From the Mendelian Genetics, F<sub>2</sub> generation of a dihybrid cross, with dominance in the two traits will result in a: Phenotypic ratio of 9:3:3:1

This type of experimental dihybrid cross led to the Law of Independent Assortment, which is:"emergence of one trait will not effect the emergence of another".

Or, the members of an allelic pair segregate independently of members of another allelic pair. All possible allelic combinations can occur in the reproductive cells.

Result of Mendelian Genetics can be analyzed by Statistics.

Probability allows to predict outcomes of many genetic crosses that conform to Mendelian inheritance[14]. One of the statistical applications that is used to analyze experimental results is the chi-square test of fitness ( $\chi^2$ ,  $\chi$  = the Greek letter chi). This statistical test is used to determine if your experimental data is within acceptable parameters of the expected or theoretical data. For example, if you toss a coin 50 times you would expect it come up 25 heads and 25 tails. But if you observe 27 heads and 23 tails when you tossed the coin, is this an acceptable deviation due to chance or is it not acceptable and therefore not due to chance and chance alone. The chi-square test of fitness can determine if the deviations from the expected values are due to chance and therefore should be accepted.

The chi-square test is as follows:

$$\chi^2 = \sum(d^2 / e)$$

Where  $\Sigma$  = the sum of,  $d$  = the difference between the expected and the observed (deviation), and  $e$  = the expected outcome

Probabilities for chi-square range from 0.99 to 0.01. If the chi-square value is within the 0.80 to 0.99 probability then the deviations are insignificant. If they are within the 0.01 to 0.50 then the deviations are significant and they are not due to chance. However, the test does NOT tell you what caused the deviations.

In biology the most common application for chi-squared is in comparing observed counts of particular cases to the expected counts. For example, Mosquitoes have just male or female sex organs. One might expect that half of the Mosquitoes are male and half female, in a location. If  $N$  numbers of mosquitoes and count that  $x_1$  of them are male and  $x_2$  of them are female, we will probably not find that exactly  $x_1 = 1/2N$  and  $x_2 = 1/2N$ . Is the difference significant enough to rule out the 50/50 hypothesis? We could almost calculate the chi-squared, but we don't know the standard deviation for each count. Never fear: most counts are distributed according to the Poisson distribution, and as such the standard deviation equals the square root of the expected count. Thus we can calculate  $X^2$ :

$$\begin{aligned}
 X^2 &= ((x_1 - E_1)^2 / E_1) + ((x_2 - E_2)^2 / E_2) + \dots + ((x_k - E_k)^2 / E_k) \\
 &= \sum_{i=1}^k \frac{(x_i - E_i)^2}{E_i}
 \end{aligned}$$

In our example there are just two cases so  $k=2$ , and the expected results are:  $E_1=1/2N$  and  $E_2=1/2N$ . Note that the  $E_i$  are generally not whole numbers even though the counts  $x_i$  must be whole numbers. If there were more cases (say  $k$  cases), we would need to know the probability  $p_i$  for each case and then we could calculate each  $E_i=p_iN$ , where  $N$  is determined by finding the total of the counts:

$$N = x_1 + x_2 + \cdots + x_k = \sum_{i=1}^k x_i$$

### 3.3 Assumptions and Result :-

- i. Random Sample Data.
- ii. A sufficiently large sample size Independence.
- iii. Similar distribution. Observations must have the same underlying distribution.
- iv. Known distribution.
- v. Finite values. Observations must be grouped in categories.
- vi. Normal distribution of deviations (observed minus expected values) is assumed. Note chi-square is a *nonparametric test* in the sense that it does not assume the parameter of normal distribution for the data -- only for the deviations.
- vii. Data level. No assumption is made about level of data. Nominal, ordinal, or interval data may be used with chi-square tests.

**GFA :-**

Step 1 : Randomly select individuals

Step 2 : Consider Mendelian F2 Generation ratio, 9:3:3:1

As for Example :-

Observed Values	Expected Values
315 long legged, black mosquitoes	$(9/16)(556) = 312.75$ long legged, black mosquitoes
108 long legged, gray mosquitoes	$(3/16)(556) = 104.25$ long legged, gray mosquitoes
101 small legged, black mosquitoes	$(3/16)(556) = 104.25$ small legged, black mosquitoes
32 small legged, gray mosquitoes	$(1/16)(556) = 34.75$ small legged, gray mosquitoes
556 Total mosquitoes	556.00 Total mosquitoes

Step 3 : Calculate Chi-Square :-

$$\chi^2 = ((315-312.75)^2 / 312.75) + ((108-104.25)^2 / 104.25) + ((101-104.25)^2 / 104.25) + ((32-34.75)^2 / 34.75)$$

Step 4 : Number of Classes, n = 4 (here)

Step 5 :  $df = 4-1 = 3$

Step 6 : Enter the Chi-Square table at  $df = 3$  and we see the probability of our chi-square value is greater than 0.90. By statistical

convention, we use the 0.05 probability level as our critical value. If the calculated chi-square value is less than the 0.05 value, we accept the hypothesis. If the value is greater than the value, we reject the hypothesis. Therefore, because the calculated chi-square value is greater than the we accept the hypothesis that the data fits a 9:3:3:1 ratio.

Chi-square value 0.47 (here).

#### 4. Result

A Chi-Square Table

	Probability				
Degrees of Freedom	0.9	0.5	0.1	0.05	0.01
1	0.02	0.46	2.71	3.84	6.64
2	0.21	1.39	4.61	5.99	9.21
3	0.58	2.37	6.25	7.82	11.35
4	1.06	3.36	7.78	9.49	13.28
5	1.61	4.35	9.24	11.07	15.09

#### 5. Conclusions

Our Research is going on. This Experimental and Data dependency definitely open a new door in the line of Computer Science. Basically, this is a desperate effort to get more optimized result by the help of Natural Solutions. In the next phase we will be concentrating on Crossover and Mutation. We are also considering multi sensor multi target optimization as well.

## 6. References :

- [1] Chi Square Tutorial, Prof. Jeff Connor-Linton Department of Linguistics, Georgetown University , connorlj@georgetown.edu
- [2] Evolution and Natural Selection, Charles Darwin, *The Origin of Species*
- [3] L-lactic Acid: A Mosquito Attractant Isolated from Humans, Acree, F., Turner, R. B., Gouck, H.K., Beroza, M., Smith, M., 1968.
- [4] Mosquito-mediated attraction of female mosquitoes to a host, Ahmadi, Abbas, McClelland, G.A.H., 1985.
- [5] Mosquito flight paths in relation to the environment effect of the forest edge upon trap catches in the field, Bidlingmayer, W.L., Hem, D.G., 1981.
- [6] The sensory physiology of host-seeking behavior in mosquitoes, Bowen, M.F., 1991, hematophagy, orientation, attractants, olfaction, chemoreception.
- [7] A genetic algorithm for the ligand-protein docking problem, Camila S. de Magalhaes; Helio J.C. Barbosa; Laurent E. Dardenne, Genet. Mol. Biol. vol.27 no.4 Sao Paulo, 2004
- [8] Host-Seeking Behavior in Hematophagous Mosquitoes (Diptera: Culicidae), Lyric C. Beaty.

[9] Probability theory and stochastic processes :

<http://www.math.niu.edu/>

[10] Genetic Algorithms, David E Glodberg

[11] George Mason University in Fairfax, Virginia,

<http://cs.gmu.edu/research/gag/>

[12] Particle swarm optimization (PSO), by Dr. Eberhart and Dr. Kennedy in 1995.

[13] ACO System, introduced by Marco Dorigo in his Ph.D. thesis (1992).

[14] The Biology Project, University of Arizona,

[http://www.biology.arizona.edu/mendelian\\_genetics/mendelian\\_genetics.html](http://www.biology.arizona.edu/mendelian_genetics/mendelian_genetics.html)

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