Current Trends on Biostatistics & Biometrics

DOI: 10.32474/CTBB.2020.02.000143

ISSN: 2644-1381

Perspective

On Extremal Optimization in Honeybee Foraging and Covid-19

Elettreby MF and Ahmed E*

Mathematics department, Faculty of Science, Egypt

***Corresponding author:** E Ahmed, Mathematics department, Faculty of Science, Mansoura 35516, Egypt

Received: April 22, 2020 **Published:** May 01, 2020

Abstract

Extremal optimization is applied in honeybee foraging and solving medical goods supply needed in Covid-19 management.

Extremal optimization

Extremal optimization (EO) [1] is a metaheuristic method [2] which is quite similar to the way the immune system (IS) renews its cells. This dynamic is called extremal dynamics [3]. It can explain the long-range memory of the immune system even without the persistence of antigens. The reason is that if a system evolves according to such dynamics then the annihilation probability for a clone (a type of cells) that has already survived for time t is proportional to 1/(1+ tc), where c is a positive constant. Therefore, the longer it lives the higher the probability that it will continue to survive. This is the memory effect observed in the immune system. Consider a system of N elements, each element assigned a single scalar variable x(i), i = 1,2, . . ., N drawn from the fixed probability distribution function p(x). For every time step, the element with the smallest value in the system is selected and renewed by assigning a new value which is drawn from p(x). It is assumed that no two x(i) can take the same value.

Definition

For the above system the typical values of x(i) increase monotonically in time. This means that any renewed element is likely to have a smaller x(i) than the bulk, and hence a shorter than average lifespan until it is again renewed. Corresponding, elements that have not been renewed for some time will have a longer than average life expectancy. This separation between the shortest and the longest-lived elements will become more pronounced as the system evolves and the average x(i) in the bulk increases.

This phenomenon is called long-time memory.

Proposition

Extremally driven systems can generally be expected to exhibit long-term memory [1].

Application in Honeybee Foraging:

In Bee foraging [4] neither do the foragers compare different nectar sources to determine the relative profitability of any one source, nor do the food storers compare different nectar loads and indicate the relative profitability of each load to the foragers. Instead, each forager knows only about its particular nectar source and independently calculates the absolute profitability of its source. Even though each of a colony's foragers operates with extremely limited information about the colony's food sources, together they will generate a coherent colony level response to different food sources in which better ones are heavily exploited and poorer ones are abandoned. This is similar to the idea of extremal optimization. Proposed algorithm:

a. Every site i has a fitness f(i)=e(i)/n(i) where e(i) is energy efficiency (energy gained per energy spent) from it and n(i) is number of foragers using it.

b. If f(i)>=rnd, where rnd is a random number uniform ally distributed between [0,1], then n(i) remain the same.

c. If f(i)<rnd then choose an integer j randomly such that f(j)>rnd then n(i)=n(i)-1 and n(j)=n(j)+1.

We have simulated this algorithm and obtained the following result:

f	.070	.228	1	1	1	1	1	1	1	1
n	0	0	1	1	2	3	4	4	4	4

Although the result is mainly monotonic, but some deviations are expected due to the random element of the process. Our results agree with the results of [5].

Application in Medical Goods Supply Needed in Covid-19 Management:

Recently Covid-19 [6] has caused a problem in medical supplies e.g. masks. This problem is similar to the one studied in sec.2. The flowers correspond to the medical goods suppliers and the bees correspond to their consumers e.g. medical workers and patients. The objective is to reach equitable distribution of users (bees) on producers (flowers). The algorithm in sec. 2 solves this problem

References

1. M F Elettreby, E Ahmed, Houari Boumedien Khenous (2014) On Metaheuristic Optimization Motivated by the Immune System. Applied Math 5(2): 318-326.
2. C Blum, A Roli (2003) ACM Computing Surveys. 35(3): 268-308.
3. S Boettcher, A Percus (2001) Optimization with Extremal Dynamics. Physical Review Letters 86(23): 5211-5214.
4. Thomas D Seeley, Scott Camazine , James Sneyd (1991) Collective decision-making in honey bees: how colonies choose among nectar sources. Behav Ecol Sociobiol 28: 277-290.
5. J Bartholdi, T D Seely, C A Tovey, J Vande Vate (1993) Pattern and effectiveness of Forager allocation Flower patches by honey bee colonies. J Theor Biol 160(1): 23-40.
6. The lancet (2020).

DOI: 10.32474/CTBB.2020.02.000143