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Optimization in India: A Historical Perspective

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ABSTRACT

Search of finding maximum or minimum is the intrinsic quality of human consciousness. In the words of Leonhard Euler "Since the fabric of the universe is most perfect, and is the work of a most wise Creator, nothing whatsoever takes place in the universe in which some form of maximum or minimum does not appear." Little is known about the contribution of Indian mathematicians in the field of optimization. Attempts have been made but in many cases it loses the spirit of the original. Even the word 'Darshan Shastra' is translated as 'Philosophy'. Moreover Indian mathematics has been the victim of Eurocentrism. Many discoveries of Indian mathematicians have been contributed to their western counterparts.So an attempt has been made to discover the contribution of Indian mathematicians in the field of optimization.

Keywords: Lebombo Bone, Mathematical Programming, Hindu Mathematics.

1. INTRODUCTION

"Since the fabric of the universe is most perfect, and is the work of a most wise Creator, nothing whatsoever takes place in the universe in which some form of maximum or minimum does not appear." Leonhard Euler

Search of finding maximum or minimum is the intrinsic quality of human consciousness. History of optimimization is as old as the human civilization is. Even adivasis have made notches on bones and trees to satisfy this quest. The oldest known possibly a mathematical model is the Lebombo bone. It was discovered in 1970 in the Lebombo mountains of Swaziland. On a baboon's fibula somebody has made 29 distinct notches. About 37000 years ago an attempt has been made to quanify time. Similar is the Ishango bone which was found near the Nile river (northeastern Congo). It is estimated to be as much as 20,000 years old. Even animals also possess this teleological tendency of the universe. How honey bees know that regular hexagonal grid is the optimal way of storing maximum honey into regions of equal area with fixed or limited perimeter.

II. INDEBTNESS

Little is known about the contribution of Indian mathematicians in the field of optimization. Indian texts are mostly written in Sanskrit, Prakrit and other regional languages creating difficulty for proper translation. There are many words in ancient texts with no proper parallel in modern languages. Attempts have been made but in many cases it loses the spirit of the original. Even the word 'Darshan Shastra' is translated as 'Philosophy'. Moreover Indian mathematics has been the victim of Eurocentrism. Many discoveries of Indian mathematicians have been contributed to their western counterparts. Infinite series attributed to western mathematicians are present in Indian texts that are many centuries older. Actualy ancient india was connected with Europe and China giving passage of such transmission. So it is not easy to find how much we are indebted to Indian mathematicians.

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III. IMPORTANCE

"Nature is an infinite sphere in which the centre is everywhere, the circumference is nowhere." Pascal

Centre of the circle is more important than its circumference. Changing a centre means a new circumference. Circumference is simply the shadow of its centre. So the history of optimization becomes important. It prevents us from making mistakes already committed by our ancestors. Historical study discourages students from attacking an unsolved problem by the same model which has led other mathematicians to failure. An untold amount of intellectual energy had been expended on the model of squaring a circle, but no conquest was made by direct assault. Innumerable attempts were made to solve the problem at a time, even, when investigators had the powerful tool of differential calculus. Some investigators dropped the subject but some who continued were ignorant of its history and misunderstood the conditions of the problem. The great army of circle-squarers had, for two thousand years, been assaulting a fortifcation which was actually indestructible. Moreover history saves time and energy spent on problems which have been solved long since.

IV. PREHISTORIC TIME

Since search of best is the intrinsic quality, models have been made even during prehistoric time. Many have been gone into the oblivion. How one can deny the marvelous achievements of inhabitants of Indus Valley Cilvilisation. Their bricks were ***optimized*** for the then brick structure. Better planned cities were made for better living standard. Similar was the "*Mohenjo-daro ruler"* which was tried to ***optimize*** measurement of length to a high degree of accuracy.

V. HINDU MATHEMATICS

Hindus have made marvelous attainments in the field of Arts and Science at a very early period. The earliest works available, the Vedas, consisting hymns of praise and poems of worship, show a high state of civilisation. The literature that follows like Brahamana, Vedangs are partly ritualistic and partly philosophical. Although they are the work of spiritual, social and religious philosophy, yet they are not free from germs of mathematics. Religion was the main focus of the earlier Hindus, and other branches of knowledge grew as help to it. But in course of time mathematics outgrew its original purpose. It is here that we find the beginnings of ganita(mathematics) and jyotisha(astronomy). Ten was their base of ganana(counting). Quest of optimization led them to find as large number as possible. In Yajurvedasaṃhitā (1200–900 BCE), the numbers as high as 10^{12} are included,

"Hail to śata ("hundred,"), hail to sahasra ("thousand,"), hail to ayuta ("ten thousand,"), hail to niyuta ("hundred thousand,"), hail to prayuta ("million,"), hail to arbuda ("ten million,"), hail to nyarbuda ("hundred million,"), hail to samudra ("billion,", literally "ocean"), hail to madhya ("ten billion,", literally "middle"), hail to anta ("hundred billion,",lit., "end"), hail to parârdha ("one trillion," lit., "beyond parts"),".

Search of minimum leds Hindus to total absence or nothing and henceforth invention of *shunya*(zero) takes place. Pingla, in *Chandah sutra* has used the symbol *shunya* even before 200 B.C. to depict the presence of absence. Pingla used it while solving a problem on number of arrangements. Bakhshali manuscript also contains the use of shunya. Use of shunya is also found in various calculations on metrics of that time. In all these

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calculations shunya is used as a numeral. In Panca Siddhantika addition and substraction of shunya are also used but for for the sake of metrical convenience.

Hindus have contributed marvellously by giving decimal place value notation. This system consists of only ten symbols, called *anka* for the numbers one to nine, and the zero symbol, called *shunya*(literally, "empty"). This system is now used throughout the world.With decimal place value system one can write any number whether big or small. For instance, the 1230 has four places, 0 at units place, 3 at tens place, 2 at hundreds place and 1 at thousands place. So any number big or small can be represented by giving different places to its *anka*. The practice of representing numbers by placing *shunya* can be traced back to the works of Bhaskara I on his commentary on *Aryabhatia* and *Ganita Pada*. Afterwards in the work of Brahmgupta and later mathematical treatises, various results of operation by *shunya* are found. Bhaskara II has given the idea of shunya as an infinitesimal. He says that the product of an anka by shunya is shunya but the anka must be retained if further calculation is required. He says that division by shunya of a finite quantity is called kha hara which means the hara(denominator) is khali(empty). He remarks in his Bijganita that this quantity can contain or extract many with no alteration, as no change takes place in infinite God at the period of creation or absorption of numerous worlds. So infinite was a mystery and it has been associated with God which is being regarded as infinite.

V. MODERN MATHEMAICAL FORMULATION OF OPTIMIZATION

In mathematics optimization or mathematical programming is the selection of the best desired objective from some set of available alternatives, keeping in mind the availability of limited resources. Optimization is actually the most efficient use of resources to maximize or minimize the objective function. In simpler terms mathematical programming consists of maximizing or minimizing a real function under certain constraints. Mathematically the problem can be stated as,

(1) : $Optimize\ f(X)$

$subject\ to\ g_i(X)\ (\leq or = \geq)\ 0,\ i = 1, 2, \ldots\ldots, m\ and\ X \geq 0$

$where\ X = [x_1\ x_2\ \ldots\ x_n]^T \epsilon R^n,$

$f(X)\ and\ g_i(X)$ **are real valued functions of** X

The problem is called a linear programming problem or LPP if the functions $f(X)$ and $g_i(X)$ are all linear.

Mathematically the LPP can be stated as:

(2) : $Maximize\ or\ minimize\ c^T X$

$subject\ to\ AX(\leq or = \geq)\ b,$

$and\ X \geq 0$

$where\ c = [c_1\ c_2 \ldots c_n]^T,\ b = [b_1\ b_2 \ldots b_n]^T,\ X = [x_1\ x_2 \ldots x_n]^T,$

VI. CONCLUSION

In the present world, the field of optimization is uncovering many discoveries. We should not forget our base. In the words of De Morgan, "The early history of the mind of men with regard to mathematics leads us to point out our own errors; and in this respect it is well to pay attention to the history of mathematics."

"We owe a lot to the Indians, who taught us how to count, without which no worthwhile scientific discovery could have been made." Indian contribution in the field of optimization is immense. It has been a victim of eurocentrism. Albert Einstein

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