A Novel approach for optimization in Mathematical calculations using Vedic Mathematics Techniques

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Abstract

Vedic Mathematics is the name given to the ancient system of mathematics, or to be precise, a unique technique of calculations based on simple rules and principles with which any mathematical problem can be solved – be it arithmetic, algebra, geometry or trigonometry. The system is based on 16 Vedic sutras or aphorisms, which are actually word formulae describing natural ways of solving a whole range of mathematical problems. In this paper we will be taking a few Vedic sutras. Akadhiken Purven (By one more than the one before), Nikhilam Navtashcharam Dashat (All from 9 and the last from 10) are two of them. NASA have adopted it fully in the realms of advanced robotics. Calculations that can be solved as quick as lightning are a great tool to adopt, but you wouldn't want to teach it worldwide in the fear that you may churn out a generation of child geniuses that may threaten the intellectual status quo.

The gift that the Hindus gave to world, thousands of years ago, and that which is currently responsible for global silicon chip technology, was none other than the invention of zero and the use of the decimal point. We call our common numbers "Arabic Numerals" but really they extend back to the Hindu concept of creation and were known as "Bindu" or Unity. All Vedic Maths is based on the understanding of Unity Consciousness which means they utilize processes or Number Bases that correspond to: 0, 10, 100, 1000, 10000 etc all of which add to 1. In light of the fact that the Vedas, literally "the illimitable storehouse of All Knowledge" came under 4 headings or categories like the Rig Veda, the Yajur Veda, the Sama Veda and the Atharva Veda. Thus a Vedic Mathematician was also an astronomer, healer and poet. It was a total system, if you are out in the field and you need to tile a square floor that is, say 108 units square. How do you do it with mental ease? I think only of the excess "8", saying how much is 108 more than my Base of 100. It is "8". So we will merely

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add this "8" to the number in question "108" and tag on the squaring of this excess:
108 Squared = 108 + 8 / 8×8 = 116 / 64 = 11,664.

Vedic mathematical methods are derived from ancient systems of computations, Compared to conventional mathematical methods, these are computationally faster and easier to perform. An application of Vedic mathematics can be effectively increased if it can made available to the beginners in various fields of study.

INTRODUCTION

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Vedic mathematics was rediscovered from the ancient Indian scriptures between 1911 and 1918 by Sri Bharati Krishna Tirthaji (1884-1960), a scholar of Sanskrit, mathematics, history and philosophy [1]. He studied these ancient texts for years and, after careful investigation, was able to reconstruct a series of mathematical formulae called *sutras*. Bharati Krishna Tirthaji, who was also the former Shankaracharya (major religious leader) of Puri, India, delved into the ancient Vedic texts and established the techniques of this system in his pioneering work, *Vedic Mathematics* (1965), which is considered the starting point for all work on Vedic mathematics.

Vedic mathematics was immediately hailed as a new alternative system of mathematics when a copy of the book reached London in the late 1960s. Some British mathematicians, including Kenneth Williams, Andrew Nicholas and Jeremy Pickles, took interest in this new system. They extended the introductory material of Bharati Krishna's book, and delivered lectures on it in London. In 1981, this was collated into a book entitled *Introductory Lectures on Vedic Mathematics* [2]. A few successive trips to India by Andrew Nicholas between 1981 and 1987 renewed interest in Vedic mathematics, and scholars and teachers in India started taking it seriously. According to Mahesh Yogi, *The* sutras *of Vedic Mathematics are the software for the cosmic computer that runs this universe*. A great deal of research is also being carried out on how to develop more powerful and easy applications of the Vedic *sutras* in geometry, calculus and computing.

Conventional mathematics is an integral part of engineering education since most engineering system designs are based on various mathematical approaches. All the leading manufacturers of microprocessors have developed their architectures to be suitable for conventional binary arithmetic methods. The need for faster processing speed is continuously driving major improvements in processor technologies, as well as the search for new algorithms. The Vedic mathematics approach is totally different and considered very close to the way a human mind works. A large amount of work has so far been done in understanding various methodologies (sutras). However, hardly any meaningful applications of Vedic algorithms have been thought of. In this

article, it is shown how a successful attempt has been made to present two and three-digit *multiplication* operations using Vedic, mathematical methods.

THE VEDIC MULTIPLICATION METHOD

The multiplication of two- or three-digit numbers utilising conventional mathematical methods (successive additions when used on computers) needs no explanation. Alternatively, the Vedic method is illustrated in the example below. The digits on the two sides of line are multiplied and the result is added in the previous *carry*. When more than one line is in the step, all the results are added with the previous carry and the process is thus continued. Initially, the previous carry is equal to zero. A unit place digit of addition result is one of the digits in the answer; this is derived from full multiplication, while the remaining digits act as a carry. If the numbers of the digits are not same in the multiplier and multiplicand, then the bigger number has to be determined. The number of digits then needs to be counted. The smaller number should be prepended with 0s so that both numbers will be of the same digits [3]. The two digit multiplication example of 54 X 48 is given below [4].

Step 1:

$$
\begin{array}{cc}
5 & 4 \\
 & | \\
\text{X} \quad 4 & 8 \\
\hline
 & 2 \\
\end{array}
$$

carry $=3$

Step 2:

$$
\begin{array}{cc}
5 & 4 \\
\times & \\
\text{X} \quad 4 & 8 \\
\hline
9 \quad 2 \\
\end{array}
$$

Prev Carry $=3$ New Carry $=5$

$$
\begin{array}{r}
40 \\
16 \\
\hline
59 \\
\end{array}
$$

Step 3:

$$
\begin{array}{cc}
5 & 4 \\
| & \\
\text{X} \quad 4 & 8 \\
\hline
\end{array}
$$

Answer   2   5   9   2

Prev Carry $=5$

$$
\begin{array}{r}
20 \\
\hline
25 \\
\end{array}
$$

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Three-digit multiplication (eg 532 X 438) is listed below.

Step 1:

$$
\begin{array}{ccc}
5 & 3 & 2 \\
 & & | \\
X \quad 4 & 3 & \mathbf{8} \\
\hline
 & & 6
\end{array}
$$

Carry = 1

Step 2:

$$
\begin{array}{ccc}
5 & 3 & 2 \\
X \quad 4 & 3 & 8 \\
\hline
 & 1 & 6
\end{array}
$$

Prev Carry = 1
24
06
───
31

new carry = 3

Step 3:

$$
\begin{array}{cccc}
5 & 3 & & 2 \\
X \quad 4 & 3 & & 8 \\
\hline
0 & 1 & & 6
\end{array}
$$

Prev Carry = 3   new carry = 6
08
09
40
───
60

Step 4:

$$
\begin{array}{cccc}
5 & 3 & & 2 \\
X \quad 4 & 3 & & 8 \\
\hline
3 & 0 & 1 & 6
\end{array}
$$

Prev carry = 6   new carry = 3
15
12
───
33

Step 5:

$$
\begin{array}{ccccccc}
 & 5 & & 3 & & 2 \\
 & | & & & & \\
\times & 4 & & 3 & & 8 \\
\hline
2 & 3 & 3 & 0 & 1 & 6 \\
\end{array}
$$

Prev Carry = 3
            20
            ――――
            23

Answer: $532 * 438 = 233{,}016$.

NATURE OF THE SUTRAS

To understand the Sutras, and for them to be useful to us, it is necessary to see them as something we can relate to in a natural way. What follows explores the possibility of the Sutras describing natural functions of mind.

Our mind is extremely subtle and fluid. There seems to be no limit to what we can think and imagine. But if we carefully watch our thoughts we find that we all use certain specific techniques: of reversal, comparison, extension, generalisation for example. And it is interesting that we all seem to develop the same mental techniques, even though we are not specifically taught how to think. It is also perhaps surprising that on examination there do not appear to be very many distinct techniques. The sixteen Sutras can be related to these naturally evolved mental processes. It is our mind that constructs the mathematics and this is done according to the natural functions of mind, which may be expressible by the Vedic Sutras.

We are not normally aware of our thought processes. We have built up layers of mental techniques since we were very young and rely totally on them. We never question them unless we are forced to do so: when for example we are confronted with a contradiction.

To appreciate the types of mental action that follow we need to see them in action in daily life, then we begin to realise just how frequently we use them. In my experience people vary a great deal in their ability to observe their thoughts and thought processes so please have an open mind and be prepared to see things in a different way.

Some of the sutras seem to fit neatly with a well-known mental function. For example, *Transpose and Apply* would describe the reversing that we often use in our thinking. We look at something from the other person's point of view; we feel compassion; we 'change our mind' and do the opposite of what

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we were going to do. It makes sense as a cosmic principle as we see plants grow and then die away, the sun rises and sets. In one of Aesop's fables a bird was trying to drink from a jug but could not reach down to the level of the water. After a while instead of struggling to get his head down far enough the bird went and got some stones which he dropped into the jug until the level had risen enough for him to drink the water.

By One More than the One Before is also easy to see as a principle: everywhere we see things that follow on from, or are created out of, other things, due to the lawful nature of the universe. The Sutra expresses how one idea naturally leads to another: just by resting the mind on an idea another idea arises. This can happen sub-consciously when our mind wanders from one thought to another (sub-Sutra) or it can be a deliberate conscious choice to develop an idea. So, given a square you know that it has four right angles, and seeing someone walking towards you, you expect to pass them shortly.

The sutra **By Addition and by Subtraction** refers to the mental process of comparison. In comparing two things we look for similarities (addition) and differences (subtraction) between them. Addition involves bringing things together into the same group, and observing similarities involves noting those qualities which the two things have in common (i.e. can be grouped together). In subtraction we observe those qualities which differ in the two things. Shown two photographs of the same person taken ten years apart we notice similarities (we recognise common features which we mentally group together) and we notice differences (the person is taller, has different hair colour etc.). This is a very common mental technique. As a natural phenomenon we see that the forces of nature continually throwing things together and separating them.

The sutra **Vertically and Crosswise** can be related to decision making and evaluation. In assessing something we weigh up all its aspects, perhaps giving strengths to each of them and then finally coming to a decision by summing all these results. For example, in deciding at what time to leave home for a meeting we may consider traffic, weather, how long it takes to prepare, implications of being late and so on. We assess the importance of each one and sum them, rather like multiplying pairs of numbers and adding the results, as we do in Vertically and Crosswise multiplication. This is also a very common mental process. As a principle of nature it seems to describe how everything is interconnected.

All from Nine and the Last from Ten: Here we first need to interpret nine and ten in more general terms in order to understand them as more general entities. In the generation of whole numbers from number one each new digit is one more than the previous one and is more complex than the previous

one. In a sense nine is the most complex digit as the next number, ten, is one with zero (i.e. 10). Ten represents a new unity, a new order of unity and it contains the previous nine numbers. Nine is the stage just before unity is reached. So the Sutra describes repeated non-unity, followed by unity. In following this sentence, for example, all the parts of it are absorbed before the full comprehension of the meaning of the sentence and we know at each step that we are moving towards a unity. All the parts are like nines, they are all short of the unity sought, but together they lead to a new unity, ten.

In fact if we look we see this principle operating everywhere. A house is built: the foundations are laid, the walls go up, the water pipes are put in etc. and the final result, ten, is the house. A plant grows until it reaches its fulfilment in its flower and its seed. We listen to someone and each point that is made is understood after hearing the words that make up the point being expressed. And each point may itself be leading to a further idea so that the same principle may apply on different levels. Whenever a new unity is realised there were steps that led to it. The same mental activity will be recognised in the way we sometimes continually think about something in order to try to understand it or to come to terms with it.

The Sutra refers to the reaching of a new state. So understanding, comprehension, realisation, enlightenment etc. all express this. A ball rolls along a table top, but when it reaches the edge it goes into a different state. Then it falls until it reaches an obstacle when it again changes its state of motion. We may see parallels in our own life.

If the Samuccaya is the same it is Zero. The word 'samuccaya' has several meanings we are told, but usually it can be interpreted as total' or 'combination'. So we may say '*If the Total is the Same it is Zero*'. Sometimes it is the sameness of something that is significant. We do not realise that the clock was ticking until it stops. A word constantly repeated becomes meaningless. As long as things are as normal (the same) we do not register them (it is zero). In a Sherlock Holmes story Sherlock Holmes points out to Dr Watson that the fact that the dog did not bark is significant (it meant that the dog knew the intruder). If walking to a place by a different route to the normal one has no advantage we are not inclined to take that route. We ignore what is irrelevant or what we prefer not to see. We 'put it out of our mind'.

If One is in Ratio the other One is Zero. We can put our mind onto anything we like. We choose our opinions and beliefs and so ignore contrary views. We choose a meal from a menu, we select certain beliefs that we choose to hold, discarding all others. A country chooses a leader, he speaks and acts for the

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people (he is in ratio) the others need do nothing. We make an assumption or we take a stand. We frequently decide to take something as true/given (in ratio) and proceed on this assumption, leaving other possibilities aside (equal to zero) for the moment. When looking for a blue sock among a drawer full of socks we can mentally tell our mind to see only blue. (The word 'ratio' comes from a Latin word that means 'reason').

By the Completion or Non-Completion. Sometimes we can see a whole even though the whole is not there. Three-quarters of a circle immediately gives the impression of a full circle. We see symmetry in the beauty of a flower even though perfect symmetry is not there. When we 'jump to a conclusion' we see, or think we see, some idea. We complete the whole. So, someone is speaking and we know what they are saying before they finish saying it. The detective pieces together what has happened by a series of clues. We say "I get the picture".

Completion implies non-completion, both are there together. We may deliberately leave something incomplete, we may wish to indicate something without actually saying it: it can be implied.

Differential Calculus. Calculus is all about change and motion, which are fundamental to creation. Mentally we may imagine the effect of changing something (while keeping other things constant); we can conduct 'thought experiments'. We may consider the effect if a tree continues to grow, if interest rates continue to rise, if the rain doesn't stop, what it might be like to jump on the moon and so on.

By the Deficiency. We often see how things fall short of an ideal. Differences from the norm stand out. We examine something we have made and see its shortcomings for example. These shortcomings are then the focus of our attention. (Looking for faults may be valuable in a car mechanic but not in a personal relationship).

It is the deficiencies or excesses that stand out and get noticed. We are interested in how much we are driving above or below the speed limit or whether we have thanked someone enough, or overdone it. A wrong note in a piece of music stands out.

Specific and General. This relates to the mental process of generalisation from the specific, which we do all the time. In fact this is just what we have been doing with the Vedic Sutras in this paper: we take the idea of, say, addition and subtraction in the mathematical sense and look for a more abstract meaning of

those words. Then we can look for mental processes that use this more abstract meaning: which is going from general to specific. Metaphors use this Sutra: when we say "leave no stone unturned" or "food for thought" it is the general quality that has been described by means of something concrete that has that quality.

We can use this technique for interpreting dreams because a dream may be a specific formulation of a general worry or concern: we may examine the essence of the dream and look for examples in the life of the dreamer of how that essential quality may manifest.

The Remainders by the Last Digit. Everything in the world is being continually modified by the things around it. We have ideas and sets of ideas about things and one observation or thought can lead to the whole structure being modified.

We can regard the ideas we have already as the remainders and the latest idea is the last digit that operates on those ideas and modifies them. For example, we learn something about someone and that modifies our opinion of them. Driving a different car to the usual one or treating someone differently because they are in an emotional state, we have to adapt our habits to cope with the change.

We also set up more permanent structures in the mind that apply for a lifetime. As we get older we can get more 'set in our ways', it is more difficult to adapt, to change our way of doing things. We say 'You can't teach an old dog new tricks'.

The Ultimate and Twice the Penultimate. In nature we often see that one thing triggers another: warm, wet weather causes seeds to germinate for example. The mind may act habitually in a certain way in response to a certain stimulus. One idea (the ultimate) may trigger a reaction, a stronger set of ideas already fixed in the mind (the penultimate). I want to say something to a certain person when I see him, the sight of that person triggers the memory. At the time I decided to speak to that person I conditioned my mind to react when that person is sighted. One idea takes over from another. It is because the fixed ideas are stronger and take over that they count twice. We can use this to our advantage by alerting the mind to be selective in some way. Mother hears baby cry in spite of all the other sounds; she has conditioned her mind to be alerted to that sound. When we say 'it rings a bell' an internal idea has been awakened by something outside. The saying 'Once bitten, twice shy' also involves this idea.

By One Less than the One Before. Sometimes we stand back and take an objective look at a situation. We may be struggling with some problem and decide that it is time to look at the bigger picture or perhaps we are feeling the

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pressure of too many commitments and think it is time to step back, relax and take a fresh look. Here you are in this room, in this country, on this planet etc.

This is the reverse of the Sutra **By One More than the One Before** (which describes deduction) and it also relates to the mental process of induction where a conclusion is reached based on a number of instances. For example the child sees objects fall to the ground when they are released and so naturally thinks that the next object released will fall. This has the same quality of stepping back.

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The Product of the Sum. Sometimes we have to assimilate several ideas and draw a result, or product, from them. 'Sum' suggests bringing some ideas together, and 'product' is a result that follows from this – it is the product of the sum. It is the overall impression. Bring a lot of men together and you have a crowd or an army: the whole is more than the sum of the parts.

All the Multipliers. Sometimes we need to summarise a number of things. The final speaker at a conference brings together all the ideas that have been aired and discussed. You are saying goodbye to someone after a meeting and bring to your mind the important points from the meeting that are relevant in order to say the appropriate things.

These interpretations of the Sutras may or may not be on the right lines; and even if they are on the right lines considerable revision may be necessary. This is because the mind is very subtle and the Sutras seem to merge together at some points. Hopefully others will be able to extend and modify these ideas.

CONCLUSIONS

Vedic mathematical methods are derived from ancient systems of computations, Compared to conventional mathematical methods, these are computationally faster and easy to perform. An awareness of Vedic mathematics can be effectively increased if it is included in engineering education. In future, all the major universities may set up appropriate research centres to promote research works in Vedic mathematics.

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