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A Brief on Big Data

... think scientifically, act scientifically... think scientifically, act scientifically... think scientifically, act...

Is this scientific temper?

Dr. R. Gopichandran

A few days ago I was in a fast developing city in our country. Holi was being celebrated with usual fervour. An announcement on the walls of the housing society clearly said that it is advisable to not overuse artificial colours. It would also be best to avoid synthetic chemicals after all. The reason was the allergy that could be caused by chemicals and make people ever more susceptible to throat infections. This could aggravate chances of falling severely ill; what with the swine flu around. For once I felt relaxed that I will not be predated upon by colour-smearing overenthusiastic fellow revellers. True to the call for safe action, bunches of people did not descend into homes and all the smearing that otherwise was rampant was completely absent. I was about to feel safer and rest assured that the announcement really had its impact. This reassured feeling, however, was transient. The shock was profound especially when a group of kids were the first to break the rules. When I asked them if they would not abide by the announcement, they replied that since other people do not really follow rules, they too did not see anything wrong in doing all that they thought was fun.

It is not the attitude; damn it. The root cause is more worrisome. It probably emerged from the conditioning kids receive due to lack of any inspiring leadership around. On the other hand, it was the selective ability of the attitude to prompt and foster disobedience that was bothersome. When the mind could perceive several signals/calls for positive action, through actually reading the announcement, it remained indifferent to the consequences of inappropriate action. Can we say the mind was scientifically tempered enough to capture the message, but not wise enough to translate the learning to action? Is it possible that a penalty clause would have made them more abiding? If yes, where is the scope for willing and proactive compliance?

Let me remain scientific enough to not broad-brush the tendency of the children in this case as chronically and pathologically indifferent. Without diluting the focus on the selective imbibitions stated above, in this case, do we view this indifference as transient and only context-specific? I really do not know. But the take away for me is the need for greater efforts and impetus to establish the much needed enabling circumstances that could guide/transform learnings to action. This means we need to go far beyond information support/sensitisation to probably handholding to ensure action. The credibility of the communicator becomes ever more important in this case. This scene also triggered significant introspection in me about my own adherence to values of common good even when a watchful eye is not around. Can I guide and inspire myself into action that prevents harm on me and my surroundings? I know I need to I go a long way in transforming myself completely before I deserve the chance to deliver change-making calls for action. I wish to report better progress as we move along. I am inspired by Gandhiji's statement that a person's true character is how she or he behaves when alone.

Some hope this morning amidst all this chaos. It was heartening to learn about the Times of India Social Impacts Awards 2015. I read about it in the newspaper Times of India (09 March 2015). Maverick action and consistency are the hallmarks of excellence in these instances that educate, inspire and transform. I am inspired by the change agents for the tenacity of purpose they have exhibited. This is true also of the National Council of Science Museums (NCSM) that was one of the recipients. I have had the honour of working closely with some people in the NCSM. It will be useful to build on the large interface museums offer with the thousands of people who visit them regularly. Can we put out a call for innovations to tackle locally relevant challenges in natural resources conservation/management in the various locations of these museums? People with innovative ideas can propose solutions that can be screened, validated and up-scaled. This can create valuable windows of opportunity to highlight the method of science in problem solving. This will also be a bottom-up approach to engagement with citizens wherein lies the calls for action. We may still be left with the challenge of sustaining scientifically tempered action beyond the solution to the challenge. This takes me to the next question about the logic beyond expecting people to change at all. Are we after all defining the logical framework of goals, approaches, tools and techniques and indicators of impacts of science and technology communication well enough? Are we expecting too much as a commonly manifest outcome across all constraints of space, time, motivations and motives? I will introspect. Any advice in this regard is welcome.

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A Brief on Big Data

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A car met with an accident at midnight on a highway and the driver became unconscious. The location where the accident took place was far away from any locality, and there was hardly any traffic on the road. However, an ambulance reached the spot of the accident within a very short time and took the driver to the nearest hospital. One of his friends driving nearby received an alert message, and he reached the hospital soon. The hospital registered the patient and the medical insurance company sent approval for the medical expenses online along with his past medical records. The car insurance company sent a crane to the accident site and took the car to a nearby service station. In a few days' time the driver recovered, the car was repaired and everything became normal.

All of us want similar care in case of any emergency. However, it may look impossible in a real life situation. But the good news is that the technology is available to provide support services in every possible situation to make life safer and more comfortable. All these and many more similar scenarios are now within the reach of reality –we are in the era of Big data.

Before going into the details of Big data, let us understand what happened immediately after the car accident. The car was equipped with crash sensor and a GPS (Global Positioning System). As soon as the crash sensor detected high impact during the crash, it inflated the air bag and also generated an alert signal. The signal was received by the respective service provider who located the car precisely through GPS data, and sent alert to the nearest emergency service providers. Information was also sent to insurance companies and relatives or friends of the driver.

From the sequence of events it is quite evident that the service provider has to maintain a series of information apart from having information about each customer – such as GPS database, emergency service provider's database, contacts of insurance providers, etc. Data are collected from different sources and remedial solution is worked out in a short time as per the requirement.

Flow of information and data sharing has increased many folds during the last decade. Email, online chat applications, social networking, and other e-commerce applications are an integral part of life for many. It is amazing to see the way value added information is provided just in time. For example, Facebook will not let you forget the birthday of your near and dear ones; online e-commerce portals provide not only numerous choices of anything you want to buy, it also compares similar products before you ask for it. You don't have to ask anyone to find direction of any place –GPS navigator is there to help you. In order to hire a cab you need to use a smart phone application – the service provider will locate you and the nearest cab will reach you in no time. Online search engines can search millions of information in a fraction of a second. Quite often it searches before you have typed all the key words – as if it knew what you wanted to write! How is all this possible? Big data analytics is the key in most of the cases. (Analytics means the principles governing any of various forms of analysis.)

A data center is able to store and process large volume of data

E-commerce started as soon as the internet became accessible to a sizeable global population. However, it got a real boost in the last couple of years due to availability of more products, customised and user-friendly applications and smart phone applications. In the near future more people will get involved in e-commerce activities and as a result much greater volume of data will be generated. Managing and analysing these data will create an opportunity for better services.

One of the key challenges in the Big data environment is to retrieve meaningful information quickly from the database. If the size of the database is large, substantial time may be required in order to generate query results. Complexity increases substantially when the heterogeneous type of data is required to be handled in a distributed computing environment. In the example cited above, it is possible that GPS data are stored in one location and customer information is stored in another location, and it is also likely that they are in two different formats. Conventional database management systems cannot deal with such situation effectively. Big data analytics are the solution.

What is Big data?

Big data is a popular term used to describe the exponential growth and availability of data. It refers to huge data sets that are diverse and are generated continuously. Quite often Big data is associated with three Vs – volume, variety and velocity. Volume refers to the flood of data generated by connected devices – from PCs and smart phones to sensors such as RFID (Radio-Frequency IDentification) readers and surveillance cameras. Variety refers to heterogeneity of data that are generated in many formats, including text, image and video. Velocity refers to the unprecedented speed at which data are generated in real time, with demands for usable information to be served up immediately.

The term 'Big data' often refers to the predictive analytics to extract value from data. The real value of Big data is in the insight it produces when analysed – finding patterns, driving meaning, making decisions. The final output of Big data analytics is intelligent response. Big data are processed using parallel software running on many computers simultaneously.

Difference between Big data and conventional database

A common misconception is that Big data is going to replace conventional structured database management systems. It is important to note that the context and sources of data are different for Big data and conventional database.

Bank ledger or personal information will continue to be stored in a conventional structured format that guarantees a high level of reliability. There are a set of properties that guarantee that database transactions are processed reliably, referred to as ACID – Atomicity, Consistency, Isolation, Durability. Atomicity refers to the ability of the database to guarantee that either all of the tasks of a transaction are performed or none of them is. The consistency property ensures that the database remains in a consistent state before and after the transaction, whether the transaction was successful or not. Isolation refers to the requirement that other operations cannot access or see the data in an intermediate state during a transaction. Durability refers to the guarantee that once the user has been notified of success, the transaction will persist, and not be undone. This means it will survive system failure, and that the database system has checked the integrity constraints and it would not need to abort the transaction.

Let's take an example about withdrawing money from an ATM. You have entered all the required information and the amount is debited from your account. However, due to some fault in the ATM, you could not receive the money. An ACID feature of the structured database that your bank is maintaining will guarantee that your money is not lost. The same is true in any online financial transaction through the internet.

Big data processing, on the other hand, does not need ACID guarantee. The real value of Big data is in the insight it produces when analysed. For example, a business house may be interested in knowing how many people of a locality are visiting fast food outlets in a month. This knowledge is useful in taking a decision on whether or not to open a new fast food outlet in that locality. This is a very simple example to explain why ACID guarantee is not required for unstructured heterogeneous data that Big data usually handles. In reality, apart from important business decisions, Big data analysis is useful in many scientific and real time applications.

Big data and cloud

Big data require clusters of servers to process large volume of unstructured data. Cloud computing is essentially deployed on pools of servers that can scale up as needed. As a result, cloud computing offers a distributed platform for Big data for analytic applications.

The data scientist

A new class of professionals who help organisations in using Big data are responsible in modelling business insights and identifying opportunities. Data science is an emerging field. Finding skilled personnel is one of the major challenges associated with Big data analytics.

Characteristics

Big data deals with data sets whose size and variety are beyond the ability of conventional database software to capture, store, manage and analyse. It often processes a steady stream of real-time data in order to make time-sensitive decisions faster than ever before. Big data processing is distributed in nature. Analytics processing is done where data volume is more or are generated at a greater speed.

Customised and user-friendly smart phone applications are becoming popular

Big data analytics is a new paradigm where information technology collaborates with business houses to identify and implement analytics that will increase operational efficiency and enable people to make better, faster decisions in real time.

Emerging technologies for managing Big data

As traditional tools and infrastructure of IT are not able to handle large and varied data sets that are increasing exponentially day by day, new technologies are emerging to make Big data analytics scalable and cost-effective. Distributed processing framework and non-relational database are going to redefine the way data are managed and analysed. In this new paradigm, processing is done where the data reside. This is completely different from the traditional approach, which retrieves data for processing at a central point. In a distributed framework like *Hadoop*, Big data is distributed to dozens, hundreds, or even thousands of servers that process data in parallel. *Hadoop* is an open-source Java-based framework, and is a part of the Apache project sponsored by the Apache Software Foundation. It includes distributed file system, a parallel processing framework called *MapReduce* and several components that support the ingestion of data, coordination of workflows, management of jobs, and monitoring of the clusters. *Hadoop* is cost-effective and more efficient in handling large unstructured data sets than traditional approaches. Traditional database can also be integrated with *Hadoop*.

Applications

A number of applications are set to take the leverage that Big data offer to the transformational potential of creating value. Making Big data more easily accessible to relevant stakeholders in a timely manner can create transparency. Big data analysis would lead to more accurate and detailed performance analysis and improved performance. Big data allow organisations to create highly specific segmentations and to customise products and services precisely to meet those needs. Sophisticated analytics can substantially improve decision making, minimise risks, and pave ways to valuable insights that would otherwise remain hidden. Scientific research is revolutionised by Big data. Scientists have the tool to analyse large volumes of data in the quickest possible time and draw inferences.

Exploring the Fibonacci Sequence


Dr. C.K. Ghosh A. I. Khan

The Fibonacci sequence is named after Leonardo of Pisa (c. 1170 – c. 1250), popularly known as Fibonacci (Fig. 1). He was born in Pisa in AD1175. The son of a merchant who also served as a Customs Officer in North Africa, Fibonacci travelled widely in Barbary (Algeria) and was later sent on business trips to Egypt, Syria, Greece, Sicily and Provence. In 1200 he returned to Pisa and used the knowledge he had gained on his travels to write Liber Abaci in which he introduced the Latin-speaking world to the decimal number system. He wrote a number of books such as *Liber Abaci* (The Book of Calculating) in 1202, *Practica Geometriae* (Practical Geometry) in 1220, *Flos* in 1225, and *Liber Quadratorum* (The Book of Squares) in 1225. Fibonacci sequence is a series of numbers in which each number is the sum of the two preceding numbers. First few numbers in the series are 1, 1, 2, 3, 5, 8, 13, 21, 34, 55…

In India, Fibonacci sequence appeared in Sanskrit prosody (a system of versification). In the Sanskrit oral tradition, there was much emphasis on how long (L) syllables that are 2 units of duration mix with the short (S) syllables that are 1 unit of duration. Counting the different patterns of L and S within a given fixed length results in the Fibonacci numbers – the number of patterns that are m short syllables-long is the Fibonacci number F_{m+1}.

According to Susantha Goonatilake of Royal Asiatic Society Sri Lanka, the development of the Fibonacci sequence "is attributed in part to Pingala (200 BC), later being associated with Virahanka (c. AD 700), Gopala (c. AD 1135), and Hemchandra (c. AD 1150)".

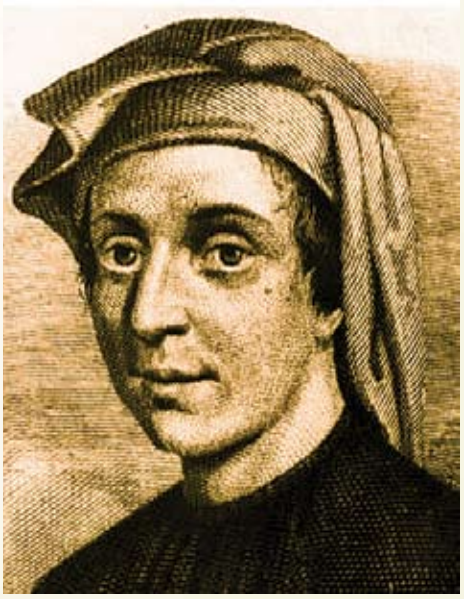

Fig. 1: Leonardo Fibonacci

The Rabbit problem

Fibonacci became interested in the reproduction of rabbits in the year 1202. He created an imaginary set of ideal conditions under which rabbits could breed and posed the question: "How many pairs of rabbits will there be in a year from now?" The ideal set of conditions was as follows:

a. First, begin with one new-born male rabbit and one new-born female rabbit.

b. A rabbit will reach sexual maturity after one month.

c. The gestation period of a rabbit is one month.

d. Once it has reached sexual maturity, a female rabbit will give birth every month.

e. A female rabbit will always give birth to one male and one female rabbit.

f. Rabbits never die.

So the question is how many male/female rabbit pairs are there after one year (12 months)?

- Month zero – At the beginning of the experiment, there is **one** pair of rabbits
- Month one – After one month, the two rabbits have mated but has not given birth. Therefore, there is still only **one** pair of rabbits.
- Month two – After two months, the first pair of rabbits gives birth to a new pair, making **two** pairs in all.
- Month three – After three months, the original pair gives birth again, and the second pair mate, but do not give birth. This makes **three** pairs.
- Month four – After four months, the original pair gives birth, and the pair born in month two gives birth. The pair born in month three mates, but does not give birth. This makes two new pairs, for a total of **five** pairs.
- Month five – After five months, every pair that was alive two months ago gives birth. This makes three new pairs, for a total of **eight**…….

Is there a way to predict the number in after a certain number of months without going through each individual month? Of course we can find the total number of rabbits for any month. The method is to find out how many pairs of rabbits were newly born that month and add that to the number of rabbits we had before the new ones were born.

So the question is how many pairs of rabbits are newly born every month? Since it takes two months for each new pair to give birth, each pair of rabbits that was alive two months ago will give birth to a new pair. In other words, the number of new pairs in each month is equal to the number of pairs alive two months ago. Furthermore, the number of rabbit pairs that were alive before the new ones were born is simply the number of pairs alive the month before. Thus to find the number of pairs of rabbits, we simply add together the number of pairs that were alive in the preceding two months.

Male bee's family tree

Within a colony of bees, only the queen produces eggs. If these eggs are fertilised then female worker bees are produced. Male bees (drones) are produced by parthenogenesis; that is, from unfertilised eggs. Female bees therefore have two parents; drones in contrast, have just one parent. The ancestry of a drone bee (D) and a worker bee (W) is shown below.

- Parents (1D, 2W)
- Grandparents (2D, 3W)
- Great Grandparents (3D, 5W)
- Great Great Gandparents (5D, 8W)
- Great Great Great Gandparents (8D, 13W)

- Great Great Great Great Gandparents (13D, 21W)
- Great Great Great Great Great Gandparents (21D, 34W)

We see that both D and W follow the Fibonacci sequence. Now, let us work out a recurrence relation for the sequence.

Recurrence relation

Albert Girad (1595-1632), a French-born mathematician, established recurrence relation in Fibonacci numbers

$F_1 = F_2 = 1$

$F_n = F_{n-1} + F_{n-2}$ {for all $n \geq 3$ .....(i)}

For $n = 3$ we have

$F_3 = F_2 + F_1$ {Substituting in (i)} $= 2$

For $n = 4$ we have

$F_4 = F_3 + F_2$ {Substituting in (i)} $= 3$

Similarly, for n = 5, 6, 7 ..... we have

$F_5 = 5$

$F_6 = 8$

$F_7 = 13$

Hence we have Fibonacci sequence as 1,1,2,3,5,8,13,21,34,55...

Binet's Formula

Once the Fibonacci sequence has been defined recursively, then, in order to find each term of the series using the definition, we have to find all the terms that precede it. This makes finding the *n*th term very difficult for large values of *n*, as we must find every term that comes before. However, there could be a way to find Fibonacci numbers without using the definition. If this were possible, one would be able to find the *n*th term of the series simply by plugging *n* into a mathematical formula. In 1843, Jacques Philippe Marie Binet discovered just such a formula for finding the *n*th term of the Fibonacci series.

Fibonacci spiral

The Fibonacci spiral is a geometric spiral (Fig. 2) whose growth is regulated by the Fibonacci series (Fig. 3). Its sudden, almost exponential growth parallels the rapid growth of the series itself.

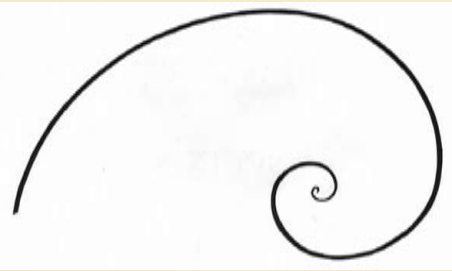

Fig. 2: Fibonacci spiral

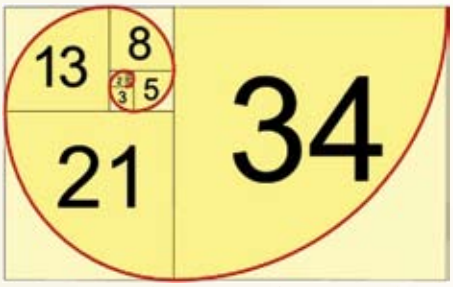

Fig. 3: Fibonacci numbers in spiral

The spiral itself is a series of connected quarter-circles drawn inside an array of squares with Fibonacci numbers for dimensions. This is illustrated in Fig. 4.

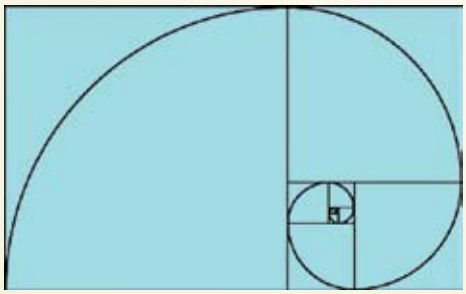

Fig. 4: Fibonacci spiral as a series of connected quarter-circles

Fibonacci series in nature

The rabbit breeding problem that caused Fibonacci to write about the sequence in *Liber abaci* may be unrealistic, but the Fibonacci numbers really do appear in nature. For example, some plants branch in such a way that they always have a Fibonacci number of growing points. Flowers often have a Fibonacci number of petals; daisies can have 34, 55 or even as many as 89 petals.

The arrangements of the seeds in a sunflower appear to be spiralling outwards both to the left and the right. In fact there is a Fibonacci number of spirals. It seems that this arrangement keeps the seeds uniformly packed no matter how large is the seed head.

Pineapples

Fibonacci sequence is found in pineapples. Pineapple scales are also patterned into spirals. Because they are roughly hexagonal in shape there are **three** distinct sets of spirals that can be observed (Fig. 5). They are as follows

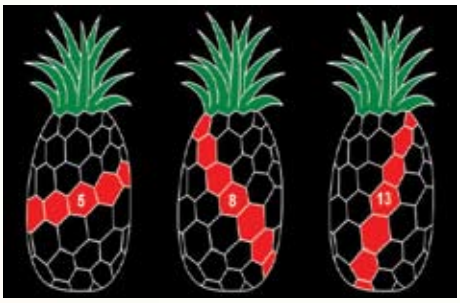

Fig. 5: Fibonacci spirals in a pineapple

- One set of **five** parallel spirals ascends at a shallow angle to the right
- A second set of **eight** parallel spirals ascends more steeply to the left
- And the third set of **13** parallel spirals ascends very steeply to the right

In pinecones there are **eight** and **thirteen** spirals opening to the left and right **eight** and **thirteen** are consecutive Fibonacci numbers. Fibonacci spiral can be found in snails and sea shells (Fig. 6). The resemblance with the spiral of Fig. 3 is remarkable. Fibonacci spirals can be found in cauliflower too.

Fig. 6: Fibonacci spiral in a Nautilus sea shell

Human hand and fingers

The Fibonacci numbers exist in human hand and fingers. For example, a person has **two** hands, which contain **five** fingers. Each finger has **three** parts separated by **two** knuckles.

Arrangements of petals on a flower

The number of petals on a flower is often one of the Fibonacci numbers. For example,

- **Two**-petalled flowers are those of Crown of thorns.
- **Three**-petalled flowers are quite common, viz., trillium and iris. There are hundreds of species, both wild and cultivated, with **five** petals, viz., columbine, pinks.

- **Eight**-petalled flowers are not as common as **five**-petalled ones, but there are quite a number of well-known species with **eight** petals, viz., bloodroot.
- Black-eyed susan and Cineraria are **13**-petalled flowers. The outer rings of ray florets in the daisy family illustrate the Fibonacci sequence extremely well.
- Daisies with 13, 21, 34, 55 or 89 petals are quite common. Ordinary field daisies have 34 petals (Fig. 7).

Fig. 7: Field daisy with 34 petals

After treading the domain of nature, let us come back to the natural home of the series, that is, mathematics. The Fibonacci numbers are studied as part of number theory and have applications in the counting of mathematical objects such as sets, permutations and sequences and to computer science. Here we present one interesting example.

Analysing the Fibonacci spiral diagram mathematically

Let us look again at the Fibonacci squares joining the diagonals of which lead to a spiral (Fig. 8). Wherever we stop, we will always get a rectangle, since the next square to add is determined by the longest edge on the current rectangle. Also, those longest edges are just the sum of the preceding two sides of squares to be added. Further, we see that each rectangle is a jigsaw puzzle made up of all the earlier squares to form a rectangle. All the squares and all the rectangles have sides which are Fibonacci numbers in length.

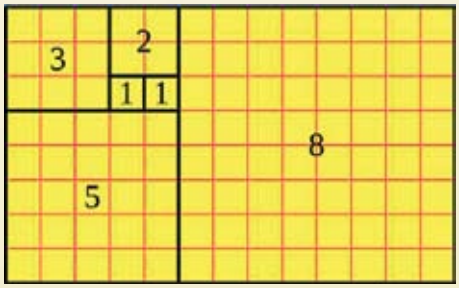

Fig. 8: Fibonacci squares that lead to a Fibonacci spiral

We express each rectangle's area as a sum of its component square areas:

The diagram shows that

$1^2 + 1^2 + 2^2 + 3^2 + 5^2 + 8^2 + 13^2 = 13\times21$

And also, the smaller rectangles show:

$1^2 + 1^2 = 1\times2$

$1^2 + 1^2 + 2^2 = 2\times3$

$1^2 + 1^2 + 2^2 + 3^2 = 3\times5$

$1^2 + 1^2 + 2^2 + 3^2 + 5^2 = 5\times8$

$1^2 + 1^2 + 2^2 + 3^2 + 5^2 + 8^2 = 8\times13$

Thus the pattern will work for any number of squares of Fibonacci numbers that we wish to sum. They always total to the largest Fibonacci number used in the squares multiplied by the next Fibonacci number.

To express the relationship in the language of mathematics:

$1^2 + 1^2 + 2^2 + 3^2 + \ldots + F(n)^2 = F(n)\,F(n+1)$ and it is true for ANY n from 1 upwards.

Some interesting applications and features of the Fibonacci sequence

- Fibonacci numbers are used in computational run-time analysis of Euclid's algorithm to determine the greatest common divisor of two integers: the worst case input for this algorithm is a pair of consecutive Fibonacci numbers
- The Fibonacci numbers are an example of a complete sequence. This means that every positive integer can be written as a sum of Fibonacci numbers, where any one number is used once at most. Specifically, every positive integer can be written in a unique way as the sum of *one or more* distinct Fibonacci numbers in such a way that the sum does not include any two consecutive Fibonacci numbers.
- Fibonacci numbers are used by some pseudo-random number generators.
- Fibonacci numbers are used in a poly-phase version of the merge sort algorithm in which an unsorted list is divided into two lists whose lengths correspond to sequential Fibonacci numbers – by dividing the list so that the two parts have lengths in the approximate proportion φ that is, the golden ratio, which is approximately equal to 1.618.
- The Fibonacci cube is an undirected graph with a Fibonacci number of nodes that has been proposed as a network topology for parallel computing.

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Dr. George Washington Carver - The man who refused to give up

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George Washington Carver was the most famous African-American scientist of his period. His story is very inspiring and a must read for all. Despite being born in a poor, slave family, he became a great scientist and rose to fame because he never gave-up. He was an agronomist, botanist, agriculturist, horticulturist, chemical wizard, chemurgist, inventor and scientist all rolled into one. He was also a painter, singer and a pianist. Right from his childhood he supported himself by working as a cook, a launderer, a dishwasher-man and a helping hand on the farm. He braved the racial discrimination to rise to fame and served as an example for fellowmen.

Carver was born to slave parents and thus no record of his exact date of birth was kept. It is widely believed that he was born between 1861 and 1865. The Iowa University, where he studied, did his Masters and worked, considers 12 July 1864 as his date of birth.

Childhood

Carver's father George, who was a farm worker, died before Carver's birth. His mother Mary was left alone to look after their three kids. Mary was a slave who worked and stayed on Moses Carver's farm. She was abducted by slave traders and baby George was raised by the Carvers. (Moses Carver named him George Carver) As little George was frail and sickly, he couldn't help Moses Carver on the farm. His brother Jim was strong and helped Moses till he began to work as a labourer on adjacent farms. But Jim died of smallpox after a few years. Susan, the wife of Moses Carver, was very protective of George. She allowed him to remain at home and help her with the household chores. Thus he became well versed in cooking, washing and cleaning. He observed and learnt needlework, and painting through practice. After finishing housework he wandered to the woods and roamed for hours observing nature. This is how he developed interest in plants, stones, rocks, animals and birds or to be more precise, anything under the Sun. His unending curiosity was his mentor. He learnt about plants through keen observation. He created a garden patch where he sort of experimented on wild plants. He also helped neighbours nurse their sick plants and they nicknamed him 'Plant doctor'! He was just eight then! Their neighbour Mrs. Mueller was so happy with his work that she gave him a Webster Speller and also taught him to read. Soon he learnt the Speller by heart! The boy yearned to learn more. Diamond Grove didn't have a school for blacks (that is how they were referred to as in those days) and so the Carvers arranged a private tutor for him. George was a fast learner and soon the tutor didn't have anything to offer.

George Washington Carver

Postage stamp issued in honour of George Washington Carver in 1998.

The quest for knowledge

The thirst and quest for knowledge made ten-year-old George leave the security of Carver's home and travel to Neosho, a village 16 km away. The Carvers realised that George was a very intelligent boy and encouraged him to pursue his goal. The boy travelled alone and on foot. He stayed all alone in a barn. He attended school. It was a tough long journey towards graduation. George moved from place to place in pursuit of education. He did all kinds of jobs from cooking to washing, dishwashing to helping on the farms to support him. Soon he became an expert laundryman and set up a laundry in every village he travelled to. He never accepted freebies. He was lucky to find good foster parents in most cities and they imbibed good moral values in him. George maintained contact with his friends and foster parents through letters. In one village in Kansas there was another George Carver and letters were often delivered wrongly. Carver solved the problem by adding Washington as his middle name.

Carver was a good student and was accepted to Highland College and was also offered scholarship, but later turned away because he was black. A very depressed George worked on a ranch, but not for long. Education was his primary goal. Later he was accepted at Simpson College, where he took special training in Etta Budd's painting class and became a fine painter. However, Etta Budd was not sure that painting alone would help him make a living and she urged him to enrol at Iowa State College, Ames and learn Horticulture and Agriculture. He passed with flying colours and was awarded Bachelor of Science degree in 1894. He was appointed as a faculty (the first black to be appointed) in Botany and also the greenhouse in-charge at Ames. He pursued Masters and was awarded the same in 1896. He gained fame as the best black agriculturist who could grow corn even on a wooden floor!

Invitation to Tuskegee

Carver would have continued to work at Iowa and lead a life of security and financial stability if he hadn't been invited to Tuskegee in Alabama. After hearing about his agricultural wizardry Booker T. Washington, who was managing the all-black school at

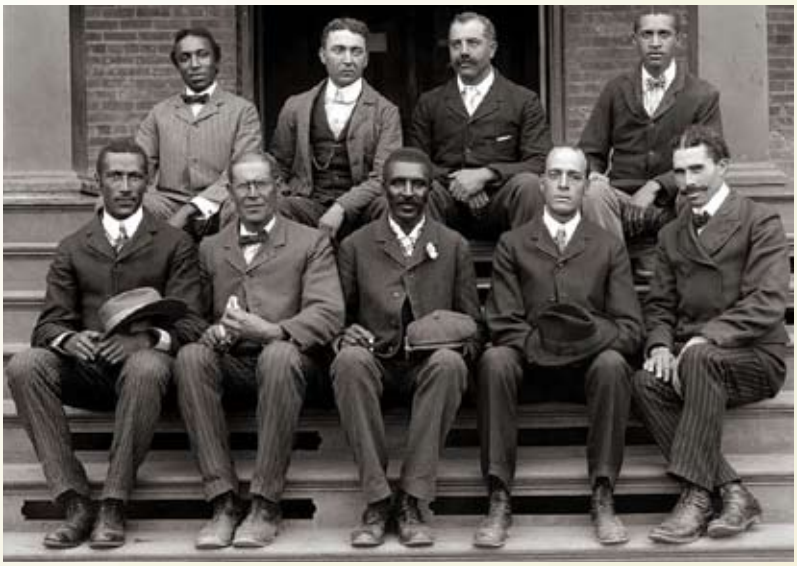
Tuskegee, invited him to work with him for the betterment of their tribe. Carver realised that this was what he really wished. He obliged and thus began the 47-year-long association with Tuskegee. Though he was appointed as the Director of Agriculture and Director of Research and Experiment Station, he was surprised when he could not locate a research lab on the premises. He persistently enquired about the lab. Booker T. Washington pointed to the vast space in front of the agricultural hall and said with a smile, "There is plenty of space and God has given you the brains!" and Carver smiled. At that instant Carver and Booker understood each other and became very good friends.

Carver's contributions

Carver's research was need based. He tackled the problems faced primarily by the farmers. He also undertook need-based research as and when required. To start with, Carver began with improvement of farmland in the South. Years of cotton monoculture had depleted the soil of vital nutrients, especially nitrogen. He demonstrated how to improve soil by using animal drippings from the barn and its regeneration by crop rotation. He further demonstrated how planting peanuts and cowpeas would improve soil health (by nitrogen fixation). Thus he stressed on organic farming. The farmers didn't pay much attention initially because the banks gave loans only for planting cotton! But when the boll weevil destroyed the entire crop, Carver again suggested planting peanut and they had no option but to oblige. Now everyone planted peanuts. Soon the region boasted a bumper peanut crop with not many uses! (In those days peanuts were chiefly used to feed pigs.) The farmers now blamed Carver!

To find a solution to farmer's plight Carver shut himself in his lab for four days and emerged when he found 24 uses for peanuts! He almost became obsessed with peanuts and soon found out more than 300 uses for peanuts! The uses range from peanut milk to animal feed, cosmetics to paints! No part of the plant was wasted. Thus Carver was a chemurgist even before the word chemurgy (a branch of applied chemistry concerned with preparing industrial products from agricultural raw materials) was coined! He worked without depleting the Natural resources. It will be wise to accept his philosophy. With similar fervour he worked on other produce and found more than 100 uses for sweet potato; 65 for pecans. He also developed a sturdy variety of cotton.

Some of his inventions were a boon during the World War 1. Sweet potato flour was partly used in bread making thus sparing precious wheat flour. During WW1 when the demand for cotton crashed and it was feared to go waste, Carver invented several used for it – from paper, rugs, paving blocks to boards. When it became difficult to procure dyes from Europe, he developed dyes for the American textile industry. He also helped the great automobile manufacturer Henry Ford in preparing plant-based replacement for natural rubber. His peanut milk was a life saver for many African infants whose mothers had died during child birth. (Rearing cows was not possible in some areas due to the fear of predators)



Carver with faculty at Tuskegee

School on Wheels – The Jessup Wagon

In order to acquaint the newly liberated slaves with the correct methods of farming, cattle rearing, sanitation and hygiene, he developed the School on wheels. The Jessup Wagon was designed from the donation given by Mr. Jessup. The wagon was equipped with a number of useful implements. The Jessup Wagon brought a positive change in the farmer's life. Even the white farmers urged Carver to guide them. Carver published 40 plus bulletins to guide farmers and villagers about food preservation and farming.

Carver as a person

Carver was shy by nature and this can be attributed to many things like his experiences in childhood, his health, his voice, etc. He was very industrious and worked for most part of the day. He loved research but preferred to work alone in the lab. He left very little notes about his research.

He was an excellent cook and developed new recipes from peanuts like peanut bread, mock chicken, peanut strips with bananas to mention a few. He wrote bulletins to popularise his research. His bulletins were very popular and sold like hot cakes.

Carver patented only three of his inventions. He believed in others benefitting from his research. Some of his inventions became a rage in those days. However, as time passed similar or better products began to be manufactured from cheaper sources and most of his inventions took a back seat.

Carver remained single by choice. He was a philanthropist in his own way. He donated his life's savings of $60,000 to found the George Washington Carver Institute for Agriculture at Tuskegee. He loved children and acted like fairy godmother to many by gifting articles like shoes, uniforms, etc. He had helped many boys during their studentship years. He called them his children.

Carver soon became a very sought after figure. Three American Presidents, Theodore Roosevelt, Calvin Coolidge and Franklin Delano Roosevelt met Carver and sought his advice on various topics. The crown prince of Sweden stayed at Tuskegee for three weeks to learn more about plants. Henry Ford and Carver were very good friends. Carver helped Ford to find alternative sources for fuel and plastics from soy.

Continued on page 26

Impacted Wisdom Teeth— Managing the trouble mongers'

Dr. Yatish Agarwal
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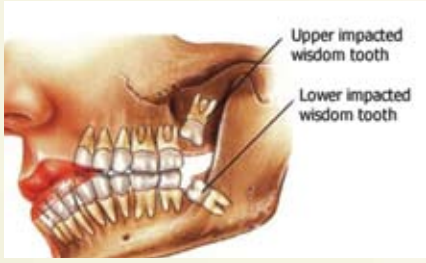
Wisdom teeth have been fabled in the folklore as a seat of intellect for many centuries. This belief is probably born out of the fact that wisdom teeth break out into the mouth in the years when an adolescent is on the doorstep of turning into a young adult, and is bubbling with knowledge. The last adult teeth to erupt into the mouth, wisdom teeth usually erupt between the ages of 17 and 25 years.



Most people have four wisdom teeth at the back of the mouth — two on the top, two on the bottom. Some people have wisdom teeth that emerge without any problems and line up with the other teeth behind the second molars. In many people, however, the mouth is too crowded for third molars to develop normally. These crowded third molars become trapped (impacted). This particularly happens when the back of the mouth does not have sufficient room for the third molars to emerge or grow normally. As a result, one or more wisdom teeth only partly see the light of the day or none at all, and, for their most part, remain buried in the jaw bone.

Most people, who have one or more impacted wisdom teeth, need such a tooth to be surgically extracted. This surgery is necessary to ease the pain and a number of other complications. Many dental surgeons recommend removing impacted wisdom teeth, whether they are causing any symptoms or not, to forestall future difficulties.

Variations

An impacted wisdom tooth may partially emerge so that some of the crown is visible (partially impacted), or it may never break through the gums (fully impacted). Whether partially or fully impacted, the tooth may:

- Grow at an angle toward the next tooth (second molar)
- Grow at an angle toward the back of the mouth
- Grow at a right angle to the other teeth, as if the wisdom tooth is "lying down" within the jawbone
- Grow straight up or down like other teeth but stay trapped within the jawbone

Knowing the symptoms

Impacted wisdom teeth don't always cause symptoms. However, when an impacted wisdom tooth becomes infected, damages adjacent gums and teeth, presses upon a nerve or causes other dental problems, you may experience some of these signs or symptoms:

- Pain and difficulty in opening mouth
- Red or swollen gums
- Tender or bleeding gums
- Swelling around the jaw
- Ear ache
- Headache
- Bad breath
- An unpleasant taste in the mouth
- Swollen nodes in the neck

Complications

Impacted wisdom teeth can cause a host of problems in the mouth:

Damage to other teeth

If the wisdom tooth pushes against the second molar, it may damage the second molar or make it more vulnerable to infection. This pressure can also cause problems with crowding of the other teeth or orthodontic treatments to straighten other teeth.

Tooth decay

Partially impacted wisdom teeth appear to be more vulnerable to tooth decay (caries) than other teeth. This probably occurs because wisdom teeth are harder to clean and because food and bacteria get easily trapped between the gum and a partially erupted tooth.

Gum disease

The difficulty of cleaning impacted, partially erupted wisdom teeth also makes them a vulnerable site for the development of a painful, inflammatory gum condition called pericoronitis.

Development of cysts in the jawbone

The wisdom tooth grows in a sac within the jawbone. The sac can fill with fluid, forming a cyst that can damage the jawbone, teeth and nerves. Rarely, a tumour — usually a noncancerous tumour — develops. This complication may require removal of tissue and bone.

When to see a doctor

If you're experiencing pain, swollen gums or other dental problems in the area behind your last molar that may indicate an impacted wisdom tooth, see your dental surgeon as soon as possible. Impacted wisdom teeth that are causing pain or other dental problems are usually surgically removed, or extracted.

Your dental surgeon may recommend a second consultation with an oral surgeon if your impacted wisdom teeth are likely to be difficult to treat.

A visit to the dental surgeon may cause so much anxiety that you can't get yourself to go, despite the pain you're experiencing. The thought of having a tooth removed may be overwhelming, but delaying care can lead to serious and permanent problems.

It is important to talk to your dental surgeon about your concerns. Anxiety is common. Do not feel embarrassed about such a sentiment. Ask your dental surgeon for suggestions on how to cope with your discomfort.

Diagnosis

The diagnosis of an impacted wisdom tooth is usually straightforward. Your dental surgeon can evaluate your teeth and mouth to determine if you have impacted wisdom teeth or if another condition is causing your problems. However, s/he is likely to still ask you to undergo a dental X-ray examination called orthopantogram (OPG), which uncovers both upper and lower set of teeth.

The X-ray examination can reveal the presence of impacted teeth, as well as signs of damage to teeth or bone.

Managing asymptomatic wisdom teeth

If impacted wisdom teeth aren't causing symptoms or apparent dental problems, they're called asymptomatic. Some disagreement exists in the dental community about how to manage asymptomatic impacted wisdom teeth. Research on this topic doesn't strongly favour one strategy over the other.

Some dental surgeons recommend removing asymptomatic wisdom teeth to prevent future potential problems. They argue:

- An asymptomatic tooth may not be free of disease and may be a particularly vulnerable site for gum disease and tooth cavities.
- The procedure rarely results in serious complications in younger adults.
- The procedure is more difficult and more likely to cause complications later in life, particularly among older adults.

Other dental surgeons recommend a more conservative approach. They note:

- There isn't enough evidence to suggest that impacted wisdom teeth not causing problems in young adulthood will later cause problems.
- The expense and risks of the procedure don't justify the expected benefit.

With a conservative approach, your dentist will monitor your teeth for decay, gum disease or other complications. S/he may recommend removing a tooth if problems arise.

Surgical removal

Surgical removal (extraction) of a wisdom tooth is almost always done as an outpatient procedure, meaning you'll go home the same day. You may have local anesthesia, which numbs your mouth; sedation that depresses your consciousness; or general anesthesia, which makes you lose consciousness.

During an extraction your dental surgeon makes an incision in your gums and removes any bone that blocks access to the impacted tooth. After removing the tooth, the surgeon typically closes the wound with stitches and packs the empty space (socket) with gauze.

You'll receive a set of instructions for caring for wound and for managing pain and swelling.

Possible complications with surgery

Most wisdom tooth extractions don't result in long-term complications. Problems that can occur include:

- Dry socket, or exposure of bone if the post-surgical blood clot gets dislodged from the socket, which can be painful and delay healing
- Infection in the socket from bacteria or trapped food particles
- Damage to sinuses near the upper wisdom teeth
- Weakening of the lower jawbone
- Damage to nerves that results in altered sensation in the lower lip, tongue or chin

However, these problems are rare, and can be resolved with patience and careful handling. Just be sure of keeping faith in your doctor.

Dr. George Washington Carver *(Continued from page 28)*

Accolades and awards

During his lifetime Carver received several awards and accolades. His paintings were honoured at the Chicago World Fair. Of the several medals he received, Spingarn medal (1923), and Roosevelt medal (1939) were the most prestigious ones. He was awarded honorary Doctorate by Simpson College, by University of Rochester, and Selma University. He was made the honorary member of American Inventors Society (1939). His name was included in the 50 outstanding Americans (1952). He was inducted in the National Inventors Hall of Fame (1990). Stamps and coins were made in his honour. His birthplace was declared as a National monument. He was the first African-American to receive this honour.

Advancing age didn't act as a barrier for Carver. He continued to be engaged in his regular lifestyle, which included waking up at 4 am and then going to the woods, and working in the lab for most part of the day. However, in December 1942 he slipped on ice and suffered a bad fall. He was advised total bed rest. He continued to sit in the bed and paint Christmas cards. He passed away on 5 January 1943. Not only Tuskegee but entire America mourned his death. USA celebrates 5 January as George Washington Carver Day every year.

Carver was buried at Tuskegee next to Booker T. Washington. The following words were carved on his tombstone: *'He could have added fortune to fame but caring for neither; he found happiness and honour in being helpful to the world.'*

So very true!

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Recent developments in science and technology

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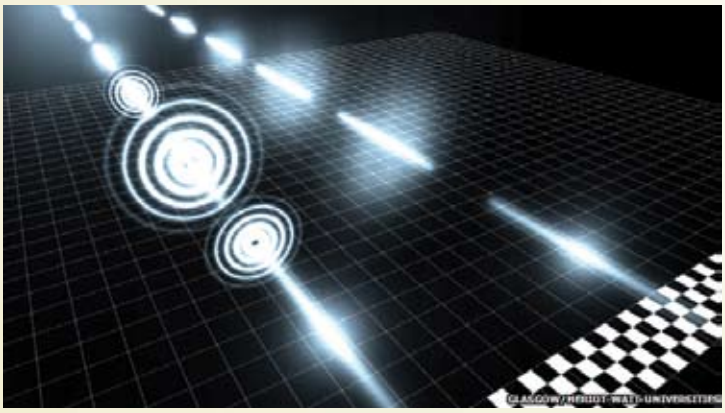
Scientists slow down the speed of light

It is well known that the speed of light in a vacuum is constant – a whopping 300,000 km per second – irrespective of whether the source or the observer is in motion. Of course, when light passes through a denser medium such as water or glass its speed becomes less, but it regains its original speed as soon as it leaves the medium. Now a team of researchers working at the University of Glasgow, UK has shown a way to slow down the speed of light without passing it through a medium. They did it by changing the 'shape' of photons by passing them through a special 'mask', which they say causes a change to the shape of the photon, making it move through a vacuum slower than an unaltered photon (*Science*, 22 January 2015 | doi: 10.1126/science.aaa3035).



Unaltered photons (right) were shown to reach the 'finishing line' (right bottom corner) later than photons that had passed through a mask (left). (Credit: Glasgow/Heriot-Watt Universities)

This unusual property of light can be better understood if we consider the dual nature light; it behaves both as particle and as wave. The wave property of light can be demonstrated by formation of 'Newton's rings' and formation of 'interference bands' when passed through a double-slit. The particle nature of light was demonstrated by Einstein to explain the photoelectric effect.

This dual description leads to two different speeds for light: the wave velocity, which for a plane wave in a vacuum is the constant, *c*; and the particle or "group" speed at which energy or information propagates, which the physicists say "can be less than *c*, in some cases". In the *Science* paper, Daniel Giovannini of the University of Glasgow and his team show that in a group of photons, which travel at the speed of light, individual photons can have a speed less than *c*. The team compares a beam of light, containing many photons, to a team of cyclists moving at a certain speed on a racing track. Although the team as a whole may move at a certain fixed speed, individual cyclists in the group may slow down from time to time without affecting the overall speed of the group. The group formation can make it difficult to define a single speed for all individual cyclists, and the same applies to light. A single pulse of light contains many photons, and scientists know that light pulses are characterised by a number of different velocities.

In the Glasgow experiment two photons – one shaped by passing through a mask and another unaltered – were released simultaneously across identical distances towards a defined finish line. The researchers found that the unaltered photon reached the finish line as predicted, but the photon which had been reshaped by the mask arrived later, meaning it was travelling at a speed slower than *c* in free space. Over a distance of one metre, the team measured a slowing of up to 20 wavelengths – many times greater than the measurement precision.

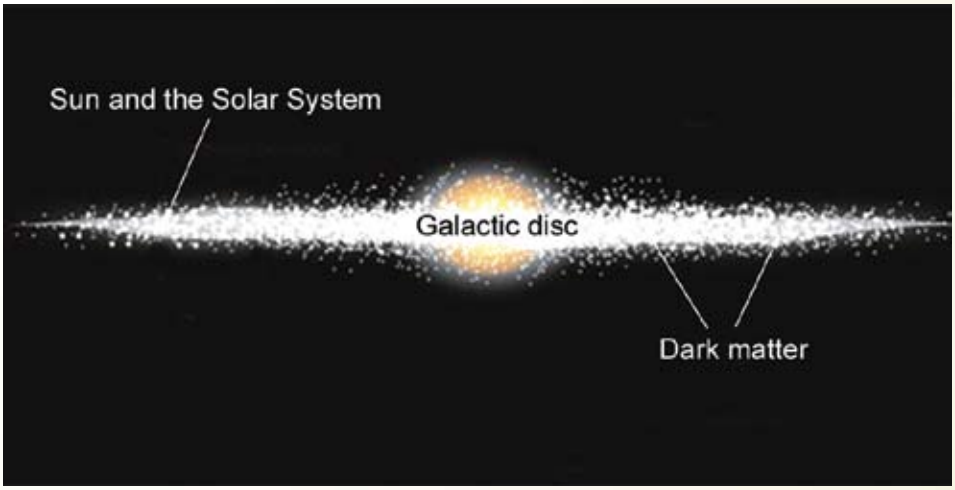
The experiment demonstrated that, after passing the light beam through a mask, photons move more slowly through air or vacuum. This is very different from the slowing effect of passing light through a medium such as water or glass, where the light is only slowed during the time it is passing through the material – it returns to the speed of light *c* after it comes out the other side. Thus, according to the researchers, the effect of passing the light through the mask is to limit the top speed at which the photons can travel. Although the effect was observed for a single photon, it applies to bright light beams too, they add.

The researchers further add that they were using group velocity to measure the light's speed. The mask, they explain, caused some of the photons in the group to move at a slight angle to the other's causing a slowdown for the group as a whole. Thus, they assure, their results are not going to turn one of the basic tenets of modern physics upside down.

Dark matter may have triggered mass extinctions

It is now well-established that dinosaurs, which ruled the Earth for 135 million years, suddenly disappeared from the face of the Earth in a catastrophic event that happened some 65 million years ago. It is also known that the extinction of dinosaurs was probably caused by the impacts of extra-terrestrial objects, such as a comet or an asteroid that struck near Mexico's Yucatán Peninsula in Central America. There have been other mass extinctions too, though not as massive as the extinction of dinosaurs, caused by extensive volcanic activity. What is interesting is that these mass extinctions have been occurring roughly every 26 million to 30 million years. What was causing these cyclic extinctions?

After analysing the occurrence of these mass extinctions, Michael Rampino, a geoscientist at New York University has suggested that these cycles may be caused by dark matter in the Milky Way galaxy (also called the Galaxy, with a capital G). His argument is very simple. It is known that our Sun and the Solar System planets occupy the distant part of one arm of the Galaxy. It is also known that, as the Sun follows the swirling motion of the Galaxy's arms, circling around the galactic centre, it also moves up and down, periodically crossing the plane that cuts the Galaxy horizontally



Side view of the Milky Way galaxy showing the position of the Sun and the Solar System and location of dark matter.

into a top and a bottom half, once every 30 million years or so. The galactic disc is where most of the Galaxy's matter is concentrated and Rampino believes dark matter is present here. Researchers estimate that in the plane of the Galaxy, each square light-year contains about one solar mass of dark matter. Like the clouds of dust and gas that astronomers can see, the periodic passage of the Solar System through clouds of dark matter may be perturbing the orbits of distant comets, causing them to fall into the inner solar system where they can strike Earth (*Monthly Notes of the Royal Astronomical Society*, 18 February 2015 | doi:10.1093/mnras/stu2708).

The real nature of dark matter still remains unknown, but scientists estimate that it is more than five times as abundant as the familiar matter that we see around us. Dark matter is different from ordinary matter because it interacts with atomic matter only through gravity. Since it does not interact with electromagnetic radiation it is invisible. Although dark matter has never been seen, scientists believe it must exist to account for huge gravitational effects in the universe. There simply is not enough visible matter to keep the planets, stars and other bodies in place, so some large invisible force must be also having an impact. The effect of its gravitational pull permits astronomers to measure the distribution of dark matter in the universe, and they thus know that in the Milky Way it is concentrated, like atomic matter, in the disc. Rampino believes that because there is more dark matter in the crowded central part of the galactic disc, it can disturb paths of comets, sending them on a collision course with Earth. Dark matter may also be responsible for additional heating of the Earth's core which can trigger volcanoes, mountain building and mass extinction events, he suggests.

Fish discovered under Antarctic ice

Life can be really tenacious and there appears to be no place of Earth totally devoid of life. Imagine the dark, cold waters 740 metres below an ice-shelf of Antarctica where sunlight never reaches and the temperature hovers around minus 2 degrees Celsius. As recently as a decade ago, life scientists believed that nothing could survive under such hostile conditions beneath Antarctica's massive ice sheets. Yet, in January this year, researchers made the surprising discovery of the existence of a unique fish besides shrimp-like crustaceans and few other invertebrates in these cold, dark waters (http://www.smithsonianmag.com/ 22 January 2015). The discovery was made by a scientific expedition called the Whillans Ice Stream Subglacial Access Research Drilling (WISSARD) project funded by the US National Science Foundation, which drilled through the 740-metre-thick ice shelf and used a small underwater robot to explore the waters below.

The Whillans Ice Stream is a glacier that flows from the West Antarctic Ice Shelf to the Ross Ice Shelf. Using a hot water-based drill the WISSARD team bored into the glacier's "grounding zone", which is the area where the glacier leaves bedrock and meets the sea. Scientists say this area at the sea bottom looks bare and "rocky, like a lunar surface,"

A small remotely operated underwater robot called Deep-SCINI was then sent down the borehole to capture images of the rocks and sediment down on the sea floor. The researchers also lifted sediment cores and seawater samples which were found to be crystal clear – suggesting that the water was only sparsely populated with microbes, and certainly not enough of them for animals to graze and sustain themselves on. That was of course not a surprise, as no one expected to see fish or other marine animals there. But soon, the video camera carried by the underwater robot brought to light fish and other aquatic animals living in perpetual darkness and cold. The first living object spotted by the camera was a bulb-eyed fish, a few centimetres long, its internal organs showing through its translucent body. The animals inhabited a wedge of seawater only 10 metres deep, sealed between the ice above and a barren, rocky seafloor below. It was a really surprising discovery.

The translucent fish that researchers discovered incredibly far beneath Antarctica's ice. Researchers saw 20 to 30 such fishes over several hours. (Credit: Whillans Ice Stream Subglacial Access Research Drilling Project).

The researchers are not yet certain if the fishes discovered represent something truly novel to science. Photographs and videos will have to be extensively analysed and the results published in a peer-

reviewed journal before the team is likely to say much more. According to some scientists, the fishes could turn out to belong to a single family, called the Nototheniidae, which began to dominate Antarctica starting around 35 million years ago, when the continent and its surrounding oceans began to cool precipitously, and the fishes evolved proteins that helped them avoid freezing solid.

The discovery of fish in waters that are extremely cold and perpetually dark poses new questions about the ability of life to thrive in extreme environments. Some scientists speculate that the discovery may have implications for the possibility of life on Jupiter's moon, Europa.

Scientists create 'genetic firewall' to make GMOs safe

Genetically modified organisms, or GMOs, are organisms that have been endowed with some special beneficial characteristic by inserting genes from other unrelated organisms through genetic engineering. Crops with better pest-resistance, drought-resistance or higher nutrient content have been developed, often with better yield and higher productivity. Genetically modified organisms are already being used in the commercial production of insulin, human growth hormone and other drug ingredients, helping produce biofuels, teaching scientists about human disease, and improving fishing and agriculture. But in many countries, including India, GMOs are looked at with suspicion, with several activist groups strongly opposing their introduction because they consider GMOs a threat to the environment. One of the biggest concerns about GMOs is that they can infiltrate wild populations and spread their altered genes among naturally occurring species.

Now, two independent groups of researchers in USA, at Yale University, led by Farren Isaacs, and at Harvard Medical School, led by George Church have devised a way to ensure that genetically modified organisms can be safely confined in the environment without the danger of the modified gene getting into natural populations and thereby overcoming a major obstacle to widespread use of GMOs in agriculture, energy production, waste management, and medicine. They have created genetically engineered bacteria that depend on synthetic amino acids to survive so that the genetically modified microbes cannot survive outside the lab (*Nature*, 21 January 2015 | doi: 10.1038/nature14095 and doi: 10.1038/nature14121).

Bacteria dependent on synthetic amino acids enables safe, new biotechnology solutions to global problems.

The researchers modified the DNA of the common bacterium *Escherichia coli* so that it requires the presence of a special synthetic amino acid that does not exist in nature to activate genes essential for growth. The new code allowed the team to link growth of the bacteria to synthetic amino acids not found in nature, establishing an important safeguard that acts as a 'firewall' and limits the spread and survival of organisms in natural environments. According to the researchers, these safe GMOs – also known as 'genetically re-coded organisms' (GROs) – will improve efficiency of genetically engineered organisms which are now being used mostly in closed systems for the production of pharmaceuticals, fuels, and new chemicals. According to the researchers, GROs are resistant against multiple viruses and fail at what they call 'horizontal gene transfer' – one of the ways genetically engineered DNA could migrate into a natural population from GMOs. The modifications offer theoretically safer *E. coli* strains that could be used in biotechnology applications with less fear that they will be contaminated by viruses or cause ecological trouble if they spill into the environment.

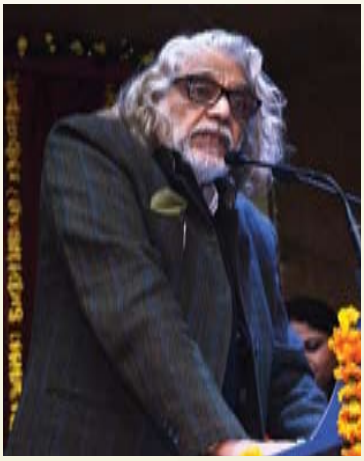
The researchers say that although the recent success was achieved with bacteria, "there is no fundamental barrier" to applying the technique to plants and animals. According to them, the new genetic code paired with artificial amino acids will allow scientists also to create safer GMOs for use in open systems, which include improved food production, designer probiotics to combat a host of diseases, and specialised microorganisms that clean up oil spills.

5th National Science Film Festival and Competition – 2015

The 5th National Science Film Festival (NSFF) 2015, a festival of Science, Technology, Health and Environment based films was organised by Vigyan Prasar in collaboration with National Council of Science Museums, Ministry of Culture, Government of India. The festival received excellent partnership from Doordarshan, All India Radio, UNICEF-UP, Centre for Environment Education (CEE), Babasaheb Bhimrao Ambedkar University, Lucknow University, Amity University, The Society of Earth Scientists, and the Council of Science and Technology, Uttar Pradesh.

Inaugural session of NSFF 2015

The 5th NSFF was inaugurated by Padma Shri Muzaffar Ali, Member of the Prasar Bharati Board, Ms. Niloufar Pourzand, Chief of UNICEF Uttar Pradesh and Ms. Meera Ali, noted fashion designer. Inaugural was followed by keynote address by Dr. Anil Rastogi, a noted film actor and former scientist, CSIR-CDRI. Well-known film maker Dr. Chandra Prakash Dwivedi was the National Jury Chair for the festival.



Padmashri Muzaffar Ali addressing the audience

A Festival Book of 5th National Science Film Festival and Competition 2015 was released by the guests. It covered synopses, photographs of all films and contact details of film makers. A film produced by UNICEF *"Paheli ki saheli"* was released and screened on the occasion. In this film problems of girls at adolescence age are presented.

For the festival science films were invited under the five categories from science film makers, media houses, production houses, government and non-government organisations, universities/colleges and schools. Special categories were designed for students of class 6 to 12 and college students. A total of 153 entries was received from film makers/institutions, out of which 64 were shortlisted for the competition by a committee of science film makers and experts.

As a part of 5th NSFF, a four-day workshop on Science Film Making was organised for budding science film makers and students of science communication and film making courses. Renowned academicians of science film making Sri Indranil Bhattacharya from Film and Television Institute of India (FTII), Pune, Prof Santosh Pandey from Ramoji Academy of Film & Television, Ramoji Film City, Hyderabad, and experts from other institutions were invited for academic sessions in the workshop. Interactive sessions with scientists and science communicators were organised for film makers.

250 science film makers, science communicators, students of mass communication and science communication courses, scientists, academicians involved in film making courses, journalists and teachers of mass communication participated in the 5th NSFF and science film making workshops. More than 4,000 students also visited the 5th NSFF. Science films were screened in parallel at the Scimax theater of Regional Science City, Lucknow, Lucknow

Members of National Jury 2015 & invited guests

Deeply involved film makers

Dr Chandraprakash Dwivedi addressing film makers during award ceremony

University, IT college, , Council of Science & Technology, UP, and Babasaheb Bhimrao Ambedkar University, Lucknow for students and visitors. More than 2,000 students and teachers participated in the parallel sessions of 5th NSFF.

24 science films were awarded with the Beaver Awards and special technical awards by Dr. Chandraprakash Dwivedi, National Jury Chair and Shri Surya Mohan Kulshreshta, Chairman, National Screening Committee and former director of Bhartendu Natya Academy at the valedictory function of 5th NSFF on 8 February 2015. Science film makers were also felicitated by national jury members – Dr Anil Kumar Rastogi, Sri Jayant Krishna, Sri Sharad Dutt, Prof Qamar Rahman, Sri Santosh Pandey, Mrs Lalitha Vaidyanathan, Dr Chandra Mohan Nautiyal and Sri Ratan Mani Lal.

Along with the Beaver Awards and certificates of merit, the films were awarded with cash prizes. For categories 'A','B' and 'C' the prize money from Gold, Silver and Bronze awards were Rs.1,00,000, Rs.50,000 and Rs.30,000 respectively. For categories 'D' and 'E', the prize money from Gold, Silver and Bronze awards were Rs.50,000, Rs.30,000 and Rs.20,000 respectively. The recipient of the Special Jury Award was given Rs.40,000 while the four Special Awards for Technical Excellence were given Rs.20,000 each.

Award winning science films

Category 'A': Popular Science Film to communicate and develop scientific temper (Target audience: General public)

S.No.	Title of Film	Award	Details of Film
1.	Redemption: A REDD + Story from India	Golden Beaver Award	Produced by: The Energy and Resources Institute (TERI) Directed by: Ms Ahona Datta Gupta and Ms Rishu Nigam
2.	What Happens When We Sleep?	Silver Beaver Award	Produced by: Vigyan Prasar Directed by: Mr Rajendra Kondapalli
3.	Mother Wasp	Bronze Beaver Award	Produced by: EMRC University of Mysore Directed by: Mr B. Sreekantachar

Category 'B': Popular Science Film to communicate and develop scientific temper (Target audience: Children of age 6 to 12)

S.No.	Title of Film	Award	Details of Film
1.	Poonthenunnan Vaayo (Come, Enjoy the nectar)	Golden Beaver Award	Produced by: Padanakendram, KSSP, Kottarakkara Directed by: Mr K.V.S. Kartha
2.	Insects That Glow	Silver Beaver Award	Produced and directed by Dr. Jitendra Singh
3.	Mere Aangan Ke Pakshi	Bronze Beaver Award	Produced and Directed by Mr M N Chikkamuniyappa

Category 'C': Film on Science, Technology and Innovation (Target audience: General public)

S.No.	Title of Film	Award	Details of Film
1.	Living With Elephants	Golden Beaver Award	Produced by: Evanescence Studios Directed by: Mr Saravanakumar Salem
2.	Flowing Forever	Silver Beaver Award	Produced by: Baanyan Tree Productions Directed by: Mr P. C. Anto
3.	Breeds of Wealth	Bronze Beaver Award	Produced by: Kerala State Biodiversity Board Directed by: Mr G. S. Unni Krishnan Nair

Category 'D': Film on Science: Film made by students pursuing degrees/diplomas (Target audience: General public)

S.No.	Title of Film	Award	Details of Film
1.	A Journey through Space and Time	Golden Beaver Award	Produced and directed by: Mr Vinay Kumar Sahu
2.	Rapan	Silver Beaver Award	Produced by: Prabharang Films production Directed by: Mr Sandip Pandurang Mane
3.	Human Island	Bronze Beaver Award	Produced by: MBL Media School Directed by: Mr Fasilul Farisa
4.	Love Story of Two Electrons	Bronze Beaver Award	Produced & directed by Mr Vivek Singh

Category 'E': How do I see Science? : Film made by students of Class VI to XII (Target audience: Student community)

S.No.	Title of Film	Award	Details of Film
1.	Science Behind Miracles	Golden Beaver Award	Produced by: K R Mangalam World School, Gurgaon Directed by: Mr Kirat Singh Mokha
2.	How Do I See Science?	Silver Beaver Award	Produced by: City International School, Mumbai Directed by: Ms Varsha Shankar and Ms Shreyaa Mohan
3.	My Kitchen Science	Bronze Beaver Award	Produced by: Mr Ganesh Kumar Aranya Directed by: Ms Apoorva Shri and Ms Shruti Kumari

Special Jury Award

Tiger's Revenge, Produced by Natural History Unit India, Directed by Mr Nalla

Special Awards for Technical Excellence

- **Cinematography** – Snnakes, Produced by Snakes Shyam and Directed by Mr Shylendra Hoode
- **Editing** – Large Mesh Purse Seining, Produced by Monsoon Productions, Directed by Mr Antony Felix
- **Graphics / Animation / Special Effects** – Guppy, Produced by Baanyan Tree Productions, Directed by Mr Sumit Osmand Shaw
- **Sound Recording and Design** – Gharat - Revival of Watermills, Produced and Directed by Mr Shriniwas Oli

Special Awards for films on Earth & Environment Sciences

- Monumental Science, Produced by: Television Programme Company, Directed by: Mr Matiur Rahman
- Phytoremediation of Manganese Mine Spoil Dumps Through Integrated Bio-Technological Approach, Produced by: Visual Impact, Directed by: Mr Kulwant Bhabra
- Vanishing Vulture, Produced & Directed by Mr Syed Abbas Hasnain Abidi

Report by : Nimish Kapoor, Scientist D, Vigyan Prasar
Email: nkapoor@vigyanprasar.gov.in

National award winners of NSFF 2015

ICMR awarded Vigyan Prasar's title 'Vigyan ki vikalangata par vijay'

The author of a Hindi book titled 'Vigyan ki vikalangata par vijay', published by Vigyan Prasar, has received the 'Biennial ICMR Award for Popular Medical books in Hindi (2012-13). The author, Vinod Kumar Mishra, received the award money of Rs.100,000 and a certificate from Shri T.S. Jawahar, Senior Deputy Director General (Administration), ICMR at a function held at Indian Council of Medical research (ICMR) headquarters in New Delhi on 12 March. 2015.

This book was published in 2013 and discusses how science and technology could minimise disabilities. Shri Mishra is a popular science writer and at the age of 3, he was afflicted with polio. But he made this disability his strength and completed his B. Tech. from Roorkee University. The author of 70 popular books, Shri Mishra works in Central Electronics Limited as an Assistant General Manager (Quality Assurance).

Publication of popular books on different themes of science and technology is a major programme of Vigyan Prasar and till now this institute has brought out more than 250 books in Hindi, English and many other Indian languages.

(Report by: Manish Mohan Gore)

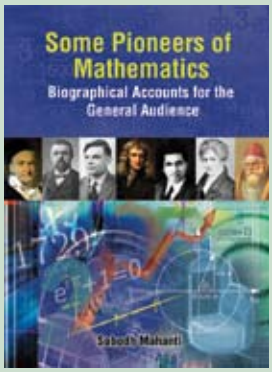
The author Vigyan Prasar's book 'Vinod Kumar Mishra (2nd from right) received the 'Biennial ICMR Award. Dr. K.N. Pandey, Dr. K.K. Singh, T.S. Jawahar, Manish Mohan Gore and Dr. V.K. Shrivastava were also present during the award

Book "Vigyan ki vikalangata par vijay" which got ICMR award

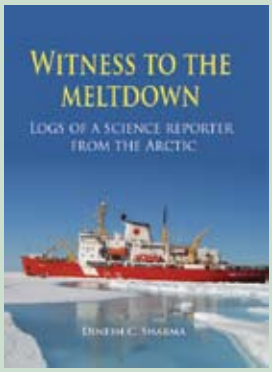
Audience present in the ICMR award function

Dr. K.K. Singh, T.S. Jawahar, Vinod Kumar Mishra and Dr. V.K. Srivastava (from L to R)

Recent Publications of Vigyan Prasar



Some Pioneers of Mathematics
Biographical Accounts for the General Audience
Author: Subodh Mahanti
ISBN: 978-81-7480-264-4
Price: ₹200



Witness to the Meltdown
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Price: ₹200

Story of the Sky
Author: Samar Bagchi
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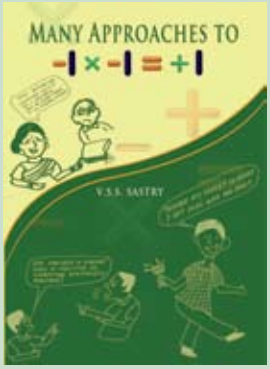
Price: ₹50



Many Approaches to -1 x -1 = + 1
Author: V.S.S. Sastry
ISBN: 978-81-7480-273-6
Price: ₹50