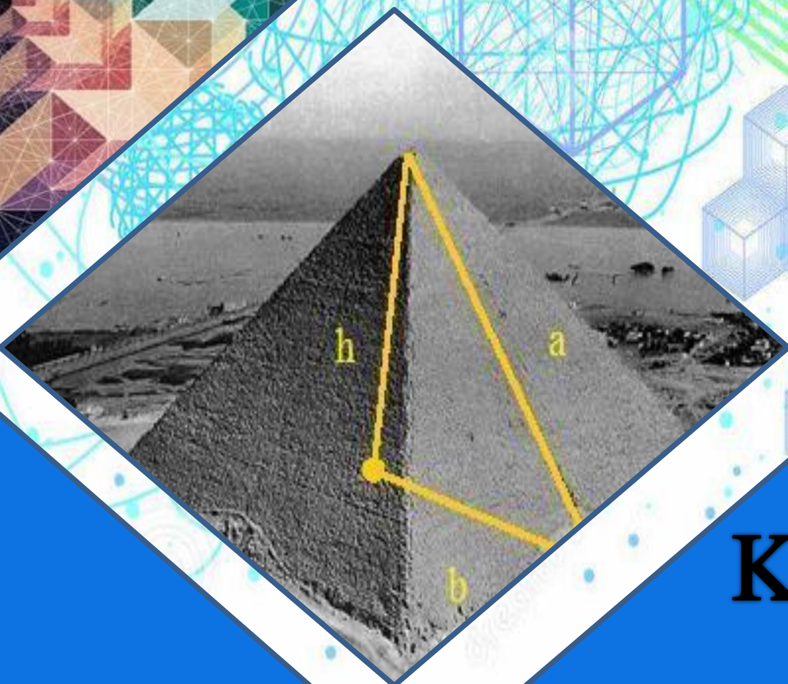
AXIOM'18

VOLUME-7



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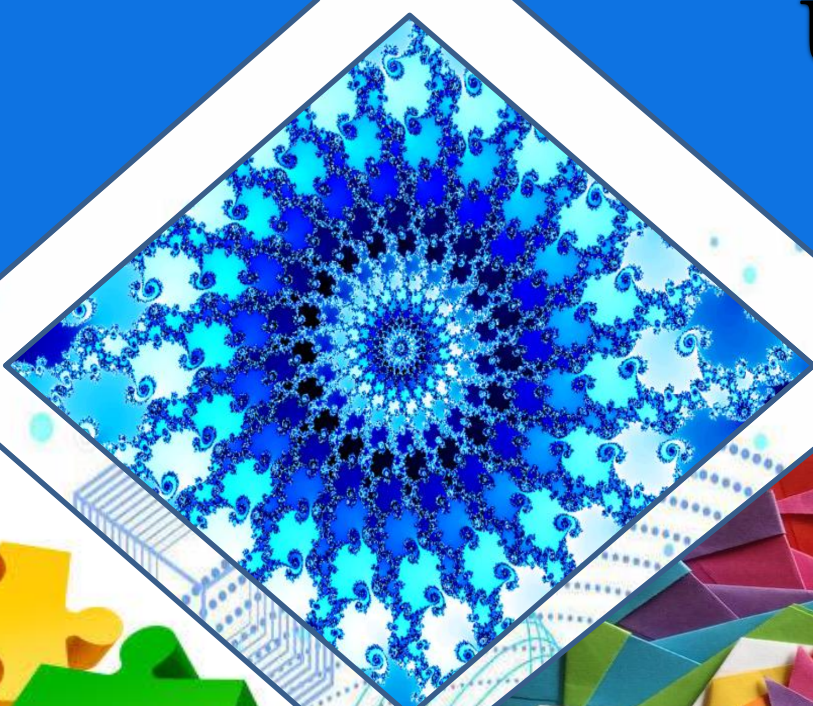

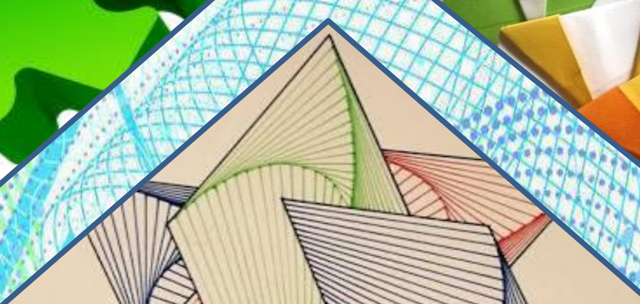

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From Principal's Desk

In the year 1987, the spectacular event of 'Supernova' enchanted us when it appeared in the sky, which actually happened more than 150,000 light years from earth, but was still visible to the naked eye. I was much younger at that time but even those days I was teaching at KNC. Since my childhood days I had been a stargazer. The cosmos intrigued me most. I discovered the cosmic beauty from hills and deserts. So when 'Supernova' happened it was so fascinating to know that a 20 years old student, called Subrahmanyan Chandrasekhar discovered this by combining the theories of stellar composition, relativity and quantum mechanics during a trip on a steamship from India to England. It was so amazing to know that the size of a star determines its fate. Stars the size of the sun live relatively quiet lives. Stars slightly larger than the sun will become white dwarves, intensely hot but small stars that will cool slowly and die. However, if a star exceeds a certain mass—'the Chandrasekhar limit'—then it is destined to become a Supernova- that means the explosion of a giant star. Life as we know is based on the element carbon, but life also requires a large variety of other, heavier atoms. A supernova explosion produces all the heavier elements and scatters them throughout the universe. I may not grasp the mathematics behind Chandrashekhar limit but I feel simply fascinated that someone thought about the cosmic order so intensely!

Supernovas are rare, just as Chandrashekhar himself was a rare discoverer. The students of maths must develop the ability to understand the mathematical order in everything around us- let the universe be your classroom.

Best wishes

Dr. Kalpana Bhakuni

Principal

MATHEMATICS, THE ROOT OF ALL HUMAN ENDEAVOUR

Last week as I was browsing through the Mumbai edition of The TOI, a very interesting caption caught my eye. It said “Get your math right for the perfect roast potato” Imagine the connection! The connect however is not mind-boggling for, as we all know, Math impacts, embodies and influences almost every known discipline. Coming back to the newspaper clip, it reported a collaborative project by students of two schools at The University of Essex and at Bedfordshire respectively that aims to maximize the surface area of the potatoes by cutting them at a 30- degree angle. Increasing the surface area l makes the potatoes more crispy and delicious. How empowered the students must have felt when professional chefs who tried the roasted potatoes gave a very positive feedback about their taste.

There really is no doubt that Mathematics empowers. So it is important that students be equipped with mathematical thinking and through their broadened spectrum, appreciate the role of mathematics in various disciplines including history, culture, social systems, commercial systems and political systems. Even in a domain like Fashion, it is rightly said that the key lies not in art and creativity, but in Mathematics, which is of immense use when designs are created digitally. We often input sketches or designs digitally to make apparels. Accurate measurements are necessary to get the visualized end output. Computer programs are used to generate such designs in which measurements must be exact. Without a basic understanding of mathematics, the sizes of designs may end up being inaccurate and the end result would spell disaster.

In today’s age and time, the term Mathematical modeling is a very familiar one. Models could take the form of graphs, tables, charts, equations, programs, dynamical systems, statistical models and the like

Coming to one of the serious threats to international peace and security, namely terrorism, no nation is immune from the dangers it poses and no society can remain disengaged from the efforts to fight it. Even a country like Singapore, that has been fortunate up till now, to have been untouched by insurgents, is in a full preparation mode to resist and combat any future act of terrorism, however remote that may be. Here comes in Mathematics again with its enormous potential in combating terrorism. The Mathematical model of terrorist cells is based on the idea that they are best modeled as partially ordered sets. We know that the number of terrorists in any network, is in any case finite and its diagrammatic representation would show a greatest element and a least element. The model captures the connections between the people within the terrorist cells as well as the intrinsic hierarchical structure that is likely to be present in terrorist networks. The people within the cell are represented as nodes on a graph and lines connecting nodes represent the fact that two people are connected in real life. Individuals of a higher status are depicted closer to the top of the diagram, with the foot soldiers of the cell represented by nodes at the bottom levels of the diagram.

Another interesting mathematical model is that of the cardiovascular system that describes and simulates the anatomic structure and the physiological response of the human system in healthy or diseased states. Since blood flow interacts both mechanically and chemically with vessel walls and tissue, this results in complex fluid structure interaction problems posing a challenge to the researcher who has to encompass aspects of metabolic regulation, micro-circulation, electrical and mechanical activity of the heart and their interactions. The problem of simulating the behavior of the new generation of biodegradable stents also requires special modeling of the degradation process which in fact is effectively described by a strong non-linear system of parabolic / hyperbolic differential equations.

Almost all financial models involve some form of mathematics or quantitative analysis and several methodologies have evolved over a period of time. Quantitative models are the need of the day and are designed to produce accurate predictions without detailing the underlying dynamics.

A major part of economic theory is presented in terms of mathematical- economic models which are a set of stylized mathematical relationships that clarify assumptions and implications e.g. Opitmization problems. Formal economic modeling began in the 19^{th} century with the use of differential calculus and game theory for utility maximization.

However just as the linguist Hayaka said that the symbol is not the thing symbolized, the map is not the territory it stands for, so the model is not the real world. In fact models may not always fit the data well but by integrating data analysis and mathematical modeling techniques, a deeper of such problems and their impact on society would come to the fore. Also the modeling process helps make thoughts more precise and go beyond the surface of a phenomenon to understand mechanisms and relationships. It provides students with realistic opportunities to connect Mathematics to significant environmental, social and other problems while incorporating recent advances in technology.

At this juncture, I would like to bring in the nexus between mathematics and poetry, both of which are my passions in that order. I do not deny that Mathematics is the science of reason and perhaps logic does not always work in poetry. But my love for Abstract Mathematics provides so much space for creativity that it helps expand the reflective domain of the mind, which is the source of poetry. Moreover, the latter combines a sense of discipline with a sense of freedom. I would attribute the attempt at precision in poetry and the ability to grasp the intangible to a sound grounding in Abstract Mathematics. The caesurae or the speaking pause in poetry could be compared with the zero in Mathematics, an absence treated like a computable presence. Beats and Meter in poetry have a lot of underlying mathematics. Mathematics, without the concept of variables and symbols representing them does not remain math and abstract mathematics often works on symbolic language. In poetry too metaphors and abstract expressions are analogous to symbols to depict what the poet actually wishes to convey. Thus the nexus between the two disciplines comes to the fore.

Coming to advanced Mathematics, I would conclude with the following words of Plato who said that advanced mathematics is for those who would serve as philosopher guardians of the city and that “Mathematics has become a critical filter for employment and full participation in our society. We can’t afford to have the majority of our population mathematically illiterate”.

Dr. Rita Malhotra

Former Principal and Math Faculty, KNC

Post-Doc Fellow, University of Paris

Visiting Faculty, University of Delhi

LIMIT OF WOMEN TENDING TO ∞

Shakuntla Devi -Reputed to make complicated mathematical calculations in her head. This made her bag the title of "The Human Computer" You might find it surprising that she did not receive any formal education. Her extraordinary abilities earned her a place in "The Guinness Book of world records.

Maria Gaetana Agnesi-An Italian mathematician, first woman to write a mathematics handbook and first woman appointed as a mathematics professor at a university.

Alexandra Bellow-A Romanian mathematician, made contributions to ergodic theory, probability and analysis. Her prominent work is on introduction of Lifting theory.

Ada Lovelace-An English Mathematician who is chiefly known for her work on the analytical engine. Went on to publish an algorithm intended to be carried out by such a machine .She is regarded as the first to recognize the full potential of a "Computing Machine"

Maryam Mirzakhani-Was an Iranian mathematician and a professor at Stanford University. First woman to be honored with the Fields Medal, the most prestigious award in Mathematics.

Kritika Narula
B.Sc. (H) Mathematics
3rd Year

A LATE BLOOMER IN THE MATH WORLD

As the name suggests, a late bloomer is a person whose talents or capabilities are not visible to others until later than usual. There had been mathematicians who discovered their talents later in life. Also, this article is about one of those late bloomers, **June Huh**.

Huh was born in California in 1983, where his parents were attending graduate school. When Huh was two years old, his parents came back to Seoul, South Korea. His father taught statistics and his mother taught Russian literature in South Korea.

In elementary school, Huh scored less in math test which convinced him that he was not very good at the subject. As a teenager he wanted to be a poet. Huh wrote many poems and a couple of novellas, mostly about his own experiences as a teenager. None were ever published. Huh didn't major in math, and when he finally applied to graduate school, he was rejected by every university but one. By the time he enrolled at Seoul National University in 2002, he had concluded that he couldn't make a living as a poet, so he decided to become a science journalist instead. He majored in astronomy and physics, in perhaps an unmindful nod to his hidden analytic abilities.

In his last year of college, when Huh was 24, the famed Japanese mathematician Heisuke Hironaka came to Seoul National as a guest professor. There he taught a yearlong lecture course in a broad area of mathematics called algebraic geometry. Huh thought that Hironaka might become his first subject as a journalist and so he attended the lectures.

Huh was among more than 100 students, including many math majors who enrolled for the lectures, but within a few weeks enrollment decreased to a handful. Huh imagines other students quit because they found Hironaka's lectures unintelligible. Huh continued because he had different expectations about what he might get out of the course.

After class, Huh started interacting to Hironaka, and the two soon began having lunch together. Huh, being a journalist, used to ask Hironaka questions about himself, but the conversation kept coming back to math. As the lunchtime conversations continued, their relationship grew. Huh graduated, and Hironaka stayed on at Seoul National for two more years. During that period, Huh began working on a master's degree in mathematics, mainly under Hironaka's guidance.

In 2009, Hironaka urges Huh to apply for master's degree in graduate schools in the U.S. His admission was largely depended on Hironaka's recommendation as he hadn't majored in math and on that his performance in the few graduate-level classes he took had been average. Most of the admissions committees were disinterested. Huh enrolled in the University of Illinois, Urbana-Champaign in the fall of 2009, after facing rejections from most of the schools.

Few years later, at the age of 34, Huh is at the peak of the math world. Huh along with the mathematicians Eric Katz and Karim Adiprasito, resolved the long-standing problem called the Rota conjecture.

Huh justifies that it's never too late to start. In-fact, ***"the last to bloom is the strongest".***

Aastha Chaudhary

B.Sc. (H) Mathematics

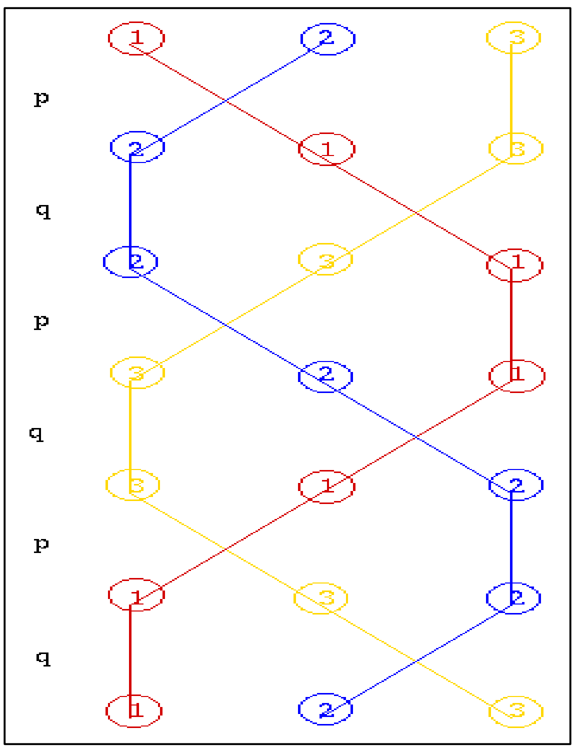
3rd Year

THE MATHEMATICS OF CHANGES: DING DONG BELL

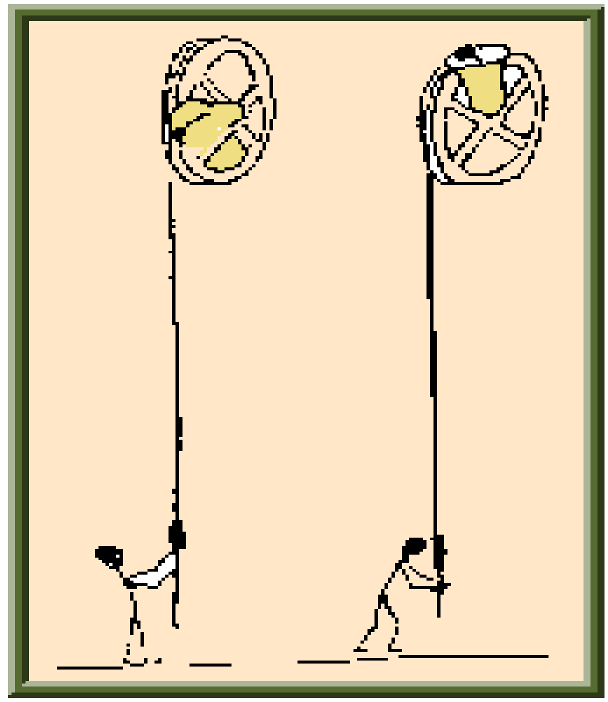
The permutations in the ringing of church bells are the different orders in which the bells can be rung on the ring of bells. The bell (each) is mounted on the wheel controlled by a bell ringer pulling on a rope. A bell rings once/revolution i.e. it rotates 360 degrees from top-dead-center back to top-dead-center and strikes (once) when it is about 70% of the way round. The bell rings alternately like clockwise and anti-clockwise and the two revolutions make a **whole pull**. A whole pull consists of two pulls on the rope.

The bell can be speed up or slow down by the bell ringer to alter its turn in the order by one place, but not by more than one. Every bell is rung just once in a sequence (a row), then all the bells are rung again, but in a different order (a permutation of the previous order), then all again in a different order and so on. Then we can say, the bells are rung in rounds and when the bells are rung in order with the notes descending in the pitch from the lightest bell i.e. the treble to the heaviest which is the tenor.

For Example, In case of three bells there are six possible orders in which they can ring, i.e. mathematically, there is a group of six bell ringing rows.



Let us start with the row 123, the next could be 213 (interchanging the order of the first two) or 132 (interchanging the order of the second two), but it could not be anything else other than these.



When we interchange the order in which the first two bells are rung, let that change be p, and when we interchange the order of the second pair, let that change be q.

The only way of ringing every possible row once beginning and ending with rounds is to ring the changes p then q then p then q then p and finally q again as demonstrated by this braid diagram. Every line shows the order in which the bells are rung and the bell ringers remember their 'parts' by remembering the shape and pattern of their strand in the braid.

By travelling across or through the circuit either clockwise or anticlockwise, we see two ways to ring a block and it is denoted by $(pq)^3$ and $(qp)^3$.

Sarvesh Kumari

B.Sc. (H) Mathematics

2nd Year

Stretch Your Mind

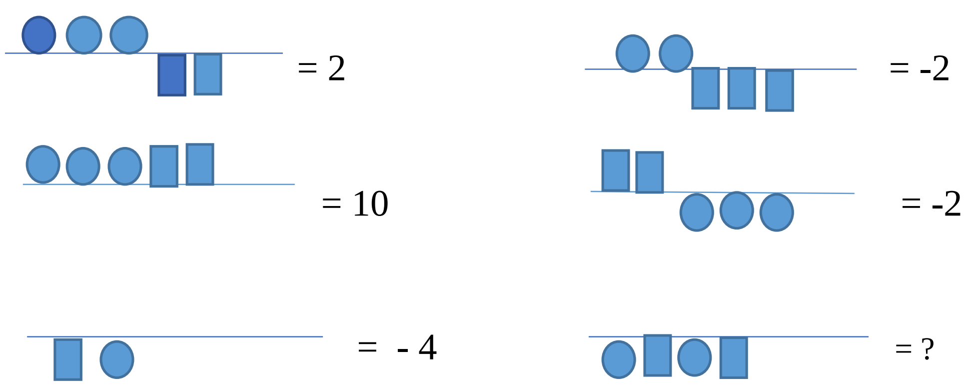
1. *Following is a word written code in which each set of two-digit numbers represents a letter. See if you decider the word.*

   41 51 55 55 32 15 44

   Hint1: Notice that 5 is the highest number used.

   Hint2: Think of rows and columns.

2. *Can you discover what is going on in the following figures? What is the relationship among the circles, squares, and dividing line that determines the respective numbers? What number goes with the sixth figure?*



The essence of mathematics is not to make simple things complicated but to make complicated things simple.

- Stan Gudder

APPLICATION OF GRAPH THEORY IN TRAFFIC MANAGEMENT

Mathematics is probably the only subject which has numerous applications in almost every field. In this article, we'll discuss the application of graph theory in traffic management.

There is so much congestion on roads with so many lanes, intersections and vehicles. Graph theory can play a key role in the phasing of traffic lights at an intersection by minimizing the total red light time during a traffic cycle keeping in mind that any two lanes that receive a green light are compatible with each other.

WHAT IS A GRAPH?

A graph is a pair of edges and vertices. It should be carefully noted that a graph does not have multiple edges or loops.

KEYTERMS

Let G be a graph then,

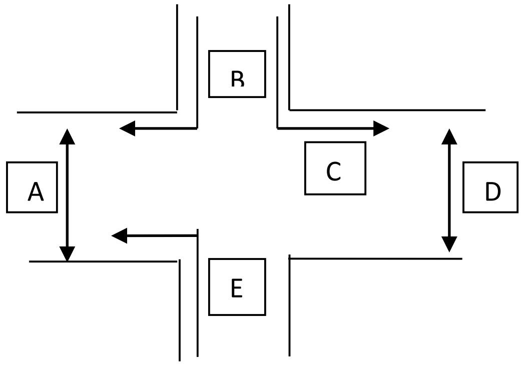
- Clique: It is a complete sub graph of G.
- Maximal clique: It is that clique which is not properly contained in any other clique of G.

ASSUMPTIONS

For the sake of simplicity, we assume the following:

- Total time for completion of all green and red lights during one cycle is 120 seconds.
- Initially, all the streams receive red light.
- Minimum green light time for any stream is 20 seconds.

Let us now consider one problem



The compatibility graph for a given problem will look like:

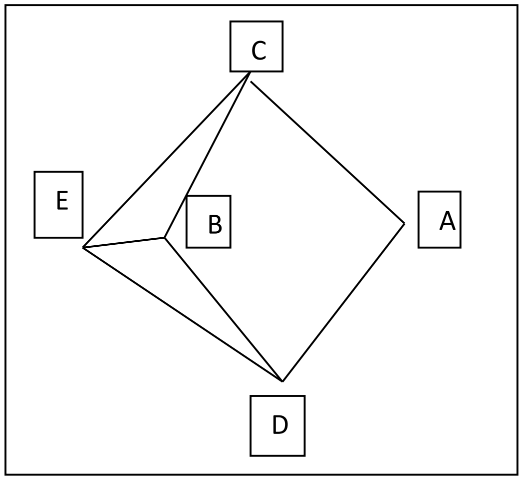


Figure 2

Maximal clique *are m [1] = {C, B, E}, m [2] = {B, D, E}, m [3] = {A, C} and m [4] = {A, D}.*

Here, each clique *m[i], 1≤ i ≤ 4*, corresponds to a phase during which all streams in that clique receive green light.

In phase 1, *(m [1]): C, B, E* receive green light at the same time.

In phase 1, *(m [2]): B, D, E* receive green light at the same time.

In phase 2, *(m [3]): A, C* receive green light at the same time.

In phase 1, *(m [4]): A, D* receive green light at the same time.

Suppose, we assign to each phase *m [i]*, a duration d *[i]*.

We have to determine *d [i]'s ≥0*, so that the total waiting time is minimum.

So, traffic stream A gets a red light when the phase m [1] and m [2] receive a green light. Hence, total red light time for *A is d [1] + d [2], B is d [3] + d[4], C is d [2] + d [4], D is d [1] + d [3] and E is d [3] + d [4].*

So, the total red light time for all the streams in one cycle is $S = 2\,d\,[1] + 2\,d\,[2] + 3\,d\,[3] + 3\,d\,[4]$.

We have to minimize S provided that

$d\,[i] \geq 0,\ d\,[1] + d\,[2] \geq 20,\ d\,[2] + d\,[4] \geq 20,\ d\,[3] + d\,[4] \geq 20,\ d\,[1] + d\,[3] \geq 20$ *and*

$d[1] + d\,[2] + d\,[3] + d\,[4] = 120.$

The solution to this LP problem will give us the least value of S.

Hence, the phasing corresponding to this least value would be the best phasing of the traffic lights.

Vishakha Goel

B.Sc. (H) Mathematics,

3rd Year

MATHEMATICAL MODEL IN 100 METER RACE

Lames (1990) pointed out that there are actually two approaches to modeling of the 100m. Both make use of the output of a performance namely-‘*the elapsed times at regular intervals of the race*’, normally every 10 meters.

- The first and the simpler of the two approaches is to find a function that very reasonably fits the output data.
- The second approach asks about the function that describes the functioning of the runner, and then fits this function to the output data.

Lames preferred the second approach to modelling of the 100m sprint. The 100m performance is characterized by two discrete parts- **acceleration** and **deceleration**.

What we are doing when we model a 100m performance of a particular runner?

We are obtaining functions s(t), v(t) and a(t) of distance, velocity and acceleration respectively in terms of time, which will enable us to calculate where he was, how fast he was going, and how much he was accelerating, at any point during the performance. In this model the independent variable is time (t), and the dependent variables are distance, velocity and acceleration.

There are **three** problems with this approach.

- Firstly the actual velocity-time or velocity-distance curve is a continuous curve of instantaneous velocity, and the speeds which are derived from the section times are average speeds for those sections. They do not lie on the real curve, so a model derived from them is misleading.
- Secondly these are based on differences between successive elapsed times, and any

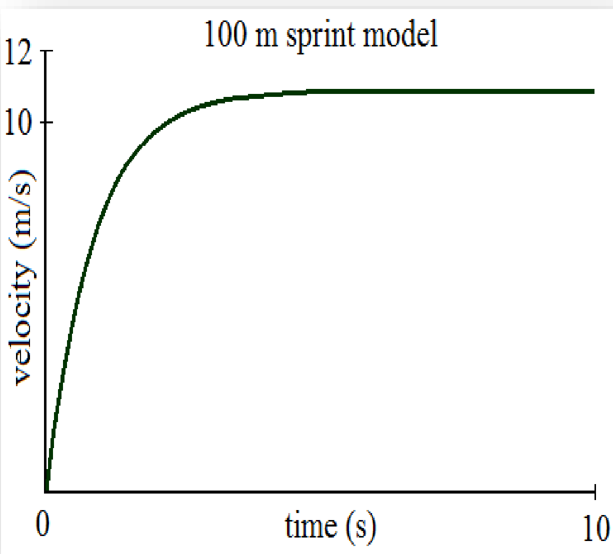
errors in the elapsed times are magnified in the differences. In short the section times and hence the calculated speeds are not decently precise.

- Thirdly, the maximum speed specified by the section times is not the real maximum velocity, but only the maximum average speed.

How to solve these problems?

The solution is **Calculus**. We can use calculus to derive from them a continuous distance-time function. The raw data then can be used to determine the constants of this function for a particular performance, and hence also the three functions of that performance. We can then have a proper description of the performance that enables us to analyze it in significant detail.

The Model



The sprinter applies maximum power to drive himself forward from a stationary position to maximum velocity as soon as possible. Maximum force is applied initially and the initial acceleration becomes maximum as F=ma. The early velocity is slow but builds up rapidly due to the large acceleration. However, in some time the acceleration diminishes and the velocity gains reduce. The acceleration drops to nothing, and the velocity becomes somewhat flat. The acceleration then becomes negative and the velocity falls for the last part of the performance.

The formula can be written as:

v(t) = A(1 - e -kt) + F(1 - e lt)

Applications

This mathematical model was applied to the men's 100m event at the 1999 World Championships, for which time was available at each 10m-point for all the finalists. From this set of data models were obtained the average performance of the first seven runners, representing archetypal elite sprinter, and also for the winner, Maurice Greene. The difference between Greene and the average finalist was identified. The really significant result to come out of the analysis was that Greene was able to accelerate for considerably longer than anyone else.

Devanshi Sinha

B.Sc. (H) Mathematics

1st Year

Puzzle pieces don't always connect, do they?

3. *If* $16_a = 20$ *and* $36_a = 32$, *what does* 26_a *equal?*

4. *Below is a list of numbers with accompanying codes. Can you decipher the code and determine the number on the last line?*

Number	*Code Number*
589	*521*
724	*386*
1346	*9764*
?	*485*

As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality.

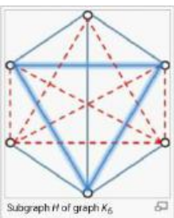
- Albert Einstein

HOW TO PLAN A PARTY?

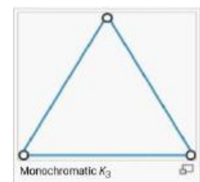
In mathematics, graph theory is the study of graphs, which are mathematical structures used to model pairwise relations between objects. Interestingly, Graph theory can be used to plan a party. For simplicity say, blue edge connects two vertices to represent that the people are mutual acquaintances and red dashed edge connects two vertices to represent that the people are mutual strangers.

In the simplistic terms of the party problem, a **Ramsey number** *R(m,n)* is the minimum number of people you must invite so that at least m people will be mutual friends or at least n people will be mutual strangers. The Ramsey number is the minimum number of vertices that that graph must have to ensure that there exists either a c1-colored monochromatic, complete sub-graph with at least m vertices or a c2-colored monochromatic, complete sub-graph with at least n vertices:

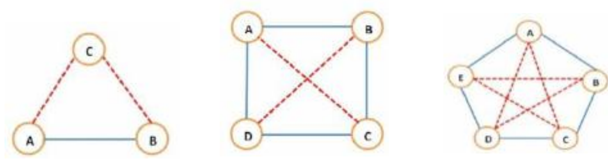
To put it in more formal terms, take a complete graph K with v vertices that has its edges painted in k colors. We call this a k-painting of Kv. A sub-graph H of K is monochromatic if all its edges are painted with the same color. Therefore, our previous results can be expanded as follows: A 2-painting of K6 must contain monochromatic K3 sub-graphs.



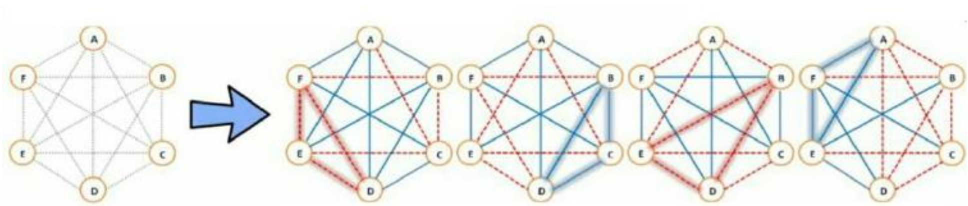
<u>Ramsey's Theorem</u> : G1, G2, …, Gk, are any k graphs, there exists an integer R(G1, G2, …, Gk) such that, when v ≥R(G1, G2, …, Gk), a k-painting of Kv must contain a sub-graph that is isomorphic to Gi and monochromatic in color i, for some i where 1 ≤ i ≤ k.



For example- You need to invite the least number of people (because you have limited food) to make sure that at least 3 people will be mutual acquaintances, or at least 3 people will be mutual strangers. It has been relatively easy to to prove that 3, 4, or 5 people are not enough to guarantee that at least 3 people will be mutual acquaintances or strangers. The counterexample in each case is given by the following images



When you invite a sixth person, it becomes a little more complicated. We can think of various cases in which 6 seems to be an answer. In the following cases, there is always a monochromatic triangle -



There are more configurations possible but there will always be a monochromatic triangle. So, the least required number is 6 (which is the Ramsey Number).

It is extremely difficult to compute Ramsey numbers for increasingly larger graphs. Many of the Ramsey numbers have been determined by using exhaustive computer algorithms that compute a range of numbers, given values for m and n.

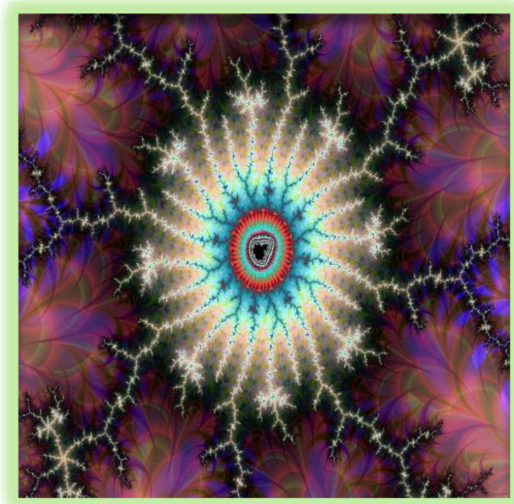
m	n	R(m, n)
3	3	6
3	4	9
3	5	14
3	6	18
3	7	23
3	8	28
3	9	36

Leena Batra

B.Sc. (H) Mathematics

3rd Year

A MATH EPIPHANY



What a world we have received
Its glorious nature do we perceive
Its hints of math seem divine
Embedded into earths design

Math puzzles can stimulate my mind
Math puzzles can cause my teeth to grind
But life so tenuous, so fragile,
It is gone, but math still stay awhile

Fractals are a wonder, seemingly endless
Snowflakes, seashells, lightning, portraying its finesse
Petals, fingers, trees altogether they've molten
A brilliant artistic number, a ratio that's golden

Math makes the world complete all the numbers we derive
Through its many sequences Fibonacci is alive
Up down left right it all can be seen
The world is full of math and anything in between
Math has been here since beginning of time
It has left its imprints even in this rhyme.

Yachna Hasija
B.Sc. (H) Mathematics
2nd Year

There is geometry in the humming of the strings; there is music in the spacing of the spheres.

- Pythagoras

Events' 17

The Department organized a talk on 11th October, 2017 by renowned Mathematician and Computer Scientist **Dr. Chandra Kant Raju** on the topic **The History of Indian Maths and its contemporary relevance**. He apprised the students about the fallible nature of Metaphysics formulated by the western world. The event culminated with a screening of an influential movie-Nil Battey Sannata.

A talk by eminent former professor **Prof. Bhu Dev Sharma** was organized on 11th September 2017, on the topic **Mathematical theory of Communication at the root of Information Age**. The event moved ahead with a presentation by the first year students on the topic- **History of Calculus**. Other highlight of the event was the showcase of a mathematical movie-The Cube.

OMICRON'17

The Annual Mathematics Day (Omicron) was held on 3rd March 2017. It started with an inaugural lecture by **Prof. Shobha Bagai**. Many events were organized by the students which include Quiz, Pictionary, Cryptography and Mathematical Relay. Everyone participated in the events with great zeal and enthusiasm.

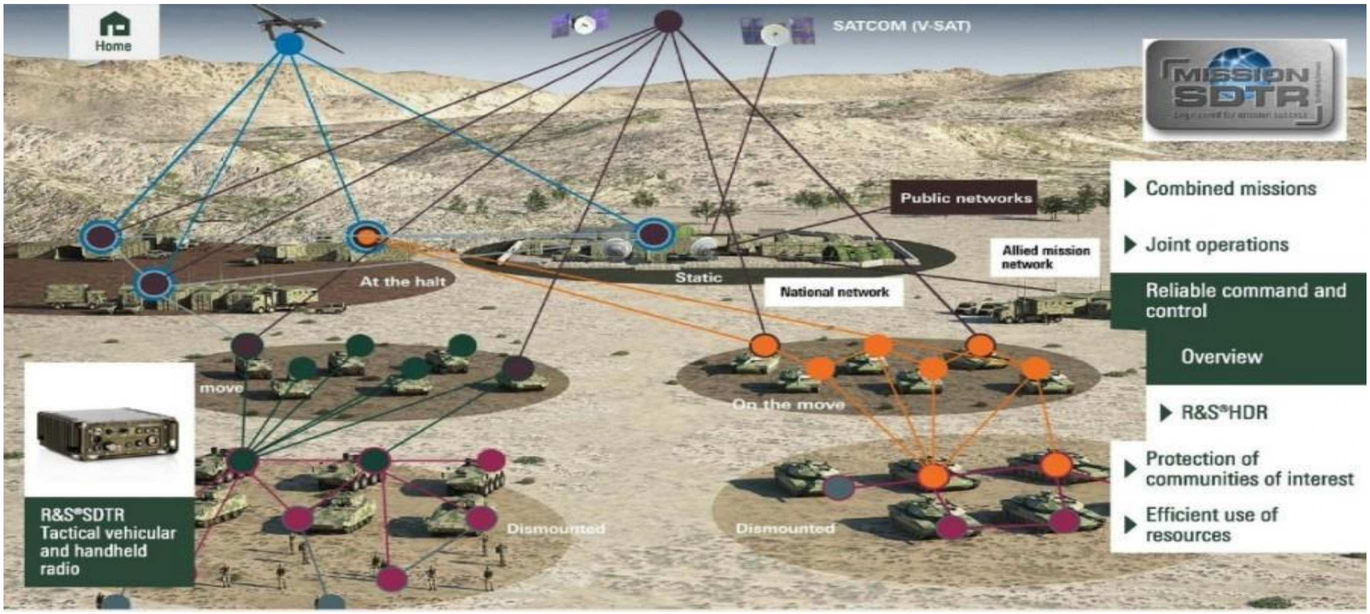
FAREWELL' 17

Our seniors have always been our source of inspiration and people to whom we juniors always look up to. It is emotional that you have finished college and going away. We bid you farewell and wish you all the best for the future.

APPLICATION OF MATHEMATICS IN DEFENCE

Mathematical sciences fulfill a lot of needs of our INDIAN ARMY as it helps in modeling systems, in analyzing and controlling complex phenomena, and in designing and improving systems of critical interest to the Army.

Development of intelligent information processing makes possible the digitized battlefield. The major objectives of the Army's mathematical research programs are to develop methods for modeling, analysis, algorithms, design, and control of physical, biological, and cognitive processes. It also aims to make possible future intelligent systems through progress in information processing.



The six components of Army mathematical research are:

1. Applied Analysis: Physics based mathematical models of humans are created to study the soldier as a system in a variety of environments. Current interest in applied analysis is in mathematical modeling of difference equations, differential equations, and integral equations for advanced materials, fluid flow, and nonlinear dynamics.

2. **Computational Mathematics**: The evolution of the Army into a modern, technology-based force is placing an increased demand on numerical methods and optimization for faster, more stable and accurate solutions to problems in the physical sciences.

3. Probability and Statistics: Critical Army needs for decision making under uncertainty is supported by research in probability and statistics. It includes probabilistic and statistical analysis of models of physical and operational phenomena.

4 .Systems and Control: The systems and control is doing effort in modeling, analysis, and designing of real-time systems, which are related to Army problems of distributed command, control, and communications and in guidance and control of automated systems.

5. Discrete Mathematics: Research in discrete mathematics in the Army involves developing and analyzing mathematical models of discrete phenomena and enhancing the applicability of these models by developing usable algorithms.

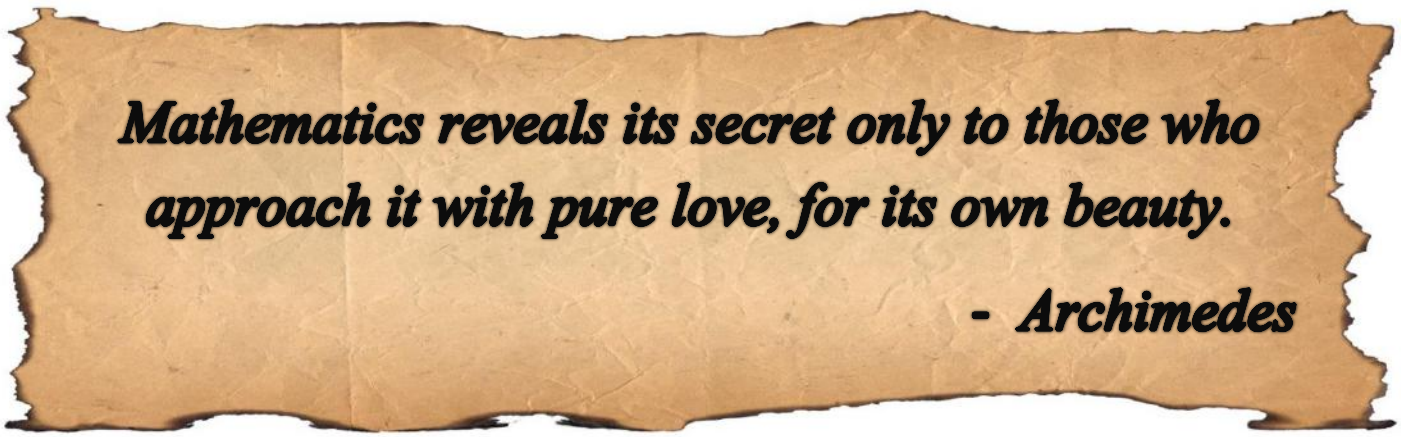
6. Intelligent Systems: Intelligent systems are defined as systems that can perform satisfactorily in the presence of uncertainties arising from changes in the environment in which they are situated. They exhibit emergent behavior.

Mathematical research is extremely important to the Army. Increasing reliability of simulations based on mathematical, statistical, and information-theoretic models and the increasing cost of carrying out physical experiments; increases the need for contributions from the mathematical sciences. The research in mathematical sciences is needed to achieve Army goals and support the Army in the field. In these ways, mathematics is a valuable and effective force multiplier for the army.

Kajal Chauhan & Divya Babbar

B.Sc. (H) Mathematics

3rd Year



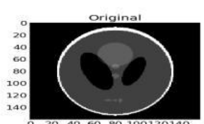
MATHEMATICS AND MEDICINE RELATION, MODELS AND APPLICATION

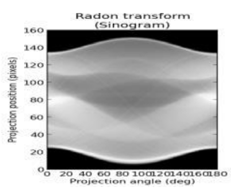
Introduction: The role of mathematics in the medical sciences is ever increasing. This is reflected in the growing number of journals and articles devoted to the subject. Today there are a number of research institutions devoted exclusively to the interface between mathematics and medicine. The common understanding that mathematics can only be used as service tool in biology or biology is too trivial for mathematical investigators is not correct. Advanced mathematics is vital for developing quantitative and theoretical approaches in biology and medicine. Similarly, advances in biological and medical sciences inspire development of new mathematical techniques.

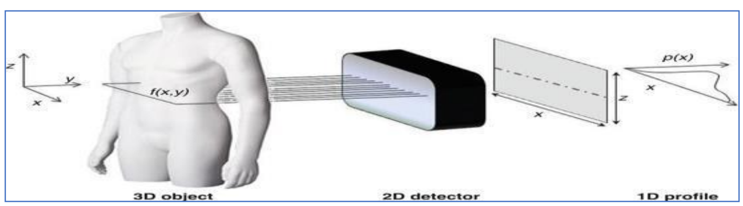
Models and Applications:

- Basic mathematical knowledge is used to calculate drug doses, concentrations, etc. An understanding of the core statistical concepts most commonly represented in the medical literature. Knowledge of algebra is used to understand calculations of acid–base status, etc. Math also provides ability to appreciate whether or not results are mathematically plausible. Problem like rate of change of drug density, growth rate of certain bacteria and number of bacteria after some time t, highest pressure exerted on the wall of arteries can be solved using differential equations.

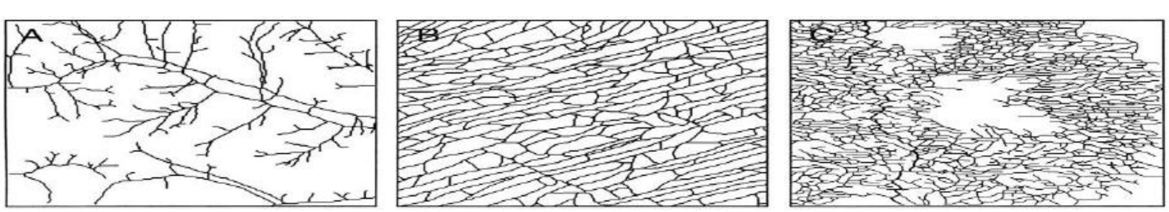
- Protein modelling constitute a lot of mathematics. Much of the function of protein is determined by its shape and movement of its pieces. For example mad cow disease is caused by the introduction of a shape carried by protein. Drugs were designed to change the shape which involve lot of mathematics specifically geometry, combinatorics and topology.
- The earliest and most familiar example of the application of mathematics to the management of an individual patient is furnished by ophthalmology, which depends essentially on geometrical optics for the correction of errors of refraction. The origin of spectacles, perhaps as early as the 14th century, is obscure and was certainly empirical. It seems that Kepler, of Kepler's Laws, at the beginning of the 17th century was the first to have a clear understanding of the eye as an optical instrument and to recognize that the image on the retina is inverted. A brief but clear account, probably the first in English, was given in Newton's Optics published in 1704, and a very detailed account, including rules for prescription of glasses, will be found in Robert Smith's Complete System of optics, published in 1738.
- Tomography, which is now used heavily nowadays as a diagnostic tool, relies on rather deep mathematics to work properly. There is in particular the Radon transform and its inverse, which are useful for reconstructing a three-dimensional visualization of body parts from "slices" taken by a CAT scanner.







- Fractal theory is a branch of mathematics that is very helpful in cancers detection. It is possible that, we model the cancer growth by some fractal structure. Recent studies have shown that fractal geometry, a vocabulary of irregular shapes, can be used to describe the pathological architecture of tumors and, perhaps more surprisingly, for yielding insights into the mechanisms of tumor growth and angiogenesis that complement those obtained by modern molecular methods. A. normal arteries and veins. B. normal subcutaneous capillaries. C. tumor vasculature. The path of minimum length is highlighted on the tumor vasculature to illustrate the tortuosity of these vessels.



- The Genetic Code is an interesting piece of Combinatorics in itself, and I can’t help but mention Genetic Algorithms which are a beautiful example of biology inspiring mathematics, rather than the converse.
- Other potential topics are the application of mathematics to Genomics, Phylogenetic and the Topology/Geometry of proteins and macromolecules.

- The Logistic Equation is a simple model of population growth, and the Lotka- Volterra Equation describes population growth in a predator-prey situation.

$$\frac{dx}{dt} = \alpha x - \beta x y$$

$$\frac{dy}{dt} = \delta x y - \gamma y$$

Where x is the number of prey (for example, rabbits); y is the number of some predator (eg. foxes);

$\frac{dy}{dt}$ and $\frac{dx}{dt}$ represent the growth rates of the two populations over time; *t* represents time; and

$\alpha, \beta, \gamma, \delta$ are positive real parameters for interaction of the two species .

- David M. Eddy's, statistical work in public health prompted the American Cancer Society to change its recommendation for the frequency of Pap smears from one year to three years.

Pooja Kumari

B.Sc. (H) Mathematics

3rd Year

PAGERANK ALGORITHM

Google comes to the rescue when you have to submit assignments or you wish to search on any random topic on the planet! But have you ever wondered as to how does Google present the list of websites you have searched a topic for? Does that happen magically or is there a race amongst the websites to decide who comes first?

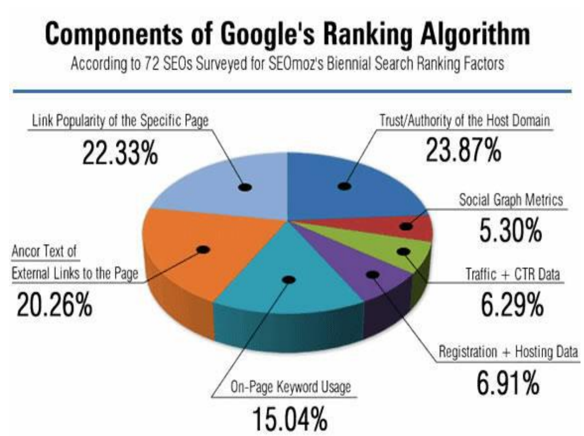
The answer is simple. The credit goes to the PageRank Algorithm which was developed by Larry Page, one of the founders of Google. The PR is nothing but simply an algorithm which was developed and used by Google to rank the order in which they display their websites whenever we search anything in their search box.

Let’s dig deeper into what it actually is.

PageRank is a link analysis algorithm that assigns a numerical weighting to each element of a hyperlinked set of documents, such as the World Wide Web, with the purpose of "measuring" its relative importance within the set. The algorithm may be applied to any collection of entities with reciprocal quotations and references. The numerical weight that it assigns to any given element E is referred to as the PageRank of E and denoted by **PR(E).** Author Rank comes among the other factors that can contribute to the importance of an entity as well.

A PageRank results from a mathematical algorithm based on the web-graph, created by all

World Wide Web pages as nodes and hyperlinks as edges, taking into consideration



authority hubs such as cnn.com or usa.gov.

The PageRank algorithm outputs a probability distribution used to represent the likelihood that a person randomly clicking on links will arrive at any particular page. The calculation of PR can be done for a collection of documents of various sizes. It has been assumed under many research papers that at the beginning of the computational process, the distribution of all the documents contained in a collection, is divided evenly among them. The computations of PageRank also require several passes, called "iterations", through the collection, to adjust approximate PageRank values so that it reflects the true theoretical value more closely.

Thus, with a perfect blend of probability, eigenvectors, and other mathematical concepts, PageRank algorithm is an important factor for responding to a user's search.

The mechanism of PR works includes counting a page's number of quality links and then roughly determining the importance of a particular website. The prescribed assumption made is that the more important websites are likely to receive more links from other websites. PageRank may not be the only algorithm that Google uses, but it is one of the first algorithms created by Google and is widely known.

The mathematics of PageRank is entirely general and can be applied to any graph or network in any domain. Thus, PageRank is now regularly used in bibliometrics, social and information network analysis, for link prediction and recommendation and in many other fields. It is even used for system analysis of road networks, as well as biology, chemistry, neuroscience, and physics.

Jaishree Garg

B.Sc. (H) Mathematics

1st Year

Answers to the puzzles

1. The word is puzzles. The two-digit numbers are decoded by making the row number the tens digit and the column number the units digit of the letter being sought. For example, the code 41 represents row 4, column 1, which is letter P

	1	2	3	4	5
1	A	B	C	D	E
2	F	G	H	I	J
3	K	L	M	N	O
4	P	Q	R	S	T
5	U	V	W	X	Y/Z

Note: It was the ancient Greek historian Polybius who first proposed a similar method of substituting numbers for letters.

2. -8. Above the line, either figure, circle or square, is worth +2 points apiece. Below the line, either figure is worth -2 points apiece. It makes no difference whether it is the circle or the square that comes first.

3. It equals 26. The midpoint between 20 and 32 is 26, and the midpoint between 16_a and 36_a is 26

4. The last number is 625. Subtract each individual digit in the numbers from 10 to crack the code.

BATCH OF 2015-18

First Row(L-R): **Shelly Sharma, Bhavika Atri, Nikita Kaushik, Riya Jain, Shivangi Sharma, Parul Gandass, Nandini Aggarwal**

Second Row(L-R): **Aastha Chaudhary, Simran Kaur Bindra, Parthvi Bhutani, Aakriti Hans, Priyanka, Kritika Narula, Vishakha Goel, Shikha Yadav, Sanskriti Gupta, Arundhuti Sen, Meenal Pant**

Third Row(L-R): **Divya Babbar, Komal Kundu, Kishori Patel, Varsha Khatana, Kajal Chouhan, Ankita Gautam, S.Deepti Nair, Pallavi Thakur, Vijaya Pathak, Sakshi Meena, Harshita , Sweta Saini**

Fourth Row(L-R): **Natasha Bidhuri, Pooja Kumari, Shivani, Sujata Singh, Jahnavi Sharma, Shailza Mishra, Prashansa Kumari, Meghna Shrivastava, Leena Batra, Kajal**

Fifth Row(L-R): **Ms. Swapnil Verma, Dr. Pooja, Dr. Pragati Gautam, Ms. Saroj Gupta, Dr. Mohammad Mueenul Hasnain, Mr. Pushpendra Kumar Vashishtha**

It takes a big heart to help shape little minds.

One book, one pen, one child & one teacher can change the world.

We experience utmost gratification contemplating the day we stepped foot into this esteemed institution. We express our heartfelt gratitude to Principal *Dr.Kalpana Bhakuni*. Our love and respect goes out to you for being of vital importance in our success.

Special thanks to H.O.D. *Dr. Pragati Gautam* and all the faculty members. The making of this newsletter wouldn't have been a smooth process without you. We are grateful to you for dedicating your valuable time in the making of this newsletter.

We would like to thank our coordinators and everyone who has contributed in the making of this newsletter directly or indirectly.

We have tried our best to be creative and industrious. The jigsaw of memories have been put together beautifully sealing the journey in a cherishable way.