Mathologic

2019

From the Principal's desk...

It's my proud privilege to write preamble for Mathema, the annual magazine of the Department of Mathematics.

To discover the innate capabilities of these budding mathematicians it's desirable to carefully craft interactions and activities within and outside the classroom. This helps to impart formal education, but with a difference.

We also want to inculcate noble values of discipline and unity in these young ladies. The vision is to produce conscientious, smart and confident citizens of India who will go out into the world and make us proud! As educators, we aim to provide a platform which explores and strengthens the potential which is innate in every individual but awaiting expression. Publishing these periodicals is a tiny step towards our goal.

I congratulate the entire editorial team and contributors for the upcoming issue of 'Mathologic' 2019 and enthusiastically look forward to reading our students' perspective on various issues undertaken.

- Dr Promila Kumar


From the Faculty advisors

Welcome to the 2nd issue of our magazine. We hope it brings something for every reader interested in mathematics.This year also the magazine has been designed and conceptualised by the students. Our is aim to encourage creativity of thought among students so that they learn and grow in every aspect.

Published annually ,Mathematics Magazine “Mathalogic” offers a lively exposition on a wide range of mathematical topics, presented in an appealing expository style accessible to both teachers and students of collegiate mathematics. This magazine publishes arcticles revealing deep and fundamental connections between several branches of mathematics.

Our special thanks to Principal Dr. Promila Kumar for her continuous support and guidance. We convey a word of thanks to Ms. Arnima Chauhan with her entire editorial team for their efforts with special mention to Ms.Tanisha Negi for the very philosophical cover design. We extend our sincere thanks to Ms.Tanya Kalra our student president and her team for their strentous effort.

Continued progress must remain our mission. We must keep enhancing our capabilities and must expand our footprint, in terms of quality and quantity.This magazine is a perfect example of vision of scale, speed and skill. This shows that we can be the best.

We wish us every success, as we strive to master the contents of this magazine and conquer new frontiers. Let us take inspiration from today’s success ,dedicate ourselves to accelerate our progress and we are confident we can!
Thank You and Best Wishes!

-Ms.Pooja Gupta (Convenor)
-Mr. Narender Kumar (Co-Convenor)

Editor's Angle

It gives me immense joy to introduce to our fellow readers, the second edition of Mathologic-The annual magazine of the Department of Mathematics,Gargi College.

This magazine was only initiated last year in the form of a newsletter and stands tall as proof to how far we have come in just 365 days.
The magazine would provide a glimpse of the various events conducted in the past year, ranging from Career counseling session to various activities held during Anant and Scintillations. The counseling program that we conducted gave students insights into different fields they can pursue, including the recent domain of Actuarial sciences. This year, we saw huge footfall in Pictionary and Quiz Up- both of which challenged the inner mathematician in every individual.

This was the first time after several years that the mathematics department had a full house, hence making the moments of organising the various events and promoting our department that much more memorable and cherishable.

We hope this magazine brings something new for every reader,as it has for every one of us involved in its making.
All the best!

- Arnima Chauhan
Editor of Mathologic (2019) and General secretoty of Mathema (2018-19)

MATHEMA - The Mathematics Association
(2018-2019)

Faculty Advisors
Ms. Pooja Gupta
Mr. Narender Kumar

President :	***Tanya kalra***
Vice President :	***Madhurika Ahuja***
General Sec :	***Arnima Chauhan , Nikita Hans***
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Proctor :	***Priti Sangwan, Nandini Dwivedi***
Coordinator for co- curricular activity :	***Diksha***
Co- coordinator :	***Shalini Toppo***
IT Coordinator :	***Rabina Divya , Mohini S. Jena***

Words of Wisdom from the Principal

Dr. Promila Kumar

Being the principle of a reputed college must be challenging, what is your key to tackle such challenges?
Tackle the things by listening to a person with patience and calm and the things can be sorted. Also however big the problem is, if you are centered, calm and patient you get a result and that could be a good result.

How has your experience as a principle been so far?
It's wonderful! Students, staff they have been very very cooperative. I'm blessed that I belong to this college where I am getting so much of support and love .

If you were to write a mission statement for your department, that is mathematics, what might it be?
I want the girls to be equipped with academics. Along with academics, they should be honest and they should apply wisdom. Since they are the students of mathematics, throughout their life they should remember that every problem has a solution.

What are your expectations from the students of Mathematics department? And are your expectations being met?
The expectations are that they should do well in their life, in academics as well as in their personal life. And when they grow old in their domestic life wherever they go, they should do well. And how far they have met the expectations, I can't comment on this because it's too early to comment as there are only a few batches but I am 100% sure everyone is doing their best .

Most of the students hesitate to participate in the extra curricular activities being from the science stream. How would you encourage them for active participation?
Look,coming from science stream they think they have no time. It's not the question of having the time or not, it is about time management. You spend so much time on social media these days that you have no time for extracurricular activities. You should know how to distribute your time. And the thing that they have to work very hard, every student, every subject needs hard work. So, it can be managed. It is only about the balance.
them

With the emergence of numerous diverse career opportunities in Mathematics, what steps would you like to take to educate the students about the same?

We already have placement cell here and we have counselling sessions. So if the students and especially mathematics students, if they want such type of guidance we can organise a counselling session. If they want us to educate i.e. department can educate them then department can equip themselves first and then tell the students. That can be arranged,you just need to show your interests.

With the advent of computerisation and improving technologies, what developments can be made in the curriculum to make the students aware of the same?

Earlier we used to have Vedic Mathematics as an add-on course in the college. If you want you can do it again. You can have a latest workshop which helps you in Mathematica typing.

You do a lot of work on it. But then there's also Matlab available. It only depends on what the students want. Are they truly enthusiastic to do something. If they show their enthusiasm we are there to help at the level of our department as well as at the level of college. When we did Vedic Mathematics it was for the whole college. And many science as well as commerce students also joined. Even now the science department has introduced a course on Ayurveda, Vedic Mathematics was a part of it. So such initiatives are already happening in the college but if the students are keen for non-particular kind of things or they shortlist certain things that they want this, we can make a module and do it for them.

Finally, what words of wisdom would you like to share with students and teachers?

Ans. That you've to be equipped with knowledge, and then you have to learn to be patient. Do time management. Use your knowledge with wisdom. That is very important.

Interviewed by:
Arnima Chauhan
Rabina Divya
Mohini S Jena

A word with the Union President

Ms. Tanya Kalra

What have been the goals/ key areas on which Mathema has worked this year?

The major key areas on which Mathema has worked this year was to encourage students to participate and contribute to the development of our Department. Then was to create more awareness among the students about the various fields in maths.

When you'd contested the elections for the post of department president, what were your expectations from this position of responsibility?

My expectation based on the description and interview was that my post would involve duties usually including working with students to resolve problems and fill the loopholes in the maths department of our college and most importantly to encourage more and more practical/research based maths workshops in order to help them grow in this subject.

We know that you've been a part of the association for 3 years now. So, how have you seen the objectives of Mathema change over the years?

Since it was the first year of our department when I became the part of Mathema, our main objective was to atleast create more awareness about our department on different platforms and then in the following years our objective was to focus on holding more and more competitions/seminars in order to help the students to grow and make them aware of the various aspects of Mathematics in real world.

What tips would you give them to manage both academics and co-curricular activities simultaneously?

First and foremost one has to find a Balance as It is never a good idea to only focus on one particular area. Then one needs to develop a schedule and needs to prioritize the tasks. And finally one should have a right attitude Most importantly and it is essential to believe that you can manage your time and be optimistic.

With the emergence of numerous, diverse career opportunities in mathematics, what steps has Mathema taken to educate the students about the same?

This year Mathema conducted a career counselling session by Mr. Manish Malik ,who is a prominent figure in the fast growing domain of actuarial sciences. He covered various career options available for the mathematics students and opened up new avenues for them.

With the advent of computerisation and the growing need of IT- trained mathematicians, what developments can be made in the college curriculum to prepare the students for the same?

The main development should be to encourage more and more of practical research work in mathematics because incredibly useful concepts like cryptography,calculus and image and signal processing have and continue to come from mathematics and are helping people solve real-world problems and hence it would help students grow and make them fit for the IT industry.

Q7. As its almost time to pass the beacon to your successors, what would be your words of wisdom for them?

"The voice that tells you 'you can't' is usually lying. The one that says you can't do it all at once usually isn't." – Marsha Wright. So, you just need to be calm and have faith in yourself in order to make a change and help Mathematics department to grow and remember 'balance' is the most important factor.

Interviewed by:
Mohini S Jena
Diksha

THE HISTORY OF BANNED NUMBERS

- Mohini S Jena, 2nd Year

They say the pen is mightier than the sword, and authorities have often agreed. From outlawed religious tracts and revolutionary manifestos to censored and burned books, we know the potential power of words to overturn the social order. But as strange as it may seem, some numbers have also been considered dangerous enough to ban. The mathematician Pythagoras and his school of followers found numerical patterns in shapes, music and stars for them, mathematics held the deepest secrets of the universe. But an Pythagorean named Hippasus discovered something disturbing.

Some quantities like the diagonal of a square with sides of length 1 couldn't be expressed by any combination of whole numbers or fractions. These numbers which we call irrational numbers, were perceived as threat to the Pythagorean notion of a perfect universe. They imagined a reality that could be described with rational numerical .Historians write that Hippasus was exiled for publicizing his findings, while legends claimed he was drowned as punishment from the gods.

In the middle ages while Europe was still using Roman numerals ,other cultures had developed positional systems that included a symbol for 0.When Arab travelers brought this system to the bustling Manheim city of Italy. Its advantages for merchants and bankers was clear. But the authorities were more worried.

Hindu Arabic numeral were considered easier to forge or alter, especially since they were less familiar to consumers than to merchants .At a time when money lending was regarded with suspicion. In the 13th century, Florence banned the use of Hindu-Arabic numerical for record keeping .negative numbers were dismissed as absurd for a long time, and prominent mathematicians like Gerolami Cardano avoided using 0 even though it would have made it much easier to find solutions to cubic and quadratic equations.

Protected information whether copyrights, proprietary materials or state secrets can be represented as numbers This idea gathered attention in 2001 when code that could be used to decrypt DVDs was widely used in the form of large prime numbers.

FLOURISHING NUMERICAL ANALYSIS

- Aastha and Palak, 3rd Year

Prehistory of Numerical Analysis :

Numerical methods deals with approximation i.e.,it gives the effective methods of computing approximate numerical solutions to mathematical solutions. With the help of numerical methods, we can solve complex problems with a great number but of very simple operations which is perfect for a computer to perform.

If we compare numerical methods analytical methods, we see that numerical methods are a better approach as compared to analytical methods. It is because in some cases analytical solutions of a mathematically defined problem is time consuming. If we consider the case of error approximation, numerical solution gave more acceptable response than analytical solution. In cases, when analytical solution is impossible, numerical methods is the best approach.

Many great mathematicians gave their contributions in numerical methods, including Newton, Euler, Lagrange, Gauss, Jacobi, Fourier, and many more.

Contributions by some mathematicians in the field of numerical methods are listed :

1. Contribution by Newton-

Newton proposed a method for finding better approximations to the roots of a real valued function, known as the Newton-Raphson method named after Isaac Newton and Joseph Raphson. Newton's method was first published in 1685
and finally in 1740, Thomas Simpson described Newton's method as an iterative method for solving general non-linear equations. He also proposed Newton Interpolation method, which is used to approximate a given function, whose values are given at tabular points, by a suitable polynomial.

2. Contribution by Joseph- Louis Lagrange-

Lagrange proposed an interpolating polynomial known as Lagrange Interpolating polynomial which is the polynomial of degree less than and equal to (n-1) that passes through 'n' points. The formula of the interpolating polynomial was first discovered by Waring in 1779 and published by Lagrange in 1795.

3. Contribution by Leonhard Euler-

Euler worked for improving numerical approximation of integrals known as Euler Approximations or Euler Method. This method is used for solving ordinary differential equations (ODEs) with a given initial value.

4. Contribution by Carl Gustav Jacob Jacobi-

He proposed Jacobi Iterative method used for determining the solutions of a diagonally dominant system of linear equations. In 2014, a refinement of this algorithm, called scheduled relaxation Jacobi method was published. This method provides improvement for solving elliptic equations on two and three dimensional cartesian grids.

Numerical methods is a vast topic which includes a lot more information other than those discussed above, like dividend differences, difference operators, LU decomposition which is a factor ization of a given square matrix into one upper triangular matrix and one lower triangular matrix such that the product of these two gives the original matrix.
Numerical methods are used to solve the problems which are impossible or extremely difficult to solve analytically.

Further numerical methods can be used for:

1. Finding roots of equations-

Bisection method, Newton-Raphson method, Fixed point iteration method, etc.

2. Solving ODEs-

Euler method, Mid-point method, etc.

3. Finding values of integrals-

Mid-point, Trapezoidal rule, Simpson's rule.

4. Interpolation-

Lagrange interpolation, Newton interpolation, etc.

Advances in numerical methods provides a balanced presentation of the latest concepts in the fields of applied mathematics, electrical and electronic engineering. It includes many new mathematical applications in modeling and simulation, systems theory, circuits, electronics, control and signal processing.

TAYLOR SERIES

- Km. Shweta Mathur and Pooja Meena, 3rd Year

Taylor's Series is the most important concept of mathematics. By this series we represent a function as an infinite sum of terms that are calculates from the values of the function's derivatives at a single point. The concept of this series which we use in mathematics calculations was given by the Scottland mathematician JAMES GREGORY and this series formally induced by the English mathematician BROOK TAYLOR in 1715.If this series is centered at zero , then that series is called also a Maclaurin Series . This series a special case of Taylor's series , named after him. This name was given by also Scottland mathematician COLIN MACLAURIN , who made extensive use of this special case of this series in 18 th century.

JAMES GREGORY was a Scottish mathematician and astronomer also. He worked an early practical design for the reflecting telescope , who is called the Gregorian telescope. He also made advanced in trigonometry and discovery infinite series representations for several trigonometric functions. He also published statement and proof of the fundamental theorem of calculus. His inventions and discovers are quadrature of the circle and hyperbola , by an infinite converging series, his method for the transformation of curves. He also invented a geometrical demonstration by the help of hyperbola, a very simple converging series for making the logarithms. That is he worked in mathematics field in his life and gave us lots of interesting concepts in mathematics.

BROOK TAYLOR was a Scottish English mathematician, who is the best known for Taylor's series and a Taylor's theorem. He studied mathematics in Cambridge under John Machin and John Keill. In 1708 he obtained a remarkable solution of the problem of the "centre of oscillation", which , however, remained unpublished until may 1714, when his claim to priority was disputed by Johann Bernoulli. Taylor's methodus Incementorum Directa at Inversa added a new branch to higher athematics, now called the "calculus of finite differences".

COLIN MACLAURIN was a Scottish mathematician who made important contributions to geometry and algebra. Maclaurin used Taylor's series to characterize maxima, minima , and points of inflection for infinitely differentiable functions in his Treatise of fluxions. He attributes the series to Taylor , though the series was known before to Newton and Gregory , and n special cases to Madhava of Sangamagrama in 14 th century India. Maclaurin received credit for his use of the series , and the Taylor series expanded around 0 is sometimes known by his name. He also made significant contributions to the gravitation attraction of ellipsoids. He also discovered Euler-Maclaurin formula in which he used it to sum powers of arithmetic progressions, derived Stirling's formula and derived the Newton-Cotes numerical integration formulas which includes Simpson's rule as a special case. He also contributed to the study of elliptic integrals, reducing many intractable integrals to problems of finding arcs for hyperbolas. His work was continued by d'Alembert and Euler, who gave a more concise approach.

PERFECT NUMBERS

- *Mohini and Ritu Yadav, 3rd Year*

A ***PERFECT NUMBER*** in number theory is that positive integer which is equal to sum of its proper positive divisors excluding the number itself. This sum is also known as aliquot sum. In ancient time Euler proved that q(q+1)/2 is a even perfect number if q is the prime of the form 2^p-1 where p is also a prime. But it is not known whether there are any odd perfect numbers, nor whether infinitely many perfect numbers exist.

EXAMPLE

6 is the first perfect number as its proper divisors are 1, 2 and 3, also 1+2+3=6.
We can also define perfect number as half the sum of all its positive divisors i.e, (1 + 2 + 3 + 6) \ 2 = 6
Next perfect number is 28.
Proper divisors of 28 are 1, 2, 4, 7, 14
1 + 2 + 4 + 7 + 14 = 28
Then the next perfect number following this is 496 and then 8128

ODD PERFECT NUMBERS

It is not known that whether there is any odd perfect number. As Euclid's rule gives all perfect even numbers this implies that no odd perfect number exists.

EVEN PERFECT NUMBERS

As mentioned above, Euclid proved that 2 p-1 (2 p -1) is an even perfect number whenever 2 p -1 is prime such that
For p = 2: 2 1 (2 2 − 1) = 6
For p = 3: 2 2 (2 3 − 1) = 28
For p = 5: 2 4 (2 5 − 1) = 496
For p = 7: 2 6 (2 7 − 1) = 8128.
This is Euclid – Euler theorem.
Prime number of 2 p -1 also known as Mersenne primes after a monk Marin Mersenne, who studied number theory and perfect numbers.
2 p -1 is prime if and only if p is prime. These types of primes are very rare.

As well as having the form 2 p-1 (2 p -1), each even number is the (2 p -1)th triangularnumber (number which counts objects arranged in equilateral triangle) and hence equal to the sum of the integers from 1 to 2 p -1 and the (2 p-1)th hexagonal number. (The nth hexagonal number h 0 is the number of distinct dots in a pattern of dots consisting of the outlines of regular hexagons with sides up to n dots, when the hexagons are overlaid so that they share one vertex.)

PAGERANK ALGORITHM

- Nidhi Singh and Nikita Kataria, 3rd Year

How Google answers our queries or how does it finds relevant page for our search ?

At the first glance, it seems like it keeps an idea of all WebPages and when a ser types a query, it counts occurrence of keyword in each web file and display results accordingly. But search engine that relies on page content to retrieve page relevance are easily spammed.
Google uses Page Rank Algorithm for ranking WebPages which saw a major improvement in quality of results.
The fundamental idea behind Page rank Algorithm is that each hyperlink is a recommendation of page for another i.e. the page which has greater number of in links to it is more important than other. So it is basically about the WebPages votes for other WebPages by linking to them and most importantly number of links for a particular page from a high ranked page.

RELATIONSHIP BETWEEN EIGEN VECTORS AND PAGERANK

Before proceeding to the relationship between Eigen vectors and PRA, it will be wise to define eigenvectors first.

Eigen Vectors : Eigen vectors are the vectors that remain unrotated by a transformation matrix and the eigenvalues are the amount by which the eigenvectors are stretched.

In pagerank, we form certain equations on the basis of certain criteria's. We then convert these equations to a matrix problem and we'll observe that the matrix problem formed is exactly an eigenvector problem.

Rank of any page (r) can be expressed as:
Q'r = r, where Q' is the stochastic matrix

This type of equation is the classic definition of eigenvector problem. And the goal is to find the Eigen value corresponding to the largest Eigen value 1. Therefore, a page rank eigenvector tells how many votes each webpage obtains from other WebPages considering their importances.

USES:

Atlast we'll like to put light on some uses of pagerank other than its social use. In neuroscience (page rank of neuron) , personalized Page rank is used by Twitter,etc.

What is Infinity

- Priya Tripathi and Vibha, 3rd Year

What infinity is, never ending of anything, like numbers, list act as infinity that is; if we can never reach at the end point that means how long we count that does not matter and we can't reach at our claim then it tends to infinity.

For Example:
If we take natural numbers which is not matter how long we count and we can not reach at the end numbers that mean list of the natural number is infinity which is uncountable.

We know that zero is the first number.

If we take 0.2 then 0.02 is smaller than 0.2. Therefore, 0.02 should come before 0.2 and so on, that is if we find a smaller number then we can insert at extra zero after the decimal point. That means listing of numbers by size is infinity.

So , mathematically , If a number greater than countable number then the number tends to infinity. The symbol of the infinity is . Infinity symbol () looks like sideways figure of eight. So, Clearly , Infinity means endless which is not a number but concept of an idea .

Infinity was invented by the English Mathematician, John Wallis in 1657.

In mathematics, infinity is treated as a number but it is not. Example of infinity is either a natural number or a real number which tends to infinity but never reach.

MATHEMATICS IN FORENSIC SCIENCE

-Rabina Divya, 3rd Year

Scientifically it is impossible to analyze forensic evidence without mathematics. From collecting evidence to its measurements and documentation, everywhere mathematics works as an important ingredient to the solution of any case by forensic scientists. There are several ways where mathematics works as a tool to solve the criminal cases, such as:-

DNA Analysis:
Probability is used to determine if there is enough of a DNA match collected from crime spot to convict of the crime .Comparison of fingerprint is done by measuring distances between grooves, and look for the pattern between the fingerprints.

Psycho – physical Detection:
Mathematically the investigators can tell that the suspect is telling truth or not, by measuring the suspect's body responds such as pulse rate, blood pressure and breathing patterns.

Measurement of death timing:
The time of the death of the victim can be known by the forensic scientists by measuring the temperature of the victim and the surrounding areas.

Height and Distance Measurements:
The weight and height of the suspect can be determined by examining the foot prints . Weight is known by comparing the depth of the foot print to the list of constants and height is known by measuring the length between the foot prints . Time and distance can be used to create a radius in which the suspects could have travelled to and from. The length of the human bones is used to estimate the height of the individual. The following formula is used to determine the person's height:
Man: $h=69.089+2.238f$ (in cm)
Woman: $h=61.412+2.317f$ (in cm) , where f is length of femur bone in cm .

Skid Marks Analysis:
Scientists can determine the speed of the car at the time of crime using the equation v=sqrt(d)/k where d= length of the skid marked, k= constant based on the car and the friction of the road and v= velocity in miles per hour .

Trajectories and Blood Splatter Analysis:
The trajectory of the falling object (bullet holes or blood splatter) can be known by using geometry. Eg: - the height of the suspect can be known by the angle of impact if the victim suffered a blow on his head. Trigonometry can be used to analyze the blood spatter, which can help in determining how hard the criminal hit the victim.

THE BLACK SCHOLES MERTON MODEL FOR OPTION PRICING

-Tanya Kalra, 3rd Year

Mathematical finance, also known as quantitative finance, is a field of applied mathematics, concerned with mathematical modelling of financial markets. Generally, mathematical finance will derive and extend the mathematical or numerical models without necessarily establishing a link to financial theory, taking observed market prices as input. Mathematical consistency is required, not compatibility with economic theory. Thus, for example, while a financial economist might study the structural reasons why a company may have a certain share price, a financial mathematician may take the share price as a given, and attempt to use calculus to obtain the corresponding value of derivatives of the stock.

French mathematician Louis Bachelier is considered the author of the first scholarly work on mathematical finance, published in 1900. But mathematical finance emerged as a discipline in the 1970s, following the work of Fischer Black, Myron Scholes and Robert Merton on option pricing theory.

The Black Scholes Merton Model For Option Pricing was first mentioned in articles “The pricing of options and Corporate Liabilities” by F.Black and M.Scholes published in the “Journal of Political Economy”.It was considered a major breakthrough the area of option pricing and had a tremendous influence on the way traders price and hedge the options.

According to the BSO model the option price and the stock price depend on the same underlying source of uncertainty and we can form a portfolio consisting of the stock and the option which eliminates this source of uncertainty. This pricing model is used to determine the fair price or theoretical value for a call or a put option based on six variables such as volatility, type of option, underlying stock price, time, strike price, and risk-free rate. The quantum of speculation is more in case of stock market derivatives, and hence proper pricing of options eliminates the opportunity for any arbitrage.

The Black Scholes formulas for the prices of European Calls and Puts with strike price X on a non dividend paying stock can be depicted as follows:

Value of a Call

$$C(S_t, t) = N(d_1)S_t - N(d_2)Ke^{-r(T-t)}$$
$$d_1 = \frac{1}{\sigma\sqrt{T-t}}\left[\ln\left(\frac{S_t}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)(T-t)\right]$$
$$d_2 = d_1 - \sigma\sqrt{T-t}$$

Value of a Put

$$P(S_t, t) = Ke^{-r(T-t)} - S_t + C(S_t, t)$$
$$= N(-d_2)Ke^{-r(T-t)} - N(-d_1)S_t$$

Where,
N(•) is the cumulative distribution function of the standard normal distribution.
T−t is the time to maturity (expressed in years)
St is the spot price of the underlying asset
K is the strike price
r is the risk free rate (annual rate, expressed in terms of continuous compounding)
σ is the volatility of returns of the underlying asset

This is largely used by option traders who buy options that are priced under the formula calculated value, and sell options that are priced higher than the Black-Scholes calculated value.

MATHEMATICS- BROADENING THE HORIZON

- Arnima Chauhan, 3rd Year

Over the past decade or more, there has been a rapid increase in the number of ways the mathematical sciences are used and the types of mathematical ideas being applied. Because many of these growth areas are fostered by the explosion in capabilities for simulation, computation, and data analysis (itself driven by orders-of-magnitude increases in data collection), the related research and its practitioners are often assumed to fall within the umbrella of computer science. But in fact people with varied backgrounds contribute to this work. The process of simulation-based science and engineering is inherently very mathematical, demanding advances in mathematical structures that enable modeling; in algorithm development; in fundamental questions of computing; and in model validation, uncertainty quantification, analysis, and optimization.

Advances in these areas are essential as computational scientists and engineers tackle greater complexity and exploit advanced computing.

These mathematical science aspects demand considerable intellectual depth and are inherently interesting for the mathematical sciences.

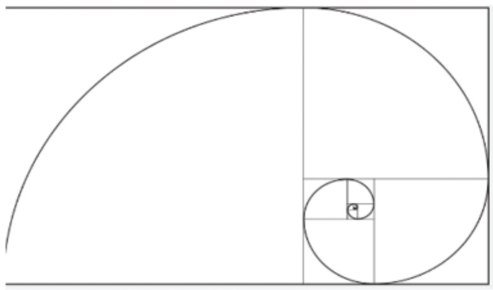
At present, much of the work in these growth areas—for example, bioinformatics, Web-based companies, financial engineering, data analytics, computational science, and engineering—is handled primarily by people who would not necessarily be labeled "mathematical scientists." But the mathematical science content of such work, even if it is not research, is considerable, and therefore it is critical for the mathematical sciences community to play a role, through education, research, and collaboration. People with mathematical science backgrounds per se can bring different perspectives that complement those of computer scientists and others, and the combination of talents can be very powerful.

MATHS IN ARTS

- Vaishali Negi and Ritu Parashar, 3rd Year

Have you ever wondered where artists find their inspiration ?
How are famous paintings such as The Mona Lisa painted to perfection ?

Well that happens because of mathematics or I'd rather say an important result of it that is The Fibonacci Sequence.



Fibonacci Sequence
An integer sequence whereby each number is the sum of the two preceding numbers 1,1,2,3,5,8,13,21,34 and so on.
Although it may not seem obvious , there is a strong connection between this mathematical sequence and the composition of artwork. By visualising each number as a square (increasing in size , in the same way as the sequence) and connecting the opposite corner of each square, you can create the fibonacci spiral.

The Fibonacci sequence is intimately connected with another mathematical construct, the golden ratio (two quantities whose ratio is the same as the sum of the total to the larger ratio).
The golden ratio is sometimes called the divine ratio Mathematicians found that it is abundant in nature such as proportion of human face , flowering of an artichoke . This principle is used in composition of picture , giving a more pleasing flow to the picture.

From the Renaissance onwards , artists have - whether purposefully or by instinct - created dramatic and attractive paintings which demonstrate Fibonacci spiral in their composition such as Mona Lisa , Robert Green-ham's Tango Final of British Championship , Blackpool.

As you can see in the image above the entire composition is perfectlyoutlined by two Fibonacci spirals , which trace the line of spotlit dance floor , the skirts in arms of the dancer and even the curve of central lady's neck and place the focus perfectly on the two foremost couples .

This complex , abstract composition makes it very to see the Fibonacci sequence at play . The most interesting aspect of Fibonacci spiral is , perhaps , the fact that it can be forced or simply found .Last year it was even observed in a journalist's photograph of brawling Ukrainian parliamentarians.

APPLIED MATHEMATICS ROLE IN DATA SCIENCE

- Mansi Awasthi, 3rd Year

Data Science has opportunities, challenges and potential future strategies for mathematics within it, and the added value that the mathematical sciences can bring to industry. With the ever increasing amount of data available, the role of data science becomes ever more important and the mathematical sciences are a key element for its success.

Many mathematical techniques are emerging which on paper provide numerous benefits to data science. As these methods are, however, new to the data science scene there is a limited number of applications and case studies of their use.

Topological Data Analysis (TDA) example is a new area of study aimed at having applications in areas such as data mining. TDA represents data using topological networks and uses data sampled from an idealized space or shape to infer information about it . It essentially allows algorithms to analyze sets of data to reveal the inherent patterns within rather than showing correlations between preselected variables.

In addition, there are many mathematical methods which have not been widely applied in the area of data science but could have the potential to bring considerable advantage.

These include:

- Neural computing
- Tropical geometry
- Topological data analysis
- Pattern theory
- Algebraic statistics

The demand for data scientists has risen dramatically in recent years and many companies are finding it hard to hire people with the relevant skills. This is partly due to the creation of new roles and skill sets in industry that did not exist before. It is uncommon to find experienced individuals who have strong sector specific skills who can also apply cutting-edge mathematical methods of data analysis. There is great value in attracting mathematicians into industrial areas to gain sector-specific knowledge or introduce sector- specific expertise to data science techniques.

The industrialists at the workshop recognized the importance of the mathematical sciences when drawing information from data, and highlighted their frustration of not having (or knowing how to have) access to mathematicians. The discussion uncovered that the implementation of tools was not a problem within industry; what they need is access to people who can provide insight. It also highlighted internal challenges within organizations, such as the need to break down silos between different teams.

For mathematicians, there are challenges of how to take the mathematical sciences to industry and what are the best mechanisms for commercialization of their knowledge.

There appears to be great demand in industry for the provision of advice on what the appropriate mathematical and statistical techniques are, and for mathematicians to engage with the domain experts to solve problems together. New collaborations can avoid non-experts taking on specialist work, and instead create and support an environment where each expert contributes from their own specialism.

TWIN PRIMES

- Sonika, 3rd Year

Everybody knows about the prime numbers. These numbers are ancient source of mathematical mystery and are infinite in numbers. Like primes does everybody know about twin primes? What are these twin primes?
And the definition comes out is-
A pair of prime numbers are twins if they differ by 2.Or we can say that the twin primes are the pairs of those primes whose difference is 2.

(3,5),(5,7),(11,13),(17,19),(29,31),(41,43),(59,61),(71,73),(101,103),(107,109)

are some examples of the twin prime pairs. The twin primes are also known as prime twins or prime pairs. The question –Are these twin primes infinitely many or not ,is a great question in number theory. And where these twin primes are used ? The twin primes are used to define one of the unusual constant Of mathematics. In 1919 , it was proved by Viggo Brun that the sum of the reciprocals of all the twin primes converged. And after this achievement of Brun ,the constant to which the sum of the reciprocals of all the twin primes converged is named as Brun's constant.

SOLVING THE SYSTEM OF LINEAR EQUATIONS USING NUMERICAL METHODS

-Anshu and Gunjan, 3rd Year

We have been taught over years on how to solve equations using various algebraic methods. These methods include substitution and the elimination method. Other algebraic methods that can be used include the quadratic formula and factorization. However, when these methods are not successful, we use the concept of numerical methods. Direct methods can solve the system in finite no. of steps and gives an accurate solution. However, there are system of equations which are very time consuming when solving with direct methods or can't be solved by direct methods. So to solve them, we resort to the numerical methods.

Numerical methods provide a technique to find an approximate but accurate solution of the system of equations.

A system of Non-linear equations:

$$F_1(x_1, x_2, \dots, x_n)=0,$$
$$F_2(x_1, x_2, \dots, x_n)=0,$$
$$\vdots$$
$$F_n(x_1, x_2, \dots, x_n)=0.$$

when $(x_1, x_2, \dots, x_n) \in R^n$ & each f_i is non linear real function , i=1,2,...,n.

Because system of non linear equations can't be solved as nicely as linear systems, we use procedure called iterative methods.

An iterative method is a procedure that is repeated over & over again to find the root of an equation or to find the solution of a system of equations.

- Numerical solution of non linear equation means a point x^* such that $f(x^*)\sim 0$
- For this, we always assume that f(x) is continuously differentiable real valued function.
- Also it is assumed that roots are isolated i.e. the root of f(x)=0 for which there is a neighbourhood which doesn't have any other root for the equation.

Convergence :

A sequence of iterates $\{x_n\}$ is said to converge with p≥1 to a point x^* if for some constant c>0.

x_{n+1} approximation in (n+1) iterations

x^* approximate solution

Order/Rate of convergence

If p=1, the solution is said to converge linearly to x^*;

if p=2, the sequence is said to be converge quadratically and so on.

Order of convergence measures how fast a sequence converges. Thus, higher the value of the order, more rapid is the sequence. In the case of numerical methods, the sequence of approximate solutions is converging to the root. If the convergence of an iterative method is more rapid, then a solution may be reached in less iterations in comparison to another method with a slower convergence. Thus, there is a huge importance of numerical methods in solving the problems.

GROUP THEORY AND IT'S EVOLUTION

- Himani Pokhriyal and Jyoti Deshwal, 3rd Year

In mathematics and abstract algebra, group theory studies the algebraic structures known as groups and also it involves concept of algebraic structures such as rings,fields and vector spaces endowed with additional operations and axioms. Galois is honored as the first mathematician linking group theory and field theory with the theory that is now known as Galois theory.

There are four major sources in the evolution of group theory:

· Classical algebra(J. L . LAGRANGE, 1770)
· Number Theory (C.F. GAUSS , 1801)
· Geometry (F.KLEIN , 1874)
· Analysis (S.LIE 1874; H.POINCARE AND F.KLEIN)

Lagrange established the results of olutions of a polynomial equation and the permutation of it's roots.In fact the study of permutation of the roots of an equation was Lagrange's theory of algebraic equation and it can said that germ of the group concept is present in his work.
The number theoretic strand was begun by ***Leonhard Euler*** and developed by ***Gauss's*** work on modular arithmetic and additive and multiplicative groups related to quadratic fields.

In geometry,groups first became important in projective geometry and later non-Euclidean geometry. ***F.Klein's Erlangen*** program proclaimed group Theory to be the organizing principles of geometry.
In 1874 the mathematician ***Lie*** introduced his general theory of transformation groups essentially called as Lie groups and represented by transformation.He worked further on results done by ***N.H.Abel*** and ***Galois*** doing in differential equation. Although Lie is not succeed in the actual formulation of Galois theory of differential equations but give some of his observations on transformation groups.

Three main historical sources of Group Theory:

CLASSICAL ALGEBRA -result to the theory of permutation groups

NUMBER THEORY -result to the theory of abelian groups

GEOMETRY AND ANALYSIS -result to the theory of transformation groups

As ***Lagrange,Ruffini*** and ***Abel*** initiated the study of permutation groups and solvability of equations.

Evarivste Galois coined the term 'group' in 1830s and was first to employ groups to determine the solvability of polynomial equations . Arthur Cayley and Augustin Louis Cauchy pushed these investigations further by creating the theory of permutations groups. Cauchy introduces permutation notation as well as the cyclic notation for permutation, transposition, recognises the identity permutation and etc. terms related to it. Jordan gives the study of linear group and subgroups.

Algebraic number theory arose with Fermat's hypothesis concerning equation of Gauss' theory.

Then after lie groups, Groups were at first implicity and later explicitly,used in algebraic problems. G.L.Drichlet established that the group of algebraic units is a direct product of a finite cyclic group and free abelian group of finite rank.Kronecker aimed at working out the laws of combination of "magnitudes" in the process giving an implicit definition of a finite abelian group.

As in number theory so in geometry and analysis group theoretic ideas remained implicit until the last third of 19th century, Moreover Klein explicit use of groups in geometry influenced conceptually rather than technically evolution of group theory for signified a genuine shift in the development of that theory form with permutaion groups to study groups of tranformation i.e. to study transformstion groups inspite of permutation groups.

The different scope of these early sources resulted in different notions of groups. The theory of groups was unified starting around 1880.Since, the impact of group theory ever growing giving rise to the birth of abstract algebra in the early 20th century, representation theory and many more influential. The classification of inite simple groups is a vast body of work from mid 20th centuryclassifying al the finite simple groups.

APPLICATIONS OF GROUP THEORY

1 Algebraic Topology: which associates groups to the objectsand used to describe certain invariantsof topological spaces.Grigori Perelman is a prominent application of this idea.

2 Algebraic geometry and cryptography: used in elliptic curves cryptography serves for public key cryptography, discrete logarithms, caeser's cipher etc.

3 Algebraic nymber theory: Euler's product formula syas that any integer decomposes in a unique way into primes.

4 Harmonic Analysis: Lie groups come under this and used for pattern recognition and other image processing techniques.

5 Combinatorics: often used to simplify the counting of a set of objects.

6 Music: presence of 12-periodicity in the series of circle of fifth yields applications of elementary group theory in musical set theory.

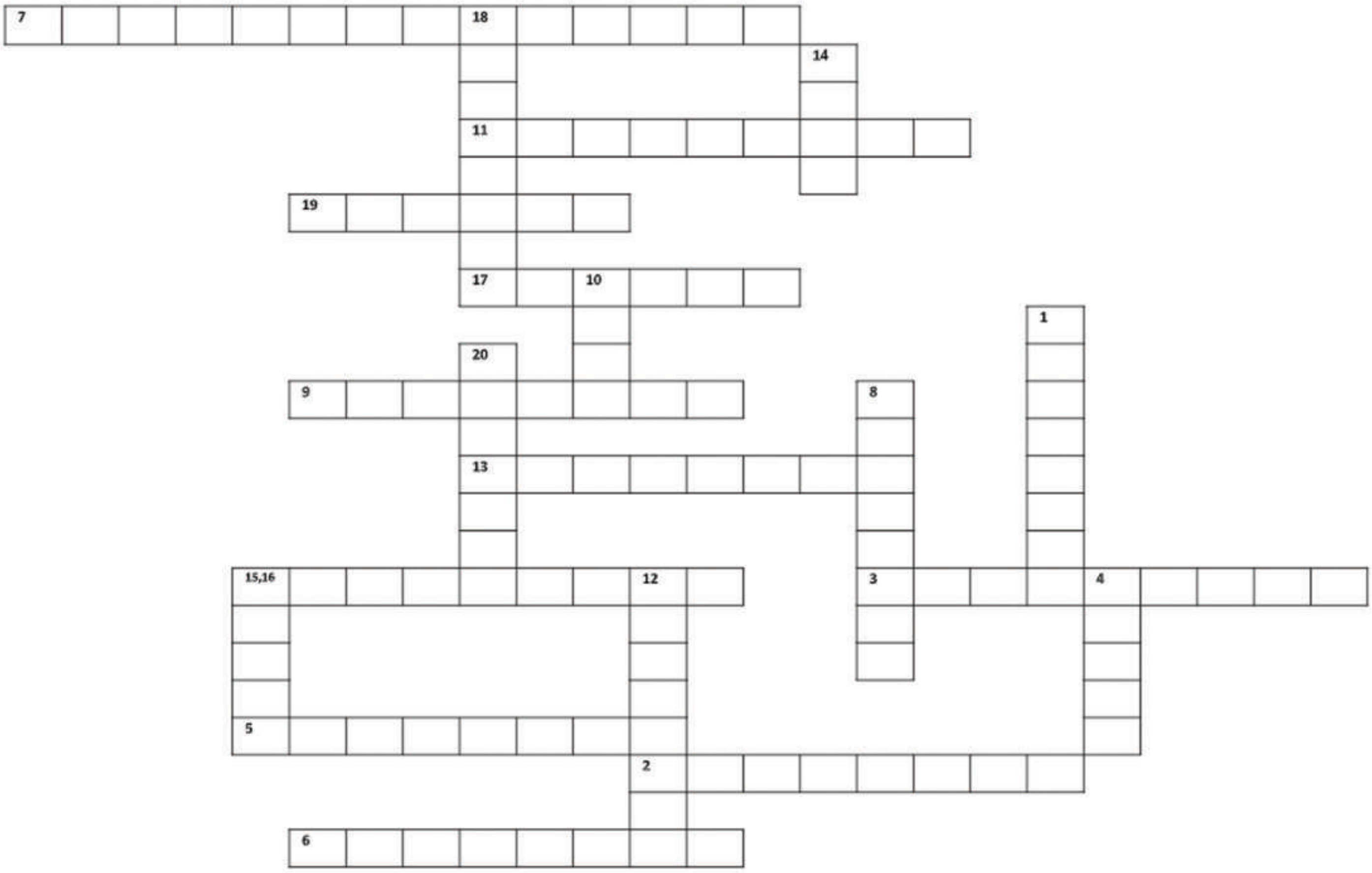
7 Physics: As they describes symmetries.It includes Standard model, gauge theory , the Lorentz group and Poincare group.

8 Chemistry and materials science: Groups used to classify crystals structures, regular polyhedra and symmetries of molecules and to determine the physical properties, spectroscopic properties and to construct molecular orbitals.

9 Stastical Mechanics: developed by Willard gibbs relating to the summing of an infinitr number of probabilities to yield a meaningful solution.

10 Puzzles/Rubik Cubes : such as the 15-puzzle and Rubik's cube.Group theory provides the conceptual framework for solving such puzzles. So you can learn an algorithm solving such puzzles.

CROSSWORD



ACROSS:-

2) A mathematical sentence that contains an equal sign.
3) Point where graph intersects an axis.
5) A relationship between sets.
6) To find the value of an expression.
7) Product.
9) The form of a linear equation Ax+By=C, with a graph that is a straight line.
11) A whole number that has no more than two factors
13) Numbers written in the form of p/q,q not equal to 0.
15) The length of the boundary around the figure.
17) The numeric values assigned to the axes of a graph.
19) A value that has magnitude but no direction.

DOWN:-

1) Symbol used to represent unknown numbers or values.
4) A comparison of two numbers by division.
8) Polynomial od degree two.
10) The inside of region of a 2-D figure measured in square units.
12) The number of times base occurs as a factor.
14) A network of evenly spaced, parallel horizontal and verticle lines.
16) A set of steps that demonstrate the truth of a given statement.
18) The branch of mathematis that deals with derivatives,integrations etc.
20) All the same or all in same manner.

ANSWERS:-

1) Variable
2) Equation
3) Intercept
4) Ratio
5) Function
6) Evaluate
7) Multiplication

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The possibilities are infinite

Token of thanks

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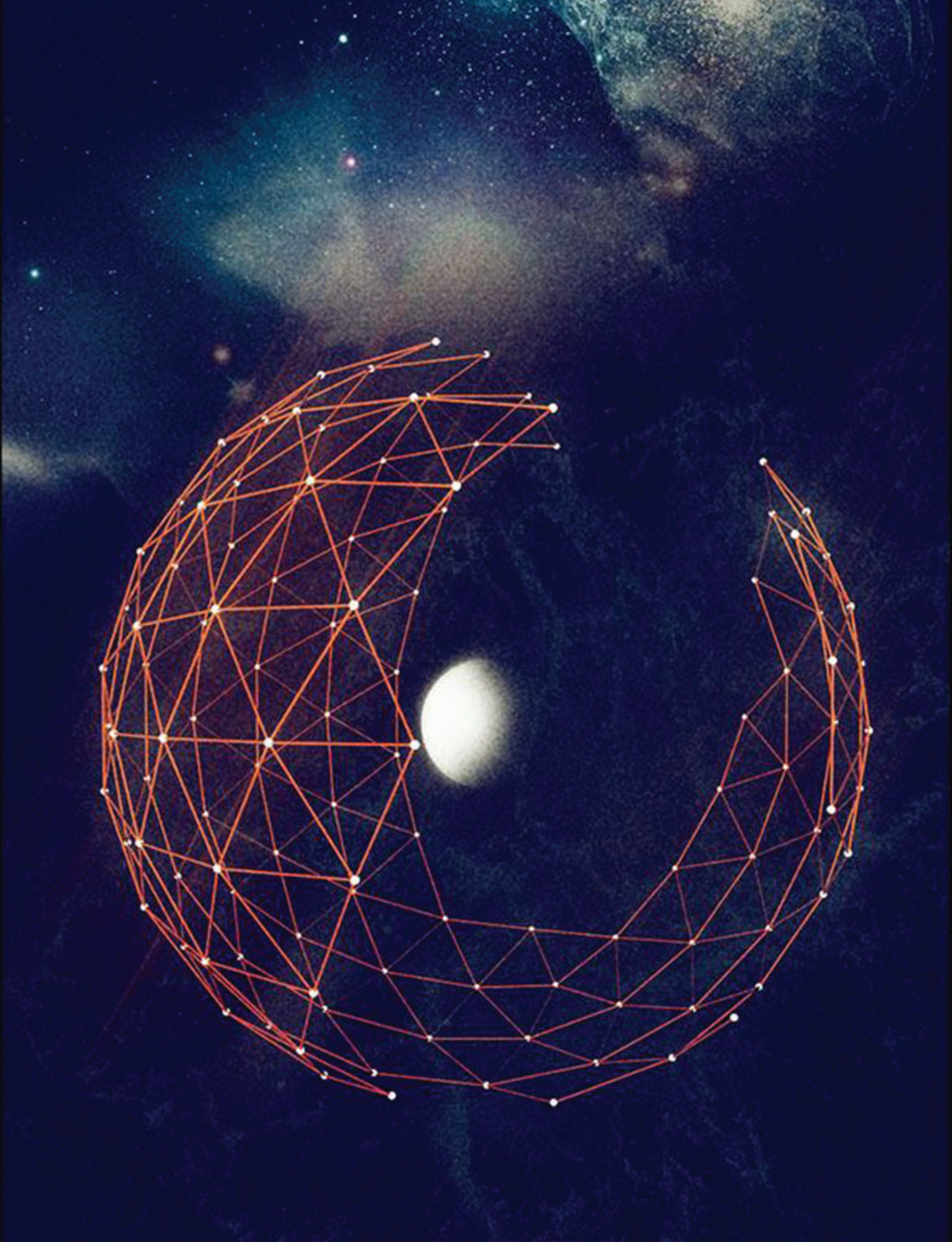

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