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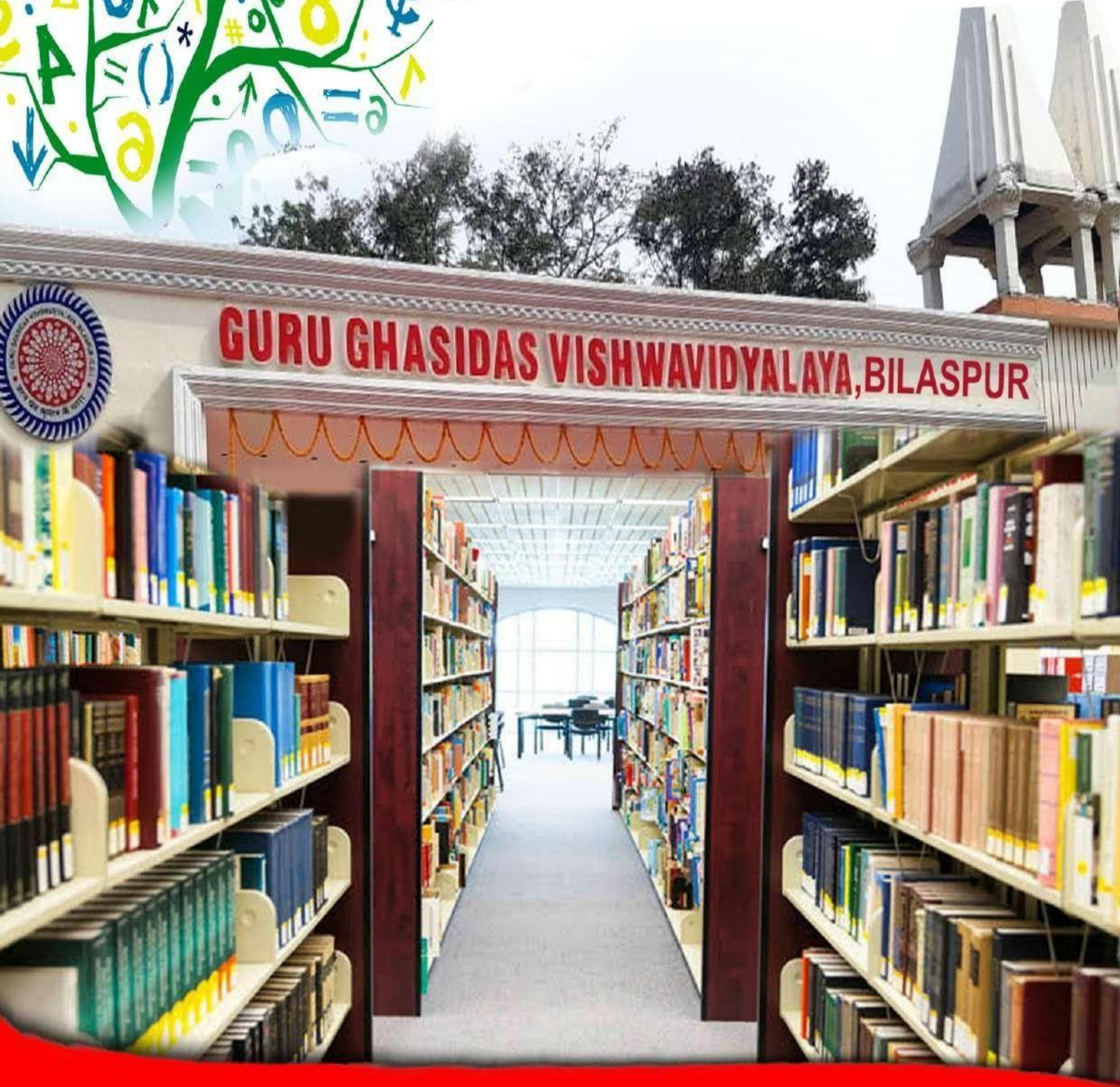

MATHEMATICOM

E-Magazine 2021
Volume – I

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Message From The Vice-Chancellor

Prof. Alok Kumar Chakrawal

It gives me great pleasure to know that ‘MATHEMATICOM’, magazine 2021-2022 is ready for publication. We believe that, in the field of education, every stakeholder is a learner and every day is an active opportunity to learn and discover. MATHEMATICOM’, therefore, is an endeavor and a pleasing initiative, which does commendable work in promoting innovation and allows students to imbibe knowledge from all branches of science reinforcing the current-day need for interdisciplinary research. I applaud the Head of the school and editorial team for the hard work and dedication they have invested in realizing this goal, and wish my dear students success in all future endeavors.

Message From The Registrar

Prof. Shailendra Kumar

I am Gratified to know that the school of mathematical and computational sciences is bringing out the 1st issue of their magazine “Mathematicom”. This is indeed a productive and subsidiary skill development tool for the students.

I extend my heartfelt greetings to all participants, authors, faculty staffs & students associated in this endeavor.

I wish them all success.

Message From The Dean, School Of Mathematical and Computational Sciences

Prof. A. S. Ranadive

It is highly pleasing to know that school for mathematical and computational sciences is ready with the first issue of E- Magazine "Mathematicom". I am also happy to notice the quality of the articles, varieties of the articles which are reflection of the creativity, innovative ideas and in-depth thinking of the students and faculties along with pursuing their academic excellence. I congratulate the editorial group and contributors of the article for their dedication and hard work in bringing out this first E- Magazine. I also appreciate the entire team from both the departments i.e. department of mathematics and department of CSIT.

Message From The HoD, CSIT

Prof. A. K. Saxena

We are privileged to extend our sincere gratitude to the editorial team of E-Magazine "Mathematicom" for giving us this opportunity in bringing out the first magazine of the school. The magazine provides a forum for our students' to exhibit their creative abilities, hidden dreams and aspirations forwriting. With all the efforts and contributions put in by the students, we trulyhope that this magazine will be informative and resourceful.

Message From The HoD, Mathematics

Dr. P.P. Murthy

I take immense pleasure in conveying my heartfelt congratulations to all of you and the editorial team of ”Mathematicom“, The magazine portrays thoughts, ideas, dreams, creative writings and aspirations of the Mathematical minds and it is a platform that provides exposure and freedom to express your views. I congratulate the efforts of the team in compiling and unleashing the hidden potential of the students and making this magazine very purposeful and meaningful.

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A LIFE LESSON FROM ARCHIMEDEAN PROPERTY

-Compiled By Pankaj Arya
Department Of Mathematics

Archimedean Property is an important result (application), which is derived from the LUB Property (Least Upper Bound Property) of Real Numbers, which simply states that the set of Natural Numbers is not bounded above in $\mathbb{R}$. However we will find in the upcoming section how the property teaches us to be optimistic in life.

Before taking a look into the Archimedean Property, we shall take an insight into the LUB property of Real Numbers.

LUB Property

Let us assume that $A \subseteq \mathbb{R}$ is bounded above in $\mathbb{R}$. Hence, by definition of Bounded Above sets, there exists a real number which is an upper bound of A. The LUB Property asserts the existence of the Least Upper Bound of A.

Given any non empty subset of $\mathbb{R}$ which is bounded above in $\mathbb{R}$, then there exists $M \in \mathbb{R}$ such that M=lub A.
This property is also known as the order completeness of $\mathbb{R}$.

Archimedean Property

Archimedean Property can be stated in two equivalent ways which we shall prove in this section:-

(P1) $\mathbb{N}$ ***is not bounded above in*** $\mathbb{R}$***. That is, given any*** $x \in \mathbb{R}$ ***, there exists*** $n \in \mathbb{N}$ ***, such that*** $n > x$***.***

(P2) Given $x, y \in \mathbb{R}$ ***with*** $x > 0$ ***, there exists*** $n \in \mathbb{N}$ ***, such that*** $nx > y$***.***

We shall prove the above properties and then prove their equivalence.

Proof

Firstly, we shall prove (P1) that $\mathbb{N}$ ***is not bounded above in*** $\mathbb{R}$***.***

We shall prove this by contradiction.

Let, if possible, $\mathbb{N}$ be bounded above in $\mathbb{R}$.

Then, by the LUB Property, since $\mathbb{N}$ is bounded above in $\mathbb{R}$, it has the LUB in $\mathbb{R}$, say M.

i.e., $\exists M \in \mathbb{R}$, such that $n \leq M \ \forall n \in \mathbb{N}$

Now since for any $n \in \mathbb{N}$, we have $n + 1 \in \mathbb{N}$ (By Peano's Postulates)

Hence , for any $n \in \mathbb{N}$, $n + 1 \leq M$ ($\because M$ is LUB of $\mathbb{N}$)

$\Rightarrow n + 1 \leq M \quad \forall n \in \mathbb{N}$
$\Rightarrow n \leq M - 1 \quad \forall n \in \mathbb{N}$
Hence, $M - 1$ is an upper bound of $\mathbb{N}$.

But this is a contradiction, since M is the least upper bound of $\mathbb{N}$ and no real number less than M can be an upper bound of $\mathbb{N}$.

Thus, $\mathbb{N}$ is not bounded above in $\mathbb{R}$. And hence for each real number , there exists a natural Number n such that $n > x$, i.e.,$\forall x \in \mathbb{R}$, $\exists n \in \mathbb{N}(n > x)$.

This proves (P1) .

Next , we shall prove (P2)

(P2) Given $x, y \in \mathbb{R}$ with $x > 0$, $\exists n \in \mathbb{N}$ such that $nx > y$

We shall prove this property using (P1) which has been already proved above.

Let $x, y \in \mathbb{R}$ with $x > 0$.

To prove that $\exists n \in \mathbb{N}$ such that $nx > y$

Let if possible, $\forall n \in \mathbb{N}$, $nx \le y$.

$\Longrightarrow \forall\, n \in \mathbb{N}$, $n \le \frac{y}{x}$ (Since, $x > 0$, so $x \neq 0$ and hence division by x is possible)

Hence , by definition of Upper Bound we find that $\frac{y}{x}$ is an upper bound for $\mathbb{N}$.

But this is a contradiction to (P1) which states that $\mathbb{N}$ is not bounded above in $\mathbb{R}$ and has been already proved.

Hence our assumption that $\forall n \in \mathbb{N}$, $nx \le y$ is not correct.

Thus, $\exists n \in \mathbb{N}$, such that $nx > y$. (Considering negation of the above statement) (where $x, y \in \mathbb{R}$ with $x > 0$)

This proves (P2).

Now from above , we see that (P2) has been proved using (P1) . Hence (P1)⟹(P2) -------------------(A)

Next, we shall prove that (P2)⟹(P1)

For this we first assume that given $x, y \in \mathbb{R}$ with $x > 0$, there exists $n \in \mathbb{N}$, such that $nx > y$

We shall prove that the set of Natural numbers $\mathbb{N}$ is not bounded above in $\mathbb{R}$.

For this , we prove that no real number can be an upper bound for the set of Natural Numbers $\mathbb{N}$.

Let α be any real number. We show that α cannot be an upper bound for $\mathbb{N}$.

For this let $x, y \in \mathbb{R}$ with $x > 0$.

Then from (P2) , there exists a natural number n such that $nx > y$------------------------ (i)

On Putting $x = 1$ and $y = \alpha$ ($\because$ $1 > 0$ and $y \in \mathbb{R}$)

From (i) , $\exists n \in \mathbb{N}$ such that $n.1 > \alpha$ (i.e., $n > \alpha$)

Hence , for every real number α, there exists a natural number n such that $n > \alpha$. (So α is not an upper bound of $\mathbb{N}$, as there exists a natural number greater than α.)

Hence , given any real number, it is not an upper bound of $\mathbb{N}$.

Thus , the set of Natural Numbers $\mathbb{N}$ is not bounded above in $\mathbb{R}$.

∴(P2)⟹(P1)--------------- (B)

From (A) and (B), we find that both statements (P1) and (P2) for the Archimedean Property are equivalent to each other.

What Does Archimedean Property Teach Us In Life?

We can learn an important life lesson from Archimedean Property (P2) stated above.

We all know that Life is full of ups and downs. Success and failure are two sides of the same coin in Life.

In some areas of life, we enjoy a lot, while sometimes we face a lot of difficult situations. But the true essence of life lies in being positive and optimistic so that any situation can be handled easily and then every problem in our life can be tackled easily. This is what Archimedean property teaches us .

We again consider (P2) of Archimedean Property

Given $x, y \in \mathbb{R}$ with $x > 0$, $\exists n \in \mathbb{N}$ such that $nx > y$

Assuming real life analogy , if we consider a difficult situation in our life with $'y'$

And if we take small positive effort say $'x'$ $(x > 0)$one by one to handle the situation , then by Archimedean Property , there must exist a natural number $'n'$ such that

$$nx > y$$

i.e., After a finite number n of positive efforts(in the form of positive number x) , we can easily overcome the difficult situation(in the form of y) , i.e., $nx > y$

This shows how the spirit of positivity can help us deal with any situation in life, which amounts to saying that we should face every challenge in life with full courage.

It has been correctly said *"Try-Try but don't cry".* The ceaseless efforts will definitely help us to overcome our obstacles.

This all amounts to show how the beautiful subject of Mathematics can teach us a lot in our daily life and day-to-day activities.

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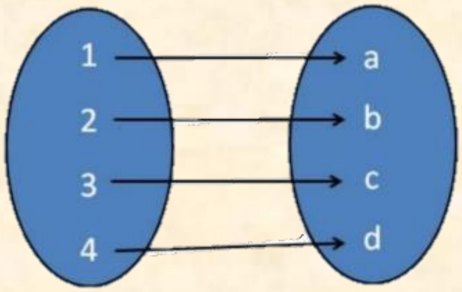
CONTINUUM HYPOTHESIS - LOGICAL JOURNEY SO FAR....

-Compiled By Shreya Mishra
Department Of Mathematics

When a student is first time introduced to the concept of infinity, he/she means it as something that is boundless, endless or larger than anything possible. Infinity (or eternity) is often correlated to spiritual importance and philosophers epitomize it as symbol of almightygod and they assume the nonexistence of anything beyond almighty.

But what if someone says, there is an infinite set larger than another set with an infinite cardinality or there exists an infinite set between any two infinite sets, Sounds absurd!! Something similar to like these 'weird' ideas was under discussion on "an undecidable statement" at the Princeton University Bicentennial Conference on "problems of mathematics" in 1946, the first major informational gathering of mathematicians after World War II. The topic under discussion was the "Continuum Hypothesis" (abbreviated CH).

Before stating the Hypothesis, let us have a quick look at some basic concepts of cardinality. Cardinality is simply the number of elements present in any set. The sets are said to be of same cardinality if there is one to one correspondence between elements of the two sets.



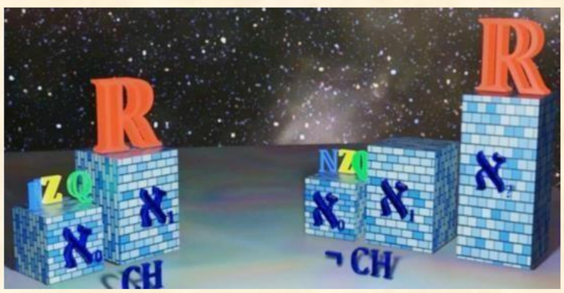
$|A|=|B|$

We can also compare the size of two infinite sets. For example one can easily establish a bijective function from set of natural numbers $\mathbb{N}$ to the set of integers $\mathbb{Z}$, hence the two sets ($\mathbb{N}$ and $\mathbb{Z}$) have the same cardinality. The set of rational numbers ($\mathbb{Q}$) is dense i.e. there are infinitely many rational numbers between any two rational numbers. Surprisingly the cardinality of set of rational numbers and that of the set of integers is same.

So now we have $|\mathbb{N}|=|\mathbb{Q}|=|\mathbb{Z}|= \aleph_0$ (Cantor named it aleph null)

Now let's consider the set of real numbers $\mathbb{R}$. Can we still define a bijective mapping from $\mathbb{N}$ to $\mathbb{R}$? No, there is no way possible to do this. The size of set of real numbers is bigger than the set of natural numbers. i.e. $|\mathbb{R}|>|\mathbb{N}|$.

So far we have found two infinite sets with reals being larger. Now the question arises can we find another set having cardinality just bigger than $\mathbb{N}$ but smaller than $\mathbb{R}$?



This question led to the birth of centuries old "continuum Hypothesis" (continuum means real numbers) which states that:

"There is no set whose cardinality is strictly between that of the integers and the real numbers". In Zermelo-Frankel set theory with axioms of choice (ZFC) this is equivalent to the following equation

$$2^{\aleph_0} = \aleph_1$$

Let us now discuss the various attempts towards solving the hypothesis. Sir Georg Cantor (1878) believed that the CH is true and put many years of unsuccessful attempts to prove it. The CH became the first on David Hilbert's list of important open questions. In 1940 Kurt Gödel proved that negation of the CH i.e. {the existence of the set with intermediate cardinality cannot be proved on standard set theory}.

So far there has been a lot of arguments both in favour as well as against the Continuum Hypothesis. Mathematicians who favoured a 'rich' and 'large' universe of sets were against CH, while those favouring a 'neat' and 'controllable' universe favoured CH. Another chapter in this quest was added when Sharon Shelab solved a generalized form of the Hypothesis which state that "If an infinite set's cardinality lies between that of an infinite set S and that of the power set P(S) of S, then it has same cardinality as either S or P(S) That is, for any infinite cardinal x there is no cardinal k such that :-

$$x < k < 2^x$$

However this doesn't bear with the CH directly, since it was moulded form of Hilbert's question. But it is a remarkable result in general direction of solving CH.

The future: will it be provable anyhow? Yes! It will. History of mathematics has been very rich with variety of extremely difficult questions and therefore without a solution up to now, But one day someone may come up with a brilliant solution. Three and half century old Fermat's last theorem and Decades old Conway Knot problem are two great examples. Probably we don't have enough tools to tackle them at moment but there is always a way to reach a conclusion as Herman Henkel rightly said,

"*In most sciences one generation tears down what another has built, In mathematics alone each generation build a new story to the old structure*". **This is the beauty of mathematics.**

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PRIME PAIR : TWIN PRIME

-Compiled By Neha Sharma
Department Of Mathematics

We all know what a Prime Number is. It is one of the best known topics of (Number Theory) in Mathematics. In brief, it is a number which is divisible by 1 and itself (e.g. 2,3,5,7...) . So we will talk about a new prime which is known as "Twin Prime". So Twin Prime Numbers are the set of two numbers that have exactly one composite number between them. They can also be defined as the pair of numbers with a difference of 2. The name twin Prime was coined by Stackel in 1916. In simple words, we can say that where two numbers have a difference of 2, they are said to be Twin Primes or twin prime is a prime with a prime gap of 2. That's why we can also say it as prime pairs. And the first twin prime numbers are {3,5}, {5,7}, {11,13} and {17,19}. It has been conjectured (but never proven).

The first few twin Prime Numbers are (3, 5), (5, 7), (11, 13), (17, 19), (29, 31), (41, 43), (59, 61), (71, 73), (101, 103), (107, 109), (137, 139), …. It has been conjured that there are infinite twin primes. According to "Sieve techniques", the sum of the reciprocals of twin primes converges hence all the pairs of twin primes are in the form of {6n-1, 6n+1} except the first pair of twin primes which is (3, 5). It has been conjured in the famous conjecture of twin primes that there are infinite twin primes. Further using sieve techniques it has been proved that the sum of the reciprocals of twin primes converges. Other than the first pairs, all pairs of twin primes have the form {6n-1, 6n+1}.

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Figure: Twin Prime Numbers

Properties Of Twin-Prime Numbers

We know that twin primes are pairs of prime numbers with a difference of two. There are few basic properties for twin primes which are as follows:-

● 5 is the only prime number that has a positive as well as a negative prime gap of two and hence is the only prime to occur in two twin primes pairs.

● Every twin primes pair other than {3, 5} is of the form {6n-1, 6n+1}

● Pair of numbers is not considered a twin prime, if there is no composite number between them, for example, {2, 3} can not be considered a twin prime pair. as there is no composite number between them.

● The sum of each twin prime pair except {3,5} is divisible by 12 as (6n-1) + (6n+1) = 12n.

Twin Prime Number Conjecture

So , Twin prime conjecture, is another word for "Polignac's conjecture", in number theory. According to the twin primes definition, there are infinite twin prime pairs with a difference of 2. Polignac's conjecture was introduced by Alphonse de Polignac in 1849. The conjecture states that, for positive even number m, there are infinitely many pairs of two consecutive prime numbers with difference n. Twin prime conjecture, also known as Polignac's conjecture asserts that there are infinitely many twin primes. Now, 3 and 5, 5 and 7, 11 and 13, and 17 and 19 are all twin primes. As numbers get larger, primes become less frequent and thus. twin primes get rarer.

The first statement of the twin prime conjecture was given in 1846 by French mathematician Alphonse de Polignac, who wrote that any even number can be expressed in infinite ways as the difference between two consecutive primes. When the even number is 2, this is the twin prime conjecture; that is, 2 = 5 − 3 = 7 − 5 = 13 − 11 = and so on. Although the conjecture is sometimes called "Euclid's twin prime conjecture", he gave the oldest known proof that there exists an infinite number of prime.

Difference Between Twin Prime Numbers And Co-Prime Numbers

Twin prime numbers are the pair of prime numbers with a difference of 2, whereas co-prime numbers are the numbers having only 1 as a common factor. All twin primes are co-primes numbers but all co-primes are not twin primes. Co-primes may not be prime numbers, they have the GCD=1. All twin primes are co-primes numbers but vice versa is not true. Co-primes need not be prime numbers, they can be any numbers with their GCD=1. For example, 13 and 14 are two co-prime numbers. The only common factor between the two numbers is 1 and hence they are co-prime. Here, (13,14) are not twin primes.

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ZERO

-Compiled By Sunima Patel
Department Of Mathematics

History Of Zero

It is believed that the number zero originated in these 3 places. Ancient India, ancient Babylon, and the Mayan civilization. The first recorded zero appeared in Mesopotamia around 3 B.C. The Mayan's invented it independently crica 4 A.D. it was later devised in India in the mid-5 th. Century, undoubtedly the complete credit goes to India for the invention of zero and its effects us as a number.

What Is Zero?

Our understanding of zero each profound when you consider these facts: we don't often, or perhaps ever, encounters zero in nature.

Number like one, two & three have a counterpart. We can see one light flash on. We can hear to beeps from a car horn.

But zero? It is requiring us to recognize that the absence of sometimes is a thing in and of itself. Nevertheless, zero doesn't have to exit to be useful. Infact, we can use the concept of zero to derive all the other numbers in the universe.

"Existence Of Zero"

Zero is a strange number and one of the greatest paradoxes of human thought. It means both everything and nothing. It is both a number and the numerical digit used to represent that number in numerals. It fulfills a central role in mathematics as the additive identity to the integers, real numbers and many others algebraic structures. Without zero, not just mathematics, but all branches of science would have struggled for clearer definition.

As a digit, (0) is used as a place holder in place value systems. The value of zero is well known today as it holds the highest value today. Without invention of (0), the binary system and computer are not possible, and without computer our life would not become easy and the height of science in which we have achieve, we would have a long way from it.

Personally, for me, I am a big zero in mathematics in every second, I think out of boxes and aim to achieve greater than a zero.

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BEAUTY OF MATHEMATICS AND THE ENVIRONMENT

-Compiled By Sourav Deep
Department Of Mathematics

Environment and Mathematics are directly related to each other. Environment consists of geometrical shapes like Circle, Triangle, Rectangle, Curve and so on. Earth is spherical, house rooms are the shape of curve, cuboid. Thus our mathematics is related to environment. Mathematics being used in Atmospheric concentrations of greenhouse gases and their effects, local weather patterns, and precipitation levels.

Mathematics and environment have an infinity relation. Mathematics is observable everywhere in environment, even when we are not hoping it. It can help to explain the way of mathematically, like line, curve, rectangle, etc.

Great Rules Of Mathematics In The Environment

Mathematics is used to calculate the size of the Earth, the distance to the Moon. It is used for the mathematical in "Climate Change And Earthquakes", Pollution. It uses to measure the size or volume of land and bodies of water, the Expansion and Contraction of Planetary features over time. (Such as Glacial Retreat or Water Levels during excess or low precipitation- i.e., flooding or drought).

What Will Be Happened Without Mathematics?

We can't do anything new. We face many problems like Solving-Problem, testing, design etc. We can't solve the environmental issues like Earthquakes and Climate change, Pollution, etc.

My Opinion About Beauty Of Mathematics

"Mathematics is everywhere, Mathematics is being seen all-around us".
I have always been thinking the purpose of different fields of Mathematics in our daily lives or its related to the environment.

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A MATHEMATICAL MYSTERY – THE RAMANUJAN SUMMATION

-Compiled By Sukhdev Nirmal
Department Of Mathematics

"What on earth are we talking about? There's no way that's true!"

This Statement is going to be true whenever we read "RAMANUJAN SUMMATION - A Mathematical Mystery".

The Ramanujan Summation: 1 + 2 + 3 + ⋯ + ∞ = -1/12 ?

Generally, Ramanujan Summation is seen to be a mystery but it is just an Anomaly. After all it defines Basic logic. How could adding a Positive integers equal not only to a Negative but a Negative Fraction? How ?

Ramanujan summation is a technique invented by an Indian mathematician Srinivasa Ramanujan for assigning a value to divergent infinite series. Although the Ramanujan summation of a divergent series is not a sum in the traditional sense, it has properties that make it mathematically useful in the study of divergent infinite series, for which conventional summation is undefined. Ramanujan summation functions as a property of partial sums. This Is somehow related to Cesaro Summation.

Cesàro summations assign values to some infinite sums that do not converge in the usual sense."The Cesàro sum is defined as the limit, as n tends to infinity, of the sequence of arithmetic means of the first n partial sums of the series".

Keeping everything in mind and trying to find a solution to the mystery—

We'll solve the mystery by proving two equally crazy claims:

1–1+1–1+1–1 ⋯ =1/2 [Grandi's Series]

1–2+3– 4+5–6⋯……….. =1/4 [Paradoxical Equation]

This is where the real magic happens.

Let , A which is equal to 1–1+1–1+1–1……….. repeated an infinite number of times.

A = 1–1+1–1+1–1⋯

On pre-adding 1 both sides

1-A=1-(1–1+1–1+1–1⋯)

1-A=1–1+1–1+1–1+1⋯

1-A =A

1-A+A=A+A. (Post -adding A both side)

1 = 2A

1/2 = A

For now, we move toward 2nd equation:

1–2+3–4+5–6⋯ = 1/4.

We let the series B =1–2+3–4+5–6⋯.

On subtracting B from A.

A-B = (1–1+1–1+1–1⋯) — (1–2+3–4+5–6⋯)

A-B = (1–1+1–1+1–1⋯) — 1+2–3+4–5+6⋯

A-B = (1–1) + (–1+2) +(1–3) + (–1+4) + (1–5) + (–1+6)⋯

A-B = 0+1–2+3–4+5⋯

A-B = B

A = 2B

1/2 = 2B

1/4 = B

We assume the series C = 1+2+3+4+5+6⋯,

On subtract C from B.

B-C = (1–2+3–4+5–6⋯)-(1+2+3+4+5+6⋯)

B-C = (1-2+3-4+5-6⋯)-1-2-3-4-5-6⋯

B-C = (1-1) + (-2-2) + (3-3) + (-4-4) + (5-5) + (-6-6) ⋯

B-C = 0-4+0-8+0-12⋯

B-C = -4-8-12⋯

We notice that, all the terms on the right side are multiples of -4, so we can pull out that constant

factor,B-C = -4(1+2+3⋯)

B-C = -4C

B = -3C

and since we have a value for B=1/4, we simply put that value in and we get our magical result:

1/4 = -3C

1/-12 = C or C = -1/12

<u>We will finally find the solution of Our Mystery !</u>

<u>Uses</u>

- It is used in string theory.

- It also has had a big impact in the area of general physics, specifically in the solution to the phenomenon know as the Casimir Effect.

About The Inventor

Srinivasa Ramanujan (22 December 1887 – 26 April 1920) was an Indian mathematician of British India era . He made substantial contributions to mathematical analysis, number theory, infinite series, and continued fractions, including solutions to mathematical problems then considered unsolvable.

Known for:

- Landau–Ramanujan constant
- Mock theta functions A Mathematical Mystery - The Ramanujan Summation
- Ramanujan conjecture
- Ramanujan prime
- Ramanujan–Soldner constant
- Ramanujan theta function
- Ramanujan's sum
- Rogers–Ramanujan

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RAMANUJAN & HARDY

-Compiled By Anjali Saw
Department Of Mathematics

The eccentric British mathematician Godfrey Harold Hardy is known for his achievement in number theory and mathematical analysis. But he is perhaps even better known for his adaptation and mentoring of the self-taught Indian mathematical genius Srinivasa Ramanujan.

In 1912, when Ramanujan started working as a clerk in the office of Madras Port trust, his work there was not much so there it was all so easy for him to devote a lot of his time to mathematical research. It what's the matter of good fortune for Srinivasan Ramanujan that the manager of his office was also and mathematician and he would have treated Ramanujan very kindly and motivated him to do mathematical research. He also suggested to Ramanujan that he should write a letter to G.H. Hardy renowned mathematician of Trinity College, University of Cambridge, England.

In 1913, Srinivasa Ramanujan begin a postal correspondence with GH Hardy he sent compilation of his 123 forums to professor Hardy as a presentation of his work. Mr Hardy recognising the brilliance of his work invited him to visit and work with him at Cambridge. Ramanujan research England bye route of his ship and their more than a dozen research paper were published bi work with professor Hardy.

In 1914, Mr Hardy remarked that "These theorem have defeated me completely. I have never seen anything in the least like this before".

Over next three years he published more than 30 papers. Among these the most notable paper include the "partition function". Ramanujan and professor Hardy together invented a new method of this function as asymptotic formula, which is known as" circle method". That together developed more fundamental paper now known as "Normal order method". This method analyse the tendency of additive arithmetic function. The paper that completely changed the course of 20th century mathematics was written in 1916. Its title was on Southern arithmetic function. In this paper Ramanujan investigated the property of fourth coefficient of standardized model. He also carried out major in investigation in the area of gamma function, modular forms, divergent series, hypergeometric series and prime number theory. He identified several efficient and rapid converging infinite series for the calculation of the value of PI with each term of the series.

The guidance of Professor Hardy. In March 1916, Srinivasa Ramanujan award B.A. in research work for this work with maximum marks (later this degree was named as Ph.D). His paper was later published in the "Journal Of London Mathematical Society". Expressing his views on this, Professor Hardy said, it was the most extraordinary paper on mathematical research ever produced and Ramanujan used his extraordinary ingenuity inconducting this experiment.

Hardy arranged for Ramanujan to be elected as a fellow of the royal society and as the fellow of Trinity College. On 6 December 1917 Ramanujan was elected to with the London mathematical society. On 2 may 1918 he was elected as a fellow of the royal society, the second Indian to receive the title. At the age 31 Ramanujan was one of the youngest fellow in the royal society history. He was elected for his investigation in "Elliptic function and the theory of numbers".

An anecdote related to Hardy - Ramanujan number1729 is famous for after visit of Hardy to see Ramanujan at hospital.

In Hardy's word " I remember once going to see him when he was ill at Putney. I had ridden in taxi cab number 1729 and remember that their number seem to me rather dull one and that I hoped it was not an unfavourable omen." "No", he replied "it is a very interesting number, it is the smallest number expressible as the sum of two cubes in two different ways" . The two different ways are,

$$1729 = 1^3 + 12^3 = 9^3 + 10^3$$

Generalization of the idea has created the notion of "taxicab numbers".

Immediately before this anecdote, Hardy quoted, “every positive integer was one of Ramanujan personal friend”.

In 1917, Ramanujan was diagnosed with tuberculosis and severe vitamin deficiency and confined to a sonatorium. In 1919, he returned to Kumbakonal, Madras and in 1920 he died ate the age of 32. Hardy Lives for more 27 years after Ramanujan death, to the report old age of 70. When asked in an interview what is the greatest contribution to mathematics was, Hardy and unhesitatingly replied it was the discovery of Ramanujan and called their collaboration “The one Romantic incident in my life”.

Ramanujan spent nearly five years in Cambridge collaborating with Hardy. They both had highly contrasting personalities. Their collaboration was a clash of different cultures, believes and working styles.

And atheist and apostle of proof and mathematical rigour, whereas Ramanujan was a deeply religious man who replied very strongly on his intuition and insights. Tried his best to fill the gap of Ramanujan education and to mentor him in the need for formal proof to support his result without hindering his inspiration.

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MATHEMATICS IS EVERYWHERE

-Compiled By Aastha Pandey
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Why Do We Study Mathematics ?

As a student of Mathematics, many times we came across with this question. Like, why do we even study Maths? What is the use of that sinθ, cosθ, ϵ, γ, etc. ? Every person from other background ask the same question. Sometimes we also feel the same, like where we use Mathematics. When we actually think about this, we came to the conclusion that Mathematics is everywhere.

Mathematics has been around us from the beginning of the time and it enters in our lives as soon as we enter this world, for instance, we get our date of birth first and also get a Mandatory Aadhar Card with a number having a dozen digits. Since our birth, we have lived surrounded by numbers and wherever there are numbers, there is Mathematics and Numbers are everywhere. To support it, let's recall. Galileo's quote "Mathematics is the language in which God has written the universe." The planets go around the sun in a precise orbit and sun goes around the Universe in a precise orbit. Days become nights and nights become days in precise orderof time.

Is Mathematics being used only by people who have eyesight? No, of course not. A person who is visually impaired used it to identify chess pieces by touching and distinguishing them geometrically within seconds. Infact, chess game involves Mathematics at every move of its pieces and chessboard is an 8x8 matrix with 64 squares. Infact, no sports can be imagined or played without the help of Mathematics. Also we communicate with our deaf friends, with the orientation of fingers which is not possible without the help of Mathematics. (Yeah, here we see the use of θ). Therefore, Mathematics plays a vital role in communication for deaf people as their language. Also if you notice, an ordinary person walks keeping the Cartesian coordinate into the mind as he can see and knows the exact location but on the other side a specially-abled who cannot see, walks keeping the Polar coordinates into the mind as he always keeps direction and distance in his mind at every step with his hand stick.

It is Mathematics only which gives sense of comparing or sense to distinguish and it is not only in human being but it can be noticed even among animals, for example, suppose in a forest an animal has five children and suddenly one of them is missing, then do not you think the mother will start searching for the child? Does it mean the mother knows counting? No of course not but certainly she has the sense to distinguish. Animals also have the sense of distance and numbers, Suppose in a forest there is a lion and a bunch of deers, the lion may not hunt deer but if there is only a deer, then the lion must run towards the deer so understanding Mathematics is the difference between life and death! Similarly, if you ever closely look at a sequence of ants, they walk in a perfect harmony with a guidist-ant. So, if animals were to have any language then it would be Mathematics only!

Mathematicians do amazing things. They discover hidden beauty in the natural world. Mathematics can also be seen in nature. We can see them in flowers as the flower petals are arranged through polar coordinate system or we know through polar transformation the number of petals. In Mathematics, Fibonacci sequence is one of the most famous and useful sequences of integers. Fibonacci spiral is the spiral when in polar coordinates, both angle and radial distance vary simultaneously. We fund Fibonacci spiral in nature; as the florets of Sunflower are always in perfect spiral of 55 , 34 and 21. The Fruit lips of the Pineapple make the same.

In this digital era, internet banking is becoming more and more common but there is a chaos with regard of safe transactions and there we fully depend on cryptology, the study of protecting our information using the codes. The reality of instant loan would not have been possible without Mathematics. The Mobile apps quickly analyse our Aadhar Number with PAN Card Number and Bank Statement. We all have Mobile and Everyday we love to take Pictures but do you know that your picture is nothing but your homomorphic image whereas if there is an identical twin of you , then it is going to be your isomorphic image.

G.P.S. has become very important in our lives as it tells us routes with the exact location, which is just possible due to the geometry of relativity with help of four satellites. We easily know the weather report of the world at home through TV with the use of Level Curves.

Mathematics helps a lot in policy formulation. The Government collects data about its citizens and statisticians analyse it to formulate the right policy. Right calculation can lead to positive results like job, creation and growth rate in our GDP, but a wrong calculation can result in negative. Similarly, a good knowledge of prime numbers can equip a mathematician for hacking. So Mathematics is like a double edged sword. Hence we need "well-defined" Mathematicians in policy making team everywhere.

So basically, Mathematics in life is as important as music to songs or Internet facility to digital India. Everyone needs Mathematics in their day-to-day life without realizing it, be it an astronaut, a farmer, an army man, a sportsman, or a shopkeeper. Mathematics is in every aspect of our lives.

Our teachers are synonymous with integration as they increase the capabilities of a constant student with their knowledge and Magnify a student's capabilities.

As a student of Mathematics, we can express our love for Mathematics by few lines:

Maths is in my heart,
In My Brain, In My Vein..
We can see it in a Triangle,
In a Circle, In a Plane..
I(i) is imaginary,
This world full of lies,
People asked, where we use maths?
Everywhere, we see through our naked eyes….

Feature Extraction of Image Using Deep Learning Techniques

-Compiled By Himanshu Sahu

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What are features of an image?

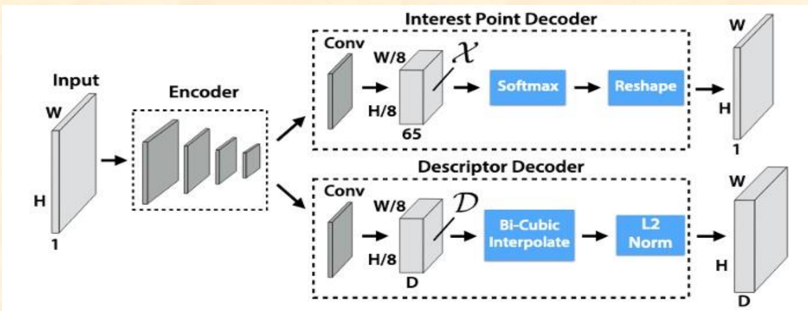
Features are parts or patterns of an object in an image that help to identify it. For example — a square has 4 corners and 4 edges, they can be called features of the square, and they help us humans identify it's a square. Features include properties like corners, edges, regions of interest points, ridges, etc.

Example:

Deep Learning feature extraction techniques

Traditional feature extractors can be replaced by a convolutional neural network (CNN), since CNN's have a strong ability to extract complex features that express the image in much more detail, learn the task specific features and are much more efficient.

1. **Super Point:** Self-Supervised Interest Point Detection and Description — The authors suggest a fully convolutional neural network that computes SIFT like interest point locations and descriptors in a single forward pass. It uses an VGG-style encode for extracting features and then two decoders, one for point detection and the other for point description



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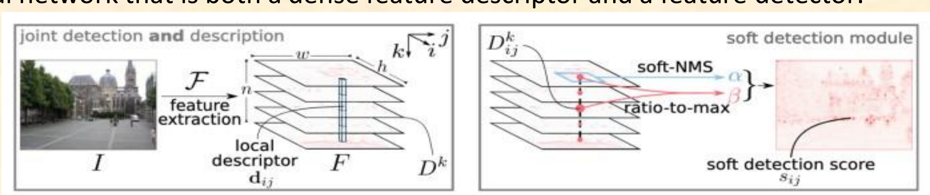
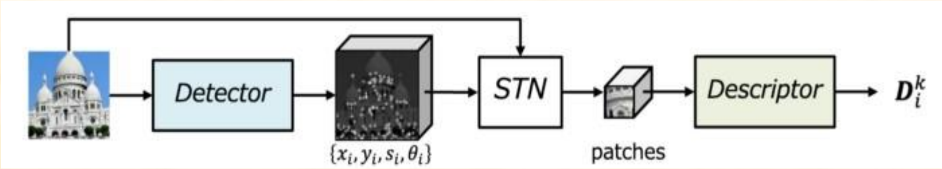
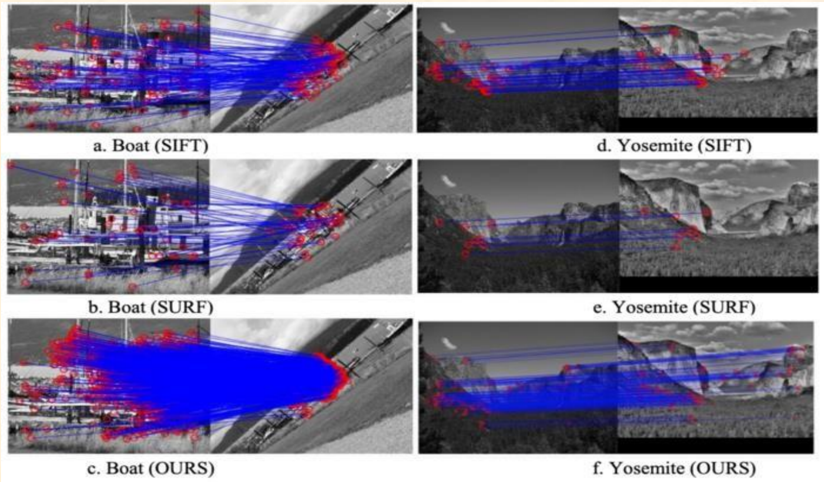
2. D2-Net: A Trainable CNN for Joint Description and Detection of Local Features— The authors suggest a single convolutional neural network that is both a dense feature descriptor and a feature detector.



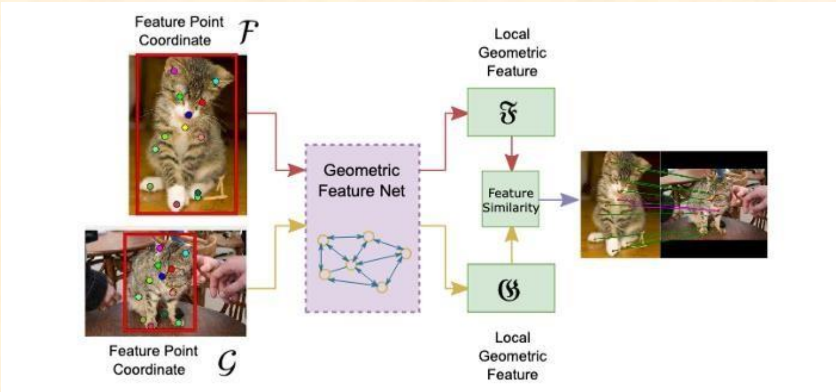
3. LF-Net: Learning Local Features from Images — The authors suggest using a sparse-matching deep architecture and use an end-to-end training approach on image pairs having relative pose and depth maps. They run their detector on the first image, find the maxima and then optimize the weights so that when run on the second image, produces a clean response map with sharp maxima at the right locations.



4. Image Feature Matching Based on Deep Learning — They adopt a deep Convolutional neural network (CNN) model, which attention on image patch, in image feature points matching.



5. Deep Graphical Feature Learning for the Feature Matching Problem — They suggest using a graph neural network to transform coordinates of feature points into local features, which would then make it easy to use a simple inference algorithm for feature matching



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SECURITY IN INTERNET OF VEHICLES

-Compiled By Prastwana

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Internet of Vehicles accustoms the transportation technology to a new version of vehicles which stretches its limits. The number of vehicles used worldwide will increase to 2 billion by 2035. The rapid growth of vehicles increases the problems of enormous traffic and fatalities due to accidents. With the emergence of 5G technology, vehicle networking is improving day by day. Tesla, the most famous company for automated vehicles, sold 2,20,00 units worldwide in 2019. IoV fuels the dream of smart cities.
A three-layer architecture defines different technologies involved in IoV. The first layer describes the data collected from various sensors about the driving patterns, vehicle positions, environmental conditions etc.

The second layer, the communication layer, cites the role of connectivity via strong networks like Bluetooth, LTE, Wi-Fi etc., in different modes like Vehicle-to-Vehicle, Vehicle-to-infrastructure, Vehicle-to-Pedestrian and Vehicle-to-Sensors.
The third layer defines the joint working of storage and big-data based technologies to perform decision-making about different risk situations like traffic congestion and accidents.

Automated vehicles are vulnerable to cyber-attacks—for example, the interconnectivity among the various modules like the brake-system, on-off the car. Any intrusion or hacking of the data by an attacker leads to manipulation of the brake system or control over the car and lock/unlock the door, thus leading to serious accidents. Attack on the vehicle communication and sensor system would have dire consequences than a data breach. Any security breach in automated vehicles would have dreadful results on both passengers and drivers in the real world.

This article talks about the Controlled Area Network that works for connectivity of internal modules of the vehicle. The modules are connected by Electronic Control Units (ECU) responsible for information sharing among the other components. CAN is responsible for safe and efficient broadcast information between them in packets.

Interconnectivity among the vehicles poses possible risks of cyber security that may harm. Most commonly, authentication problems in messages, fabrication, DDoS attacks. On physical terms, problems like jamming of doors, manipulating speedometer values etc. Cyber security technologies provide a way to keep an eye on possible attacks in automotive via the implementation of intrusion detection systems. Intrusion detection aims to raise the alarm whenever an attack occurs. Tobias Christian Hoppe talked first about the deployment of IDS in automotive focused on the typical CAN network. Various researchers have explained the application of IDS at three positions CAN networks, ECUs and central gateways. IDS are of two types- Host-based and Network-based. Attaching the IDS to ECUs of the vehicle is an example of host-based IDS, similar to the implementation of IDS on a desktop. On the other hand, IDS monitor the onboard vehicle communication to identify the possible attacks in central gateways and the CAN network exemplify Network-based IDS.

Comparative to Open System Interconnections networking layers, Controlled Area Networks works on the first two layers i.e., physical and data link layers. ECUs (example, Antilock Braking System, Power Control Module etc.) transmit packets with information about the vehicle's current state. Here is the data frame information of the CAN protocol.

SLR	11 Bit IDENTIFIER	RTR	IDE	r0	DLC	0-8 Bytes DATA	CRC	ACK	EOF	IFS

The arbitration or identity field or 11-bit identifier, identifies each frame. Higher is the priority when ID number is low, to the frame during concurrent communication among multiple ECUs. RTR bit signifies remote communication requesting any information from any other ID. The Data field actually carries the message (up to 8 bytes) and each piece of information in the message is called signal.

So basically, an intrusion detection-based security system aims to detect and alert whenever any malicious activity happens. Machine learning techniques are suitable for this. Nowadays, transfer learning and unsupervised learning are being tested apart from supervised learning, and many deep learning approaches. More specifically, deep learning techniques are paving a new way for more efficient and robust detection mechanisms for powerful security, ensuring the seamless and rigorous working of IoV.

At last, hope this article successfully develops inquisitiveness on IoVs and provides a brief understanding. IoV is very vast and exciting and here, only a part of security concern is discussed. So, it would be great to explore IoV and implement cyber security in it.

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ACHIEVEMENTS

Following is list of achievements of students of Applied Mathematics and Computer Science:

1. **Shreyan Sharma (M.Sc. Mathematics 2nd year)**
    - Won Gold medal for scoring highest marks in Mathematics Department in year 2020-21.

2. **Shreya Mishra (B.Sc. Mathematics 3rd year)**
    - Won Gold medal & Guru Ghasi das medal for scoring highest marks in year 2020-21.
    - Attended mini-MTTS 2019.
    - Qualified BHU PET for masters.

3. **Lalbahadur Sahu (B.Sc. Mathematics 3rd year)**
    - Won Gold medal for scoring highest marks in Mathematics department in 202-21.
    - Qualified JAM by AIR 44 and secured a seat in IIT Bombay.

4. **Gagan Soni (B.Sc. Mathematics 3rd year)**
    - Qualified JAM by AIR 333 and secured a seat in IIT Madras.

5. **Sagar Ratnakar (B.Sc. Mathematics 3rd year)**
    - Qualified JAM and secured a seat in IIT Bhubaneswar.

6. **Om Rathore (B.Sc. Mathematics 3rd year)**
    - Qualified for Hyderabad university by 32-Rank.

7. **Pankaj Arya (B.Sc. Mathematics 3rd year)**
    - Attended mini-MTTS programme 2020.
    - Attended MTTS programme 2021.

8. **Adarsh Sahu, MCA**
    - Won Gold medal for scoring highest marks in MCA course of CSIT Dept. in year 2020-21.

9. **Bhupendra Dewangan, MSc,(CS)**
    - Won Gold medal for scoring highest marks in MSc(CS) course of CSIT Dept. in year 2020-21.

10. **Bhupendra Dewangan and Harish Dewangan, MSc.(CS)**
    - Qualified NET(Lectureship) exam in the year 2020.

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