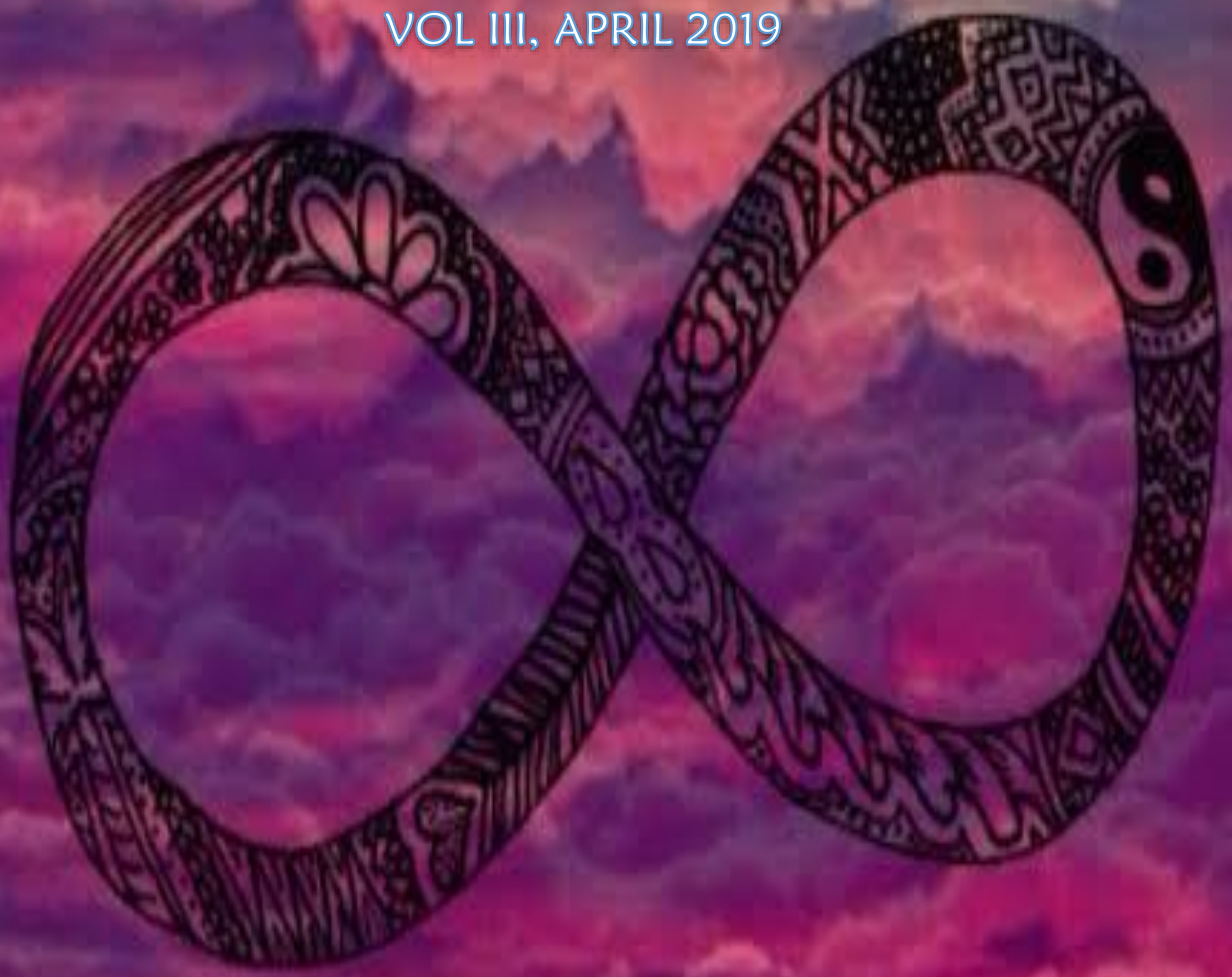
ANANTYA

. . . Beyond Infinity

VOL III, APRIL 2019



DEPARTMENT OF MATHEMATICS, STATISTICS & COMPUTER SCIENCE

MATA SUNDRI COLLEGE FOR WOMEN

(UNIVERSITY OF DELHI)

MATA SUNDRI JI

Sikh women have played a constructive, significant and positive role in Sikh history, equal to men and yet they haven't won a whisper of recognition from the historians.

One such woman was Mata Sundri ji, born on 23rd Dec., 1667 and was popularly known as "The Great Mother of Khalsa", amongst the Sikh masses. She was the daughter of Bhai Ram Saran, a Kumarav Khatri of Bijvara, in present day Hoshiarpur district of the Punjab. She was married to Guru Gobind Singh ji on 4th April 1684 at Anandpur.

Mata Sundri ji was recognized as a capable successor and leader of the Panth, as she took the responsibility of all the tasks after the demise of her husband, Guru Gobind Singh ji. Mataji established a Training Academy at Amritsar, headed by Bhai Mani Singh, and thereby played a commendable role in teaching of Sikh scriptures and religious values. She completed a formidable challenge of compiling the works and writing of tenth Guru, entitled Vidya Sagar, which is now known as Dasam Granth. She had spent all her years in leading the Sikh Panth. She was the accepted mediator and judge for the Sikhs. She was a remarkable personality of strong principles and adhered to a strict code of conduct. Another achievement of Mata Sundri was the protection of the building of Gurdwara Rakab Ganj, the last resting place of Guru Tegh Bahadur.

All the Sikhs all over India were considered by Mata Sundri to be her children and she kept in constant touch with them through her edicts such as those addressed to the Sikhs in Patna (Bihar) and the Jamania Sikh assembly. Sikhs from Kabul and Kandahar came to visit her and take her blessings.

Mata Sundri ji is the epitome of selflessness and austerity. She will always shine like a star and will guide the people to the right path.

We bow our heads as a mark of respect before the greatness of her soul.

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PRINCIPAL'S DESK

As the old proverb says 'it takes a village to raise a child', is one that rings true for me and with this in mind I believe it is the exceptional quality of our staff, and the nurturing relationships with our students that make a difference for each child. We are all stronger together.

It gives me immense pleasure to pen a few words for 'ANANTYA: Beyond Infinity', the magazine of the department of Mathematics, Statistics and Computer Science exclusively meant for churning out the latent writing talent which bears great potentiality of sharpening your skills as part of your overall personality development. I congratulate all the contributors and the editorial board for bringing out such a beautiful magazine.

Such academic endeavors not only provide opportunity to the faculty to present their ideas and opinions in a logical sequential manner but also, enable the students to unravel their creativity. It is a commendable effort so as to develop valuable skills in the students and for them to become more confident in putting their opinions on the front.

I feel proud being the Principal of such a wonderful institution dedicated to the causes of better India. Come on let's give our best and make this institution a modern temple of learning through our diligence, devotion and dedication.

Let us bow our heads before the Almighty for His blessings. Wishing you all the best…!

Dr. Harpreet Kaur
(Principal)

FROM THE EDITORS' DESK

As the cold winter breeze gives way to sprightly saplings signaling the coming of spring, we bring our department magazine 'ANANTYA: Beyond Infinity'.

Very few have fully realized the wealth of sympathy, kindness and generosity hidden in the soul of a child. The effort of every educator should be to unlock that treasure and Mata Sundri College for Women is an excellent example where everyone strives indefatigably for this. This institution has been nurturing young minds for the past 50 years with the belief that 'the heart of education is the education of the heart'.

We are pleased to present to you the third edition of 'ANANTYA', magazine by departments of Mathematics, Statistics and Computer Science of Mata Sundri College for Women. Enjoy every moment you have because in life there aren't rewinds, only flashbacks. For you, we have worked hard to bring up an exhilarating flashback of the inception of our department, its history and the events and achievements during the session 2018-2019.

The team hopes to build on this ethos just as much during the upcoming academic years. Hope you like our efforts and get inspired for a new beginning!

-Dr. Ramita Sahni (Assistant Professor-Mathematics)

-Chamandeep Kaur & Simran Minocha

FROM THE DESK OF TEACHER IN-CHARGE

It gives me immense pleasure to pen down few words for the third edition of **'Anantya: Beyond Infinity'.** Each issue of our e-magazine is a milestone that marks our growth, unfolds our imaginations and gives life to our thoughts and aspirations.

Nurturing creativity and inspiring innovation are two of the key elements of a successful education, and this platform is the perfect amalgamation of both. It harnesses the creative energies of the academic community, and distils the essence of their inspired imagination in the most brilliant way possible. The 3rd edition is a combined effort of our Department Society- '**Asymptote**', dedicated teachers of Departments of Mathematics, Statistics and Computer Science and hardworking students.

The session 2018-2019 was indeed a special session for the Department as it conducted various interesting events. we organized Digital India Workshop on 12th September 2018, career oriented- Python workshop was organized on 28th September, a movie screening on "Imitation Game" was held on 31st October 2018 and moreover the Annual departmental event- MASTACOM'19 was held on 19th January 2018.

I congratulate the students and faculty members who are associated to bring out the e-magazine in the present commendable form. I am sure the Department Society ASYMPTOTE will continue to bring out future editions periodically of the e-magazine.

Teacher In-Charge

Ms. Sonia Aneja

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- Ms. Gurinder Jit Kaur
- Ms. Mandeep Walia
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- Dr. Rashmi Verma
- Ms. Gurpreet Kaur
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Computer Science

- Ms. Priyanka Gupta
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ANNUAL REPORT

Department of Mathematics, Statistics and Computer Science
Session 2018-2019

Awareness Workshop on Digital India Initiative

The "Awareness Workshop on Digital India Initiative" was jointly organized by the departments of Mathematics, Statistics and Computer Science, Mata Sundri College for Women (University of Delhi) on 12th September 2018 at Mata Sahib Kaur auditorium in the college premises. It was conducted by CSC e-Governance Services India Limited. The distinguished speakers for the event were Ms. Bhagwati Jamnal, Manager–Education, CSC e-Governance Services India Limited and Mr. Omveer Chaudhary, Manager–Education, CSC e-Governance Services India Limited.

The workshop was attended by more than 300 college students and faculty members. The objective of the workshop was to spread awareness about the Digital India Programme, which is a flagship programme of the Ministry of Electronics & Information Technology, Government of India and to showcase the impact of progress made by the CSC e-Governance Services India Limited under Digital India Initiative in delivering e-governance services and digital empowerment schemes.

Speaking on the occasion, Ms. Bhagwati Jamnal talked about vision of Digital India programme to transform India into digitally empowered society and knowledge economy. She spoke about how the common service centres (CSCs) are becoming an access point for delivery of various e-governance & public utility services to people in rural areas of the country. During this session, some of the prominent citizen centric schemes under Digital India programme were showcased. These included PMG Disha which provides digital literacy training and research opportunities to students, Stree Swabhiman which strives to create awareness about women health & hygiene, Investor Awareness Project, Legal Literacy & Tele-Law to provide legal advice, Pradhan Mantri Jan Aushadhi Scheme providing tele health consultations and e-Pashu Chiktsa. She also shed some light on UMANG & BHIM App which would be extremely useful for the students.

The second session began with a film on Digital India. During this session, Mr. Omveer Chaudhary talked about opportunities & challenges for social entrepreneurship in Digital India Initiative. He informed students about Digital India Internship Programme, Ayushman Bharat Scheme, Electronic Development & Centre of Excellence on Internet of Things (IOT). He urged students to take part in CSC Campaign to Make India Green which aimed to spread awareness about importance of tree plantation for environment conservation.

This was followed by question-answer session where students and staff interacted with the speakers and asked various questions on Digital India Initiative taken up by the government. The students found the workshop extremely enlightening and informative. The event was a success and was well appreciated by one and all.

Introduction to Python - Hands on Analytics Workshop

Departments of Mathematics and Statistics Mata Sundri College for Women, University of Delhi jointly organized a full day- Hands-on learning workshop on "Introduction to Programming in Python" in partnership with Weekendr in Lab 3, on 28th September 2018 for about 70 students. The workshop started at 10 am and continued till 4 pm. This event was conducted by Mr. Vibhor Gupta, Founder and Director of Weekendr and Mobiquel and Co-Founder of Findow.

The workshop was divided into 5 sessions. In the first session, basic concepts of Python were covered at an introductory level -Variables and Assignment. Followed by loops- if-else, for and while in the next session. The third session included- lists, tuples, sets, dictionary, CSV reading to Python. The fourth session introduced the concept of data sciences using Python. Last but not the least, the last session covered some basic statistical concepts like Mean, Median and Mode using Numpy and some graphs like Linechart, Barchart and Bargraph using MatplotLib.

The workshop concluded with an interactive session between the students and the speaker. This workshop turned out to be a fruitful one and proved to be beneficial for the students in the field of machine learning.

At the same time, Department of Computer Science organized a workshop on Python Programming for their students. The Faculty for the event was Dr Nikhil Kumar Rajput, Assistant Professor at Department of Computer Science, Ramanujan College, and University of Delhi. It was attended by around 40 participants.

The objective of the workshop was specifically to introduce Python to students and help them learn to use it practically. The workshop was divided into two sessions. The first session introduced Basic fundamentals of Python. In the second session, its applications including Machine Learning (ML), Support Vector Machine (SVM) and Linear Regression were covered. Students created python scripts and worked on the data-sets to apply ML and SVM. The speaker interacted with the students on one-to-one basis and provided them with valuable tips on how they can use python as a tool for research and development. The students found the sessions beneficial and interesting as the Faculty shared his immense knowledge and expertise on the topic in an elaborate yet simple manner. The workshop was conducted as part of special technology-based training programmes, organized by Department of Computer Science, Mata Sundri College for Women, with an aim to help students improve and enhance their technical skills.

Movie Screening

The Department of Mathematics organized a movie screening on the "Imitation Game" on 31st October, 2018. It was an inter department event held in the Mata Sahib Kaur Auditorium from 12:00-3:00 PM.

The Imitation Game is a film based on Cryptographer Turing's life. Alan Turing was a manifestly unusual hero. In his professional life, he conceived of the modern computer before the technology to build it even existed. As a patriot, he helped win the Second World War, not by leading troops or firing bullets. The Germans used the Enigma machine (the greatest encryption device in history, used by the Germans for all major communications.) Alan used his knowledge of cryptography to build a machine that broke the Nazi's codes as part of a secret military operation. The movie inspired the students to realise how what the society thought about him did not affect him or his work and how his hard work made the world an infinitely better place precisely because he was extraordinary.

MASTACOM'19

Departments of Mathematics, Statistics and Computer Science of Mata Sundri College for Women, University of Delhi jointly organized the annual departmental one-day long event-MASTACOM'19 on 19th January 2019 from 10:00 AM to 4:00PM.

The event commenced at 10:00 AM in Mata Sahib Kaur Auditorium with inauguration ceremony that began with the College prayer, followed by welcome and introduction of the two Guest Speakers for the event, Prof. D. K. Lobiyal and Prof. Shobha Bagai by Ms Sonia Aneja, teacher-in-charge of Department of Mathematics. Dr. Harpreet Kaur, Principal, Mata Sundri College for Women, University of Delhi, in her welcome address, motivated the participants to make full utilization of the technical talks. She explained how the applications of mathematical concepts can be seen in the architectural design of Golden temple and other monuments. The event was attended by more than 250 students and faculty members.

The first technical talk was on "Mobile Communication", presented by Prof. D. K. Lobiyal, Dean, School of Computer & Systems Sciences, Jawaharlal Nehru University. In an informative session, he elaborated on the basic working, technologies and challenges of mobile communication, along with the brief history and applications of wireless networks. In the second talk titled "Problem-based learning in Mathematics", delivered by Prof. Shobha Bagai, Professor, Cluster Innovation Centre, University of Delhi, the focus was on helping the students learn about a subject through the experience of analyzing, discussing and solving a real-world problem. She discussed about the concept of Principal Component Analysis and the Lights out game. Some of the problems she discussed were taken up during the teaching assignment at Cluster Innovation Center. She emphasized how these problems led to research at undergraduate level. The talks concluded with an interactive session between the students and the speakers, followed by vote of thanks.

The talks were followed by a refreshment break for the students as well as the faculty members. Mastacom'19 proceeded with six fun-filled events, with two each, conducted in parallel sessions. Student-volunteers organized the events well, under the guidance of their Faculty coordinators. The students actively participated in these activity-based events, and showed much enthusiasm. The registration for the events began almost a week earlier. Each event had 2 prizes, one for the Winner and the second one for the runners up.

Following is the list of events with their rounds:

Event name	Event Time	Event Summary
MATH - ∏RATE : A MATHEMATICAL QUIZ	1:00 – 2:00 PM	A total of 18 teams, with 2 members each, participated in it. It began with a Prelims round consisting of MCQs, on the basis of which 10 teams qualified for Round-1, the Logical round. Then, 7 teams made it to Round-2 which was the Visual round. 5 teams reached the Final Round named "Take your pick". It was a blend of entertainment and enrichment of knowledge.
COOK - A-DOODLE	1:00 – 2:00 PM	It involved the use of artistic skills of students and encouraged them to use their imagination. There were 18 participants who were given "career" as the word to include in their creativity.
MATHEMATICAL TAMBOLA	2:00 – 3:00 PM	Mathematical equations were given which participants had to solve to get the number for tambola. Overall, 50 students participated in it. It tested the problem-solving ability and cognitive skills of participants.
MINUTE TO WIN IT	2:00 – 3:00 PM	A total of 13 teams, with 2 members each, participated in it. One minute was given to each team, to guess a clue, match the clock, and sell a product, thereby; making many interesting rounds that even the judges enjoyed watching. It indeed involved the skill of time management by the team members.
TREASURE HUNT	3:00 – 4:00 PM	It was a time-bound activity and 28 teams, with 3 members each, participated in it. There were three rounds, with elimination in each round. Various parts of college premises were used to place the clues. Students worked with verve and vigour to reach the next clue. It involved tremendous team work and coordination among the team members.
CLICK YOUR HUNT	3:00 – 4:00 PM	There were 14 teams, each having 3 participants. The three rounds made the students buzz their brains, solve the riddles and click the clues, followed by a fun-game to play.

Adieu to Gurinderjit Ma'am

On 28th February, 2019 Ms Gurinderjit Kaur Ma'am (Department of Mathematics) retired from this institution after completing 40 years in service. She left no stone unturned in this beautiful journey. She was the most hardworking, sincere, and genuine faculty member of our department. We wish her all the best for her upcoming years. Thank you, ma'am for everything.

Career Talk

A talk on "Career Opportunities in the Entertainment Industry - The Art and Science of Animation" by Dr. Jagmohan Rai (Associate Professor, PGDAV College, Delhi University) was held on 28th March, 2019 at 12 noon in Mata Sahib Kaur Auditorium. The purpose of the talk was to apprise the students with the applications of Mathematics and Computer Science in the entertainment industry. The cinema of today, traditional as well as the animated movies, is highly dependent on CGA - Computer Generated Art, which in turn uses tools from both mathematics and computer science. The Visual Effects shown in Bahubali and so many other movies are examples of the use of these sciences in cinema. The talk mainly focused on the animation industry and types of job opportunities it offers. The students had an interactive session with the speaker and gained utmost knowledge in the subject and enjoyed.

MATHEMATICS

MATHEMATICS NEWS 2018

-Compiled by Dr. Preeti

2018 saw many developments in the field mathematics worldwide.

Largest prime number ever found has over 23 million digits. Through a collaborative effort, utilizing computers distributed around the world, Mathematicians discovered that the number $2^{77,232,917} - 1$ is prime. The new prime number, known as M77232917, is one million digits larger than the previous record. It is also a particularly rare type of prime called *a* Mersenne prime, meaning that it is one less than a power of two. The discovery was made by a computer volunteered by *Jonathan Pace*, as part of the Great Internet Mersenne Prime Search (GIMPS). The mathematics world had been abuzz over the news that Sir Michael Atiyah, the famous Fields Medalist and Abel Prize winner, claimed to have solved the Riemann hypothesis. Although, the work presented by Atiyah didn't constitute a proof of the Riemann Hypothesis and was later discarded by Mathematicians around the world. Atiyah's by no means was the first claimed proof of the Riemann Hypothesis of recent years; many end up in the wastepaper bins of academic mathematicians around the world, who get sent them in handfuls. Only some claimed proofs get this level of attention though, and this one has been somewhat unique in that it was taken a lot more seriously than usual.

Urmila Mahadev, a graduate student at UC Berkeley, who developed a protocol that uses classical cryptography to verify quantum computations. Mahadev's result gives a method to check whether the results of a quantum computation are correct using only the power of classical computation.

Another important result in quantum computing came from Ewin Tang, an 18-year old recent graduate of the University of Texas, Austin. From prior results in quantum computing it was thought that a certain Netflix-type recommendation algorithm was a strong candidate for exponential speedup with quantum algorithms as opposed to classical algorithms. But in this paper, Tang showed that this is not actually the case, by giving a "quantum-inspired" classical algorithm.

In a study, Ben-David and his colleagues from University of Waterloo considered a learning model called estimating the maximum (EMX), which captures many common machine learning tasks. The research found that no mathematical method would ever be able to tell, given a task in that model, whether an AI-based tool could handle that task or not.
Sadly, this year marked the passing of some pioneering figures in mathematics.

Fields medalist and Abel prize winner Prof Sir Michael Atiyah, died at the age of 89. He has been described as the best mathematician since Sir Isaac Newton. Sir Michael was best known for his co-development of a branch of mathematics called topological K-theory and the Atiyah-Singer index theorem. His research also involved deep insights relating to mathematical concepts known as "vector bundles". His work in these areas has helped theoretical physicists to advance their understanding of quantum field theory and general relativity.
Peter Swinnerton-Dyer who made important contributions to number theory, most famously the Birch and Swinnerton-Dyer Conjecture also passed away this year.

References:

1. *The Daily Newsletters New Scientist and The Conversation.*
2. *American Mathematical Society Blogs*

DATA SCIENCE: A NEW REVOLUTION

-Dr. Ramita Sahni

Data is the New Oil

Data Science is the science which uses computer science, statistics and machine learning, visualization and human-computer interactions to collect, clean, integrate, analyze, visualize, and interact with data to create data products.

Data science is a blend of skills in three major areas:

1. **Hacking Skills**- i.e., creativity and ingenuity in using technical skills to build things and find clever solutions to problems.
2. **Math & Statistics Knowledge**- At the heart of mining data insight and building data product is the ability to view the data through a quantitative lens. There are textures, dimensions, and correlations in data that can be expressed mathematically and statistically.
3. **Substantive Expertise**

A vast field, data science uses a lot of theories and techniques that are a part of other fields like information science, mathematics, statics, chemometrics and computer science. Some of the methods used in data science include probability models, machine learning, signal processing, data mining, statistical learning, database, data engineering, visualization, pattern recognition and learning, uncertainty modeling, computer programming among others.

Lifecycle of Data Science

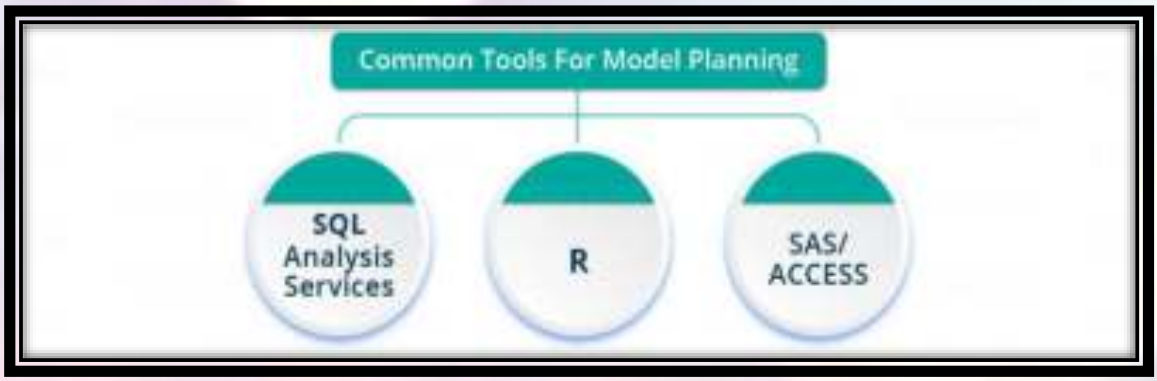
A common mistake made in Data Science projects is rushing into data collection and analysis, without understanding the requirements or even framing the business problem properly. Therefore, it is very important to follow all the phases throughout the lifecycle of Data Science to ensure the smooth functioning of the project.

Here is a brief overview of the main phases of the Data Science Lifecycle:

Phase 1- Discovery: Before beginning the project, it is highly important to understand the various specifications, requirements, priorities and required budget. In addition to this, a data scientist should have the required resources in terms of manpower, technology, time and above all the data to support the project. Framing and formulation of initial hypotheses is done in this phase.

Phase 2- Data preparation: Exploration, preprocessing and conditioning of data is done prior to the modeling. Basically, an analytical sandbox is required so as to perform analytics for the entire duration.

Phase 3- Model planning: In this phase, the methods and techniques are considered to draw the relationships between variables. These methods, in addition set the base for the algorithms which are implemented in the next phase. Some of the model planning tools is depicted in the following flowchart.



1. **R** has a complete set of modeling capabilities and provides a good environment for building interpretive models.
2. **SQL Analysis services** can perform in-database analytics using common data mining functions and basic predictive models.
3. **SAS/ACCESS** can be used to access data from Hadoop and is used for creating repeatable and reusable model flow diagrams.

Although, many tools are present in the market but R is the most commonly used tool. In addition to the above mentioned, there are tools like Excel, Minitab, Python, Tableau etc.

Phase 4- Model building: In this phase, datasets are developed for training and testing purposes. Several algorithms and learning techniques like classification, association and clustering to build the model.

Phase 5- Operationalize: In this phase, final reports, briefings, technical documents etc. are delivered. This will provide you a clear picture of the performance and other related constraints on a small scale before full deployment.

Phase 6- Communicate results: In the last phase, all the key findings are identified and are communicated to the stakeholders. Also, this phase plays a key role in determining the results of the project whether success or failure based on the criteria developed in Phase 1.

Important Subjects

Data science has become a new career field for the blooming youngsters. To pursue a career in this field, the aspirant should possess knowledge of the following subjects:-

- Statistics
- Econometrics
- Probability Theory
- Optimization
- Matrix Algebra
- Basics of Programming
- Analytical Skills
- Great Levels of Curiosity, Interest in reading and analyzing market trends, Mergers & Acquisitions, Decisions being taken by firms today.

Software Knowledge

For data scientist knowledge of atleast one software is essential. It's not necessary to know all of them but an intermediate working knowledge of any one of them is a testimony that you'll be able to pick the rest.

- R
- Python
- SAS
- SQL

Recruiters for Data Scientists

These days it seems like everyone wants a Data Scientist, and for a good reason. Harvard University labeled this profession "the sexiest job of the 21st century." And according to LinkedIn, the career has seen an exponential growth becoming the second fastest growing profession. Data scientist is something for which almost every growing company is ready to hire. There are many MNC's and startups for this field.

Some MNC's are

- Barclays
- Walmart
- Deloitte
- Mc. Kinsey & Company
- Gartner
- Citigroup
- Ernst & Young etc.

Some Startups are

- Snapdeal
- Paytm
- Oyo
- Ola
- Zomato
- Flipkart
- ZOHO
- Practo etc.

Message for Aspirants

- Think and react logically
- Have basic statistical knowledge
- Have intermediate knowledge of at-least one analytics tool.
- There is no limit to learning analytics, only that we need to find our interest areas be it R/SAS/Python, and our domain of interest eg. banking, insurance etc.

Inspired by Geniuses: Lives and Work of Trailblazing Mathematicians

- Sheenu Teotia

"Mathematics reveals its secret only to those who approach it with pure love, for its own beauty." This quote by Archimedes undoubtedly holds true for majestic mathematicians like Srinivasa Ramanujan, Ada Lovelace, Bertrand Russell, Karl Pearson, Bernhard Riemann, G.H. Hardy, William Thomson and the list goes on.


Srinivasa Ramanujan


Bertrand Russell


Ada Loveace


G H Hardy


Bernhard Riemann

Srinivasa Ramanujan was an Indian mathematician who made significant contributions to mathematical analysis, number theory, and continued fractions. What made his achievements really extraordinary was the fact that he received almost no formal training in pure mathematics and started working on his own mathematical research in isolation. Born into a humble family in southern India, he began displaying signs of his brilliance at a young age. He excelled in mathematics as a school student, and mastered a book on advanced trigonometry written by S. L. Loney by the time he was 13. While in his mid-teens, he was introduced to the book 'A Synopsis of Elementary Results in Pure and Applied Mathematics' which played an instrumental role in awakening his mathematical genius. By the time he was in his late-teens, he had already investigated the Bernoulli numbers and had calculated the Euler–Mascheroni constant up to 15 decimal places. After years of struggling, he was able to publish his first paper in the 'Journal of the Indian Mathematical Society' which helped him gain recognition. He moved to England and began working with the renowned mathematician G. H. Hardy. Their partnership, though productive, was short-lived as Ramanujan died of an illness at the age of just 32. He was elected a Fellow of the Royal Society in 1918, as one of the youngest Fellows in the history of the Royal Society. He was elected "for his investigation in Elliptic functions and the Theory of Numbers. The same year, he was also elected a Fellow of Trinity College—the first Indian to be so honored.

Bertrand Arthur William Russell was one of the finest names in the list of great philosophers, logicians, mathematicians, historian, and social critics from Great Britain. He was also a proud receiver of the Nobel Prize in Literature in 1950.In 1900s, Russell escorted the British "revolt against idealism". Russell is also believed to be the founder of the analytic philosophy, accompanied by his ancestor Gottlob Frege and apprentice Ludwig Wittgenstein. Russell's famous philosophical essay "On Denoting" has been acknowledged as a "paradigm of philosophy". Russell was also a remarkable anti-war activist and also imprisoned for carrying a pacifist activism during World War I. Eventually, he also raised voice against Adolf Hitler and criticized Stalinist totalitarianism. He even campaigned against the involvement of United States in the

Vietnam War. Russell also acted as a blunt supporter of nuclear disarmament. The works of Bertrand Russell had a noticeable impact on logic, mathematics, set theory, linguistics and specifically on philosophy of language, epistemology, and metaphysics. Russell was elected a fellow of the Royal Society in 1908, and elected a Lifetime Fellow of Trinity College in 1944.He was also awarded the De Morgan Medal of the London Mathematical Society in 1932, Sylvester Medal of the Royal Society in 1934, Kalinga Prize in 1957 and Jerusalem Prize in 1963.

Ada Lovelace is known for her mathematical works in collaboration with the "Father of the Computer", Charles Babbage. She was initiated into the profession by her mother, who feared that poetry would spoil the young woman's morals, just as it did for Ada's father, Lord Byron. Ada Lovelace was a brilliant mathematician, known mainly for the assistance she provided to Charles Babbage on his 'Differential Engine' and 'Analytical Engine'. She wrote the world's earliest algorithm for the 'Analytical Engine', which allowed the machine to calculate 'Bernoulli numbers'. Her mathematical writings were much appreciated by eminent people like Michael Faraday. Despite a short life, Lovelace left her mark in the history of mathematics and computers.

Godfrey Harold Hardy was an English mathematician, famous for his contributions to number theory and mathematical analysis. He was also a great collaborator and had authored or coauthored more than 300 papers and 11 books. He is best remembered for his work on 'Hardy–Ramanujan asymptotic formula' and 'Hardy–Littlewood circle method,' while in biology, he is famous for his work on 'Hardy–Weinberg principle', which deals with population genetics.

Georg Friedrich Bernhard Riemann was a German mathematician, known for his contribution to differential geometry, number theory and complex analysis. He moved to the University of Berlin to study mathematics under eminent teachers. He lived for only thirty-nine years but within this short span of time, he contributed significantly to various branches of mathematics, changing the course of future research works and laying the foundation of Einstein's relativity theory. He is best remembered for his novel approaches to the study of geometry. He is also famous for his contributions to the theory of functions, complex analysis, and number theory. His works inspired Eugenio Beltrami to produce a description of non-Euclidean geometry and provided the mathematical foundation for Albert Einstein's theory of relativity.

As it can be seen from the lives of the above mathematicians the most important thing for a young mathematician is to be patient and persistent. When thinking about a problem, perhaps the most useful device one can employ is to bear the problem in mind all the time: it worked for Newton, and it has worked for many a mortal as well. Do not be afraid to make mistakes. A mistake for a chess player is fatal; for a mathematician it is part of the course. What one should be terrified of is a blank sheet in front of you after having thought about a problem for a little while. Summing up the advice, I could hardly do better than recall what Vitruvius wrote over two thousand years ago: "For neither genius without learning nor learning without genius can make a perfect artist."

THE CONGRUENCE RELATION & ITS APPLICATIONS

-Dr. Rashmi Verma

Abstract. The congruence relation has been extensively used in proving results in classical and modern algebra as well as in developing algorithms as per technological requirements of the society. Several results and applications of the congruence relation in areas viz., cryptography, coding theory and number theory have been discussed.

1. Introduction

The divisibility rule of a number and the bar code of a product may appear quite unrelated to each other; the first being a theoretical concept of number theory which was in existence as early as third century and the latter is one of the many significant contributions of coding theory to the real world in the twentieth century. The congruence relation is intimately related to not just these two but a number of theoretical concepts and concrete applications in real world traversing centuries of time and diverse areas of mathematics and computer science.

Though the Chinese mathematician Sunzi (3rd Century A.D.) gave a theorem popularly known as Chinese Remainder Theorem in his book *Sunzi Sauanjing*, the notion of congruence was first introduced and used by Gauss (1801) in his book *Disquisitiones Arithmeticae*. The work by Sunzi contains neither a proof nor a full algorithm and an algorithm for solving this problem was described by Aryabhatta in sixth century A.D. Modular mathematics is a powerful tool that has been used to test for divisibility by a number. These rules are important in mathematics as they save lots of time and effort. Leonardo Fibonacci, in his book *Liber Abaci* has given the divisibility rules for numbers 7, 9 and 11. Martin Gardner (1962) explained and popularized divisibility rules in a column "Mathematical Games" in Scientific American. During the early twentieth century, electromechanical machines were invented to do encryption and decryption using transposition, poly alphabetic substitution and a kind of additive substitution. Wallace Flint (1932), Bernard Silver and Norman Joseph Woodland (1949), David Whitaker (1967), Kottay (1968), George Laurer (1969), William Bill course (1971), Baumeister (1972), and many other researchers have used congruence to develop algorithms to solve real world problems.

Section 2 gives an overview of the congruence relation. In section 3, applications of the congruence relation have been discussed. Section 4 presents conclusion.

2. The Congruence Relation

We define the congruence relation and state few results required to discuss applications of this relation.

Definition 2.1. Let $n > 1$ be a fixed natural number. Given integers a and b, a is said to be congruent to b modulo n, denoted by $a \equiv b(mod\ n)$, if and only if $n \mid (a - b)$.

n is called the modulus of the congruence. We also say a is congruent to b mod n.

Theorem 2.1. *Let $n > 0$ be a fixed integer and a, b, c, d be arbitrary integers. Then the following properties hold:*

(i) $a \equiv a(mod\ n)$.

(ii) *If* $a \equiv b(mod\ n)$, *then* $b \equiv a(mod\ n)$.

(iii) *If* $a \equiv b(mod\ n)$ *and* $b \equiv c(mod\ n)$, *then* $a \equiv c(mod\ n)$.

(iv) *If* $a \equiv b(mod\ n)$ *and* $c \equiv d(mod\ n)$, *then* $(a + c) \equiv (b + d)(mod\ n)$ *and* $ac \equiv bd(mod\ n)$.

(v) *If* $a \equiv b(mod\ n)$, *then* $(a + c) \equiv (b + c)(mod\ n)$ *and* $ac \equiv bc(mod\ n)$.

(vi) *If* $a \equiv b(\mathrm{mod}\, n)$, *then* $a^k \equiv b^k(\mathrm{mod}\, n)$ *for any positive integer k.*

As a binary relation on **Z**, (i), (ii) and (iii) properties ensure that the congruence relation is an equivalence relation. The equivalence classes of congruence mod *n* are called congruence classes defined as follows:

Definition 2.2. The congruence class mod *n* of an integer *a*, denoted by [*a*], is the set of all integers to which *a* is congruent mod *n*. Thus,

$$[a] = \{b \in \boldsymbol{Z} \mid a \equiv b(\mathrm{mod}\, n)\}.$$

Theorem 2.2. *Let a, b and n be integers with n > 1. Then the following statements are equivalent.*

(i) $n \mid (a - b)$
(ii) $a \equiv b(\mathrm{mod}\, n)$
(iii) $a \in [b]$
(iv) $b \in [a]$
(v) $[a] = [b]$

Theorem 2.3. *If* $ca \equiv cb(\mathrm{mod}\, n)$ *and gcd (c, n) = d, then* $a \equiv b(\mathrm{mod}\, n/d)$.

Theorem 2.4. *If* $ca \equiv cb(\mathrm{mod}\, n)$ *and gcd (c, n) = 1, then* $a \equiv b(\mathrm{mod}\, n)$.

Theorem 2.5. *If* $ca \equiv cb(\mathrm{mod}\, p)$ *and p is not a factor of c where p is a prime number, then* $a \equiv b(\mathrm{mod}\, p)$.

Theorem 2.6. *Let* $P(x) = \sum_{k=0}^{m} c_k x^k$ *be a polynomial function of x with integral coefficients* c_k.

(i) *If* $a \equiv b(\mathrm{mod}\, n)$, *then* $P(a) \equiv P(b)(\mathrm{mod}\, n)$.
(ii) *If a is a solution of* $P(x) \equiv 0(\mathrm{mod}\, n)$ *and* $a \equiv b(\mathrm{mod}\, n)$, *then b is also a solution.*

3. ***Applications***

The congruence relation has widespread applications in several areas of mathematics. In this section we discuss few applications of the congruence relation in cryptography, coding theory and number theory.

3 .1 Ciphers.

In cryptography, a cipher is an algorithm for performing encryption or decryption of a message. A cipher generally substitutes the same number of characters as are in the given message. Caesar cipher is a type of substitution cipher in which each alphabet is shifted by a predefined number of places. Caeser shifted the alphabet by three places. The correspondence between letter of the original message or plaintext and the letter of the encrypted message or ciphertext is as follows:

Letter	A	B	C	D	E	F	G	H	I	J	K	L	M
Number	D	E	F	G	H	I	J	K	L	M	N	O	P
Letter	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Number	Q	R	S	T	U	V	W	X	Y	Z	A	B	C

If the message in plaintext is ALL THE BEST, then ciphertext of this message is DOO WKH EHVW. Mathematically, we assign a number to each alphabet as follows:

Letter	A	B	C	D	E	F	G	H	I	J	K	L	M
Number	0	1	2	3	4	5	6	7	8	9	10	11	12
Letter	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Number	13	14	15	16	17	18	19	20	21	22	23	24	25

If *x* represents number of a letter of the plaintext and *y* the number of corresponding letter of the ciphertext, then Caeser cipher can be expressed as

$$y - x \equiv 3(mod\ 26).$$

Generalizing Caeser cipher, we get the equation

$$y - ax \equiv b(mod\ 26),$$

Where a and b are integers, "ROT13" is a special case of Caesar cipher with $a = 1$ and $b = 3$ which is widely used in online settings to hide joke punch lines, puzzle solutions etc.

Example: 3.1. Let $a = 3$ and $b = 2$, then the equation is $y - 3x \equiv 2(mod\ 26)$. If the message in plaintext is ALL THE BEST. The corresponding letter in cipher text is computed as follows:

Plaintext	A	L	T	H	E	B	S
X	0	11	19	7	4	1	18
y	2	9	7	23	14	5	4
Ciphertext	C	J	H	X	O	F	E

The ciphertext of this message is CJJ HXO FOEH.

Vigenere cipher is more sophisticated than simple substitution. In this cipher, a word or phrase is used as the secret key. Using the number for each letter as in Caeser cipher, let x, y and z represent numbers corresponding to letters in plaintext, key and cipher text respectively. The equation of this cipher is

$$z \equiv (x + y)mod26.$$

Example: 3.2. If the message in plaintext is ALLTHE BEST and the key is BLESS.The corresponding letter in ciphertext is computed as follows:

Plaintext	A	L	L	T	H	E	B	E	S	T
X	0	11	11	19	7	4	1	4	18	19
Key	B	L	E	S	S	B	L	E	S	S
Y	1	11	4	18	18	1	11	4	18	18
Z	1	22	15	11	25	5	12	8	10	11
Ciphertext	B	W	P	L	Z	F	M	I	K	L

The ciphertext of given message is BWP LZF MIKL.

In other words, each letter is encrypted with a Caeser cipher, the encryption being a cyclic shift of the alphabet, but with different letters shifted by different amounts. This cipher is an improvement over Caeser cipher or in general, substitution cipher. A letter of plaintext, if repeated, is usually encrypted differently. Also, a letter in ciphertext, if repeated, may represent different letters of plaintext.

A one-time pad is a cipher which may be used if the message is conveyed in a digital form expressed as a sequence of zeros and ones only. The key is a random binary string. The ciphertext is obtained by the equation

$$z \equiv (x + y)mod2,$$

Where, x, y and z denotedigitsof plaintext, key and ciphertext respectively.

Example 3.3. Suppose that the given message is 01001110100 and key is 10111101000.

Plaintext	0	1	0	0	1	1	1	0	1	0	0
Key	1	0	1	0	1	1	0	1	0	0	0
Ciphertext	1	1	1	0	0	0	1	1	1	0	0

The ciphertext is 11100011100.
Though the one-time pad is secure against cryptoanalysis, a limitation of one-time pad is that it is usually difficult and expensive to transport the key to intended recipient for decryption.

3.2. Identification Numbers.

In coding theory, a message is encrypted as a code where the input digits are appended by adding more digits called as check digits. These check digits empower a code with error detection and correction capability. Over the past few decades several identification numbers have been developed with the last digit as check digit and thus single error can be detected. International Standard Book Number (ISBN) is assigned to a book to identify the country of publication, the publisher and the book. Introduced as a 9-digit number in 1967, it was modified as a 10-digit number in 1970. In 2007, the number length has been increased to 13. In a 10-digit or 13-digit ISBN, the digits except the last digit of an ISBN contain relevant information. The last digit is a check digit that helps to identify if a given ISBN is correct. In a 10-digit ISBN $a_1a_2\ldots a_{10}$, the first nine digits a_1, a_2,…, $a_9$are in the range 0—9, anda_{10} is chosen in the range
0—10 such that

$$\sum_{i=1}^{10}(11-i)a_i \equiv 0(mod\ 11).$$

If a_{10} is 10, it is denoted by X.
In a 13-digit ISBN $a_1a_2\ldots a_{13}$, each a_i is chosen in the range 0—9 and a_{13} is chosen such that
$a_1 + 3a_2 + a_3 + 3a_4 + \ldots + a_{11} + 3a_{12} + a_{13} \equiv 0(mod\ 10)$.

Example: 3.4. (i) Is there any book with ISBN 0-13-092001-2?
$10(0) + 9(1) + 8(3) + 7(0) + 6(9) + 5(2) + 4(0) + 3(0) + 2(1) + 1(2) = 101 \equiv 2(mod\ 11)$.
Therefore, the given number is not an ISBN.
(ii) The first twelve digits of an ISBN are 978-0-306-40615, what is the check digit?
$9 + 3(7) + 8 + 3(0) + 3 + 3(0) + 6 + 3(4) + 0 + 3(6) + 1 + 3(5) + a_{13} = 93 + a_{13} \equiv 0(mod\ 10)$which gives check digit as 7.
It is worth noting that single errors can be detected but errors in two digits might go undetected as illustrated in following example.

Example: 3.5. If an ISBN 978-0-306-406157 is wrongly copied as 973-0-806-406157, then $9 + 3(7) + 3 + 3(0) + 8 + 3(0) + 6 + 3(4) + 0 + 3(6) + 1 + 3(5) + 7 = 100 \equiv 0(mod\ 10)$. Thus, no error shall be detected.

Universal Product Code (UPC) or bar code is used to identify the sale of goods. The number is represented as a pattern of black and white stripes of various thickness. UPC is a 12 digit number $a_1a_2\ldots a_{12}$, with each a_i in the range 0—9, i = 1,2,…,12. The check digit is a_{12} chosen so that
$3a_1 + a_2 + 3a_3 + 4a_4 + \ldots + 3a_{11} + a_{12} \equiv 0(mod\ 10)$.

Example: 3.6. (i) Is there any article with UPC 0-64200-11589-6?
$3(0) + 6 + 3(4) + 2 + 3(0) + 0 + 3(1) + 1 + 3(5) + 8 + 3(9) + 6 \equiv 0(mod\ 10)$.
Therefore the given number is a UPC.
(ii) The first eleven digits of a UPC are 1-93452-60310, what is the last digit?
$3(1) + 9 + 3(3) + 4 + 3(5) + 2 + 3(6) + 0 + 3(3) + 1 + 3(0) + a_{12} \equiv 0(mod\ 10)$.
$70 + a_{12} \equiv 0(mod\ 10)$ which gives $a_{12} = 0$.

It is worth noting that single errors can be detected but errors in two digits might go undetected as illustrated in following example.

Example: 3.7. If a UPC 1-93452-60310-0 is wrongly copied as 1-43952-60310-0, then $3(1) + 4 + 3(3) + 9 + 3(5) + 2 + 3(6) + 0 + 3(3) + 1 + 3(0) + 0 \equiv 0(mod\ 10)$.
Thus no error shall be detected.
There are many other identification numbers with a specified congruence relation that are in use. Most of them are single error detecting as well. The US post office money order number is an eleven digit number $a_1a_2\ldots a_{11}$ with a_{11} as check digit and each a_i isin the range 0—9. The digits satisfy the following formula:

$$\sum_{i=1}^{10} a_i \equiv a_{11}(mod\ 9).$$

The US airline ticket number is a fifteen-digit number $a_1a_2\ldots a_{15}$ with a_{15} as check digit and each a_i is in the range 0—9. The digits satisfy the following formula:

$$\sum_{i=1}^{14} 10^{14-i}a_i \equiv a_{15}(mod\ 7).$$

The IBM scheme has identification number $a_1a_2\ldots a_n$ consisting of digits 0—9. It has variable length n. The digits satisfy the following formula:
$P[a_1] + a_2 + P[a_3] + a_4 + \cdots + P[a_{n-1}] + a_n \equiv 0(mod\ 10)$, if n is even
and
$a_1 + P[a_2] + a_3 + P[a_4] + \cdots + P[a_{n-1}] + a_n \equiv 0(mod\ 10)$, if$n$ is odd,
Where P is the permutation array $\begin{pmatrix} 0\,1\,2\,3\,4\,5\,6\,7\,8\,9 \\ 0\,2\,4\,6\,8\,1\,3\,5\,7\,9 \end{pmatrix}$.

3 .3 Results on Divisibility. We now prove some results using the congruence relation.

(i) 41 divides $2^{20} - 1$.

Proof. We know that $2^5 \equiv -9(mod 41)$. Using Theorem 2.1(vi) we get, $(2^5)^4 \equiv (-9)^4(mod 41)$. This implies $2^{20} \equiv -81 \times 81(mod 41)$. Also $81 \equiv -1(mod\ 41)$. Therefore $81 \times 81 \equiv 1(mod\ 41)$. Using Theorem 2.1(iii), we get the desired result.

(ii) Let $N = a_m10^m + a_{m-1}10^{m-1} + \ldots + a_1 10 + a_0$ be the decimal expansion of the positive integer N, $0 \le a_i \le 9$, and let $S = a_m + a_{m-1} + \ldots + a_1 + a_0$. Then 9 divides N if and only if 9 divides S.

Proof. Consider $P(x) = \sum_{i=0}^{m} a^i x^i$, a polynomial with integral coefficients. We know that $10 \equiv 1(mod\ 9)$. Using Theorem 2.6(i) we get $P(10) \equiv P(1)(mod\ 9)$ which gives $N \equiv S(mod\ 9)$. It follows from Theorem 2.6(ii) that $N \equiv 0(mod\ 9)$ if and only if $S \equiv 0(mod\ 9)$. Thus 9 divides N if and only if 9 divides S.

(iii) Let $N = a_m10^m + a_{m-1}10^{m-1} + \ldots + a_1 10 + a_0$ be the decimal expansion of the positive integer N, $0 \le a_i \le 9$, and let $S = a_0 - a_1 + a_2 - \ldots + (-1)^m a_m$ .Then 11 divides N if and only if 11 divides S.

The result can be proved as in (ii) using the congruence relation $10 \equiv -1(mod\ 11)$.

(iv) An integer is divisible by 2 if and only if its unit digits is 0, 2, 4, 6 or 8.
(v) An integer is divisible by 3 if and only if sum of its digits is divisible by 3.
(vi) An integer is divisible by 4 if and only if the number formed by its tens and unit digits is divisible by 4.
(vii) An integer is divisible by 5 if and only if its unit digit is 0 or 5.

(viii) Let $N = a_m 10^m + a_{m-1}10^{m-1} + \ldots + a_1 10 + a_0$ be the decimal expansion of the positive integer N, $0 \leq a_i \leq 9$. Then N is divisible by 7, 11 and 13 if and only if 7, 11 and 13 divide the integer $M = (100a_2 + 10a_1 + a_0) - (100a_5 + 10a_4 + a_3) + (100a_8 + 10a_7 + a_6) - \ldots$

(ix) Given an integer N, let M be the integer formed by reversing the order of the digits of N. Then $N - M$ is divisible by 9.

There exist many more results on divisibility which are proved using the congruences.

Example: 3.8. Consider any number $N = 235098765436271$, say. Then N is not divisible by 2, 3, 4, 5 and 9 but is divisible by 11.

3.4: Solution of Linear Congruence. An equation of the form $ax \equiv b(mod\ n)$ is called a linear congruence. An integer x_0 is called a solution of such an equation if $x_0 \equiv b(mod\ n)$. The number of solutions of such an equation means the number of incongruent integers satisfying this congruence. We state few results on solutions of linear congruence.

Theorem 3.1. *The linear congruence* $ax \equiv b(mod\ n)$ *has a solution if and only if* $d \mid b$ *where* $d = gcd(a, n)$. *If* $d \mid b$, *then it has d mutually incongruent solutions modulo n.*

Theorem 3.2. *The congruences* $ax \equiv b(mod\ n)$ *and* $ax \equiv b(mod\ n)$ *admit a simultaneous solution if and only if gcd (n, m)* $|(a - b)$. *If a solution exists, it is unique modulo lcm (n, m).*

Theorem 3.3. *(Chinese Remainder Theorem) Let* $n_1, n_2, \ldots, n_r$ *be positive integers such that* $gcd(n_i, n_j) = 1$ *for* $i \neq j$. *Then the system of linear conguences*

$$x \equiv a_1(mod\ n_1),$$
$$x \equiv a_2(mod\ n_2),$$
$$\vdots$$
$$x \equiv a_r(mod\ n_r),$$

has a simultaneous solution, which is unique modulo the integer $n_1 n_2 \ldots n_r$.

Example 3.9. Suppose that we want to find a number which leaves the remainders 2, 3 and 2 when divided by 3, 5 and 7 respectively. The problem reduces to finding the solution to the system of three congruences

$$x \equiv 2(mod\ 3)$$
$$x \equiv 3(mod\ 5)$$
$$x \equiv 2(mod\ 7).$$

This problem was asked by Sun-Tsu and appears in Chinese literature as early as first century A.D.

Example 3.10. To solve the linear congruence $17x \equiv 9(mod\ 276)$ is equivalent to finding the solution of the system of congruences

$$x \equiv 2(mod\ 3)$$
$$x \equiv 2(mod\ 3)$$
$$x \equiv 2(mod\ 3)$$

or equivalently

$$x \equiv 2(mod\ 3)$$
$$x \equiv 2(mod\ 3)$$
$$x \equiv 2(mod\ 3)$$

Example 3.11. (The basket of eggs problem: Brahmagupta (7th Century A.D.) One egg remains when the eggs are removed from the basket 2, 3, 4, 5 or 6 at a time, but no egg remains if they are removed 7 at a time. The problem is to find the smallest number of eggs that could have been in the basket. The problem reduces to finding the solution of the system of congruences

$$x \equiv 1(mod\ 2)$$
$$x \equiv 1(mod\ 3)$$
$$x \equiv 1(mod\ 4)$$
$$x \equiv 1(mod\ 5)$$
$$x \equiv 1(mod\ 6)$$
$$x \equiv 0(mod\ 7)$$

The smallest positive value of *x*, if it exists, is the required number of eggs.

Example 3.12.(Ancient Chinese Problem) A band of 17 pirates stole a sack of gold coins. When they tried to divide the fortune into equal portions, 3 coins remained. In the ensuing brawl over who should get the extra coins, one pirate was killed. The wealth was redistributed, but this time an equal division left 10 coins. Again an argument developed in which another pirate was killed. But now the total fortune was evenly distributed among the survivors. The problem was to find the least number of coins that could have been stolen. The problem reduces to finding the solution of the system of congruences

$$x \equiv 3(mod\ 17)$$
$$x \equiv 10(mod\ 16)$$
$$x \equiv 0(mod\ 15).$$

The smallest positive value of *x*, if it exists, is the required number of coins.

Conclusion

The congruence relation has been extensively used in proving results in classical and modern algebra as well as in developing algorithms as per technological needs of the society.

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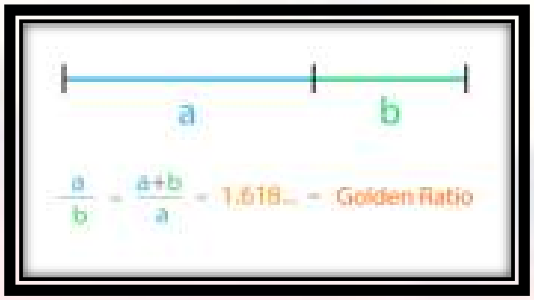
GOLDEN RATIO

-Compiled by Muskan Bajaj

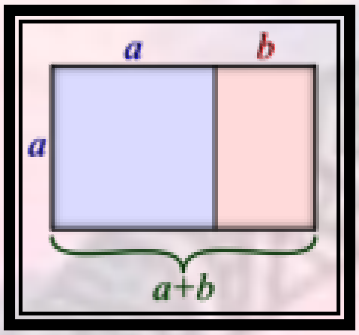
What is the Golden Ratio?

In mathematics, two quantities are in the golden ratio if their ratio is the same as the ratio of their sum to the larger of the two quantities. The golden ratio is also called the golden mean or golden section. Other names include extreme and mean ratio, medial section, divine proportion, divine section, golden proportion, golden cut, and golden number.



How is the golden ratio calculated?

1. Find the longer segment and label is a.
2. Find the shorter segment and label is b.
3. Input the values into the formula.
4. Take the sum a and b and divide by a.
5. Take a divided by b.
6. If the proportion is in the golden ratio, it will equal approximately 1.618.
7. Use the golden ratio calculator to check your result.



History

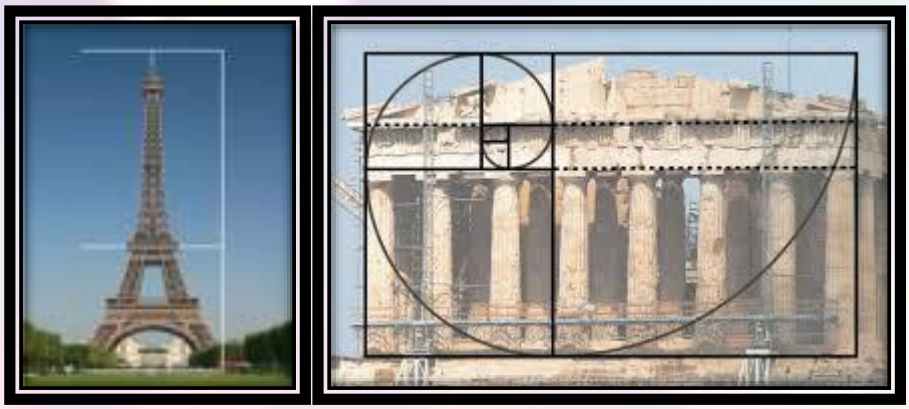
The ancient Greek philosopher Pythagoras left behind no writing, he is generally credited with knowledge of the golden ratio and the related dodecahedron, and imparting this knowledge to his followers; their symbol was the pentagram. According to one story, the 5th-century Pythagorean Hippasus discovered that the golden ratio was an irrational number, surprising other Pythagoreans. Hippasus was also the first to write of the dodecahedron, with Theaetetus being the first to describe all five possible regular solids. In the Republic, Plato expresses the concept of self-similarity in his Analogy of the divided line. Euclid in his elements provides several propositions and their proofs employing the golden ratio, using it in the construction of the pentagon, icosahedrons and dodecahedron.

Application

The golden ratio has more applications than we can think of in our day to day life. Some of them are:

Architecture

The number can be seen in the architecture of many ancient creations, like the Great Pyramids and the Parthenon.Phidias was a Greek sculptor and mathematician who is thought to have applied phi to the design of sculptures for the Parthenon. Plato considered the Golden ratio to be the most universally binding of mathematical relationships. Later, Euclid linked the Golden ratio to the construction of a pentagram.The Eiffel tower is also made using golden ratio.



Art

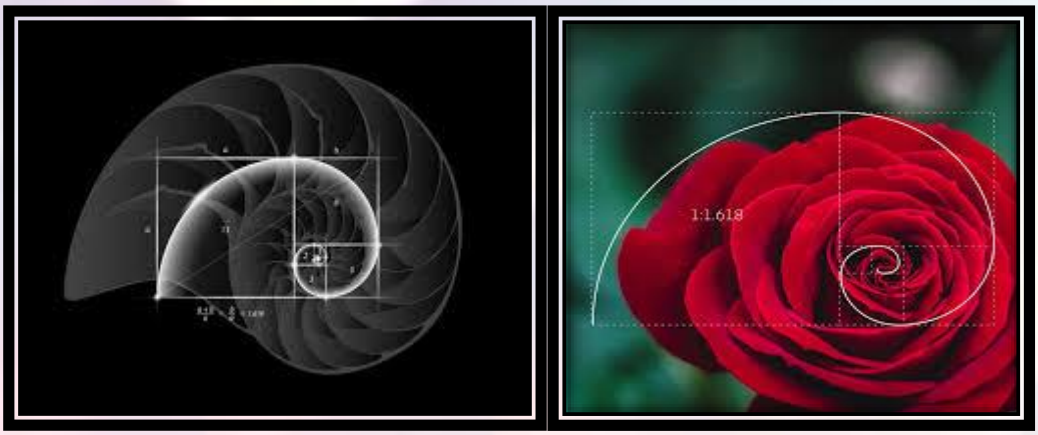
The Golden ratio was used to achieve balance and beauty in many Renaissance paintings and sculptures. Da Vinci himself used the Golden ratio to define all of the proportions in his Last Supper, including the dimensions of the table and the proportions of the walls and backgrounds. The Golden ratio also appears in da Vinci's Vitruvian Man and the Mona Lisa. Other artists who employed the Golden ratio include Michelangelo, Raphael, Rembrandt, Seurat, and Salvador Dali.

Human face

Faces, both human and nonhuman, abound with examples of the Golden Ratio. The mouth and nose are each positioned at golden sections of the distance between the eyes and the bottom of the chin. Similar proportions can been seen from the side, and even the eye and ear itself (which follows along a spiral).

Nature

In 1754, Charles Bonnet pointed out that the spiral phyllotaxic of plants was frequently expressed in successive golden ratio series. Adolf Zeising also found the golden ratio expressed in the arrangement of parts such as leaves and branches along the stems of plants and veins in leaves. Snail shells and nautilus shells follow the logarithmic spiral. It can also be seen in the horns of certain goats, and the shape of certain spider's webs. We can see the golden ratio in the galaxies as well.



Facts

i. There are actually two golden numbers : $\phi \approx 1.618$ (the golden mean) and $\Phi \approx 0.618$ (the golden ratio)
ii. $\phi - 1 = 1/\phi = \Phi$. These (and their opposites) are the only real numbers which differ from their reciprocals by exactly one.
iii. The continued fraction representation of ϕ is [1;1,1,1,1,…]
iv. ϕ and Φ are, in a very strict sense, the most irrational numbers.
v. There are approximately ϕ kilometers in a mile
vi. Even national geographic have their web page designed using golden ratio.

Sources:

- *Quora*
- *https://www.livescience.com*
- *Wikipedia*

LIFE CHANGING MATHEMATICS

-Simran Minocha

A **lottery** is a form of gambling that involves the drawing of numbers for a prize. Lotteries come in many formats. For example, the prize can be a fixed amount of cash or goods. In this format there is risk to the organizer if insufficient tickets are sold. More commonly the prize fund will be a fixed percentage of the receipts. A popular form of this is the "50–50" draw where the organizers promise that the prize will be 50% of the revenue. Many recent lotteries allow purchasers to select the numbers on the lottery ticket, resulting in the possibility of multiple winners.

The purchase of lottery tickets cannot be accounted for by decision models based on expected value maximization. The reason is that lottery tickets cost more than the expected gain, so someone maximizing expected value should not buy lottery tickets. Yet, lottery purchases can be explained by decision models based on expected utility maximization, as the curvature of the utility function can be adjusted to capture risk-seeking behavior. More general models based on utility functions defined on things other than the lottery outcomes can also account for lottery purchase. In addition to the lottery prizes, the ticket may enable some purchasers to experience a thrill and to indulge in a fantasy of becoming wealthy. If the entertainment value (or other non-monetary value) obtained by playing is high enough for a given individual, then the purchase of a lottery ticket could represent a gain in overall utility. In such a case, the disutility of a monetary loss could be outweighed by the combined expected utility of monetary and non-monetary gain, thus making the purchase a rational decision for that individual.

Probability of winning

Chances of matching different numbers of balls in a 6-from-49 lotto	
Number of balls matched	**Probability**
6	1 in 13,983,816
5	1 in 1,906,884
4	1 in 211,876
3	1 in 18,424
2	1 in 1,176
1	1 in 49
0	1 in 2.3

The chances of winning a lottery jackpot can vary widely depending on the lottery design, and are determined by several factors, including the count of possible numbers, the count of winning numbers drawn, whether or not order is significant, and whether drawn numbers are returned for the possibility of further drawing.

In a simple 6-from-49 lotto, a player chooses six numbers from 1 to 49 (no duplicates are allowed). If all six numbers on the player's ticket match those produced in the official drawing (regardless of the order in which the numbers are drawn), then the player is a jackpot winner. For such a lottery, the chance of being a jackpot winner is 1 in 13,983,816.

In bonus ball lotteries where the bonus ball is compulsory, the odds are often even lower. In 6 Mega Millions multi-state lottery in the United States, 5 numbers are drawn from a group of 75 and 1 number is drawn from a group of 15, and a player must match all 6 balls to win the jackpot prize. The chance of winning the jackpot is 1 in 258,890,850.

The odds of winning can also be reduced by increasing the group from which numbers are drawn. In the Super Enalotto of Italy, players must match 6 numbers out of 90. The chance of winning the jackpot is 1 in 622,614,630.

Most lotteries give lesser prizes for matching just some of the winning numbers, with a lesser prize for fewer matches. Although none of these additional prizes affect the chances of winning the jackpot, they do improve the odds of winning something and therefore add a little to the value of the ticket.

Let's read about the husband and wife team out of Michigan who figured out how to game the lottery, and walked away with almost $27 million over the course of nine years. But it turns out there's a greater mystery in the world of lottery watchers.

Her name is **Joan Ginther**, and she won the Texas Lottery at least four times in 10 years, while apparently buying thousands if not millions of dollars worth of tickets. She first won the lottery in 1993, when she won $5.4 million in the Lotto Texas. Her next win came in 2006 when she won $2 million in the Holiday Millionaire scratch-off. Her third win happened in 2008, where she won $3 million from a Millions and Millions ticket. In 2010, her final win occurred, where she won $10 million, her largest prize yet, bringing her total winnings to $20.4 million. The odds of winning these many times are one in 200 million.

Oh, did I mention she has a Stanford PhD in statistics, lives in Las Vegas, and yet repeatedly made the trip to a single store in rural Texas to make many of her purchases?

Yes, the plot thickens. And so far at least, nobody knows exactly how she did it.

E: AN IRRATIONAL COUSIN OF PI

- Chamandeep Kaur

e is the most important and ubiquitous number in higher mathematics. Some mathematicians say it is impossible to conceive of a universe in which e & π do not exist. Like π, e is an irrational number. Its decimal sequence goes on forever and does not repeat in any permanent pattern:

$$e = 2.718281828459045904523536 \ldots.$$

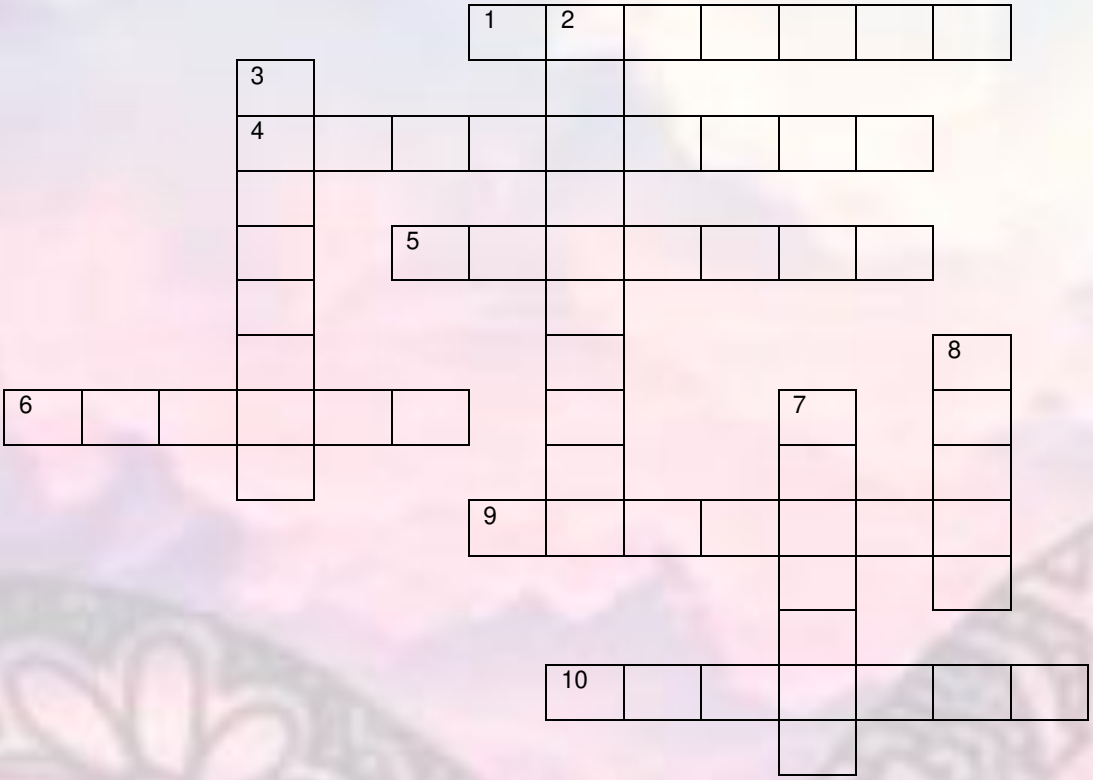
Martin Gardner, the well-known author of numerous books on science and mathematics, points out an interesting fact in the expansion of e & π.

Pi goes on and on….
And e is just as cursed.
I wonder: Which is larger
When their digits are reversed?

Euler, as ubiquitous in mathematics as e, was the first to study and to use the symbol e in 1727. In the classic Mathematical Recreations and Essays (1892), W.W. Rouse Ball writes about another coincidence involving e:, 'If we compare two packs of cards (one of them having been well shuffled), card by card, what is the probability that we shall get right through the packs without finding a single coincidence? The answer is $\frac{1}{e}$ (with an error of less than10^{-69}, for packs of 52 cards). Many people are prepared to bet no coincidence will occur, so an unscrupulous gamble might profit by knowing that $e > 2$'.

LOGIC MAGIC

-Dr. Karuna Mamtani



ACROSS

1. A Square is a special kind of

4. A straight line which a curve approaches arbitrarily closely, but never reaches, as they go to infinity.

5. Star like curve

6. Greek mathematician who wrote the book, Elements of Geometry

9. A polygon that is equilateral and equiangular.

10. A truncated cone or pyramid in which the plane cutting off the apex is parallel to the base

DOWN

2. Line segment stretched under the right angle.

3. Any symbol that could represent a number

7. A conic section which is essentially a stretched circle.

8. Line segment joining the end Points of an arc.

FUN WITH MATHS

- Simran Minocha

1) Apples n Friends

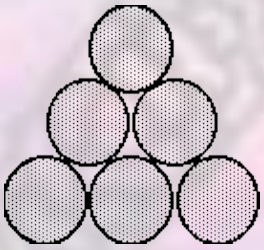
You have a basket containing ten apples. You have ten friends, who each desire an apple. You give each of your friend's one apple.
Now all your friends have one apple each, yet there is an apple remaining in the basket. How?

2) Cutting Across A Cross

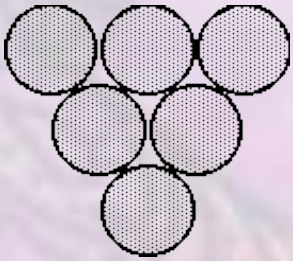
Here is an ordinary cross. You are allowed to make two straight cuts across it. How do you cut it to make the most pieces?

3) Pure Coin-cidence

Look at the triangle of six pennies alongside:
I want to turn this triangle upside-down:



So that it looks like this:



What is the smallest number of coins I must move?

ANSWERS: LOGIC MAGIC

***Across*:**

1. Rhombus
4. Asymptote
5. Asteroid
6. Euclid
9. Regular
10. Frustum

***Down*:**

2. Hypotenuse
3. Variable
7. Ellipse
8. Chord

ANSWERS: FUN WITH MATHS

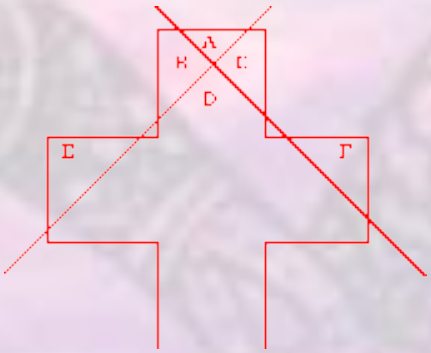
Solution 1:

You give an apple each to your first nine friends, and a basket with an apple to your tenth friend.

Each friend has an apple, and one of them has it in a basket. (Alternative answer: one friend already had an apple and put it in the basket.)

Solution 2:

This is one way of making six pieces with two cuts. I couldn't do any better!



Solution 3:

It is necessary only to move two coins, as the diagrams reveal:

STATISTICS

BIOSTATISTICS

-Compiled by Dr. Meenu Goel

Biostatistics is one area of applied statistics that concerns itself with the application of statistical methods to medical, biological, epidemiological and health related problems. Biostatistics is a growing field with applications in many areas of biology including epidemiology, medical sciences, health sciences, educational research and environmental sciences. It is concerned with collection, organization, summarization and analysis of data and also concerned with drawing inferences about a body of data when only a part of the data is observed. Data are numbers which can be measurements or can be obtained by counting and obtained from

- Analysis of records
- Surveys
- Counting
- Experiments
- Reports

Biostatistics has made major contributions to our understanding of countless public health issues, such as:

- Chronic diseases
- Cancer
- Human growth and development
- The relationship between genetics and the environment
- AIDS
- Environmental health (the impact and monitoring of)

Biostatistics is integral to the advancement of knowledge, not only in public health policy, but also in biology, health policy, clinical medicine, health economics, genomics, proteomics, and a number of other disciplines. The goal of biostatistics is to disentangle the data received and make valid inferences that can be used to solve problems in public health.

Without statistical analysis, all of the data collected by biologists wouldn't mean much. Statistical tests used in biology serve a number of functions, including measuring correlation, comparing means of variables and predicting change in variables. The types of statistical tests used include chi-squares, t-tests, ANOVA, regression tests and more.

Statistical tests used in biology help provide scientists with insight about processes that are either too vast, too microscopic or too numerous to be analyzed by other methods. The main role of statistics in biology is to test hypotheses. However, other statistical tests are used in biology to help set up experiments and interpret results. Some statistical concepts can help choose sample size or which organisms to study from a group.

The basic types of statistical tests used in biology fall into four basic categories: correlational, comparison of means, regression and nonparametric. Correlational tests measure how closely two or more variables are related. Comparisons of means measure the difference between the means of two or more sets of variables or datasets. Regressions analyze if a change in one variable can predict change in another, and nonparametric tests are used for datasets that don't meet the requirements for parametric analysis tests.

Sources:

https://www.kean.edu/~fosborne/bstat/01intro.html
https://www.publichealthcareeredu.org/biostatistics-and-informatics/

ROLE OF QUALITY MANAGEMENT WITHIN THE LEAN MANUFACTURING POLICY

-Yashaswee Bakshi

The Toyota Production System recognizes that managing quality is as important as managing just-in-time strategies in a Lean Manufacturing philosophy.
Quality management topics like Six Sigma, DMAIC, and Jidoka are important in the context of Lean Manufacturing because the ultimate goal is to eliminate waste in the value stream and one of the most common types of waste is the correction waste. **Correction waste** happens when it is necessary to work around poor quality in components or material from suppliers or it is necessary to repair, rework or scrap defective product units.

Quality management starts in product and process design. Concepts like **Poka-yoke and Jidoka** stress that the design of a product and process should eliminate the probability of error whenever possible, making the correct process visually obvious, and making any errors immediately visually obvious. Standardization, visual work instructions, and automated inspection are some of the tools used to minimize the potential for errors.

Six Sigma techniques and strategies are widely used in conjunction with Lean Manufacturing initiatives to help eliminate waste attributed to poor quality by providing the tools to focus on the right problems, diagnose the right root-cause of issues, and apply corrective action as quickly as possible. Six Sigma methodology uses statistical tools to systematically analyze processes and reduce process variations leading to better quality and performance.

Quality management requirements could be viewed by some as creating a burden of cost and time on the manufacturing process. The potential burden on the overall value stream should be a considered, but more importantly we should continually stress the benefits of predictable consistent quality to the entire team and identify the **cost of poor quality** to the overall performance of the organization.
Automation in inspection, record keeping, and verification steps can relieve some of the burden of quality processes. Automation is also a double bonus because every time we can take some manual clerical steps out of the process, we are not only cutting down cycle time and labor, but we are also eliminating potential points of human error in the equation.

Statistical Process Control (SPC) techniques including control and process capability charts conduct data and process analysis to understand, detect, and control variation, change, inefficiencies, and deficiencies. When a process shows variation with an unexpected, non-random pattern, such as a shift, trend, or cycle, the process is unstable and unpredictable, or it is out of control. Out-of-control processes are wasteful processes that because they will produce unacceptable amounts of defective product or scrap material.

Workflow and rule engines, like the ones enforcing the Western Electric rules in SPC, can automate analysis in the background and alert assigned personnel automatically based on defined rules that are consistently implemented by the system. Automation can be viewed as a sidekick that is performing analysis on the side and bringing to the attention of the operator any out of control condition as soon as it is detected.

Statistical sampling and auditing methodologies allow us to further reduce the cost of inspection procedures by providing the appropriate quality confidence level with less than 100% inspection requirements. Automated data collection and statistical software tools are able to continuously monitor multiple processes and increase oversight as needed on suppliers and internal processes that are falling out of normal parameters. These tools greatly decrease overhead when compared to other traditional manual oversight methodologies.

Another aspect of Toyota's Lean and **Jidoka** philosophy is a culture of stopping to fix problems right away--the earlier the better. In order to do this we need (1) tools to help us achieve quality the first time, (2) tools to monitor processes that are susceptible to variables like environmental conditions, material variances, equipment wear and tear, or operator training, and (3) an efficient corrective action process.
Quality metrics are as important as throughput, cycle-time and schedule adherence metrics in our overall assessment of a Lean organization. Metrics are needed to narrow areas that require attention for continuous improvement (Kaizen) initiatives, and to quantify the organization's ongoing improvement achievements. We cannot improve what we cannot measure.

Six Sigma practitioners use the **DMAIC** process to systematically reduce variability in a manufacturing process. Lean practitioners also refer to the Toyota problem solving methodology and kaizen workshops. All of these different methodologies can come together in a Corrective Action system to track all continuous improvement efforts. An Enterprise Quality Management System (EQMS) and Corrective and Preventive Action (CAPA) system are essential to documenting and tracking the entire problem-solving process ensuring a consistent review process and a closed-loop methodology that verifies effectiveness of the corrective action or reopens the problem for further analysis. The corrective action system can be used to also track and resolve productivity problems that are not related to quality issues.

The inspection and parts genealogy data recorded during manufacturing is not only used for performance metrics and root-cause analysis. In regulated industries, historical data is required to allow process certification and audits. **Regulatory compliance** and audit considerations are becoming more common in many industries. Regulatory guidelines from agencies like ISO, FDA, FAA, DoD, or ASME are all aimed at encouraging process control and quality assurance throughout the entire manufacturing process in order to achieve consistent quality results at the end. This general goal of the guidelines should be embraced as a goal to eliminate waste of poor quality due to deficient quality management processes.

Manufacturers have tackled regulatory requirements in the past with tons of paperwork, labor intensive validation processes, and a variety of disconnected systems and spreadsheets. Many of these old processes require double validation because manual procedures are prone to error. However, modern manufacturing and quality management software solutions can streamline and automate processes making it possible to improve productivity while enforcing compliance.

DATA AND THEIR COLLECTION

-Ritu Malpani

DEFINITION OF DATA

Data is factual information (such as measurement or statistics) used on the basis of reasoning discussion or calculations. It can be visualized using graphs, images or other analysis tools.

TYPES OF DATA

1) CATEGORICAL DATA
   (a) NOMINAL DATA
   (b) ORDINAL DATA
   (c) SCALE
2) NUMERICAL DATA
   (a) DISCRETE DATA
   (b) CONTINUOUS DATA

CATEGORICAL DATA (Qualitative Data)
It represents types of data which may be divided into categories(groups).
Example: Age group

(a) NOMINAL: Assign no. to objects when different no. indicate different objects. The no. has no real meaning other than differentiating between objects.
Example: Gender: 1= 'Male', 2= 'Female'.

(b) ORDINAL: Ordinal data unlike nominal data involve some order; ordinal no. stand in relation to each other in a ranked fashion.
Example: Students ranked as: 1= 'Excellent', 2= 'Very good', 3= 'Good', 4= 'Poor'.

(c) SCALE: Data is treated as scale when its values represent ordered categories with a meaningful metric, so that distance comparisons between values are appropriate.
Example: Age in years, income in thousands of rupees

NUMERICAL DATA (Quantitative Data)
It is quantitative data which means it can be measured using numbers and these no. can be placed in ascending or descending order.
Example: Age, marks, etc.

(a)DISCRETE DATA: Discrete data is one that has clear spaces between values. It can take only distinct or separate values.
Example: Number of calls.

(b)CONTINUOUS DATA: Continuous data is one that falls on a continuous sequence. It can take any value in some interval.
Example: Call duration.

SOURCES OF DATA

PRIMARY DATA: It refers to the data that investigator collect for the very first time. This type of data has not been collected either by this or any other investigator before.

- ADVANTAGES:
  1. Data interpretation is better.
  2. Targeted issues are addressed.

- DISADVANTAGES:
  1. High cost
  2. Time consuming

- METHODS OF COLLETION OF DATA:

  3. DIRECT PERSONAL INVESTIGATION: - The investigator is responsible for personally approaching a respondent and investigating the research and gather appropriate information.
  4. INDIRECT ORAL INTERVIEW: - The investigator approaches an indirect respondent who possesses the appropriate information for the research.
  5. MAILED QUESTIONNAIRE: - The respondent answers the questionnaire and forwards it back to the investigator after marking his/her responses.
  6. SCHEDULES: - In this, interviewer questions the respondent according to the questions mentioned in a form. This form is known as a schedule.

SECONDARY DATA: It is the data that has been already collected by and readily available from other sources. When we use statistical method with primary data from another purpose for our purpose, we refer to it as secondary data.

- ADVANTAGES:
  1. Time saving
  2. Cost Efficient

- DISADVANTAGES:
  1. There is no accuracy.
  2. Data may be outdated.

- METHODS OF COLLETION OF DATA:

1. PUBLISHED SOURCES: - There are many national organizations, international agencies and official publications that collect various statistical data. They also collect information related to various socio-economic phenomena and publishes them. Central government official publication, committee reports etc are some published sources of secondary data.
2. UNPUBLISHED SOURCES: - Some statistical data are not always a part of publications. Such data are stored by institutions and private firms. Researchers often make use of these unpublished data in order to make their researches all the more original.

6-SIGMA

-Rashi Arora

Control limits are statistical process control tools which allow you to determine whether your process is stable and in control, or trending towards increased variability which could lead to defects in the end product.
They are split into upper control limits and lower control limits (i.e. -UCL and LCL).
Control charts are two-dimensional graphs plotting the performance of a process on one axis, and time or the sequence of data samples on the other axis. These charts plot a sequence of measured data points from the process. We can also view the sequence of points as a distribution.
Control charts have the following attributes determined by the data itself:
An average or centre line for the data: It's the sum of all the input data divided by the total number of data points.
An upper control limit (UCL): It's typically three process standard deviations above the average.
A lower control limit (LCL): It's typically three process standard deviations below the average.
If the process is in control it should roughly approximate a normal distribution around the mean, and all data points should be inside the upper and lower control limits.

6 SIGMA CONTROL LIMITS

Six Sigma is a disciplined, data-driven approach and methodology for eliminating defects (driving toward six standard deviations between the mean and the nearest specification limit) in any process – from manufacturing to transactional and from product to service.
The upper control limit of 58.7 is three standard deviations above the average. The lower control limit of 41.3 is three standard deviations below the average. Plus or minus three standard deviations from the mean includes **99.7** percent of all the data in a normally distributed population. Therefore, you have a 99.7-percent probability that a process data point will fall between these two limits. That means you have only a 0.3-percent chance that a measurement will be above the UCL or below the LCL.

APPLICATIONS OF 6 SIGMA

Six Sigma is one of the more recent quality improvement initiatives to gain popularity and acceptance in many sectors such as

- Manufacturing sector
- Financial sector
- Health care sector
- Research and development sector
- Engineering and construction sector

The fundamental idea of six sigma is that if performance is improved, quality, capacity cycle time, inventory levels, and other key factors as reduction waste, energy sources and environment will also improve. Thus, when these factors are improved, both the provider and the customer experience greater satisfaction in performing business transactions.
Successful implementation and growing organizational interest in six sigma method have been exploding in the last few years. It is rapidly becoming a major driving force for many technology-driven, project-driven organizations. Factors influencing successful six sigma projects include management involvement and organizational commitment, project management and control skills, cultural change, and continuous training.

REGRESSION TO MEAN

-Compiled by Dr. Meenu Goel & Anjali Gupta

If something varies normally between two far extremes,
It usually swings back naturally to values in between.
From sport to crime and illnesses, we see this common theme,
An effect we call, statistically, 'regression to the mean'.

When Brucie plays his cards right and he's holding up a queen,
You know that next a lower card is likely to be seen,
Because there are so many cards much lower than a queen.
It's simple probability, it's 'regression to the mean'.

Random fluctuations of performances in sports,
Befuddle sports professionals, who use gimmicks of all sorts,
Crystals, magnets, copper bracelets they esteem,
But improvements in achievement are 'regression to the mean'.

A man with awful backache, that sometimes gets much worse,
May turn to herbal remedies and swear his pain's reversed.
Perhaps it has, but not because the herbalist intervened,
The pain will ease quite simply through 'regression to the mean'.

Evidence-based treatments that doctors should assign,
Use tests that will be randomized, controlled and double-blind,
Stopping self-deception before those test-results are seen,
It stops them being fooled by 'regression to the mean'.

Big international drug firms are rightly criticised,
For concealing contrary evidence and other sorts of lies,
So how come homeopathy and herbalists have been,
Permitted to bamboozle us with 'regression to the mean'?

While scientific medicine cannot cure all ills,
It does do so much better than those homeopathic sugar pills,
That a child should die through want of proper treatment is obscene,
When wishful-thinking parents fall for 'regression to the mean'.

When much that was untreatable is curable, it's tragic
That patients turn from medicine to phony cure-all magic.
The alternative to thinking is delusionary dreams,
Alas, from death there will be no 'regression to the mean'.

-Andrew Porter

Source-
http://www.talkstats.com/threads/statistics-poetry.23441/#post

COMPUTER SCIENCE

LATEST IN TECHNOLOGY

-Compiled by Ms. Priyanka Gupta

Rectennas: A device that convert Wi-Fi signals to electricity

Study published in Nature Journal said that researchers from MIT and elsewhere has developed a device, called a "rectenna", that capture energy from Wi-Fi signals—and turn it into direct current electricity. The rectenna consists of a small gold antenna—about the size of an SD card—which converts a variety of wireless signals—wi-fi, bluetooth, cellular LTE—into an AC signal. Next, the AC signal travels into the semiconductor called three-atom-thick molybdenum disulfide (MoS_2), which converts it into a DC voltage.

The device is flexible and, using radio signals from home Wi-Fi, cell phones and radio, it spits out about 40 microwatts of power. Enough to light up a simple LED display or power a biosensor. It could drive power-thrifty pacemakers, hearing aids and sensors in the Internet of Things (IoT).

Robot Learns to Play Jenga

The robots are coming and marching at a fast pace. They have become a common feature of everyday life from cleaning home to medical surgeries. Recently, a study published in the journal Science Robotics says, MIT scientists have developed a robot that can play a game of Jenga, the popular game involves removing one block at a time from a stack of 54 arranged in 18 layers of three.

The robot is equipped with a soft-pronged gripper, a force-sensing wrist cuff, and an external camera, all of which it uses to see and feel the tower and carefully extract blocks without toppling the tower. It "learns" whether to remove a specific block in real time, using visual and tactile feedback.

As the robot carefully pushes against a block, a computer takes in visual and tactile feedback from its camera and cuff, and compares these measurements to moves that the robot previously made. It also considers the outcomes of those moves — specifically, whether a block, in a certain configuration and pushed with a certain amount of force, was successfully extracted or not.

EVOLVING ERA OF DIGITIZATION: INTERNET OF EVERYTHING VS INTERNET OF THINGS

-Compiled by Ashema Hasti

Introduction

Internet of Things (IoT) has become a buzzword and it is the technology that rules the world as on date. The IoT is a term coined by Kevin Ashton back in 1999 and the term quickly gained popularity as a way to refer to physical devices that are able to connect and exchange data. IoT is defined as networks of physical and virtual objects. It is an interaction between sensors and intelligent devices, with capability of data communication. IoT allows things to be connected any time at any place and using any network or any type of service. By using IoT, we can connect to billions of components to the internet.

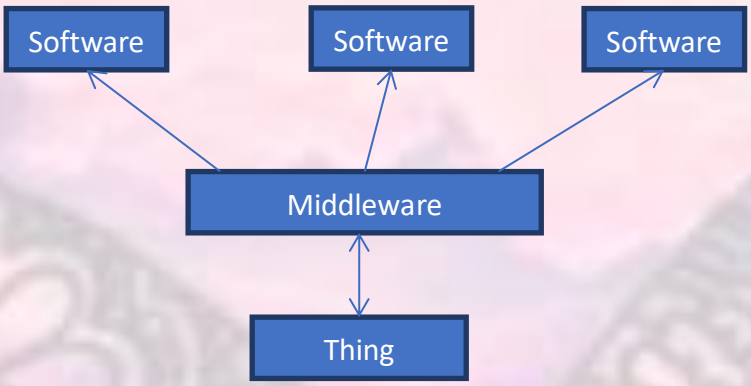


Figure 1.: IoT Architecture

As seen in Figure 1.1, the component labelled as "Thing" is the physical device that detects or measures the properties of the item and transforms the collected data to the middleware. The middleware is responsible for connecting to the different types of sensors and application layer communicates with the controlling and monitoring a user interface and has the ability to control the sensors and middleware through hardware instructions.

***From Internet of Things to Internet of Everything*:**

CISCO is believed to have coined the term "Internet of Everything (IoE)". IoE is bringing together people, process, data and things to make networked connections more relevant and valuable than ever before.

IoE involves the following:

- People: People connect to the internet through use of devices like PCs, tablets, smartphones, etc. Under IoE, people connect for more than just browsing or social media. People have started controlling their home devices such as ACs, CCTVs, TVs, etc from remote locations and through remote cameras.
- Data: Connected things can send higher –level information back to machines, computers and people for further evaluation and decision making.
- Things: Things are devices with mandatory communication and optional sensing capabilities. Soon, things will become context-aware and provide better information to help in decision making.

- Processes: Processes bring together people, data and things in order to deliver more value in the connected world. They also ensure that right information is delivered to all concerned in time and in correct way.

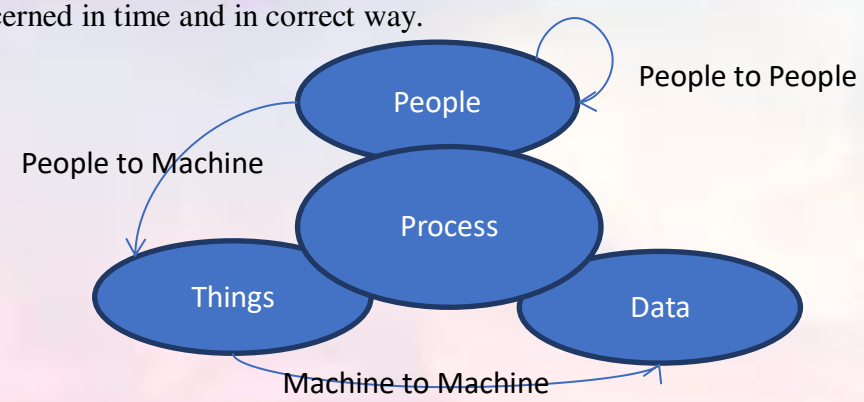


Figure 1.2: Components of IoE

Similarities between IoT and IoE:

1. Both rely on devices and things: Things are identifiable objects that can be integrated into IoT and IoE. Devices are producers of data.
2. Both involve data generation and transmission. Devices like sensors generate data that is transmitted over communication networks and is processed by machines such as computers.

Differences between IoT and IoE:

1. IoT does not include people. Although people interact in IoT, they are not considered as part of IoT.
2. Things need not be context-aware in IoT though we have context-aware things in IoT.
3. IoT does not include processes. IoT is about connecting things. There is nothing that says how to bring the things together. IoE include business and industrial processes that bring things, data and people together.

Real-world Applications of IoT and IoE

Let's take a real-world scenario of operating an air conditioner at home where laptops/tablets/smartphones are used by the users to regulate temperature and moisture settings. This is under the umbrella of IoT. Now when the user enters his car and is driving towards his home, then the mobile device (with the help of GPS) automatically sets on the air conditioner at a particular time, with user's preferred settings of room temperature and moisture, without any human intervention. This comes under the umbrella of IoE.

An example of IoT is a smart plug that plugs into a regular outlet, accepts the power cord from any device, and can be used to turn it on and off on a set schedule or when you hit a button on your smartphone. Another model of smart plug can monitor how much energy your devices are using, helping you make your home more energy-efficient. You can see when the plugs are on, how much power they're using, and set schedules for operation right from the mobile app.

Another example of IoT device is the Philips Hue lighting system, which is the most popular of the smart bulbs currently available. What can a smart bulb do that a regular one can't? For one, it can change colors—the Philips Hue lights can change to any color you choose; they'll even match the tones in a photo that you upload via the app. They can also be turned on and off on a schedule or from your smartphone, and the Hue bulbs can even be synced with your music for an awesome sound-and-light party.

Challenges in IoT and IoE

Security Challenges:

- All devices and sensors will have cyber presence
- Traditional cyber-security approaches not sufficient
- Multi-layer security is necessary

Communication Challenges:

- Integrated networks (probably a characteristic of 5G)
    - Machine-to-Machine Communications in later 4G
- Very long battery life
- Automated deployment and de-confliction
- Spectrum availability and uniformity across national boundaries

Future applications of IoE:

- Internet of Everything is going to be a boon to the hospitality industry, where hotel kitchens will soon be equipped to provide nutritious, satisfying meals aligned with the full array of dietary requirements. It will be easier than ever to deliver meals with appropriate ingredients, calorie count, and more. Also, IoE will make it possible for guests to access their rooms instantly simply by having their mobile device ready, making lost keys a thing of the past and providing total room security.
- Wearables combined with the ability to connect via the key pillars of IoE, such as cloud, mobility, video, and analytics, individuals will be able to monitor and quantify their lives like never before—and make changes in real-time with larger capacity for benefit. We'll be more self-aware in every aspect of life, from exercise to financial management, use of energy and utilities, learning, etc.
- Along with advances in collaboration, analytics, and mobility, the availability of cheap, ubiquitous sensors is driving the transformation. Such sensors will compile data on moods, habits, diet, drug combinations, and just about anything we do. In the process, we will gain key insights on personal trends.
- When combined with Data Analytics and Machine Learning, IoE is expected to influence business strategies and human interaction with technology. Data will be generated by things and possibly analysed too. Machine learning based systems will analyze data to draw inferences and make decisions.
- Smart cities: They will comprise of smart parking solutions, structural health monitoring of buildings, bridges and monuments, smart detection of traffic congestion and smart lighting.
- Smart agriculture: monitoring systems to detect climatic conditions for maximization of production. In dry zones, the smart systems will help in selective irrigation to save water resources where not required.
- E-Health: It comprises of patients' surveillance, assistance provided to elderly or disabled people and self-monitoring wearable devices to monitor heart-rate, quality of sleep, etc.

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ARTIFICIAL INTELLIGENCE IS EVERYWHERE

-Paridhi Shah

History:

1. John McCarthy was first to coin the term artificial intelligence and in 1956 had the first conference on AI.
2. In 1969 'SHAKEY' was the first general purpose mobile robot built (with respect to today's standard though he was very simple, data was processed differently from this time, he was able to do things with some purpose rather than just following some instructions).
3. In 1997 supercomputer 'DEEP BLUE' was designed which defeated the world chess champion in a game (first time a computer was seen defeating a human on logics).
4. In 2002, first commercially successful robotic vacuum cleaner created.
5. In last more than a decade till today (2005-18) we have speech recognition (siri, google assistant, alexa), RPA, dancing robots, smart homes and more to come.

So what is artificial intelligence?

AI is a form of computer science used to create intelligent human machines that can recognize human speech, objects, can learn, plan and solve problems like **humans**.

Types of AI

- **Purely Reactive: -** Limited memory- these machines use previous data and keeps adding it to their memory. Example: If I ask suggest me a restaurant, them it will use previous data and restaurant visited quite frequently and nearby will be suggested.
- **Theory of Mind:** - This kind of an AI has capability to understand thoughts and emotions and interact socially. Machine based on this AI is yet to be built.
- **Self Aware**:- Future generation of machines. They will be super intelligent. Like terminator or ultron or vision.

The entire tech world is debating the consequences of artificial intelligence and the part AI is going to play in shaping our future. While we might think that AI is at least a few years away from causing any considerable effects on our lives, the fact remains that it is already having an enormous impact on us. Artificial intelligence is affecting our decisions and our lifestyles every day. Don't believe me? Well, read along as we tell you 10 examples of artificial intelligence you are using in your daily life:

1. Smart phones

Smart phones have become the most indispensable tech product that we own today and we use it almost all the time. Well, if you are using a smart phone, you are interacting with AI whether you know it or not. From the obvious AI features such as the built-in smart assistants to not so obvious ones such as the portrait mode in the camera, AI is impacting our lives every day.

Firstly, there are the obvious AI elements which most of us have some knowledge about. For example, when you are using a smart assistant, whether it's Google Assistant, Alexa, Siri, or Bixby, you more or less know that these assistants are based on AI. However, when we are using a feature such as the portrait mode effect while shooting a picture, we never consider that AI might be behind that too. Have you ever thought how Google Pixel 2 can capture such great portrait shots with just a single lens? The answer is artificial intelligence.

2. **Smart Cars and Drones**

Talking about the AI, there is no better and more prominent display of this technology than what smart car and drone manufacturers are doing with it. Just a few years back, using a fully

automatic car was a dream, however, now companies like Tesla have made so much progress that we already have a fleet of semi-automatic cars on the road.
Companies like Amazon and Walmart are heavily investing in drone delivery programs and it will become a reality far sooner than what you expect. If you think that's far-fetched, do note that militaries all over the world are already using successful drone programs.

3. Social Media Feeds
Even if you are living under a rock, there's a high probability that you are tweeting from underneath it. If Twitter's not your choice of poison, maybe it's Facebook or Instagram, or Snapchat or any of the myriad of social media apps out there. Well, if you are using social media, most of your decisions are being impacted by artificial intelligence.
From the feeds that you see in your timeline to the notifications that you receive from these apps, everything is curated by AI. AI takes all your past behavior, web searches, interactions, and everything else that you do when you are on these websites and tailors the experience just for you. The sole purpose of AI here is to make the apps so addictive that you come back to them again and again, and I am ready to place a bet that AI is winning this war against you.

4. Music and Media Streaming Services
Whether you are using Spotify, Netflix, or YouTube, AI is making the decisions for you. You might feel that you are in total control but you are not. And as it is with everything, sometimes its good and sometimes it bad.
I also remember going down the YouTube rabbit hole wasting countless hours just watching the recommended videos. That recommended videos section has become so good at knowing my taste that it's scary. So, next time you are hitting play on a recommended video on YouTube or watching a recommended show on Netflix, or listening to a pre-created playlist on Spotify, or any other media and music streaming service for that matter, remember that AI is playing a big role in that.

5. Video Games
The video game industry is probably one of the earliest adopters of AI. The integration started very small with the use of AI to generate random levels that people can play. However, that has increased to a level which goes far beyond what one can even imagine. Any game that you play has some sort of AI element to it. When you are playing a game such as CS GO, PUBG or Fortnite, you essentially start against a couple of AI-powered bots and then move to play against real players. Even when you are playing a single person story mode game, you are playing against AI bosses. If you are playing racing games, you are racing against AI bots.

6. Online Ads Network
One of the biggest users of artificial intelligence is the online ad industry which uses AI to not only track user statistics but also serve us ads based on those statistics. Without AI, the online ad industry will just fail as it would show random ads to users with no connection to their preferences what so ever. AI has become so successful in determining our interests and serving us ads that the global digital ad industry has crossed 250 billion US dollars with the industry projected to cross the 300 billion mark in 2019. So, next time when you are going online and seeing ads or product recommendation, know that AI is impacting your life.

7. Navigation and Travel
Most of us travel from time to time and use the navigation on almost a daily basis. Do you know that whether you are using Google or Apple Maps for navigating, or calling an Uber, or booking a flight ticket, you are using AI? Well, if you didn't know that before, it's time that

you open your eyes. Both Google and Apple along with other navigation services use artificial intelligence to interpret hundreds of thousands of data point that they receive to give you real-time traffic data. When you are calling an Uber, both the pricing and the car that matches your ride request is decided by AI. As you can see, AI plays a significant role in how we reach from point A to point B.

8. Banking and Finance

The banking and finance industry plays a major role in our lives. I mean the world runs on money and banks are essentially the gatekeepers that regulate that flow. Did you know that the banking and finance industry heavily relies on artificial intelligence for things like customer service, fraud protection, investment, and more? A simple example is the automated emails that you receive from banks whenever you do an out of the ordinary transaction. Well, that's AI watching over your account and trying to warn you of any fraud.

AI is also being trained to look at large samples of fraud data and find a pattern so that you can be warned before it happens to you. Also, when you hitch a little snag and chat with bank's customer service, chances are that you are chatting with an AI bot. Even the big players in the finance industry use AI to analyze data to find the best avenues to invest money so they can get the most returns with the least risk. That's not all, AI is poised to play an even bigger role in the industry as major banks across the world are investing billions of dollars in the AI technology and we all will observe its effects sooner than later.

9. Smart Home Devices

We are even willingly letting artificial intelligence in our houses. Many of the smart home devices that we buy use artificial intelligence to learn our behavior so that they can adjust the settings themselves to make the experience as friction less as possible for us. We have already talked about smart voice assistants which we use to control these smart home devices, and as we know, they are the prime example of AI impacting our lives.

I will agree that a perfect AI-powered house which reacts to our choices in real-lives is still a decade or so away, however, we are seeing the steps that will take us there. I mean, there are smart thermostats which adjust the temperature based on your preferences, smart lights that change the color and intensity of lights based on time and much more. It won't be long when our main interactions with all our smart home devices will be through AI only.

10. Security and Surveillance

While we can all debate the ethics of using a broad surveillance system, there's no denying the fact that it is being used and AI is playing a big part in that. It is not possible for humans to keep monitoring multiple monitors with feeds from hundreds if not thousands of cameras at the same time, and hence, using AI makes perfect sense. With technologies like object recognition and facial recognition getting better and better every day, it won't be long when all the security camera feeds are being monitored by an AI and not a human. While there's still time before AI can be fully implemented, this is going to be our future.

INTERNET OF THINGS

- Bhanvi Singh

The "Internet of things" (IoT) has become a growing topic. In my vacations I have learned a bit about this which I want to share in a very simple language. In our day to day life, we see many devices like mobiles, routers, laptops, tablets etc which are connected to internet. Hence, internet of things is a combination or system of all these devices which are connected to internet. All these devices communicate with each other and provide some better result for us. So Internet of things is basically a combination of all these devices that are connected to internet.

For Example- In case of a car accident, a help could be called on the accident spot by the car that has a GPS unit which is connected to the internet. How Internet of things Work?

1. First, We have sensors, these are small pieces that can be placed anywhere (Car, Home, Fridge). Sensors collect data and send to some processing device.

2. Next level in Iot is local processing. So we have device that processes some data received from sensors and take some decision also.

3. Then we have local storage. Data collected from sensors is huge so we need to store it locally.

4. Next we have to set up network. Since we need to interconnect things, we have to send data to cloud for processing.

5. Then we have a cloud storage to store data.

6. Next we need to process the data in the cloud to get some good result and provide notifications to the user on his/her phone.

Applications of IoT:-
1. Smart Home: Smart Home is very powerful application of IOT.
But what is a Smart Home? Wouldn't you love if you could switch on air conditioning before reaching home or switch off lights even after you have left home? Don't be surprised. With IoT, companies are building products to make your life simpler and convenient. Smart Home products are promised to save time, energy and money.

2. Wearables: Wearables have experienced a explosive demand in markets all over the world. Companies like Google, Samsung have invested heavily in building such devices. These devices broadly cover fitness, health and entertainment requirements. They are highly energy efficient and small sized.

3. Connected Cars: A connected car is a vehicle which is able to optimize it's own operation, maintenance as well as comfort of passengers using onboard sensors and internet connectivity. The automotive digital technology has focused on optimizing vehicles internal functions. But now, this attention is growing towards enhancing the in-car experience.

4. Smart Cities: Smart city is another powerful application of IoT generating curiosity among world's population. Automated transportation, traffic management, water distribution, smart surveillance smarter, energy management systems, water distribution, waste management, urban security and environmental monitoring all are examples of internet of things applications for smart cities.

5. IoT in agriculture: With the continuous increase in world's population, demand for food supply is extremely raised. Sensing for soil moisture and nutrients, controlling water usage for plant growth and determining custom fertilizer are some simple uses of IoT.

6. Smart Retail: The potential of IoT in the retail sector is enormous. IoT provides an opportunity to retailers to connect with the customers to enhance the in-store experience. Smartphones will be the way for retailers to remain connected with their consumers even out of store. Interacting through Smartphones technology can help retailers serve their consumers better. They can also track consumer's path through a store and improve store layout and place premium products in high traffic areas.

COMPUTER SCIENCE AND HOW HAS IT EVOLVED

-Ankita Sharma

Computer Science is the study of computers and computational systems. This includes their theory, design, development, and application of the software systems. Computer science is relatively young recognised science. Its transition from static to dynamic is important. On the first large scale electronic computer called ENIAC, operations were performed by reading encoded instructions into *a pattern of holes punched into a paper card*.

It has been inspired by wooden punch cards used to automate fabric weaves. According to Tim Berners-Lee himself the Web 1.0 could be considered as the "*read-only web*". In other words, the early web only allowed users to search for information and read it. The lack of active interaction leads to the birth of Web 2.0, the "*read-write*" web. Now even a non-technical user has the ability to contribute content and interact with other web users.

The oldest known complex computing device, called the **Antikythera** mechanism, dates back to 87 B.C; it's surmised the Greeks used this gear-operated contraption (found in a shipwreck in the Aegean Sea early in the 20th century, though its significance wasn't realized until 2006) to calculate astronomical positions and help them navigate through the seas. Computing took another leap in 1843, when English mathematician Ada Lovelace wrote the first computer algorithm, in collaboration with Charles Babbage, who devised a theory of the first programmable computer. But the modern computing-machine era began with Alan Turing's conception of the Turing Machine, and three Bell Labs scientists invention of the transistor, which made modern-style computing possible, and landed them the 1956 Nobel Prize in Physics.

Computers no longer take up rooms – even very powerful ones now fit in the palm of your hand. They are cheap enough to put in refrigerators, irrigation systems, thermostats, smoke detectors, cars, streetlights, and clothing. They can even be embedded in your skin. The coming computing era will be dominated by *artificial intelligence, the IoT, robotics, and unprecedented connectivity.* And even if things are advancing at a sub-exponential rate, it will still be an incredible next step in the evolution of computer science.

INTELLIGENT TRANSPORT SYSTEM: STATE OF THE ART

-Dr. Nidhi

Today's transportation system is of paramount concern among researchers, policy makers, and automobile manufacturers. At present, Road traffic crashes represent the eighth leading cause of death globally across all age groups. Road accidents approximately lead to loss of 1.35 million lives and upto 50 million injuries annually worldwide, according to the 2018 Global Status Report on Road Safety, by World Health Organization (WHO). The report further estimated that the low and middle income countries contribute 93% world's fatalities rate leading to 3% GDP on road traffic accidents. Increasing traffic congestions, injuries and deaths in road accidents have made it one of the world's largest "public health" and "injury prevention" problem. Road accidents are an outcome of interplay of various factors such as an increased vehicular traffic due to rapid urbanization, violation of traffic rules, fault in traffic lights, road topology, improper use of warning signs, driver's behavior etc.

India ranks highest in road fatalities across the globe. By 2030, road accidents will further turns to seventh leading cause of death if no proper prevention measures and actions taken soon. Therefore, road safety has become an issue of concern both at national and international level. United Nations in 2010 took a resolution that led to the formation of the Decade of Action for Road Safety (2011-2020). India is a signatory to Brasilia Declaration, in which, 2030 agenda for Sustainable Development has set to achieve 50% reduction in road deaths and injuries from road traffic crashes by 2020 which at present hard to achieve. (Source: WHO, 2018 statistics).

Intelligent Transportation System (ITS) came into limelight to promote the road safety and mitigate the effects of congestions, accidents and crashes. ITS introduce Information Technology to the vehicles to make driving safer, efficient and more comfortable. Hence, vehicular communication network called Vehicular Adhoc Network (VANET) emerged to enable a communication web among vehicles and road side infrastructures. VANET uses short to medium range wireless communication (approx. 1000m) among vehicles, infrastructure and Road Side Units using Dedicated Short-Range Communication (DSRC) protocol. Federal Communication Commission (FCC) of US allocated 75 MHz of bandwidth in the 5.9 GHz (5.85-5.925 GHz) band for the generation of DSRC. This standard supports the overall safety and efficiency of the transportation system by connecting the unprecedented technology of wireless communication among vehicular web. Therefore, DSRC is also known as WAVE (Wireless Access in Vehicular Environments) in which it enables vehicular communication at low latency with high data transfer rate (upto 27Mbps) without usage charges. Such vehicular communication permits the 'fully connected', 'information–rich', 'quick' and 'cost-efficient' distribution of data for the benefit of passenger's safety, comfort, and decreases the adverse environmental impacts to a great extent.

One of the most promising areas is the study of the communications among vehicles and Road-Side Units (RSUs). The goal of self-organized vehicular traffic management and control strategies is to dynamically manage the traffic, reduces the congestion, re-routes the traffic, and hence, decreases the fuel consumption and overall emission generation.

Due to the expensive cost of deploying and complexity of implementing such a system in real world, research in VANET relies on modeling and simulation. However, the simulation

depends on the modelling of realistic vehicular traffic mobility model that represents the movement pattern of mobile users including its location, velocity and acceleration over time.

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CYBORGS

-Diya Garg

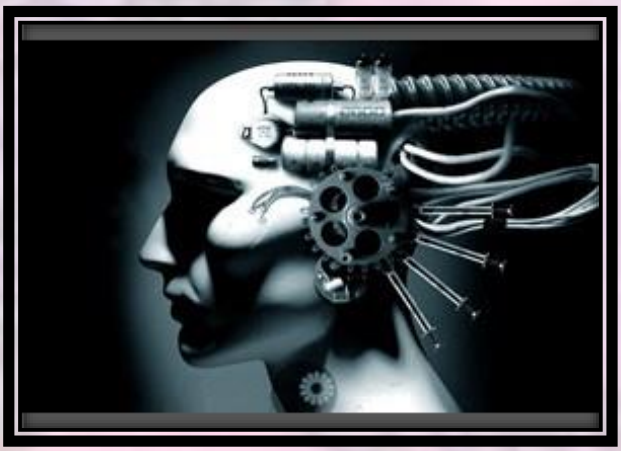
“If your smart-phone is glued to your hands, then we believe you are already a kind of Cyborg.”

It’s an organism that has both organic (“natural”) and cybernetic (“machine”) parts. In other words, when people become cyborgs, they’re partly human and partly machine. That’s most of us!

The term 'Cyborg' was coined in 1960 by Manfred Clynes and Nathan S. Kline. Part of the diverse use of the word “cyborg” revolves around how humans see their interactions with technology.
A person could be considered a cyborg when they are outfitted with implants such as artificial heart valves, cochlear implants or insulin pumps. A person could even be called a cyborg when they are using specific wearable technologies like Google Glass, or even using laptops or mobile devices to do work.

D. S. Halacy's Cyborg: Evolution of the Superman in 1965 featured an introduction which spoke of a "new frontier" that was "not merely space, but more profoundly the relationship between 'inner space' to 'outer space' – a bridge between mind and matter."

In effect, cyborgs can have biological intelligence as well as artificial intelligence because of their unique makeup. And like many AI’s, a cyborg’s actions can be manipulated by a controller. An AI of a certain caliber is able to process and spew out information at a significantly faster rate than the smartest person in the world can. That’s a shockingly rapid transfer of information. The human mind as it stands now may find that even thinking about this is overwhelming. But a cybernetic intelligence might not. However, the cons of these two types of alternate intelligence are equally alarming.



Elon Musk is one of those names which gets thrown around by the media a lot. It’s the millionaire/futurist’s opinion that a cybernetic relationship, or a merging of a biological intelligence (eg: a human brain) with an artificial intelligence, may stand a chance at competing with robots in the upcoming decades.

Over an year ago, the SpaceX CEO said that eventually, human beings of the present will become irrelevant in the future. Who’s to blame? We, humans. If Musk is right in his prediction, our descendants could be living out their lives with an ordinary central nervous system (including a brain), but attached to this system would be a synthetic yet superior intelligence.

There can be / are several problems associated with the concept of human cyborgs. The most logical of these is brought to light by the question, “Who would be controlling the huma n cyborgs?” The homo sapien biobots could be manipulated by full-fledged AI’s, the very entities we would (hypothetically) be competing with in the battle for “superior” intelligence. Even if our cyborg children are not being manipulated at all, their lives could quickly become dull and tasteless. Common relationships would also be dry because the cyborgs would have no need to relate. Every cyborg would be aware of anything every other cyborg was. There would be no room for explanations, self-expressions, or friendly debates. Our would-be cybernetic descendants might be alive, but they wouldn’t be truly living.

"I will love on with my heart gone,
I'll carry on fine because I am now both organic and cybernetic."

WHY COMPUTER SCIENCE IS JUST AWESOME?

-Kanwalpreet Kaur Dhingra

Being a 21st century student it will not be wrong to say that computer science is just awesome because every privilege provided to us today, whether it is E-wallet apps such as Paytm, Phonepe or online shopping apps such as Amazon, Flipkart or online education apps such as Unacademy, Byju's or the online reservation websites such as IRCTC or even... our social media such as YouTube, WhatsApp, Facebook, Instagram; everything is just possible because of computer software and the mastermind brains behind it.

Choosing computer science as a carrier is considered a wise choice as it is estimated to be the everlasting carrier with a wide scope. Infact, computer science graduates are in high demand and have a nice command over other candidate. There are actually many reasons to choose to study computers, which includes a common belief of people that a computer science student earns big bucks.

Moreover, Computer scientists are needed in every type of industry. Problems in science, engineering, health care, and so many other areas can be solved by computers. It's up to the computer scientist to figure out how to design the software to apply the solution. Computer scientists theorise, design, develop, and apply the software and hardware for the future use.

Computers are not only here to stay, they are the wave of the future. Only a device like the computer can change the way we work, live, and think. I see computers taking us places where no man has gone before. Students can receive education from their own home taking classes online. This is an option that a growing number of students are taking advantage of. Even college education is available for students who are not able to attend a traditional university or college.

Many of today's successful small companies simply could not exist without computer technology. Each year hundreds of thousands of individuals launch businesses based from their home or in small office location. They use computers and software not only to perform basic work function but to manage and grow their companies.

Nowadays, the whole scenario of banking has changed. With the development of internet banking you can open your accounts, check your balance online transfer money, pay bills and print statements from the comfort of your home. Banks use computers extensively to operate efficiently. The benefits of this indeed amazing subject are countless. Computers and technology are definitely not a topic to ignore as our honourable prime minister Mr.Narendra Modi Ji too have laid emphasis on **DIGITAL INDIA CAMPAIGN**. This clearly shows the future of this field. Truly, the computer is one of the most incredible inventions of this time period or any other.

ARTIFICIAL INTELLIGENCE, ROBOTICS, ETHICAL HACKING, CRYPTOGRAPHY, DATA ANAYLYSIS, ASTRONOMY etc. are some of the many higher branches of computer science and technology. The human genome project, AIDS vaccine research, environmental monitoring and protection, weather forecast, etc. use the technology of computer science.

But, getting into computer science is not so easy. People today are becoming the trap of the insane market demand, they don't try to realize the technical skill set behind becoming a programmer; they simply do it because many others are doing it and so…this becomes a rat race wherein people blindly follow each other forgetting their own capabilities and skills.

It is always misconcepted that a computer science student seems to be of a sun-deprived geek sitting for hours and typing 0s and 1s as fast as he can. But it's not the case, in fact, Computer science is about thinking how best to solve a challenging problem and having the imagination to see the world differently more than it is. To strike the gold, one has to work really hard and build the logical mindset. Maths is an important area which cannot be ignored if one needs to be a master in softwares. Whether thinking through a sophisticated algorithm or persevering through debugging a program, computer science does increase one's appreciation for solving difficult problems and provides the framework to solve new ones, which results in a stimulating educational experience.

At last, having myself truly impressed by computers, I would like to pack up this article by putting a famous quote by Alfred Aho,

"Computer Science is a science of abstraction -creating the right model for a problem and devising the appropriate mechanizable techniques to solve it."

MATHEMATICS is the QUEEN of sciences

STATISTICS mean never having to say you're certain

COMPUTERS are not good or bad, they are powerful

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