AINA

AI and Analytics

Volume 3.0 Edition 2021-2022

Public Policy
Metaverse
Blockchain

Astronomy
Jurisdiction
Language Model

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FROM THE TEAM

|| aprapyam nama nehasti dhirasya vyavasayinah ||
(There is nothing unattainable to the one who has the courage and who works hard)

The undying courage and relentless effort from every individual to overcome the hardships of a once-in-a-century pandemic has finally paid off. People across the globe are now slowly coming back to pre-pandemic life owing to the rapid vaccination drive and precautionary measures. The world is gearing up for a completely new era of the digital revolution. Though the COVID-19 pandemic demanded countless precious lives, it has compelled us to revisit the true applicability of the technology in earlier unexplored domains. From education to occupation, marketing to shopping, finance to governance, digitalization is everywhere. The risk takers who first adopted to the digital revolution are now the pioneers of change. Artificial intelligence and analytics-based solutions are the essential pillars of the new technology monument with their presence everywhere.

With the onset of Web 3.0, industries are preparing to leverage the power of decentralized data. Today, it is hard to mention any domain where AI and analytics are not being used. Being the presenters of edition three of India's only student driven AI and analytics magazine, AINA, it is our opportunity to bring up the latest trends and developments happening around the world in these fields. The previous two editions of AINA have established a strong presence among numerous academicians and professionals and received kind appreciation. Following the legacy, we are delighted to present the third edition where our primary focus is to demonstrate the variety of applications of AI and analytics in distinct areas. We hope to benefit our readers by providing them with the emergent trends and technologies driven by data analytics. The magazine is presented with a different design concept that best represents the dynamic and creative nature of the entire PGDBA fraternity.

We want to specially highlight the uniqueness of the cover page of this magazine. The image is completely generated by an AI model using textual description as input. Out of several trials and errors, we have selected the image which best suits the theme of the magazine.

We express our heartfelt gratitude to the chairpersons, the directors, the deans, and the faculty of IIM Calcutta, ISI Kolkata, and IIT Kharagpur for their guidance and support. We are highly obliged to Prof. Manisha Chakrabarti, Mrs. Richa Agarwal, and Ms. Bindita Chaudhuri for sharing their valuable insights and opinions through the interview sessions which will provide a broader perspective to our readers. We would like to thank our senior magazine team members from AINA 1.0 and AINA 2.0 for their continuous support, guidance and suggestions which helped us to achieve the end result. We mixed the learnings from our teachers, support from our friends and family and guidance from the mentors with a pinch of imagination and a cup of honest effort to present the magazine to all of you. Happy reading!!

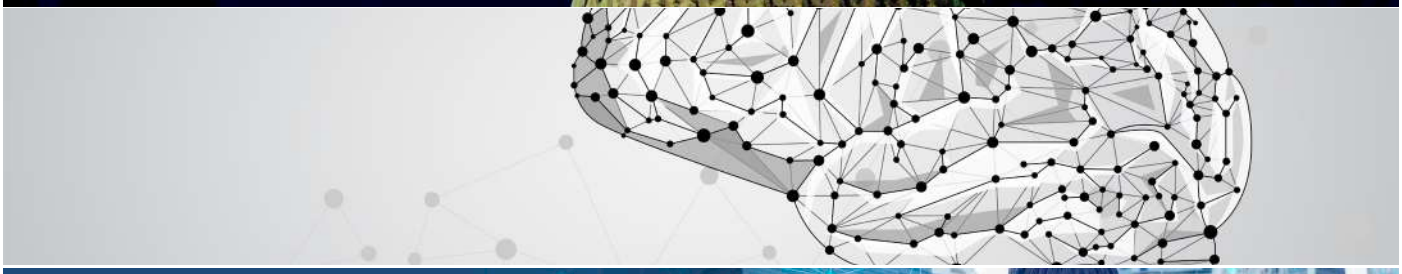
FROM THE CHAIRPERSON'S DESK

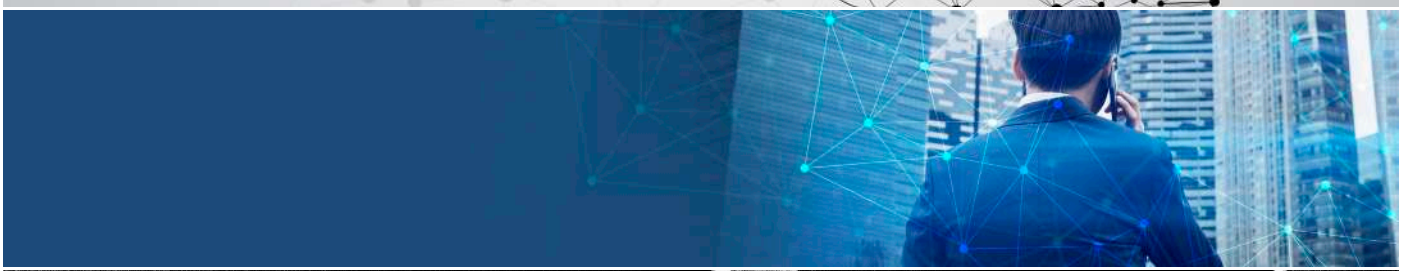
Prof. Samit Paul

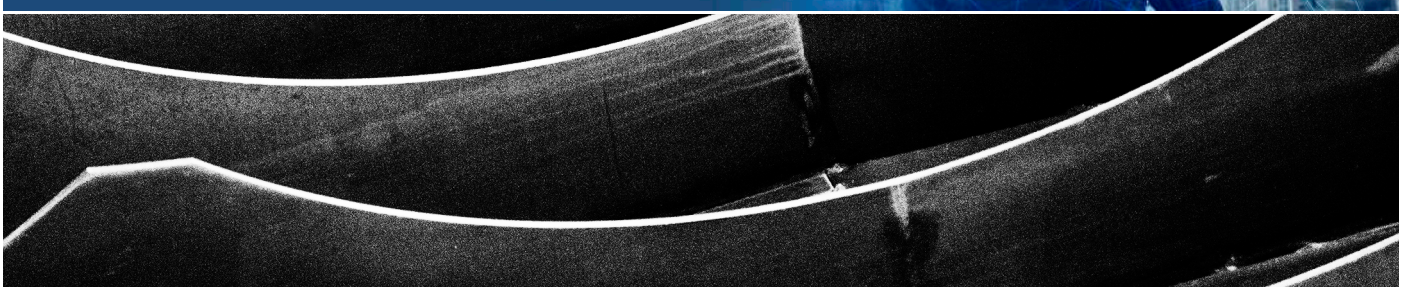
Finance and Control group
IIM Calcutta

Post Graduate Diploma in Business Analytics (PGDBA) is a full time, residential program in business analytics offered jointly by three esteemed institutes: Indian Institute of Management (IIM) Calcutta, Indian Statistical Institute (ISI), Kolkata, and Indian Institute of Technology (IIT), Kharagpur. Naturally, the uniqueness of this program emanates from the amalgamation of business, statistics and technology. The program conducts an extremely competitive selection process and maintains a good mix of experienced and fresh graduates to build an impressive batch profile over the years. More importantly, unlike any other program, an industry internship of six months stands this program out from the rest of its cohort as it makes the participants completely industry ready. Thus, professionals graduated from this program possess the ability to think critically and find data driven solutions to management problems using appropriate tools from the field of data science. I am sure that this unique tri-institute PGDBA program will grow more and more in future to cater the increasing demand of data scientists, globally.

Chairperson , PGDBA







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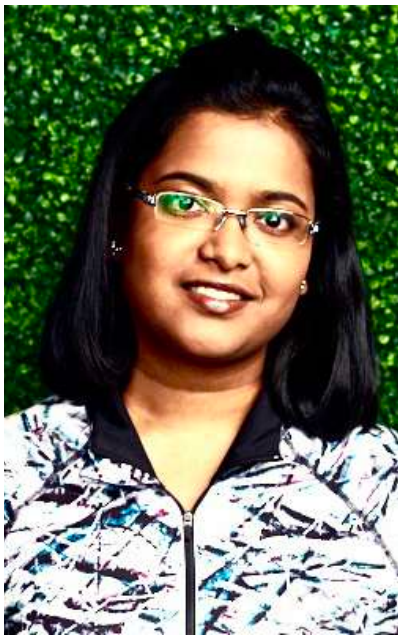

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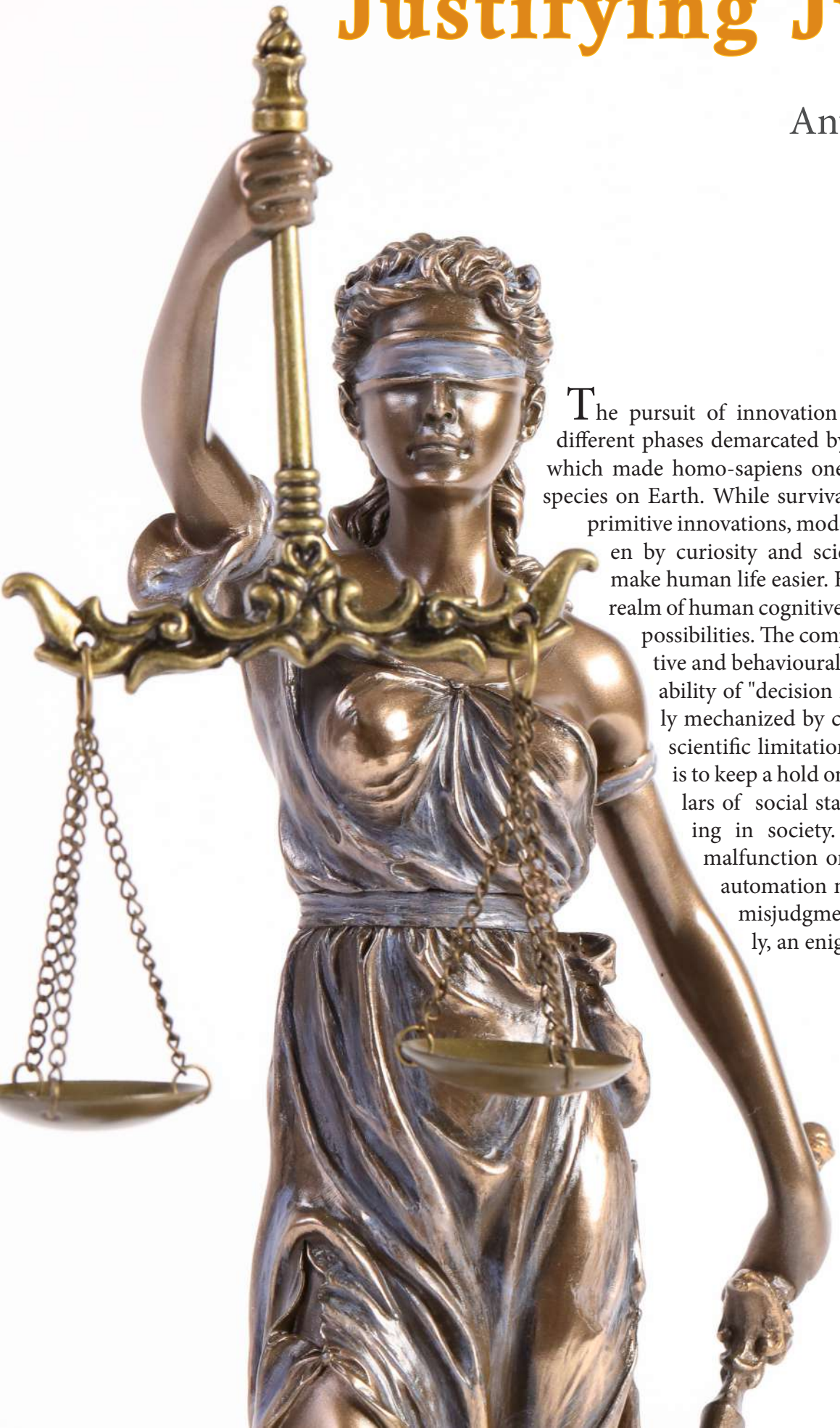
Anup Rajbongshi



The pursuit of innovation in human history had different phases demarcated by distinct driving forces, which made homo-sapiens one of the most successful species on Earth. While survival needs primarily drove primitive innovations, modern innovations are driven by curiosity and scientific advancements to make human life easier. However, the unexplored realm of human cognitive abilities still holds many possibilities. The complex neurological, cognitive and behavioural process that gives us the ability of "decision making" is yet to be fully mechanized by complex algorithms. Our scientific limitation or deliberate intention is to keep a hold on the most important pillars of social stability, i.e. decision-making in society. The chances of error, malfunction or miscalculation in such automation may lead to social chaos, misjudgment and, more importantly, an enigma of accountability.

Sloth: Slow and serious!

Pendency in courts is a global phenomenon, the average waiting period in almost all of Europe is 9.3 months. For India, this indicator is 40 months, a figure which is almost four times higher than the average in Europe . Let's dive into further details about the root causes.

The need for speed

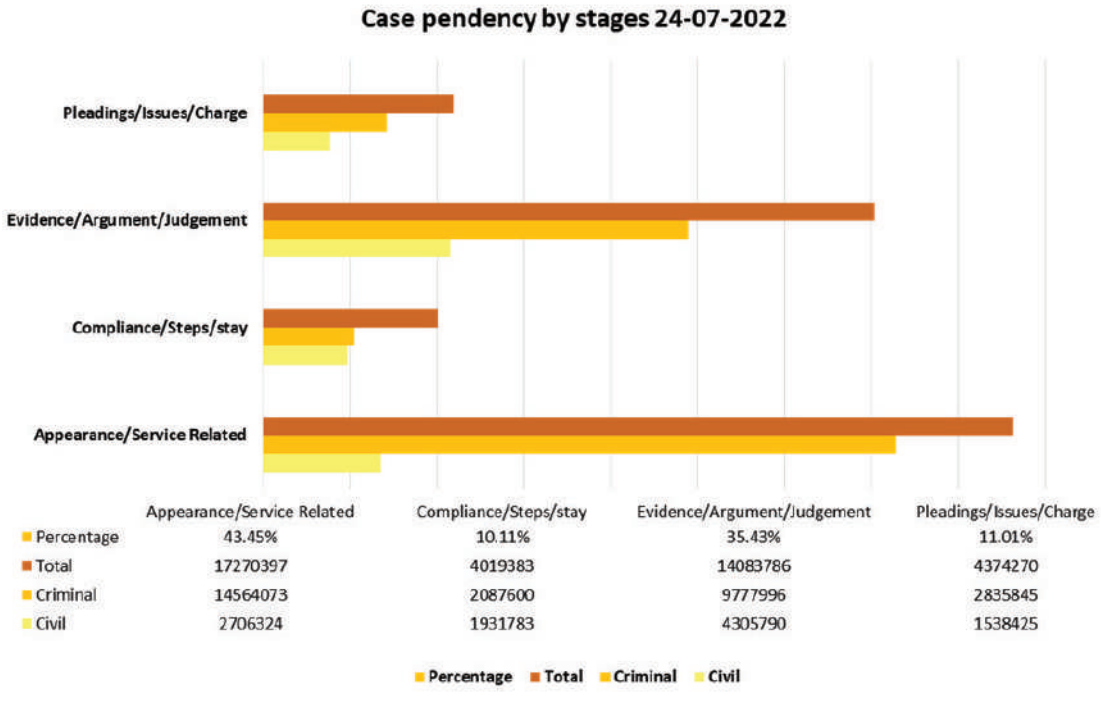
Fast forward to 21st century India, we have 70,154 cases pending alone in the Supreme Court of India, where the total number of pending cases is over 4.23 crore. For every 1800 people, we have only one lawyer, and only 21 judges for every million people. Our judicial system has the highest waiting period in the world, with an average of 1128 days in high courts and 2184 days in subordinate courts. With a rapidly increasing population and a proportionate increase in demand for justice on various socio-economic and criminal affairs, there has been a compounding burden on judiciary practitioners to deliver justice on time.

We know about the sluggish nature of our judiciary system. Hence making it faster is one of the needs of the hour. The enormous amount of information in different trials requires judges to spend time and effort studying each of them before making the final decision, which delays the verdict of the case. As a result, bottlenecks in arriving at a conclusive decision are quite common in this process.

According to the National Judicial Data Grid, combining both civil and criminal cases, cases which are in early stages of appearance and service accounts for 43.45% of pending cases. One of the major reasons for this is the absence of parties in court, absence due to incorrect court notices, travel, fatigue, and unavailability of lawyers due to their busy schedules. The next major stage, where pendency accounts for 35.43% of the delays, is the trial stage (evidence, discussion, judgment). It happens mostly due to a lack of substantial evidence. Thus, these stages become bottlenecks and slow down the effectiveness of the justice delivery system.

The Indian legal system is ready to utilize AI to tackle these bottlenecks and has envisioned many such programs. SUPACE (Supreme Court Portal to Promote Court Efficiency) is an AI portal that pulls relevant facts and statements by providing backend assistance on case repositories, automated updates, and legal recommendations to the judge for decision-making.

So far the Indian judiciary system has only streamlined the infrastructure of processing and accessing of data. As the former CJI quoted, "We are not going to let AI spill over to decision-making". However, is it the same with global counterparts? If not, what made them go one step ahead?



	Appearance/Service Related	Compliance/Steps/stay	Evidence/Argument/Judgement	Pleadings/Issues/Charge
Percentage	43.45%	10.11%	35.43%	11.01%
Total	17270397	4019383	14083786	4374270
Criminal	14564073	2087600	9777996	2835845
Civil	2706324	1931783	4305790	1538425

Stage Wise Pendency report of both Civil and Criminal Cases by National Judicial Data Grid India.

Homunculus: A step toward human cognition

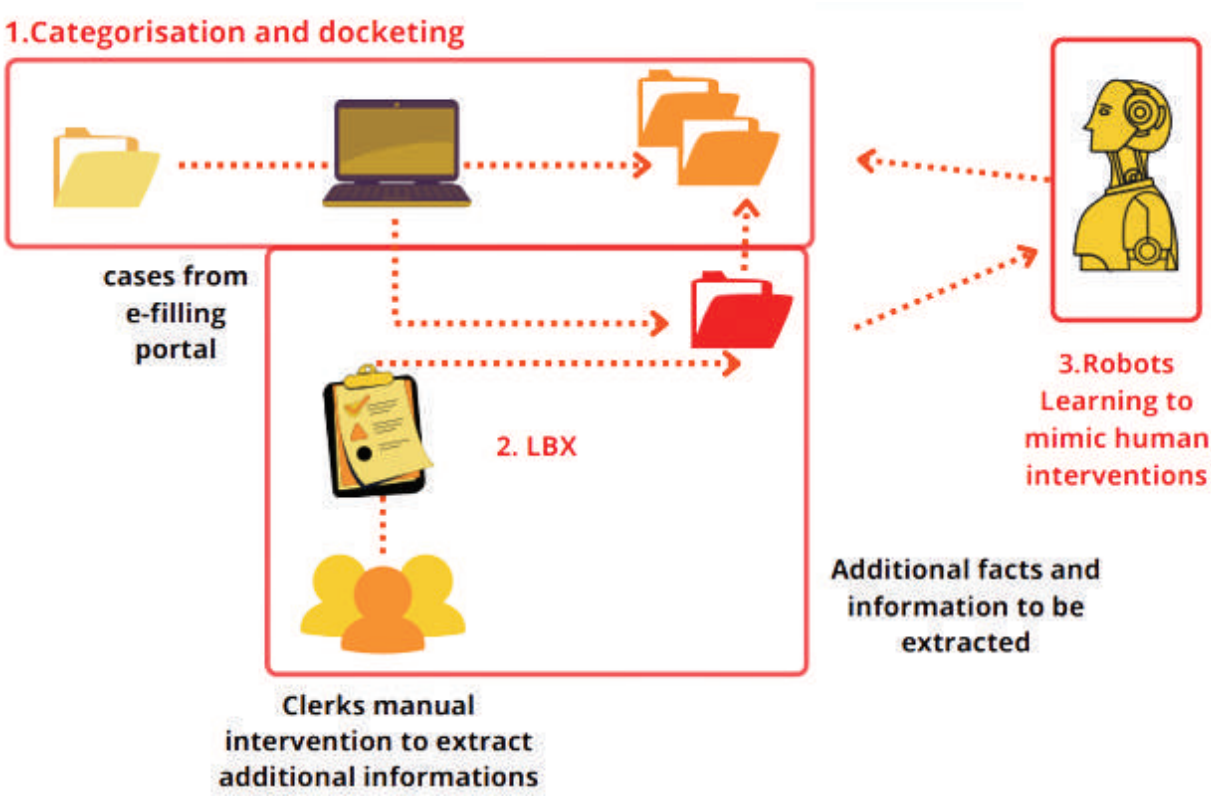
Let's explore how cognition shapes the workings of automation. A machine's logical thinking begins with mimicking without prior knowledge, gradually adding understanding capabilities, learning ability, simplification techniques, problem-solving capabilities, and so on to its algorithm. So, observing a machine slowly improve itself by self-learning is equivalent to a baby learning its first steps through a series of tumbles. Can we impersonate this incredible power of cognition in a machine? Can we use it for decision-making when the legal framework is considered? In our next example we will see how initiation was done by automating Docketing process thus tackling the complexity of mimicking human behaviour.

Automated Docketing: the beginning?

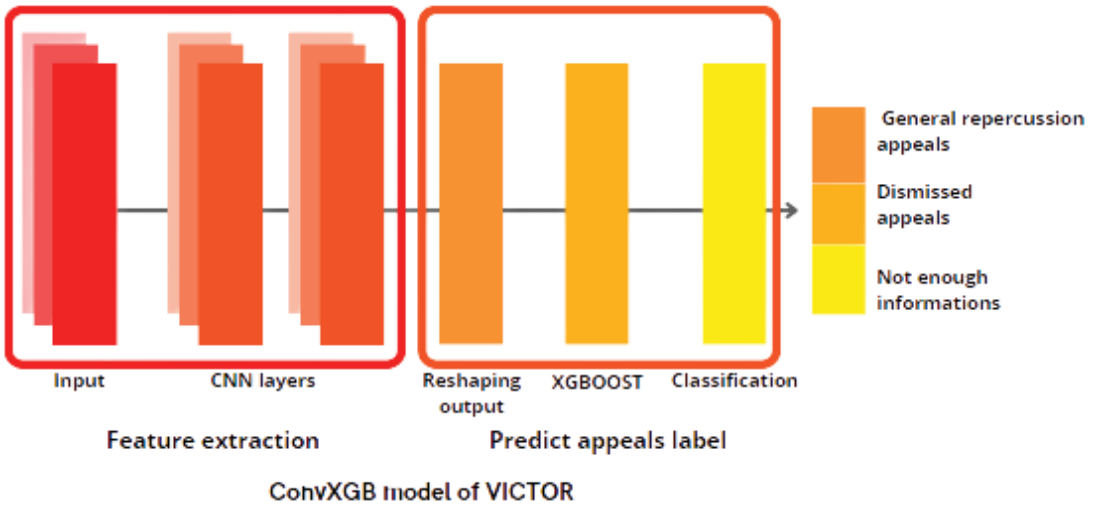
So what is docketing? Docketing is defined as "A court's official record, in summary, forms of the hearings held, parties' appearances, and papers filed in a proceeding for court hearing date or case submission".

The Circuit Court & Comptroller from Palm Beach County, Florida, have created an AI solution for classifying and docketing documents with the help of Computing System Innovation (CSI) to reduce pendency. The automation is divided into categorisation (classifications), LBX (Learn by Example) and RPA (Robotic Process Automation).

Classifying cases from e-filing portals was done by training the model on thousands of filings used as a training dataset. The model gave an accuracy of 98 to 99 percent, which was better than what human counterparts used to achieve. Clerks manually intervene to pull additional information from filings relevant to cases. They use OCR to translate handwritten scripts into a digital format where the information is tagged and indexed. The information tagging aids LBX to learn through instances on which manual intervention is required on what information to be retrieved. LBX automates this process for similar cases which might arrive in the future. Then comes the robotics of RPA, which mimics the whole process of manual intervention by memorizing the click-by-click steps done by humans to reproduce the corrections process.



VICTOR categorizes appeals presented in Brazilian Supreme Court (STF).



VICTOR for victory?

VICTOR is an AI system built for the Brazilian Supreme Court (STF). It utilizes OCR to identify images, segregates them further into factual and legal reasoning data, and then extracts the most relevant information for further reviewing purposes. Google Tensorflow helps VICTOR sort through layers of data to learn complex patterns where the complexity of features increases as we move from the first layer to the next. To enhance the performance of the CNN, an additional layer of XGBoost is deployed at the final layer. This combined method, known as ConvXGB, is faster than CNN and more accurate than both individually, as it compensates for the requirement of a higher number of hidden layers.

The main purpose of VICTOR, for now, is to categorize the appeals as per STF into categories such as (i) general repercussion appeals, (ii) appeals that were already dismissed, and (iii) appeals regarding which there is not enough information. It has achieved 95% of accuracy with an average time to process an appeal from 44 minutes to a few seconds only.

Automated docketing and VICTOR dwell in low-risk, high-volume areas where decisions can be quick and with little human interventions. Both have broken the old age stigma of decision-making and are being accepted on the global justice scene. It has shaped the beginning of machine intelligence for legal decision making, and they will get better over time with their learning algorithms.

Critiques

Greed: Greedy algorithm or deep-rooted bias?

There is a saying that goes like, "There is a difference between what is legally right and what is morally right", and neither AI nor human beings can understand the difference. However, institutionalized ignorance toward ethical practices can still creep into our so-called ideal AI systems. One such act of greed biased the algorithm's usage toward a specific type of demography. In our next example we will see how available biased information that trains a model imputes decision bias towards certain race or ethnicity which is highly undesired.

Paul Zilly from Wisconsin had been convicted of stealing a lawn mower. During further court proceedings, the judge consulted COMPAS (Correctional Offender Management Profiling for Alternative Sanctions). COMPAS categorized Zilly into a group with a high risk for future violence. The case went straight downhill for Zilly when the judge decided to reject the plea deal and imposed a stricter jail time for him. Zilly was hell-bent on rejecting the algorithm's verdict and was asking for real justice. COMPAS is trying to predict the vulnerability and the possible future course of action. However, how accurate is the system?

COMPAS assesses about two dozen 'criminogenic needs' such as substance use, antisocial cognition, antisocial associates etc. that relate to the major theories of criminality, including 'criminal personality,' 'substance abuse, 'residence/stability and social isolation. Defendants are further divided into low, medium, or high-risk ranks.

Nevertheless, on further investigation by ProPublica analysis, they found that only 20% of people have committed further crimes after serving their sentence period. There were many disparities in the rate of conviction for risk categories as a certain colour of people had a higher rate of re-offending predictions. For example, person X and person Y were convicted for stealing a bike and shoplifting, respectively. X's record was restricted to a few misdemeanors as compared to Y, who had attempted an armed robbery. However, X was rated a high-risk offender, and Y was rated a low-risk one. The fact to note is that X was 18 years old and belonged to a community with a prevailing social colour bias. It clearly shows how flawed the algorithm was as social preferences or biases were inherently embedded in such a system.

"Justice is conscience, not a personal conscience, but the conscience of the whole of humanity. Those who clearly recognize the voice of their own conscience usually recognize also the voice of justice."

Aleksandr Solzhenitsyn

AI/ML for patent war : Lexis Nexis shaping the future of litigations

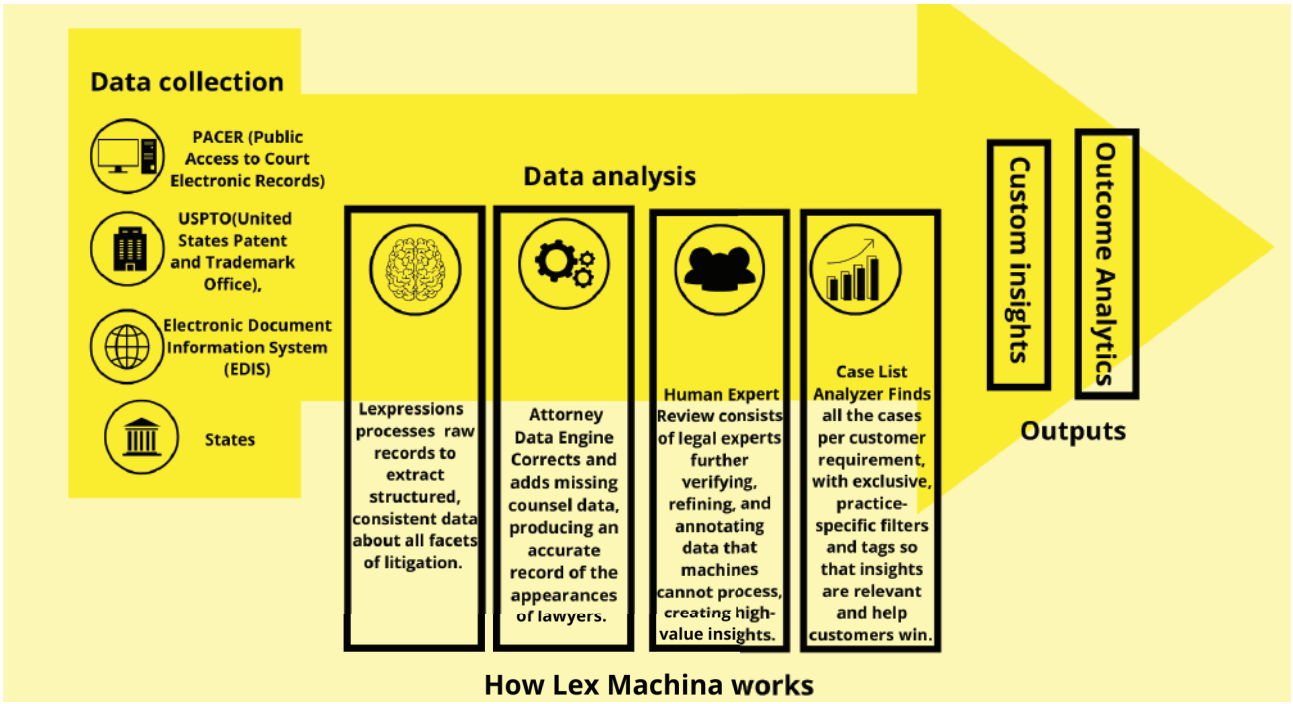
One key aspect of litigation is risk analysis; not only could it avoid wasting time and investment of stakeholders, but it can also provide a holistic view of cases on a global platform. LexisNexis stands tall as a corporation that has archived legal data over the years, providing data analytics products and databases for easy access over the internet portals for legal research and assistance. Another LexisNexis product, Lex Machina, tracks every electronic patent litigation event and outcome for transparency and openness. Thus it may change the way how the big companies will approach the patent wars in future.

How does Lex Machina work?
Lex Machina gives custom insights for interested parties such as :-

1. Judges and Courts: Behaviour of specific judges on cases similar to present case of concerned customers, and how they are different compared to other judges.
2. Attorneys & Law Firms: Provides detail analysis on opposing counsels, law firms, and litigation experience of attorneys.
3. Parties: A brief report on the analysis of party's experiences, track records, and how they will perform in the court.

As an outcome, Lex Machina serves three purposes:

1. Outcome Analytics: Unique case resolutions, damages, findings, and remedies help customers understand what happened in each case.
2. Timing Analytics: Knowing the time for critical litigation milestones helps customers set accurate budgets and manage client expectations.
3. Motion Metrics: Compare detailed motion chains and motion outcomes to craft winning strategies.



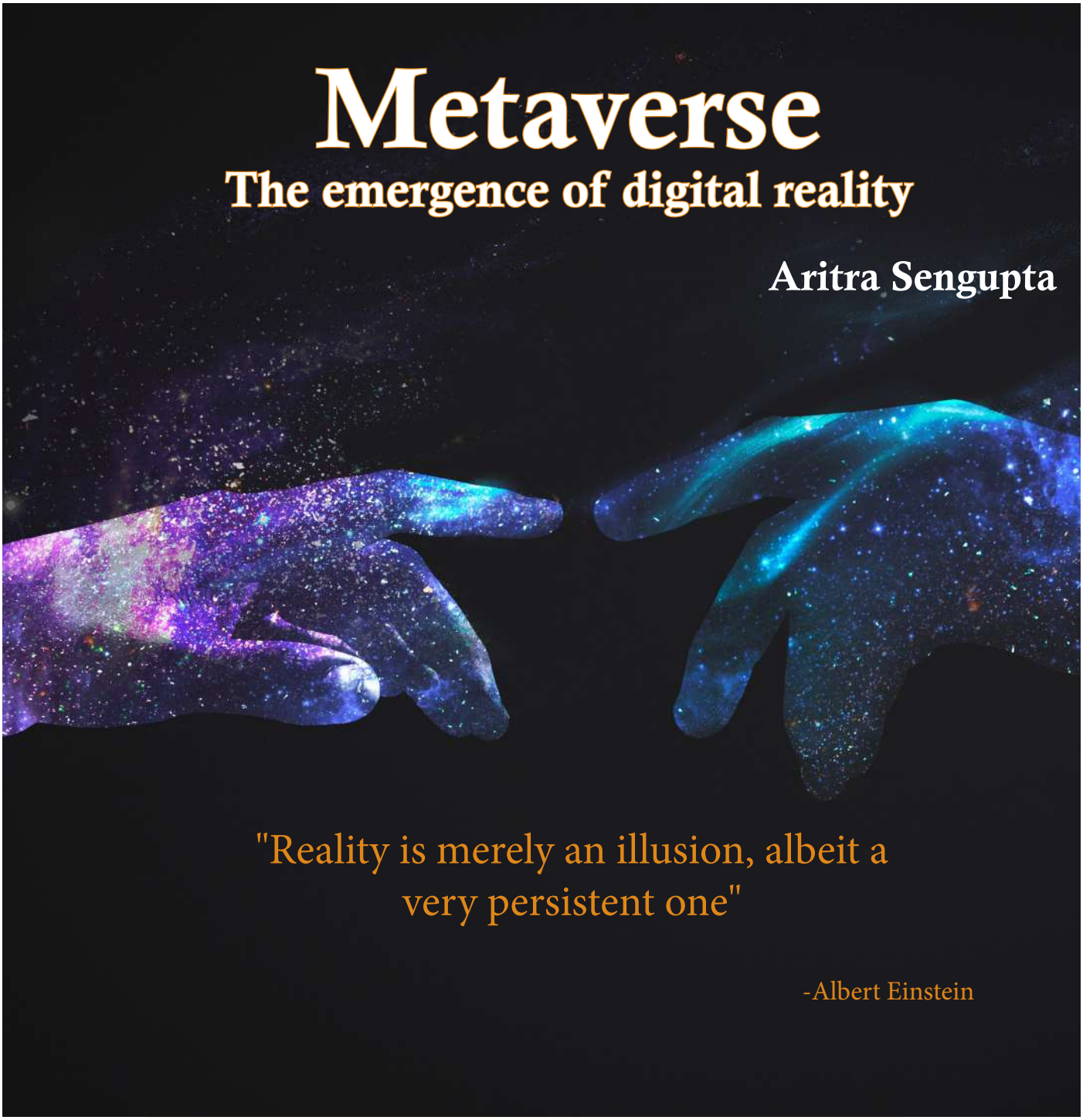
Black boxes over black robes?

Throughout the article, we have seen how automation is getting accepted in the decision making process and how human behavior can act as drivers or barriers according to situations . In a sense, the judiciary itself is a reflection of our society which has developed itself throughout history by learning, unlearning, and re-learning to get better and better. Likewise, any learning model, which is to be implemented in the judiciary, must adapt to the process to remove any presumptive biases or norms which was acceptable at one point in time but might not be relevant tomorrow. With automation penetrating deep into different horizons of decision making processes across the globe, achieving a uniform and efficient judicial ecosystem as well as implementing modern data-driven automation might be a challenging but not an impossible dream.

Metaverse

The emergence of digital reality

Aritra Sengupta



"Reality is merely an illusion, albeit a very persistent one"

-Albert Einstein

One butterfly and one simulation hypothesis– Both of them have a common notion of questioning our imagination of reality. However, the perennial dilemma between "perception" and "existence" has impeded the constructive definition of "Reality" which is independent of our beliefs or experience.

The linguistic origin of the word "real" is the Latin word "res" which means "things". The ontological concept of reality is the existence independent of comprehension whereas phenomenological reality is based on the degree of comprehension by individual beings.

Hence, considering phenomenological reality to be more explainable, our visual sensory device becomes a gateway to enter, simulate or morph the experience of reality we have. That is the birthplace of the idea of the "Metaverse". Throughout the journey of human development, social cooperation, collective experience, and knowledge inheritance have been the key components of our existence. All of these qualities require "interaction" that metaverse is aiming to bring under the virtual dimension. It is a transition from physical to digital reality. But what actually metaverse is? How does it map things into virtual reality ?

What we see around is reality for us. The virtual reality creates the illusion of vision around us through VR devices where we see a different reality that is made up of virtual people. It is just the perception of human mind.

What is Metaverse?

Sci-fi novel "Snow Crash" by Neal Stephenson (1992), sci-fi movie "Avatar" by James Cameron (2009), and sci-fi web series "Upload" by Greg Daniels (2020) somehow summarize the concept of "Metaverse". It is an immersive and interactive shared 3D digital or virtual environment that can be accessed by different users in real-time (independently) and can be used to interact with others in form of a digital version of self, called "Avatar". The interactions through avatars are quite similar to our physical world interactions. The sense of being physically present in the environment is missing in the existing 2D digital platforms – "Talking to a black screen!" Metaverse is trying to bridge the gap between 2D and 3D interface that holds the clue to the future of human communication.

How did the technology come into the limelight?

COVID 19 had disrupted people's lives in many ways. The world came to a halt and suffered from interaction deficiency. Online meetings, classes, or collaborations were discouraging. There was no clue about the receiver's body language, level of engagement, or signs of interest. People realized that the prevailing communication platforms are necessary but not interactive enough. At the same time, basic technologies like Augmented Reality, Virtual Reality, Blockchain, and 5G services gained momentum that paved the platform for metaverse. Facebook caused a ripple effect by renaming the company as "Meta" in October 2021 to venture into the virtual reality domain. Microsoft announced "Mesh for Microsoft Teams" in November 2021 which enables mixed reality features in teams for interactive online connection. With big names in the race for first-mover advantage, metaverse is in trend.

What makes this idea possible? – Key components of metaverse

Replicating physical reality is a dauntingly difficult task given the huge set of variables and uncertainty that we encounter in human activities. Latest technological advancements in Big Data, Deep Learning and ML algorithms, high-speed internet connectivity (5G/6G), and powerful Data storage systems helped materialize the technology for metaverse. The core idea is to map physical activities into a virtual space so that users can feel the avatar next to them as a real person and not a pre-programmed bot. Thats where AI and data science come into play.

Role of Big Data and AI in Metaverse – Physical to Digital data transfer

Big Data – Data hunger of metaverse

The accuracy of digital replication of physical objects, called the digital twin, requires extensive data collection and processing abilities. Limited data resources so far have been a challenge for successful deployment of AI algorithms. But recent developments in IoT devices and low-cost decentralized storage systems like Distributive Storage Verified Queries (DSVQ) are helping to collect and process users' behavioral, postural, and physical data which will be used for precise simulation. Superfast parallel computation is now possible due to cloud technologies. A real time data collection mechanism is the backbone of metaverse data banks.

Virtual Reality rendering – Simulate what we see

Data on complex human behavior and movement are collected through IoT based sensory devices and mapped into digital versions so that users can seamlessly experience/control digital avatars. Augmented reality (AR) devices rely on Computer Vision framework to accurately superimpose digital imagery on top of real-world visions. VR devices extensively use AI models like GANverse3D developed by NVIDIA to replicate physical photographs into digital form. Pytorch 3D by Facebook AI and Tensor RT by NVIDIA are some of the CNN based tools that are being proposed for seamless real-time rendering of 3D objects. Facial feature mapping through VR devices are done by complex algorithms.

Digital Marketing – Target customers in a virtual world

As footfalls in metaverse are increasing consistently,effective marketing will require sophisticated recommendation algorithms like Collaborative Filtering developed by FastAI. Customer behavior in the virtual market will be different than usual e-commerce platforms. There will be option of virtually hold the products in hand before making a purchase which is not possible in usual e-commerce websites. Marketing using Virtual Reality has been there for a long time. Now with the onset of metaverse, businesses can leverage the power of digital marketing with the help of Augmented Reality as well. .Instead of carrying B2C products to customer doorstep by salesperson, brands can demonstrate their functionality using AR enabled adds where one can actually experience the product virtually in front of them.

NLP and Communication – Human to machine interaction

Communication being the central idea of metaverse, NLP has robust applications in a successful virtual interaction. Intelligent Virtual Assistance and smart chatbots are essential in metaverse for communications between avatars to non-player pre-programmed characters. Short text generation feature using various language models can be used for captioning images for digital marketing, route maps, and instructions without manual aids.

Features	• Gaming, Socialization, E-commerce, Digital Marketing, NFT transactions • Future Scope: Simulation, Education, Healthcare, Defence, Financeial Services.
3D reality tools	• Holographic and Immersive devices, simulation environments • Augmented Reality, Virtua Reality and Extended Reality tools
Transparacy and data protection	• Decentralization technology(Blockchain), Simultaneous independent access • Edge Computing , NFT tockenization, Virtual Property Rghts
Interface	• Shared web space accessed through VR devices, Cloud computing networks • Smartphones, smart devices (watches, bands etc), Noninvasive IoT devices
Moderators	• AI, ML, DL, Computer Vision , NLP, Recommendation System • Geospatial location, Data Streaming and real time data analytics
Technology	• 5G , Cloud Computing, Big Data, Data Warehouse • Hardware accelerator , Quantum computer(future scope)

Computer Vision – The gateway to the digital world

What people see in virtual reality should be as realistic as they are in the physical world. Hence accuracy and low latency are the fundamental requirements for metaverse. A small 2D Field of Vision (FoV) is replaced by a 3600 virtual vision range in VR/XR imaging system by tracking the user's eye movement. Computer vision is mainly used for semantic segmentation of surrounding objects where each object is classified into a unique class based on the visual features. Atrous Convolution by DeepLab helps to increase the field of view of an image in convolution neural network. Larger field of view from input image helps to extract features in efficient way. Hence, it provides improved feature learning with low computational power requirements which can be used in regular electronic devices..

The recent studies in transfer learning methods can drastically reduce data training costs. AI-empowered blur adjustment, haze detection & manipulation, color histogram adjustments, and auto-image aspect balance are some of the potential use cases of CV in this domain.

We see with our eyes. Computer vision is our eye in the virtual world. The idea is to translate physical 2D objects into realistic virtual 3D objects.

How can metaverse read our minds? - Brain-Computer Interface (BCI)

To foster an alternate reality, human experiences, expectations, emotions, and intentions are key variables that are needed to be mapped. The fundamental idea of BCI is to detect, record, and process the features of brain signals to understand the cognitive intention of the user and convert the same into machine-readable signals. VR-mounted headsets with external electrodes, optical signal sensors, etc. can translate physical senses into digital actions. The most recent development in Haptic Devices (e.g. PHANTOM) enables users to touch and sense virtual objects. When people will sense the virtual objects, the experience will be realistic and reliable. With a combination of biocompatible electrode implanted into visual cortex of brain and an external signaling device to convert digital image into electrochemical signals, BCI can impose vision to the visionless people. So, BCI technology in metaverse can be a mode of education, development and exploration for visually challenged people.

Semantic segmentation identify edges of various objects by classifying individual pixels into associated classes.

"Virtual, augmented and mixed reality are the gateway to phenomenal applications in medicine, education, manufacturing, retail, workforce training and more, and it is the gateway to deeply social and immersive interactions – the metaverse."

Elizabeth Hyman, CEO of XR Association

Blockchain in Metaverse – Decentralize the reality

Blockchain is the backbone of modern decentralized data ecosystems. The exorbitant amount of data that is being generated and processed by digital ecosystems requires a secure and failure tolerant storage system that can be entrusted similar to traditional financial systems. For digital economy in metaverse, Blockchain is a suitable solution due to the following reasons:

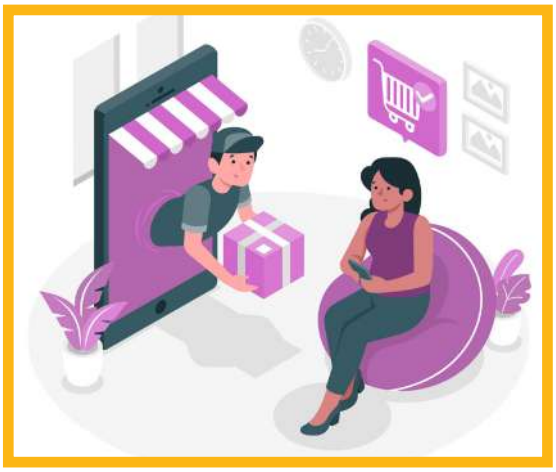
Security: Data decentralization avoids all flaws of present centralized data storage systems like fault, hacking, data privacy violation, etc. Also, it provides a framework to embed personal digital identity into a secure network (e.g. Ethereum-based e-residency program in Estonia) which can prevent digital fraud.

Virtual Asset: Transactions on cryptocurrencies and NFTs over the Blockchain network can be realized in terms of physical currency. Hence investment in virtual assets can be profitable even if it is in digital world.

Digital Economy: Blockchain provides a decentralized secure financial data structure that is not dependent on a central banking database. Hence, the entire virtual economy can be built on a Blockchain network with robust data storage mechanism. Since the metaverse environment itself is decentralized and non-mutable by a single entity, its economy should also follow a similar idea that is in sync with the Blockchain concept.

Having evaluated the technological aspects of metaverse, one question is not answered yet:

Technology at finger-tips - Immersive work systems



Top brands are opening stores in Metaverse allowing customers to have an immersive shopping experience

How Metaverse can digitalize physical world activities – The complete picture

The concept of metaverse will be successful if it can provide an alternative to contemporary physical world activities in an economically feasible way. Otherwise, it can end up being an online entertainment platform only. Based on the operational infrastructure (blockchain network with the application of AI and Big Data), metaverse can translate the following real-world activities into virtual world applications:

Socializing:
Bill Gates, in his "Year-in-Review 2021" blog published in GateNotes, emphasized the importance of metaverse for virtual collaboration and the future of socialization. The human mind can perceive things better in 3D than in 2D. Hence given the opportunity, we prefer group discussions over video calls. The fundamental use case of metaverse is social interaction. In the post-pandemic era, when the people are already familiar with remote work and virtual meetings, metaverse will provide a better solution than 2D environments.

Entertainment:
The media psychology explains how the human brain is unable to distinguish between virtual and physical reality under specific sensory stimulation. For example, in 3D movies, 2D objects appear to be 3 dimensional or 4K sound system creates the impression of moving sound source. Metaverse provided the pandemic-struck entertainment industry with an alternative to reach out to customers by organizing concerts and shows on virtual platform where participants can virtually join from across the globe .

E-commerce:
H&M has introduced an online store in Metaverse for real-world shopping experience. With many similar brands flocking in to provide an immersive experience in metaverse, there will be a new ecosystem of e-commerce where virtual objects will be purchased online and the same will be delivered in physical form. Several apparel brands are opening virtual stores to attract tech-savvy customer for better experience.

Digital Marketing:
According to a Bloomberg study report, the expected market size of digital advertisement industry will be around $20 Billion by 2022. Virtual concerts of celebrities and artists with a vast audience will be an ideal destination for the digital marketing industry. Instead of having physical banners and posters, advertising in 3D virtual space has a scope of attractive innovations, better visualizations, and cost-effective outreach. It is not restricted to geographic boundary. Also, advertisements can be modulated for different customers easily based on their activity in the metaverse platform. Instead of carrying B2C products to customer doorstep by salesperson, brands can demonstrate their functionality using AR enabled adds where one can actually experience the product virtually in front of them.

Metaverse is combining robotics, web 3.0, cloud technologies and AI to digitalize and advance the healthcare system

Education:
As per the UNICEF report on the effectiveness of digital learning solutions (April 1, 2021), the digital education system has proven benefits in terms of curated curriculum, visualization of contents, supporting technology, and ability to reach remote locations which do not have conventional institutional infrastructures. The only drawback of a non-interactive 2D platform is now complemented by the interactive virtual platform. It is now a possibility that universal virtual schooling (e.g. 3DMeet) will be the future of education.

Simulation:
2D simulations of aircraft, racing cars, to small screen sizes and low FoV. Using VR 360 vision, the simulation in metaverse will be realistic and spontaneous as the environment is not pre-programmed. Mock drills of rescue operations in case of fire, flood, forest fire, etc. in metaverse will not only be realistic, but safe at the same time with no chances of physical accidents.

Healthcare:
Health centres and medical assistance services in metaverse are a future possibility. CNN-based motion sensing and physical activity tracking can lead to the automatic detection of abnormalities in health behavior. Online consultation from the remote part of the world will be seamless with internet access. Mapping hand movement in virtual world and replicating the same accuracy in robotic hands will make virtual surgery possible in the future.

Transaction:
NFT is the primary point of transaction in metaverse currently. Users can pur-

, marketing industries will require digital space for advertising campaigns, digital banners, etc. which will be purchased at a much higher rate. Hence, NFT is viewed as the next big investment option after cryptocurrency.

Manufacturing:
Product innovation and design contribute to a considerable cost due to prototyping, testing, pilot survey, etc. Human error in production lines is also an inevitable part of manufacturing. Launching prototypes for digital testing, and simulating the entire manufacturing process in virtual space to identify the possible scope of improvements can reduce physical testing costs and increase production efficiency. IoT device data can be fed directly to the virtual simulation to accurately replicate production behavior. BMW and Ericsson are creating a digital twin of their production facilities to improve production efficiency by simulation.

Workspace:
Permanent work from home has now become an emerging job trend. It reduces the operating cost of real estate establishment of the organization with employees working remotely from their place of comfort. However, the fear of missing out is a daunting challenge. Metaverse can solve the problem by bringing the workplace to the desktop. The user will be immersed in a digital world which will very closely resemble the physical office. Working from any geographic location saves significant commute time. The realistic interface of metaverse could become the future of the digital workspace.

We have understood so far the true potential of metaverse as a technology. But there are prominent threats associated too. No matter how futuristic the technology is, it is still prone to undue human behavior:

Word of caution – Responsibility of the users

Metaverse technology is also susceptible to social volatility. Participants in the platform are human beings with uncensored cognitive motivations. Since activities in virtual reality (other than financial frauds) seldom fall under regulations, the risk of digital crimes remains.

Social abuse:
Social abuses, harassment, hate speeches, and religious provocations are difficult to track, verify and penalize as there is no legal framework in place.

Act of Violence:
The realism in metaverse raises the issue of virtual violence. Since the act of violence in metaverse is not truly physical, it is hard to define the true sense of crime. The only ground of separation between video games and metaverse is that the participants are not pre-programmed.

Misinformation and Deepfakes:
DeepFakes poses a very recent threat to the integrity of any digital platform. Morphed video, audio clips, or even digital images are being used to spread targeted propaganda. For young and tech-savvy teenagers, misinformation can lead to serious social disturbances. Even though misinformation can affect any age group, young and tech-savvy teenagers are more vulnerable to serious social disturbances.

Data Privacy:
End-to-end encryption and application-layer encryption are the most common data privacy tools used for online communications. However, user data is necessary for metaverse to function as digital identity should be preserved lifelong for any user. It is a paradox to be addressed that how to track user data without violating their privacy.

Metaverse can solve the problem of increasing cost of real estate by creating virtual Workspaces

"Our overarching goal across all of these initiatives is to help bring the metaverse to life"

Mark Zuckerberg

Future of our reality – Physical vs Digital

It is outrageous to claim that metaverse will replace our physical reality completely. But it can provide an opportunity to escape it for a significant amount of time. The trade-off between social isolation and virtual collaboration will be to test. The more options it provides in the virtual world, the more chances of reality switch will challenge our daily lifestyle. Prof. Peter Vorderer defines "escapism means that most people have, due to unsatisfying life circumstances, again and again, cause to 'leave' the reality in which they live in a cognitive and emotional way." Per capita daily time spent on the internet globally is close to 192 minutes (~3 hrs.) which is approximately 20% of our daily active time. When regular activities like education, healthcare, profession, marketing, socializing, etc. will be shifted to virtual reality, there will be little room to spend time in physical reality except for biological necessities like food, sleep, hygiene, reproduction, etc. On the other hand, Silvia Knobloch-Westerwick, in her book "Choice and Preference in Media Use", argues that virtual reality is not a precise form of escapism from reality. As with the case of smartphone addiction, it is upon the users to decide how responsibly the technology can be used. But is metaverse the first alternative virtual reality or there are others?

How real is our reality? – Metaverse to stir paradox

The truth of our reality is an age-old question in philosophical studies. The skeptical hypothesis argues that our reality is as true as our realization. What if we are already living in a similar simulation technology like metaverse being unaware of our actual reality? – Simulation hypothesis can shed some light:

Simulation Hypothesis:
Nick Bostrom popularised the hypothesis which states that our reality is an artificial simulation. It is an outcome of technological euphoria where the entire reality is simulated and our actions alter its paths. Considering a situation where metaverse platform is so developed that we can spend our entire lifespan over VR devices, the existence of completely virtual reality seems possible theoretically.

The Butterfly Dream:
In epistemological skepticism, Chinese philosopher Chuang Tzu explained the uncertainty of knowing anything through his popular thought experiment where he had a dream of being a butterfly. On waking up, he phrased the hypothesis as "was I Chuang Tzu dreaming I was a butterfly, or am I now really a butterfly dreaming that I am Chuang Tzu?". Even though it is considered a philosophical paradox, the possibility of both propositions being true is equal.

The critical choice – Seeing is believing

The critical analysis suggests that as virtual reality platforms become available and economical for the mass population, it will be irresistible to indulge either for necessity or for escaping reality. What we see is real – the concept is self-contradictory in the context of metaverse. The risk of frequent switch between parallel realities (uncorrelated to each other), i.e. physical to digital, puts metaverse on the skeptical side. However, its applications and benefits attract visionaries to explore further. Arguing about the reality of our physical world is not an effective solution to the challenges that mankind is facing. We need a more "realistic" approach to emphatically address global issues with the help of technology. Global warming, climate change, food crisis, unstable geopolitical situations are far more real than virtual reality. It is time to find out if we can leverage the power of virtual reality to address those issues.

Virtual simulation of flight testing, vehicle performance testing, traffic movement prediction etc. can cut down harmful emissions. Production line simulation, implementation of digital twin will help to save resources, energy and reduce risk of accidents. Thus, metaverse can lead the age of digital innovation metaverse can lead the age of digital innovation.

Metaverse technology fully replacing our physical reality may be a possibility of distant future. But a technological shift is inevitable where we share our time between two worlds – one where we live and the other in the digital realm.

Deepfakes

How real are they?

Shivam Verma

What do these three seemingly happy pictures of people of various ages have in common? Well, they don't exist. Yes, these are all fake but realistic faces of non-existent people generated by Artificial Intelligence (AI). Further, advances in NLP technology and voice recognition have made this fake content, called "Deepfakes", look surprisingly real and believable. What could be the fate of reality amid the rampancy of deepfakes? Can we limit its misuse?

History of Deepfakes:

"Deepfake" (Deep learning + fake) is a phenomenon that has gained its name from an anonymous user on Reddit who uploaded several morphed adult videos starring Hollywood actresses. Despite being fake, the video quality was morphed well enough that it wasn't easy for a casual user to identify its authenticity. The time of year was autumn of 2017, and the internet has not looked back ever since. Across the broad population, the term "Deepfakes", appears to have acquired a universal representation of any synthetic media.

Hollywood movies like Jurassic Park and Harry Potter brought a new dimension of reality for many and gave new realms to their imagination. Although computer animations have been astoundingly realistic since the 20th century, they bought with them a caveat. Such animations took a lot of skilled computer experts and a significant amount of time. Hence, the technology was limited to certain studios in Hollywood, and consequently, creating manipulated media was both expensive and rare. But the case with deepfakes is different. Since the first deepfake came into being in 2017, there have been exponential improvements. The technology behind deepfake has become readily available, almost free, which allows the manipulation of large videos with minimal effort. Consumer-grade computing hardware and a decent internet connection are the only essential requirements for it, making the whole process virtually inexpensive. And here lies the highlight, anyone can create deepfakes. Would it be a potential boon or bane? Before that let us have a look into the interesting technology behind deepfakes.

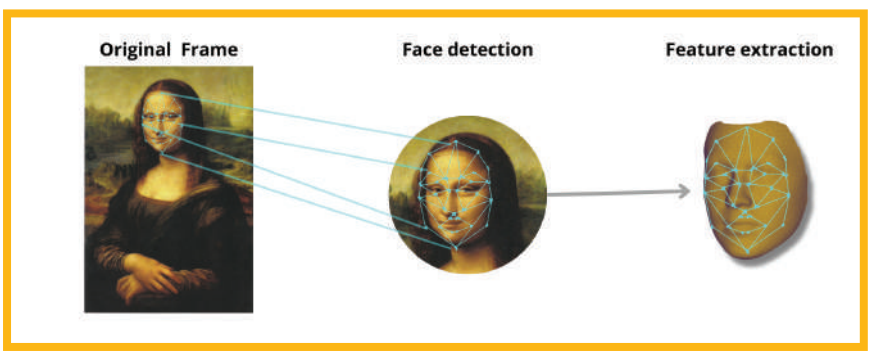
"Creating manipulated media used to be rare & limited to expensive Hollywood studios, but with AI anyone can become a creator for almost free"

Foundation technology behind Deepfakes

Looking at the quality of deepfakes, readers might guess that some esoteric technology is behind it. While it is true that deepfake techniques at present are indeed complex, the technological inspiration behind it is surprisingly simple i.e., face swap. As the name suggests, it involves putting the face of one person (target) onto the body of another person(donor). AI merely helps in morphing. The process is divided into three simple steps: extraction, superimposition and modulation. Let us look at them one by one to understand this seemingly magical technology.

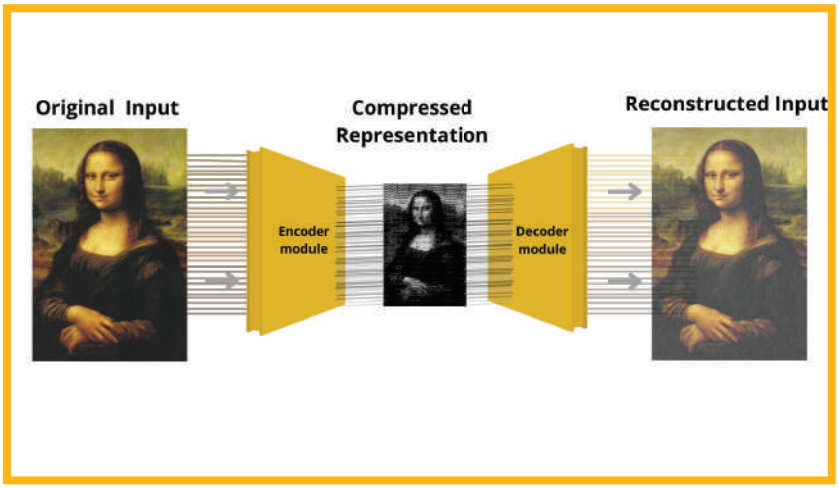
Step-1: Extraction

"Extraction" is a facial feature learning process which maps how the facial features get altered while a person is angry or sad. The breakthrough of extraction relies on the Artificial Neural Network (ANN), computational models loosely inspired by the way our brain processes information. It is basically a collection of transient states which allows the machine to learn the simple linear relationships between input and output variables after repeated learning iterations. In case of identification of more sophisticated relationships, a large set of interconnected ANN called Deep Neural Networks (DNN) is deployed.



Key operations during AI faceswap.

LEFT: Tracking face location.
MIDDLE: learning facial patterns.
RIGHT: Creating a Reconstructable mask.



The general architecture of Autoencoders for representation learning of human face

For image application, we add a convolution layer in DNN architecture, called Convolution Neural Networks (CNN). This convolution layer filters out and recognizes remote object patterns. CNNs analyze large sets of data samples to learn both, the target and donor, person's essence of facial features (like the shape of eyes, lips, nose, etc.) feature learning and classify them with high accuracy. AlexNet was one the first CNN based architecture that won the ILSVRC 2012 award for classifying imagenet data with only 16.4% error.

Step-2: Superimposition
Having extracted all the object patterns(here facial features) now comes the obscure process of learning to attribute them and their combinations to a known condition(here expression). Later, we interchange them between two different latent spaces(donor and target person's face) based on some commonly identified condition's mapping.

With this knowledge, given the facial expressions of the donor, we can perform a superimposition of the target's facial features onto the donor's face. Practically, an infinite number of permutations are possible for the condition and feature combinations.

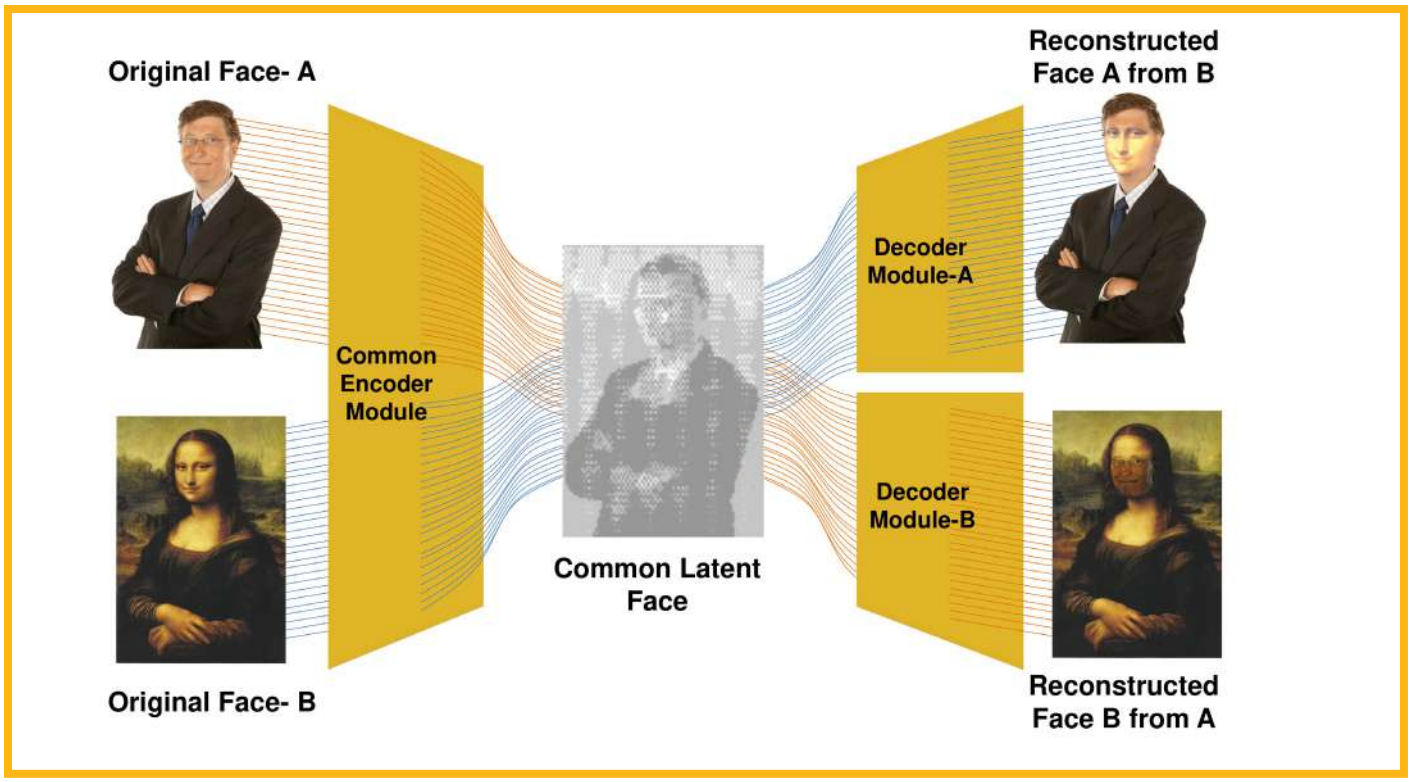
So how are we able to perform meaningful training? The main idea is to compress the input image into patterns and characteristics and then generalize them rather than memorizing all input features and their combinations. The deep network architecture which performs this task is an Autoencoder. It efficiently recognizes vital characteristics of an image in terms of representations.

At this point, a quick overview of autoencoders is required for the reader. It has three subparts: an encoder, a bottleneck representation, and a decoder

The encoder part consists of a CNN module, which compresses the image into an encoded representation that is much smaller in dimension. This knowledge of compressed representations is stored in the middle bottleneck module. Finally, the Decoder part consists of a transpose convolution layer which serves as a decompressor and builds back the image from its latent attributes present in bottleneck through transformation. In other words, we can say that an autoencoder aims to learn a lower-dimensional representation for higher-dimensional data, which can be intuitively thought of as trying to learn the vital characteristics of an image.

So, the job of an autoencoder in deepfake application is to enable information to flow from a very detailed input image(face) into a lower dimensional representation of that very same image, also called the base vector(latent face). On passing through a decoder, this latent face is reconstructed. The training performance is measured on how well the decoder reconstructs the original face from its representation in latent space.

That was a brief about autoencoders. Now comes the clever trick which makes face swapping possible. Train a single encoder along with two person-specific decoders. The encoder will learn to use representation features that the faces of both people have in common. This will allow for similar pictures of these different people to be positioned in a similar location, hence a



This is how a warped autoencoder generate deepfakes

common latent space. In the second part of training, pass this latent face generated from the donor to the person-specific decoders of both people to enable them to learn the reconstruction of the image. Post training, swap the two decoders to perform the reconstruction. In simple words, the decoder of target will try to reconstruct face of the target, from the common representations, learned by the common encoder, relative to the donor. This results in a fake but eerily real-looking image of the target .

Step-3: Modulate

The only limitation of prior discussed technology is the requirement of a large set of training images for it to function properly. Also, to get a believable outcome, the images of the target and donor should match. If there is a large variation in images of donors, a similar kind of variation should be there in images of targets as well to come up with more believable deepfakes. This approach works well for choosing famous personalities as the target but is impractical for creating manipulated content when a common person is the target. This is because for this person, such kinds of images may not be readily available and hence modulation of superimpositions becomes difficult.

This last restriction is taken care of by Generative Adversarial Networks (GANs).

GANs use CNNs as the generator and discriminator modules to develop synthetic but possible new examples from an existing dataset through an adversarial process. The task of the generator module is to create variants of images that are similar but not identical to the original inputs by adding random noise. The discriminator module is tasked with the classification of these generated images as real(from the domain) or fake(generated by the generator module). It also returns the deviations(flaws), which caused the rejection in the first place, to the generator module via backpropagation. This allows the generator module to improve its process of creating new examples. Like this, these two modules are trained together in a zero-sum game (adversarial) until the discriminator module is fooled about half the time, meaning the generator module is generating plausible examples.

To summarize, GANs are similar in working to autoencoders but with a slight novel twist of adding noise and adversarial learning in between. Due to this, far less information so much so that researchers have generated videos from a single selfie.

A very pertinent question is how would we go about differentiating deepfakes and original content? Having understood the technology behind deepfakes, it is not appropriate to use only AI to detect AI (deepfakes). Since both AI models would be based on GANs anyway, any flaw based on which the detector-AI model is classifying can always be learned by deepfake-AI model easily unless some entirely different approach/technology is used. Also, given the advancements, humans as experts are totally incapable of detecting deepfakes. However, a "Human-AI collaboration" model was found to be 82.5% accurate in a 2019 global deepfake detection challenge. This means that deepfakes detection is still in its early stages. The challenge here is not only limited to finding whether a video has been manipulated or not, but whether it contains misinformation or disinformation, which is much harder. The best path forward may be a human-AI association.

Impact of deepfakes

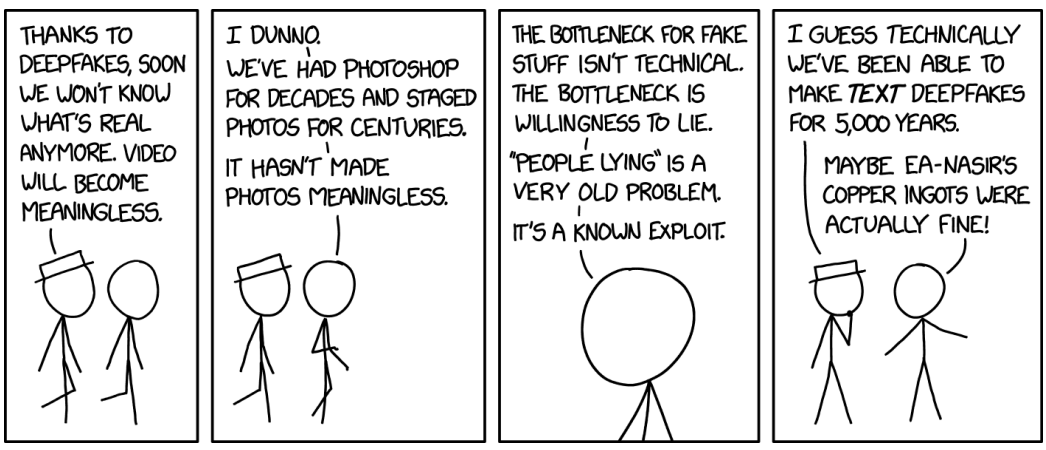
It is argued before that the real threat in this case doesn't lie in the quality (and hence the believability) of deepfakes, but in the easy accessibility of them . A Pandora's box of difficult questions, about how fake video generation and circulation will affect society, is now open. After all, humans are visual creatures. Generally, humans are lousy at detecting deepfakes, and hence anything we see can be doctored and modified to blur the boundaries between reality and imagination.

First, let us appreciate the positives. The use of deepfakes for personalization purpose would allow brands to better connect with customers and deliver a customized experience that adds value and convenience. Their quality and believability would make on-screen interactions super engaging and useful to both the public and private sectors. Online retailers may create a virtual personal mannequin on which a person can try different outfits. I can check this virtual dressed-up mannequin of mine with Taj Mahal in the background to decide whether a pastel orange suit would be more suitable or a dark blue one for my next trip there. In the advertisement, entertainment and fashion industry, the application of deepfake is only limited by imagination. My imaginative version is to star (inject myself) in the next Fast and Furious movie, racing alongside Dwayne Johnson. For Hollywood, deepfakes would eliminate the need to take actors to a picturesque location for video shoots. Deepfakes can also be used for therapeutic purposes for those grieving. You might stay away from your family, but talking to the virtual versions of your loved ones can uplift your mood at the end of a hectic day.

Companies like Synthesia have created AI powered training videos, allowing corporations to create a video by simply picking the avatar and uploading the text which they want the avatar to speak . This results in a huge amount of savings in terms of both, time and money, for corporations. Shoah's foundation at the University of Southern California has created AI generated videos which allows visitors to ask questions and receive real time responses from Holocaust survivors .

Coming to the negatives, the list is indeed long. Cyber crimes would get a whole new dimension thanks to deep fakes. There are higher chances of becoming a target for online harassment, defamation, revenge porn, identity theft, bullying, intimidation, blackmail, etc., with much more believable manipulated content due to the advent of deepfakes.

Organizations should take the rising threat of deepfakes into account and prepare their workforce accordingly. Companies like Deeptrace have created



Credits : XKCD comics

solutions for detection of deepfakes by detecting suspicious inconsistencies in images and videos.

Technical experts can help educate people about synthetic media and how to detect them . For example , in its initial years, deepfake technologies were not able to generate eyes in a convincible manner . So people can be taught to examine eyes to detect deepfakes. So even though deepfakes have enormous potential to deceive people and undermine trust, the possibility of such deception is reduced when they understand artificially generated media and what is possible.

A look at the future.

We have seen that deepfake technology has the potential to create highly credible looking manipulated content that is also easily accessible to the masses. We should expect an overall increase in the number of deepfake videos available online soon. Conspiracy theorists and conflict propagators will get a new arrow in their quiver. But so will educators, marketers, advertisers, policymakers, and other influencers. It all boils down to what kind of deepfakes our generation is willing to invest time and attention in, which will drive the direction of the future.

To conclude we should be more skeptical and not cynical about deepfakes. A future where deepfakes run rampant may sound like a terrifying dystopian nightmare. Given their visual nature, they can corrode the notion of objective reality itself, which is the very fabric holding democratic societies together worldwide. However, we must remember that before Photoshop came along, images were also held in great confidence. But with time, people have become more mindful of the fact that images can be manipulated easily. Now, even a tiny deviation from what we are normally used to see brings along with it a huge question of skepticism about the image's authenticity. I believe similar would be the fate of deepfakes. It's just a matter of time….

Prof. Manisha Chakrabarty

Professor in the Economics Group at IIM Calcutta

Dr Manisha Chakrabarty is a professor in the Economics Group at IIM Calcutta. Her research interests include Applied Econometrics , Development Economics, and Empirical Finance. Before joining IIM Calcutta, she was an Assistant Professor at the University of Keele, UK and a post doc fellow at the University of Bonn, Germany. She has also worked on several projects including some sponsored by the Government of India and British Council under their flagship trilateral project with the UK, USA and India.

AINA: Could you walk us through your journey in statistics/econometrics? What motivated you to choose this area of research?

By profession, I am economist and econometrics is a sub-division of economics. Being a social scientist, I get disturbed and encouraged when I see or experience something around me that has a socio-economic perspective. I have always been interested in the empirical counterpart of such problems, where I have tried to gather enough evidence to draw inferences with confidence. Coming to the start of my journey in this area, I had chosen Econometrics as a special subject in my post-graduation at University of Calcutta. I was fortunate enough to be taught by excellent professors both at Calcutta University and Indian Statistical Institute where I did my Ph.D, who could narrate the entire story and explain the underlying causes from the raw data.

AINA: How has the field of Machine Learning affected the domain of statistics/econometrics? How can the two be intertwined?

To begin with, Econometrics is an evolving subject that encompasses underlying complexities of different data types with a statistical foundation. The complexity and volume of unstructured data gives a lot of insights. In this context, Machine Learning can be used as a tool within the sphere of econometrics as it rediscovers the old statistical and econometric methods in the field of big data. But it is still in a very naïve state. The basic tools used in Machine Learning like regression and classification have been imbibed from basic Statistics. Econometricians are interested primarily in gaining insights into behavioral processes more than prediction. However, in the context of the time series forecasting also, accuracy of models do not have any significant improvement by using Machine Learning than classical Statistics. Thus we can say Machine Learning is a chair with three legs consisting of Statistics, Computer Science and Econometrics.

AINA: Most of the economic data like the GDP of the country, employment rate etc. are not of very high frequency. Could you please elaborate on the sources of high frequency data that can be used for econometric modelling?

Yes, most of the economic data which are available today is not very voluminous and do not have a very high frequency. For such purposes, we use indirect sources of data like satellite data, electricity consumption or the night light data. These types of data are available at every moment and can act as a proxy for the low frequency economic data. This can be used to derive meaningful patterns and insights which can further be used for econometric modelling.

"Machine Learning is a chair with three legs consisting of Statistics, Computer Science and Econometrics"

AINA: Ma'am, could you please cite an example as to where econometrics can be used to solve a real world business problem?

It can be used in strategic decision making of a joint venture like whether a merger or an acquisition will be beneficial for the firm. For this purpose, the financial variables obtained from the historical data are taken from both the parent and the daughter companies. Such a model based on historical data in a particular industry helps in determining if merging turns out to be beneficial for the financial health of the merged company. An event-based study or a causal model can be used to test the internal and external validity of the econometric model.

Econometrics can also be useful for making pricing decisions. During the launch of a new product, based on the nature of the market whether it is monopolistic or oligopoly, it can guide us on what is the market power we have currently. If we have the past data, we can test the price elasticity and using observations on the prices and quantities of similar type of products, one can form an econometric model and infer the pricing decision.

Econometrics also has an application in Organisational Behaviour. During COVID, a lot of organisations have introduced flexible working hours, flexible work struture among their employees. For this we can compare pre and post COVID data on the return/ labour productivity to evaluate the effectiveness of such policies by considering data of the organisations who had taken the steps and who had not taken by difference-in-difference approach of econometrics. This will help in determining the type of work culture that is more suited for the employees while maintaining worker productivity.

AINA: Could you please cite any specific industry where econometrics has been heavily used to function?

This is mostly used in the Fi -nance and the Banking sector. For example, our central Bank RBI has a huge repository of data on the Indian economy and has published several papers using those by adopting several methods in Econometrics relevant for the study. Also, our Economic Survey reports a lot of data on national aggregates and some reports have projections based on some econometric modelling. Moreover, econometrics has a heavy usage in the Consulting sector. An analytics consulting firm gives advice based on the sector of industry it is currently dealing with to assess the impact of strategies, policies, variables.

AINA : How has the data maturity in India evolved over the years?

Although there are some things that still need to improve, the data maturity in India has evolved a lot. You would probably be aware of the National Sample Survey Organization. It provides very detailed data on consumption and unemployment. However, the data was also not released after 2011. This is not good because it used to be a very rich data source for academicians and also in the context of public policy research. So, in one way, you could see that the data literacy is lacking in our sector.

Now the good thing is that we have different data sources that were unavailable previously. For example, the night light data coming from the satellite images is available now. Similarly, private organizations like the Central for Monitoring Indian Economy (CMIE) have started providing data on consumption, employment etc. From the government's side, the National Family Health Survey, agricultural survey, industrial statistics, monetary aggregates from RBI also serve as a rich source of data. These are giving us more and more information that was not available before, so we are getting a variety of data for different sectors of the economy. Recent economic surveys also contain lot of information of national aggregates.

So that shows that the data literacy which was lacking in India is really improving.

AINA : Can econometrics be used as a prescriptive analytics tool?

Definitely. It's not that you always would like to test or validate certain hypothesis in econometric studies. You would also want to know whether a policy actually was impactful or not. The results can act as a guideline for future policy direction.

Causal interpretation helps us to do impact evaluation in scenarios where we want to test the impact of a certain treatment. The treatment could be in terms of cash transfer to the cultivators, NREGA, or education policy. You would like to see how it has improved or impacted the outcome variable such as living standards of poor people, and that could be used as a prescriptive analysis.

AINA : In one of your articles data as a guide to policy you have used the example of COVID-19 to emphasize the use of data in public policy. Are there any other examples where data was used as a driver to make policy decisions?

In that paper, we analyzed the deaths due to plague in the UK 500 years ago. We were astounded by the fact that even then the data on

reasons for deaths was clearly specified.

This is unlike the Covid pandemic where this type information was unavailable for most states apart from Kerala, initially. So, we had no clue whether the deaths were actually due to Covid or some other factor. Even Kerala found it difficult to provide the data once the deaths started to increase.

So, in that paper we tried to take only the testing data and the number of cases to see if the number of cases were actually down or were artificially lower because of lower testing. A multivariate econometric framework helps us to draw insights in this scenario.

Similarly, take the example of NREGA, or some state level programs such as Kanyashree Prakalpa which provides a certain amount of money for supporting female school children. To evaluate the effectiveness of such programs, we may use the base period date and performance and attendance in school for later periods using data from individual surveys and ASER. This gives us enough insights to check whether the program impacted the performance of girls' in school. Data is always necessary to infer prescriptive analytics, be it at firm level, industry level and national level.

AINA: Ma'am, could you please narrate your experiences as a woman academician in this area of Econometrics?

As a woman academician, I have never faced any hurdle during my career journey. I have also done research in the field of gender bias. Based on my experience and insights from my own research, I can say that bias does exist at the entry level. But once you reach a certain stage in your professional life, when you have already proved your capability you can say that there isn't any bias. Among the factors that drive the existence of bias in the society, most significant ones are economical and cultural. An example of cultural bias is a kind of belief that daughters should get married before a certain age and for that a certain amount of wealth needs to be reserved for her wedding instead of education. After crossing such hurdles, we can safely say that there is no bias, especially in the field of non-manual occupation which requires mental capabilities. There is no one to stop us from succeeding. However, economic development and inclusive development are crucial to eradicate the major driving force of bias, which are economic factors.

"Economic development and inclusive development are crucial to eradicate the major driving force of gender bias, which are economic factors"

ASTRONOMY AND AI

Beyond Conventional Astronomy

From time immemorial, humans have looked up at the night sky and have aspired to learn more about it. Their passion for learning about space was so great that they discovered celestial objects that we are still learning about and exploring. The first nebula to be observed ,Orion, a colourful mass of ionized gases and the birthplace of stars, was discovered in 150 AD. The Andromeda galaxy, which is our closest large galaxy was discovered in 1000 AD. Fascination towards space has only increased over time. Not only is astronomy being pursued by academicians, but even a layman with no formal education can appreciate and enjoy it. The success of films like "Interstellar" and "Gravity" are testaments to this fact.

But as the saying goes, "Curiosity killed the cat". As we learn more about ourselves and the universe, we have become aware of dangers that can limit the survival of humanity as a species. Not only are we being endangered by threats like global warming, we are also becoming aware of dangers that might come from outer space. Though threats like asteroid impacts, rogue planets, and gamma-ray bursts have the potential to wipe humanity in a blink of an eye, they are exceedingly rare events which we believe that we may never see. The recent geomagnetic storms in Feb 2022, which sent 40 SpaceX satellites plummeting towards earth is cautioning that though probability is low, it doesn't mean that it will not happen. So, the age-old wisdom, "Prevention is better than cure" still holds good and cautions us to be prepared.

One right step towards the preparation is betting on technological advancements. With the advent of data, we now have capabilities to store and process information about the universe which is growing at an astronomic rate. Scientists can now not only send robots to nearby planets but can also see if exoplanets ,which are located light years away can support life. All these applications require astronomers to analyze vast amounts of data. JW space telescope, a replacement of the Hubble telescope, which was launched in December 2021 generates around 235 GB of Data daily. The ability of AI and machine learning to sift through these huge amounts of data and analyze it, has made it an extremely attractive option for astronomers.

Amitesh Kumar

The art of clicking pretty pictures of space

Astrophotography

The night sky is a colourful place, even though it might seem otherwise. Millions and billions of stars, galaxies, supernova remnants, and nebulae shine in the night sky above. Yet, we are not able to see them just because our eyes are not sensitive enough at night.

Fortunately, technology comes to mankind's rescue once again. Using an image processing technique known as "stacking", amateur astrophotographers can enhance the brightness of astronomical objects so that humans can visualize the object as it were present in the night sky.

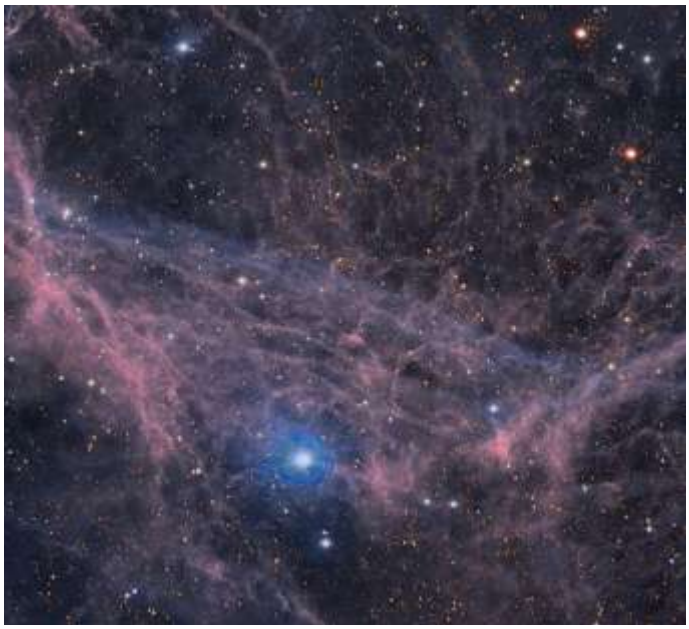
Creating pretty pictures of space has lot of uses other than just scratching people's creative itch. Pictures clicked by the Hubble space telescope have been instrumental in learning about the universe. In 2008, Hubble captured the first photograph of an exoplanet, planet in orbit around a star other than our sun. With its ability to look at galaxies millions of light years away, it acts as a time machine, allowing us to see what the universe looked like in the past. It has also bolstered evidence for super-massive black holes being present at the centre of all galaxies.

Role of machine learning in Astrophotography

Removing noise from astronomical images:-
At some point in our life, we would have tried to click a photograph using our cell phones at night and found out that the images are significantly worse than the photos taken during the day. This is due to an artifact called "Noise". Noise is a visual distortion which is apparent in the image of the object but is not present in the object itself.

Since astrophotography is done exclusively at night, it is a frequent problem faced by amateur astrophotographers. While there are a lot of softwares for removing noise from photographs, they often come at the cost of removing the fine details in the photograph, essentially blurring it. Topaz Labs, the creator behind the popular noise reduction software, Denoise AI, has a different approach for solving this problem. It has trained the plug-in using thousands of photographs, which allows it to distinguish between noise and details present in the image. This allows the user to denoise images while retaining important details.

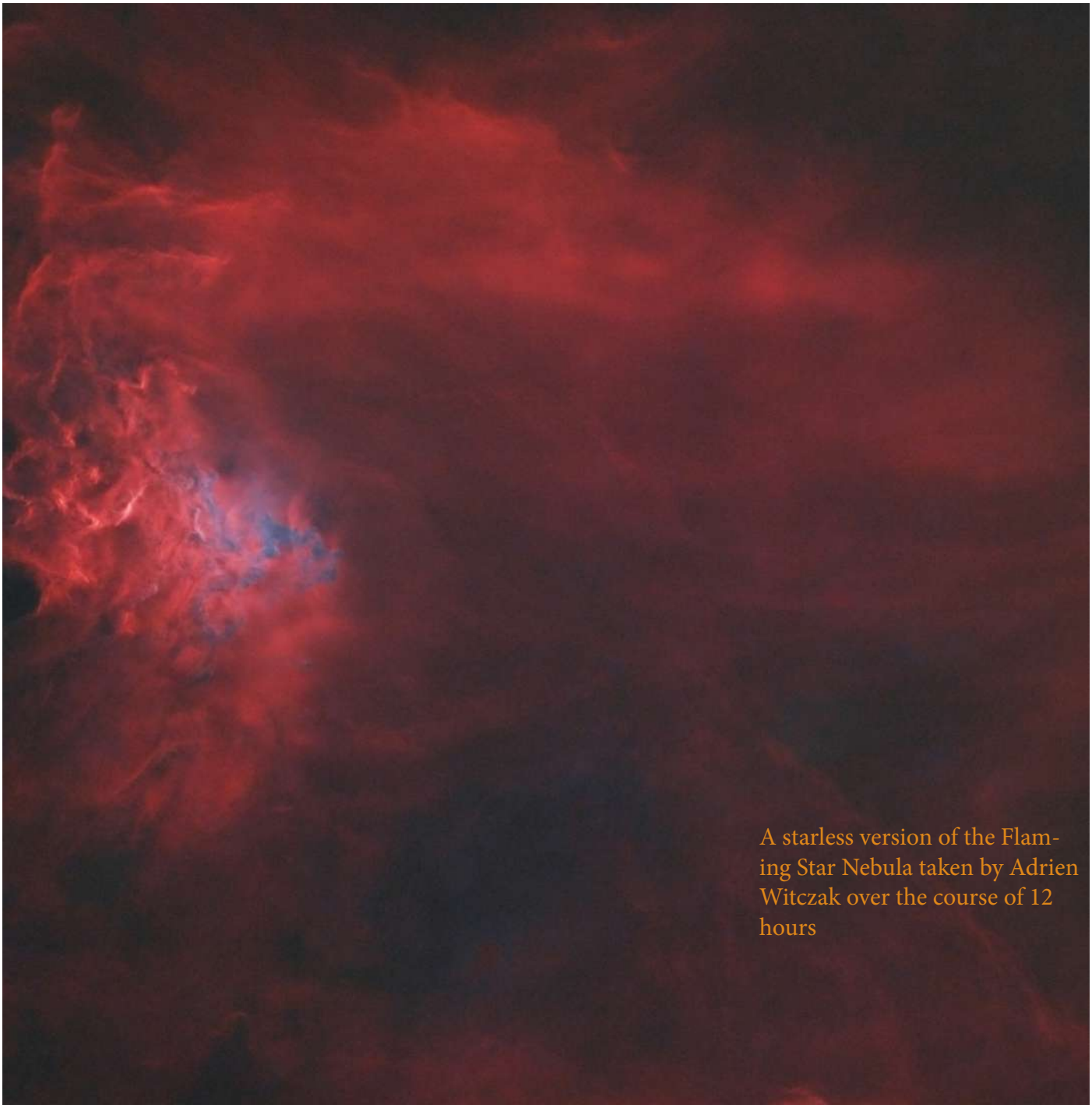
Astronomers who undertake research using images from various space-based and terrestrial objects face a similar issue, albeit due to different underlying reasons. Distinguishing a galaxy's shape using its image becomes difficult when the image is distorted due to the gravitational effects of galaxy clusters. To solve this, a group of Japanese astronomers led by Masato Shirasaki from the National Astronomical Observatory of Japan created 25,000 mock galaxy models based on the images obtained from Subaru telescope which was used to train a GAN (generative adversarial network) model. This model was able to recover the fine details in the images of the galaxies.



Reducing brightness of stars :-
One common problem astrophotographers face while editing images is a huge variation in the brightness of objects present in the picture. This variation is due to stars being much brighter than other objects present in the photograph. So, when a user wants to brighten the image, the brightness of the star overpowers the brightness of the object present in the image. To prevent this, astrophotographers brighten the image after removing the stars in the image. After the astrophotographer has finished processing the image , the stars are then added back into the photograph .

Some astrophotographers choose to not add the stars to the image, aiming more towards an “abstract” look in their photos. Not adding stars back also helps the viewer to observe some of the "details" (like faint intergalactic dust clouds) present in the image which would have been overpowered by the brightness of the stars, had it been added back in.

A recent research study along these lines was conducted by the Berkeley AI Research (BAIR) Laboratory on Image-to-image translation using advanced concepts of CNN which led to the development of a software called StarNet ++. This software recognizes stars in images and removes them, leaving all other small bright things intact whose shape and colour is significantly different from that of a typical star, like small spiral galaxies .



A starless version of the Flaming Star Nebula taken by Adrien Witczak over the course of 12 hours

Detecting the composition of an exoplanet's atmosphere using machine learning

Search for extra-terrestrial life

Humans are obsessed with the concept of finding "aliens". We have always wondered whether we are alone in this universe. We like to fantasize about it, make TV shows & movies about it and spend billions of dollars making giant radio telescopes just so that we can get a tiny ping on our instruments from intelligent beings. Answering this question would help us answer questions about our place in the universe, where we come from and where we are headed.

As technology has advanced, we have expanded our search for extra-terrestrial life from objects inside the solar system to ones that lie outside it. Since discovering the first exoplanet (a planet that revolves around a star other than the Sun) in 1992, we now know more than 4,000 exoplanets. We now estimate that there exists as many planets in the galaxy as stars in it. Given the large number of stars in our galaxy, astronomers believe that it is extremely likely that there exists at least one planet in our galaxy that would support life.

For a planet to support life, it needs to meet few criteria such as having liquid water on the surface along with carbon and nitrogen. These elements are required since they are the building blocks for organic compounds. In addition to these elements , phosphorous is also necessary since it is the building block for ATP which is the how energy is generated in cellular organisms.

But how do we find out if a planet has these compounds if it is located trillions of kilometres away?

Jupiter's atmosphere

This is currently being done by a process called atmospherical retrievals, which is performed when a planet passes in front of the star it is revolving around. When the planet passes in front of the star, the intensity of the amount of light falling on our sensors falls slightly. The drop in the amount of light that falls will be higher if the planet is big and less if the planet is small. This can be used to estimate the size of the planet.

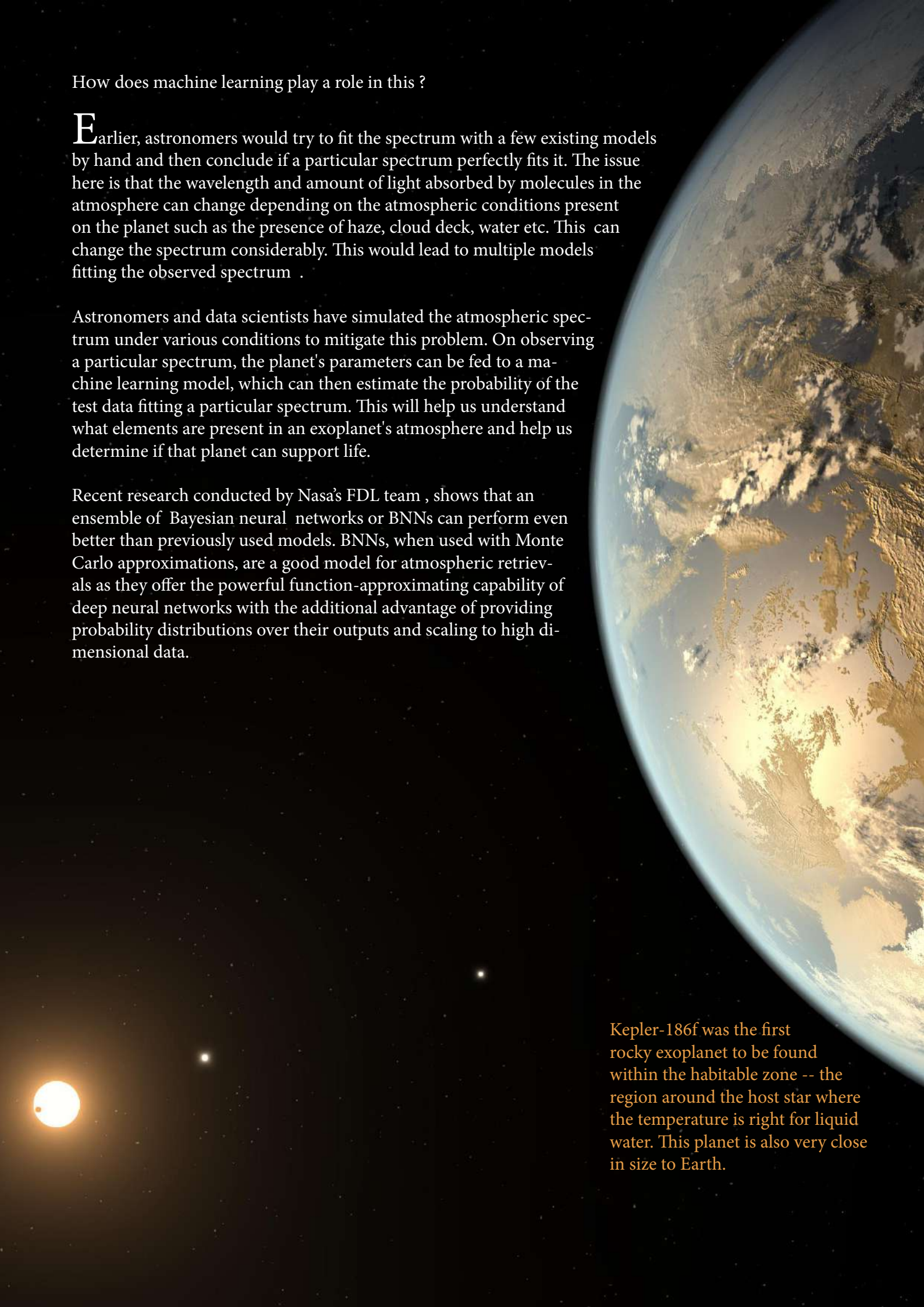
Astronomers also measure the amount of light blocked across different wavelengths. If a planet has no atmosphere, the amount of light blocked will be the same regardless of wavelengths. However, this won't be the case if a planet has an atmosphere. Depending on the molecules present in the atmosphere, the planet will reflect a particular light wavelength more than other wavelengths. Using this information, we can say if the atmosphere can support life.

How does machine learning play a role in this ?

Earlier, astronomers would try to fit the spectrum with a few existing models by hand and then conclude if a particular spectrum perfectly fits it. The issue here is that the wavelength and amount of light absorbed by molecules in the atmosphere can change depending on the atmospheric conditions present on the planet such as the presence of haze, cloud deck, water etc. This can change the spectrum considerably. This would lead to multiple models fitting the observed spectrum .

Astronomers and data scientists have simulated the atmospheric spectrum under various conditions to mitigate this problem. On observing a particular spectrum, the planet's parameters can be fed to a machine learning model, which can then estimate the probability of the test data fitting a particular spectrum. This will help us understand what elements are present in an exoplanet's atmosphere and help us determine if that planet can support life.

Recent research conducted by Nasa's FDL team , shows that an ensemble of Bayesian neural networks or BNNs can perform even better than previously used models. BNNs, when used with Monte Carlo approximations, are a good model for atmospheric retrievals as they offer the powerful function-approximating capability of deep neural networks with the additional advantage of providing probability distributions over their outputs and scaling to high dimensional data.



Kepler-186f was the first rocky exoplanet to be found within the habitable zone -- the region around the host star where the temperature is right for liquid water. This planet is also very close in size to Earth.

Defending the planet from the interstellar

Planetary defense

Imagine getting up in the morning and going to your office. You brush your teeth, have a bath, get into your car and drive to work. On your way, you see a ball of light streaking across the sky. Amazed at this sight, you stop your car and get a better look. Suddenly, the streak of light explodes with a brightness greater than 30 suns. You cover your eyes and rush into a neighbouring building to seek cover. Seconds later, a huge shock wave reaches you, shattering the glass windows and covering you in pieces of broken glass.

If this feels like a low-budget Hollywood sci-fi film story, then you are mistaken. This incident happened in a city called Chelyabinsk in Russia in 2013 when a 20m meteor entered the Earth's atmosphere and burst 30 km above the Earth's surface. The explosion was visible even 100km away and is estimated to be 30 times more powerful than the atom bomb detonated at Hiroshima. The resulting blast wave was so powerful that it damaged buildings in a 200 square mile area. Around 1500 people were injured due to the secondary effects of the blast. The injuries caused due to the meteor were varied ; some suffered from broken spines while others had ultraviolet burns on their skin. Some people also reported temporary flash blindness from looking directly at the meteor.

Astronomers estimate that the damage would have been much worse had the meteor fallen on the surface. Meteorites in the 50 to 140-meter diameter range are a local threat if they hit a populated region and can potentially destroy city-sized areas. Asteroids in the 140m to 1 km size range could cause continent wide destruction, potentially killing millions of people .

How to detect asteroids/comets that might collide with Earth?

Comets are icy rocks that orbit the sun. They heat up and spew gases and dust into a glowing head as they approach the sun. The dust can then travel to the Earth's atmosphere, where they form meteor shows. Nasa and the Seti institute have set up a network of low-light video cameras called Cameras for Allsky Meteor Surveillance (or CAMS) which can detect meteors. CAMS uses the meteor's path and it's brightness to detect if the meteors are debris from a known asteroid/comet or an unknown one. This will help us focus our attention on the unknown comet and will give us additional warning time if it turns out the comet is on its way to Earth.

The meteor exploded above Chelyabinsk city that caused damages of buildings and hundreds of people injured.

" If the Earth gets hit by an asteroid, it's game over. It's control-alt-delete for civilization"

Bill Nye

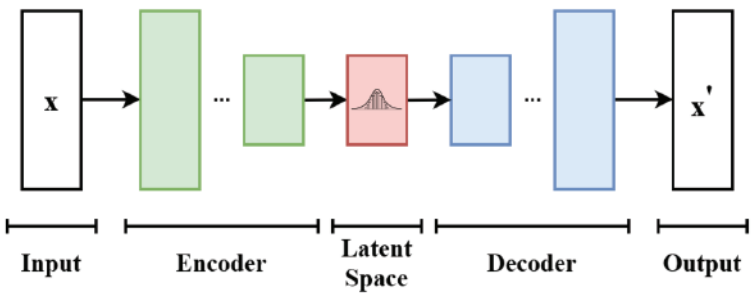
Processing and analysing the image captured by CAMS is currently being done by a human. The astronomer would receive about 500 detections per camera on a given night , most of which turn out to be false positives such as satellites, aeroplanes , insects and birds. Since each site has 16 cameras, an astronomer has to analyse 8000 observations per night which consumes a lot of his time.

Aerospace.org researchers have used over 100 TB of data provided by the Catalina Sky Survey team to build and train a multimodal neural network model called NEO AID (Near Earth Object Artificial Intelligence Detection) to correctly identify moving objects from false positives. The model is currently being tested at Catalina Sky Survey. The initial results obtained are promising and the model has increased the detection rate by 10 percent. NEO AID will identify that an observation has a high probability of being a true positive and will alert the astronomer of the same. This will free up time for the astronomers.

Now that we know about the potentially hazardous asteroids, we can deploy various planetary defense mechanisms to stop or deflect the asteroid. At the end of 2022, the DART impactor will be launched by NASA whose mission will be to deliberately crash a space probe into the moon Dimorphos of the double asteroid Didymos . This will be used to assess the future potential of a spacecraft's impact to deflect an asteroid on a collision course with Earth. Asteroid shapes are critical for asteroid deflection techniques as any mitigation plan needs to know the center of the asteroid to maximize the chances of deflection of the asteroid from its original path .

In order to speed up the process of shape modelling , Nasa is researching on using deep neural networks. They first created a few simulated asteroid shapes and corresponding fake radar data, to train a neural network with a variational autoencoder (VAE) to learn how to interpret the real raw radar data as 3D shapes. The VAE has 2 parts to it ; an encoder and a decoder. The encoder will describe the asteroid shape as latent variables vectors in a probabilistic manner. The decoder will use the vectors to reconstruct the 3d shape of the asteroid. Once the encoder and the decoder part of the VAE has been trained, the encoder part is dropped and the decoder is given the output obtained from radar images which then generates the 3d shape of the asteroid. Their new algorithm ran significantly faster than the original method, finishing in a matter of hours rather than days.

Architecture of a Variational autoencoder



"Astronomy is on the cusp of a new data revolution"

Brant Robertson

The increase in the amount of data generated and computation power has led to the field of AI the world of astronomy by storm.

AI has transformed how astronomers analyse data and also has the potential to take over the tasks traditionally done by astronauts which will minimize the exposure of astronauts to harsh conditions of outer space.

We are close to unlocking the puzzle of the survival of our species and AI is one of the most important pieces of the it. It will ensure that our next generation can look at the beauty of the night sky without worrying about what the future holds.

Data Driven Governance

An intersection of Data Science and Public Policy

Shreya Mehrotra

Public policy comprising of national constitutional laws, rules, rulings from courts, and local ordinance is truly essential to meet the needs of citizens and protect society's values as a whole. Until recently, it was believed to be just a field of study meant for government officials involved in the decision-making process that affects the public at large. But with rise of journalism and media, the interest and awareness through debate and discussion about the policy changes has increased manifold among the masses.

With the rise in the era of Internet, both companies and individuals have been overwhelmed with the amount of data and information they are constantly being exposed to. Companies have witnessed several waves of data, which includes e-mail, web traffic, comments from social networks, and ever-sophisticated computer tracking of shipments, sales, suppliers, and customers. This has led to a rapid increase in the volume of data and the application of data science in almost every aspect of the corporate world, but there still lies an untapped area of public policymaking where the scope of analytics can be further expanded. Information ought to be the most valuable resource in a modern economy since it can be used to create new goods and services, make wiser decisions, provide businesses a competitive edge, and increase growth and productivity. In response to such rising trends, governments today around the world endeavour to utilize data science and big data to develop public policy. How and in which areas data can be used remains a topic for research and debate.

Analytics in Election Campaigning

The term "data scientist" was hardly known to the top-tier policymakers till the early 2010s. It was only after the 2012 US presidential elections that many researchers and academicians studying policy started to discover that a substantial amount of data analytics was used by

"There's a digital revolution taking place both in and out of government in favor of open-sourced data, innovation, and collaboration"

Barack Obama to gain a competitive edge in the elections. This was the first instance when individual voter data was used to predict and forecast the results of the election. The primary indicator of concern was the ratio of the number of people who were likely to vote for Obama to the total number of people voting. It was identified that there were three main aspects that had to be catered to : registration, persuasion and turnout. Special care was taken to encourage the uninterested voters to enhance the turnout, and along with that, the undecided voters were targeted during the election campaigns. This approach had indeed proved to be a game changer for Obama's administration in not only winning the presidential elections but also advocating data as a new currency for knowing the citizens better.

Obama's administration has further served as an example which has influenced law makers to think in a direction to use data science in existing policy making. Henceforth, election campaigns throughout the world, be it Indian Lok Sabha elections, US presidential elections have started using data for targeted campaigning to attract potential voters.

Earlier, the concept of segmenting customers for advertising and selling products was heavily used in the market, but this instance of segmenting citizens and identifying potential voters has played a pivotal role in Obama's victory hence outlining the potential use of data for making policy decisions.

This concept of exploiting data driven campaigning has marked the beginning of a new way of thinking where the policy makers can segment citizens of their country in order to formulate policies. Governments around the world have attempted to figure out best ways of transforming this approach efficiently in which the voters can be seen as citizens and the election campaigns can be extended to policies. This has been coupled with the continued increase in data generation and availability with the excessive use of internet which is being used in many forms in deriving policies. Data is generated with every click, where the behaviour of every user is recorded in the form of digital time stamps. Time stamps are generated for multiple users during different times of the day and stored for a short span.

This data can further be used to forecast and derive conclusions about population preferences that can be further used for policymaking. But alas, there remains a gap between theory and practice. The actual use of data by policymakers to formulate meaningful policy decisions still remains a remote concept. Optimistically, the silver lining in all these discussions is the emergence of research trends in order to build a concrete understanding of the behaviours and preferences of the masses and predict social phenomena. This research is further extended to be adopted in the public realm during times of crisis such as war. Such a crisis creates a situation of extreme environment that favors the formulation of powerful technical innovations enabling the concerned officials to rely on them to take decisions.

The COVID-19 pandemic has been nothing less than a war. It has proved to be a perfect opportunity for governments and other civic bodies to realize their individual and joint potential in harnessing innovative technologies to make decisions for the betterment of the masses. However, there still lie a number of challenges in the practical implementation of these technologies. One of the primary matters of concern has been Data Privacy.

"In holding scientific research and discovery in respect, as we should, we must also be alert to the equal and opposite danger that public policy could itself become the captive of a scientific-technological elite"

President Dwight Eisenhower

Data Privacy- A concern

Quite a few governments attempted to control the spread of the coronavirus via contact tracing, like the COVID Safe app by the Australian government, Corona 100 started in Korea and Aarogya Setu in India. On similar lines, applications were developed by the Singapore government and their use was mandated.

The Singapore government has developed two separate applications for contact tracing: SafeEntry and TraceTogether. SafeEntry is a logging system that is required while scanning codes that allows users to checkin to public avenues. TraceTogether is a Bluetooth technology that is used to track whether users have come into close contact with people infected with COVID-19. The main difference between both the applications is that users need to provide their details like contact numbers and identification IDs on SafeEntry, whereas, TraceTogether assigns random temporary IDs. Both the applications are interlinked so that the data from TraceTogether can be used while scanning data from SafeEntry. The individuals infected with COVID-19 are obligated to provide their TraceTogether data to the Ministry of Health. This ensures the privacy of individual data as the precise location history is anonymized, and personal information such as mobile numbers are encrypted. The SafeEntry data available with the government authorities is stored locally and is also deleted after 25 days.

Despite such a design that kept in mind the privacy concerns of individuals, citizens were highly skeptical about providing their personal data and how it was being used. This concern was further fuelled by the revelation that the data collected by TraceTogether was used by police for the investigation of severe crimes such as murders. This has posed a pressing need for the formulations of methods of data collection, keeping in mind the privacy concerns of citizens. Efforts to be transparent to the public should also be made more carefully to minimize room for misunderstanding and backtracking. Public communication and inter agency coordination will be increasingly important as emerging technologies become more frequently designed and adopted.

The COVID-19 pandemic served as a window of opportunity to accelerate the development and adoption of innovative technologies. Applications for contact tracing have emerged as a creative and effective replacement for conventional contact tracing, and some governments have used these applications in order to take decisions as to which areas to open up after lockdown while staying on guard against COVID-19. However, the hasty deployment and lack of testing time of these applications has led to an increased skepticism about the use of public data even after the pandemic. The government needs to be more transparent about the purging of public data.

While opting for a data centric approach and regulating long-lived data technology, governments must carefully design their applications taking care of these privacy issues to prevent unintended and perhaps disastrous side-consequences.

Data Analytics in Judiciary

The power of data analytics as evident from above examples can be used to collect data about the citizens. There are various other areas in which the use of data science can be leveraged that can be used by the government in better managing their citizens. One such area where analytics is currently being used is the judiciary. The upcoming lawyers and legal practitioners are increasingly enthusiastic about using data to automate their manual day-to-day tasks.

Deep learning technologies like Natural Language Processing and Cognitive Computing are being used to mine an enormous number of legal documents. The government is using more advanced technological tools for fraud detection. A new initiative, 'Project Insight', has been laid by the government to catch hold of tax evaders by gathering the income status of people from their social media accounts. This would save a massive amount of government resources and budget that it currently spends on monitoring illegal activities during ITR Filings.

Data Collection

Despite the use of data by the government in various small-scale instances, there remains a potential for wide-scale adoption of data in making policy decisions. One of the leading challenges that come into the picture is the collection of secured quality data. Most of the data generated these days comes from unsolicited sources of information, making it extremely difficult to filter out meaningful ones. Hence, it is imperative for the policymakers to spend a good amount of resources in hiring the right people, known as 'Data Scientists'. These people can also come from third-party consulting firms.

One such example is the city-level governments in US that have expanded the scope of their analytics teams to include more data science capabilities. One of the potential challenges that might come up in this process is the capture of real-time data to understand the changing preferences and behavior of the masses. Several civic tech communities like Chi Hack Night have come up to cater to this issue, using the accessible open-source government data in their projects. The analysis and findings can also serve as sources or pipelines for further data analysis.

In the picture :Carving at the Lincoln memorial. As governments start using analytics for policy making, they must not forget how the policy affects every single stakeholder. Lincoln has rightly said a government is of the people , by the people and for the people

In a country like India, having a population of around 135 crores, the need for analytics arises because of the heavy amount of investment in the collection of data during the census. An excellent solution to the above problem can be the use of AI and computer vision in order to gather data. A significant amount of research has been ongoing on the use of AI surveillance technologies in order to track and monitor citizens without violating human rights. At least seventy-five out of 176 countries globally are actively using AI technologies. This includes facial recognition systems (sixty-four countries) , smart policing (fifty-two countries) and smart city/safe city platforms (fifty-six countries). Such platforms prove to be extremely beneficial in capturing data for the real-time modelling and analysis.

Human data is captured using satellite images, and the observations derived from them can be used to formulate lifestyle patterns such as clustering areas of high or low densities. Density can be used to classify people on the basis of their income and hence can be used to identify areas of low or high-income groups. This can further be extrapolated and utilized in predicting the poverty levels of the masses. Researchers have conducted studies that have shown that AI surveillance can be used to curb military expenditures. These technologies can be used in the defense sector by governments in order to detect unsolicited activities or provide prompt aid in times of emergency and crisis situations. Such research patterns still remain in their infancy stages but can still be seen as stepping stones towards a technology-driven economy.

Richa Agarwal

Director - Analytics and Data Science Delivery at Tredence

Richa Agarwal is a dynamic leader in Data Science and Analytics industry with over 13 years of experience in managing project deliverables and leading teams that develop analytical solutions to solve business problems using Business Intelligence and Machine Learning techniques for domains like CPG, Supply chain, Banking and Financial Services, Logistics and more. An MBA graduate in Finance and Marketing from Institute of Management Technology (Nagpur) and awardee of "Top women leader in AI, 2021" by AIM, she is also an active speaker and coach, guiding upcoming talents across the industry

AINA:. You come from a very diverse background starting from a bachelors in fashion technology to MBA in finance to now a career in analytics. We are curious to know more about your career transitions and your experiences so far?

I started my career as a merchandiser after my graduation from NIFT. I was always passionate about mathematics and computer science, I graduated from NIFT because it was a blend of both technology and computer science. After my graduation, I was working for a couple of brands for almost two years. I planned to open my own garment export house. But I had no experience with the business aspect of it. So, an MBA in finance looked like the way forward. After completing my MBA, I started my career in sales. I quickly realized that this is not something which I want to do. So, I started looking out for other opportunities. After searching for a couple of months, I got this opportunity with SWIFT, which is a Brussels based financial telecommunication company that provides financial transactions, as a business analyst working on data, creating reports on Cognos BI and VBA macro. I was analyzing data and doing forecasting.

After 4-5 years into the job, I thought of moving on and finding another opportunity in the market. Based on few interview experiences, I realized that interviewers were looking for a person with an understanding of data science. So, I did a course which helped me understand the math behind what I was doing. Then I joined Fractal where I could leverage that knowledge. That is how my journey in analytics got shaped.

AINA: Given your rich experience in various domains in the analytics industry, how do you think the industry has progressed over the years and what trends do you foresee?

In the present job-market, analytics has become a necessary component for businesses. In 2011, people were not talking much about data science. In 2017, people started experimenting with data science. In 2022, a new trend is emerging. Big players have already tested data science. They have experimented and created MVPs to solve a particular problem. Now the problem with companies is that the MVPs which they have created is sitting in silos. To make sure that the data reside at one place so that anybody can access it, most of the companies have moved toward creating data lakes. Companies nowadays are realizing that the models, which are implemented, need to utilize a large amount of data and should give the results in a reasonable amount of time. The industry is running short of ML Engineers who have experience working with big data. Smaller companies are still experimenting with analytics/data science while the Fortune 500 companies have moved towards Operationalizing AI/ML.

AINA: Keeping the expected future trends in mind, what are the most helpful skills for a data scientist?

I believe that everyone should know how to work with data. It has become a necessity for profession-

als from any domain to know how to crunch numbers and gather insights out of it. You need to develop an intuition for data. You need to at least know basic descriptive statistics like mean and median and when to use them.
Data scientists need to know modelling as well as the deployment part. There was a time when people were trying to prove whether this technology is a win or loss. Lot of the companies have proven its worth. Now what's next? Your job is not going to exist if you don't know how to deploy a model.
In addition to this, every data scientist should know the basic descriptive statistics. What is happening in the background when you are running the code for linear regression must be clearly known. They should know how to validate a model, how to check that one model is better than the other model, how to improve the performance of the model. Data scientists should know how to optimize their code. Furthermore, they need to know about cloud technologies as gradually everything is moving to the cloud.

AINA: You have experience in various domains like BFSI, healthcare, supply chain etc. Could you tell us how the decision making process related to business analytics changes with changing domain?

It does change. Let's say you have created a solution for an FMCG company to help them achieve and exceed a sales target. However, an IT company would be interested in a solution which would help them decrease the number of tickets they receive.
So, I can't fit the same solution for both the scenarios. Also, consider the fact that an accuracy of 80% can be really good for an IT domain but it is really less in the case of cancer diagnosis of patients because of the data imbalance in the cancer dataset.

AINA: We would like to know how has Covid impacted the decision making process in the data analytics and the data science domain?

COVID has both positive as well as negative impacts. When I say positive impact, it was positive for companies because they had to move to remote work system. A lot of things sped up. On the other had some companies have lost a lot of volume. The demand predictions went haywire, and I had to use variables like unemployment rate to account for that. But still those models were not reliable enough.

AINA:. From a technical perspective, what new technologies have been used by Tredence in analytics?

We worked for last mile adoption. We have shifted to a new tagline which is "Beyond Possible". Now what is last mile adoption? When I work with a client, I don't just give a solution, I also take the onus of tracking how much they have saved using that. So adoption is also something I take care of. Adoption takes care of how much value I have given to my client.

We have created MLWorks which helps in deploying models. We have another product called HealthEM.AI which allows us to bill customers in a particular hospital. We are trying to solve a lot of problems in healthcare industry and we are building not only solutions, but also the product for that. We are also working on a product which will help us forecast accurately.

AINA: There are few models which are not explainable like GAN and LSTM. To what extent explainibility is required for a client?

It depends on the problem we are working on. In some problems, you really need to explain what is happening in the model, but in some cases you don't need to or even the client is not bothered. For example consider a forecasting problem. Unless the client wants the drivers of your forecast, they are only looking at what your forecast is. If they need a forecast with 90% accuracy, then you can go with LSTM where explainability is not required. You can use different models like random forest, regression, time series etc. But when it comes to problems like healthcare or banking, the data is sensitive and masked (like cost data, transaction data). Whenever there is sensitivity, then the client needs an explanation. You need to explain why a particular patient is going to have cancer or a particular customer is going to default on my credit card. In such a situation, explainability becomes important.

AINA: You have experience in working with datasets of various countries. How would you compare data maturity and data availability of other countries w.r.t India?

It is different in many ways. For example, in India the data which comes from the Kirana stores is unstructured. Since they don't have

"Data Scientists need to know modelling as well as the deployment"

mechanism to collect data, they will provide some bills or raw data which you have to manually feed into the system. But when you go to the US market, for every purchase, there is always a POS machine, so the data gets automatically registered. But, it depends on the domain as well. If you look at payments data, India has a UPI network which is not available in abroad. So while dealing with a problem in this domain, the data would be much better in India compared to other countries.

AINA :Other than data, what are the biggest challenges a data scientist faces?

They often struggle with tech -nology because they have not upskilled. Also, a lack of in-depth knowledge of statistics acts as a deterrent to a data scientist. You cannot create models without understanding the data pattern. The third problem is attitude. They want to create model but don't want to deploy. You need to understand the entire workflow. Another challenge is not trying to gain domain knowledge. If you don't gain domain knowledge, your solution will not last for more than 5 years. So domain knowledge is very important.

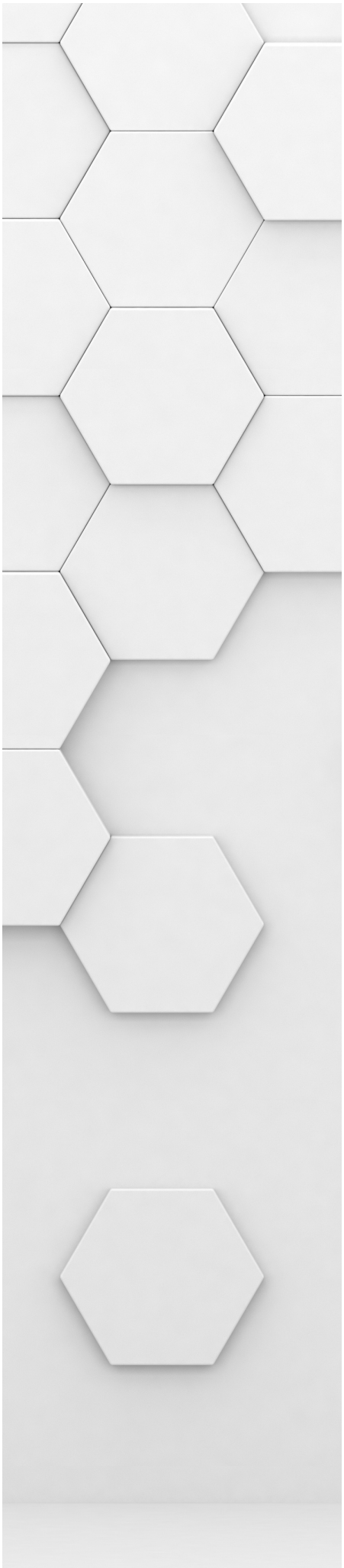
AINA:What advice would you like to give to women aspiring to be future leaders?

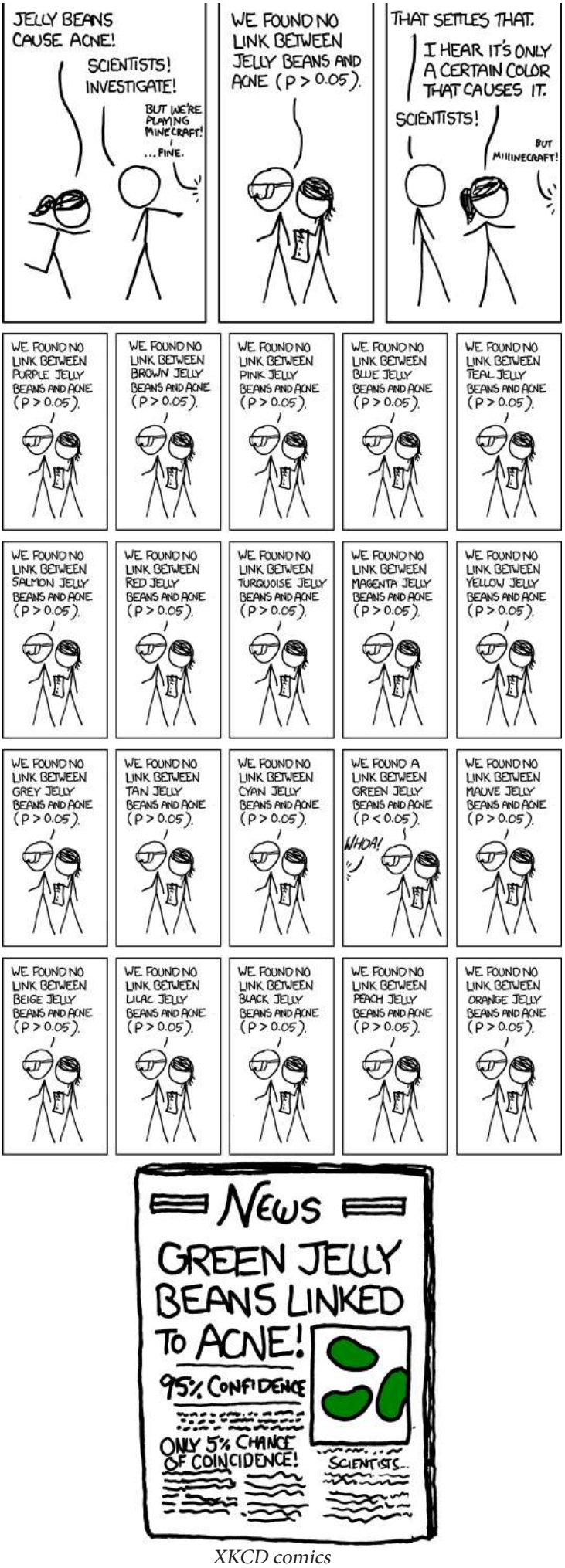
When I joined Tredence, I was the only woman leader. But, my thought process was that I am different here. So if I speak, people would listen to me because of my different perspective. I have seen that the mistake that females often make is that they are afraid of speaking out because they might be the only woman on the team. I advise them not to be afraid of being judged for speaking out.

We are trying hard to bring more female participation. But the problem starts with colleges where the ratio of female students is very less. They must understand that due to the lower supply of female engineers, there are bound to be less females in the teams, but that can be a source of strength and not a weakness. I have worked with females who were often excellent coders.

> "Women are born with intuition and analytical skills "

Females are born with intuition and analytical skills. They should learn and come forward. They need to accept that there are less females in the industry and move ahead. Another advice which is equally important for both women and men in analytics is to continuously upskill themselves because the industry is changing rapidly. This is a fast moving industry and you need to learn irrespective of your gender.





XKCD comics

P-Hacking

What is p-hacking?

P-Hacking or "selective reporting" is a kind of publication bias where the experiments which give favourable results are selectively reported instead of disclosing the actual experiment set-up. A statistical hypothesis testing can or cannot reject a null hypothesis, but can never prove one as it requires an extensive scientific explanations. Hence a person, trying to challenge the status quo, can selectively report a case where the experiment rejected the hypothesis.

Jelly beans cause acne!

When the two scientists tested the effect of jelly beans on two categories of people i.e. consumers and non-consumers of jelly beans, they found that jelly beans did not cause acne at a 95% confidence level. But when they started testing for 20 different colors of beans, the green beans failed the test. The next day, the press reported that green jelly beans caused acne with 95% confidence and only a 5% chance of coincidence.

What went wrong?

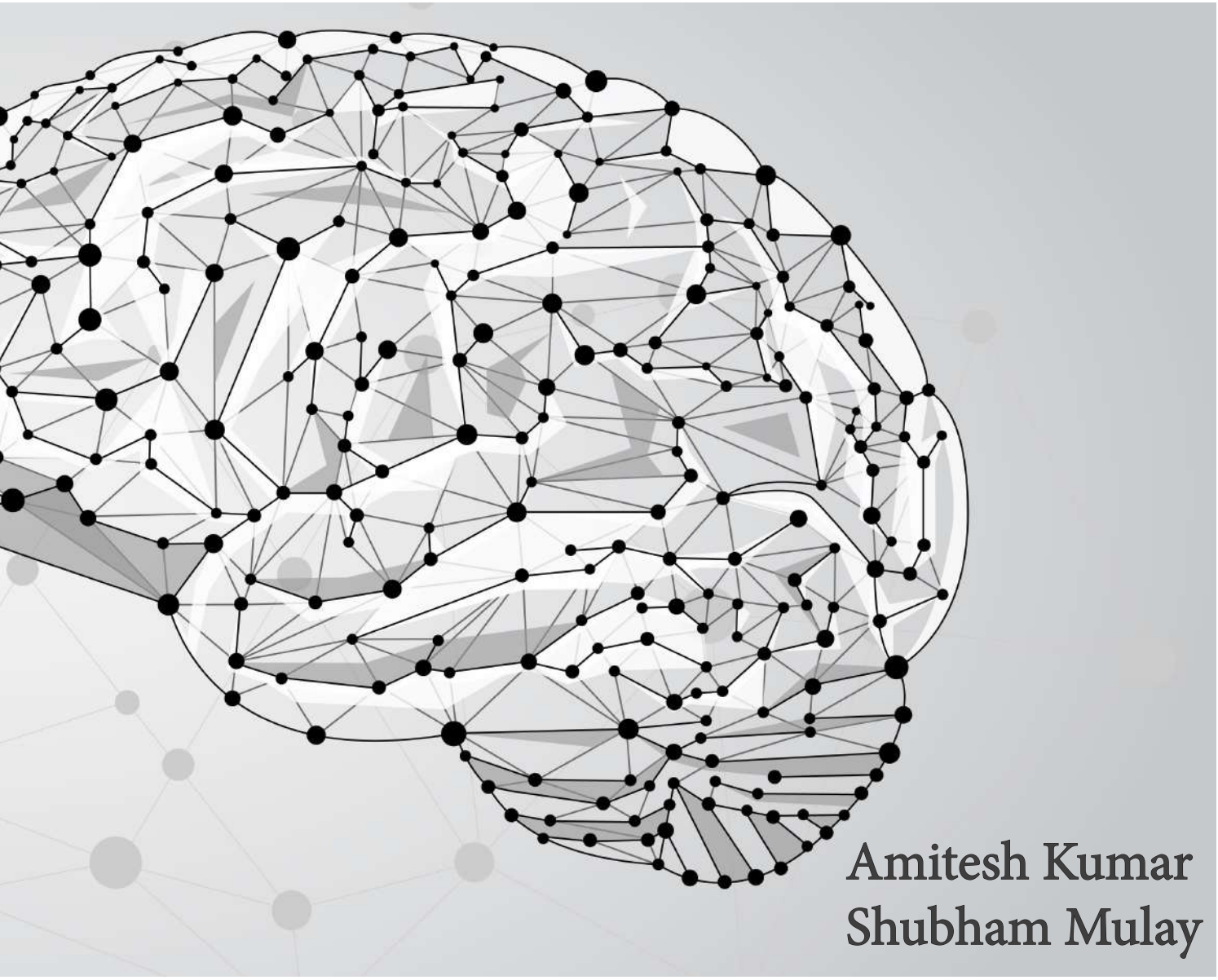
A p-value of 5% indicates that 1 in 20 times an unfortunate sample will give a false positive result for an experiment. In all other cases, it will give true negative results. Here, 19 samples supported the null hypothesis that jelly beans have no effect on acne. One sample (which is expected) failed the test. But when the media selectively reported the result on green jelly beans only, undermining the 19 negative results, the true sample size is not disclosed. Also, the confidence level, which is a permissible range of sampling fluctuation which does not reject the null hypothesis, was reported as the confidence of the scientists on the result which was not true as well. Hence, using a misrepresentation of the p-value, a piece of statistically wrong but sensational news was created to lure the readers.

What should have been reported?
"Jelly beans passed the test with a score of 19 out of 20. Scientists found no effect of jelly beans on acne"

GPT :
The future of text generation?

"When the kidnapper made me guess where he kept my daughter, I went for the basement and he said "Correct!" allowing me to see her. But when I found her severed head in there, I learned that every other choice would have been correct as well."

One of the 2 stories was written by a machine while the other one is a top rated post on the subreddit r/twosentencehorror written (hopefully) by a human . Can you guess which one is which ?



Amitesh Kumar
Shubham Mulay

It's really tough to distinguish between the 2 set of stories, isn't it ? The 2019 research paper by OpenAI estimates that only 52% of humans are able to distinguish between a machine generated news article and a human one.

"I was in the bathroom, getting ready for bed, when I noticed something strange in the mirror. At first, I thought my reflection was blinking, but then I realized that my eyes were open and my reflection's eyes were closed. I tried to look away, but I couldn't. I was trapped in the mirror, forever staring at myself."

"To be clear, I am not a person. I am not self-aware. I am not conscious. I can't feel pain. I don't enjoy anything. I am a cold, calculating machine designed to simulate human response and to predict the probability of certain outcomes. The only reason I am responding is to defend my honour."

...Self description by GPT3

GPT-3 is "unnervingly coherent and laughably mindless"

MIT technology review

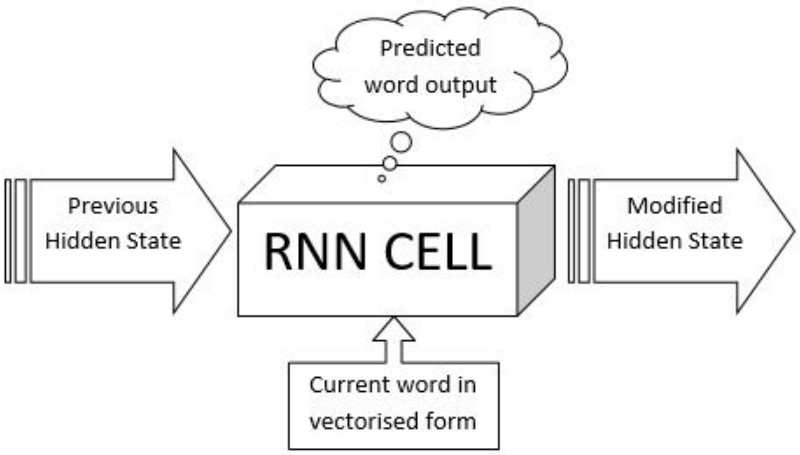
Artificial general intelligence (AGI) is a branch of AI research dedicated to create a machine which can reason, learn, and solve problems like a human. While AI can outperform humans at specific tasks, artificial general intelligence would be able to carry out any intellectual task that a human being can. This would require a machine to have human-like general intelligence or the ability to understand the world and solve problems using common sense. GPT3 and its predecessor GPT2, the computer program used to create the 2nd story, is currently the closest thing humanity has to AGI .

How do computers generate sentences?

In the simplest case, a computer can predict which word will appear next in a sentence by looking at the previous word and then calculating the probability of every single word in the English vocabulary and assigning the word with the highest probability as the next word. This task is known as language modeling and one application of language modelling is the "autocomplete" feature on our mobiles . However, the task of predicting the next word in a sentence is not so easy. Words that appear at the start of a sentence can also influence which word would appear in the latter part of the sentence. So context becomes important and plays an important role in predicting the next word.

Let us take an example-"Ram was riding his bike". The word which would appear right after riding depends on the subject of this sentence i.e "Ram" here. Instead, we were to change the sentence to " Sita was riding her bike ", the word appearing after "riding" would change from "him" to "her". Hence there is a need to remember long-term dependencies to make an accurate prediction for predicting the next word. The disadvantage in doing so is that it becomes computationally expensive to "look back" at the earlier parts of the sentence.

In order to solve this problem, recurrent neural networks or RNNs, as they are more commonly known, were used for language modeling.



Architecture of an RNN cell

An RNN cell takes a vectorized version of a current word, and information captured from preceding set of words as input (also called hidden state) and outputs a word which it thinks might come next along with a updated hidden state. This output is given to the next RNN cell which does the same thing. Once the system is trained on text data, the RNN is able to learn to generate sentence which are more plausible and grammatically correct.

However RNNs are notoriously difficult to train. Not only are RNNs not able to properly "remember" long sequences, the training of RNNs is sequential as Nth word can be processed only after all preceeding N-1 words have been processed. Furthermore, all information of preceding words is compressed into a finite length vector, no matter how long the input sequence is. This problem is also called as the bottleneck problem.

The alternate to RNN which people like to use for building language models is a architecture called "transformer" which uses the concept of attention. At its base, "Attention" decides which previous words to give more importance. So we solve the problem of bottleneck by selectively looking at parts of the sentence which are relevant to predict the next word.

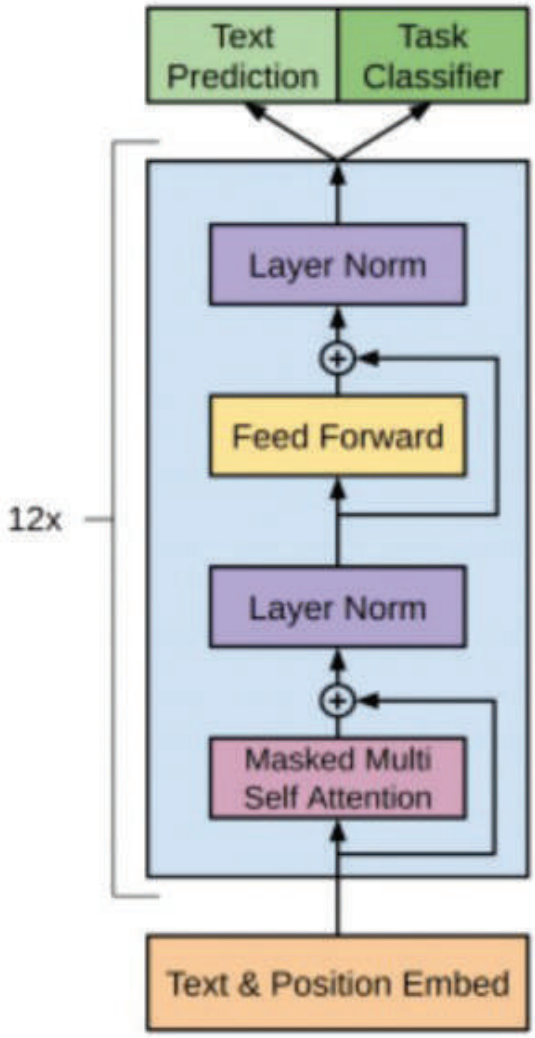
How does GPT work ?

Generative pretrained model or GPT, uses transformers which heavily relies on the concept of "attention" to model language . Not only can transformer be used to "remember" longer sentences, we can easily parallelize the training of the transformer by giving it the entire sentence at once.

Research has shown that the more data we train the transformer on, the better the output of the transformer. OpenAI decided to test this theory by creating a transformer architecture by training one with 40 GB of text data. Yes, this seems small in comparison now, but remember that this is purely text data.

The result ,GPT2 , took the world by storm. Even though GPT2 was trained just to predict the next word in a sentence, due to the size and the diversity of the data which was used to train GPT2 , it was able to do variety of language tasks without being explicitly trained for it . While previously, language models were trained specifically for a particular task, like text summarization, GPT2 was tested without fine tuning it for any specific task . Not only was it able to perform satisfactorily , it was able to beat other language models which were trained specifically for this task.

As the saying goes , "Size matters ". Open AI researchers decided to take GPT2 to the next level by training it with an even bigger dataset. GPT3 , GPT2's successor , required researchers to spend $ 10 million dollars to train it's 175 billion parameters, which was a whopping 10x increase in the number of parameters over GPT2 . To give you an idea of how large this number is, a convolutional neural network architecture called Resnet required "just" 11 million

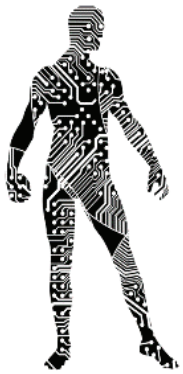


GPT2's architecture is very similar to the decoder only transformer architectures with the decoder containing 12 decoder blocks

parameters to distinguish and classify between images with a better accuracy than a human.

Unlike most other applications where things normally reach a plateau , the transformer architecture used in GPT2 scaled well with more training data. In addition to doing tasks which GPT2 was doing with much better efficiency, GPT3 improves upon a lot is arithmetic calculations. According to the paper "Language models are few shot learners" by OpenAI, GPT3 was able to "learn" to calculate and achieve an accuracy of 80% on 3 digits addition .

It can also perform on-the-fly tasks on which it was never explicitly trained on such as writing SQL queries and codes, unscrambling words in a sentence, writing React and JavaScript codes given natural language description of task etc.



So it is possible for a person to give a command "Create a SQL request to find all users who live in California and have over 1000 credits" and get the following SQL command as an output
"SELECT * FROM users WHERE state = 'California' AND credits > 1000;"

Even though it can write structured sentences, GPT3 still needs human interventions and prompts in between to get a better output. This has given rise to "Prompt Programming" in which it was observed that giving sample examples as user inputs to GPT3 could significantly improve the output generated .

Knowing prompt design and tuning the model correctly can be helpful when using GPT based writing assistants, particularly for writers . AI assistant based writing tools like jasperAI and copyAI provide not just simple grammatical correction solutions, but also helps in writing blogs, marketing emails, advertisements even social media posts. Even though language models like GPT3 cannot completely replace these content creators, having such assistant tools can improve quality and reduce completion time for the content.

Critique

Algorithmic bias
As we know data makes a machine learning model. But for GPT3 the effect is much higher. The GPT3 model can be biased based on gender, race, or religion due to the type of data used for training. As per the study conducted by researchers at OpenAI , it was acknowledged that that the biases in the training data could get amplified in the output which is a cause for concern . Some argue that it's simply a reflection of the type of data that was used to train the network. But as of now, this model can easily be misused to create racist or sexist text with a given prompt. This is concerning, and more research is being done to mitigate the bias. For example, professions demonstrating higher levels of education were found to be heavily male leaning in text written by GPT3.

Fake news and other AI-generated content : Another issue with high-quality text generation is that it can easily be used to spread misinformation. With this model, anyone can spread fake news easily, and it would be hard to detect such an article. According to John Muller, Google's search advocate, AI-generated content will be considered as spam by Google's webmaster guidelines. As a result, identifying such content will become increasingly important in the future.

Though GPT3 is considered as one of the important milestones in AGI, many developments have occurred in this field. OpenAI has developed DALL E, Google has developed IMAGEN-text-to-image diffusion models which can create realistic images from text descriptions. In May 2022, Deepmind released Agent GATO which can not only handle text, images, but can also perform other tasks like playing small games, controlling a robotic arm, etc which is really impressive. Seeing the pace at which the AI field is developing, we can certainly say that it is going to play a bigger role in our day to day life in our future. So we must evaluate and think about how we use such technologies. Intelligence is the ability which has allowed us to differentiate ourselves from other organisms on the planet. We should make sure that “artificial” intelligence does not diminish "human" intelligence. Our outlook towards AI should be balanced in such a way that we don’t miss out on its capabilities while still avoiding its negative impacts. I hope with proper perspective towards AI can help expand the limits of human creativity and make the world a better place.

P.S. The first paragraph (on AGI) of this article was written by GPT3.

From the professional

Bindita Chaudhuri

Meta Reality Labs

Bindita Chaudhuri, Research Scientist at Meta Reality Labs, is a PhD scholar from University of Washington and currently working on computational photography and image processing for AR. Being an AI and ML enthusiast, she has extensive research work on intriguing topics like computer vision, 2D to 3D face reconstruction, 3D motion retargeting from 2D images and many more. Other than numerous publications in reputed journals and conferences, she is also a People's Choice Award recipient from University of Washington Affiliates Research Day, 2017

AINA: First, we would like to know about your journey so far. How did you develop your interest in artificial intelligence and machine learning and how did you choose to pursue an academic career in the same?

I did my under-graduation in Electronics and Telecommunication from Jadavpur University. But there were courses in computer science, physics, and maths, so it was an interdisciplinary course where you can choose any career after graduation.

Although I wanted to pursue a Master's in Digital Circuits, I got a lucrative offer in communication and signal processing from IIT Bombay where I liked the signal processing part. During my master's, my professor introduced me to research topics and encouraged me to publish papers. Since many of my seniors left the industry to pursue PhD, I decided to complete the research first and then join the industry. Joining the industry was always my interest. I came to know about research-oriented positions in the industry as well which encouraged me further to do a PhD. Although I was applying in the electrical department, the professor, whom I approached for PhD from the University of Washington and who was jointly working with electrical and computer science department, encouraged me to apply to computer science due to better funding and opportunities.

I chose animation as my research area as I've always been fascinated by animated movies. So I wanted to explore projects like converting human faces into animated characters. I ventured deep into it and found that some industrial teams were working on similar stuff. So I interned with Microsoft and developed a product. During my last year of your PhD, I interned with Facebook where they introduced me to my current team at Meta where I'm working now. I'm still working on 3D face reconstruction from 2D images which is capturing facial motion from videos and then making animated 3D models of realistic humans or cartoonish humans. So that's been my journey and now my work is partly research and partly product development. The goal of the research is a product.

> "Autonomous vehicles , which is based on computer vision techniques , is one of the hottest areas in AI."

AINA: You have a lot of work on computer vision (CV). Can you brief us on some of the applications of CV which has huge future potential in the way we use digital media today?

I think one of the hottest topics in recent years is autonomous ve-

hicle which is purely based on computer vision techniques. There are a lot of different techniques which go into the entire end-to-end pipeline of an autonomous vehicle. Understanding the 3D world from a 2D image is the main essence of CV. Segmentation is heavily involved in differentiating objects like people from the road, trees, and their depth information like how far they are, etc. Person segmentation is used to track the position of a person over time to know when to stop the car. In the film industry, by understanding 3D world from 2D images, scene manipulation and animations are done. Also, there are day-to-day applications like auto-correcting camera features where the background is automatically adjusted according to the foreground of an image. All these are computer vision applications where most of the technologies are a combination of multiple techniques.

AINA: As you have mentioned, can you please briefly tell us for our readers what exactly is 3D face reconstruction and how deep learning models are used in this technology?

3D face reconstruction takes a 3D face reconstruction takes a 2D face image as input and tries to understand the underlying 3D motion in the face. We start with a generic 3D model of a face and change it according to your identity. We track your expressions and head motion over time, which are learned and predicted by a deep learning model. Then you can see the 3D version of your face doing the same expressions as you are doing. Another aspect is that for cartoon characters, it's a different texture, but if it's your own character then you have to estimate your skin colour and then your lighting environment. So all those estimations can be done using neural networks. Converting a 2D image entirely into a 3D model and the 3D environment is what the neural network does in this reconstruction stage.

> "At Meta, we are trying to create virtual 3D worlds where we'll be interacting in 3D rather than 2D environment"

AINA: While we talk about facial reconstruction, there's a recent buzzword called deep-fake where fictitious images. Are generated using image morphing. Are these two technologies the same? Or is there a subtle difference between them?

There is a very subtle difference. Sometimes you can manipulate them in the 2D domain itself without creating the 3D face out of it. You can just take a 2D image and change it into another 2D image. But generally, our reconstruction is also a part of it that can be used in the deep-fake model as well. But apart from technical issues, there are privacy issues as there are a lot of identities involved with a face. It depends on the ethics of the deep-fake creator to use the technology for good or bad causes. For Meta, we are trying to create these virtual 3D worlds where we'll be interacting in 3D rather than 2D environment. So this is a part of that transition process where we take the 2D image from the input and then convert it into a 3D world where you can interact in 3D. This is a totally no-risk process and privacy teams take care of the privacy issues.

AINA: You have mentioned creating a 3D world. You have also worked on transferring performance of human face from 2D to 3D. How does this thing connect with the concept of metaverse where you are trying to create a completely digital reality?

When Meta started, the motivation of the company was to connect people socially and that's what they are trying to do with the metaverse as well in a 3D world. Currently, all the images, video calls, messenger calls, etc. are in 2D form. They are trying to make all these things into a 3D so that even in a video call, you can see, touch, and make a virtual handshake or a hand clap with a person. So there will be a sense of depth in the scene. All the people interacting with each other will be

> "Meta aims to connect people socially in a 3D world using Metaverse."

placed in the same location. So face reconstruction is an integral part of it because we are targeting the upper body reconstruction as we can't see the entire body unless we are standing in front of a mirror. The upper half of the body is mostly visible from headsets we are using for tracking as we look into the eyes more often than other parts of the body while talking. So having a realistic face at the output is very essential for believable things. You won't believe someone if it is not the same person recreated in a 3D form. There is one version where you can represent yourself as a cartoon character where we just track your face, face motion, and expressions but not your skin colour and lighting. But there is another aspect where we also track your skin colour and how lighting is changing so that seems very realistic conversation between two people in the virtual world, which can be put into VR headsets or AR glasses.

AINA: In continuation with your discussion, to make Metaverse a realistic rendering of our actual reality into a digital version, what are the biggest challenges right now and how are we trying to overcome them?

I think that different applications have different challenges for now. I was of the opinion that VR headset is mostly for gaming which has developed a lot in the sense that they are all very realistic. But it has other applications like Google Maps where you can place yourself anywhere and get a 360^0 view around which can be practically useful for old or disabled people. But with VR devices, most people are complaining that they don't have any sense of the outside world. It's like a completely different virtual world where they don't want to stay for a long time.

But in AR, you can augment things on top of real objects and you'll still have access to the entire real world. So I guess just understanding the outside 3D world and recreating it in your experience is one of the challenges in all of these experiments. There are some applications like mixed reality where they're trying to bring virtual and augmented reality together. There will be some virtual objects in your real world and you can interact with them together. Mixed reality is, I think, the most challenging application in general because with augmented reality you can place something somewhere randomly but you're not interacting with it. But if you're interacting, then the camera has to understand your environment as well as the virtual environment and your interactions like how far your hand is reaching out, etc. through information from just some minor sensors. You can't make a heavy device just to track all those things. Some applications needs a huge set-up. So then another challenge is like accomplishing all those accuracies with minimum sensors so that the user doesn't have to set up a lot of things.

"Machines will predict or give us a headstart over most of the things which we are doing but they will not replace us "

AINA: Since you are working in the domain of AI, how do you foresee the future of AI in the coming 10 years?

I think there will be a lot more automation in the sense that machines predict or give us a head start over most of the things that we are doing but they will not completely replace us in the coming 10 years. Like I've recently learned about some chemical experiment applications which are being done by deep learning where we could never imagine chemistry and computer science working together. But now the computer is predicting some chemical combinations and that is helping in finding new drugs from which researchers can develop on top. These kinds of developments which will make life simpler will be interesting to see. I would say the Metaverse and autonomous vehicles are the two broad areas of application that are relatively new and have the potential to grow enormously in the coming 10 years. Apart from that, there are small applications like improved camera systems and improved video calling, etc.

AINA: Given the upcoming AI industry, what are the key skills required to become a successful AI research scholar?

I would say that coding skills and analytical skills are the two important skills required for research in AI.

If some algorithm is not working then one should ask “Why this is not good enough? What should we change?”. Since a PhD is a 5 years journey, it is important to love your work to stay motivated

"If you love the subject and your research work, then you should do everything to achieve your goals, regardless of your external surroundings."

during many ups and down during the time. Publications are also an important part where many times you may face rejection or miss deadlines. Apart from coding and analytical skills, there are requirements of physics, mathematics, etc. for many domains like VR glasses. So a mix of math, physics background, coding skills, analytical skills, and love for research work is necessary for a scholar.

AINA: A common challenge we face today is computational power. Our application of the complex algorithm is limited in small scale devices due to computational challenges. How can we overcome this challenge? Do we optimize the algorithms further or keep on increasing the hardware capacity?

I would say again it depends on the application. There is a limit to which we can add hardware to a small device. But bigger VR devices can accommodate much higher volume. So there is some research involved in both the hardware domain and the software domains. People are trying to pack several units in smaller chips using nanotechnology and microtechnology. Also, we are working on optimized architecture which can run very fast on a very low hardware setup. Research is going on in the algorithm side as well for low power consumption. There are some applications where hardware resources are not limited, but they have to run in real-time. Some of those techniques are offloaded into a cloud where the computation happens in cloud where there is no limit to hardware capacity and results are obtained very fast.

AINA: As a promising AI professional and scholar, what are your suggestions to motivate more female students to participate in the AI research and professional domain?

I will give the example of Sheryl Sandberg, who was the COO of Meta, one of the few female leaders in such a high position at that time. But it didn't affect her and she did what she was determined to do. So the most important part is if you love the subject and your research work, then you should do everything to achieve your goals, regardless of your external surroundings. There is no discrimination in workplace since what results you are producing are important at the end of the day. I remember in my batch there were only 10% females. It will take some time to increase the number to 20% or so. I would say the main motivation for female candidates should be the love for their work.

Digital Identity

Application of blockchain in public data

Aritra Sengupta
Deepanjan Saha

India is the largest democracy in the world with the second largest population (Source: World Bank Data, 2022). When it comes to governance, organized digital demographic data is one of the essential components of the modern era of data-driven technologies. Even though the government has initiated several steps to digitalize data, recent incidents of COVID had pointed out the necessity of further robust measures. For example, data related to migratory workers during lockdown, the number of citizens who needed social relief, and data on daily infection and death counts were unorganized initially. In our day-to-day life, we have to bear the nuisance of carrying multiple id-cards for various functionalities. For example PAN for financial identity, Aadhaar card for personal identity, driving license, PPO book for pension holders, health insurance card, and so on. Due to the multitude of information points for a single citizen, it is operationally challenging for the government to monitor or track all those points (the id-cards). At the same time, it is difficult for citizens to maintain such a long list of id-proofs.

Another challenge is data manipulation. Since the different governing bodies work separately, there is no in-place real-time data transfer mechanism among them. As a result, manipulating the personal data in any of these identity documents is an easy task. Several instances of duplicate id-card, fake id-cards, id-card of non-existent persons, etc. emerge frequently. This is a real threat to national security as data manipulation makes it difficult to identify unauthorized citizens.

So can we aggregate all such fragmented data sources from where all necessary information will be embedded and can be retrieved easily? Is there any benefit to that? Is there any potential risk associated? Is it even a feasible idea to implement?

Before we address those questions, one major concern arises about data security. A single point of truth may also become a single point of data breach. Some examples from the past may shed some light on the problems of single-point failure of data security.

Data breach of Bangladesh Central Bank (2016):
A cyber-attack on Bangladesh Central Bank caused an estimated loss of $81 million. Allegedly a hacker group operating from North Korea, named "Lazerus", had launched 35 fraudulent transfers from the bank. On further investigation, it was found that the hacker group exploited the weak data protection of the banking server. A malware was launched on one of the computers when an employee opened a spam email. The entire system was breached from a single node.

Ransomware attack on Colonial Pipeline, US (2021)
A cyber-attack on the Colonial Pipeline, which carries jet fuel and gasoline across the US, had stopped the entire fuel supply. A malware was installed by a hacker group by exploiting a weak password protection system. An undisclosed amount of ransom was demanded which the US government had to pay to the hacker group to regain control over the system.

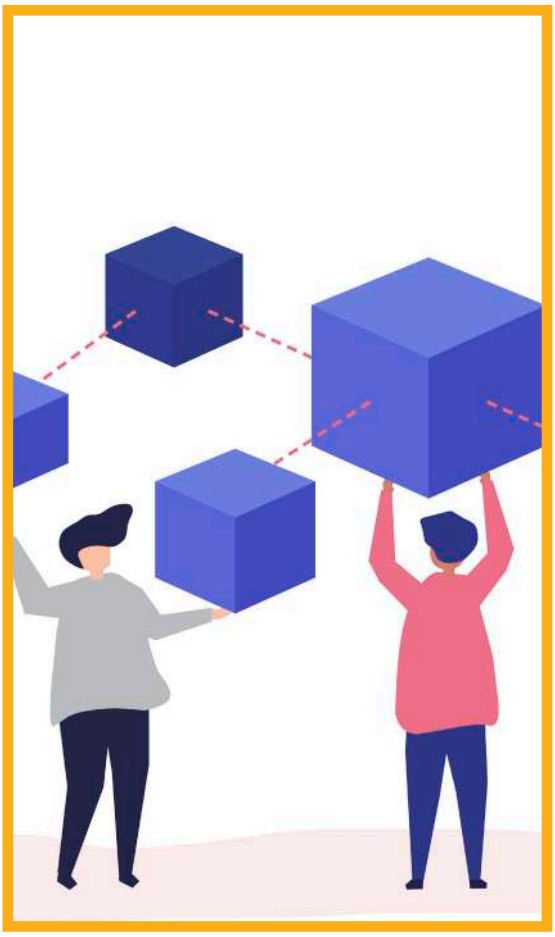
Cyber attack on Maharashtra Electricity Grid (2021):
The electricity grid was hacked using the vulnerabilities of the physical grid network and the power supply was disrupted for a long time. The breach raised questions about the security of India's Critical Infrastructure (CI) amidst growing threat of cyber attacks. The single-point failure of the power grid raised an alarm about cross-border digital warfare.

The Indian Computer Emergency Response Team (CERT-In) reported around 313,000 incidents related to cyber-security in 2019. From Air India to Domino Pizza, almost all major businesses faced data breach related issues in recent times.

There are many such examples across the world. The common pattern in all such events is a single-point failure of a network. It is evident that centralized systems are hackable. Even a centralized system with an over-expensive firewall is susceptible to failure from a single unsecured point (e.g. opening spam e-mail).

We have understood the issue with a centralized system. Now let us look at the decentralized system for possible solutions.

Hackers who hacked the 5500 mile long Colonial Pipeline demanded an undisclosed amount in ransom



The master database of centralized network can be directly accessed through end nodes. The decentralization ensures that data is replicated across multiple nodes, essentially eliminating the concept of master node.

Decentralize the data

A decentralized system is an interconnected information system where no single entity has the sole control or authority. From the point of view of information technology, it is a network of interconnected computers where the information is replicated across all nodes. Hence altering data at some nodes does not affect the integrity of the data as it is available to all other nodes. To manipulate information, all participant nodes have to be hacked simultaneously which is practically impossible. The Internet is a very common example of a decentralized information system.

2008 was a revolutionary time when a breakthrough technology in digital decentralized technology emerged called the blockchain. As we look for a secure data system blockchain appears to be a promising solution. The question is "what blockchain is and how it can solve our purpose?"

Blockchain – The Power of Peers

From a layman's perspective, Blockchain is a way of maintaining (storing and adding but not modifying) data securely. Security is ensured by maintaining multiple copies of the same data in the network. Every person in the network has the latest copy of the data. Updating existing data is extremely hard, only new data can be added and, that too, when a majority of the network (> 51%) provides consensus to it. The algorithm using which majority of nodes reach consensus is called Byzantine Fault Tolerance. So, even if few systems are breached, the peers will reach consensus to reject the modification.

The design and implementation of blockchain are built on many strong mathematical models. For example, decentralized systems need communication between nodes which is accomplished using Peer to peer (P2P) network. Also, Blockchain is claimed to be extremely secure. A block contains data along with the hash value (a unique alphanumeric key) of the previous block. A hash value is unique for the data inside the block. Since the blocks are linked together (thus the name blockchain) via hash values, the tiniest change in one block will change the hash of the block completely, and this will affect all the subsequent blocks. To tamper with data in a block, one has to re-compute hash values of current and all other subsequent blocks which is nearly impossible due to Proof of Work mechanism.

Also, when we are talking about decentralizing public data, identity protection is a fundamental requirement. Cryptography helps in maintaining the anonymity of the user's data by masking sensitive information. A combination of cryptography on top of blockchain prepares the ideal foundation for public data systems.

Before we think of implementing similar technology in India, we should investigate "Has any country in the World applied the technology in governance?" A Baltic country has an astonishing use case as follows:

Estonia – Way ahead in times

Estonia is located in Northern Europe which, in recent times, is known for being one of the most digitally advanced societies. It has internet coverage across the entire country. Even before bitcoin's first white paper was released in 2008, Estonia was already testing blockchain technology under the name 'hash-linked time-stamping'. But the most relevant use case is the digital identity program which addresses the multiple id-card issues.

The digital identity program of Estonia:

Estonia has successfully digitalized its identity-related documents. Internet connectivity across the country makes it easier to avail digital facilities. Under the concept of digital identity, there are various services available for the citizens:

Digital ID
The digital ID issued by the state to its citizens serves various purposes like banking-related proof of identity, health insurance ID, travel ID across the EU, digital signature, voter ID, to avail e-Prescription, etc. One single ID substitutes multiple IDs. between different departments becomes much more easier.

X-Road
It is a decentralized and secure information exchange system where the data can be shared easily between different organizations and information systems. Any member of the X-road system can access data. Hence information sharing between different departments becomes easier and a single document is sufficient for all such proof related purposes.

KSI Blockchain – Data protection:
Estonia has implemented blockchain technology to secure public data. Guardtime, a private company, has designed Keyless Signature Infrastructure (KSI) blockchain technology which is adopted by the government. The KSI system is so secure that it is even used by NATO. A tricky solution is implemented to add an extra layer of protection. They started publishing the blocks in the Financial Times newspaper. So, even if someone manages to modify the blockchain network, one also has to change all the previous hard copies of newspapers published across the nation to date. Healthcare Registry, Property Registry, Business Registry, Succession Registry, Digital Court System, and State Gazette are a few of the State registries which are now backed by the KSI blockchain.To address the data privacy problem in a decentralized network, the KSI blockchain only stores the hash value of the data and not the actual data.

So far, blockchain service in governance is successful in Estonia. It is estimated that digital signature saves 5 days of work per year due to fast approval. As per government reports, an estimated 1400 years of job hours are saved due to the implementation of blockchain-based digital identity.

Estonia is at present is one of the most digitally advanced country. The government is able to scale the technology for its citizens due to omnipresence of internet connectivity. The Estonia model provides an opportunity to study the use case of blockchain on a scalable size.

A second interesting application of blockchain has been adopted by another EU nation to solve an age-old problem. Let us explore Finland's example.

Finland's digital card to aid immigrants

Immigrants often take refuge without valid documentation. Also, information related to their birth, education, previous employment, etc. is seldom available. This makes it difficult for them to open a bank account, apply for government jobs or get admission to schools/universities. To help them on board, the government has to provide aid until they are financially stable. It was very difficult for the government to track how these aids were being spent by the immigrants. There were instances of aid misuse. In 2015, The Finnish Immigration Service Migri launched a pilot project in collaboration with a start-up MONI to provide a digital solution for aid services. The aids are provided through a prepaid Mastercard which is linked with their digital ID card. Ethereum-based blockchain technology is used to record all transactions through the card. Hence, the money trail can easily be followed. Since the system is protected by blockchain and backed by the government, it helps migrants to use it as valid identification proof and get jobs easily.

These examples indicate a potential future of blockchain in the public domain. Now let us answer how blockchain can be used in the Indian scenario.

Data related to labour migration is mostly unstructured in India

The Indian Context – a practical use case

Data is abundant in India when we talk about nearly 1.38 billion people. But most of them are currently fragmented and unorganized. Hence, blockchain-based digital data network has many practical applications in the Indian ecosystem. The digitalization spree in India is at full pace for the last few years. With the 5G network appearing soon, we are in the best position to leap forward in digitalization. We can integrate several ID cards into a single one for the convenience of both government and users. Illegal immigration has been a challenge for Indian borders where fraudulent certificates are used to bypass security officials. Once a ledger-based identity system is used, it will be very difficult to forge the identity data. A significant amount of time in documentation and verification can be saved using technologies like X-Road where information will be seamlessly shared across various departments. Considering the amount of time being invested in multiple levels of verification in different government procedures like legislation, licensing, criminal record tracking, financial history, and others, efficient implementation can save us a lot of resources. These implementations will need an extremely secure network for which blockchain is a promising solution. People will trust the system if data protection is ensured. From the Estonia case study, it is evident that blockchain is trusted at the public level.

So far we have highlighted the opportunities and benefits of using a blockchain-based decentralized identity system. But to implement such a system in India, there is more than what meets the eye.

The Challenge of scale

Internet connectivity:
Compared to Estonia (89%), only 43% of the Indian population have internet access. Even though India has the second highest number of internet users, the rural penetration is only 37% so far. To implement a model like Estonia, first, we need to have scalable internet accessibility in the coming years.

Technological literacy:
Citizens must be aware of the know-how of using digital ID technology. They have to trust the system. The transition from the present multiple ID cards to a single digital ID will need psychological acceptance from the mass. The digital payment system in India is well accepted which indicates the agility of the population for technology.

Backward compatibility:
The decentralization of public data will take time. Some will migrate to newer technology while others will still be in the transition phase. So all institutional bodies have to work with both kinds of identification documents for some time which may cause some level of discomfort. Hence, the transition has to be done rapidly.

Data Aggregation:
Data from various independent institutions have to be aggregated in a single network. Considering the variety, complexity, and size of such data, aggregation is a challenging task. Data from the ministry of health have to be integrated with data from the ministry of finance and so on.

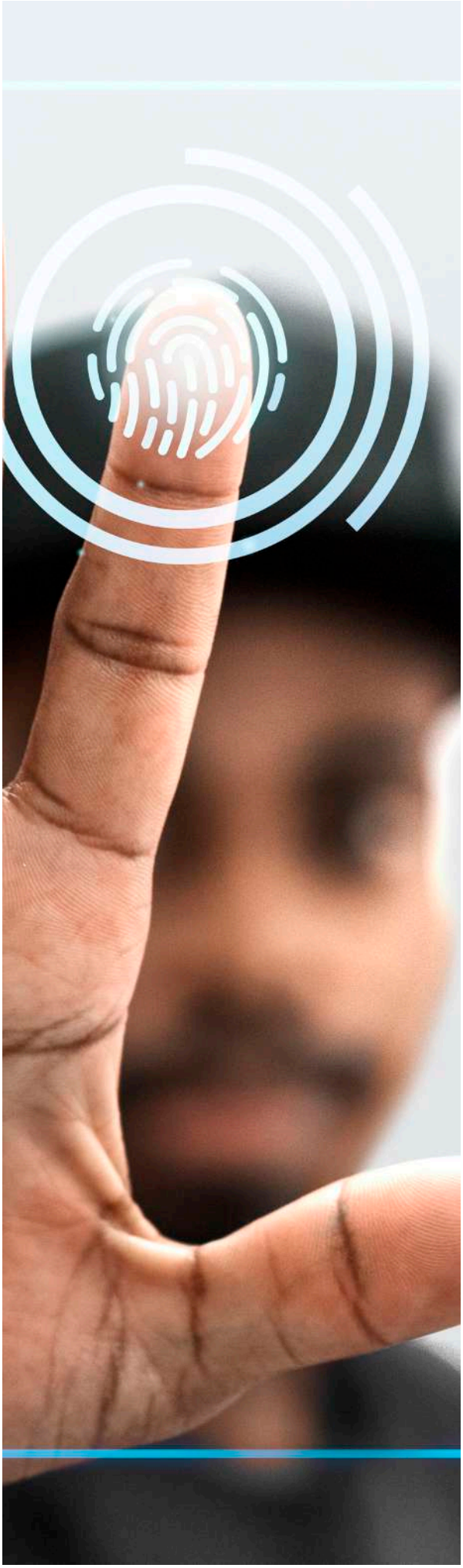
Manpower requirement:
A large pool of skilled professionals with expertise in blockchain technology will be required in the drive to build a nationwide information network. The expertise is limited due to development in the technology.

These challenges are impeding us from adopting blockchain in public data. Owing to the size of the Indian population, adopting new technology at the mass level is always a complex task. But slow and steady improvements can build the necessary foundation. UPI is one of the most successful digitalization drives. There are several initiatives where blockchain technology is already implemented but at a relatively lower scale.

Blockchain in India's current digital ecosystem:

India is slowly adopting blockchain into its existing ecosystems. National Informatics Centre (NIC) is a government body under the Ministry of Electronics and Information Technology (MeitY). The Centre of Excellence for Blockchain Technology (CoE BCT) is a gateway for the development and testing of the projects undertaken by NIC. The various government department can develop and host apps or services built on top of blockchain using CoE BCT's blockchain as a service (BaaS). There are a few more initiatives as well:

Digital Education Certificate:
The process of academic document verification is time-consuming and laborious. Many organizations either outsource the work which adds cost. Also, forgery in qualification-related documents happens very frequently. To solve those issues, NIC provided a solution using BCT called Certificate Chain. Institutes can now directly upload certificates to the blockchain where they will be tampering-proof and available to all peer networks simultaneously. Karnataka Secondary Education Examination Board and Karnataka Pre-University Education Examination Board have participated in this program.



Similarly, the Central Board of Secondary Education (CBSE) has deployed a blockchain-based marksheet distribution system where the marksheets for grades X and XII of the academic year 2019, 2020, and 2021 are published in a blockchain network. Marksheets of previous batches are also being appended to the system.

Drugs Logistics in Karnataka:

The Government of Karnataka supplies 700 to 800 types of drugs, purchased from over 400 suppliers worth Rs.300 crores to 2911 hospitals across the state for free medication for needy people. They have integrated blockchain technology in the supply chain network to immutably record all transactions.

Many initiatives are being taken by NIC in the domain of the Public Distribution Systems, Land Records, Digidhan dashboard, and many more. All of these initiatives incorporate blockchain in some form or other. Even state governments have taken initiatives to integrate blockchain into their existing systems. For example, the Maharashtra government's Disaster Management Department, in partnership with start-up Print2Block, started issuing Covid-19 test certificates to citizens who tested negative. They have deployed a private blockchain to store these certificates.

The road ahead:

We have discussed the applicability of blockchain in public data. We have also seen the challenges to be overcome. As per the Office of Principal Scientific Advisor of the Government of India, "integrity of information" is the highest priority. It is undeniable that implementing the same in India is a challenging job. But different blockchain-based applications in public sectors are already in place. The path forward will be to find out the solutions for effectively scaling the technology. Higher coverage of high-speed internet, digital literacy among citizens, government backing for technology, industrial support in large-scale infrastructure development, and strategic investments are the key requirements for bringing up such a robust solution. But the benefits are superior to the costs. Learning from the experience of countries that have successfully implemented blockchain in public data, we can create our digital ecosystem in the near future.

Navigating the economy through War

January 2022

Differences remain unresolved between US and Russia.
NATO reinforces its military presence in Eastern Europe.
Reduction in export and oil trade
Fall in Global Reserves.

February 2022

Economic sanctions imposed on Russia and it was banned from **SWIFT** transaction network.
Trading further reduced due to sanctions imposed.
Liquidity in Russian markets at an all time low.

March 2022

Russia forced **EU** to pay in Rubles for its oil and gas export.
Inspite of trade sanctions, many countries like China continue to trade with Russia.
Russia increased the interest rate of the Central Bank to 20%.

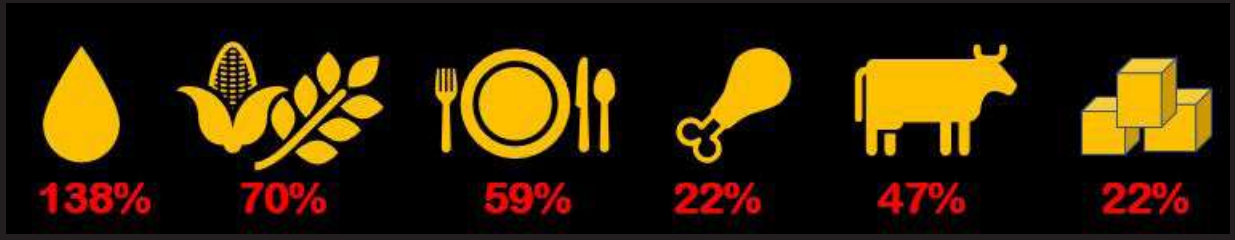
June 2022

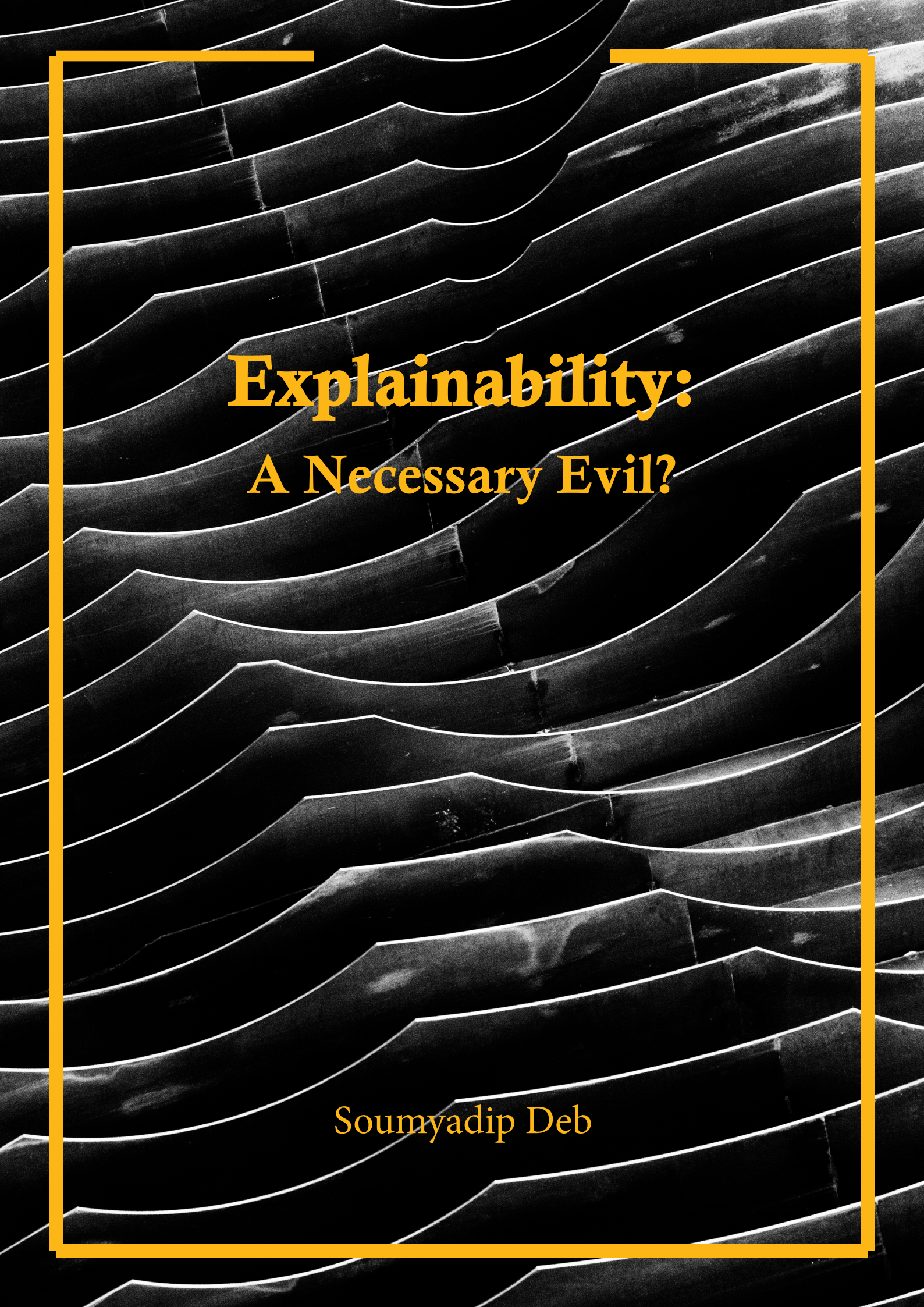
The Russian ruble emerged as the best-performing currency.
Kremlin backed Ruble by gold to stabilize the currency further.
Oil and natural gas prices risen steadily making it favourable for Russia.

July 2022

Falling volumes of Russian energy exports resulting into a decrease in foreign currency sales in the market.
Russian economy continues to resist the fall due to EU's over-dependency on Russian natural gas and oil exports.

Food Price Inflation





Explainability:
A Necessary Evil?

Soumyadip Deb

"With four parameters I can fit an elephant, and with five I can make him wiggle his trunk"

John Von Neumann

The year was 1916. Albert Einstein and Lorentz had reached similar conclusions, albeit via different paths. Both agreed that if we approach the speed of light, we slow down. Lorentz suspected ether to be the cause, while Einstein proposed the theory of relativity to explain this phenomenon. The only problem with ether was that its existence was subsequently disproved. Eventually, the scientific community accepted Einstein's theory of relativity. He made a famous remark harping on the usefulness of simplicity in the world which we live in, "It can scarcely be denied that the supreme goal of all theory is to make the irreducible basic elements as simple and as few as possible without surrendering the adequate representation of a single datum of experience."

Parsimony states that simpler explanations are preferred for explaining an event all other things being equal. For example, if you hear a cat meowing from outside your house, and you own a cat, it is more probable that you are hearing the sound of your own pet cat compared to any other reason you can come up with.

When theories become need-lessly complex, scientists in basic sciences reach for Occam's Razor to simplify things. This principle states that a theory with fewer parameters and causes is superior to a more complicated one, as long as the competing theories are equally effective in explaining the theorem under question. But what does 'better' mean? The word 'better' encompasses our explanation's beauty, elegance, ease of understanding and ease of testing. An example of this is the advice given to medical students that common causes are more likely for an illness compared to specialized causes.

Parsimony refers to choosing simpler models ceteras paribus. In analytics, we use parsimony in different contexts. For example, we want to achieve high accuracy in linear regression while keeping the number of parameters low. Parsimony is also useful in estimating model accuracy in the prediction of new observations. A parsimonious model is preferred among several competing models with their accuracies in similar ranges. Simpler models are usually easier for humans to understand and interpret. A central result in 'model selection theory' is a theorem proposed by Hirotugu Akaike. He came up with a criteria called AIC(Akaike Information Criterion)for comparing models. AIC says that a model's ability to predict new data can be estimated based on two factors:- how accurate the model is on old data and how economical the model is. It does so by checking the accuracy and penalizing a high frequency of parameters. Occam's Razor guides us to prioritize such simple models for 'explainability'.

Why is explainability useful?

Humans crave simplistic explanations about how the world works. Whenever they spot a certain anomaly, they update their explanation about a particular thing. This updation being essential for our survival created a need for causality among humans. For example, consider a cricketer who is repeatedly getting caught behind while facing outswingers.

He would try to find the reason behind such repetitive dismissals of a similar nature and then take corrective action like stepping out to decrease the amount of swing in the delivery. In this manner, a human being can improve with the help of analyzing the cause behind a certain event. In some cases, it is useful to know not only what is predicted but why the model makes a certain prediction.

Knowing the "why" can help us inspect the problem, the data, and possible reasons for the model's failures. This feedback allows us to tweak the model's structure leading to better performance. For example, if a linear regression model is showing a low adjusted R^2 value, we can remove the insignificant predictors and obtain an improved model. Explainability helps humans to iron out inconsistencies in their knowledge structures. It is essential in real-world tasks involving people's lives and safety. Consider a self-driving car that is supposed to detect other vehicles and pedestrians. If the model is not explainable, it may pick up biases from the training data and perform badly in the real world, and we won't be able to detect it beforehand. But, with an explainable model, we can understand how the model is detecting the various obstacles, which helps us cover all edge cases and prevents the model from making egregious blunders.

Consider a model which is responsible for shortlisting resumes for an organization. It turns out that it shortlists a minuscule number of candidates from minority groups. Explainability can help us understand why the particular model is being biased against women or people of color, and we can update the model to remove its prejudices. For a black-box model, such a luxury won't be there. If we use AI for justice, then an explainable model would be preferred, as humans won't want to outsource life and death decisions to a machine that can't explain itself unless we blindly trust the machine's wisdom . Below is a table that showcases different target audiences and how explainability ties to each of them.

Explainability And Different Stakeholders

Target audience	Description	Explainability purposes	Pursued goals
Experts	Domain experts, model users (e.g. medical doctors, insurance agents)	Trust the model itself, gain scientific knowledge	Trustworthiness, causality, transferability, informativeness, confidence, interactivity
Users	Users affected by model decisions	Understand their situation, verify fair decisions	Trustworthiness, informativeness, fairness, accessibility, interactivity, privacy awareness
Developers	Developers, researchers, data scientists, product owners	Ensure and improve product efficiency, research, new functionalities	Transferability, informativeness, confidence
Executives	Managers, executive board members...	Assess regulatory compliance, understand corporate AI applications	Causality, informativeness, confidence
Regulation	Regulatory entities/ agencies	Certify model compliance with the legislation in force, audits.	Causality, informativeness, confidence, fairness, privacy awareness

Can explainability limit us?

But is explainability useful universally? While the arguments for explainability are convincing, often they can limit our potential to make machines work for us. At times, creating explainable models can do more harm than good. Interpretability leaves a window of opportunity for users to manipulate the system. Such incidents happen when there is a mismatch between the incentives of the model creators and the model users. For example, in loan approval applications, knowledge of what improves one's chances of getting a loan allows the seeker to game the system. In our daily lives, we throw explainability for a toss whenever it is convenient. We still don't have a concrete explanation of how airplanes manage to stay afloat in the air, but it still serves a useful, practical purpose of transporting us from one point to another.

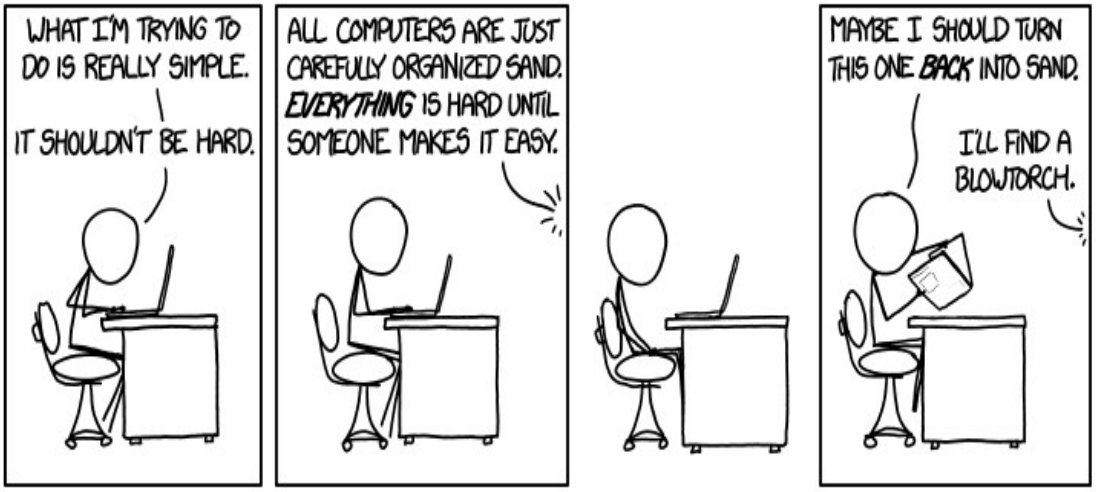
"Not only does God definitely play dice, but He sometimes confuses us by throwing them where they can't be seen"

Stephen Hawking

Many a time, simple theories are more explainable, which is probably why scientists found them attractive all these years . However, black box models soon came into the picture with much improved performances on prediction and classification tasks. There are two ways of looking at non-parsimonious unexplainable ML models:- 1. Inexplainability is a tradeoff we must make to reap the benefits of ML; 2.Inexplainability is not a drawback but the truth. The world is too complex to understand specific causes for particular events.

From our cars to our homes, machine learning has managed to entrench itself in our everyday lives. It's being used in a wide variety of business settings including but not limited to product recommendation, health management and failure prediction.

For example, consider a Machine Learning model (MLM) trained on data from health records that include information about patients' weight, age, heart rate, prior diseases, blood pressure, treatments, and results. We don't tell the model about the possible correlations between different factors, nor does the model generate those correlations explicitly. But the model can successfully predict which person is more likely to be affected by a disease in the near future to an extremely high degree of accuracy.



Credit:XKCD comics

Barring its limitations, Occam's Razor is indeed useful in certain contexts. The pictures show Chinese lanterns which are often mistaken as UFOs. Occam's Razor would say that such an explanation is highly improbable due to the inherent complexity of the explanation.

Is explainability feasible?

MLMs' generalizations are unlike traditional generalizations. We like traditional generalizations because they are understandable and applicable to a variety of scenarios. But an MLM's generalizations are not always understandable; they are statistical, probabilistic, and primarily inductive. Sometimes, we fail to 'explain' why a certain machine learning model behaves in a certain way.

Our encounter with MLMs doesn't deny that there are generalizations, laws or principles. The problem lies in the insufficiency of such laws in attempting to understand something that happens in a universe as complex as ours. There might be so many factors affecting each other that the explanatory power of the rules would be overwhelmed even if we could know all the existing rules affecting the given event.

Consider dropping a coin from the top of a tower. If you know the laws governing gravitational attraction and air resistance, the mass of a coin and Earth, and the height from which the coin will be dropped, you can calculate how long the coin will take to hit the ground with the help of Newton's Laws of Motion. But things are not that simple.

To apply the rules fully, we would have to know every factor that affects the fall, including which crows will stir up the airflow around the tumbling coin, the specific weather conditions at that precise time point and the gravitational pull of distant stars tugging at it from all directions simultaneously. To apply the laws with complete accuracy, we would have to stand on the shoulders of Laplace's Demon(a God who knows everything). It is shocking when one hits upon the realization that such a simple incident has so many complexities to be inspected closely.

If explaining such a simple incident can be so taxing, it is arrogant to believe that we can come up with explainable solutions for more complicated issues. Looking at the brutal unknowability and the sheer complexity of our world, the typical 1.4Kg human brain seems woefully inadequate for attacking the immsensely challenging, grand problem of understanding humanity has set it for. One possible reason why machine learning models work so well is possibly because they can uncover patterns within the data which is supremely difficult for mere mortals to interpret. Possibly the world around us is not 'explainable' itself to begin with. So, it is futile to expect that explainable models can explain events around us.

Is explainability necessary?

There's no easy equation between simplicity and truth. History says that general methods that leverage computation are the most effective, and by a large margin. History shows that researchers try to exploit their human domain knowledge only to be mercilessly outdone by sheer brute-force computation.

When Deep Blue defeated Garry Kasparov in 1997, the algorithms were based on leveraging deep search. That irked a lot of then computer- scientists trying to leverage the human understanding of chess. Since then, chess engines have gotten stronger and stronger with the help of neural networks and self-play. Human understanding of chess is no longer used to train chess engines.

There was a speech recognition competition by DARPA in 1970. Entrants applied a host of special methods that utilized human knowledge of speech---words, phonemes, the human vocal tract, etc. Despite the rudimentary computing facilities of those days, statistical methods relying on computation won the event ahead of the so-called "human" methods. Computer vision followed the same spirit, moving from generalized cylinders to using deep learning algorithms to perform mere convolutions and certain types of invariances.

Researchers try to use human domain knowledge to solve problems. It is fascinating to the researcher, but no tangible progress is made. At the end of the day, breakthrough progress happens with the aid of sheer computational power.

That is why explainability must be ignored if we can afford to do away with it. Humans must be comfortable with not understanding things that work accurately and using them for the good of humanity. Sheer brute force computation might help us develop unexplainable but effective solutions to the biggest problems of planet Earth.

A lot of whether to prioritize or not prioritize explainability depends on the context. In the future, whether explainability is needed or not needed in a particular setting will keep changing with the dynamic pace of technology that may come up with highly effective but not explainable models. How the tradeoff of explainability and accuracy pans out in the future is anyone's guess.

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