AINA

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EDITOR's NOTE

The liberalization of nations, rapid technological adoption and accessible computational resources are among the several factors that have set the ideal premise for the advent of *"The AI revolution"*. The global pandemic has only elevated this transformation to one which is as close to reality, as life itself. In the recent decade, AI has raised fortunes for many, yet there are countless others, whose failures remind us to reinforce our fundamentals. Amidst all the ongoing buzz on AI, even a novice can realize how only a limited few attempt to understand and fully utilize the intricacies it beholds.

This student magazine is a humble yet necessary attempt to bridge the world of business understanding with that of academic/ technical acumen. We believe, our prudent scrutiny makes this magazine an indispensable resource for every sincere reader who wishes to build the right comprehension of AI and Business Analytics. Also, to the expert, this magazine serves as the platform to witness the multitude of advancements in the recent times.

Our heartfelt gratitude to the chairperson, the directors, deans and faculty of all the three institutions, especially to Prof. Malay Bhattacharyya and Prof. Amitava Bandyopadhyay for their kind encouragement and continued support. Many thanks to our peers and our amazing alumni, specifically Mr. Vidyadhar Mudium, Mr. Sowrya Regana and Mr. Rajath Nandan for their patient efforts and timely feedback. Finally, we remain indebted to our family, friends, mentors and the almighty lord for their subtle intervention in this pioneering endeavor.

"Our intelligence is what makes us human, and AI is an extension of that quality."

—Prof. Yann LeCun, New York University

THE TEAM

Aditya Gadepalli

Editor–in-Chief & Lead Designer

Kolli Parasuram

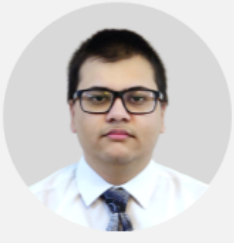
Content Strategist

Chandu V Grandhi

Sub-editor and Marketing Lead

Anudeep Immidisetty

Managing Editor



Srijan Gupta

Creative Director

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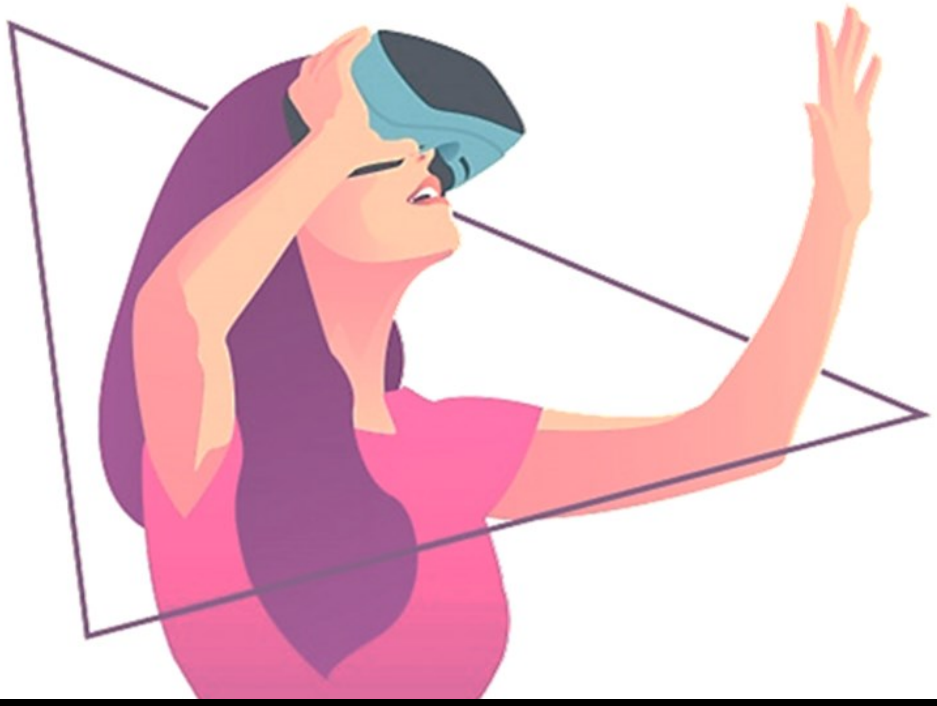


QUICK READS

Note: Please see pages 44-45 for references, acknowledgements/disclaimers and contact details.

Start Small, Think Big

Leveraging AI to transform the future of the MSME sector

BY ANUDEEP IMMIDISETTY

Micro, Small and Medium Enterprises (MSMEs) are a significant component of the Indian economy owing to the fact that it is the second-largest employment provider, after agriculture in India. Currently, there are 63 million such enterprises in various industries employing close to 124 million people, accounting for 8% of India's GDP and 45% of merchandise exports. Hence, this sector is justifiably called the growth engine of the nation. The MSME sector in India consists of 99.4% Micro Enterprises, 0.52% Small Enterprises and 0.08% Medium Enterprises. These enterprises are broadly classified into two categories namely,

1. Manufacturing
2. Services

Recently, the Government of India has updated the definitions of MSMEs (see table). The revised definition is thought to be in favor of MSMEs. This is because earlier, firms tried to operate conservatively owing to the fear that if they outgrow the size of what has been defined as an MSME, they would not be entitled to the benefits provided by the government. With the revised definition, they need not worry about growing in size and still avail benefits.

It has been estimated that an investment of one lakh in fixed assets in the small scale sector, on an average generates employment for four people. Besides providing large employment opportunities at lower cost of capital, MSMEs help industrialize the backward & rural areas alleviating the regional imbalances and moving towards uniform distribution of value and wealth.

The current article enunciates the **"applications of AI in MSME businesses"** to significantly boost their performance by anchoring the potential of AI. Before moving on to the applications of AI in various industries of MSME, lets understand the strengths, weaknesses, opportunities and threats these businesses face (see table in the next page).

Why should MSMEs use AI?

The extent of operations and services that can be optimized by AI is immense as it is evolving at a significantly fast pace across domains. Large scale manufacturers and big corporate competitors of the MSMEs are us-

Existing and Revised Definitions of MSMEs

Previous MSME Definitions			
Criteria: Investment in Plant & Machinery or Equipment			
Classification	Micro	Small	Medium
Mfg. Enterprises	Investment < Rs. 25 lac	Investment < Rs. 5 cr	Investment < Rs. 10 cr
Services Enterprises	Investment < Rs. 10 lac	Investment < Rs. 2 cr	Investment < Rs. 5 cr
Revised Definitions of MSMEs			
Criteria: Investment and Annual Turnover			
Classification	Micro	Small	Medium
Manufacturing & Services Enterprises	Investment < Rs. 1 cr and Turnover < Rs. 5 cr	Investment < Rs. 10 cr and Turnover < Rs. 50 cr	Investment < Rs. 20 cr and Turnover < Rs. 100 cr

Strengths	Weakness
• Lesser investment • Extensive support from the government • Capacity to adjust with changing environment	• Lack of adequate and timely access to finance • Obsolete technology hampers production efficiency • Competition with big players in marketing efforts • Designing, packaging and product display
Opportunities	**Threats**
• Programs like "Make in India", "Startup India", "Digital India" open newer markets • New payment systems are enabling hassle-free B2B and B2C payments • Well developed AI, Data Analytics, Robotics, IoT systems that improve efficiency	• Industry 4.0 implies use of high-end technologies by competitors involved in large-scale manufacturing • Regulatory risk and policy uncertainty • Necessity of government approvals and permissions • Patent/IPR accessibility and understanding

ing IoT devices for data collection and bringing value to the data using AI. According to a McKinsey report, Marketing and Sales, Supply Chain Management, Manufacturing are the three key areas where the impact of AI is going to be substantial. They estimate that AI can create $1.2 trillion to $2 trillion across world businesses in Supply Chain Management and Manufacturing. Hence, MSMEs can greatly benefit by using AI in various phases of their activities.

How can MSMEs use AI to up their game?

Manufacturing MSMEs

In this section, we discuss the applications of AI for MSMEs in the manufacturing sector.

Supply Chain Management

For businesses operating in manufacturing and logistics, AI can help enhance their supply chain, ultimately improving the overall efficiency and reducing costs. The diagram (see next page) represents the general supply chain of a company and how AI can help in various stages of it.

Manufacturing Analytics

Analytics for Production

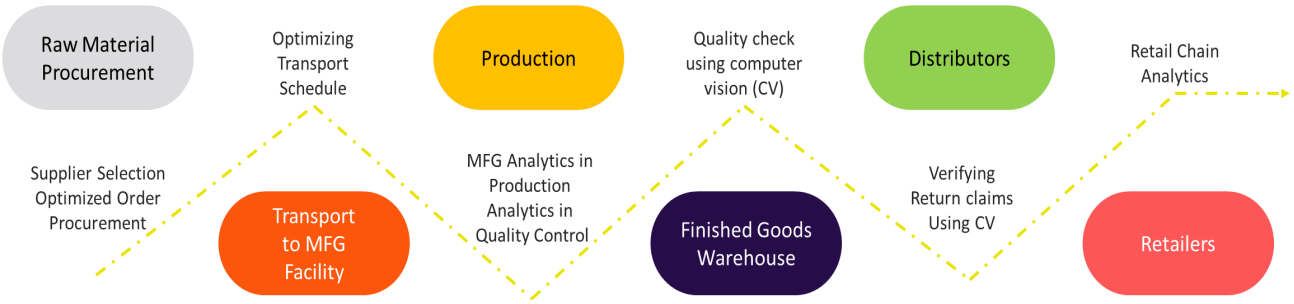
The manufacturing maze encompasses phases such as raw materials, logistics, financing and ultimately packaging the final product. The businesses must manage these whilst dealing with changing consumer demand and facing aggressive competition. Analytics in this process helps in discovering, dissecting the pain points and analyzing key performance indicators such as production quantity, plant downtime, operating costs, return on assets, among others, in order to enhance the production process and meet business goals. Prescriptive analytics in this regard helps maintain balance between several important indices while moving towards a certain common goal, that is achieving profit. However, for this process to happen, data needs to be collected continuously from the equipment. This can be enabled using cutting edge IoT devices which can collect data reflecting the entire manufacturing process.

Using such data, analytics can also be used to do preventive maintenance of the equipment. Predictive analytics can be used to forecast the possible failure of the machine components and take corrective actions.

Analytics for Quality Control

Faulty equipment results in producing products of meagre quality. This amounts to increased return goods thereby causing monetary losses. The quality of the manufactured product depends significantly on the factors and attributes related to manufacturing machines such as engine temperature, spindle vibration frequency, RPM, humidity, etc.

In this context, we discuss briefly how this is brought into action. The first step in this process is collating the data at one place. Data about product quality deviations and equipment maintenance history is collected from ERP/PIMS/DCS systems. This is combined with equipment condition records gathered through a time period (say an year). The combined data set is then fed into advanced AI and ML algorithms, which can then detect causal correlations in the incoming data records. Uncovered correlations are reflected in predictive models, which are then used



to identify combinations of equipment condition and environmental parameters that can lead to product quality issues.

For instance, if we take the example of the pulp processing industry, some of the quality issues include deviations in the concentration of dissolved alkali. The machine learning algorithm, using data from IoT devices detects hidden patterns in the data and states that a higher concentration of alkali stems from a deviation in two process parameters: surged white liquor flow, attenuated processing temperature.

Other Applications

Even though MSMEs are dominated by manufacturing and service firms, they also have to do sales and marketing as a part of their business. Analytics can be used in various stages of marketing like customer segmentation to do demographic based targeting, analyzing customer behavior and designing new products, market mix modelling to analyze the effectiveness of their advertising, customer feedback analysis to improve their existing offerings etc.

Business process analytics is important for bigger firms to establish synergy between their various units. Alex Pentland, in his book Social Physics describes his experiment on how he used behavior data to increase employee productivity in call centers. This is called People Analytics. However, in the case of MSMEs, due to their size such issues do not arise often.

Service MSMEs

We now discuss about how firms that come under this bracket can use AI to enhance their business.

Providing **AI as service** to small enterprises

As described in the previous sections, MSME firms are in dire need of AI to enhance their operations. However, owing to their scale of operations, they often cannot rope in big consulting firms to do the job for them. Hence, the service firms in the MSME sector can offer AI as a service to small scale firms.

AI/Automation on existing projects

Firms that offer software as a service could revamp their applications to include AI capabilities and achieve an edge over their competitors. Also, they can design and launch dedicated AI services for MSMEs as there are very few players in this domain.

In recent times, organizations across sectors are looking for adopting innovations in technology into their business processes to boost up their revenues and establish their brand value. Accenture, in their analysis, have stated that investments by certain firms in AI are expected to increase their revenue by 30% over the next four years. Hence, MSME firms should also adapt to this thriving technology in order to compete against the large corporations. They can establish relations with academia most of which, especially the big universities which have extensively included AI programs ino their curriculum. This will therefore establish a win-win situation for both. Also, they could enter into a contract with their current SaaS providers.

There is a scope for newer companies to enter into this field and provide tailor-made AI services to firms and businesses operating in domains ranging from manufacturing to sales and marketing. This will significantly generate revenue and employment opportunities whilst helping several communities achieve their economic goals.

PRIVACY IN AN OPEN WORLD

BY CHANDU V. GRANDHI

User info such as names, gender, zip codes, IP addresses etc. are collected, analyzed & stored alongside similar confidential information by many firms. In most cases, cryptography is employed for data encryption to make it unintelligible without the decryption key. Such data can lead to serious problems when in wrong hands. Hence, “Data Privacy” is quintessential today.

Data privacy and data security are often confused to be synonymous. While data privacy deals with the proper usage, collection, retention, deletion, and storage of data, data security is all about policies, method and means to secure personal data.

With increasing computational ability, reverse engineering or decoding is a real threat. Thanks to the legal developments around the data privacy, regulations have been constantly upgrading to match today’s standards. The European Commission drafted the General Data Privacy Regulation or GDPR to identify & take appropriate measures against those responsible in such cases of breach or mishandling of data. It is mandatory for all organizations established or operating in EU to abide by these.

Facebook-Cambridge Analytica scandal which involved psychological profiling during the US elections’16 is largely credited with raising several privacy concerns. This sparked a new debate about the competence of firms against policy violations.

The concept of "K-anonymity" in privacy protection is quite popular. As per common definition: “If the information for each person contained in the release cannot be distinguished from at least k-1 individuals whose info also appear in the release, then k-anonymity is achieved.”

“Differential privacy” enable sharing of data while withholding the sensitive information of individuals in dataset. This results in the same output both with the presence or absence of the user information in the model & guarantees protection against such attacks measured using "privacy loss" metric. It is important to understand that differential privacy models are used for the protection of private data only.

Several edge-computing techniques have been deployed to store and process data at end-user devices. Apple developed strong computational capabilities and development libraries on the A13 bionic chip, thereby eliminating the need to upload data to cloud for processing.

As Google phrased it in their 2017 paper, “Federated learning” (FL) is a distributed machine learning approach which enables model training on a large corpus of decentralized data residing on end devices such as mobile phones. These companies assimilate galactic amounts of data whose centralization is usually privacy intrusive. FL facilitates data distribution globally, avoiding the collection at a single source. Information from the “teacher” models is processed and the outputs are used to train a “student” model that receives the inputs from these teachers. Well designed FL methods can ensure utmost privacy even against generative means of reverse engineering. With people often sharing crucial data such as location and contacts to several mobile applications with least deliberation, it is often the individual’s role to selectively secure their data to ensure privacy, especially in the post-privacy age of hyper-customization & exceptionally accurate recommendation engines.

Battlefield 2.0

BY SRIJAN GUPTA

"Whoever leads AI, will lead the world" – Vladimir Putin*

The above statement illustrates how AI will soon govern actions across the continents. The US military is cognizant of Chinese and Russian investments in AI. They understand the edge that AI provides on the battlefield. While there is consensus that it is essential to cultivate a workforce that can rapidly adopt AI in defense, there is only a limited idea on how to achieve this goal.

Data Availability

Surveillance today is done using plethora of mediums like satellite imagery, frequency taps, reconnaissance helicopters and aircraft, UAVs, Airborne Warning and Control System (AWACS), ground-based electronic devices and human intelligence. The resultant data thus collected is enormous. For reference, a UAV with mounted ARGUS ground surveillance systems collects about 40 gigabytes of information per second!

With these growing amounts of data, AI is certain to revolutionize the field of defence. AI enabled security systems of defense can easily figure out a cyberattack pattern and develop tools to combat counterattacks. They can exponentially improve the ability of defense systems to determine the location of their goals and also help defense personnel in monitoring their threats, thereby, increasing their situational awareness and preparedness. These are just a few examples, and we haven't even scratched the surface. [12] This simply highlights the enormous potential AI possesses, that is set to revolutionize the sphere of Defence for the world's biggest democracy whose total budget sanctioned for its armed forces accounted for $57 billion or INR 4.1 trillion for the financial year 2019.

Few Application in the Indian Military

Mission Analytics: Force laydown strategies are heavily dependent on the rotation of new or suitable replacement. When a unit completes its deployment, it often needs to be replaced by another with comparable and/or superior capabilities. These happening adjustments requires leaders or posting officers to have high confidence in the planned schedules and information about asset availability at their fingertips. Mission analytics can meet these needs by integrating with existing supply chain, maintenance, personnel-training database and analyzing the cross-functional dependencies between them to best optimize resource allocation and utilization decisions. Insights into these components of the readiness cycle enable defense leaders to identify issues early, ensure units are prepared for operations, and have a range of options should a contingency arise. Furthermore, incorporating these results visually with interactive interfaces allows the representative knowledge, data and insights to be conveniently accessible, easier to interpret, and informative to the decision makers. This will ultimately lead to a convenient and streamlined process that helps assess the preparedness better and improves resource allocation and prioritization. This is, but one, powerful of the component of data-driven deployments.

Intelligent systems and Robotics: The Centre of Artificial Intelligence and Robotics (CAIR), part of Defense Research and Development Organization (DRDO), has been developing several autonomous technology-based products. They are focused on net-centric communication systems for tactical command control. For surveillance and reconnaissance purposes, CAIR has developed intriguing probes like snake robots, hexa-bots, and sentries which are loaded with in-built comprehensive library working on AI-based algorithms and data mining approaches. They can potentially be used for image recognition, video analysis, activity prediction, NLP, and swarming with the capability to under-

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*"Artificial intelligence is the future, not only for Russia, but for all humankind," said Putin, reports *RT*. "It comes with colossal opportunities, but also threats that are difficult to predict. Whoever becomes the leader in this sphere will become the ruler of the world."

take operations from rugged terrains of Himalayas to the dry harsh conditions of the Thar. These will assist in equipping Indian armed forces with self-reliant, adaptable & fault-tolerant systems; besides improving their ability to execute tasks autonomously.

Riots/Agitation Alert: Innefu Labs have developed a deployable end-to-end solution to forecast and alert on a potential agitation movement. They are also working on facial biometrics tool to investigate riots. When an agitation happens anywhere across the country, there are multiple factors like social media posts, hash tags or news articles, religious group's posts and other trend or key influencers in open source media that promote a negative propaganda. Based on these correlated metrics, they merge all the data with the intelligence data from police agencies. Machine language algorithm and data mining techniques throws up patterns that are not visible to the naked eye.

Will an AI policy pave way for new breakthroughs in Indian Defense sector?

The changing nature of a war and its environment have necessitated the understanding of cultural, technical, and technological landscape of the area of interest. These may include network vulnerabilities, societal taboos, sensitivities, and legal loopholes. Tackling these hence further requests more data. There is also an unsaid necessity to keep matching rivals' capabilities in this sphere hence demanding further advancements and upgradations to similar platforms.

But all these come with their fair share of challenges. The Supreme Court's verdict on the right to privacy being a fundamental right for every citizen, it has become increasingly difficult for government agencies to gather personnel & surveillance insights to manage security within the country and actionable insights against potential agitators, as quoted by Prabir Chetia, Head of Business Research & Advisory at ARANCA. Data collected by government agencies on citizens have affinity to attract legal actions nationwide and global condemnations worldwide, since they are capable of violating fundamental rights of human code.

Massive computing power is readily available on demand, these days, via cloud-based computing platforms, at much reduced costs. This also facilitates the storage and analysis of gathered data and intelligence, potentially processing billions of data points in a matter of seconds. But sharing data over cloud involves privacy concerns over sensitive info.

Endgame

Analytics driven platforms have the potential to leverage actionable insights and wisdom from available data and have the potential to become a strategic instrument for the defense services in India across a wide range of services. Adoption of stringent policies to drive AI adoption and innovation, and stricter and more elaborate cloud storage and computing regulations, can surely help these technologies to transform India's national security. And all this must be done in a timely manner, because time is of utmost essence on the battlefield of today's advancements.

Abhijit Bandyopadhyay, Director
Analytics and Consulting, Visa

Vishal Gossain, VP
Scotiabank, Canada.

Sanjay Kar, Head of Analytics
Equifax India

David Zakkam, VP
Analytics, Swiggy

Shrikant Dash, MD
AIM, GCB, Citi

Industry

Sudhanshu Katiyar, AVP
Royal Bank of Scotland

Neeraj Gehani, Director
Dunnhumby

Utsab Chakraborty, Manager
Customer Analytics, Flipkart

Sanjeev Kumar, VP Engg.
LeapYear Technologies

Inga-Lena Darkow, Team-lead,
BASF, Hongkong

The PGDBA V batch had the privilege of interacting with several experts from the corporate during the pandemic.

Connect

Sayandeb Banerjee, Co-Founder and CEO ,TheMathCompany

Saptarshi Basu, Director, Head of Prod. Analytics, Flipkart

Arghya Mukherjee, Asst.Director Retail & CPG Analytics, WNS (GS)

Asha Subramanian, Sr.Director Human Resources, Goibibo

Tushar Walwadikar, Principal Accenture Mgmt. Consulting

Manish Gupta, Principal Applied Scientist, Microsoft

Sandipan Dutta, Quant Analyst Tower Research Capital

Sajith Kurup, Director Marketing Analytics, ABInBev

Ravi Kaushik, VP Data Sciences, Near

Gulshan S, Director Strategic HR , Near

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The Age of "Intelligent" Networks

Role of analytics and Telecom in IoT

BY KOLLI PARASURAM

In 1980s to late 1990s when people imagined how technology would shape the 21st century human life-style, their thoughts ranged from flying cars to voice-controlled devices. Although many of these are still distant dreams in our reality, Telecom and Data analytics have been pivotal in the evolution of several innovations. This article briefly explains about the interdependency of Telecom, Data Analytics and the role they'll play for IoT development in Industrial Revolution 4.0. Before delving into the main story, let's discuss the past development and recent milestones.

Sixty Starlink satellites were successfully launched by SpaceX on 23rd May,2019 as a part of their Satellite internet project. CEO Elon Musk revealed that using Starlink network, even the remotest parts of the world can enjoy high data speeds without the necessity of any optical fiber connection.

The "Digital India" campaign launched by the Government of India on 1st July,2015 has given a great impetus for internet usage in India. During the same period, Reliance-Jio entered and disrupted the entire Telecom industry, causing severe discounting in data prices. As Jio offered free data, internet usage deeply penetrated to the rural and remote areas of India. In addition, Tech-giants like Google offered free Wi-Fi (railwire) in many public places. Facebook also initiated "internet.org" on similar lines. This all together drove the single agenda of making Internet a part of everyday human life, thereby increasing the internet user base considerably. This lays the path for the widespread deployment of mobile and IoT devices thereby increasing data collection. This "Big Data" will be used for the development of several analytics models worldwide.

The Rise of Telecom

Telecommunication or Telecom has evolved from using pigeons to the invention of wired systems (Landline, Broadband) and wireless communication (Mobile). The journey of wireless communication has always been inaccordance to the needs of the users. The next few paragraphs discuss briefly about evolution of Telecom over the years.

Terminology Alert! (see glossary)

Initially, "1G" started with Analog Modulated signals being transmitted from mobiles. However, there were issues of poor voice quality and limited capacity. Then came the widely accepted Global System for Mobile communication or GSM, the "2G" which used FDD, FDMA and TDMA together for the mobile to communicate with the Core Network. Only call & SMS options were available with GSM. In order to cater the need to use internet in mobile devices, GPRS was launched with the limitation of the user not being able to use data during calls. With the growing demand for high-speed data and improved capacity standards, the WCDMA and FDD technique was used in radio networks of 3G/UMTS, which allows the user to access call and data services simultaneously with increased data speed.

With growing consumption of data and need for better performance, 4G-LTE systems were developed, which use OFDMA

in Downlink, SC-FDMA in Uplink along with FDD/ TDD in radio network. The LTE has a specification of throughput of more than 100Mbps and a latency of less than 10ms attained under ideal conditions. With voice call not being intrinsic in 4G, the CSFB feature enabled the user to switch to 2G/3G technology in order to make or receive call. To have good data speed even with voice call in progress, IMS was introduced as the much needed addition to 4G, the "VoLTE", where a shared channel is allotted for voice call unlike 2G/3G with HD voice transmission at ~64 Kbps.

IMS is not a new development. It existed much earlier theoretically as a part of 3G architectures. But it was not implemented due to heavy costs and limited impact. IMS was implemented for making VoLTE calls feasible and thereby finally meeting user needs. Throughout the journey, we observe that telecom industry has always moved in ways that best satisfy the user needs and expectations.

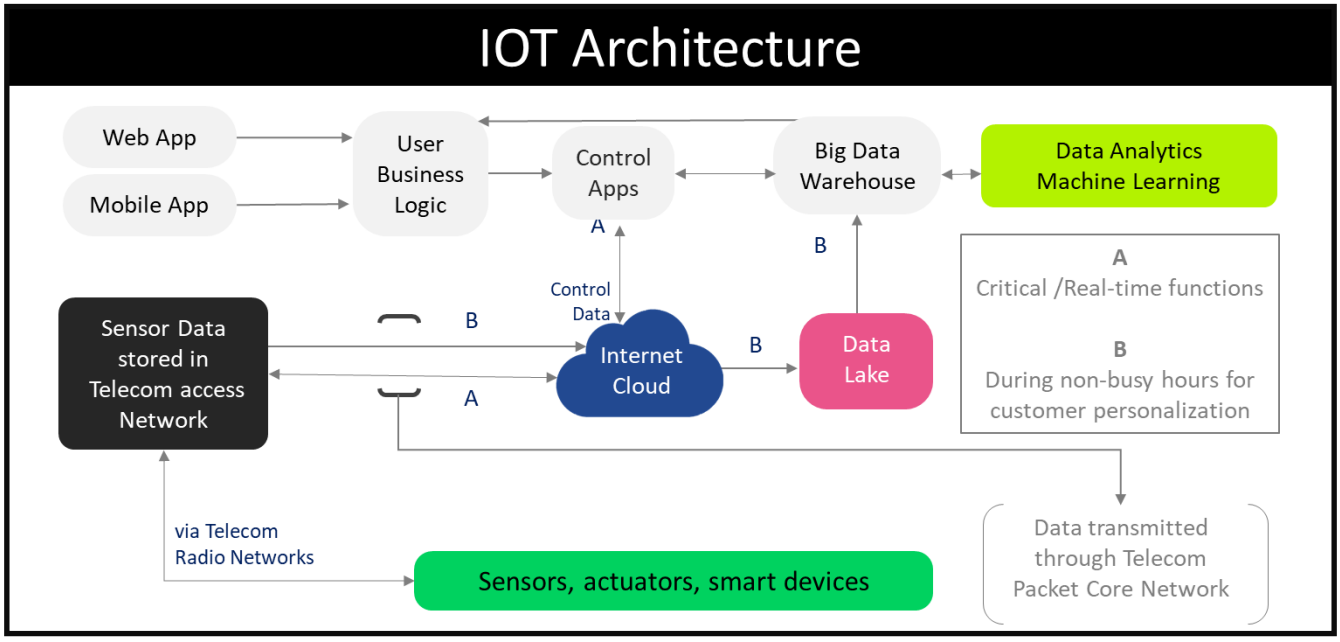
The all-pervasive Analytics

Analytics is not a new entrant in the field of Tele-communication. Widely used in many activities, analytics has many applications in telecom such as drafting site deployment plans, identification of underperforming cells, etc. In ground applications, there are a wide range of case studies, for example, descriptive analytics is very useful for customer complaint data to identify poor coverage locations. Predictive analytics can predict the churn rate and expected revenue generation. Prioritizing the locations can be done using Prescriptive analytics.

Of course, The next "BIG" thing

Internet of Things (IoT) refers to objects, devices, and/or machines in daily human usage which utilize mechanical and computing resources, often using sensors and actuators. They transfer this data over a network through the internet. IoT gives humans, the power to control things remotely, provided all the devices are connected over the single platform of internet.

The utilization of IoT smart devices will rapidly increase in the future as they are pivotal for smart cities and smart home developments in Industry 4.0. Hence, the IPv6 addresses (128-bit) will be allocated to accommodate the numerous devices that are to come in the near future. These smart devices can be among the below two types:



- Devices that can be remotely controlled.

Eg: A person wanting to switch off devices at home after he reached office, using an application in Mobile/Web server.

- Devices that auto-adapt to the scenario.

Eg: Self-driving car, automatic power switches using motion-sensing, etc. These devices might need internet connection as providing processing power to every IoT device would make them costly and heavy.

Two important features in evaluating the effectiveness of IoT devices are: 1) Last mile connection: How does it connect to the Internet? 2) Latency: How fast and effective is it functioning?

Last Mile Connection

In general, Bluetooth/Wi-Fi can be used for connecting IoT devices to the internet. But the most standard way is to use mobile networks, as they are already connected across the world and are capable of maintaining the connection even when the object is moving.

Latency

Latency can be defined as the round-trip time between the communicators. It is the time taken for a request to travel from the sender to the receiver, for the receiver to process that request and send back the response to the sender. Latency is highly crucial in real-time service applications like remotely operated devices, as a few milliseconds delay in decision-making may lead to very drastic consequences.

Note: Although IoT is capable of working on the upcoming 5G networks, the 5G Architecture is not yet standardized completely. Kindly refer to the 4G architecture for a better understanding of Radio & Packet Core.

The Business Perspective

The Telecom companies currently have high penetration in terms of connectivity which makes them suitable partners for entering into the IoT business in terms of connectivity, sales & marketing. Moreover, the telecom industry has already connected even rural areas with optical fiber network. Telecom firms have stores/agents all over the country through which they can now sell IoT devices to their customers. This gives Telecom companies an edge to expand their business.

The revenue boost can be attained not only by selling but also by providing O&M services to small-scale IoT devices. Most importantly, in the IoT architecture the B-part sensor data, which has less priority during transmission forms a Data Lake. This "Big Data" can be used for many purposes by leveraging analytics alongside.

> " The latency of 1 ms is still an unfulfilled dream and achieving it remains a challenge "

Customer behavior analysis using Big Data can help in market segmentation, need and demand identification, allowing telecom companies in designing more economical and profitable recharge plans for customers whilst introducing new products targeting different customer segments. These actions might help in increasing customer satisfaction and company revenues. This is a perfect example where analytics helps telecom companies to improve their standards.

Analytics models are always data hungry. These models become more robust with increasing data. The Data Lake in the IoT architecture provides a lot of quality and real-time data which helps in developing efficient models that can be deployed in the real-world. This is the complementary example where telecom helps analytics industry to improve their models.

Let us consider the example of a burglar alarm that's being widely used in homes

these days. The sensors detect the actions and send the input to a distributed Controller via the radio network of telecom. The "distributed controller" has the computational power to run the machine learning model developed by analytics teams. The output is sent to sensors and the users accordingly. This is one scenario where both telecom & analytics together serve customer needs.

The above examples clearly show that both the analytics and telecom industries should go hand-in-hand for their overall development, which then assists the usage of IoT in Industry 4.0.

The Verdict

The "International Telecommunication Union" (ITU), sets the 5G standards keeping in view the requirements of IoT deployment in the future. 5G network standards prescribe a throughput of 1 Gbps and latency of 1ms. The said data speed can be obtained easily at optical fiber connected locations. But the latency of 1ms is still an unfulfilled dream and achieving it remains a challenge till date. Also, the 5G spectrum would be selected in chunks according to the necessity of different IoT devices as per their priority between data speed and coverage/latency. Say, for some IoT devices data speed may not be as important as coverage like a simple smart electric bulb needing an 'ON' message. Also, some IoT devices of non-real-time applications need faster data speeds than coverage to procure assimilated data at the earliest (eg: O&M data of smart devices). But many real-time applications require both high data speed and minimum Latency. (eg: self-driving cars, real-time holograms). Many unfulfilled dreams of 20th century can be realized by the magical convergence of analytics, telecom and computation fields. Yet, these are the bottlenecks for Industrial Revolution 4.0:

- Low network latency
- Requirement of huge computational resources over a distributed network
- Access to and processing capacity to handle huge amounts of data
- Faster processing times
- High model accuracies

Many experts believe that the "Self-driving Car" that is completely autonomous and can has the ability to communicate with its surroundings without any human intervention, will be the greatest achievement of Industry 4.0. This dream demands all the aforementioned things to be realized in reality.

The main limitation from the telecom Industry in IoT deployment is attaining **1ms latency**, the 5G standard. Hence, 5G development along with real-time, highly accurate and effectively deployed analytics models will determine the future of IoT deployment and Industry 4.0.

Glossary	
FDD	Frequency Division Duplexing
FDMA	Frequency Division Multiple Access
TDMA	Time Division Multiple Access
GPRS	General Packet Radio Service
WCDMA	Wideband Code Division Multiple Access
TDD	Time Division Duplexing
LTE	Long Term Evolution
OFDMA	Orthogonal FDMA
SC-FDMA	Single Carrier- FDMA
CSFB	Circuit Switch Fall Back
IMS	IP Multimedia System
VoLTE	Voice over LTE

ORIGIN China
Wuhan Wet Market

TOP 5 WORST AFFECTED NATIONS

USA
Brazil
India
Russia
Peru

192 Countries Affected
(as of July 15, 2020)

DATA SOURCES

data.gov.in
2000+ datasets on COVID-19 by Govt. Of INDIA

John Hopkins University
data(Leading Medical University)
Raw a on cases (worldwide)

Covid19india.org
Visualizations on Crowdsourced Data

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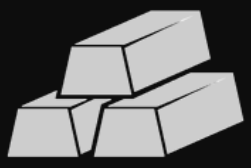
Pre-processed data
(Worldwide and Country-wise)

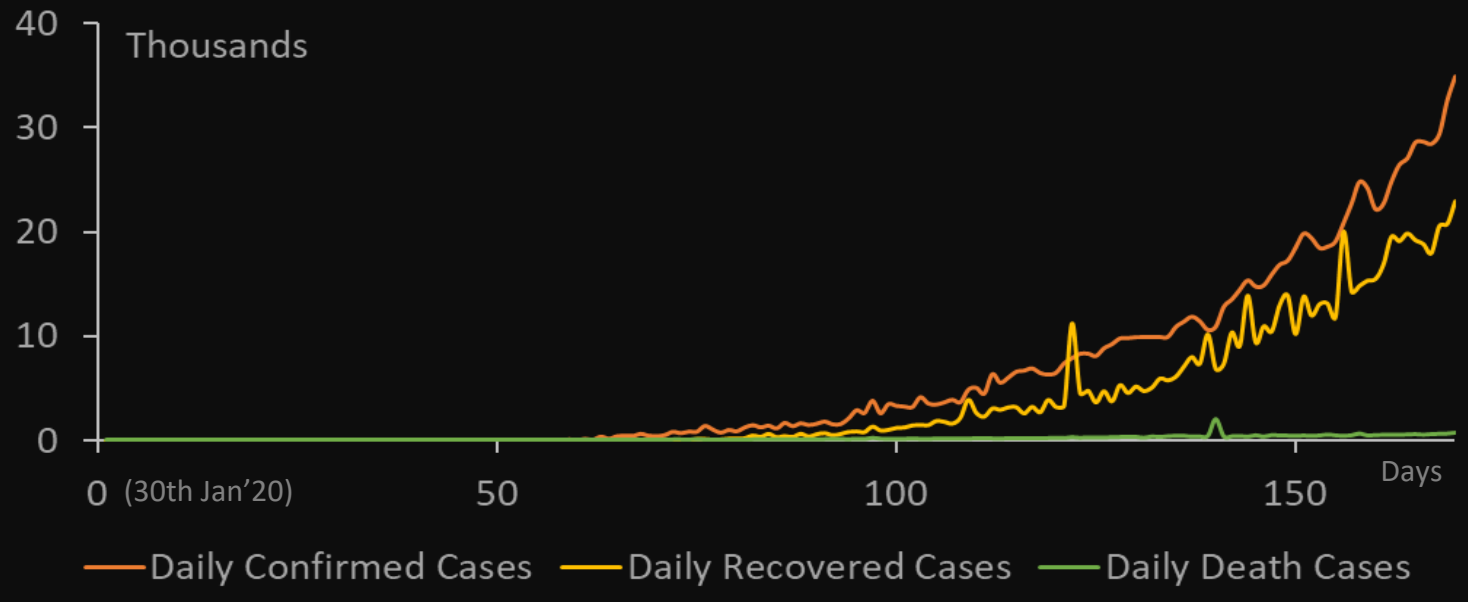
-$40.32
In April 2020, the prices of Oil Futures crashed to a historic low



~27.24%
Gold prices have shot upwards from the recent low of March'20

Energy, **Healthcare**, **FMCG** and **Telecom** sectors have shown adequate **growth** despite the pandemic
Finance, **Infrastructure**, **Manufacturing** and **Capital Goods** sectors exhibit a strong **negative correlation**

THE INDIAN SCENARIO

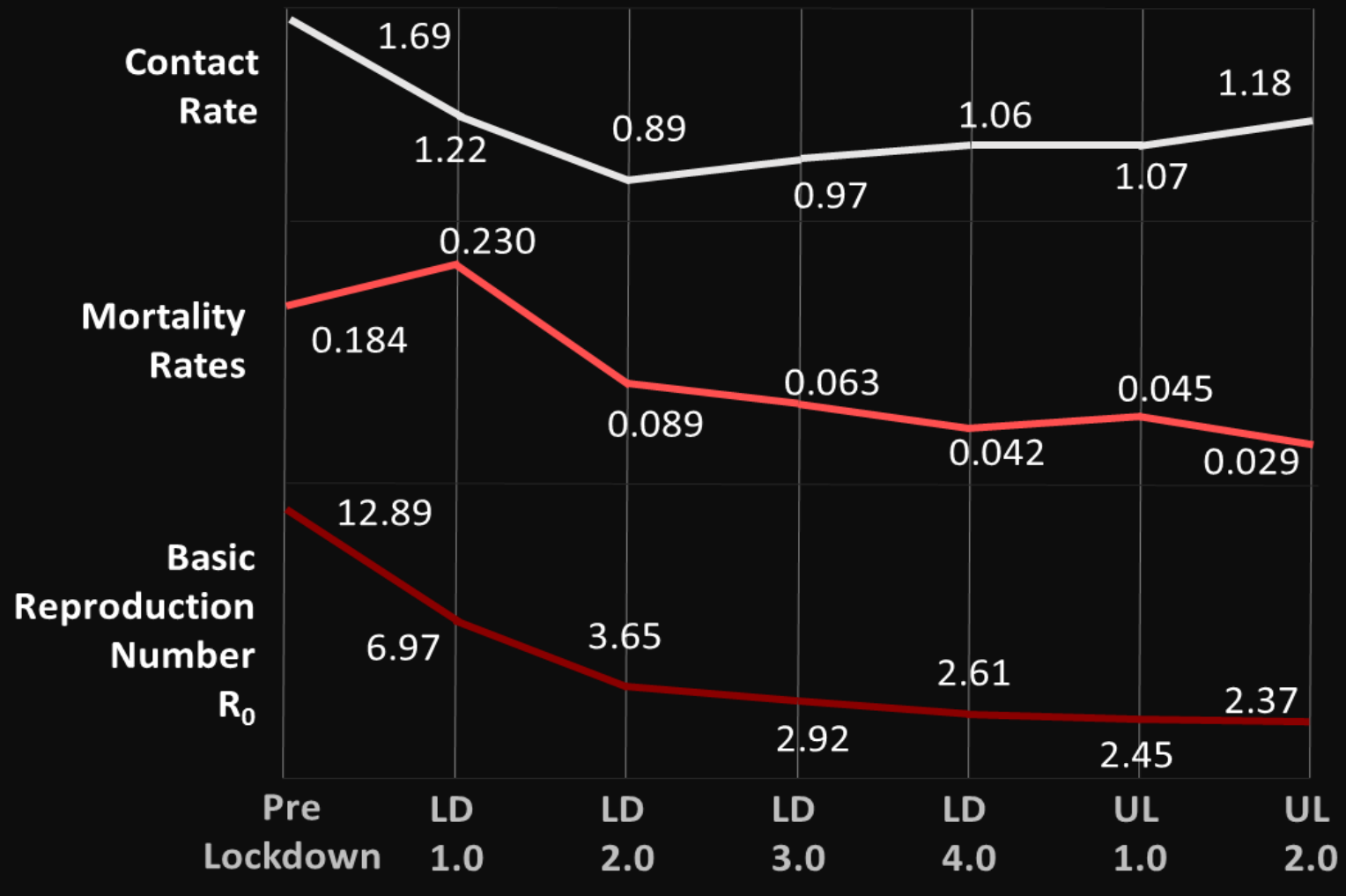


Amidst rapidly rising cases, improving the **Recovery Rate** is the way ahead

Contact Rate describes the rate of contact between susceptible and infected individuals

Mortality rate describes the ratio of deaths to the total number of infected individuals

R_0 describes the expected cases caused by an infected individual in a given population



High contact rate, medium R_0 & low mortality rate → **Community transmission Phase**

The Chronicles of Vision

The evolution of AI from the roots of Computer Vision

BY ADITYA GADEPALLI

What do the iPhone, the latest Star Wars movie, NASA and Walmart have in common? What connects Google with the temple town of Madurai? Well, many things, maybe. But definitely two simple words that have been shaping the modern world in ways that are subtle yet ubiquitous. "Computer Vision" (CV) has been both the origin and back-bone of several advancements that surround us today. Classifying it as a mere subject of study would only be a futile attempt to encompass a universe of intelligent concepts, applications and inter-disciplinary accomplishments. While popular opinion credits advancements in Deep Learning (DL) and the leap in our computational power to the rapid expansion of the field, it is indeed the constant perseverance of researchers and firms to adopt and implement CV techniques (followed by Speech Recognition and Natural Language Processing) at scale that pushed the boundaries of these advancements.

A note to the readers

Understanding the roots and history of a field fosters a deeper appreciation of the current state of things. Much of the early and recent advancements in deep learning, have emerged from this field of Computer Vision. The first half of this cover story is an exhaustive chronicle inspired from the lectures of CS231n by Stanford University, Deep Learning at IIT Kharagpur and an article by Rostyslav Demush. It sets the premise and replaces technical jargon with simpler intuitions for any sincere reader. Despite many abbreviations and references it has been ensured that no prior knowledge of machine learning would be needed in comprehending this part. The second part will then offer a diverse perspective about the various real-world applications and challenges that businesses across the world face while implementing these CV techniques.

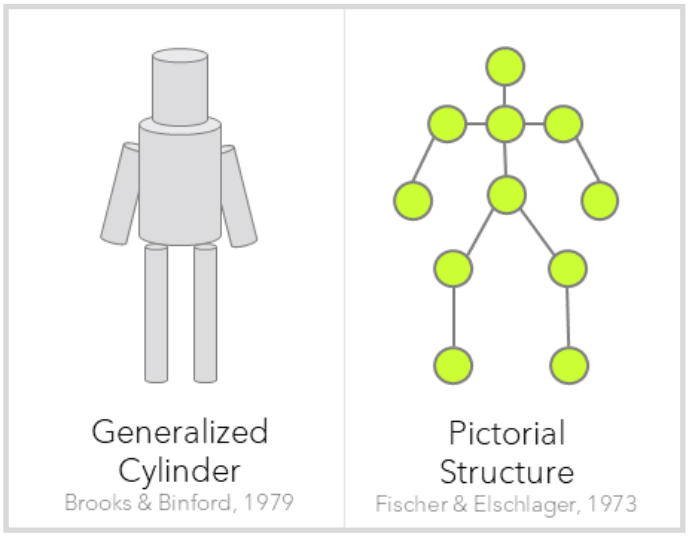
The Origins

One of the foundational ideas of today's neural networks comes from Frank Rosenblatt's research at the Cornell Aeronautical Laboratory in 1957. He used a IBM 704 computer with a custom built network of circuits to achieve object recognition. He called it "Perceptron", the first ever image classification application using a computer. This originated the idea that computers can be programmed to "learn" tasks which were earlier believed to be exclusive to humans.

While a binary cat classifier (Cat or No Cat) is the "hello world" for several CV practitioners today, their species played a foundational role for CV and neural networks in general. In 1959, two neurophysiologists, David Hubel and Torsten Weisel were studying the properties of a Cat's visual cortical neurons and how its visual experience affected its cortical architecture. After numerous attempts of placing electrodes within the cat's visual cortex to sense neural activity (with local anesthesia of course!), they accidentally noticed a neuron firing when they slipped a new slide into the projector. This led them to publish "Receptive fields of single neurons in the cat's striate cortex", a work that provided the very first intuitions about neural networks. The very same year, Russell Kirsch and his team developed an image scanner that could transform photos into digital images by converting them into a grid (or matrix) of numbers that binary machines could understand. This was much better than the 1920s based punch card system of storing and transmitting digital images. Also, the very same year saw the invention of the MOSFET (Metal–Oxide–Semiconductor Field-Effect Transis-

tor) at Bell Laboratories. These are building blocks of the image sensors we use in today's digital cameras.

With advancements in the digital front, the then PhD student Larry Roberts in his thesis "Machine Perception of 3D solids" published in 1963 described methods to extract 3D information about objects from their 2D photographs. This very first thesis in the field of CV marked the rise of computer vision as a cognitive science, much beyond mere perception. This decade also marked several milestones in the field of Digital Image Processing (DIP), especially through the efforts of the American Jet Propulsion Laboratory (now under NASA). They used several DIP techniques such as geometric correction, gradation transformation, noise removal, etc. and stitched together the 100,000 images sent by Space Detector Ranger 7 in 1964 to map the surface of the moon. This event led to the historic human mission to the moon (Apollo 11, 1969), yet the prohibitive cost of the hardware for such image processing pushed semiconductor researchers to come up with more efficient and powerful yet cost effective solutions.



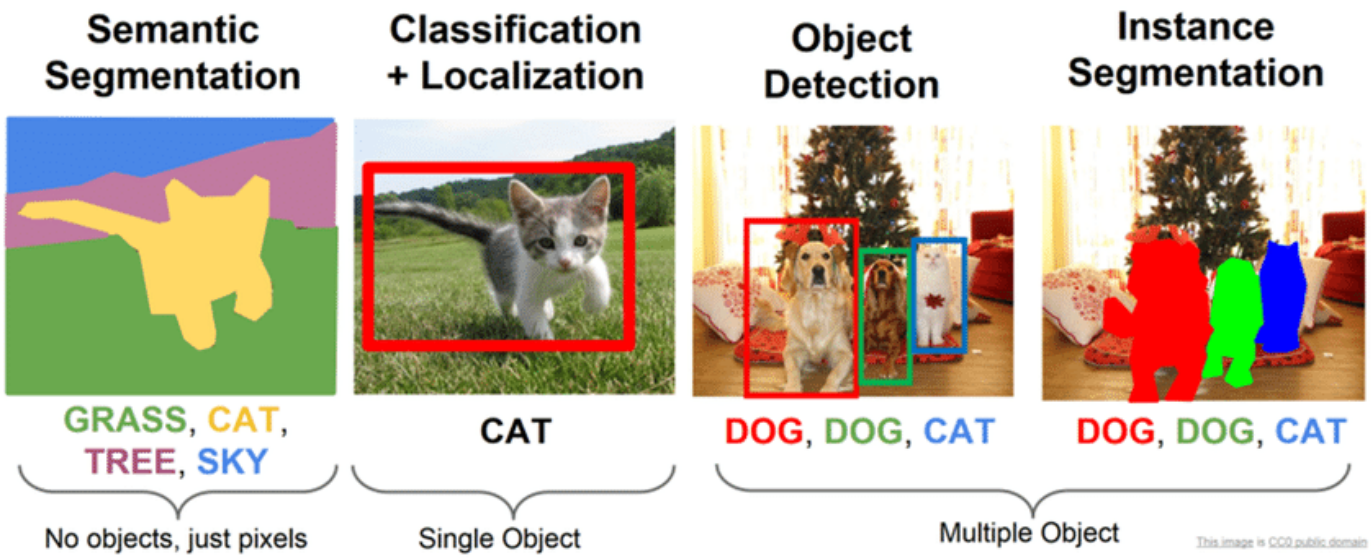
The 1966 "Summer Vision project" at MIT led by Gerald Jay Sussman under the guidance of his doctoral advisor Prof.Seymour Papert and Prof. Marvin Minsky tried to solve the "vision" problem, that is to distinguish objects from their backgrounds and distinctly identify them. This ambitious project, though unfulfilled, started the pursuit of Computer Vision as an academic discipline of research. In the late 1970s, the British neuroscientist

David Marr in his book "Vision: A computational investigation into the human representation and processing of visual information" described the hierarchical and functional aspects of vision. He suggested that visual perception begins with detection of "features" like edges, shapes and boundaries and how this information hierarchically adds up to help us understand the environment that we interact with. Parallelly, Kunihiko Fukushima, a Japanese computer scientist developed "Neocognitron" which was a self-organizing artificial neural network (ANN) that performed pattern recognition tasks agnostic to positional shift in images, thereby paving the way for today's much popular Convolutional Neural Networks (CNN).

The beginning of a modern era

In 1989, a young French scientist Yann LeCun used the idea of "back-propagation" to build "LeNet-5", a CNN that could recognize handwritten zip codes. The corpus of these several handwritten digits was soon developed into the famous MNIST database. This is arguably the first commercial application of CV. The famous CV researcher Prof. Jitendra Malik, in 1997 leveraged graph theory to attempt the "perceptual grouping" task, the process of determining which regions of the visual scene belong to which particular groups or object classes.

With a slight diversion from the ideas of "Generalized Cylinders" and "Pictorial Structures" in the 1970s where every object was believed to be a combination of regular geometric shapes/structures, David Lowe in 1997, shifted CV research towards "feature based learning" methods with his SIFT (Scale -Invariant Feature Transforms) model where he proposed the idea of critical features like edges which remain similar despite transformations on the images. In the image above we see that the features remain similar.



In 2001 the "Viola-Jones algorithm" using AdaBoost (a popular machine learning technique) for real-time facial recognition was developed. Soon Fujifilm introduced the face recognition feature into digital cameras around 2006. It is important to note how this algorithm is extensively used in facial recognition systems with some modifications even till date.

Works like "Histogram of Gradients" (HoG 2005) and "Spatial Pyramid Matching" (SPM 2006) suggested the use of spatial features built by extracting features from different parts of the image. Soon the use of CNNs would revolutionize the field entirely.

With growing commercial application, there was a need to benchmark algorithm performances against standard datasets. This led to the creation of the *PASCAL-VOC challenge,* with a dataset of 20k images and twenty object classes. Prof. Fei-Fei Li and her team presented the much bigger "ImageNet" dataset at the prestigious "Computer Vision and Pattern Recognition" (CVPR) 2009 conference. Soon the ImageNet Large Scale Visual Recognition Challenge (ILSVRC) challenge was launched. It is through this challenge that many of the state-of-the-art architectures saw their introduction and development. Though traditional machine learning techniques such as the K-Nearest Neighbours approach were earlier used, they couldn't provide satisfactory results. After the LeNet-5, with the 2012 winner "AlexNet" architecture, CV based image recognition took a great leap and made further progress with "ZFNet", "VGG", "ResNet" and numerous other deeper architectures in the years that followed. Today there are several benchmark datasets like Cityscapes, CIFAR, Microsoft's COCO etc. that are helping researchers build better applications for CV.

Digging Deeper

(Terminology Alert!)

Since the history and basic foundations of modern CV are now known, we briefly define some of the prominent computer vision tasks and then a few models and recent techniques.

Image Classification is the task of classifying given images into different classes, say separating the images of a cat vs those that do not contain a cat or maybe contain something else like a dog.

Object Localization is the task of identifying the exact location of an object within a given image. This is done by drawing a rectangular "bounding box" around object of interest.

Object Detection combines these two tasks to localizes and classify one or more objects in an image.

Semantic Segmentation is the same object localization task with much refinement, where every pixel of the image is classified into its respective class, thereby giving pixel level "masks" for each class of interest.

Instance Segmentation is an extension of the above, where, multiple instances of the same object can be distinctly identified at a pixel-to-pixel basis.

In the recent times, Ross Girshick and his team have proposed the R-CNN (or Regions with CNN features) family of models comprising of R-CNN, Fast R-CNN, Faster R-CNN and Mask R-CNN to address the above tasks in real time. These models fully exploit the CNN framework to perform the above CV tasks within milliseconds per image. It is these models that have led to deployment of CNNs in real-time applications. Also, in 2015 Joseph Redmon and Ali Farhadi proposed the YOLO (You Only Look Once) family of models that are much faster, but these class of models suffer from a minor loss of accuracy.

Soon the era of video classification and captioning began bringing the much earlier sequence models such as RNN (Recurrent Neural Networks-1993) and LSTM (Long Short Term Memory-1997) into prominence. Their applications are so versatile that they extend into speech recognition, language translation & several time/sequence based applications.

With such broad range of applicability, these advanced methods, though tough to comprehend, have revolutionized several activities of every day relevance. We explore these in the in brief in the infographic that follows.

The Cutting Edge

Deep Generative Modelling has taken the center stage in recent times. In 2014, Ian Goodfellow developed the famous Generative Adversarial Networks or GANs. These are algorithmic architectures that use two neural networks, pitting one against the other (thus the "adversarial") in order to generate new, synthetic instances of data that can pass for real data. Therefore, it addresses the data availability problem in a very cost-effective and timely

manner. Their application will soon be very widespread. In fact, the very notion of "deep fakes" came to the spotlight due to the astounding accuracy with which GANs perform such tasks of image generation. Their famous counterpart is the "Variational Autoencoder" or VAE in short. Based on an Encoder-Decoder architecture, they are much popular in the Bayesian world. While VAEs offer good explainability (better perceivable latent features), they are yet to gain much popularity in the research community.

First proposed in 1998 by neuroscientists Laurent Itti, Christof Koch and Ernst Niebu, "Saliency Maps" have been a guide to understanding "visual attention". They can be used to evaluate which pixels are better utilized by the model for delivering a certain outcome. There are several interesting studies that have clearly shown how these "black box" models, though outputting the correct result, often do so using incorrect references (see example). With the growing importance of explainability and fairness in AI models, all the frameworks discussed earlier will surely witness several updates in the near future.

IT'S NOW OR NEVER

Widespread use of mobiles with cameras has flooded the digital world with images

Extensive R&D on computation specific hardware has accelerated the progress of CV

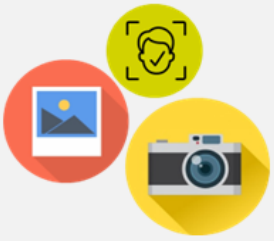
Recently developed techniques make the best use of the both hardware and software resources

Computation Power is becoming cheaper by the day, increasing accessibility

What's in it for me?

Self-Driving cars utilize computer vision through cameras and lidars. Their market is expected to reach $556.67 billion by 2026.

Optical Character Recognition (OCR) is one of the very first commercial applications of CV. OCR along with NLP can be used to literally "read" large text corpuses. Use-cases like, automated content retrieval for search & question-answering systems, counterfeit detection, images to text/tabular data conversion, automated mining of financial reports, handwriting detection etc. might have a market size of $13.38 billion by 2025.



Facial recognition has been popularized by Apple's Face ID and Chinese government's intense social surveillance. The "auto-focus", "smile detection", "Google Lens", 'QR/Zip Code scanner", "noise removal" features are possible vastly due to CV. Also, filters for digital images and photo scanning apps like Adobe Scan use CV. This market might be worth $9.21 billion by 2024.

Social media and image sharing platforms like Instagram and Snapchat leverage CV techniques to build better filters and use ML/DL based recommendation engines to display relevant content. Their market is expected to cross $180.82 billion by 2025.

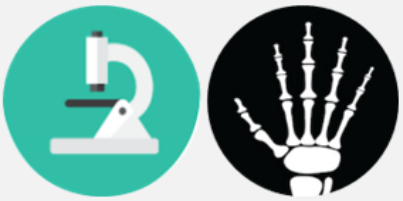
Landscape mapping and remote sensing using aerial/satellite imagery, automated drones, building footprint detection to assist disaster mitigation efforts and astronomical imaging use CV-DL techniques. The net worth of this combined market might be $16.88 billion.

The above figures are estimates sourced from the internet & are subject to changes as per market conditions. Please note that these are not to be considered as definitive. See pg 44 –45 for references.

What's in it for me? (contd.)

Digital and social media marketing efforts can be boosted by using CV. It helps firms understand the "visual attention" of different ad elements without solely relying on A/B testing. Also, GANs have created the scope for artificial personalities as models. This market may reach $42.17 billion by 2025.

Medical Imaging and automated diagnosis is gaining both popularity and regulatory approval. In fact, preliminary screening for diseases like diabetic retinopathy, skin cancer, COVID-19 can be done using CV. This life saving market is estimated to be worth at least $48.41 billion by 2022.



Automated quality control in the manufacturing industry uses CV. IR Cameras can help assess the inner state of machinery. This is worth $2.2 billion currently.

The next big technology of the future, AR/VR applications extend into gaming, visual assistance in low visibility, virtual meetings & entertainment spaces. They are a spin off from the computer graphics industry which mainly used products based on DIP & CV techniques. This is valued at $571.42 billion by 2025.

THE BROADER PERSPECTIVE

Industry	% Adoption
Technology	67
Consulting Services	53
Health Care/ Pharma	52
Manufacturing	52
Business Services	47
Government/ Non-Profit	40

Expectations by business from the implementation of Computer Vision

1. Improved accuracy or reduced errors across all use-cases
2. Better customer experiences
3. Enhanced predictive analytics
4. Increased process efficiency or productivity of tasks
5. Sharpened risk management and fraud detection

Key Implementation Challenges

1. Lack of understanding and strategy
2. Presence of Organizational silos
3. Improper data collection and storage
4. Data security and privacy issues
5. Legacy systems/ architecture

The Way Ahead

1. Understanding the scope of CV
2. Improved collaboration with academia
3. Utilization of open source research
4. Alignment with business processes
5. Improved budget allocations

The above figures are estimates sourced from the internet & are subject to changes as per market conditions. Please note that these are not to be considered as definitive. See pg 44 –45 for references.

Predominant Musical Instrument Classification based on Spectral Features

BY KARTHIKEYA RACHARLA, VINEET KUMAR, BHUSHAN CHAUDHARI , ANKIT KHAIRKAR, PATURU HARISH

With the aim to examine one of the cornerstone problems of Musical Instrument Retrieval (MIR), a spectral feature-based methodology for the classification of predominant instruments used in an audio sample is presented. For this purpose, the IRMAS dataset has been chosen. It includes clips of 3846 music samples with around 192 minutes run-time recorded from various sources in the last century, spanning multiple genres like country folk, classical, pop-rock, Latin-soul etc., making the data set diverse and better training.

Feature Extraction

While processing the audio dataset, it was found that despite having the same sound notes, the Spectrogram (the visual representation of the spectrum of frequencies of a signal over time) varies based on the instrument through which the musical note gets originated. This property of the spectrogram helps in capturing and predicting the instrument. For transformation from time domain to frequency domain, Mel Frequency Cepstral Coefficients (MFCC) were generated using FFT, then Mel Scale Filtering for scale transformation from frequency scale to Mel-scale. The audio spectrum is then analyzed by extracting MFCC's based on the default inputs of sampling rate (44.1 kHz) and hop size (hop length between the frames) is chosen as 512.

Additional Features

Based on the literature review, several additional features were used in this context such as:

1. Zero Crossing Rate (ZCR) – indicates the rate at which the audio signal crosses zero
2. Spectral Centroid (SC) – indicates the frequency at which the energy of a spectrum is centered upon, featuring the impression of the brightness of the audio sample
3. Spectral Bandwidth (SB) – represents the weighted average of the frequency signal by spectrum
4. Spectral Roll off (SR) – measures the frequency under which a defined proportion of the overall spectral energy belongs to.

Hann Windowing, a smoothing technique ideal for frequency resolution & reducing the spectral leakage is applied, while utilizing the Python inbuilt audio libraries - Essentia and Librosa. Several supervised algorithms were utilized for classification among which the SVM classifier has outperformed all the other model tryouts with an accuracy of 79%. Unsupervised techniques were also implemented among which the Hierarchical clustering was found to perform substantially well.

Having started as an academic project at ISI, this research paper was presented at the 7th International Conference on Signal Processing and Integrated Networks (SPIN) 2020, (having approximately 31% acceptance rate) organized at New Delhi during 27-28 February 2020, subsequently getting featured in the IEEE Xplore journal.

Paper Link: https://ieeexplore.ieee.org/abstract/document/9071125/

get . . . set . . . go..!!

TOOLS

Python

R

LIBRARIES

Scikit Learn

Plotly

Matplotlib

NumPy and Pandas of course!

FRAMEWORKS

TensorFlow

PyTorch

H2O.ai

HuggingFace

PyCaret

ONLINE KERNELS

Kaggle

QBlocks

Google Colab

Gradient by PaperSpace

ONLINE LECTURES

CS231n
CNNs for Visual Recognition

CS224n
NLP with Deep Learning

MUST SEE

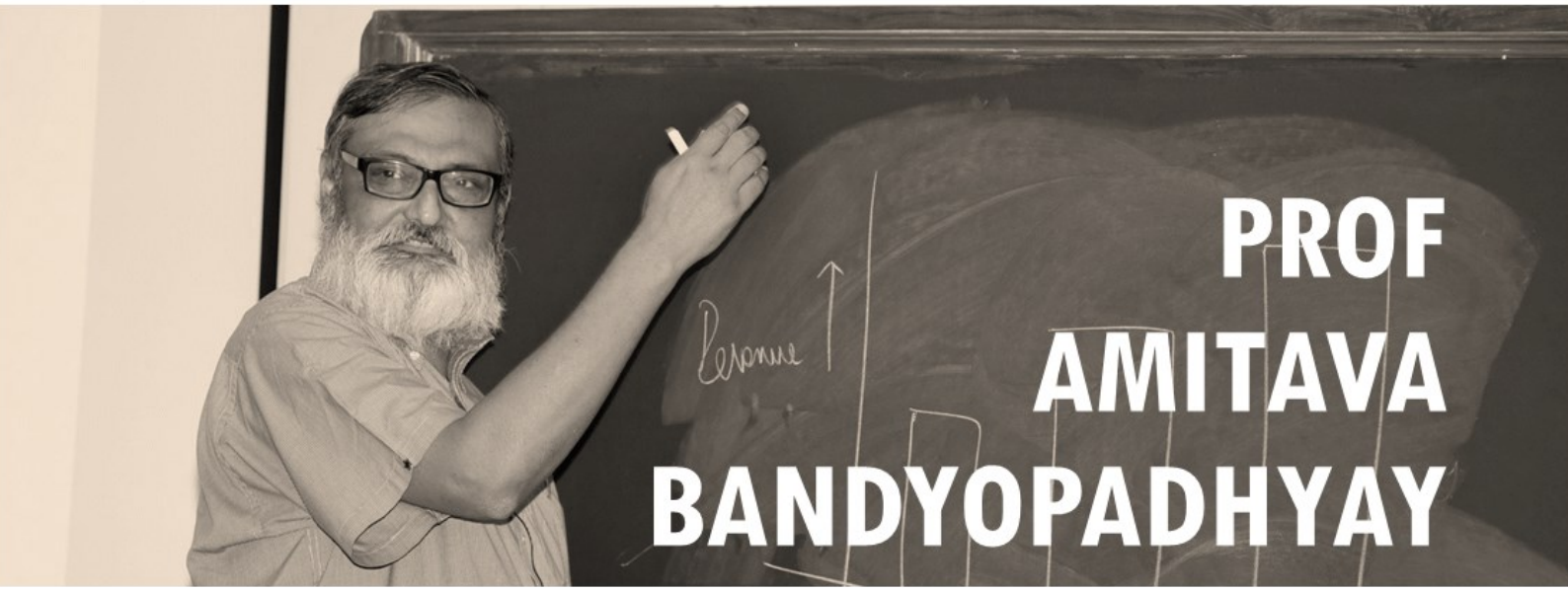
Interpretable ML
by Christoph Molnar

fast.ai

Full Stack Deep Learning

PEOPLE TO FOLLOW

Yann LeCun, Geoffrey Hinton, Yoshua Bengio,
Jitendra Malik, Ross Girshick, Jürgen Schmidhuber,
Andrew Ng, Pieter Abbeel, Ian Goodfellow,
Sudalai Rajkumar, Abhishek Thakur, Alex Pentland



Associated with PGDBA from its inception, Prof. Amitava Bandyopadhyay is a Sr. Technical Officer at SQC&OR unit of ISI Kolkata. He is an accomplished expert who has worked with numerous industries, governments & researchers over 40+ years. He is currently working on a COVID-19 dashboard & attempting to collaborate with multiple state governments to provide actionable insights for unlocking in India.

AINA: How did your journey in statistics begin?

Prof: Entry to the field of statistics as far as I'm concerned was completely serendipity, it just happened. There is no specific reason behind it. For a long time, it was not easy for me to understand how statistics can be really applied. I got into ISI in 1975 as a student, and got some basic, theoretical understanding of statistics but did not have a clue about how it could be used to solve real problems. The real practice, or so to say the journey, started from the 90's. That was the time I could see real world problems as random experiments giving rise to random variables. Slowly, I could see how probability distributions essentially summarize information related to the real world and the roles parameters play. Two books that came very handy were 'Out of the Crisis' by W Edward Deming and 'Statistical Methods for Quality Improvement' by Hitoshi Kume helped me see real world problems from a statistical perspective.

AINA: Can you share one interesting problem you've solved in your early days?

Prof: I still remember my work with a cigarette manufacturer. I'm fairly proud because I implemented what is called a "control chart" in the year 1996-97 and later on observed it was relevant in 2016 as well. A statistical technique implemented and up and running for over 20 years is not a small thing. When you look at a cigarette, the cigarette is filled with tobacco as the main ingredient. Tobacco, being an agricultural product, comes in various densities. Thus, the amount of tobacco filled in a cigarette could have a large variation. If the variation is large, the amount of tobacco filled will naturally vary and may well go beyond the specification. If you fill more, you may lose money & if you keep less, you may lose your customers. Plus, the quality suffers as specifications are not met. The major question was how to control this. The answer was fairly simple but very counter intuitive. What we have seen is, there was a system to take a number of cigarettes every few minutes, measure the weight, calculate the density and accordingly control the flow of tobacco whenever the density was out of specification. There is a knob to control the quantum of tobacco being filled. In our experiments, surprisingly, the variability was found to be less when the control was made less often. That was a very stunning finding. After careful thinking, we could understand that variance of the process remains about constant while the mean shifts. For every mean shift if you are making an adjustment, it becomes a random walk & increases variability. Thus, the real solution is in focusing on variability offline rather than controlling mean frequently – a very interesting insight. Later, I encountered many problems that I've solved similarly. For instance, the company ordered a large dryer for drying tobacco to moderate its moisture content. The tobacco moves on a conveyor belt, there are automatic sensors which measure the moisture every few seconds and make adjustments. Here, the problem was with the variability of mois-

ture content. This too was following the same pattern as the previous problem. So, these were cases where statistical methods enabled us to develop implementable, counter-intuitive, control and improvement systems that led to direct improvement of quality – and these systems are working for over 2 decades! Subsequently there were many such interesting experiences.

AINA: Can you tell us about the various scenarios where you've applied statistics in real-life?

Prof: My forte has been applications of statistics, mainly in manufacturing and the various associated domains (maintenance, procurement etc.) of manufacturing units. Also, I did work with the software industry starting from Infosys way back in 1999 until 2015-16. Since 2014 – 15, I've been predominantly involved with government institutions and a few private firms as well. During 2013 – 14 we worked on estimation of the quantum of fake currency in circulation in India. This was very much talked about at that point of time and seemingly an impossible problem to tackle as very few people report cases of counterfeit currency. Rough estimates given by the investigation agencies were over several thousand crores. We used an elegant technique – we theorized the supply chain of counterfeit currency and then used bank data to come out with our estimate as other data were not available. Our estimate was shockingly lower than the estimate by the investigation agencies – about 400 crores rather than several thousands of crores. This was reported in the Wall Street Journal as well. Later, post demonetization, when actual money (currency notes) was collected & counted, fake currency amounted to only 41 crores. This was a very interesting revelation and showed that statistical theory can lead to very accurate estimates if the underlying system can me understood well. Similarly, I worked with the Govt. of Tamil Nadu to help them in their Swachh Bharat journey. In this exercise we devised ways to measure cleanliness of Urban Local Bodies objectively, imparting newer perspectives to me. These are the kind of applications that I've seen in the past few years.

AINA: What role is statistics going to play in the decision-making process post COVID?

Prof: Why post COVID, why not pre-COVID? If you look at any particular situation, you observe something. For example, today we've observed that the number of deaths due to COVID is something. From the aegis of individual observations, we try to take some action. However, one must note that individual observations are often myopic. There is something in the background that you need to understand. This is invisible to the naked eye, only statistics can make you understand this. For instance, we need to understand whether the death rate is going up or not rather than whether death on a particular day is high, what is the average time for recovery – did it increase, how it varies across states or across time etc. You cannot act on a particular observation is something I learnt from my past work. You look at one particular outcome & say that the cigarette is heavier. Did the cigarette become heavier on an average? Does it make sense to measure like that at this point of time and attribute it as change in the average? Or is it just because of random variation? Somethings are seen because of some random variation. I think this is one major point we need to understand. Say today, the number of accidents in a particular stretch of road is high compared to that of yesterday. Does it mean that system has become more dangerous compared to yesterday? Looking at the numbers from the perspective of the random variable, understanding the parameters, which may or may not have changed, and defining the problem from that particular perspective was all along important & will remain important. Hence statistics is important because as mentioned, decisions should not be taken based on a single particular observation but on a holistic summary of a range of observations. Now that things have become even more dangerous due to COVID, we have to work in a manner such that we are most efficient.

AINA: How do we define & choose a right metric for any given problem/scenario? How to build conviction that it is the apt means to convey/comprehend the scenario?

Prof: This is a difficult question. There are two ways in which one can approach. One is "deductive" approach & other is the "inductive" approach. If you look at statistical theory, given a set of assumptions you prove a certain theorem and derive something. That is deductive and the scope of debate is limited to mathematical aspects. But analytics is largely inductive. For example, how do I assess the level of risk due to COVID. In such cases, forming the right question itself is difficult and subject to debate. Here, I try to figure out what are the metrics that can be looked at, which is not really a deductive problem. Inductive reasoning has its drawbacks. An analytics expert might be looking at a particular problem & form an impression which will vary from person to person with

ample scope for debate. But a good analyst would learn both the deductive reasoning, and also to some extent the inductive reasoning by practice. Using inductive reasoning, one can come up with the metrics. This might not answer your question fully, so let me try to give examples. If you look at the COVID situation, the rate of recovery has wide variation. In fact, on 29th of May 2020, in Mumbai, the number of recoveries was around 8000. The day before that was zero. If you simply plot the number of recovered people from the data available, you'll be confused. So that leads me to believe that there is probably some systemic issue, because if I am affected then multiple tests need to be done. Somebody will have to take my sample, take it somewhere, get the tests done, and you need to approve it to release me. So, there are many administrative processes involved. This appreciation of the underlying system would facilitate formulating interesting questions – an essential part of inductive reasoning. Hence, one needs to look at the explanatory analysis & frame questions using concepts of probability and variation, but as I told you the inductive processes will always be subjected to debate.

AINA: Computational Capacity & power have multiplied several fold helping analytics to grow. How has your experience on this been over the years?

Prof: I will say there are many positives but few negatives too. Primarily, in statistical problems, we used to deal mostly with "Supervised Analytics" or dependency methodology. Nowadays data collection & pre-processing have become easier. We have several methods in which we not only explain the response variable but also predict the response variable often using some non-parametric methods. Additionally, we have problems in which the learning need not be supervised, often called "Unsupervised Analytics" where we mostly are concerned with patterns and structures in data. Today these Statistical & AI methods have become easy to implement. I can analyze and give results quickly and explore many alternatives. This is a major positive. But two major negatives, particularly in engineering industries and similar fields, is that there is science involved in a concept and even without considering those aspects one can just fit the models and give results. This could be quite problematic if models are fitted without even going into basics. Another concern is that one would quickly model on certain data, expecting that the same model will work for any/all data. In summary, the pros are: lots of methodologies are available, accessibility is high, data is largely democratized and as a result of that I am able to do things very fast and devise many different solutions. While the cons are: there are specific scientific problems which should be looked at from multiple perspectives and one must not neglect connecting them with the science involved – a fact that is often falling by the wayside these days.

> "While deductive skills are important, one must be able to frame the right questions too."

AINA: And the last question. What common fallacies must one pursuing this field avoid?

Prof: This has two major aspects to it. First is when you are taking about AI/ML or a statistical solution, you always talk about probability. For example, I expect "at least X" positive cases tomorrow in Delhi. This is a probability statement. We are calculating it using some model or a parametric distribution. So, the role of probability is pivotal. No matter what methodology/code you use for a prediction problem, the underlying question is involving probability. In few cases, people doing short courses or are self-taught might not be reminded about the role of probability. This might not be true for all courses. But I suspect this issue might exist. In such cases one may take the predictions/ estimates too seriously. Second one, which is also applicable for professionals who have gone through fairly rigorous programmes is whenever I am solving a problem using an explanatory model or any other model, I'm necessarily using a model which can be parametric or non-parametric. There are assumptions associated with each model. George Box made a famous statement: "All Models are wrong, but some are useful" In fact, the current COVID scenario made it much clearer. Many people in the last few months have tried to predict the number of active cases without considering the underlying limitations & assumptions in the model they are implementing which might not be valid in real life. Hence one must check if the underlying assumptions would remain valid during the prediction periods & only then move to the further steps. Finally, one must ensure that the model is coherent with reality and make sure that model will not fall flat if the underlying scenario changes.

AINA: Thank you very much for sharing your invaluable insights and experiences with us.

Prof: Stay safe and all the best!

The world is not fAIr

BY SOWRYA REGANA

The fast paced and multi directional development of AI applications is supporting humans in areas ranging from buying a simple toothbrush to sending reusable spacecrafts into the space. As AI is being increasingly adopted in crucial and sensitive applications, it raises the need to study about the biases that these systems bring to the table. Recent times have seen significant increase in the examples of AI systems reflecting or exacerbating machine biases, from racist facial recognition to sexist natural language processing. Recently, American Civil Liberty Union filed a case against Detroit Police for falsely arresting an African American due to mis-identification attributed to its facial recognition software.

According to IBM Research, there are more than 180 human biases in AI systems. Biases, of any kind threaten to overshadow AI's technological gains and potential benefits and hence have become a primary matter of concern for Policy Makers (governments), Auditors, Businesses and their end-users. Businesses often tend to shorthand their explanation of AI bias by blaming it on biased training data. But the reality is more nuanced. Biases can creep in long before the data is collected, sometimes at various stages of the data collection process. In the current article, we collate the various bias and fairness notions defined and proposed by researchers actively working in the field of ethical AI. In the interest of readers, these definitions have been adapted verbatim from the paper. (see note at the end of the article)

Historical Bias is the already existing bias and socio-technical issues in the world that can seep into from the data generation process even given a perfect sampling and feature selection. An example of this type of bias can be found in a 2018 image search result where searching for women CEOs ultimately resulted in fewer female CEO images due to the fact that only 5% of Fortune 500 CEOs were woman—which would cause the search results to be biased towards male CEOs.

Representation Bias happens from the way we define and sample from a population. Lacking geographical diversity in datasets like ImageNet is an example for this type of bias. This demonstrates a bias towards Western countries

These are few of the many existing biases that affect AI systems. However, there are also some fairness notions which when followed ensure that AI systems are free from few of these biases.

Algorithms do what they're taught, unfortunately some are taught prejudices and unethical biases by societal patterns hidden in the training data. To build algorithms responsibly, we need to pay close attention to various sources of potential discrimination or unintended harmful consequences. Due to increasing usage of AI in judicial systems, health care and other crucial domains, it is very important to ensure that it gives an unbiased output. Businesses and organizations should also ensure that their AI systems are be free from bias both from data and also the algorithmic perspective.

*The groups that are often victims of discrimination are termed as protected groups. It varies based on context. (Ex. African-Americans, females etc.)

Interested readers can kindly go through the paper titled "A Survey on Bias and Fairness in Machine Learning" available on ArXiv : https://arxiv.org/pdf/1908.09635.pdf

Fairness Notions	
Equalized Odds	Protected and unprotected groups should have equal rates for true positives and false positives.
Equal Opportunity	Protected & unprotected groups posses equal true positive rates
Demographic Parity	The likelihood of a positive outcome should be the same regardless of whether the person is in the protected group
Fairness through Awareness	Any two individuals similar w.r.t. a similarity (inverse distance) metric defined for a task must have similar outcome
Fairness through Unawareness	No explicit usage of protected attributes

The "Trillion" Dollar Dream

Will advent of AI into the legal services market mark a new revolution?

BY CHANDU V. GRANDHI

Remember the tv series "Suits"? The title is quite apt given the fact that the cast appears in suits for most of the screen time. With the sassy remarks and witty dialogues, it was quite impactful, enough to make me think of jumping ships to such a career. Keeping aside my interests and the show, lets dig deeper into our legal system. Before we delve any further, let me ask – "Did you read the Indian Penal Code?" Most readers would say no. It's not easy to read a book which is full of rules and regulations without any fictional characters or stories, not to mention the subtle differences in interpretation caused by a mere change of few words/tenses. Yet such is its power that it helps people abide and steers the society towards a more mature and positive direction.

The scenario of real-life professionals is often quite different from those depicted in popular tv shows/series. Most of them work long hours, pouring over documents, researching similar cases, phrasing suitable arguments, prepping the clients, checking for revisions etc. to fulfill a case successfully. While such exhaustive routines are a part of their daily life, not all of them belong to the same profile. Few practitioners also work on business cases such as mergers and acquisitions, partnerships, con-

tract preparations, litigations etc. The advent of technology has undoubtedly helped them in easing the hardships, yet many tasks still consume lots of effort and time. In the field where most of the issues take years to see their verdict, the entry of AI and data analytics is expected to set newer standards.

The sheer logic-based nature of the legal framework attracts the idea of machine learning deployment, which largely are credited at deciphering such rule-based mechanism with perfection. Also, automation of manual efforts would provide space for many important discussions, especially those which cannot afford the luxury of time. We now discuss few applications of AI in the legal practice, many of which are gaining importance whilst under constant improvement.

Content Research

This includes assessment/audit of the given situation whilst keeping a keen eye for inconsistencies (both positive and negative) within the legal framework of interpretation. With the help of Natural Language Processing and Knowledge Graphs, this tiring procedure can be made more efficient. Activities like searching, highlighting, extraction of relevant information, managing documents and compiling reports can all be automated. Such automation reduces manual errors and simultaneously saves several human-hours of effort. In fact, Levetron has developed a tool which is capable of high-speed processing of contracts in 20 different languages. The financial giant JP Morgan itself has made a grand entry into this domain through the tool "COIN" (Contract Intelligence), which extracts information from contracts and agreements requiring 36k human-hours of processing within few seconds.

Despite exhaustive information availability over the internet today, its utilization to search for relevant articles and answer queries is not possible in all cases. Processing such abundant sources and extracting relevant information manually, not only overwhelms the user, but also leads to missing out on relevant and important articles. A recommendation engine tuned to the legal databases would be of great use, as one can then obtain necessary info and answers within a short span and within few clicks. A recommendation engine developed by Ross Intelligence does the same by asking necessary questions and provides selected readings and relevant articles to the users. Ideally, one would be needing to go through all the case details, develop a summary, identify the keywords and map these to the relevant articles to develop a recommendation system. While such a gargantuan data annotation task would seem severely taxing, its utility far exceeds the magnitude of initial efforts. In fact, unsupervised topic modelling and sentiment discovery mechanisms can be leveraged to assist in such system's development efforts. Several other Information Retrieval methodologies can be adopted to smoothen the process of building such useful recommendation engines.

Automation of manual efforts would provide space for many important discussions, especially those which cannot afford the luxury of time.

Case Verdicts

While usage of text analytics helps us in predicting the relevancy of the information we are providing, it's also possible to develop models that can predict the verdict of a case, based on pre-trained algorithms. This is similar to the prediction models we use in our daily lives, but it can be used to evaluate possible outcomes for a specific case and thereby help in taking relevant measures. AI firms like Intraspexion, Ravel Law ventured into the same to help predict the rulings and check for threats of litigations. Another firm Premonition, asserts that it can predict the case outcome by analyzing the lawyer's win rate, case duration and nature and also judge the event of a possible delay in the case with sufficient accuracy.

Models have been developed to identify which cases are more likely to settle, thereby reducing the load on the legal system. Casetext developed a program, CARA, which can help in forecasting the arguments

of the opposing counsel, useful in training new associates or expecting the unexpected. Infact, there are studies that show how recidivism can be predicted. Nevertheless, these algorithms and models need to be thoroughly evaluated on the grounds of fairness notions to mitigate any undue algorithmic bias owing to historical data used for their development. With the growing concerns about ethical AI, these applications will definitely be under the scanner soon.

Intellectual Property Registration

For any company worth its salt, IPR is essential, especially in terms of differentiating itself from the competition. The application process involves a whole deal of manual search and verification, often working against the applicant's favor due to the time sensitive nature of patent approvals. In addition, any errors from the applicant's side can result in a loss. Hence the presence of all essentials are of utmost importance during submission. Smart shell, ANAQUA studio and few other companies are working on the automation of drafting and reviewing of applications. TrademarkNow has developed an algorithm for shortening the search time for clearance. With such improvement we may soon see automated approval too in the near future.

Contracts Automation & Policy Drafting

Many clients approach lawyers for drafting contracts (like NDA, Employment, MoU etc). Also other seek advocates' guidance for developing policies (Sexual Harassment, Terms of Service, Privacy policy etc) as these require serious attention to terminology involved. Yet, automation remains a possibility here, wherein, usage of a specific set of templates and identification of suitable terms from past agreements can considerably reduce the time needed for manual drafting to a matter of few minutes, with only a further review.

Crime/Criminal Detection

The financial sector, especially the banking and trading domains employ several complex algorithms used to detect fraud or chance of a criminal activity. This usage is not limited to private firms, but extends to several government organizations which use them in identify companies engaging in such activi-

ties. It is a common fact that several machine learning algorithms are in deployment towards these efforts of fraud detection. Apart from the cyber crime surveillance, physically recognizing convicts though computer vision and video analytics by using deep learning can be quite resourceful. They can help in identifying a person or even a group of individuals from a captured picture or footage. Many nations have deployed this technology to identify perpetrators to speed up the legal procedure. Skylark Labs has signed deals with the US and Indian government in deployment of drones in order to enforce social distancing norms. China is quite famous for its deployment of social surveillance measures across several parts of the nation. During the pandemic, it has been utilizing these in identifying and shaming people who weren't using masks in public. Several companies have come up with trained models which can identify people even with the presence of masks.

Digital Advocacy

With the current NLP and audio analytic techniques, several voice activated softwares have been created. At the current pace of growth in AI technology and automated programming, the prospect of a digital lawyer to interview users about legal issues, submit paperwork and take up litigations seems a reality not so far in the near future. Nevertheless, such a possibility would mean overcoming several technical and legal challenges. Yet, once developed these may be deployed to set the legal charges free of cost. This will reduce the burden on the current system while truly democratizing the access to justice for every citizen.

Critique

While all the above points suggest great changes in the legal system with the entry of AI, there are still a few factors which need to be considered for evaluating its benefits.

- Although these automation models are much efficient, they still rely on humans for generating, curating and cataloging, modelling the data.
- Computational resources required would put a dent in the finances with only little or delayed returns as current AI systems require highly skilled workforce to implement effectively.
- Classifying cases whose verdicts involve additional factors such as mutual settlements, political complications, emotional pleas etc. are difficult.
- Bias is one issue whose presence may result in severe ethical issues.
- Current advancements in NLP are yet to satisfactorily detect sarcasm, deploy emotions, humanitarian thought process, mimicking human behavior, making it difficult to extract important features involved in the case.
- Digital/Robot lawyers need a deep understanding of society's working, great deal of language processing and quick responses, not to mention the most essential human interaction ability, making it difficult to eliminate the human factor from the equation
- For complicated cases, the complexity in giving out verdict due to the nature of the crimes, behavior of the defendants, losses to the victims, severity of occurrence, past records of similar verdicts need to be accounted for, something which most models are not usually trained to handle.
- The rule of law mandates to not punish any innocent person. This needs the absence of any false positives and false negative (foregoing the guilty thereby punishing an innocent in their place) outcomes in order to maintain the societal trust in the system.
- Most AI models are black boxes which results in accountability issues as they cannot be evaluated without in depth statistical acumen to get reasonable/ satisfactory answers.
- Blind trust in the output of the AI model without knowledge of the basic framework of underlying assumptions and operating conditions can often lead to unpleasant results.

Despite the advances in legal informatics and computational law, an economically viable solution addressing the current complexity is yet to be realized. Still, the trillion-dollar legal services market might soon witness its next big revolution in the decade ahead.

The Paradigm Shift

Envisioning "Hybrid" Hyperlocal delivery systems

BY ADITYA GADEPALLI AND ANUDEEP IMMIDISETTY

The world is rapidly adopting several technologies and the rate of such adoption has never been so high. With the introduction of the iPhone in 2008, the entire business world has forayed into an unprecedented digital domain. Throughout the recent decade many businesses have hence migrated to the digital landscape and with 4G data in widespread access, many underprivileged classes too have become "netizens". Amidst such disruptions, e-commerce has been one of the best recipients of this "internet advantage". In fact, post demonetization many people have adopted digital payment as a regular choice of transaction, and this has led to even more convenience for online shopping. With such disruptive growth, many e-commerce giants have been constantly upgrading their supply chain models to be more efficient and robust to the up- surging demand. They have indeed become so efficient that we are in an era of "hyper efficiency" where delay is now accounted for in the scale of minutes. Despite such improvements, availability and competition have proven to be a pinprick to these giants.

These e-commerce platforms are also faced with the larger problem of competition with the rise of hyperlocal startups who specialize in delivering consumer goods like groceries and also medicines within a matter of a few hours with their same day delivery options. These startups resort to the much critiqued model of "Hyperlocal delivery" which needs specialized teams to work with spatio-temporal forecasting techniques and advanced operations research techniques to service the demand in the least time possible whilst incurring least cost as well. But these startups too have started their own private label brands to reap higher margins, thereby unfavorably affecting the local retailers and everyone in the consumer goods supply chain to a considerable extent.

There is also a growing unrest amongst retailers who have been subsumed by the shift of demand towards the e-commerce giants. Moreover, these e-commerce giants, powered by data science and machine learning can precisely target the right customer with the perfect product line, extraordinary discounts and at the correct time. Even festive season sales have completely shifted online due to the "Flash sale" phenomenon.

There is a possibility of a cascading shutdown of local retail stores across localities. This might seemingly look beneficial for the e-commerce giants at the first look; but deeper scrutiny reveals that as per the principles of Game Theory as suggested by the Nobel laureate and mathematician-cum-economist Professor John Nash, such unhealthy competition can lead to a lose-lose situation in the long run wherein the purchasing power of the overall market drops due to large scale loss of income streams. The best way, therefore, is one of cooperation wherein both the retailers, the e-commerce giants and the seldom discussed manufacturers all benefit. Such an ecosystem of cooperation certainly demands for well designed mathematical models and broader consideration of consumer behaviors.

While some might propose the much recent Hyperlocal model as a solution, many firms in the past have suggested otherwise. Quality

and margins are the major concerns. The risk is not just quantified on margin values of products involved, but the very churn of those loyal to the platform in case of compromised quality (both in terms of goods delivered and the delivery experience) cannot be underestimated. In this scenario, a "Hybrid Hyperlocal" model which combines the strength of both the traditional warehouse-inventory model and Hyperlocal model to achieve a category specific distribution mechanism for the arising orders will facilitate the e-commerce giants to provide similar offerings like within day delivery in numerous locations. We believe such an approach would ensure the simultaneous growth of both local retailers and e-commerce giants, giving each an adequate share of the pie.

Briefly, the hybrid hyperlocal model proposes that the e-commerce giants could establish partnerships with local vendors and outsource some (not all) of the orders generated in their system to local vendors. Often, such hyperlocal vendors give very less margin to the e-commerce company as compared to their established sellers and manufacturers. The hybrid hyperlocal model analyses the spatio-temporal demand and selects the orders that can be outsourced to hyperlocal partners based on certain factors. Such factors include shipping costs incurred to ship a product in the main supply line, loss of margin due to outsourcing, reduction in stress on the main supply line due to outsourcing, enhancement in customer satisfaction, retailer reliability, reduction in delivery time etc. Since these factors might vary significantly depending upon the type of product and retailer involved, the model prescribes different strategies for different types of products. It is often easy to provide same day delivery in cities and in locations near to the company warehouse. However, customers who are farther away from the access points of the company should also be satisfied with the services provided. We believe that the hybrid hyperlocal model would solve this problem effectively. In simple words, such a model would ensure there's enough cooperation within the retail environment and ensure adequate incentives for the local retailers whilst also catering to the exhaustive product availability needs of the e-commerce firms. Though one might rightly ask whether such exhaustive product variety and availability would be a matter of serious concern, it is important to note how customer loyalty has been relatively turbulent for these big firms. The demands of today's customers are pushing the boundaries of consumer goods supply chains. Also, while the expansion of supply chain resources would seem a good investment to ensure such needs are met, it's worth leveraging local markets to cater such needs, even at the cost of losing margins due to such outsourcing. Low margin-High volume-high quantity goods can be prioritized towards such outsourcing while maintaining the rest of the orders within the main supply lines. This combined with appropriate marketing efforts would ensure the distribution of high margin goods over the internal supply lines, providing better returns. While it is tough to ascertain what awaits us in the post COVID world, an established incentive structure for quality control and a sustainable growth strategy built on symbiotic grounds between the big players and the local markets would surely help surpass the several challenges to come.

" The demands of today's customers are pushing the boundaries of consumer goods supply chains "

The Imitation Game

Shaping AI through history

BY MADHUSUDHAN BODICHARLA

In the year of 1964, during the USSR Chess Championship, a gripping game ensured between Mikhail Tal, often regarded as a creative genius and one of the best attacking players of all time and grandmaster Evgeni Vasiukov. Mikhail Tal is known for his unpredictability and improvisation, often sacrificing pieces for a better position in the game. After losing 2 pawns each, at the 19th move Tal sacrificed his knight for a pawn to weaken his opponents king. He almost took 40 mins to sacrifice the knight. The next day, every newspaper emphasized about this move, mentioning how he analyzed all possible variations and made the best possible move. Later, he laughingly puts away all these speculations that in reality, he started thinking of all variations but possibilities seemed endless and somehow got deviated to thinking about ways to get hippo out of a swamp, a reference from Russian couplet he remembers. When he gave up on his engineering skills to save the animal, he played the knight sacrifice step with pure intuition. He is immortalized in the world of chess for his great initiatives, often challenging his opponents against his threats and intuitive sacrifices.

Are these intuitions always rational? Or are they based on logic? According to Herbert Simon, a cognitive psychologist and a nobel laureate, more expertise means better intuition. Expertise gives the ability to recognize a large number of relevant cues and retrieve from memory how to respond in a particular situation.

Chess grandmasters, during the game, generally form a hypothesis about the best move within just five seconds. In most cases, the final decision move is usually from initial intuition . Moreover, it is this ability that accounts for a very large proportion of their chess skill. In blitz or speed chess, even the grandmaster may just prefer these first cues. Considering very few choices consciously, they often discard several others at a subconscious level. It is this work of Herbert Simon, that paved the way for Neural networks in AI.

Neural Networks work similarly with hidden layers that recognize the unexplainable patterns through learning and the final layers then process recognized information of heuristic patterns. Therefore, Herbert Simon is rightly considered the founding father of Artificial Intelligence. Thus the foundations for AI were laid on the theories of human intelligence

Study of Human Intelligence

Objective Approach

From the viewpoint of “Information process theory”, intelligence is a by-product of one’s learning ability. For understanding the concept of learning, it would be necessary to look at the evolution of its concepts in psychology i.e., learning described by behavioral school of thought. “Behaviorism” which was founded by John B Watson, approached psychology as an experimental and objective science that emphasizes concepts that can be observed. Hence learning behaviors through stimuli and response was at its focus.

The association of stimuli and response through “reinforcements” in Operant con-

ditioning by B.F Skinner is parallel to the machine learning concept of association between explanatory and response variables. Reinforcement Learning draws inspiration from the operant conditioning. In classical conditioning the association between conditioned and unconditioned stimuli is parallel to finding correlations in ML. In fact, the Spearman correlation coefficient which is widely used in statistics and machine learning was developed by Charles Spearman. He was an English psychologist and pioneer in psychometrics who developed approaches for measurement of intelligence.

Cognitive Approach

This approach succeeded the behavioral approach, basing its focus on understanding the internal process that went between stimuli and response, largely considered a black box by behaviorism. Cognitive psychology measures behavior to infer mechanisms of cognition. It details such mechanisms along with experiments to verify them. This approach attempts to apply scientific understanding to human behavior. The development of computers made it possible to measure the response times for specific stimuli with great precision, helping the study of underlying cognitive processes.

Event-Related Potential (ERP's) technology enabled us to study the brain's electrical activity . But how did we apply this in AI? Deconstruction of mental process through scientific means gave us objective insights. These insights can be used in reconstructing similar neural network models. Information process theory, parallel neural networks, etc., stand testimony to this.

One of the important contributions of cognitive psychology to machine learning comes from the area of problem solving. The four major stages of problem solving recognized by cognitive psychology are: 1) problem identification and understanding, 2) potential solution generation, 3) solution examination and 4) result evaluation. At the evaluation stage, the outcome is evaluated on how close it is to the goal and this cycle repeats. This process is directly applied in machine learning where the goal is to reduce the errors (or loss function) in final output. The amount of error in each iteration is used as feedback for re-adjusting the weights.

Some strategies of problem solving recognized by cognitive psychology like trial and error, heuristic analysis, algorithm approach and insights (sub-conscious mental memory) have found relevance in the field of Deep Neural Networks.

Intelligence : A broader perspective

How intelligent can computers be? Actually, modern-day computers perform complex calculations at blinding speeds. They carry out millions of computations per second, far beyond us mortals. This is only true for repetitive tasks. However, intelligence is not just about computation speed and accuracy, it also involves learning by interacting with environment in meaningful ways.

Intelligence can be broadly classified into two categories: General intelligence and Social / Flexible intelligence. One of the modern branches of computer science that deals with social intelligence is "Affective Computing". It is the study and development of systems and devices that can recognize, interpret, process, and simulate human affects. It is an interdisciplinary field spanning computer science, psychology, and cognitive science.

In the long run, social skills and an understanding of human emotion along with game theory would be valuable for a social agent. The understandig of emotions and motiva-

tion would give better insights for an agent in decision-making. Some computer systems mimic human emotion and expressions to appear more sensitive in their human interactions. This has great applications when used with "Decision-Making theory" and bounded rationality in administrative behavior.

One of the early products of this research in affective computing is Kismet, an autonomous robot designed to engage in social interactions with human, termed the "Cog Project" at MIT. Kismet was given auditory, visual, and proprioception abilities to interact with humans. Kismet emotes through various facial expressions, vocalizations and some posture movements. One of the key area of expression for kismet are facial expressions that included movements of eyebrows, eyelids lips, jaws, ears, and head. Kismet uses variety of phonemes to express in language and resembles a baby's babbling. Sentiment analysis and chatbots have far greater implications when advanced in affective computing.

The AI Revolution in Chess Engines

The game of chess represented the pinnacle of AI research over several decades. Today machines can easily outplay the best players in the world at GO, Chess, Shogi etc. In Chess, there were very early attempts, right from the 1950s to design computer chess engines to defeat human grand masters. However, it wasn't until 1991, when "Deep Thought" (renamed DeepBlue) announced to take up the challenge, did these attempts come to the spotlight.

In 1997, "DeepBlue", the Chess engine by IBM, for the first time comprehensively defeated the then world reigning champion Garry Kasparov, who is considered by many as the greatest chess player to have ever lived. DeepBlue cannot be termed as AI since it uses Alpha-Beta pruning algorithm, and no neural networks were involved. It explores a vast search tree by using a large

> "An engine's solution may look ugly to human eyes, even if it is unquestionably a winning move"

number of clever heuristics and domain-specific adaptations that were programmed into it. Grand masters in chess generally evaluate 5 to 7 steps ahead. Computer chess engines need to explore tree variations much more than those steps. This brute force algorithm of exploring possibilities minimizing the value of opponent's pieces. Since 1997, Chess Engines ruled the Chess board and have greatly contributed to the game of chess and the process of chess education.

It was only after a decade, "DeepMind Technologies", a UK based company which was later acquired by Google started deploying chess engines based on Reinforcement Learning. In 2017, "AlphaZero" by DeepMind, a chess engine with just basic knowledge of chess rules, taught itself chess within 4 hours by playing zillions of games with itself based on trial and error through reinforcement learning. It was able to defeat Stockfish8, the top chess engine champion 2016 in a 100 games match with 28 wins and 72 draws. It can be noted that "AlphaGo" and "Elmo" developed by DeepMind, the best computer chess engines at Go and Shogi (Japanese chess) respectively in 2016, were defeated by AlphaZero in 2017.

Also, the recently released "Agent57" can outperform the human benchmark in Atari57 suite of computer games.

But what has changed in 22 years reign of computer chess engines? Earlier chess engines easily surpassed 3000 FIDE rating, a feat yet to be achieved by humans (highest ever FIDE rating 2882 by Magnus Carlsen in 2014). However, the earlier models like DeepBlue, failed to give insights into the way humans played chess. Hence, initial enthusiasm of chess engines in giving insights to the way chess is played, had quickly evaporated.

In earlier models like DeepBlue, despite the hand-crafted heuristics, the fundamentals of an engine's superiority lies in the calculation and execution of a true brute force algorithm exploring vast number of moves to solve a position. A chess program or an "engine" like Stockfish examines about 60 million positions a second.

An engine's solution may look ugly to human eyes, even if it is unquestionably a winning move. It may suggest a queen sacrifice to save a pawn to exploit some other positional advantage. Hence these engines didn't add too much value to the way humans play chess. There's a clear distinction in the way computer engines and humans play chess. Hence, a move is categorized as an "engine move" if it, though for a winning cause, doesn't make sense to humans. Today, most Grand Masters base their preparation for tournaments by playing against other strong players than with a machine. They sometimes use chess engines to understand certain complex positions. After his defeat with DeepBlue, Garry Kasparov recognized this distinct style of play. He pioneered a game called Advanced Chess, that involved humans and computers collaborating which never took off.

AlphaZero by DeepMind, used Deep Reinforcement Learning that has given it a distinctive and instantly recognizable style. Its ideas are efficient, more visible, in more strategic way towards the final goal of a checkmate than for a material balance. Interestingly, many of AlphaZero's ideas match accepted human rules derived from years of playing chess. However it would effectively combine small heuristics that are considered minor like the activating all pieces, dominating center in to a whole game strategy . Its style of play is described as "alien" unlike other computer chess engines. A fit description of its play would be that of a human chess player with unusually high FIDE rating.

"To err is human", because AlphaZero has learned chess like a human does and reinforcement learning that's etched in the annals of human evolution, its play may be more insightful to chess education. Although it is still early to judge its impact on chess education, the response from the upper echelons of the chess community has been largely positive. In future, it is necessary to assimilate AI technologies with the understanding of human limitations, knowledge of human psychology for more effective collaborations as against a mindless AI. The fields of administration, economics and psychology have greatly advanced with adoption from classical to neo classical theories by adopting more humanistic approaches based on bounded rationality. Hence, the future of AI appears & requires to be a more interdisciplinary study and cross domain collaborations.

Google introduces Cloud AI platform "Pipelines" (beta) to deploy ML models faster than ever

Microsoft builds one of the Top 5 publicly disclosed supercomputers in the world

This new infrastructure (now available on Azure) can train extremely large AI/ML models. The supercomputer built in collaboration with and exclusively for OpenAI is a single system with more than 285,000 CPU cores, 10,000 GPUs and 400 gbps of network connectivity per GPU server.

AI outpaces Moore's Law

Moore's Law states that processor speeds double every 18 months to two years, which means doubled application performance for the same hardware cost. Stanford University's AI Index reports reveal that the computational power of AI is accelerating 6x faster than traditional processor development.

Altran develops ML tool to protect and improve codebases

Altran in association with Microsoft, announced an ML Tool that can predict and identify the source code files that carry higher risk of having bugs. This minimizes the cost of fixing them and speeds up development cycles.

Facebook's TransCoder AI

automatically translate code between Java/Python/C++

Such accurate and unsupervised code migration (from legacy systems especially) opens doors for many new ideas whilst saving several hours of time.

Nuance Launches "Nuance Mix" for Conversational AI

Nuance Communications announced a new tool design to let client organizations design and deploy their own conversational AI systems, without the need for specialized expertise. It is used to build conversational AI solutions tailored for customer's needs.

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