Applications of Artificial Intelligence and Machine Earning in Various Domains

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Abstract

Artificial Intelligence(AI) and Machine Learning(ML) are implicitly being employed in all walks of life and will conquer the forthcoming future of all domains. AI/ML algorithms are rapidly being implemented futuristically by many diverse sectors and different types of industries to enhance their productivity and hence profits. This report encompasses a detailed literature survey and review of the current trending applications and existing implementations of AI/ML/Data Science in the spheres of Healthcare, Law, E-Commerce and IT industries. It is imperative to know what AI and its parasols are about, how they are being implemented in diverse genres with a quest to find and invent solutions to their hindering complex problems. This survey aims to educate its reader on an explorement of the existing technologies developed, invented and utilized by industry giants to revolutionize technology. The extensive survey herein also stipulates the cognizance of the lesser-known entire process entwined in data analytics, from data collection to data analysis and representation. The various algorithms used in diverse industry sectors for the relative AI technologies are also expounded. Moreover, the survey holds a unique quotient since it is an amalgamation of AI/ML algorithms, technologies, implementations, process flow, and existing examples, a configuration of all dimensions explored.

Keywords: Artificial Intelligence and Machine learning real time applications in- e-commerce, healthcare, judiciary, tech companies.

1. Introduction

AI, ML are the future of the elite world of technology. ML and Deep Learning (DL) harbor under the umbrella of AI. ML has been the utmost trend setter in technology industry in the last few years as a better accessible side of AI, with computers learning to complete tasks without being directly programmed to do so. Today, almost every domain uses ML to optimize their work, lesser man power, make smarter decisions, easier work done, eliminating human errors basically making life easier, efficient and convenient. ML applications are made effectively available to common man through the platforms of Google, Facebook, Amazon, IBM Watson, Uber, SIRI and more. It has the ability to mechanize a large segment of expert manual labor, hence it has taken over most aspects of technical industry and will conquer furthermore, but the degree to which this effects a personnel depends on the level of complexity concerned in the job. Machine learning enables the automation of singular tasks, whereas many jobs involve multiple

tasks and even multitasking at higher level for which machine learning requires some human touch. For any individual looking to pursue a career in ML, the first step will be to scavenge through the lengths and breadths of what ML is all about, what it actually encases, what is its background, what is its future and where do its real time implementations and applications lie. For an amateur to lurk into the areas of ML/AI/DL/Data Mining (DM), one needs to know the basics, required to understand the complex algorithms, implementing tools, technologies being invented and implemented worldwide and the scope for each in various sectors/ domains. Although this technology is not new, it is now gaining more momentum, due to the emergence of advanced computing technologies. The factors responsible for resurgent interests in ML are affordable and powerful computation processing, increasingly growing volumes of huge data sets, and affordable data storage options. Today, companies can make informed decisions by using ML algorithms to develop analytical models, which uncover connections, trends and patterns with minimal or no human intervention. The focus here is on iterative learning. Analyzing the hidden trends and patterns makes it easy to predict future problems and prevent them from occurring. A machine learning algorithm usually follows a certain type of data and then uses the patterns hidden in that data to provide solutions. This aspect of machines' ability to learn from experience and make crucial decisions for us, is the revolutionary part of technology. Some of the key machine learning algorithms that are used most commonly are : Random forests, Artificial Neural Networks, Naïve Bayes, Decision trees, Regression, Clustering and classification, K-nearest neighbor, Support vector machines, Boosting and bagging gradient, Multivariate adaptive regression, Classification and regression trees (CART), Principal component analysis et al;

The secret to successfully harnessing the applications of ML lies in not just knowing the algorithms, but in pairing them accurately with the right tools (such as: R, Python, SQL, TensorFlow, Anaconda, Hadoop, Matlab.) and processes such as: data collection, data exploration, data visualization, data quality and management, data model, model validation, statistical analysis of results and accuracy measures, developing graphical user interface, comparing various machine learning models and identifying the best, identify best performers through automated ensemble model evaluation, automated data-to-decision process.

This survey paper gives a brief overview of all the latest as well as futuristic emerging and upgraded techniques, tools, algorithms of ML that are being exuberantly utilized in most domains wherever ML can be applied. The report will also take the reader through the most intriguing and emerging implications of ML algorithms, pros and cons, scope and what they are capable of in the mega technical sectors/domains, the collaboration of all of these together collectively are not available all at once in the same paper hence it is novel and gives an upper edge to the reader to gain valuable insights to the implicit spectrum of the most in demand technology, thereby assisting the reader to benefit from and to make interpretations in order to gain a directive path for choosing ML as a career.

The objective of the work encapsulated is to showcase the exploration done through a detailed extensive literature survey on the machine learning- applications, existing implementations, algorithms used, tools used and technologies developed in numerous sectors/domain of the world such as Healthcare, Finance, Retail/E-commerce, and Judiciary. The report also encompasses an understanding of AI/ML/DL/DM interpretable by any personnel new to data science.

2. Difference between AI, DL, DM and ML

While AI is the mother of all, an umbrella encompassing all these domains, ML is the larger chunk of it that encompasses DL algorithms which are inspired by the information processing patterns found in human brain. DL is basically the next evolution of ML based on artificial neural networks. Ultimately all these methodologies have the same goal of deriving insights, patterns and trends to make more informed decisions, their approaches differ. DM is performed on certain data sets with the aim to find out interesting patterns betwixt the items in a data set by using techniques developed by ML for predicting the outcome. Whereas, ML is the ability of a computer to learn from mined datasets. ML algorithms use the information representing the relationship between items in data sets and build models so that it can predict future outcomes. A brief analogy of these domains are summed up below.

2.1 Deep Learning

DL has the unique ability to combine computing power and neural networks to learn complex patterns in huge volumes of data. These techniques are used to identify words within sounds, and objects within images. It has the capability of modeling and processing non-linear relationships. It allows parallel and sequential computation, similar to the human brain. It can address more complicated tasks like medical diagnosis, business problems, language translation, and other social problems.

2.2 Data Mining

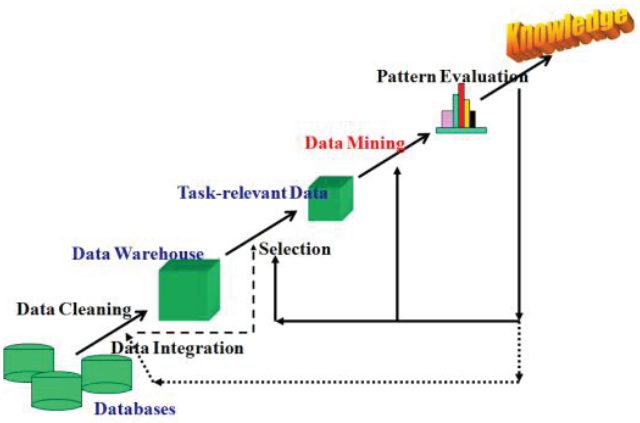

Figure 1: Process flow of KDP in data mining [1]

Data mining is also known as Knowledge Discovery Process (KDP) (see Figure 1), is a field of computer science that is used to explore the properties of datasets. It requires human intervention. Large datasets collected from DB, RDMS, data warehouses or complex datasets like time series, spatial, etc. are mined to deduce informative correlations and patterns among the data which were not known previously. The results are insightful to improve business processes, and decision making. DM is a superset of methods involving ML and traditional statistical algorithms, time series, text and other domains of analytics. Moreover it also involves the study and practice of data manipulation and data storage.

2.3 Machine Learning

ML is a powerful AI technique for crunching petabytes of complex data to infer from it by automating analytical model building. It helps cognitive systems to learn and engage with the world in a customized way. ML has the ability to unleash an underlying structure, even in the absence of a theory on what the data structure could look like. The basic concept behind ML algorithms is to give the computer an end goal, let the algorithm fail over it repeatedly till it learns from those mistakes to ultimately achieve the goal i.e. the machine learns from experience. Such an iterative concept produces reliable, accurate, effective, easier decisions and results. To be derive and employ a ML model accurate these guidelines are a must:

- Superior data preparation capabilities
- Knowledge of basic and advanced statistical and ML algorithms
- Scalability and optimization techniques
- Automation and iterative processes
- Knowledge of ensemble modeling.

Figure 2. depicts the generic guidelines on deploying a ML model. These steps are mandatory to any algorithm.

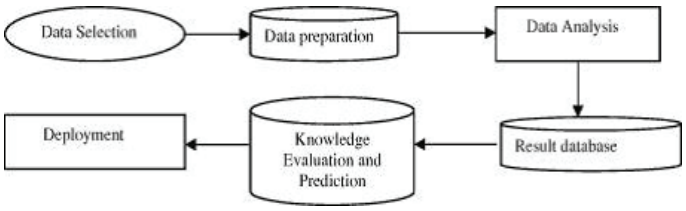

Figure 2: General process flow of data modelling in ML

Machine Learning can be broadly classified briefly into 3 categories:

- Supervised Learning- These algorithms are trained using labels, as an input where the desired outcome is already known. It receives a set of input instructions along with corresponding accurate outcomes hence the name. The learning algorithm then compares the actual outcome with the accurate outcome and flag an error, if any discrepancy. Methods include regression, classification, gradient boosting, and prediction, also uses different patterns to proactively predict the values of a label on extra unlabeled data. This method is used in areas where historical data is used to predict events that are likely to occur in the future.
- Unsupervised Learning- finds its application in areas were data has no historical labels. The main aim is to analyze data, identify a pattern and structure within the available data set. It can also identify outliers in the available data sets. Widely used techniques are- k-means clustering, self-organizing maps, value decomposition, mapping of nearest neighbor etc.
- Semi-supervised Learning-this technique uses both unlabeled and labeled data for training. Algorithms include- regression, classification and prediction.
- Reinforcement Learning- mainly used in navigation, robotics and gaming. The actions that yield best rewards are identified by algorithms that use trial and error methods. There are three major components in reinforcement learning, namely, the agent, the actions and the environment. The agent is the decision maker, the actions are what an agent does, and the environment is what an agent interacts with. The main aim of this kind of learning is to select the actions that maximize the reward, within a specified time. The primary idea is to identify the best policy or the method that helps businesses in achieving the goals faster [2].

Figure 3 summarizes the major successful ML/AI algorithms being used and under what category they perform.

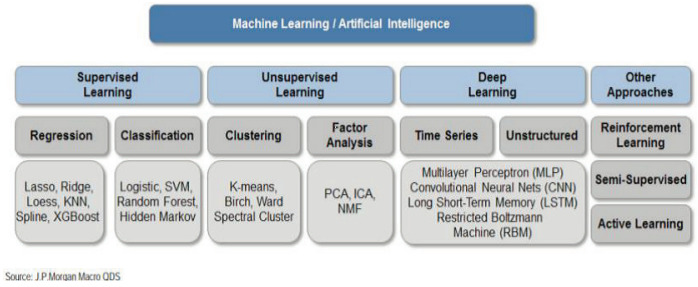

Figure 3: Classification techniques of ML and AI

3. Applications of ML/AI in domains

ML is taking the world over in all fields of industries from Healthcare, Agriculture, Sports, HR, Finance, Supply Chain, Retail/E-commerce, Education, Media, Judiciary, Marketing and Automation. The core technologies used in collaboration with ML, in these industries are as follows:

Core Tech:

- AI
- Deep Learning
- NLP Platforms
- Predictive APIs
- Image Recognition
- Speech Recognition

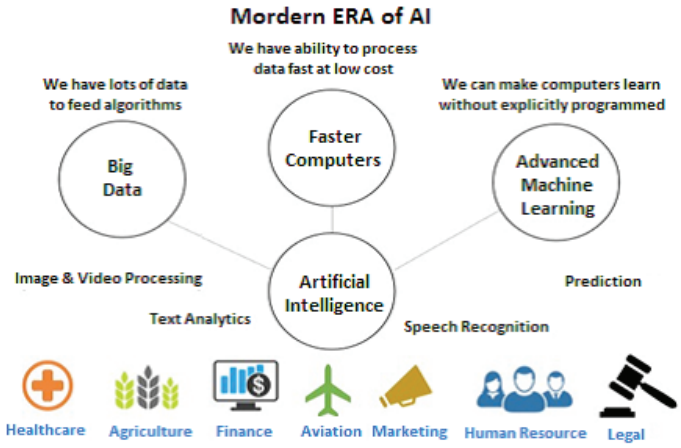

Figure 4: Depiction of modern era AI [2]

Rethinking Enterprises and Industries:	Rethinking Humans/HCI:	Supporting Technologies:
Sales Security/Authentication Fraud Detection HR/Recruiting Marketing Personal Assistant Intelligence Tools Healthcare E-commerce Law and order Media Automation Education AdTech Agriculture Education Finance Legal Manufacturing Medical Oil/Gas Media/Content Consumer Finance Philanthropies Automotive Diagnostics Retail	Augmented Reality Gestural Computing Robotics Emotion Recognition	Hardware Data Prep Data Collection

Figure 5: Various sectors/domains ML is being Implemented

Figure 4 is a brief depiction of industries where AI is booming drastically. Figure 5 is an overview of the industries deploying ML techniques for processing.

Below is a brief overview of the numerous ML applications being used in multiple domains with the technologies, tools and algorithms.

3.1 Healthcare

ML is now reinventing healthcare industry by its advanced patient diagnosis, prevention of illness, prediction of rare and dangerous diseases [3]. Using AI/ML to analyze and cross check symptoms against databases containing millions of other cases and illnesses has led to faster diagnoses, saving lives through quicker treatment and decreasing the time a patient spends in the hospital (see Figure 6). Hospitals are currently using these algorithms to more accurately detect tumors in radiology scans and analyze different moles.

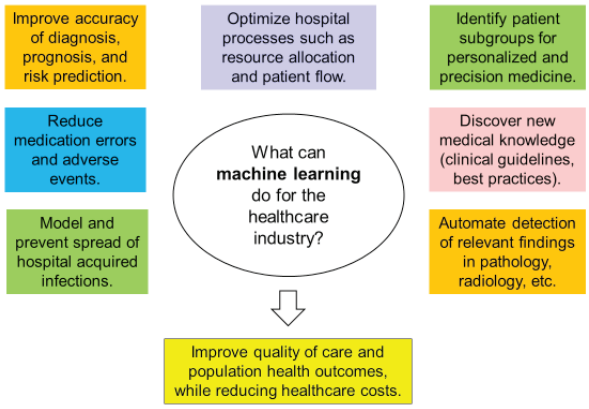

Figure 6: Advantages of using ML in healthcare industries

Some real world implementations of ML in healthcare sector:

3.1.1 Alerting tool

DeepMind and the Royal Free hospital (London) have employed an AI-based instant alerting tool to identify patients at risk of Acute Kidney Injury(AKI). The Royal Free NHS Foundation Trust and Google's DeepMind AI venture have created a real-time alerting system since AKI affects 1 in 6 hospital patients and can lead to longer length of stay, increased critical care utilization, higher risk of mortality (est. ~40,000) deaths/year in England and higher costs (est. £1bn/year across the NHS in England)[3]. The app- Streams, monitors patients' blood test results, combined with information from patient's EHR, and sends an instant AKI alert to the most appropriate clinician when it identifies signs of deterioration allowing clinicians to intervene sooner. The impact: Full service evaluation currently in progress, reports of positive feedback from early staff users with anecdotal evidence that the app saves up to 2 hours/day of nursing time and AKI identified in up to 11 patients/ day through the alerting system. Figure 7 is a real time process flow defining an healthcare automated system deployed in few countries, sourced from Gadfly.

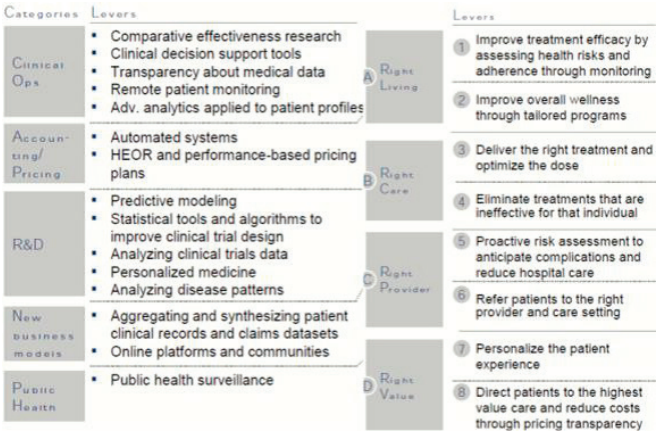

Figure 7: General Process Flowchart of a Healthcare Automation System

3.1.2 Prediction of diagnosis

Researchers are currently working to analyze massive quantities of patient care data (Electronic Health Records and health insurance claims) to discover anomalous patterns of care which significantly impact outcomes. The pattern detection approaches have been successfully applied to detect regions of interest in digital pathology slides, and work surprisingly well to detect prostate cancer, and other forms of cancer. Key features: efficient, accurate search over subareas of an image. Better prediction of patients' future diagnoses, risks, and care needs can enable more effective and efficient treatment and preventive care. Early and accurate prediction of each patient's.

3.1.3 Diagnosis Related Group (DRG)

It can better predict demand and allocate scarce hospital resources such as beds and operating rooms, optimize hospital processes of resource allocation and patient flow.

3.1.4 Predicting Adverse Drug Effects (ADE)

Random forest can accurately predict ADEs using data from EHRs. Clinical coded data (recordings of diagnoses and prescribed drugs) has higher prediction performance than clinical measurements, though both used together have better predictive performance for certain ADEs. Feature selection reduces dimensionality and sparsity, further improves predictive performance. ADEs are responsible for ~5% of hospital admissions Internationally and systems based on voluntary spontaneous reporting fail to capture ~94% of ADEs [4].

3.1.5 MRI based detection of breast cancer

Medical imaging is now crucial in the early detection and diagnosis of breast cancer. Researchers at Tianjin University in China have proposed an automated computer-aided diagnosis (CADx) framework for MRI in breast cancer. The approach outperforms most other state-of-the-art ADx MRI diagnostic systems, significantly reducing the rate of false positive classification. This method combines many ML techniques, including: Ensemble Under Sampling (EUS) to use for imbalanced data processing, Relief algorithm for feature selection, the Subspace method for giving data diversity, and Adaboost for improving base classifier performance.

3.1.6 Predicting the risk of hepatitis C progressions in kids:

Prediction models that incorporate clinical data can capture non-linear disease regression in chronic hepatitis C. The approach uses two outcomes measures fibrosis progression, and liver-related clinical outcomes and a range of predictive

variables based on longitudinal clinical, laboratory and histological data. The model, constructed using logistic regression, random forest and boosting, to predict an outcome in the next 12 months, and can help target expensive therapies for patients with most urgent need, guide the magnitude of clinical monitoring required, and provide prognostic information. The results were that 94% negative predictive value, the proportion of patients identified as not at risk of progression, that do not progress. $p < 0.0001$ probability that longitudinal predictive model is superior to pre-existing prediction model.

3.1.7 Tracking hospital operations:

Real-time tracking improves data availability and accuracy, allowing for better capacity utilization and automation of routine administration activities. The algorithms used are DBMS, NLP, CART and regression. Tracking hospital operations allows automation, reducing the headcount upto 50% and cutting patient waiting times in half, resulting in upto 50% fewer fatalities and 40-50% shorter patient waiting time [5].

Real world applications include: Company products such as

- IBM Watson Health - is a cognitive computing robot. Technical Approach- Uses hundreds of computational techniques, conducts NLP queries on structured and unstructured data, generates hypotheses, scores evidence, and returns answers, uses IBM DeepQA software, Apache UIMA Architecture, clusters of Linux servers, and Hadoop. Focusing on breadth and depth scale, combination of approaches, and parallel processing.
- Artificial Pancreas and Smart Infusion Pumps by Medtronic MiniMed Connect- SMARTGUARD mimics some functions of healthy pancreas, predicts low glucose levels and stops pump. Insulin pump and continuous glucose monitoring can report directly to a smartphone partnered with Samsung.
- Healogram: Mobile platform that helps providers remotely monitor patients postsurgical procedure. similarly iDAvatars: Virtual avatar, Sophie, uses AI and NLP to remotely monitor patients.
- Hospital Based Robots- University of California, at Mission Bay uses 25 TUG Robots by Aethon that travel 481 m/day in 1300 trips, equating time saving of 315 hours. Similarly, Yujin Robots can deliver drugs, linens, and meals, and also throw away medical waste, soiled sheets, trash. Robotic Assistants developed in Japan, the Robobear medical assistant lifts patients into and out of beds, help position humans into sitting and standing positions, also lift patients from wheelchairs.
- Challenges faced while implementing ML in healthcare:
- Complexity: coordination of care is difficult.
- Business Challenges: Legal and Ethical Challenges
- Threat to human jobs: Strong fear associated with technology displacing human workers.
- Cost: The high costs for developing, testing, certifying, and implementing can be a barrier.
- Regulation: Health IT regulations are debated at national level. Finding the right balance of public health protection and fostering innovation.
- Liability: to deal with computer failings, raises the issue of data de-identification, privacy, security, and espionage.
- Human Touch: How to interact with AI. How strongly will it require the human touch and human compassion in health care [6].

3.2 Judiciary and Legal Industry

Law firms are turning to ML to process massive amounts of legal precedents data. J.P.Morgan, for instance, uses a program dubbed Control Intelligence to review documents of previous cases in seconds that would otherwise take thousands of hours [7]. It's unlikely for ML/AI to replace lawyers in future, given the necessity of rebuttal and human logic/appeal, but its incorporation will surely reduce the time taken to construct a case, expedite trials, speed up processes of the court. The legal industry faces multiples challenges as such :

- Volumes of legal documents equating to at least half the population of a country hence a massive DBMS needs to be developed which works efficiently and swiftly and does not faulter.
- Junior lawyer/paralegals doing grunt work, retention rate, the work done by machines will have no human touch.
- Stringent regulatory compliance: there needs to be a body dedicated to governing and monitoring for any corruptions or malfunctions.
- Shortfall of skilled workforce.
- Quick Turnaround time expectations to help deal with crores of people's problems on daily basis.
- How ML is helping in solving legal problems: Helping lawyers perform due diligence and research
- Contract lifecycle management automation
- Using past cases, win/loss rates and a judge's history to derive trends and patterns.
- Document Automation
- Analyzing large IP portfolios and drawing insights from the content.
- Legal compliance automation [8].

Table 1 is the depiction of tasks and actions performed by ML algorithm developed for legal assistance, sourced from J.P. Morgan macro QDS. Figure 8 both shows currently deployed legal search automated system by Gadfly.

Table 1. Current Applications of ML/AI implemented in Law Firms

S. No.	Application	Description of Application	Related software/ firm
1	Due Diligence	To uncover background information litigators use AI tools to perform diligence. It helps in advising clients on the options available in a legal situation and the required action to overcome the problem.	Kira Systems, Leverton, eBrevia, Ross Intelligence, JP Morgan, Thought River, Law Geex, Judicata, Legal Robot, Casetext's CARA.
2	Prediction Technology	Using artificial intelligence software, results are generated that predict the outcome of litigation.	Everlaw, DISCO, Catalyst, Exterrro, Brainspace discovery, Intraspexion, Premonition.
3	Legal Analytics	On the basis of previous case win/ loss history, previous case law and judge's history, lawyers can use data points which can be utilized for patterns and trends.	Lex Machina, Ravel Law
4	Document Automation	To create filled out documents on the basis of data inputs, software templates are used by law firms.	The report, perfect NDA
5	Intellectual Property	Lawyers use AI tools which guide them to analyze large IP portfolios and to draw insights from the context.	Trademark Now, ANAQUA Studio, Smart Shell
6	Electronic Billing	Legal AI helps lawyers in computing lawyers' billable hours automatically.	Bright flag, Smokeball

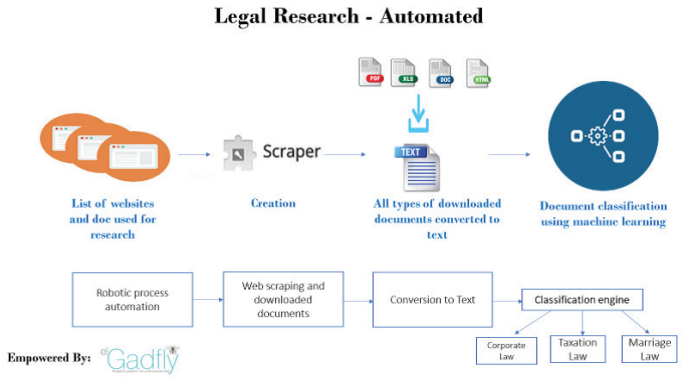

Figure 8: ML/NLP enabled Automated Searching process implemented by Gadfly company

Law firms and government bodies in India are having limited resources and maximum corruption. Hence there is an urgency in the requirement of automated regulatory systems that monitor and provide solutions to our pending cases. In India there are over are 2 million cases pending! Hence the scope is high and would revolutionize Indian judiciary.

3.3 E-Commerce

All online companies analyze the purchase history of their customers to make personalized product recommendations. The ability to capture, analyze, and use customer data to provide a personalized shopping experience is the near future of sales and marketing. The science of online recommendations has become increasingly complex, and will become even more nuanced as more data streams such as social media are incorporated to provide better recommendations. While online retail is already experiencing the early onset of ML deployment, one of the most exciting things is the application of this technology in the physical store environment. Retailers would develop the ability to analyze customers as they walk in with the incorporation of video analytics, retailers will be able to configure what products customers are viewing, and even where they are looking on the product – whether the price, the features or pictures on the box, this analysis will help customers find right products with appropriate offers and flourish the retail business. Electronic cheques and bank transfers involving higher value transactions are significant features of business-to-business (B2B) segment and whereas cash /card based low value transactions are significant features of business to consumer (B2C) segment.

Futuristic E-Commerce technology is Cloud Computing, which can be seen as a collection of concepts in several research fields like Service Oriented Architectures, development of Parallel, Distributed and Grid Computing. Its the three complementary services are: Hardware-as-a- Service, Software-as-a-Service (SaaS) and Data-as-a Service (DaaS) [9]; together form Platform-as-a-Service. There arises complexity in selling Cloud service in the market place, as the traditional business value chain which is more like product based approach does not suit cloud computing.

Big Data Market and Vendors: Massively Parallel Processing and No SQL Databases are the major categories of vendors for handling structured data. But in today's growing complexity of Big Data (texts, comments, sensor data, emojis, videos, pictures, audio, etc.). Hadoop offers the best possible choice. Hadoop is the backend technology which needs to be accessed and supported by front end tools. Revolutionary new platforms of large scale, massive parallel data access is the fundamental pillar of Big Data. Ad hoc and one-time extraction, parsing, processing, indexing, and analytics are the unique features of Hadoop like Data Bases. Oracle, IBM, and Microsoft have all adopted Hadoop including the open source Apache Spark. Some of the E-Commerce giants like Amazon and Google supply the customers with inbuilt Big Data Capabilities like product catalog, historical pricing, analytics, integration of data with other sources at ease. Community detection in social networks is possible by utilizing graph partitioning algorithms to identify dense sub graphs representing user communities.

Some current real world applications being used in the Indian Market are as follows:

a. Amazon's ML algorithm has been an excellent weapon to fight fake product reviews on their website. The algorithms learn which reviews would be most useful to customers to identify ones that are real or fake. Amazon has also litigated

charges against several websites that have created fake product reviews. Amazon Echo, Alexa is a virtual assistant that uses ASR, IoT and NLP to aide in assistance [10]. The algorithms required are Naïve Bayes theorem for probability to calculate the probability of occurrence of the next sequence of data, decision trees to maintain

a hierarchy of language grammar, and a powerful classification algorithm such as Neural Networks or deep learning.

b. Myntra uses virtual mirrors for its customers to experience surreal shopping experience like shopping at malls but actually from their homes. The customers can visualize the products by uploading a picture of themselves and the algorithms puts the clothes/products on them to show how it would look on them.

c. Lenskart used a similar kind of algorithm to virtualize the experience of people trying on different styles of eyewear frames straight from homes.

3.3 Finance

Vast amounts of data in finance industry from transaction to customer data are increasingly looking for interpreting most from the data that they hold to devise new business opportunities, deliver customer services and detect frequent banking frauds. Portfolio management companies are using traditional methods like analyzing margin profiles, growth profile, free cash flow, the return ratios, pricing power available through reports. A reliable and efficient ML product is in demand for valuable assistance [10]. From Figure 9 the basic understanding workflow of a financial automated assistance system is seen. Source: J.P Morgan macro QDS.

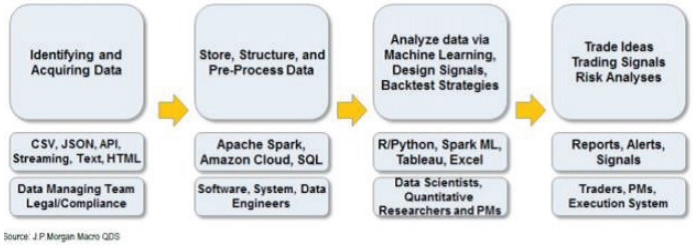

Figure 9: Basic workflow of ML powered finance assistant

4. Conclusion

In this survey, a thorough research in various applications of ML are defined in depth as per technical and non-technical understanding. In short, the main objective of this report was to provide assistance to anyone new or sceptical about pursuing this excellent field of science. It gives its reader a glimpse of what ML is about and where are the various sectors one can make career out of depending on individual's interest and passion. There are several more areas of application that are not mentioned in the report since that would make this report endless hence we conclude with our understanding of most emerging, developing and important application of ML. The various sources from where the data is collected is cited and mentioned wherever possible. The flowcharts and block diagrams have been curated on an online platform called draw.io and few other figures have been sourced from direct company sources online in order to prove their authenticity.

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