

Machine Learning for Decision Makers

Cognitive Computing Fundamentals
for Better Decision Making

Patanjali Kashyap

Apress®

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Bangalore, Karnataka, India

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*To my late father, Dr. Damador Prasad Singh, who had serious doubts
that I would matriculate and get a job.*

*And to my mother, Dr. Meena Singh, who always believed that one day
I would be able to bring moon on Earth.*

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About the Author



Dr. Patanjali Kashyap holds a PhD in physics and an MCA. He currently works as a technology manager at a leading American bank. Professionally he deals with high-impact mission-critical financial and innovative new-generation technology projects on a day-to-day basis. He has worked with the technology giants, like Infosys and Cognizant, on technology solutions. He is an expert of the Agile process, machine learning, Big Data, and the cloud computing paradigm. He possesses a sound understanding of Microsoft Azure and cognitive computing platforms like Watson and Microsoft cognitive services. The .NET technologies are his first love. Patanjali has worked on a spectrum of .NET and associated technologies, including SQL Server and component-based architectures, since

their inception. He also enjoys working on SharePoint (content management in general), as well as dealing with knowledge management, positive technology, psychological computing, and the UNIX system. He is very experienced in software development methodologies, application support, and maintenance.

He possesses a restless mind that's always looking for innovation and he is involved in idea generation in all areas of life, including spirituality, positive psychology, brain science, and cutting-edge technologies. He is a strong believer in cross/inter-disciplinary study. His view of "everything is linked" is reflected in his work. For example, he filed a patent on improving and measuring the performance of an individual by using emotional, social, moral, and vadatac intelligence. This presents a unique novel synthesis of management science, physics, information technology, and organizational behavior.

Patanjali has published several research and whitepapers on multiple topics. He is involved in organizational initiatives, such as building world-class teams and dynamic cultures across enterprises. He is the go-to person for incorporating positivity and enthusiasm in enterprises. His fresh way of synthesizing Indian Vedic philosophies with the Western practical management insight for building flawless organizational dynamics is much appreciated in corporate circles. He is an implementer of ancient mythologies in the modern workplace. Patanjali is also involved in leadership development and building growth frameworks for the same.

Apart from his MCA, Patanjali holds a Masters in bioinformatics, physics, and computer science (M.Phil.).

About the Technical Reviewer



Jojo Moolayil is a data scientist and the author of the book: *Smarter Decisions – The Intersection of Internet of Things and Decision Science*. With over five years of industrial experience in data science, decision science, and IoT, he has worked with industry leaders on high-impact and critical projects across multiple verticals. He is currently associated with General Electric, the pioneer and leader in data science for Industrial IoT, and lives in Bengaluru—the silicon valley of India.

He was born and raised in Pune, India and graduated from the University of Pune with a major in Information Technology Engineering. He started his career with Mu Sigma Inc., the world's largest pure play analytics provider, and worked with the leaders of many Fortune 50 clients. One of the early enthusiasts to venture into IoT analytics, he converged his knowledge from decision science to bring the problem-solving frameworks and his knowledge from data and decision science to IoT analytics.

To cement his foundation in data science for industrial IoT and scale the impact of the problem solving experiments, he joined a fast-growing IoT analytics startup called Flutura based in Bangalore and headquartered in the valley. After a short stint with Flutura, Moolayil moved on to work with the leaders of Industrial IoT—General Electric, in Bangalore, where he focused on solving decision science problems for Industrial IoT use cases. As a part of his role in GE, Moolayil also focuses on developing data science and decision science products and platforms for industrial IoT.

Apart from authoring books on Decision Science and IoT, Moolayil has also been the technical reviewer for various books on machine learning, deep learning, and business analytics with Apress. He is an active data science tutor and maintains a blog at <http://www.jojomoolayil.com/web/blog/>.

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I would like to thank my family, friends, and mentors.

Foreword

"The world is one big data problem."

—Andrew McAfee, Center for Digital Business at the
MIT Sloan School of Management

Machine learning, big data, AI , cognitive and cloud computing is already making a large impact across several social spheres and is increasingly being applied to solve problems in almost all spheres from technology, consumer behavior, healthcare, financial markets, commerce, transportation and even in providing civic amenities to town and cities.

As a part of my profession, I get numerous opportunities to interact with many senior executives across organizations on topics that are on top of their mind and the problems that they are trying to solve for their organizations. During many of these discussions with senior leaders across organizations, I have come to realize that almost all of them recognize the potential of machine learning and its associated technologies. Many of them are also aware that these technologies are being used to solve some of the most exciting problems in today's world including some within the organizations that they work for. However, it is striking how few of them actually understand the fundamental concepts behind these technologies. Knowing more about these important concepts will enable them to apply these technologies better and thereby drastically improve decision-making in their organizations.

I can't blame you if you are one such decision maker for your enterprise, who knows little about the underlying concepts behind these technologies. I am one too (or atleast I was too till I read this book). There are very few resources, books or papers that deal with this complex topic in a way that makes it easier for the readers to comprehend. The existing publications address this topic from the perspective of a technologist or a big data scientist and hardly ever from the perspective of a decision maker who wants to apply these technologies. This book, on the other hand, addresses it from the perspective of a decision maker in an enterprise while still covering the concepts in detail and the use cases for them.

I am glad that Dr Patanjali Kashyap decided to write a book on this topic. Having known him for several years now, I believe that Dr. Kashyap is uniquely placed to address this large and complex topic. As a part of his professional experience he has played several roles including the role of a machine learning expert as well that of a senior decision maker for an enterprise. In this book, he has been able to present the concepts in a language that any decision maker and senior executive in a corporation will be able to appreciate.

■ FOREWORD

Hope this book changes the way you apply these advanced technologies to improve decision-making for your enterprise.

By Ashish Singh
Sr. Director - HR at Myntra
XLRI Jamshedpur
B. Tech, IIT (BHU)

For a number of years now machine learning has been talked about in the technology world but it has remained a bit of a mystery to the C-level suite who do not understand the myriad of acronyms used and what they should care about it. In this book Dr Kashyap has de-mystified the whole concept and provided holistic insights to decision makers to help them to grasp the concepts of machine learning and associated technologies. This book should be read by anyone who runs a business so that they can understand the benefits of machine learning and how it can be applied to their individual business model.

As any business owner is aware; new technologies disrupts the status quo and there is no doubt that machine learning in combination with IOT and big data analytics are disrupting existing business models. It can create new services or enhance ways of delivering existing services that all adds up to creating new areas of revenue for the firm. For example in manufacturing industries smart systems would be able to predict machine failure before it happens. This alone has the potential to save a lot of money. Marketing analytics makes marketing team smart enough to map customers' expense habits, so that personalized shopping experiences are provided to the customers. In summary machine learning can incorporate intelligence and smartness everywhere. This will make a holistic system of smarter applications, products and experiences for users, employees, clients and customers.

As well as the fundamental concepts and architectures associated with machine learning, this book is crammed with useful use cases and real life scenarios. I found that this helps to bring the subject to life and helps the reader visualise what it means for their business.

I strongly recommend this book for anyone who wants to gain a broad perspective on the subject of machine learning and associated technologies.

—Selvan

Preface

Technology is growing quicker than ever. Social media, the Internet of Things, Big Data, mobile devices, cloud computing, and machine learning are changing the way we live and do business. The whole world and everything in it is getting linked. For example, more than three billion Internet, billions of mobile, and billion devices users are linked to each other and have created a web of data and a collaborative communication ecosystem. Machine learning is the next most important movement of innovation, which is guided by developments in computing power and based on the solid foundation of mathematics. Its capability of accumulation of huge sizes of data in the cloud at nominal cost, and laidback access to sophisticated algorithms, is changing everything around us. Machine learning is the most disruptive and influential technology in the recent time and it's also able to make changes to the complete business ecosystem.

Today, almost every enterprise is willing to integrate machine learning into the fabric of commerce in order to succeed. However, until a few years ago, machine learning was out of scope for businesses. The high cost to incorporate machine learning solutions to the business was backed by scarcity of talent availability, infrastructure, and imperfect data. But innovations in the field of storage devices, microprocessing technologies, and availability of tiny networking devices flipped the dynamics and business sentiment. This sparked the Internet of Things, which is flora and fauna of digitally linked devices.

Riding on the wave of IOT, new sets of devices, equipment, and products—like mobile phones, toothbrushes, shirts, light bulbs, cars, and so on—can now interact and talk to each other. These devices—along with the connected ecosystem of machines, people, and processes—generate huge volumes of data. Businesses need that data for effective decision making for their growth, customers, and clients. This needs to be smart, intelligent, and relevant in the market forces enterprises to come up with new way to gather, digest, and apply data for useful purposes. Therefore, this data becomes the main enabler of IoT and machine learning. The impact of machine learning, IoT, and Big Data analytics is not limited just to the business; ultimately it can go miles ahead to provide satisfaction to the customer and create new avenues of profit generation that matter most to the business. Machine learning made it possible to generate a complete universe of business applications, products, and capabilities that serve customers and enhance life experiences of the individuals across domains, verticals, and industries. This includes finance, manufacturing, retail, sales, service, marketing, and so on....

Machine learning has a strong impact and consequences for and every area of business. For example, the sales team will be able to forecast prospects and emphasize the most likely leads in a timely manner. Customer service teams can send subsequent generations of service proactively to the users, clients, customers, and other businesses. In the manufacturing industries, smart systems can predict machine failure before it happens. Marketing analytics make the marketing team smart enough to map customers' expense habits, so that personalized shopping experiences are provided to the customers. Machine learning can potentially incorporate intelligence everywhere. This will create a holistic system of smarter applications, products, and experiences for users, employees, clients, and customers.

In this context, this book is written to provide holistic insights to the decision makers to enlighten them. The book will help you grasp the concepts of machine learning and associated technologies in a fast, efficient, and reliable way, so you can make effective, smart, and efficient business decisions. This book covers almost all aspects of machine learning, ranging from algorithms to industry applications.

Wherever possible, required practical guidelines and best practices related to machine learning and associated technologies are also discussed. Architects and technical people can use this book to understand machine learning, IoT, Big Data, and cognitive computing in a collective way. This book is written to make the audience future-ready and help them cope with any challenges related to machine learning.

Here is a brief outline of the book's chapters.

Chapter 1: Let's Integrate with Machine Learning

This chapter sets the stage. It talks about the main technologies and topics used in the book. It also provides a brief description of IoT, Big Data/analytics, machine learning, and cloud and cognitive computing. It presents a comprehensive model of these technologies.

Chapter 2: The Practical Concepts of Machine Learning

This chapter explains the fundamental concepts of ML in detail, including its evolution and history. It throws some light on the multi-disciplinary nature of machine learning and its relationship with artificial intelligence, neural networks, statistics, and brain science (with the backdrop of cognitive and cloud computing). The chapter also covers fundamental architectures and other important aspects tied to machine learning.

Chapter 3: Machine Learning Algorithms and Their Relationship with Modern Technologies

This chapter discusses in detail the common methods and techniques for machine learning. The main subject of the chapter is the algorithm. Therefore, it covers some main stream algorithms in detail, including relevant use cases, advantages, disadvantages, and practical applications.

Chapter 4: Technology Stacks for Machine Learning and Associated Technologies

This chapter discusses the technology stacks of machine learning and associated technologies, like Big Data, Internet of Things (IoT), and cognitive and cloud computing in detail. It also provides an overview of technology offerings from different leading vendors in the areas of machine learning and allied fields. It presents ample amounts of practical use cases.

Chapter 5: Industrial Applications of Machine Learning

This chapter talks about business challenges associated with machine learning (ML) technologies. It also discusses a few real-time scenarios and use cases. Apart from this, it will throw light on applications of ML across industries, including manufacturing, health care, finance and banking, customer services, retail and so on. About 20 domains and industries are covered in the chapter.

Chapter 6: I Am the Future: Machine Learning in Action

This chapter discusses real-time case studies, scenarios, and points of views related to machine learning. Multiple products, applications, and services are described in the project.

Chapter 7: Innovation, KPIs, Best Practices, and More for Machine Learning

This chapter discusses metrics, performance measures, and KPIs for machine learning. The chapter also discusses best practices, patterns, and practices for machine learning.

Chapter 8: Do Not Forget Me: The Human Side of Machine Learning

This chapter discusses the people and cultural aspects of machine learning or innovation-oriented organizations. The focus of this chapter is to highlight key requirements of building a great place to work in new generation enterprises and to provide guidelines, methods, and tricks. It also provides a brief roadmap of incorporating emotional, moral, spiritual, and social intelligence in the workplace.

Chapter 9: Let's Wrap Up: The Final Destination

This chapter concludes the concepts in the book and showcases the connections among them.

Acknowledgments

In the summer of 2016, as I was returning from Rameswaram on a pilgrimage with my mother, wife, and son, Celestin (Senior Manager of Editor Acquisition at Apress) called and asked me if I was interested in writing a book on machine learning for Apress. I was not expecting this question and told him that I would get back to him. I asked my mother and wife Amrita whether I should take the offer. I asked the same question to my one-year-old son Maheer and my dog Simba. Trapped in this dilemma of go/no-go, I called Aditya, my friend who works with me, and asked for his advice. Responses from everywhere were positive and encouraging. Unanimously, I was told to take the offer. I thought for a few seconds and then picked up the phone to accept the offer.

When I look back now, everything that has happened in the last year was an extraordinary journey of acquiring intellect and learning for me. While writing these acknowledgments, I want to thank my wife, mother, and son for their cooperation. I want to acknowledge that, due to this book and my job, I felt guilt for missing out on spending time with my son. There were occasions when he was standing by the closed door of my study room asking me to open it and I did not open the door because I was busy writing. Numerous other incidents like this happened. Similar incidents happened with my dog Simba as well. I confined his life to his room because of my lack of time, but he never complained and remained as companionable and affectionate as ever. Simba, my apologies and thanks for your patience and unconditional love.

There are many other people I want to thank, because without their best wishes, this book would never have been realized. One of those people is my mother. She was a university professor by profession. She groomed me to become what I am now. She always encouraged me to do something different. Writing a book is one of those things that she always believed I would do. She is the only person in the world who has complete faith in my potential. Without her continuous moral and emotional support, this book would have been impossible...so thanks Ma. I want to thank my sisters, Poonam and Indra, for their encouragement as well.

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Introduction

Tools for Thought and Creativity: Yours, Mine, and Ours

This section gives you information about using the book in a nutshell. I have taken an unusual approach to explain the concepts related to targeted technologies and subject matter of the book. Generally, this type of approach is not seen in mainstream books, especially in the technology space. There might be multiple reasons for that. One prominent reason, however, is that readers are not willing to experiment. They prefer to go with the tried, tested, and established presentation methodologies. I dared to “experiment” because the target audience of the book is “out of the box thinkers” and hence their thought process is more likely disruptive in nature.

To explain innovative experiments, uniqueness, and disruptions, some “unusual” tools and techniques are required, which must be intuitive in nature. Hence, multiple innovative, unseen, underutilized, informal tools, techniques, and methodologies are used in this book. They are definitely helpful in explaining the concepts and ideas related to machine learning and associated technologies. My thought has been to consolidate and present the zest of all the tools and techniques used in this book, in one place and discuss them in brief. This approach will help the reader know more about them. This introduction also tells a brief story of all the upcoming chapters, which I am going to cover in the book. This overview will help the readers get an overview of the subject matter.

I enjoyed writing this book and hope that reading it will be a pleasurable and knowledgeable experience for you as well. Ideas contained in the book will help you continuously innovate and find new pathways. I tried to trigger that disruptive thought process in this book. Having said that, now it is high time to go into the subject matter. So, let’s start with the tools and techniques used in the book.

Mind Maps

The concept of mind mapping was invented by Tony Buzan. He is an advocate of the techniques of mind mapping and mental literacy. In this book, mind map techniques are used to summarize, visualize, and explain some important concepts. However, the maps can be used as an effective remembering and note taking technique as well. Mind maps have great value, especially when you are trying to make a decision. As most of our decisions are made and acted on in a fraction of seconds, we generally do not have much

■ INTRODUCTION

choice but to select one option out of two or more alternatives. If we practice mind map techniques, then our brain circuits, commonly known as neurons, will be rewired and we can create new intelligent pathways. This would enable us to visualize any situation quickly and make decisions at lightning speed.

Making business decisions is crucial and critical and generally demand quick reaction time. Mind map facilitates achieving a quick reaction time. The mind map is a whole-brain technique, as it uses the right and left hemispheres of the brain. Details presented in the form of mind maps are easy to remember because they follow the brain's pattern of thought.

Both parts of the brain have their own sets of functions and responsibilities. In short, the right hemisphere of the brain is responsible for creativity, whereas the left is for logic. If you use both parts of your brain ("the whole brain") in balance with their full potential, instead of using just one part in dominance, you will be in a better position to make efficient and effective decisions. Integrating images, graphics, colors, and emotions with text enables you to gain maximum benefit of your brain.

■ According to Tony Buzan's official website A *mind map* is a powerful graphic technique that provides a universal key to unlock the potential of the brain. It harnesses the full range of cortical skills—word, image, number, logic, rhythm, colors, and spatial awareness—in a single, uniquely powerful manner. In so doing, it gives you the freedom to roam the infinite expanses of your brain. The mind map can be applied to every aspect of life where improved learning and clearer thinking will enhance human performance.

You can draw mind maps by hand with the use of a pen and paper for multiple purposes and occasions, like attending a meeting, participating in discussions, brainstorming, for summarizing facts, creating project plans, and so on. You can also create one using the software and tools available in the market, such as Mindjet Manager (see Figure 1 for steps to create mind map).

Mind maps are very effective tools for visual representation of facts. Hence, I have used them in this book to provide a snapshot. I sincerely believe that it will provoke your creative thinking. Mind maps are placed at the end of each chapter to provide brief summaries. However, you can create your own mind maps, apart from the ones provided in the book, to get a better grasp of the subject matter. You can also use them for further customization and personalization of the content. I strongly recommend that you use mind maps during your professional activities like problem solving and taking meetings notes. Mind maps are a great tool for brainstorming sessions and project management as well. Mind maps available in the book can be used for remembering concepts and facts, wherever required.

You will discover that the mind mapping technique helps you make the decisions you want to endorse to others.

Here are the steps for creating a mind map:

1. In the middle of the paper, enclose the main idea.
2. Add a branch from the center for each point; use colors.
3. Write an important word/phrase on each branch of your diagram, which will help you add details.
4. Add symbols and illustrations.
5. Use legible CAPITAL letters.
6. Make important ideas larger.
7. Personalize your mind map.
8. Underline words and use bold letters.

Creativity is a key while drawing mind maps, so be creative and outrageous. It is always good to construct your mind map horizontally, because it will give you extra room for your work. On top of everything, try to bring some emotional content to your drawing, because our brains are wired and designed to pay attention to emotional biochemistry.

Adding a little surprise, humor, and interest will definitely improve your overall mind map and learning experience.

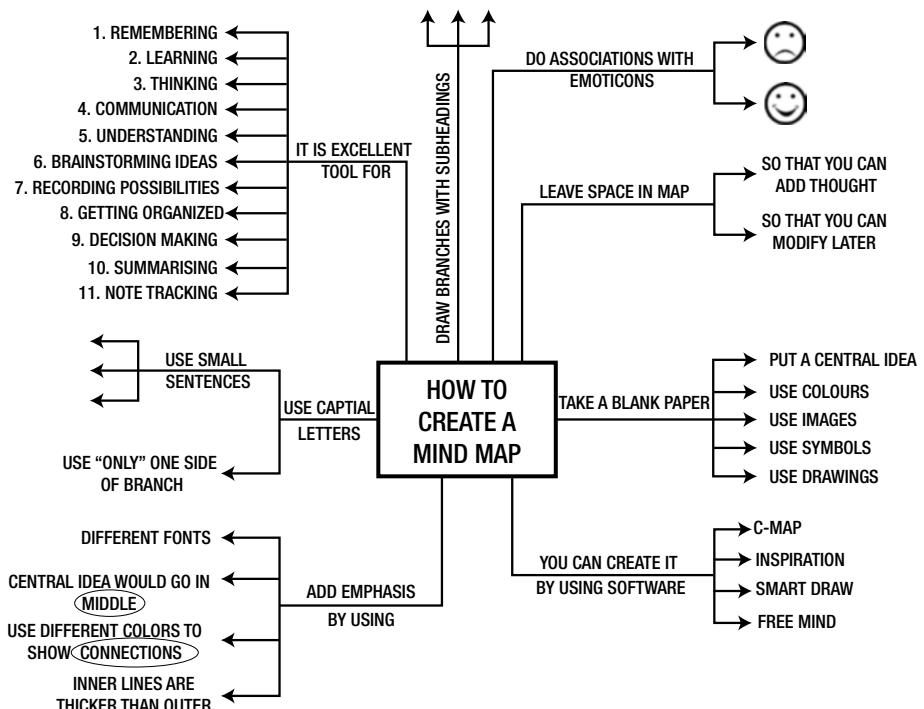


Figure 1. How to create a mind map

■ INTRODUCTION

In Figure 2, software testing is the theme of this particular mind map, and a variety of associated sub-themes originate from it, such as black box testing, functional testing, non-functional testing, and so on. These are based on requirements and you could go to multiple levels of sub-themes.

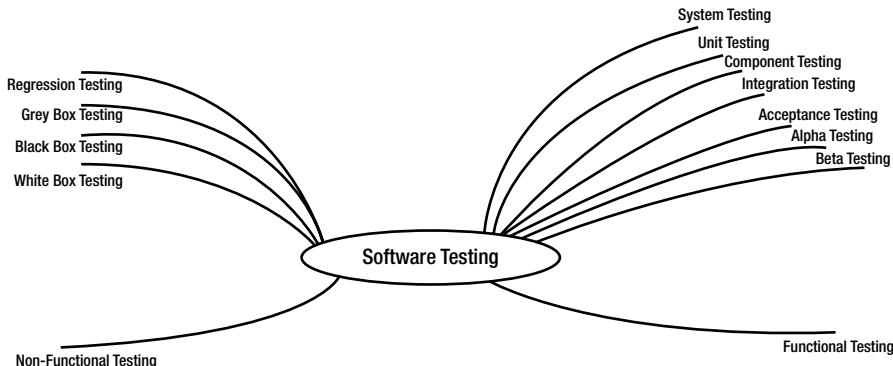


Figure 2. Example of a mind map (software testing)

Some common uses of mind maps:

- *Creating summaries of books, chapters, or other concepts and important facts:* Mind maps can be used to summarize almost anything, including books, chapters, requirement specification documents, business meetings, point of views, etc. I used mind maps in the book to summarizing and highlight the contents of a particular chapter. However, they can also summarize concepts and topics.
- *Brainstorming and idea generation:* Mind maps are good during brainstorming and idea generation sessions. You can also use collaborative mind mapping techniques (this is when mind maps created by different people and teams are combined to make one consolidated and comprehensive “master mind map”).
- *Problem solving:* Mind maps are often used by business teams to help highlight the connections among different parts of a complex problem. Solving them effectively and efficiently leads the team to a solution. The process begins by writing down the different characteristics of the problem on paper or any other media type (as agreed upon by individuals or the groups/teams), then drawing associations and expanding the details. This process can be repeated over and over until the problem becomes clear and a solution becomes apparent.
- *Integrated analysis and decision making:* By writing down all the variables and features about a decision in a visual top-down format, you can see how they all are interrelated. These mind maps are similar to those used for problem solving, but there is often a coating of analysis and explanation added through the use of associations and callouts.

- *Discover new ideas:* You may come up with ideas that you never thought of by using a mind map. This is the beauty of a mind map; it can enable you to “discover” hidden relations and associated facts. This happens because while you’re using or creating mind maps, you are actually using both parts of your brain (the creative right brain and the logical left brain).
- *Relating different ideas:* Since you can now visualize how different ideas relate, you are in a good position to associate two or more ideas. This gives you the power to combine the best of the available options and customize them according to your needs.

Other important areas where mind maps can be used are during content creation, when taking notes, during project management, and when planning.

Visual and Textual Summary of the Topics/Chapters

When an idea or concept is conveyed in terms of visuals, it is known as a visualized concept or idea. However, if it is extended for providing an overview of the written, visual, or verbal material or opinion, it may be called a visualized summary. I used these techniques in the book to emphasize concepts and topics. But did not explain each concept or topic that is used. I have used them wherever I felt they added value. Also, for summarizing some chapters, they are used along with mind maps. Now the obvious question is—why a combination of two techniques (mind mapping and visual and text summary) to represent associated facts in the form of snapshots or visuals? The answer is multi-fold; a few answers are described here:

- Mind mapping is an informal technique of summarizing and representing facts, whereas visual and text summary is the formal way. It gives you a choice to select the appropriate method, based on convenience, comfort, and need.
- Mind mapping techniques are still not very popular. Also, they take some time to learn, especially if you’re not familiar with the concept. So, if you are in a hurry and do not want to waste your time learning and practicing a new learning method and technique, you could stick to something you are good and comfortable.
- Traditional block diagrams (Figure 3) are also a good way to present visual facts. However, most of us are not familiar with its real potential. We can realize the power, when it is paired with an innovative textual way of representation (attaching emoticons with bulleted text). In combination, they become an extraordinary tool. In this book, I tried to exploit them for various purposes and did not confine myself only to summarizing. I have used them to explain concepts and ideas, as well as to represent facts, information, knowledge, and wisdom.

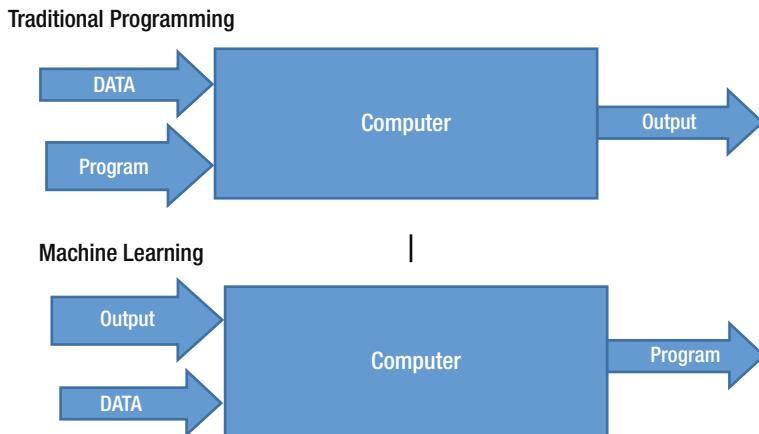


Figure 3. Block diagram

I personally prefer redundancy, which is saying and repeating the same things in multiple ways (if possible and required) with different media types and multiple senses. This approach increases the chances that content gets coded in more than one area of your brain. If you do not believe in redundancy, you must associate yourself with the traditional way of fact representation.

Images and visuals generally convey more and accurate information. This fact is established and supported by numerous researches in the field of brain science and psychology. So in a nutshell, we can confidently say that “visual is the new verbal”. Following this concept provides you with a powerful tool for innovative thoughts and creativity.

Ready-to-Use Presentations/Slides for Decision Makers

Generally, decision makers and managers have to give presentations at multiple places, forums, and conferences to communicate and present their vision and thoughts. Typically, they prepare PowerPoint slides to do this. The idea behind incorporating this concept into the book is to provide decision makers some ready-to-use generic slides, so that they use them. You will find them on this book's page of the Apress website. If required, you can customize and personalize them based on your needs.

Important Questions and Answers

While reading a technical book, we generally encounter a lot of technical material.

However, during this journey of reading, a few concepts need more precise, to the point, and focused answers. Also, some frequently asked questions need instant responses. The notion of including a section of important questions and their answers in the book is to provide the reader with quick answers to some important questions. These answers are based on my knowledge of the subject, paired with market research and the wisdom of the industry.

Customer Stories, Case Studies, Use Cases, and Success Stories

Customer stories, case studies, use cases, and customer success stories are tools. They can be used to analyze and show vendor capabilities. Their benefits are many if they are used correctly. I use them in the book to provide real-time situations, problems, issues, and the actions taken on them.

- Case studies are detailed and in depth, and they explain in detail a customer's situation, their problems, and the process by which those problems were addressed. Case studies sometimes include use cases, but often they are more condensed than a use case would be if available on its own. Case studies can be released independently, listed on a web site, made available on your blog, or even presented in the form of videos.
- The focus of success stories is on the success or outcome. Typically, customer stories or customer success stories are shorter in comparison to case studies. Nowadays talking about customer stories has become a trend. Every company has a separate section on their website for this. In this book, I kept my focus on real customer stories and used them as and when required.
- Finally, let's talk about use cases. A use case explains a particular application for the user's product or service. It typically describes exactly how the application is implemented and why the product is the best for the job. Use cases are truly good from marketing to technical addressees, particularly for specialists who may have a great knowledge and understanding of technology, but not understand the specific product to know why it's the best fit for a particular scenario or situation. By understanding use cases, decision makers can learn more about how the product is exactly differentiated.

Quick Tips and Techniques

This section is used to provide quick tips on the topic under discussion. For example, I often highlight an effective technique related to the topic at hand, with the goal of helping the readers get a better grasp of the subject matter.

Jargon Busters

Jargon refers to a collection of domain-specific terminology with precise and specialized meanings. This section demystifies some commonly used jargon that's specific to machine learning, IoT, virtual reality, and cognitive and cloud computing. The Jargon Buster sections are very important in a book like this, as there is a lot of jargon associated with these technologies. This section is meant to help readers understand and decode specific terminology in a quick and precise way.

Latest Trends and Research

Machine learning and its associated fields are happening and evolving fields. Something new is taking shape all the time, around the clock, across the industries, enterprises, and research laboratories. This section compiles the most relevant research and trends, especially from businesses such as retail, automotive, health, etc., and places them in the chapters at the appropriate places. These details will help you make good decisions.

Industry Bites

Machine learning, IoT, quantifiable self, cloud, and cognitive computing are evolving and growing fields of study. The industries and enterprises around them are maturing, dying, and expanding at a very rapid rate. Hence it is natural that decision makers of these industries are on a crossroad of dynamic decision making. This situation requires alignment of their visions and ideas with the thought process of the industry. However, to listen to other voices, visualizing peer strategies become very important. Unfortunately, not much information is available in consolidated and centralized form in the available literature and resources (including online), so these sections cover that gap. They provide relevant and contemporary information at the appropriate places. Apart from that, some quick statements from core industries (such as leadership, management, organizational psychology, and behavior) are mentioned in this section.

Audio and Video Links

In this section, you'll find audio and video links for some of the resources used in this book. Also, I have intentionally made this chapter specific, so that you can get pointed resources about the topic at hand, instead of scattered ones.

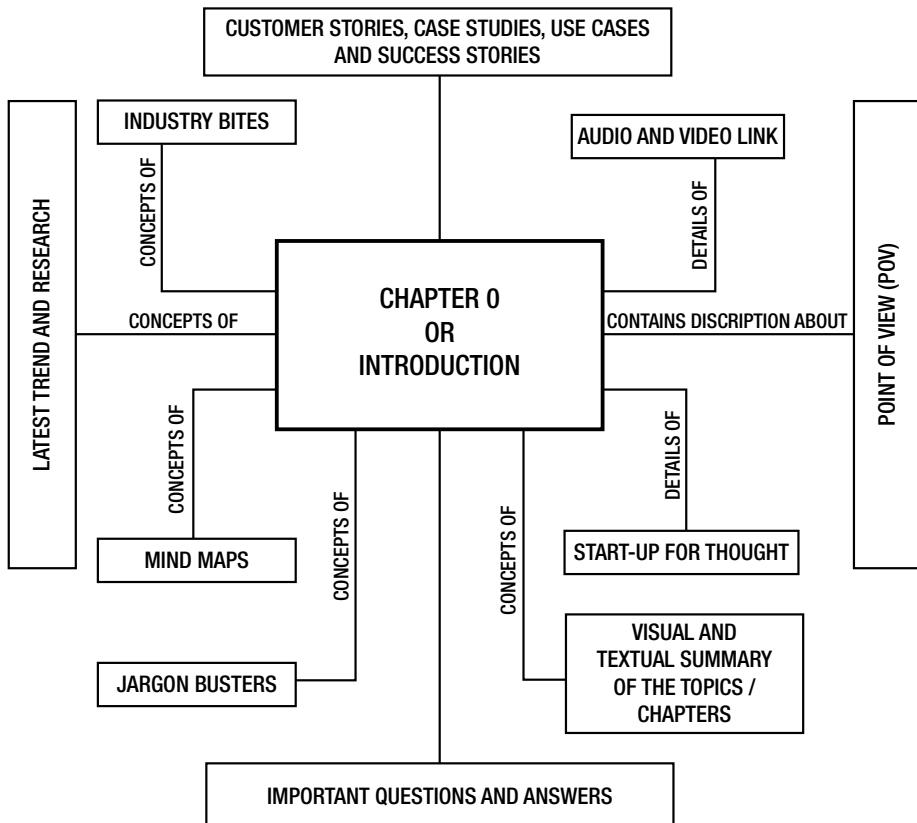
Start-Ups for Thought

In this section, you will find brief descriptions of promising start-ups in the areas of machine learning, IoT, quantitative self, virtual reality, AI, and cloud and cognitive computing. The descriptions include a primer of their products, services, strategies, and vision.

Summary

This introduction provided an overview of all the tools and techniques used in book. It also explained in brief the upcoming chapters.

Mind Map



CHAPTER 1



Let's Integrate with Machine Learning

In this chapter, I present a holistic synopsis of how machine learning works in conjunction with other technologies like IoT, Big Data analytics, and cloud and cognitive computing. Technically machine learning cannot and “never” should be understood in isolation. It is a multi-disciplinary subject. This is the reason why an integrative view of suite of concepts and technologies is required before going into the details of the machine learning technical landscape. Even for academic purposes, if someone wants to understand the working of machine learning, they have to learn the nuts and bolts in detail. Hence, it is natural for business leaders and managers to have a holistic and integrative understanding of machine learning to get hold on the subject. It becomes more important if they are interested in the subject for business reasons. As you have started reading this book, I assume that you want to get acquainted with the concepts of machine learning.

During my endeavor to provide a conceptual foundation of machine learning and its associated technology, I address multiple business questions, such as “What is machine learning?”, “What is the business case for machine learning?”, “How do we use machine learning?”, “What are the key features of machine learning?”, “Where can we implement machine learning?”, “What are the major techniques/types used in machine learning?”, and “Why is machine learning required for business?”

These questions are answered in detail in this or following chapters. Also, the key business benefits and values of successful machine learning implementations are discussed in the appropriate places.

Almost the same set of questions, thoughts, and concepts are addressed for the other associated technologies as well. This chapter explores the core concepts behind advanced analytics and discusses how they can be leveraged in a knowledge-driven cognitive environment. With the right level of advanced analytics, the system can gain deeper insights and predict outcomes in a more accurate and insightful manner for the business. Hence, it is essential to study them in a practical way. This chapter sets the knowledge platform and provides you that practical knowledge you are looking for.

Your Business, My Technology, and Our Interplay of Thoughts

My argument is very simple and you will find its reflection throughout the book. I argue that technologies—like the cloud, Big Data analytics, machine learning, and cognitive computing—enable growth, profit, and revenue. My focus is not to explain this model and its benefit in stepwise fashion but to explain the technologies behind it.

In any business scenario, results or outcomes have multiple dimensions. But what is important for the enterprises, business leaders, and stakeholders is to know how it impacts their business strategies. The outcome depends on multiple factors, such as how quickly the infrastructure is ready, the cost per transition, the implementation time for the new applications, and even how partners including suppliers are integrated in the overall supply chain and decision making. Other important factor is the level of automation the enterprise has (from bottom to top).

Machine learning or, in other words “automation of automation,” and cognitive computing are changing the way decisions are made. Monotonous, repeated and less skilled human intervention is being replaced with “intelligent” automation and that’s changing the dynamics of decision making. However, the result of this is coming in the positive way and increasing the efficiency and effectiveness of overall business process and decision making. Its impact will be felt on enterprise profit, revenue growth, and operational efficiency. Enterprises will get business value at all levels and areas of their investments, whether it’s IT infrastructure, IT application, business process, operations, or finance. If they adopt the right context-based approach to technology adoption, benefits are bound to come.

Adoption of the cloud empowers companies with quick provisioning of the resources and reduced cost per transition and workstation. Most of the requirements for application development are available on-demand in a cloud-based environment, so implementing a new application is fast. Suppliers have availability and access to the robust supply chain, hence integrating their services and logistics becomes easy. The cloud provides on-demand data analytics and machine learning-based context-oriented cognitive computing functionalities in an automated fashion. This enables enterprises to enjoy high revenue growth and increased return on investment.

If we follow the trends and direction of the IT industry from last couple of years, one signal is very clearly coming out that—industries are betting heavily on the new generation of technologies. Old thoughts and technical pillars are getting destroyed and the new ones are piling up rapidly. IBM, Microsoft, Google, and Facebook patents filled in recent years show the direction of the industry. Microsoft is the leader in patent filing, with over 200 artificial intelligence related patent applications since 2009. Google is in second place with over 150 patent filings. Patents include elements of cloud computing, cognitive computing, Big Data analytics, and machine learning. The following links provide a snapshot of the patent landscape in recent years.

- <https://www-03.ibm.com/press/us/en/presskit/42874.wss>
- <https://cbi-blog.s3.amazonaws.com/blog/wp-content/uploads/2017/01/1-ai-patents-overall.png>

The cloud, the Internet of Things (IoT), Big Data, and analytics enable effective and appropriate machine learning implementation and focused strategies. Machine learning is at the core of cognitive computing, which provides the power of real-time evidence-based automated decision making capabilities to enterprises. You will get the pointed knowledge in desired steps and be able to combine all the pieces together to visualize the complete picture. Actually, this is a journey from data to wisdom. You get data through IoT systems and other sources of data, store that data in a cloud-based data store, and then apply analytics techniques on it to make sense out of it. Then you automate the analytical process by applying machine learning techniques to find patterns and make accurate predictions for getting better business results. You refine the results by iterative run of the models/algorithms. The options are backed by a confidence level and evidence of suggestions. An end to end solution!

It is worth mentioning here that this separation of technology and division of layers is logical, i.e. there is no “hard” boundary defined in the standard and professional literature. For example, a lot of technical literature couple Big Data analytics and machine learning together. Some treat machine learning and cognitive computing as one. However, segregation gives neatness to the thought process, hence I take this approach.

By studying the five technical pillars of current and future innovative and knowledge-based business ecosystem (the cloud, Big Data, IoT, machine learning, and cognitive computing), you will be able to draw correct inferences and make suitable business strategies and decisions for your enterprises. By the end of the chapter, you will understand what these technologies are all about, what they mean, and how they matter to the business ecosystem.

General Introduction to Machine Learning

Machine learning is a fascinating concept these days, and nearly everyone in business world is talking about it. It's a promising technology that has the potential to change the prevalent business environment and bring disruption in action. Decision-makers have started considering machine learning as a tool to design and implement their strategies and innovative thoughts. Implementing machine learning in organizations or enterprises is not easy. One of the reasons for this is the lack of useful and reliable data. Having relevant data is essential for effective machine learning implementation. But, getting relevant and purified data is a big challenge. Riding on recent advancements and developments in the field of IoT-enabled technologies and Big Data analytics, now it is comparatively easy for enterprises to store and analyze data efficiently and effectively. This luxury of availability of Big Data on-demand and in real time leads to the successful implementation of machine learning projects, products, applications, and services.

This also empowers decision-makers to create some great and path-breaking strategies. Because of this, we started seeing, listening, and realizing results and success stories around machine learning. The concept of machine learning is not recent and can be traced back and linked with the artificial intelligence and expert systems. As mentioned, in recent times, it has been getting a lot of attention and traction because of some path-breaking achievements. For example, IBM Watson's capabilities to predict oncological outcome better than doctors or Facebook's success in accurately identifying the faces of humans.

In the era of machine learning and Big Data analytics, generalized prediction is at the heart of almost every scientific/business decision. The study of generalization from data is the central topic of machine learning. In current and future business scenarios, predicting outcome is the key to the organization's success. Decision-makers want to see and allow strategies to be made and implemented that not only look at historical data but also make sense out of it. Optimistically, they want that to happen automatically. The expect system would "predict" the behavior of customer and their future need comes as a report to them. Companies can then make effective decisions based on the reports and dashboards in real time. For example, in investment banking, decision-makers want to build software that would help their credit risk officer predict most likely customer defaults. A telecom company wants to predict a customer's inclination to default on a bill based on the behavioral analysis of the customers. This would provide them with future projections of payment liabilities in real time. Based on historical payment details of a customer and machine learning, it is well possible.

In fact, decision-makers are not satisfied only with the prediction, they are more interested in understanding why someone is going to do something. Decision-makers want to explore the "why" of the story and build their strategies around that mindset or behavior. Technically as we know, machine learning learns from the data. The outcome of learning depends on the level of analytics done on the data set. Therefore, it is important to take a look at the level of learning analytics. I give a brief primer of the concept here and come back on this in the later chapters, where it needs further elaboration.

Typically, there are four levels of learning analytics associated with machine learning:

- *Descriptive*: What has happened and what is happening? It generally looks at facts, data, and figures and provides detailed analysis. It is used for preparing data for advance analysis or for day-to-day business intelligence.
- *Diagnostic*: Why did this happen? Examine the descriptive elements and allow for critical reasoning.
- *Predictive*: What will happen? Provide different elements and focus on what the outcome would be. Prove future possibilities and trends. Use statistical techniques such as linear and logistic regression to understand trends and predict future outcomes.
- *Prescriptive*: What should I do and why should I do it? How a specific result or outcome can be achieved through the use of a specific set of elements. Its focus is on decision making and efficiency improvements. Simulation is used to analyze complex system behavior and identify uses.

Recent developments in the field of cognitive computing have encouraged *cognitive analytics*, as its output is more human like, so it is more beneficial. Cognitive analytics takes perspective analytics to the next level. Companies essentially need prescriptive analytics to drive insights, recommendations, and optimizations. Cognitive analytics actually test, learn, and adapt over time and derive even greater insights. It bridges the gap among machine learning, Big Data, and practical decision-making in real time with high confidence and provides contextual insights.

Based on the outcome of the level of analytics that are performed on the data set, companies encourage or discourage particular behavior according to their needs. This triggered a new era of man-machine collaboration, cooperation, and communication. While the machine identifies the patterns, the human responsibilities are to interpret them and put them to different micro-segment and to recommend and suggest some course of action. In a nutshell, machine learning technologies are here to help humans refine and increase their potential.

The Details of Machine Learning

Machine learning is known for its multi-disciplinary nature. It includes multiple fields of study, ranging from philosophy to sociology to artificial intelligence. However, in this book machine learning is treated as a subfield of artificial intelligence, which is explained as the ability of machines to learn, think, and solve a problem or issue in the way that humans do. It helps computers (software) to act and respond without being explicitly programmed to do so.

Here are some formal definitions of machine learning:

- Machine learning is concerned with the design and development of algorithms and techniques that allow computers to learn. The major focus of ML is to extract information from data automatically, by computational and statistical methods. It is thus closely related to data mining and statistics. (Svensson and Sodeberg, 2008)
- Machine learning inherited and borrowed on concepts and results from many fields, e.g., artificial intelligence, probability and statistics, computational complexity theory, control theory, information theory, philosophy, psychology, neurobiology, and other fields. (Mitchell, 1997, p. 2)

Here are some important highlights about machine learning:

- Machine learning is a kind of artificial intelligence (AI) that enables computers to learn without being explicitly programmed.
- Machine or software learns from past experiences through machine learning.
- Software can improve its performances by use of intelligent programs (machine learning) in an iterative fashion.
- Machine learning algorithms have an ability to learn, teach, adapt to the changes, and improve with experience in the data/environment.
- Machine learning is about developing code to enable the machine to learn to perform tasks.
- A computer program or algorithm is treated as a learning program if it learns from experience relative to some class of tasks and performance measure (iteratively).
- A machine learning program is successful if its performance at the tasks improves with experiences (based on data).

Machine learning is focused on using advanced computational mechanism to develop dynamic algorithms that detect patterns in data, learn from experience, adjust programs, and improve accordingly.

The purpose of machine learning is to find meaningful simplicity and information/insights in the midst of disorderedly complexity. It tries to optimize a performance criterion using past experience based on its learning. It is actually data driven science that operates through a set of data-driven algorithms. Machine learning provides power to the computers to discover and find pattern in “huge warehouse of data”.

Rather than use the traditional way of procedural programming (if condition A is valid then perform B set of tasks), machine learning uses advanced techniques of computational mechanism to allow computers to learn from experience, and adjust and improve programs accordingly. See Figure 1-1.

Traditional Programming



Machine Learning



Figure 1-1. Traditional programming compared to machine learning

QUICK BYTES

When do we apply machine learning?

- When the system needs to be dynamic, self-learning and adaptive.
- At the time of multiple iterative and complex procedures.
- If the decision has to be taken instantly and real time.
- When we have complex multiple sources and a huge amount of time series data.
- When generalization of observation is required.

Applications of machine learning:

- Machine insight and computer vision, including object recognition
 - Natural language processing, syntactic pattern recognition
 - Search engines, medical analysis, brain-machine interfaces
 - Detecting credit card fraud, stock market analysis, classifying DNA sequences
 - Speech and handwriting recognition, Adaptive websites, Robot locomotion
 - Computational advertising, computational finance, health monitoring
 - Sentiment analysis/opinion mining, affective computing, information retrieval
 - Recommender systems, optimization of systems
-

Machine learning fundamentally helps teach computers (through data, logic, and software) to “how to learn and what to do”. A machine learning program finds or discovers patterns in data and then behaves accordingly. The computation involves two phases (see Figure 1-2).

- In the first phase of computations, the specified set of data is recognized by machine learning algorithms or programs. On the basis of that, it will come up with a model.
- The second phase uses that model (created in the first phase) for predictions.

This sequence continues in iteration and the user gets refined results. Learning through itself in iterations is the basic characteristic of a machine learning algorithm and program. To achieve this, machine learning mainly uses two methods called *supervised* and *unsupervised learning*.

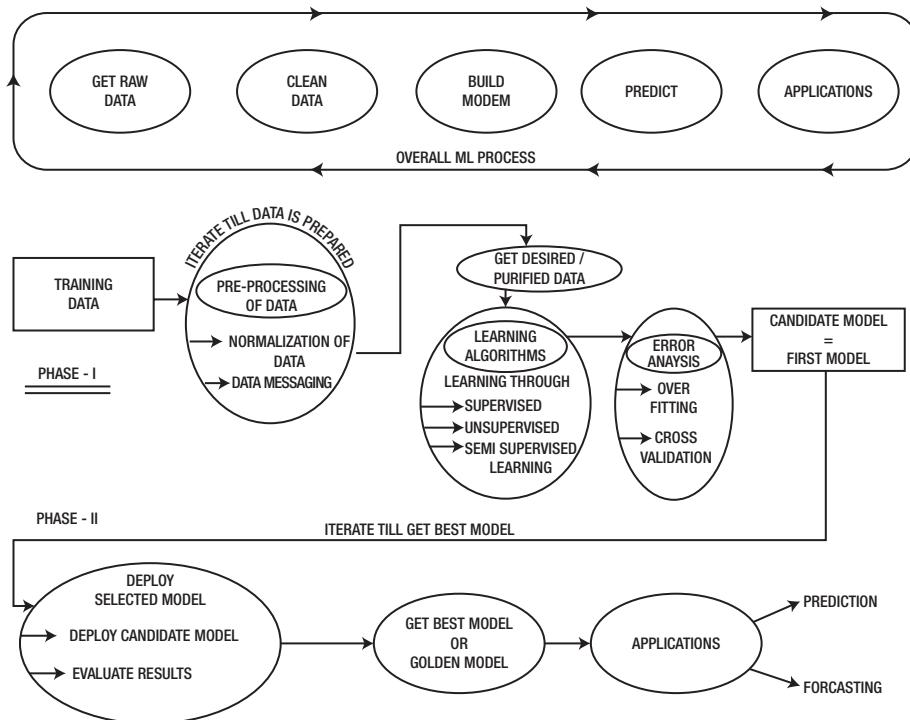
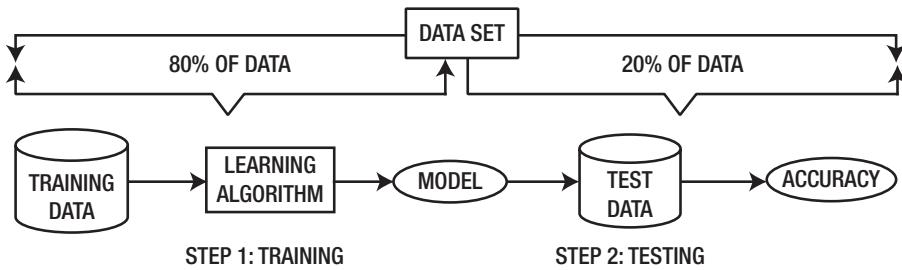


Figure 1-2. Machine learning process

Supervised Learning

Supervised learning is the learning process where the output variable is known. The output evidence of the variable is explicitly used in training. In supervised learning data has “labels”, in other words you know what you’re trying to predict. Actually, this algorithm contains a target or outcome variable that’s to be predicted from a given set of predictors (independent variables). Using these set of variables, a function would be generated that maps inputs to anticipated outcomes. The training process goes until the model attains an anticipated level of correctness on the training data (see Figure 1-3).

1. Learning or training: Models learn using training data.
2. Test the model using unseen test data, to test the accuracy of the model.



- * MACHINE LEARNING WOULD NOT PROVIDE AN OUT-OF-BOX SOLUTIONS GENERALLY HUMAN INPUT AND SUPERVISION IS REQUIRED.
- * MODELS IN MACHINE LEARNING CONTEXT CAN BE TRAINED TO TAKE DECISIONS BASED ON EXPERIENCE. MODEL CAN BE MODIFIED BASED ON RESPONSES TO CHANGES IN DATA.
- * OUT OF TOTAL AVAILABLE DATA, 20 TO 30% OF DATA IS PUT ASIDE AND RESERVED FOR TESTING THE ACCURACY OF THE MODEL.

Figure 1-3. Supervised learning

Unsupervised Learning

In unsupervised learning, the outcomes are unknown. Clustering is happening on the available data set to reveal meaningful partitions and hierarchies. Unlike supervised learning, unsupervised learning is used against data that does not have history. In unsupervised learning, the algorithm has to explore and find the unlabelled data. Also, it has to find hidden structure in the data set. The class level of data is unknown. There is no target or outcome variable present to predict/estimate in unsupervised learning.

Unsupervised learning is used in populating specific clusters out of different available clusters. This technique is best suited for segmenting customers in different clusters for specific involvement. Some of its area of application are self-organizing maps, nearest neighbor mapping, singular value decomposition, and k-means clustering. E-commerce companies like Amazon use this technique for online recommendations, identification of data outliers, and segment text topics.

Machine learning changed the way data extraction and its interpretation happens. It uses automatic sets of generic methods and algorithms. Previous to this, traditional statistical techniques were used for similar types of analysis. Companies are using these new set of learning theories and practices for revenue generation. Therefore, machine learning already started impacting many business and research organizations. Products and services are built around machine learning to achieve market leadership.

As disruption and innovation is the mantra for success of most business strategies, machine learning and its related technologies take central stage. This is the main reason why the data-intensive machine-learning methods have been adopted in the field of

science, technology, commerce, and management. This is a type of revolution which is leading industry to more evidence-based decision-making with the help of computers across many walks of life. The five steps of evidence-based decision making are:

1. Ask: Translate a practical issue into an answerable question.
2. Acquire: Systematically search for and retrieve the evidence.
3. Appraise: Critically judge the trustworthiness of the evidence.
4. Apply: Incorporate the evidence into the decision-making process.
5. Assess: Evaluate the outcome of the decision taken.

Machine learning has a strong scientific foundation, which includes studies of pattern reorganization, mathematical optimization, computational learning theory, self-optimizations, nature-inspired algorithms, and others. Machine learning is so pervasive that we are using it dozens of times a day without knowing it. We are using it for online entertainment (Netflix), practical speech recognition (Apple's Siri), effective web searching, and improving our understanding of the human genome. Machine learning answered the questions of how to build intelligent computers and software that improve their capabilities by themselves through self-learning and assist humans in all walks of life.

Characteristics of Machine Learning

Now is good time to take a look at the characteristics of machine learning. Understanding these characteristics will give you a compressive outlook toward the technology. Let's take a look at the characteristics:

- Ability to automatically adopt and modify behavior based on the users needs. For example, personalized email or news.
- Ability to discover new knowledge from large database of facts.
- Ability to assist humans and replace monotonous tasks, which require some intelligence.
- Ability to generate "insight" by iteratively operating on data and learn from mistakes.

Current Business Challenges for Machine Learning

Implementation of machine learning contains many challenges. Its application areas and scope is wide, so the challenges are also multifaceted. Let's take a look at them.

Handling, managing, and using complex and heterogeneous data: Huge volumes of complex data are being generated every day (every second, to be precise) from multiple heterogeneous sources of data about the customer. However, getting insight out of this data is one of the challenges. Also, availability of data sometime makes business requirements/decisions more complex and time consuming because demand and expectations of customer are extraordinarily high. Fulfilling the customer's expectations is a challenging task.

Typically, unknown relationships and correlations are hidden within a large amount of multi-sourced and multi-structured data. Developing algorithms that detect meaningful regularities from such data is another set of challenges. However, machine learning's marriage with advanced computational, data crunching, and analytics techniques make it possible.

Storing, managing, and analyzing large volumes of data is challenge. However, recent advancements in machine learning, Big Data, and storing technologies provide us with an array of solutions to managing this challenge of complexity and heterogeneity of data. The good thing is these offered solutions are scalable, custom built, quick, automated, accurate, and efficient. They also support real-time environments.

Dynamic business scenarios, systems, and methods: New knowledge and insights about the tasks, activities, and business are constantly being discovered, generated, and created by humans. Hence, it is difficult to continuously re-design or re-create systems and models "by hand" which will be in synchronization if frequent changes happening in the areas mentioned previously, including business environments from the organization perspective on a dynamic basis. Therefore, the complex data and changing business scenarios need some methods and techniques to teach systems (computers) to do this on their behalf. However, creating this type of dynamic system is not easy. To cope with this challenge, machine learning is one of the most important tools. The ML systems make predictions based on defined methodology that's self-dynamic and adaptive in nature. Their computational efficiency can be improved as they are dynamic and flexible systems.

Unpredictable system behavior: System designers and technology specialists often produce machines that do not work as desired. Even they work with fullest capacity they are less effective in providing real time assistance and decision making support. However, business typically need efficient, focused and accurate systems which fulfill their requirements with ease and efficiency. Therefore, systems that can learn to derive conclusions and assist in making decisions by itself with a very little or no human intervention is the need of the hour. But designing a system or systems that potentially resolve the prevalence of unpredictability from the decision is a challenging task. With the suite of traditional technologies this become more tedious. Machine learning technologies are able to accomplish this by analyzing data without any prior assumptions about the structure of business data. Hence, to encounter the challenge of unpredictable system behavior, ML is the best available technology in the pack.

The Needs and Business Drivers of Machine Learning

ML is today's most hyped and growing field, lying at the intersection of computer science, statistics, artificial intelligence, and data science. Decisions makers, data scientists, software developers, and researchers are using machine learning to gain insights and be competitive. They are trying to achieve goals that were previously out of reach. For instance, programs/software/machine that learn from experiences and understand consumer behavior were just not possible some years back. However, system that make purchase recommendations, recognize images, and protect against fraud are now part of life.

Recent progress in machine learning has been driven by the development of new learning algorithms and innovative researches, backed by the ongoing explosion in online and offline data. Also, the availability of low cost computation plays an important role. Here are the few driving forces that justify the need of machine learning and look at the business drivers of it.

- *Diversity of data:* Data is being generated from different channels and its nature and format are different.
- *Capacity and dimension:* The increase in the number of data sources and the globalization of diversification of businesses have led to the exponential growth of the data.
- *Speed:* As data volume increases, so must the speed at which data is captured and transformed.
- *Complexity:* With the increasing complexity of data, high data quality and security is required to enable data collection, transformation, and analysis to achieve expedient decision making.
- *Applicability:* These aforementioned factors can compromise the applicability of the data to business process and performance improvement.

What Are Big Data and Big Data Analytics?

Big Data is one of the important concepts of our time. It is a phenomenon that has taken the world by storm. Data is growing at a compound annual growth rate of almost 60% per year. As per studies, 70% of that huge data is unstructured. Examples of unstructured data are video files, data related to social media, etc. A look at the diversity of data itself tells the story and the challenges associated with it. Big Data is a burning topic in IT and the business world. Different people have different views and opinions about it. However, everyone agrees that:

- Big Data refers to a huge amount of unstructured or semi-structured data.
- Storing this mammoth detail is beyond the capacity of typical traditional database systems (relational databases).
- Legacy software tools are unable to capture, manage, and process Big Data.

Big Data is a relative term, which depends on organization's size. Big Data is not just referring traditionally data warehouses, but it includes operational data stores that can be used for real-time applications. Also, Big Data is about finding value from the available data, which is the key of success for business. Companies try to understand their customers better, so that they can come up with more targeted products and services for them. To do this they are increasingly adopting analytical techniques for doing analysis on larger sets of data. To perform operations on data effectively, efficiently, and accurately, they are expanding their traditional data sets by integrating them with social media data, text analytics, and sensor data to get a complete understanding of customer's behavior.

More data can potentially give accurate insight once analytics are performed on it. Therefore, Big Data can also be a weapon for optimizing business process. Companies started using it to create new processes or to fine-tune the existing ones. For example, retailers optimize their stocks based on the recommendation of predictive model, which generates “insight” from the analysis of social media, web search trends, and weather forecast data. Leaders understand that it is just the beginning of the era of Big Data and analytics and if they are not aware or willing to take advantage of this, they will definitely be left behind and lose the competitive advantage. This is a really huge risk for them!

Here are a few formal definitions and some insight about Big Data:

- Big Data refers to data sets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyze.
- Analyst firm IDC defines it as: Big Data technologies describe a new generation of technologies and architectures, designed to economically extract value from very large volumes of a wide variety of data, by enabling high-velocity capture, discovery, and/or analysis.
- David Kellogg defines Big Data in very simple language as “too big to be reasonably handled by current/traditional technologies,” and the consulting firm McKinsey & Company agrees to it.
- Big Data technologies describe a new generation of technologies and architectures, designed to economically extract value from very large volumes of a wide variety of data, by enabling high velocity capture, discovery and/or analysis. Big Data plays a big role in creating superior business value in today’s world. These days, this includes a plethora of data generated from diverse data sources like enterprise wide transaction systems, machine logs, RFID systems, sensor data sources, customer call centers, weblogs, and social media logs.
- Big Data is high-volume, high-velocity data resources that mandate cost-effective, innovative ways of information processing for greater insight and effective decision making.

THE MAJOR SOURCES OF BIG DATA

- *Black Box Data:* This is the data generated by aircrafts, including jets and helicopters. Black box data contains flight staff voices, microphone recordings, and aircraft performance related information.
- *Social Media Data:* The data generated at social media sites such as Twitter, Facebook, Instagram, Pinterest, and Google+.
- *Stock Exchange Data:* This typically contains information about share selling and buying decisions taken by traders or individual customers.

- *Power Grid Data:* This contains information about nodes based on usage information, power consumption details, etc.
 - *Transport Data:* This contains information about possible capacity, vehicle model, availability of vehicle, and distance covered by a vehicle. Now as vehicles have built-in intelligent systems and are connected through IoT, the amount of information they generate is huge.
 - *Search Engine Data:* This is one of the major causes and sources of Big Data. Search engines have massive databases and information repositories from where they get and store this type of data.
-

The Three Vs of Big Data

Big Data for the small organizations are the small data for the large organization. For some enterprises, 2TB might appear big, whereas for others, 20TB might be big. Some larger enterprises consider 200GB as big. This term is qualitative and relative, and it is difficult to make a uniform guideline. Hence it is necessary to identify Big Data by a few characteristics. These characteristics of Big Data are commonly known as three Vs of Big Data:

- Velocity: Near-time, real-time, batch, etc.
- Variety: Structured, unstructured, semi-structured, logs, sensor data, images, etc.
- Volume: Terabytes, petabytes, transactions, files, records, etc.

Velocity

Big Data is fast growing data. The rate or the velocity at which the data is growing is horrendous. Some predictions say that it would take over five to six years to watch the amount of video that is being engaging the worldwide network every second.

Velocity indicates the speed at which the data is being created. Different applications have different latency requirements. However, in today's competitive environment, leaders and decision-makers want the essential extracted "insight" from the data/information as soon as possible. Once the data arrives in the corporate boundaries instant analysis is the key to success. This is required because data, information, and insight are tightly integrated with decision making. Data is getting produced at different speeds for different business mostly in real time or in real near time. For example, trading and stock related data, tweets on Twitter, status updates/likes/shares on Facebook/other social media sites, and many others are generated in real time/near real time.

Variety

Variety denotes the dissimilar formats in which the data is being created and stored. Different applications create and store the data in dissimilar formats. In today's business environment, there are huge volumes of unstructured, structured, and semistructured data being created and maintained in organizations or enterprises. Until the great progress happened in the field of Big Data technologies, the industry didn't have any reliable tools and technologies that could work with such huge unstructured data that enterprise gets.

Data is not only stored in traditional flat files, spreadsheets, relational databases etc., but a lot of unstructured data is stored in the form of images, audio files, video files, web logs, sensor data, and many other formats. This characteristic of varied data formats is denoted as *variety* in the Big Data environment. Beyond structured data like numbers, tables, and words, Big Data also includes lots of unstructured data like video surveillance from sensors, streams, medical records, and photos posted to social network sites etc. We all know that even if it is unstructured it can be very useful and because of this unstructured variety, it poses as the biggest challenges. Most technologists predict that in coming times most of the Internet traffic will be video, specifically, long-form video.

In current dynamically changing business scenarios, enterprises require data from all the sources. This includes structured data which comes from enterprise databases and warehouse systems and also the type of data that is being generated outside of the organizations, like click stream data, social media, etc. Integrating this data into organizations existing systems enables them to stay in touch with their customers in real time or near to real time. This closeness with the customers helps organizations remain competitive and relevant.

Volume

Volume denotes the size of the data that enterprises are using for multiple purposes. With the recent progress and development of technology and with the popularity of social media, the amount of data is rising very quickly. This data is spread across dissimilar places, in different formats, in large volumes fluctuating from gigabytes to terabytes, petabytes, and more. The data is not only created and generated by individuals, but huge volumes of data are being created by machines.

Big Data is generally measured in terabytes (1,000 gigabytes) and even petabytes (1,000 terabytes) of data. 1,000 petabytes equals an exabyte and 1,000 exabytes equals a zettabyte, which is equivalent to 1 billion terabytes. To visualize a zettabyte, imagine this—if an 11-ounce cup of coffee represents a gigabyte of data then a zettabyte is the Great Wall of China.

What Is Analytics

Analytics is basically the discovery and finding of communication in meaningful patterns of data sets, which can be achieved with any data set no matter big or small. Actually, Big Data is not the necessary criteria to leverage analytics and drive data-based decision making. If Big Data does not meet the three Vs parameter, it does not qualify as Big Data.

The analytics lifecycle passed through six major standard and robust procedural phases, which were dependent and associated with each other and were resolved until each phase meets specific criteria (see Figure 1-4). The operation starts from understanding business environment and ends in deriving results, developing recommendations, implementation, and incorporation of findings in the system. Finally, continuous improvement of accuracy and efficiency of the model performance is being maintained through regular calibration. They are illustrated in Figure 1-4.

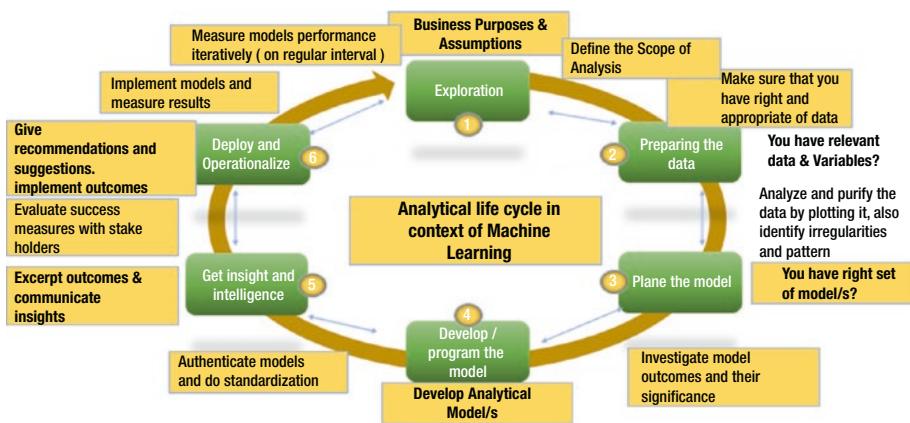


Figure 1-4. Major steps followed in analytics

The following list explains all the major steps involved in the analysis presented in a consolidated way:

- *Business objectives and hypothesis*: In this phase the business scenario, objectives, and availability of data in the Big Data platform are analyzed. This is also called the discovery phase.
- *Data extraction, preparation, and sampling*: In the second stage, the list of variables and tentative time period taken for analysis are defined.
- *Model planning and development of predictive models/algorithms*: In this phase, models are designed and efficient models based on the results are finalized.
- *Derive results, develop strategic solutions, recommendations and operationalization*: In this stage insights are derived from models, based on the results and their conversion to strategic solutions. Business recommendations are also made during this phase. Finally, action items are developed on the basis of recommendations made, which the company can implement based on their priorities and preferences.

What Is Cloud Computing?

A widely adopted definition of cloud computing comes from the U.S. National Institute of Standards and Technology:

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (for example, networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

At an abstract level, cloud computing is a collection of best practices and can be one of the ways to design, implement, and use traditional and innovative technologies. The cloud computing paradigm enables business to implement solutions in simple, efficient, and reliable ways. Cloud computing is related to the technical know-how of creating a stable, robust, and secure technology base around a mix of established and evolving process, framework, and best practices. The cloud computing paradigm has the following:

- Five characteristics
- Three service modes
- Four deployment modes of cloud computing

Let's take a detailed look at the characteristics, services, and deployment models.

Essential Characteristics of Cloud Computing

Here are the essential characteristics:

- *On-demand self-service and provisioning*: This characteristic provides power to the users to provision computing capabilities for need by themselves. This includes but is not limited to managing server time and storage. The provisioning of service happens automatically without human interaction and intervention.
- *Wider network access*: Service and other capabilities are available over the network of networks. These services are made available to the users through multiple kinds of platforms, frameworks, devices, and equipment. Devices and equipment like mobile phones, laptops, desktops, and wearable systems are connected and available through wider network access to the magnitude of users. Wider network access provides high availability, which is very critical in multiple business scenarios.
- *Resource pooling*: Computing resources and services are pooled to serve multiple consumers with dissimilar physical and virtual resources. The facility of dynamic resources allocation and deallocation according to consumer demand makes resource pooling very useful.

- *Speedy elasticity:* The ability of quick provisioning of computing and other resource capabilities, in most cases automatically, to rapidly scale up, and rapidly released to quickly scale in, enable rapid elasticity.
- *Measured service:* Resources and service usage can be monitored, measured, controlled, and reported, mostly with the help of dashboard or graphical user interfaces. So, the provider and consumer of the service appreciate how much and when they are using the services and product. This is critical for the strategic decision and fine tuning processes.
- *Dynamic pricing model:* Dynamic pricing models so the users can use services and other capabilities on a pay-per-use basis.

The combination of the characteristics, requirements, deployment, and service models creates a cloud solution. This solution is provided by many vendors, including, Microsoft, Google, Amazon, and IBM. Now we will look at the service and deployment models.

Deployment Models

There are three different types of cloud computing deployment models available, commonly known as public, private, and hybrid.

- *Public cloud:* In public cloud deployment model, resources are shared over the Internet and used as needed by different groups, individuals, or organizations. Typical public cloud offerings are applications and services. The same is available to users in pay-per-use models. A one to many relationships exist between the provider and consumer in this deployment model. That means that one provider serves multiple users.
- *Private cloud:* If there is one provider and one consumer, it comes under the private deployment model. In this type of service model, a one to one mapping between consumer and provider exists. The resources are not shared and are dedicated to organizations, individual users, or enterprises. Customization is easy, but there's no room for economy of scale.
- *Hybrid cloud:* A hybrid cloud refers to a mix or combination of public and private clouds. In this model, a combination of two or more deployment models (public and private) are integrated. This model is popular among users for multiple reasons. It provides the power of flexibility and control on the resources. For instance, a banking organization may use public cloud for storing non-critical and unimportant transactional data but use private cloud for storing and monitoring critical information, like bank details of customer (sometimes they would rather use on-premise arrangements for that). For additional information related to risk and benefits, see Table 1-1.

Table 1-1. Deployment Model Benefits and Risks

Deployment Model	Benefits	Risks and Issues
Public	1. Costs 2. Time-to-market 3. Elasticity 4. Self-service 5. Simplicity	1. Lack of control 2. Security 3. Regulatory and compliance 4. Data migration 5. Application development 6. Software licensing 7. Vendor lock-in 8. Limitations
Private	1. Control 2. Security 3. Compliance	1. Scale 2. Management tools 3. Charge-back 4. Adoption 5. ROI
Hybrid	1. Flexibility 2. Security 3. Efficiencies	1. Multiple points of failure 2. Most of the risks and issues associated with public and private hosting models are applicable here as well

Apart from popular deployment models, i.e., public, private, and hybrid, another variant also exists which is commonly known as a *community cloud*. This is a specialized offering.

In the *community cloud model*, infrastructure is shared by several organizations. It supports a specific community that has a shared concern. So, it is a service model that provides a cloud computing solution to a limited number of individuals or organizations that are governed, managed, and secured commonly by all the participating organizations. Other possibility is that all this is managed and maintained by a third-party service provider which provides common services to all the interested parties (in this case, the organizations).

Service Models

There are three different cloud service offerings—Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS). Apart from these there are numerous others, like, function as a service, analytics as a service, machine learning as a service, and even life as a service, to everything as a service. However, only the main three are discussed here.

- *Infrastructure-as-a-Service (IaaS)*: The providers offer highly selective computing functionality such as compute power, storage, archive, or other basic infrastructure components that are available over the Internet (or to be precise on the cloud). They generally associate customizable utility pricing and delivery

scheme with the offering. Service providers own the equipment, networking devices, and storage hardware and are responsible for hosting, coding, operation, and maintenance.

- *Platform as a service (PaaS)*: The service provider provisions or establishes a fully function computing and solution or technology stack. Once the platform is “established,” applications are deployed on that. The provider provides the network, servers, and storage for the environment or the “platform”. They also take care of scalability and maintenance related requirements.
- *Software as a service (SaaS)*: Applications are hosted by a vendor or provider and made available to the consumers over a network. Typically, over the Internet. The software application functionality is delivered through a used-based pricing model. The underlying application resources are shared among a large number of users.

For a detailed view of the benefits associated with these service models, see Table 1-2.

Table 1-2. Benefits of Service Models

Service Models	Benefits
Software as a Service (SaaS)	<ul style="list-style-type: none"> • The application is hosted centrally • Software testing takes place at a faster rate • Reduction in IT operational costs • No need to install new software or release updates
Platform as a Service (PaaS)	<ul style="list-style-type: none"> • Facilitation of hosting capabilities • Designing and developing the application • Integrating web services and databases • Providing security, scalability, and storage
Infrastructure as a Service (IaaS)	<ul style="list-style-type: none"> • Virtualization of desktop • Internet availability • Use of billing model • Computerized administrative tasks

As the cloud computing model continues to develop quickly, the new businesses in the form of “as a service” models continue to appear. For example, integration of Big Data and the cloud now gives birth to Analytics (AaaS). Its as a service platform meant for faster and scalable ways to integrate, analyze, transform, and visualize structured, semi-structured, and unstructured data (in real time).

Similarly, other models and services like compliance as a service, communications as a service, and human resource as a service are targeted to specific needs. In the very raw form, this model of business is described as “anything as a service,” or abbreviated as “XaaS” where X denotes any service someone wants that can be obtained in the cloud.

Challenges of Cloud Computing

The following are the challenges related to cloud computing:

- *Privacy and security:* The cloud environment data is not hosted on the company's own infrastructure, so companies have concerns regarding the security and privacy.
- Possibilities for data leakage or virus attack potentially lead to critical situations in terms of security and privacy. However, all the previous concerns are handled by the providers or third party with the help of robust architecture, intelligent backup technologies, security frameworks, appropriate deployment models, and automated process and policies. Moreover, cloud computing is mature technology now and capable of handling any challenge related to security and privacy.
- *Availability:* From a cloud perspective, availability is the ratio of time a system or component is functional, to the total time it is required or expected to function. This can be articulated through direct proportion (for example, 8/10 or 0.8) or as a percentage (for example, 80%). Availability is typically measured by the sum of downtime your application or server has in a given period. Typically, a year is used as a standard parameter. For accurate calculation, unplanned downtime and planned downtime are both taken under consideration. Also, the cloud providers cannot give an assurance on the uptime of their external Internet connection, which could shut all access to the cloud.
- *Reliability:* In perspective of cloud computing environment, reliability refers to the ability of a cloud related hardware or software component(s) to constantly achieve and perform tasks. The consistency in performance and accomplishment of tasks must synchronize according to its specifications and promises given by the service provider. In theory, a reliable product or service is completely free of errors. In practice, cloud vendors or service providers commonly express product reliability as a percentage.

However, in real life there are instances of outages and service failure at the infrastructure or facilities of the cloud service providers. Sometime very serious events occur, which ultimately affect the business. It raises apprehensions over the trustworthiness of the cloud solutions and offerings. However, enterprises are now ready and prepared to deal with some level of failures and reliability issues in cloud-based environments. The cloud service vendors generally guarantee 99.999 percent uptime. With the recent advent of new technologies, they are able to fulfill the promises as well. But some companies are still skeptical about the loss of control when an outage occurs.

- *Cultural change:* Enterprises desire a “culture of innovation, agility, flexibility, and quick adoption” in IT, especially in cloud-based environments because by its very nature it is agile and dynamic. It is important that IT enterprises enables new ideas, thoughts, and projects to get off the ground quickly and allow for faster iterations. Cloud computing helps to reduce the lead time to provision the environments, it reduces from weeks to minutes for the enterprises. The cost of building the environments also drops significantly. The pay-as-you-go pricing model ensures that the business does not have to worry about the infrastructure and resource costs after the completion of experiments. Also, this as well reduces the cost of experimentation. The cloud also provides multiple out-of-the-box features, functionalities, and tools to empower agile development.

What Is IoT?

The Internet of Things (IoT) is understood as a self-configuring wireless network of sensors and devices. Its ultimate goal and purpose is to connect all “things or objects”. In IoT, an object or thing is connected to other objects or things over the Internet, either as a source of data or as a consumer. Some objects may be armed with small computers or processing units, which can process the data they receive.

Most experts agree that the impact of Internet of Things on our lives will be far greater than the combined impact of computers and Internet have had so far. With the dawn of the Internet of things (IoT), technologies like near field communication (NFC), and wearable, intelligent smartphones have become a reality and are embedded in our day-to-day life.

IoT basically integrates the physical and digital worlds by bringing dissimilar ideas, elements, and components together. It tries to create a seamlessly interconnected network of devices (wired or wireless) that communicate over the Internet in a holistic way. The number of connected devices is in the trillions. Practically we may visualize IoT as the network of objects, which refers to the networked interconnection of commonplace objects.

This is an established fact that IoT impacts almost every business and individual by its wider impact to society and commerce.

Moreover, integration of mobile, cloud, machine learning, cognitive computing, and the Internet of Things affects a range of business operations and habits of individuals. For example, it changed the types of devices and equipment that are used in organizations for connection purposes. A new generation of connection devices in association with innovative services enables unique intelligent systems. These intelligent systems are powered by IoT device-generated data.

The Internet of Things helps businesses gain efficiencies, effectiveness and harness intelligence from a wide range of connected and available equipment. Overall, once an organization is powered by IoT, its operational capabilities increase. This, in turn, pays off in the form of customer satisfaction. IoT will also have a deep impact on people's lives. It is helpful in improving public safety, transportation, and healthcare with better information and quicker transportation and communication. IoT in fact affects societies, people, and organizations in multiple ways.

Some formal definitions of IoT are mentioned here:

- IoT is about connecting with everyday things around us using Internet technologies.
- IoT starts with connecting your things, meaning the things that matter most to your business. IoT is about making your data come together in new ways. Tap into data with IoT enabled dashboards. Uncover actionable intelligence. It helps you to modernize how you do business. (Microsoft, on its landing page of IoT.)
- IoT links smart objects to the Internet. It can enable an exchange of data never available before and bring users information in a more secure way. Cisco estimates the IoT will consist of 50 billion devices connected to the Internet by 2020. Gain deeper insight with analytics using our IoT System to enhance productivity, create new business models, and generate new revenue streams. (Cisco, on its landing page of IoT.)

Evolution, Development, and the Future of IoT

The quantum growth and universality of IoT have created multiple ways to access heterogeneous data. It also boosts the analytical techniques that extract data from desperate data sources and combines data types that are important for decision making. The ability to accumulate, store, and connect all this data and then make sense out of it will help enterprises differentiate themselves. The power of real-time access and analysis of data provides an opportunity to grow fast and bring disruption to their business models.

JARGON BUSTER

- *Lifelogging* is the process of tracking and maintaining personal data that's generated by our own behavioral activities. You can do this with the help of simply using pen or paper or by electronic gadgets and applications. Lifelogging originated primarily as a way to save raw personal data about ourselves. Lifelogging actually tracks personal behavior data like exercising, moving, running, sleeping, and eating.
- *Quantified Self* may be defined as self-knowledge through numbers. Quantified self is about analyzing lifelogged data to find correlations among the personal data sets and drawing conclusions on the basis of that.

The goal of all this is to improve health, wellness, and lives of the individuals.

Characteristics of the Internet of Things

IoT devices are linked or connected to the Internet via wireless and wired Internet connections. These sensors and devices could use many types of local area networks and connections such as RFID, NFC, WiFi, and Bluetooth for connectivity. Sensors can also have wide area connectivity such as Global System for Mobile (GSM), General Packet Radio Service (GPRS), Third/Fourth generation (3G/4G) mobile networks, and Long Term Evolution (LTE). The Internet of Things will do the following.

Be capable of connecting non-living and living things: An IoT system must have capability to connect to the Internet. It includes almost everything from industrial machinery to homes to everyday usable objects. The types of items range from automobile to spacecraft to toothbrush. It can also be living creatures, organism such as plants, farm animals and people.

The Internet of Things has the potential of connecting everything through the Internet. So, based on its nature, the next step is often called the “Internet of everything,” a term that originated at Cisco. It refers to the natural extension of the Internet of Things. The vision is to connect everything, including people, places, objects, processes, and data. Basically, anything that can be potentially connected to the Internet through sensors and networks participates in these connected ecosystems.

Be capable of collecting and transmitting data through sensors: The physical objects that are being connected must contain sensors (one or more). Each sensor is capable of sensing a specific condition like location, vibration, motion, gesture, and temperature. In IoT ecosystem, these sensors and devices connect to each other and to other systems that can understand and then present information based on the sensor's data feeds. These sensors must be capable of providing new information to an enterprise's systems, process, and people.

Communicate over an IP network: IoT enabled devices or equipment can communicate with each other through underlying enabling technologies. Technology provides empowerment to IoT enabled objects through which they share data about their condition and the surrounding environment with people, software systems, and other machines. This data can be shared in real time, stored or collected, and is usable to maximize business benefits wherever and whenever required.

As IoT systems and ecosystem mature, everything (people, place, process and things) present on the network will have a digital identity and connectivity. This means “things, place, people or objects” can be identified and tracked in real time. They can communicate with objects or the system of objects according to the criticality of the situation in real time. It is a known fact that the volume of connected devices is very high and growing at a rapid rate. Hence IPv4 standard is not enough because of limited number of available IP address therefore uses of IPv6 is encouraged.

The concept of the Internet of Things evolves with the maturity of Internet. Intelligent devices and services are becoming smarter day by day.

Challenges of the Internet of Things

IoT technical and business ecosystems require a lot of research and expertise to establish, set up, operate, and perform, before they start paying off. By their complex technical nature of incorporating the need of process, diversity of network, heterogeneity of data and devices, these ecosystems require a careful and thoughtful approach for decision making. Therefore, lots of challenges are associated with their implementation. Having said that, let's take a look at the challenges of the IoT ecosystem.

- *Working with variety of stakeholders, devices, standards, hardware, and protocols:* Establishing, building, and making sure that the IoT ecosystem is up and running is one of the biggest challenges. Because it involves fine tuning and synchronization of a diverse set of technologies, protocols, processes, and communication methods with multiple stakeholders. Also, it works with a diversity of devices and makes sure that everything works together holistically in a desired way, which is a challenge.
- *Managing remote devices:* The IoT cloud ecosystem typically contains a huge number of sensors, gateways, equipment, and devices. Moreover, they are distributed across geographies, some of which may be in remote locations. Managing all these devices remotely in the efficient and effective way, so that they work in an integrated way, is one of the major challenges.
- *Interoperability of devices:* The seamless transportation of data and communication, synchronization and collaboration among them is a challenge. Because data flows on complex networks and sometime on a network of networks. This nature of data flow demands seamless communication between sensors, equipment, and other devices. Typically, devices are manufactured or created by different vendors and companies according to their areas of expertise. Achieving interoperability of equipment, sensors, and devices is a challenge.
- *Data integration and consolidation:* Once the IoT system or ecosystem is established or set up, the data streams from multiple sensors, mobile devices, social media networks, and from other web or connected resources starts coming in an ad hoc fashion. THIS data is continuously available. One of the biggest challenges is to handle the data by making sure that data integrity does not break and that it's available in synchronization with application logic.
- *System flexibility:* IoT is still in the nascent phase and somewhat immature. Its standard and protocols are still evolving and are at the beginning stage of evolution. By the time they evolve fully as an established and mature system, more and more sensors and applications with increased capabilities and diversity will have popped up and added in an unorganized and ad hock manner. Therefore, the existing ecosystem of applications, networks,

devices, and services need to be flexible enough to accommodate those changes lined up in the future.

- *Data security:* In an IoT ecosystem, most of the data is collected from the various devices, which are the part of the enterprise or individual's private network. It contains sensitive personal and enterprise business critical data that needs to be protected and secured from unauthorized access.
- *Handling huge data volumes:* The IoT system deals with many devices, and it results in the huge volume of data coming at high frequency. Managing, measuring, and effectively using that data in real time is a challenge. It is closely associated with data performance and the issue of latency.

How IoT Works

The IoT ecosystem is made or created by many components, or layers. On the device level, as mentioned earlier, it contains some sensors and processing units. Then the Internet or precisely the network comes in to the picture, which connects those devices to the larger network. The gateways act as a secure bridge between these sensors, other tiny equipment, and devices. It also connects to the cloud through standard networking. The top layer handles overall monitoring and management of the IoT ecosystem. Also at this layer, analytics is performed on the collected and persisted data, including applications and the value the IoT ecosystem exposes.

Now, let's look at each part of the IoT ecosystem and broadly at the involved technologies it deals with:

- *Edge devices and sensors:* IoT is all about seamless communication and connection between devices and objects. This is achieved through the edge devices and sensors. They can sense and trigger at various levels of involvedness. One of the examples of these is in the space of wearables, where intelligent wristbands and watches include biometric sensing components. In the automotive space, you'll find networks and suites of smart devices that coordinate and communicate among themselves through sensors and encapsulate the complexity with the user. These "technically" connected systems provide a more pleasurable driving experience to the driver.
- *Gateway and its communication techniques:* The gateway is an essential part of the IoT environment. An IoT gateway is an "in-between" device between device and network. The gateway provides power to collect and securely transport data from the devices and equipment to the network. The gateway is essentially not a singular component but rather a network of gateways that connect to all the distant devices. It is generally capable of scaling with the device growth.

The gateway can be used for multiple purposes, but two of them are very important. First it can be the bridge that migrates collected edge data to the cloud and second, it can be used as a data processor. Gateways are helpful in reducing the volume of available data on its way to the cloud because it filters “junk data” by making decisions instantly based on the data available.

The cloud is an integral part of the IoT ecosystem. IoT gives the cloud the power of scaling and elasticity. As data grows from edge devices, the capability to scale the storage and networking resources becomes very important. Compute resources in cloud environment enables the development of the IoT ecosystems. In cloud computing environments, virtualization makes elastic compute possible. Virtualization provides flexibility to slice up a processor to represent two or more virtual processors, where each virtual processor logically time-shares the physical processor. When one processor needs less computing power and resources, and another virtual processor needs more resources, the system can logically exploit those physical resources. This enables maximum utilization of available resources.

Virtualization is not a new concept; it has matured enough to add value to almost all technology stacks available for information technology, especially to cloud computing and related areas. Virtualization means that when more IoT data flows from edge devices, physical processors can be ramped up automatically based on need to cope with the demands of these data flows. When the flow of data subsides, these resources can be reassigned to other tasks and responsibilities to save power, effort, and cost.

What Is Cognitive Computing?

The term “cognitive” refers to the mental process of knowing, including features such as awareness, conciseness, insight, reasoning ability, and judgment. Cognitive computing refers to self-learning systems that use data mining, pattern recognition and matching, and natural language processing much in the same way the human brain works.

Formally, we can define cognitive computing systems as able to learn and interact naturally with users to extend the capability of humans or machines. So that humans would be able to do more what they could do on their own in the normal without cognitive computing enable environment. These system(s) will respond to the environment by themselves, without pre-programming. They can sense, learn, infer and interact. In a nutshell, cognitive computing systems can sense or perceive the environment and collect the data on the basis of need and situations. Understand, interpret and analyze the “context” based on collected data and information, and make decision based on reasoning and act accordingly.

Broadly cognitive computing systems uses machine learning algorithms and Big Data analytics to achieve the desired behavior but it is not confined to these technologies. The goal of cognitive computing is to create automated systems that are capable of not only solving problems but that can suggest best possible alternative out of available options without requiring human assistance. Technically, the cognitive computing systems can access and analyze massive store of historical data, then apply machine learning algorithms and techniques to determine the connections and correlations across

all of those information pieces. It uses a knowledgebase as the apparatus for discovery of patterns, decision support, and deep learning. It decides what's right in a given situation and provides the appropriate answer at the appropriate time in the appropriate context.

Some professional definitions of cognitive computing:

- Cognitive computing is the simulation of human thought processes in a computerized model. Cognitive computing involves self-learning systems that use data mining, pattern recognition, and natural language processing to mimic the way the human brain works. The goal of cognitive computing is to create automated IT systems that are capable of solving problems without requiring human assistance. (WhatIs.com)
- Cognitive computing systems are based on dialog oriented natural language interfaces and machine learning algorithms; have knowledge enabled processes and mimic human like decision making abilities to enable man and machine to interact more naturally thereby extending human expertise and efficiency by intelligently analyzing volumes of data and coming up with insights and solutions in a fraction of the time it now takes. (Wipro's landing page of cognitive computing.)

Cognitive systems are different from current computing systems as they move beyond tabulation, calculation, and pre-compiled rules and programs. This technology allows people and enterprises to interact with computers using natural languages like English.

This enables customers to convey their thoughts, concerns, and expectations in more natural way. Hence understanding customers and users is much easier. This “natural human like understanding” empowers organizations and enterprises to achieve customer satisfaction of the highest degree and helps them to win their trust. Moreover, they are able to get customer delight, which results in lifelong customer relationship loyalty. The idea of interacting with computers and automated systems (robots) in a natural language is not new. Actually, it is one of the most loved topics of science fiction films and sorties (including *Star Wars*).

Here are some of the use cases of cognitive computing that illustrate what these systems can achieve:

- *Application management through diagnosis in real time:* Recognize application related problems and provide solutions and fix them before the user realizes it.
- *Service Helpdesk:* Understand user problems while interacting with them through call/video/textual manner and provide a solution in real-time.
- *Security control and management:* To devices, equipment, and society, through, face, voice, and body movement recognition.
- *Productivity management:* Incorporate intelligence into routine tasks to reduce/minimize human effort.

How Cognitive Computing Works

Cognitive technologies enable devices and things to sense by seeing and hearing like humans and then draw inferences by doing real time reasoning and analysis in context of anticipating needs of individual. Finally, these technologies enable devices to take actions in the form of activities “intuitively,” based on the context.

In the past, users needed to write the text in some predefined format to perform tasks, so the system could understand and produce result accordingly. Whereas in cognitive environment, the system understands the situation based on data analysis and produces appropriate results by applying intelligence to the data set. If a user wanted to conduct a search, they had to input the keywords manually, whereas with the help of natural language processing, cognitive technologies allow and empower people to ask questions or speak in sentences when interacting with systems, the same way they would talk to another human being to get their answer.

For example, with Apple Siri or Microsoft Cortana, you just ask a question and the software analyzes your questions based on all the available options (internally it uses machine learning and Big Data technologies to do this) and provides you with the most appropriate answer.

Cognitive computing systems use machine learning to get smarter over time, just the way humans do (see Figure 1-5). Unlike older technologies, new generation cognitive computing systems analyze vast amounts of data and generate insights. Cognitive computing offers the opportunity to resolve some of the greatest challenges humankind faces today. It's helping doctors solve health crises across the globe by fighting with diseases like cancer and Parkinson's. It's allowing scientists to synthesize existing research and develop new breakthroughs. It's assisting governments and non-profits with planning for and response to disasters. And, it's enabling businesses in nearly every industry to better serve their customers.

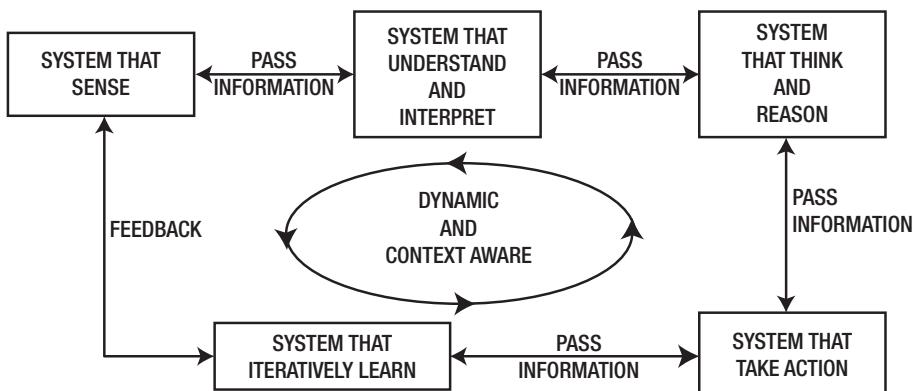


Figure 1-5. Cognitive computing

Cognitive computing is inspired by the human brain and it is here to extend our abilities by serving as a natural extension of our senses. It has the potential of contextually customizing and personalizing our experience, while creating human like interactions with devices and things. It is capable of doing personalization. Moreover, personalization is done on the basis of where user is, what the user is doing, and what they are planning to do. For example, when user is in a business meeting, his mobile device will show him the relevant information about the meeting, take notes on his behalf, and even suggest a location and time for his next meeting. When he is at home, it will recognize different family members and present each of them in the appropriate content. It will help him see his work e-mail, while his child will see his favorite cartoon show.

Fundamentally, cognitive technologies enable computers to make sense of structured, semi-structured, and unstructured data in a given context by analyzing it to find and discover the hidden patterns in the data. However, as of now ultimately humans verify or discard captured information from cognitive technologies. This process happens iteratively and with each iteration, cognitive computers become better at identifying patterns.

In the last few years, we are witnessing that devices, machines, and things (including cars, refrigerators, and other commonly used products) are becoming much more intuitive. They are helping and simplifying our daily lives. The best example is smartphones, which are becoming more aware of our preferences and surroundings. They have become “smart” and capable of anticipating our needs and providing us with relevant information at the appropriate time.

Characteristics of Cognitive Computing

Here are the characteristics of cognitive computing:

- Engage in dialog generation and evaluation of hypothesis
- Understand and make sense of natural language
- Provide supporting evidence to the decisions
- Consume heterogeneous (big) data
- Respond with a degree of confidence and provide evidence for the same
- Learn with every interaction and improve on it with time
- Provide contextual guidance and insights to the offered actions
- Provide support for decision making
- Relate between relations
- Comprehend users at a deeper level

NERVANA SYSTEMS: A MACHINE LEARNING STARTUP

Nervana Systems was recently acquired by Intel. They are experts in providing deep learning solutions. They are using artificial intelligence and machine learning or more precisely “deep learning” as a computational paradigm. Nervana is building solutions augmented from algorithms to silicon to resolve machine learning problems. For the past two years, Naveen Rao (founder) and his team of 48 at Nervana Systems have been building technology to power the next generation of intelligent and smart applications.

Nervana acquired a reputation and credibility for being one of pioneers in developing the machine learning and cognitive technology. Recently, the U.S. chip making giant Intel acquired the San Diego headquartered startup for a reported \$408 million. Nervana's founders think that their AI expertise combined with Intel's capabilities and huge market reach (Intel has the best semiconductor technology in the world) will allow Nervana to realize their vision and create something truly special. The founder, Naveen Rao, assured his team that they'll maintain their “startup mentality “while scaling up with the pace of the big company like Intel. Nervana Systems was co-founded by Naveen Rao, Arjun Bansal, and Amir Khosrowshaki.

How the Cloud, IoT, Machine Learning, Big Data Analytics, and Cognitive Computing Work Together

The complexity of nexus between these technologies and makes cognitive computing and machine learning vital in realizing the true value of the Internet of Things and Big Data. This thought becomes more relevant in dynamic and Agile ecosystems of technologies and business process that demands innovation and disruption on a continuous basis. The motive of the Internet of Things is to connect enterprise, data, and people more closely. The utility of data would be limited by its own complications until useful inferences are drawn out of it. Without sense or inference, IoT data is of no use.

Machine learning, with its association of analytics, refines the data through models and algorithms by continuously processing (new data) in real time. This trains the system to adapt to changing patterns and associations in the data. Also, wider analytical processes and tools help to discover patterns and anomalies in large volumes of data that can anticipate and predict business outcomes.

In this complete process, data is very important because for accuracy in prediction or recommendation. For providing action steps, a cognitive system requires large, effective, and sufficient amount of data. Based on the quality of the available data set, the cognitive system can discover patterns within the data set (with the help of the machine learning algorithm). If the data is not large, the result is not consistent and accurate. This would lead to incorrect predictions and wrong and useless patterns, which will be hazardous to the enterprises and defeat the overall purpose. A cognitive system also requires the ingestion and mapping of data so that the system can begin to discover connections between data sources to get insights.

To accomplish the goal of finding insights and value, a cognitive system uses almost all forms of data, including structured, semi-structured, and unstructured data. Machine learning algorithms are the heart and backbone of all this. They enable the complete process and play a big role in providing value added IoT and Big Data services by finding the patterns, correlations, and anomalies in the data.

Now we come to technology and implementation of this overall thought. You get data through IoT systems and other sources like log files and archives. IoT acts as a limitless source of data generator (as IoT is connecting virtual and physical objects to the Internet) and creator. The cloud could play the role of organizer and resource provider for IoT and other data sources. Also, the cloud in general serves as an abstraction for hiding complexity and implementation functionality. Data is getting stored in the cloud on a continuous and real time basis and then data analytics are applied on them to make sense off this data. Machine learning techniques find patterns to make predictions for getting better business results.

Let's put this in a systematic way. For the benefit of understanding, I divided the complete flow in multiple layers. However, this is not the standard segregation and depends on the implementation. Also, it varies from enterprise to enterprise based on the strategies around it. For example, in some implementations, the machine learning layer is paired with the data analytics layer, whereas in other cognitive computing implementations, the layer is merged with machine learning, data analytics, and Big Data layers. But overall, all experts agree that layers/technologies are part and parcel of any machine learning or cognitive computing implementation strategy. Here is a glimpse of the complete story.

1. *Cloud infrastructure:* This layer provides all the basic infrastructure in the cloud, including software and hardware resources. The hosting model would give options about which model to select based on need. After that, the service model can be selected according to the need. Once that's done, you would be ready for the next step. If you already have this layer ready for you, then proceed directly to the next layer. This is not necessary that someone mandatorily has to "purchase" services offered by cloud provider. You can skip this and go to the available services offered in other layers.
2. *Big Data layer:* This layer receives, stores, and provides you all types of data (structured, unstructured, semi-structured, including IoT and real-time streaming chunks) for further analysis.
3. *Big Data analytics layer:* In this layer, analytics are performed on the received and stored data of the Big Data layer. This layer is very important for any cognitive or machine learning platform, architecture or framework. As here only from data hindsight to foresight through insight would be achieved.

4. *Machine learning layer:* In this layer, machine learning activities are performed on the data in collaboration and close communication with the data analytics layer. Available algorithms of machine learning, viz. supervised, unsupervised, and semi-supervised come into play here and they repeatedly run algorithms in an iterative manner on the data sets received. On the basis of this, prescriptive, predictive, and diagnostic prediction are performed.
5. *Cognitive computing layer:* In this layer, cognitive computing activities are performed. Like suggesting the best action based on the available list of action items. Provides natural language “real life” interface for man/machine collaboration and communication.
6. *Presentation and reporting layer:* This is the layer where the end user interacts with the system by either providing input or getting output. For example, if someone wants to see some report that contains trends in a particular region of the country. He would get that information through the tools involved in this layer, like Microsoft BI.

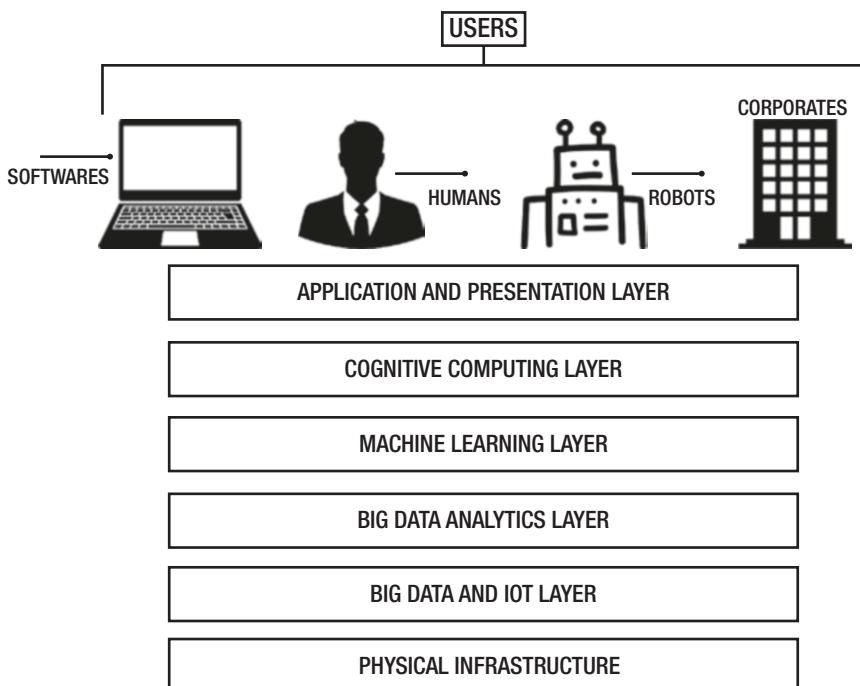


Figure 1-6. comprehensive model

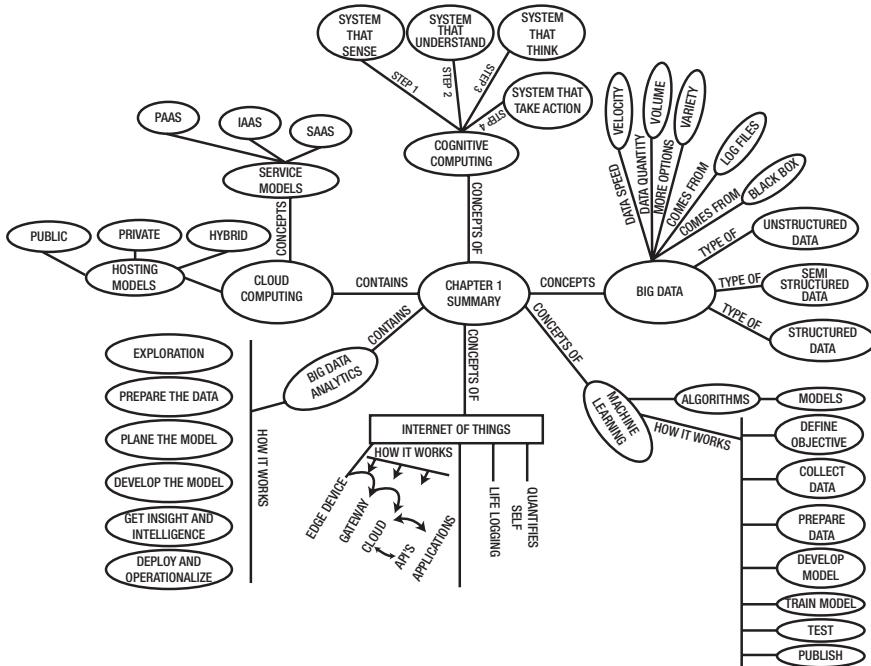
Video Link

<http://pages.skytree.net/webinar-od-machine-learning-how-to-make-it-work-watch.html?aliId=7353129>

Summary

This chapter set the context for machine learning and associated technologies for business users. It also provided a brief look at technical details and business cases, and their importance in the present business ecosystem. It discussed the cloud, Big Data, Big Data analytics, machine learning, and cognitive computing. At the end of chapter, you read about a holistic and integrative model that consists of all associated technologies of machine learning in a layered manner. That explained how they work together to provide solutions to solve business challenges.

Mind Map



CHAPTER 2



The Practical Concepts of Machine Learning

This is an important chapter because it discusses the basic and practical concepts of machine learning (ML). I did not take the academic book style to explain these concepts. I have directed my thoughts and energy to provide you with the concepts that are useful during practical decision making. Hence, while explaining the concepts, terminologies, and technical details, I use examples and case studies that are helpful in extracting relevant insight from the chapter.

The chapter starts with the evolution and history of machine learning with the notion of finding links between different schools of thought and philosophies. It takes you to the world of artificial intelligence by traveling through the last few decades of advancements and progress. After that, it provides glimpses of future applications of ML. This chapter contains a huge section on the business opportunities that machine learning is generating. This will provide you with insight into business opportunities that are coming up or already exist in the machine learning enabled fields. Again, for tools like this, relevant examples and case studies are used extensively.

There is a thin line between application areas and business opportunities. Application areas of a technology might be the area of opportunity as well. For example, machine learning is widely applied in the retail industries for doing different types of predictions and recommendations. At the same time, enormous business opportunities exist for the enterprises for enhancing the existing product and services by using the ML technologies and creating a new market for them and engaging customers by providing proper recommendations based on habits/behavioral analysis. So, parallel discussions on application areas and business opportunities provide the most contemporary and futuristic vision on the subject.

I also discuss some important models, algorithms, tools, frameworks, and programming languages involved in machine learning. There is a section on machine learning architecture that will give you a holistic and integrative view of the “generalized” architecture of machine learning. In a nutshell, this chapter provides you with overall insight into the technologies under discussion.

Linking History, Evolution, Machine Learning, and Artificial Intelligence

The field of artificial intelligence is based on the possibility of automating human thoughts and their cognitive abilities. Broadly, AI technologies try to simulate and reproduce human thoughts and behavior. These thoughts and behavior can be further categorized into thinking, speaking, feeling, and reasoning. The science of designing programs makes computers smarter and this includes the goal of “making computers do things at which humans are better”.

Historically Greek, Indian, and Chinese scholars have a firm belief of the concept of the “thinking machine”. They believe that the “thinking machine” is possible and building one is achievable. Their philosophers, psychologists, and mathematicians were engaged in this approach with their thoughts, inventions, and discoveries. However, they mostly worked in isolation in their confined geographical boundaries. Because they did not have the “luxury” to be always connected as we have now, a consolidated thought never emerged which could be accepted by everyone.

For example, during the 17th century, Gottfried Leibniz, Thomas Hobbes, and René Descartes explored the possibilities of explaining thoughts simply by using mathematical symbols. But their ideas were not connected to each other and existed in isolation. Explaining thoughts in the form of symbols and logical steps is part of algorithmic study. Algorithm development is a branch of mathematics. Algorithms played a crucial part in the evolution of artificial intelligence and machine learning. Hence, it’s not possible to discuss history, evolution, and development of AI and machine learning without considering algorithms.

Representing, explaining, and splitting the facts and figures of a complex problem into symbols and rational/logical steps is the central theme of algorithms. Algorithms established themselves as a primary tool for problem solving due to their simplicity and effectiveness of explaining a problem. Development and uses of algorithms can be linked with the Babylonians and they get credit for inventing the first devised factorization and square roots in 1600 BC (which can be achieved through logical steps). However, Euclid’s finding of the Greatest Common Divider in 300 BC and Aryabhata’s discovery of 0 are some of the earliest examples of development and impact of algorithms in human history.

Ada Lovelace’s derivation of first algorithm intended to be carried out by machines in 1843 would be taken as a benchmark for algorithmic development. Ada’s work laid the foundations, but she never talked or wrote about anything close to artificial intelligence. Formally, AI takes birth with Alan Turing’s paper entitled “Computing Machinery and Intelligence”. This interesting research paper was published in 1950. In the paper, Turing invented, explained, and theoretically tried to establish the idea of whether machines can think or not. The paper explained and conveyed some very important concepts but with limitations. At the downside, the paper was not very generic and mostly was confined to conceptual boundaries.

The Turing paper explained the concept of AI with the help of game based hypotheses. Games involving three players. Player A is a computer and Player B is a human. Each must prove to Player C (a human who can't see either Player A or Player B) whether they are human or computer. If Player C can't determine who is human and who isn't on a consistent basis, the computer wins. We may agree or disagree with this hypothesis, but it definitely lays down the foundation of artificial intelligence.

The term *artificial intelligence* was first chanted by [John McCarthy](#) in 1955. He thought and explained it as the "discipline of science and engineering of intelligent machine". He also emphasized the computer's working ability of knowledge "without being explicitly programmed". His thought was path breaking at that time. He explained the concepts of "explicit programming" while he was trying to explain artificial intelligence.

AI is incredibly complex because of its multi-disciplinary nature and expectations of solving some of the biggest problems of human kind. Initially, there was a lot of optimism associated with AI during its inception and progress in the 1950s and 1960s. In its initial days, it was believed that, by riding the potential and power of AI, the world would produce intelligent machines in just 20 years.

As mentioned earlier, AI includes and is influenced by many other disciplines. One example of this is the concept of shallow and deep learning, which originally comes from psychology. The main reason behind this influence is the goal of AI itself. Mainly, it was thought, documented, explained, and imagined as a machine that has the capability of processing the "simulation of thought process". Hence, it was expected from AI enabled systems that they would mimic human physical and cognitive behavior. Likewise, human thought processes are influenced and affected by multiple factors, including sociological, psychological, and biological aspects. Therefore, it was natural that AI would be developed by considering multiple areas of human endeavor under its umbrella.

In the last few decades, machine learning has evolved as a separate science. If we trace back in history, we can find the genes of machine learning in computer science and statistics. In its early days, ML took inspiration from computer-assisted tutoring systems. Over the years, ML has, in turn, encouraged growth in this field to produce intelligent tutoring systems based on AI techniques. However, machine learning actually originated from pattern recognition and neural networks. These are the sub-fields of artificial intelligence. The notion backed by the theory that computers can learn without being programmed to perform specific sets of tasks is the main motive behind machine learning development.

The method of viewing and treating machine learning these days is different from its original form. In its early days, ML was seen as a computation, processing, and storage hungry endeavor, whereas now it is visualized as a data-driven technology. This change in mindset forced enterprises and researchers alike to carry out experiments and validate a computer's learning ability from data (or Big Data). Here the iterative aspect of machine learning becomes important because as models are exposed to new data set, they are able to independently adapt patterns from the data lake (see the sidebar called "Jargon Buster"). They learn from previous computations or iterations to produce reliable, efficient, effective decisions, results, and actions.

JARGON BUSTER

- ***Machine Intelligence:*** Artificial intelligence related capabilities such as machine learning, deep learning, cognitive analytics, robotics process automation (RPA), and bots collectively make up machine intelligence. Algorithmic capabilities that can augment employee performance, automate increasingly complex workloads, and develop “cognitive agents” (a term used for machine learning based intelligent personal assistance) that simulate human thinking and engagement come under the machine intelligence umbrella.
- ***Robotic Process Automation (RPA):*** This is a type of software robot also commonly known as a “bot”. These are used to accomplish monotonous business processes by imitating the ways people interact with software applications.
- ***Data Lake:*** A gigantic but easily accessible, centralized source of huge volumes of structured, semi-structured, and unstructured data. A typical data lake is thought of as a data store that's capable of storing everything in terms of Big Data. Data lakes are mainly “storage” of Big Data and do not provide any significant classification or segregation of the stored data. Hence, the data lake is less structured compared to a data warehouse. Data lakes serve as a data source for multiple intelligent systems. Once they have the data they processed, analyzed, and optimized, they use it for different purposes. Any type of analytics or machine learning activities are generally performed on the “assessed” data of data lake.
- ***Data Island:*** A data store that resides on devices like PDA (Personal Digital Assistant) or other computing devices, which have nonexistent or limited external connectivity. Therefore, it limits the ability of the user to synchronize with or copy the data to other devices. Hence, when new data is added to the system, the ability to move the “newly added data” elsewhere becomes difficult or impossible. From a database perspective, a data island is like a related group of tables. For example, a database has 15 tables, 10 are related to one group called group1 and 5 are related to group2. A condition exists that group1 and group2 are not linked to each other. In such situations, it would be called that your database or model has two data islands—group1 and group2—and they work in isolation.

References:

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 - <https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Technology/gx-tech-trends-the-kinetic-enterprise.pdf>
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IBM's Arthur Samuel was the first person who used the term "machine learning" while he was developing the first self-learning computer program called a game checker. Previous to Samuel's work, nobody formally provided the idea that computers could be self-programmed. The general thought and assumption was that, for computers to perform any task, "pre-programming" would be required and the computer would not be able to perform any task(s) without being explicitly programmed.

A more formal definition of machine learning came in the late 90s by Tom Mitchell (1998). He stated that "A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P, if its performance in task T, as measured by P, improves with experience E". In simplified form, what he meant was that a computer program is said to be self-learning if it has the ability to predict a definite result with increasing accuracy over time (in an iterative manner) when it operates on a data set.

Machine Learning, AI, the Brain, and the Business of Intelligence

According to John von Neumann (a pioneer scientist in computer science who derived the first formal structure of computer), neurons can learn from "patterns" based on their inputs. Neuroscientists now term this as neurotransmitter concentrations. However, von Neumann was not aware of how neurological learning works. It is a recent advancement in neuroscience that tells us that learning takes place through the generation/creation and destruction of connections between available neurons in the brain.

JARGON BUSTER

- ***Neurons:*** The human brain contains approximately 100 billion nerve cells, also called *neurons*. Neurons have the incredible skills to gather and communicate electrochemical signals. Gates and wires in a computer can be thought of as neurons. Neurons have the same characteristics and similar makeup as other cells. However, the built-in electrochemical properties lets them transmit signals over long distances. They have fantastic capabilities to connect to each other and send messages among themselves.

von Neumann notes that the speed of neural processing is extremely slow, on the order of a hundred calculations per second, but the brain compensates this through massive parallel processing. Neurons connect, create new pathways, and circuits in a “parallel” computation fashion. Likewise, modern day computers carry out parallel processing for performing/learning tasks. As mentioned earlier, brain-like artificial intelligence isn’t a new idea. The concept of neural networks, which would be capable of mimicking the basic structure of the brain, was extremely popular in the 1980s in the scientific community. But during that time, the field of artificial intelligence lacked the computing power and availability of huge quality training data. Both the computing power and data are mandatory for the models powered by algorithms to become really effective.

Recent advancements in computer hardware have contributed to cheaper processing power (in terms of speed and memory). Hence, one section of the scientific and industrial community is trying hard to achieve human intelligence through computers. The result of this effort is seen in the form of multiple robots and huge machines coming out of the labs. One of the goals of achieving “human intelligence” is to get business and commercial advantages over competitors. One example of this is IBM Watson. The scientific and industrial community (mainly the business community, including start-ups) is trying to cash recent advancement in technologies through several “quick” products and services. They are coming up with the chatbot (automated user query replying machines/software) type of products/service by leveraging already available platforms, services, and frameworks. Technologies like deep learning and natural language processing enable these platforms.

A new breed of entrepreneurs is reaching out to “targeted and focused” customers using the “me first” approach. What this means is that they are portraying themselves as the real innovator and provider of breakthrough machine learning enabled products, applications, and services. They are appearing for the “first time” in the market and potentially having capabilities to disrupt the market/industry dynamics. To make their point, they create quick prototypes and convert them into the products in an Agile fashion. They avoid having to perform extensive research from scratch.

However, both are betting on “data” now and most of the achievements in these areas is guided by the data itself.

The actual learning capabilities of machine learning are achieved by learning algorithms, which are representative of neural networks in the human brain (as ultimately it tries to simulate the brain’s behavior). The basic “intent” of machine learning algorithm is also to find patterns similar to the brain. The model of simulation of artificial neural network helps the system gather and process information about the given data sets. Then, with its self-learning ability, it extrapolates the data to predict future events and occurrences. The end result of this overall process comes in the form of logical decisions made by machine and human together.

Humans learn and understand through trial and error with continuous process of successive approximations. Humans frame a theory about a specific task, and based on the result of the first trial or approximation, they regulate their theory accordingly. This process continues iteratively until the optimal result is achieved. Machine learning algorithms work in a similar fashion. As the machine learning system gathers and processes more and more data, their results get better and better. This happens because it provides them the ability to refine output and helps them predict the relationship between existing variables with increasing accuracy.

General Architecture of Machine Learning

Figure 2-1 presents the general architecture of a machine learning system. Typically, it has six parts. However, it can be customized based on the need of the project, the system to be created, and the requirements.

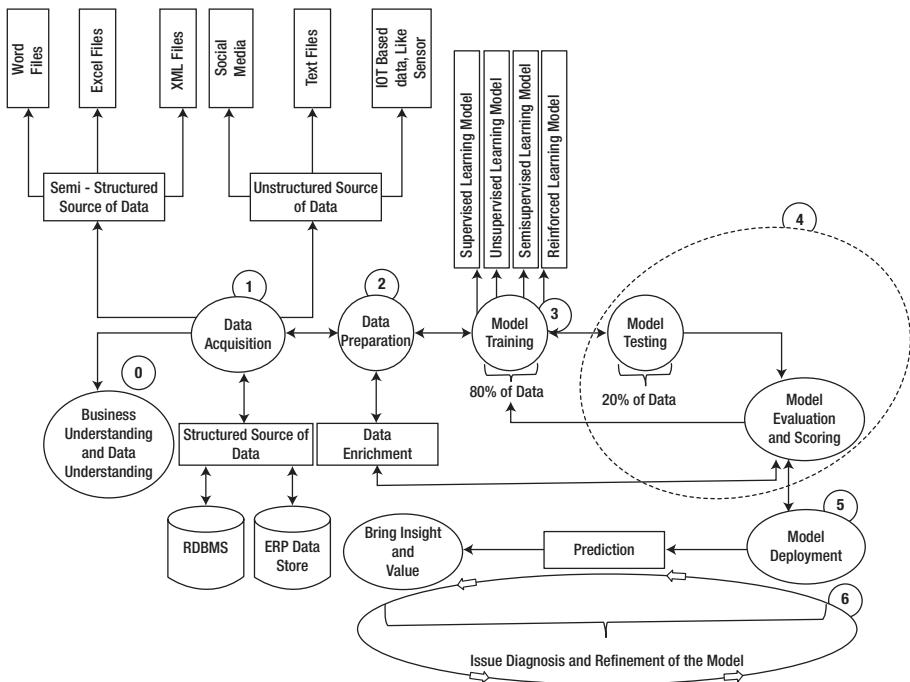


Figure 2-1. Block diagrams for general technical architecture of machine learning

This list includes descriptions of each part:

- **Data Acquisition** (collect and gather data set): For creating any machine learning system, you need two important things to work on—the data and the models. When acquiring/gathering the data, you have to be sure to have enough quality data. As a general rule of thumb, the more data you have, the better the possibility of having an accurate prediction. Therefore, you have to be very selective with your data sources.
- **Data preparation** (join, filter, cleanse data sets): Once you have the data available for your machine learning system, you have to prepare it. You are enabling your ML systems to do the further processing by providing data in a format that it wants or is tuned for. The learning system takes data in a particular format, not in a crude and ad hoc format. Also, multiple transformational operations need to happen on data sets, which includes filtering,

manipulation, sampling, and scaling. Once these steps are performed successfully, the data is reduced (converted) to the desired format. For example, while preparing a data set, you have to scrub missing values, edit the columns in a particular format, and split your data set for training followed by validation. This enables you to feed data to your selected training model.

- *Train the model* (use machine learning to generalize): While you are in the process of creating an accurate machine learning model for your work, the one mandatory thing you have to discover is what type of analysis will help you achieve your goal. Accordingly, you have to train your model. It may be a classification analysis (a typical example is finding spam vs. non-spam in the system), a clustering analysis (is an automatic classification required?), or a regression analysis (is my model going to do prediction and forecasting?). Once this is done, you have to compare the results of multiple available models. This exercise enables you to know which model is the most efficient for your data set.

Let's put this in a more systematic way:

- *Evaluate/test the model* (simulate and cross-validate): Evaluating the performance of a machine learning model is one of the very important stages. It gives you an idea of how successful the predictions of a data set have been by a trained model. Also, evaluation and cross validation are established and standard methods measure the performance of the model under consideration. Both provide you an evaluation metrics, which allow you to evaluate and judge the preference of other model so that you can make the best choice.
- *Deployment* (run in the score; track the concept drift): Assuming the previous steps are completed successfully and you are satisfied with the outcome of the model (basically values), this is a strong indicator that your evaluation is successful and your model is ready for the next step. As you tried multiple models during evaluation, you have to clean up everything and make sure that only one model is left now, with the optimum performance. Publish/deploy your model now (in Azure ML you have to define an input and output and then run and publish it as a web service).
- *Diagnose issues and refine the system*: In the (usual) case if system does not meet the success criteria the first time, you diagnose the issues and refine the system. If the corrective action is not taken at the time, this will lead to reduction of prediction accuracy. Visualization is a powerful tool for identifying and showcasing the problems with data, models, or algorithms. However, issues can also be diagnosed by using synthetic data sampled from the model.

Note Refining the system means decontaminating the data, models, visualizations, inference, or evaluation. This is ongoing activity to make model perfect. Diagnosing issues and refinement activities must be repeated until the system is performing at a level necessary for the intended application. Model-based machine learning can make this repeated refinement process much quicker. The refinement suggestions need to be immediately applied to the model. This allows for rapid exploration of a number of models.

Machine Learning: You and Your Data

Machine learning is an old science, but it is gaining fresh momentum due to generation of huge amounts of data from heterogeneous sources at a rapid pace. The variety of forms is something which is the headlines in the industry. While many machine learning algorithms have been around for a long time and carry its legacy from statistics, the ability to automatically apply complex mathematical calculations and logic to Big Data with the help of sophisticated analytics over and over, faster and faster, is a recent development.

Technology Related to Machine Learning

This section presents some common machine learning and associated technologies and their relationship. It will help the reader grab some important concepts.

- *Data Science*: On broader level, data science can be seen as an integrative discipline of mathematical science, statistics, and programming. However, it must not be confined to only these areas of studies and extended to artificial intelligence, statistical behavioral science, database technologies, psychology, sociology, cognition, and neuro-science.
- *Data Analysis*: An investigative activity. In data analysis, after scanning the available data set, the analyst gets insights hidden in the data sets.
- *Data Analytics*: When we apply mathematics, statistics, and algorithms on the available data set to find insight and meaningful correlations between them, the process is called data analytics. Analytics is the outcome of analysis. Whereas analysis is the method or group of methods, which can be used to analyze the data.
- *Predictive Analytics*: Conceptualizing and generating a quantitative model that permits an outcome or result to be predicted based on as considerable historical data/information can be a complicated and technologically intensive task. As input data contains numerous variables and all need to be consider simultaneously. Out of those variables some are very relevant and others may not be that significant in determining the outcome. The predictive model governs that what insights from the data can be extracted and used to make an accurate and relevant

prediction in a given scenario. A good model allows and is open to changes so that it can accommodate the change in the variables. At times changes are required in order to increase predictability. The right change may increase the chances of a desired outcome.

- *Data Mining:* Used to find patterns in the available data set. This term became popular in the late 90s and early 2000s when organizations realized the power of consolidating data and their uses. With the use of this technology, data from heterogeneous sources is brought together to discover previously unknown trends, anomalies, and correlations. Data mining permits searching through massive amounts of data without having any precise idea what you're looking for. It helps identify correlations in available data set through the use of the techniques like brute force analysis and neural networks.

Note Data mining can be thought of as a superset of many different methods and techniques to extract insights from available data. The technology may involve traditional statistical methods or techniques or the advanced concepts like machine learning. A few techniques that come under the data mining umbrella are statistical algorithms, machine learning, text analytics, time series analysis, and other areas of analytics. Data mining also includes the study and practice of data storage and data manipulation.

- *Deep Learning:* Techniques and algorithms are being used to identify specific objects in images and carry out natural language processing. With the help of combined power of computing resources, large amounts of data and special type of neural networks, deep learning can identify complicated patterns in large data sets. Researchers, institutions, and enterprises are now looking to apply deep learning algorithm's pattern recognition capabilities to more complex tasks. For example, it is applied in automatic language translation, medical analyses, and other significant social and business problems areas.
- *Shallow Learning:* The concept of shallow and deep learning originally comes from psychology. Broadly, shallow learning refers to superficial understanding of the subject "without knowing the deeper concepts". For example, you memorize your reading, without trying to think and understand its underlying meaning or implication. Whereas deep learning is about exploring the subject/reading in greater details. It involves your wish to comprehend the basic principles. Also, it is about your ability to put forward your own arguments. So, in a nutshell, shallow learning is about memorizing facts, whereas deep learning is about formulating logical and deep arguments.

The field of artificial intelligence associates deep learning algorithms with neural networks, which contain two or more layers of neurons. Mostly it is used for pattern recognition related tasks. However, they are also used for image, video, and speech recognition activities. Broadly, machine learning algorithms that are not categorized as deep learning are known as shallow machine learning algorithms. For tasks that involve high volumes of training data and greater computational power, deep machine learning algorithms are a good pick. Also, deep learning is always a better choice for the data set that has no clear features. Hence in the areas such as image and voice recognitions, it is widely used. If the data is already characterized by powerful features, shallow machine learning algorithms are a good choice because they are proven effective and efficient in computational savings.

Machine learning is born from artificial intelligence, so their relationship is very intimate. On the broader level, deep learning, pattern recognition, and shallow learning all are related. Machine learning is a group or collection of algorithms and set of techniques used to design a responsive automated system that can learn from data are filling its associated technologies. The algorithms of ML are usually having a strong mathematical and statistical basis. These are not tightly coupled with domain knowledge and data pre-processing. Mathematic is sites in this core. Therefore, it could also defined as a field of computer science that uses statistical methods to create programs that would improve its performance over time, detect patterns in huge quantities of data that humans would be unlikely to find manually. Like artificial intelligence, machine learning attempts to replace explicit programming with automatic detection of parameters. However, machine learning works on non-aggregated data that contains discrete samples, which include both positive as well as negative cases. For example, if someone wants to find/detect fraud in financial data set, they need individual transaction records that show examples of valid transactions specific to fraud.

Need for Machine Learning

Most of us at times think that the world is messy and chaotic, which leads to a lot of problems because of uncertainty. However, some people visualize this “problem” as a business opportunity. They start finding solutions that would transform this “uncertainty or unpredictability” to predictability based on data and use of technology. They start providing solutions to new enterprises around predictions. The old and established enterprises hone their skill sets and come up with path breaking products and services or hire/purchase them from the providers to sustain and accelerate the market.

IBM Watson, Microsoft cognitive services, and a lot of other products created a new set of offerings. Success stories like Netflix's adoption of machine learning technology for predicting behavior of their customers and offering them “personalized” services, which ultimately improved their revenue and customer satisfaction, has given new insight to businesses and customers alike. Also, it exposes the potential of recommendation based services, applications, and products. We can see that software/applications/machines are predicting customer behavior in a confined sense and human behavior in a broader sense, which is historically known for its unpredictability.

Mining, compiling, and using adequate data and thoroughly evaluating all the variables involved may not produce accurate predictions of upcoming events. But they would definitely take you adjacent to that goal. Machine learning provides us algorithms that can measure many variables. For example, how does a group or individual perform under certain climatic conditions? How many points would a certain sports team score/generate when a superstar player is expelled from the team? What is the best team composition of the team in certain given conditions?

With the help of mathematics (more accurately, statistics), trained humans can shuffle and play with the mathematical variables for getting the desired results or outcome. But they will not be able to tackle thousands of variables at a time. Because neurologically, the human brain is weak at handling so much information. This is in fact proved by numerous researches in neuroscience and neuroplasticity. But a machine can do this very easily with the help of effective and efficient algorithms. Therefore, a mechanism is required that would help humans cross the boundary of limitations of not being able to handle multiple variables.... Welcome to the fantastic world of machine learning—it is here to rescue you from problems and serve your needs.

The criterion for “prediction” is to effectively and efficiently recognize patterns in the available quality data and use the available, appropriate variable in the proper manner. Once the software recognizes those patterns, it uses them to anticipate future events and happenings. Apart from this, they can do a lot of other things much more effectively, like helping you make decisions and providing a list of action items. Prediction, automated decision making, and action planning are the need of the hour and the reality of tomorrow.

When it comes to making money and profit, “sufficient” is the alien word. For business and enterprises, it is mandatory that they always find new markets and be able to come up with innovative products on an ongoing basis. They have to be informed about new market trends, new competitors, and align their thoughts according to the changing needs of the time and market. In the current business and commercial world, machine learning has emerged as a “need” for the industries and enterprises. Almost all the industries are affected by it, mostly in a positive way. Hence, the need for machine learning is dearer in today’s commercial and personal worlds.

Machine Learning Business Opportunities

Technologies, like machine learning, Big Data analytics, and cloud and cognitive computing, are transforming the business models of almost all the industries across the globe. The old ways of doing business are changing rapidly. Enterprises across all the vertical and horizontal markets are finding novel ways to operate and innovate their businesses. This creates new business opportunities and avenues for digital and physical enterprises. Entrepreneurship is on the rise; innovative minds are creating new business models around the new generation of technologies. The result of this traction is showcased in the form of optimized operations, reduced costs, improved services, and/or launching new products. Lots of companies are using ML for their financial benefits and achieving business completeness:

- AOL uses machine learning to provide shopping recommendations.
- Booz Allen Hamilton uses machine learning (Mahout’s clustering algorithms) for its business purposes.

- Cull.tv uses machine learning for its content recommendations system.
- DataMine Lab uses the machine learning cluster classification algorithm to improve their clients ad targeting.
- Drupal is betting on machine learning algorithms for providing their open source content recommendation solutions and systems.
- Evolv is using machine learning based platforms for predicting its workforce related activities.
- Foursquare and Idealo uses Mahout (a machine learning framework) for its recommendation engine.
- Google uses machine learning for computing the probabilities of clicks for its AdSense and other advertising networks.
- Machine learning algorithms and models are used for automated algorithmic trading (AAT). Money market-based companies set and train models and use them to place trades in nanoseconds. A large percentage of today's trades are made by computers and lots of big FinTech enterprises are involved in this.
- Retailers use machine learning to optimize and recommend their inventory, marketing activities, product placement, pricing, and targeting. Some examples are Walmart, Apple, and Flipchart.
- Pharmaceutical companies like Rose Pharmaceuticals use machine learning for data mining related activities.
- India is home to the third largest cluster of AI startups in world. These startups are involved in development of bots, recognition tools, and machine learning enabled virtual assistance (Source: KPMG).
- India is also ranked third in implementing robotic automation on in its core business process. Finance professionals are ready to adopt machine learning based automation to save time and get help in decision making processes (Source: KPMG).
- Companies like Microsoft, IBM, Google, and Amazon are providing "off-the-self" platforms. Startups are using these platforms to find their own solutions. Also, the big giants launched several ML products and applications to solve and enhance a number of industry specific challenges in the recent times.

As machine learning is everywhere, business opportunity is tremendous in almost all these areas. New generations of machine learning have several innovative capabilities that serve as a catalyst for business opportunities. Apart from technical areas, machine learning is creating new opportunities in these functional areas:

- Research and development
- Production and operations
- Sales and marketing

- Customer support
- Financial, human resource, and administrative functions
- Agriculture, healthcare, utilities, oil and gas
- Retail tread
- Mining, construction, wearable tread, wholesale, arts, entertainment and recreation, real state
- Educational services, accommodation and food service, warehousing and manufacturing

Apart from all this, industry specific opportunities are also being generated. Some new areas have popped up in the recent times with the growth of machine learning, some of them being emotion based products and services, intuitive learning, intelligent drones and robots, chatbots, and many more. Today's consumer wants applications, products, and services that are more intuitive. Consumers are now closer to applications than ever, owing to the wide exposure to personal assistance devices like mobile phones and smart watches. Their expectation from the applications and products is to "understand" their way of working and behavior.

This actually opens a new horizon of "transformable" business opportunities. Also, there has been a shift in the mindset of decision makers from creating "data" to "insight oriented and intuitive" product and service which generates tremendous business prospects. This thought process is unique for the industries and enterprises. However, it is a different story that this "thought process" is guided by market dynamics and competition. Machine learning based digitation is enabling multiple type of innovations. The digital universe is growing with the unexpected speed and creating lot of opportunities.

It is worth having a look on the "WISDOM" pyramid (or data hierarchy) now because the next section is majorly focused on its individual components. The lower layer of the pyramid refers to large amount of data produced by the unstructured (including IoT devices), semi-structured, and structured sources of data (see Figure 2-2). They generate data in petabytes or even more. The layer above the data is "information" which provides filtered, structured, and machine-understandable information from the data. Also, it works as a layer of abstraction and summarizes the available data. However, what humans and high-level sophisticated applications need are services, not information.

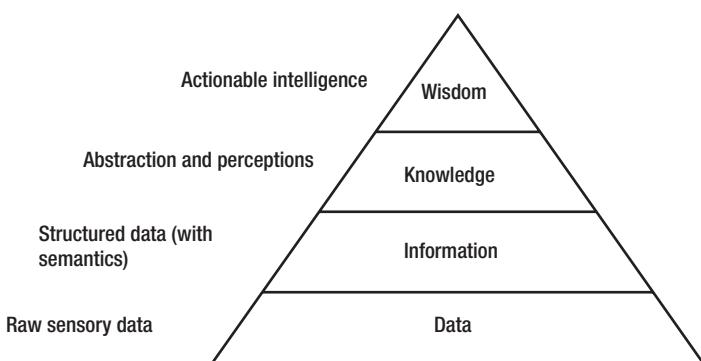


Figure 2-2. The wisdom pyramid

The unseen knowledge (third layer) above the Information layer is capable of providing a better understanding of the data and information. It also presents information in a machine understandable format which can be used by machines to generate insight after analyzing the “refined” information. The knowledge layer is further refined to an upper level known as the *wisdom* layer. It does the refinement on the knowledge layer for finding wisdom from the hidden “sea” of knowledge. With the hidden knowledge, a machine can conclude something called *wisdom* that can be used for forecasting (which essentially predicts what will happen in the future) and providing insights and action steps. This kind of wisdom can be used to develop end-to-end intuitive, smart, and intelligent products and services. This organization of data narrowing down from cluttered mere facts to wisdom can be visualized and think of in multiple ways. For example, if you think of them from the technical perspective, they can be linked in the following manner:

- The data layer is associated with IoT which includes structured, unstructured, and semi-structured data or Big Data in a nutshell.
- Information and knowledge is associated with Big Data analytics.
- The wisdom layer is associated with machine learning and cognitive computing.

For enterprises, business and commerce opportunities exist all around and are related to machine learning. Leaders have to grab them. However, to harness the enormous potential of the machine learning ecosystem, business leaders and decision makers have to invest in technology and at the same time they have to work toward transforming their organization. Therefore, the mindset become critical. Some of the thoughts that can help in creating and exploiting breakthrough opportunities are:

- Leaders have to work for an integrative approach of machine, software, process, and data.
- Adoption of superfast experimenting, testing, learning, and scaling approach.
- Quickly reimaging, reinventing, and innovating on the business model wherever required.
- Adopting digitalization and building capabilities around that. This is different from land, labor, and machine models of business.
- Adopting and implementing technology specific and less bureaucratic processes across the organization.
- Adopting policies and frameworks that encourage investment in process, people, and technology.

Business opportunity is a general term and it exists in multiple areas. Machine learning helps to create jobs and open the avenues for generating profit and streamlining labor market to function better. Advancement in robotic process automation, robotics, artificial intelligence, deep and machine learning build a new era of breakthrough innovation and opportunities. Connecting these evolving technologies will solve complex problems of business and provide benefits to the companies. Potentially there are

numerous ways to exploit the opportunity exists in these areas, which starts from sensing the new avenue of business to creating, maintaining, and transforming the existing business ecosystem.

For instance, ML can enable business to improve their performance, efficiencies, and effectiveness. This can be achieved by the reducing errors, increasing quality and speed of the operations. ML does things beyond human capacity, therefore it provides an edge in few cases. Business is also moving from a reactive way of operation to a proactive mode of operation. For example, businesses previously had to wait for a machine to fail and then call maintenance but now they can determine the condition of specific equipment to predict when to perform maintenance. This is due to advancement in the machine learning technology.

For the benefit of the readers, I categorized the applications, products, and services (APS) related to machine learning and cognitive computing or broadly artificial intelligence in five areas. All the areas contain huge business opportunities. Let's start with the first category.

Customer Experience Enrichment

Under this category, I put the applications, products, and services (APS) that can make decisions on their own, without any or minimal intervention from humans. They are self-sufficient and can extract insight from systems automatically. I confine myself to the customer space because of the scope of the subject matter of the book. However, its boundaries are almost endless and the dimensions are infinite. There are enormous business opportunities in this area. The following sections explain the broader segregation of APS of this type.

Automated Machine Learning Based Customer Support Systems

Companies like Wise.io use machine learning for providing “wise and intelligent” customer support. For example, they help their customers resolve higher customer service ticket volumes and provide quicker response to their customers. As a result, their client’s customer care agents can focus on solving more critical customer issues, instead of routine work.

Here is how it could help a business:

- Machine learning enables the support engine to predict which group or individual agent should receive the new customer ticket based on the skill set of support representative. After that, the engine will automatically put the ticket in the respective queue.
- Machine learning enables the support interface (engine) to show the agents the best response template to be used based on the content and history of the ticket.
- If a machine learning enabled system finds solution to the customer raised ticket/issue in knowledge repository, the system automatically picks the resolution, fixes the issue, and responds to tickets. Wipro machine learning and artificial intelligence based system are working on the same philosophies. Wipro is using this to achieve customer delight and to enhance the agent’s productivity.

A TALE OF CUSTOMER SUPPORT AND AUTOMATION

Automation is about consuming or using technology to permit processes to run flawlessly without manual/human intervention. This thought is the opposite of the hypothesis which anticipates that business automation will replace human resources or knowledge workers. Automation facilitates knowledge workers to concentrate on more intuitive tasks. It actually frees them from the responsibility of administrative and repetitive tasks. It allows human intervention only at places where they are indispensable. Automation is possible almost everywhere but it plays a greater role especially in organizations where resources and their knowledge are very precious. Here are four ways customer support teams can reap the benefits of automation:

- *No repetitive work:* Support teams are generally flooded with repetitive requests. Most of the time, they are forced to answer the same question again and again. At times, it becomes frustrating and demotivating for them. Automation serves as a savior for the support teams in situations of this type. The automated system would help to handle a situation like this in multiple ways. For example, based on the severity or priority of availability of tickets, the system would route the “issue tickets” to the appropriate support executive, who has the proper skill set and expertise in solving “a particular type of issue”. Other examples of this type would be, say, the support team receives a ticket with a “specific” class of issue, now based on the classification or class of the ticket, the system automatically goes to available knowledge base, finds the solution from there and thus fixes the issue. Once the issue is fixed, the system would close the ticket and notify the requestor that the issue has been taken care of.
- *Be consistent:* Automation permits grouping or centralization of knowledge and enables its proper storing and recording. Once the process of knowledge capturing is automated, it would be easily optimized and easily referenced across any organization. This is very important to “centralize” the knowledge, as teams (support, development) at times work in isolation and there are situations when communication gaps cause damages. Also, teams have a tendency to make separate support document for their work, from which other teams would not get benefitted, if it is not shared.
- *Robust scaling:* Many support teams start out small. They use key artifacts (like documents), speak to their colleagues and SMEs to fix issues which come in their way, educate customers, and inform the rest of the organization about their latest progress. All this is

easily feasible unless the customer base is small and the number of incoming tickets is less. But once the customer base starts growing, tickets start piling up, ticket queue starts growing and the real problem comes in front. As time-intensive, manual processes deliver less than perfect results, automation becomes critical for companies as they have to utilize and protect their hard-earned knowledge. As any company grows, the employee attrition becomes critical. Automation would safeguard them against this situation as well.

- *Be happy:* The life of agents or customer service representatives is monotonous and demanding. They have to work on the same set of activities during their working hours. Providing agents the power of auto-knowledge bases and personalized issue resolution guidance increases agent satisfaction. Automatically, routing tickets to agents with certain skillsets, personality traits, and performance indicators shows that you value their individuality and also that you are equipped with the proper data sources to ensure their success. In short, customer support automation recognizes individuality and empowers teams with the resources to be proactive rather than reactive.
-

Machine Learning Customer Retention Systems

Product and marketing teams of most of the enterprises face continuous challenge to retain customers. Generally, customer behavior would be very unpredictable. For example, business has very little idea why a customer cancelled an order which they place earlier. Now with the help of machine learning based retention applications and approach, which is powered by innovative ML algorithms, enterprises analyze various touch-points of customer interactions. This would enable them to make corrective actions to retain the customer. This helps enterprises in multiple ways. A few of them are mentioned here:

- Predicting customer behavior deviation in the initial stage of engagement to take action
- Showing reasons for customer behavior deviation for each individual customer
- Recommending and suggesting the most suitable marketing strategies
- Personalized and individualized content to improve retention of customers
- Helping to ensure customer's "professional" health is known to each customer-facing team in every interaction

With a more intuitive, innovative, and data-driven approach to customer success and retention, organizations can be more efficient and effective in prioritizing. They are able to serve the most critical customers while continuing to drive satisfaction across the entire existing customer base.

BUSINESS SUCCESS, CUSTOMER ENGAGEMENT, AND MACHINE LEARNING

Customer success begins with finding and locating the right customer for the business. The selection of customer must be based on the portfolio of the product and services available in cart of the business. This enables businesses to provide appropriate services and products to the targeted customer. If business is not able to find, locate, and select the right customer for their offerings their profit will suffer. Also, the selection of wrong customer will lead to customer disengagement and brand damage. The perfect fit or “ideal” customers actually help business to get maximum return on their marketing spend and achieving improved ROI. To find the “right” customer, businesses have to know and understand a few important things:

- Who the customers are.
- How the business team will approach and acquire them based on their needs and wants.
- How to position or present products or service offerings to deliver maximum value.
- How to predict that what a “particular” customer is likely to buy in the coming days and months.
- Which customers are going to be the largest spenders.
- What marketing content is most appropriate for the targeted customers.
- Which sales representatives are the best match for handling a “type” of customer.

Machine learning technologies are of enormously helpful in finding the answers to these questions. With the proper application of analytics techniques on historical, structured, and semi-structured data related to the customer, business will get insight about the customer's behavior. Also, based on the insight, business can generate strategies that provide them multi-fold benefits. Some of those benefits are described next .

Appropriate Customer Acquisition

Machine learning enabled applications and products help the business sales team focus on leads that result in appropriate customers, and helps the marketing team present the best content based on the individual's personality and their buying patterns. Other benefits of appropriate customer acquisition are:

- Higher sales and deal win percentage
- Better promotion and marketing translation rates

- Higher ROI on marketing and promotion spend
- More appropriate campaigns through personalization

Support Your Customer

Machine learning based applications, products, and services help business to provide better support to the customers. For instance, product support is generally achieved by ticket based systems (systems which provide logging of issues). If a machine learning based ticketing tool or system is used for the purpose of providing customer support, it would automatically route tickets to the most appropriate agent or generate auto-response messages by the intelligent use of existing knowledge base. Benefits of machine learning based customer support:

- Quick channelization of service or customer ticket to the appropriate agent or executive
- More reliable support because the system is automated and less human intervention is required
- Greater productivity for customer service representative as monotonous work is taken care of by the system and they would take more valuable tasks
- Efficient customer self-help

Expand Your Customer Base

Machine learning based systems, applications, and products help businesses identify, track, and analyze the usage patterns and messaging of the customers. It helps them to find the potential “suitable” customers who will help them expand the business by engaging themselves. Adding more and more customers to the business ecosystem means additional revenue. Also, if the customer is engaged with the business, it helps them in multi-fold ways, including word of mouth publicity. Some other benefits of machine learning enabled customer expansion include:

- Greater product assignation
- More revenue and cost benefit from cross-sell
- Increase in upsell opportunities

Retain Customers

Machine learning based applications can identify the at-risk customers and the signals they are demonstrating, while predicting what content or approach will most likely re-engage them. This strategy powered by machine learning helps businesses retain their customers. Customer retention is far most important for the business because it is cheaper and takes fewer resources than getting new customers. Some of the benefits of customer retention include:

- Reduction in customer churn
 - Greater dependable approach for account managers
 - More productive account managers
-

Customer Segmentation Applications and Products

Getting a new customer in this competitive business environment is difficult. A lot of hard work and effort is invested in that. Also, getting a new customer is only half the battle. Retaining customers by delivering ongoing value and satisfaction is the key to success. The question of how a company should continuously deliver value to each customer, so that the customer engages more intensely, is a challenge. But once a business achieves this, it can provoke customers to buy more and more products or services. By offering “wise and intelligent” machine learning enabled revenue growth and finance (FinTech) applications to the customer, they would realize the value of their money. The new generation of machine learning APS is capable of enhancing economic, financial, and revenue streams of customers. Also, organizations benefit by doing this because it enables them to achieve effective and efficient customer segmentation.

How it can potentially help business:

- Matching the right product or service with the right customer
- Recommending or suggesting the best price available point to determine upsell
- Providing personalized marketing messaging to the individual customer

Consumers or customer data integrated with past outcomes presents a holistic predictive roadmap for delivering additional value to customers and expanding revenue for the enterprises.

Intelligent Customer Prioritization and Classification Products, Applications, and Services (APS)

Traditionally, business tries to find their “appropriate” customers from the sea of available database of customers. Machine learning helps to classify, prioritize, and rank the most suitable customers. This enables teams not only to target “ideal” customers but also to provide them with their desired product or service quickly and thus seal the deal.

How it can potentially help business:

- Improving the close rate for the sales pipeline
- Increasing the return on your marketing spend
- Making the best use of your sales team

With a data-driven approach uncovering the patterns of target market, sales teams can develop an efficiently led prioritization process to focus on the best opportunities. Here is as glimpse of the technological and process operations of predictive APS.

1. Machine learning technology analyzes historical data (for example, closed tickets) and identifies the patterns and correlations in them. Based on the analysis, it tries to find how those previous patterns took place (how tickets were classified, routed, and resolved).
2. After that, when the new event happens (new support tickets arrive), machine learning based engine immediately verifies the content and predicts attributes and recommends an appropriate response.
3. Based on the predictions, a trigger can route rules or response macros to automate the complete process.
4. Once a resolution is found, the system learns and adapts its predictions so that it is always up-to-date with current needs and processes.

Autonomous and Intuitive Systems

The applications, products, and services (APS) that fall under this category generally have the capability to “think” like humans. This is an evolving area. Basically, these APS try to mimic the human brain. They create artificial neural circuits and pathways, exactly the way the human brain generates biological neurons. They are potentially capable of making decisions based on the situations and have ability to “adjust” in dynamically changing environments. There are enormous business opportunities existing in this area and multiple types of applications and services are made to take business advantage. The following sections describe a broader segregation of APS of this type.

Autonomous Systems

Machine learning is playing a crucial role in the development of intuitive applications, products, and services. The data is building blocks of APS. This data can help statistical procedures recognize intuitive patterns in a sea of data through data mining. Machine learning processes, algorithms, and methods use artificial neural networks to generate predictions. In turn, this leads to automated decision-making and action planning. For example, Siemens created a software simulation environment with the help of neural networks (SENN) that can be used to provide answers to various questions. Siemens is using SENN to predict raw material prices.

Autonomous systems are the best examples of intuitive products and services. An altogether new market is emerging around them, and they will become an interesting business soon. Apart from the Siemens, other companies are introducing autonomous system based products. These companies are offering individualized and personalized products. As the market is gaining momentum, cost is also becoming competitive. In all the cases ranging from industrial or service robots to cars and drones, the common thread among these systems is the ability to perform general tasks. They also have capabilities to make “small” decisions (as of now) based on their ability to sense and process information in a dynamically changing environment and situation.

LATEST TRENDS

The human-free interview (technology enabled) is picking up. HireVue is a pioneer in making video interview software. They work with around 600 organizations/enterprises. Their list of clients includes Deloitte, JPMorgan Chase, Under Armour, and some key U.S. airlines. In 2016, HireVue is planning to conduct 2.5 million interviews for their clients. This is a significant growth in volume (up from 13,000 five years ago). Most of the interviews (90%) that HireVue conducts are “on-demand” interviews. In this type of scenario, nobody exists at the other end.

Human-free video interviews have proven themselves efficient for hiring managers. Also, this provides opportunities for companies to get to know more about the people whom they are interviewing. In the process of video interview, human involvement is only required during review of the answers provided by the interviewees (in future this will also be automated with the more advanced use of machine learning and cognitive computing). Humans can do this at their convenience. For example, they can align their schedule, tasks, and availability and make time for the review during their downtime. Also, they need not travel for on-campus recruitment. Using HireVue, a lot of enterprises are getting tangible benefits. For example, Hilton is able to reduce its hiring cycle to 4.5 days, which is almost 20 days shorter than their previous hiring period. Cigna is able to bring down its requirement travel expenses for its recruiters from \$1 million a year to under \$1,00,000 per year.

Candidates are also getting benefits from robot based recruitment, mainly in the form of convenience. Now, the candidates/interviewees are able to give on-demand interviews. However, the robot-based interviews are not here to replace human interaction completely (at least in the shorter term). Most companies are using it for first-round screening interviews, after which the traditional one-on-one sort of interview happens for the final selection.

Self-Learning Machines Products, Applications, and Services

A new breed of machine learning systems like AlphaGo is evolving to fulfill the demand of hyper intelligence systems. Enterprises like Google achieved a milestone in the creation and development of self-learning machines. In March 2016, AlphaGo defeated world's best Go players: Lee Sedol. Lee Sedol, is the second-highest ranking professional Go player. Go is an Asian game considered very complex for computer to understand and interpret. Because the game has an almost infinite number of possible positions, this means that someone who plays it has to bet on intuition and not just be confined to calculation of moves.

AlphaGo was developed by Google's DeepMind which is focused for solving complex tasks. AlphaGo uses reinforcement learning algorithm (a type of machine learning algorithm). In the reinforcement algorithm, the system learns to use a value function that rates and ranks game positions by analyzing millions of past games (data set) and then playing against itself. The same algorithm is used by Siemens to optimize its wind and gas turbines, which is again an example of a successful self-learning machine.

Computer systems that can learn from various types of data and draw their own inferences are also one of the areas related to machine learning. For example, Siemens is working on enabling wind turbines to automatically regulate themselves according to changing environmental conditions like wind and weather. It will help them boost their electricity output. The foundational logic for self-optimizing wind turbines is the ability to drive wind characteristics from the turbines based on operating data. The associated parameters, which are measured by sensors in and outside wind power facilities, include wind direction and force, air temperature, current and voltage, and vibrations in large components such as generators and rotor blades.

Deep Learning and Simulated Neuron Based APS

Deep learning techniques in association with machine learning are generating a lot of business opportunities, for example, enabling a new application to use automated image recognition. APS around these technologies are using simulated neuron techniques for linking multiple levels of results based on available data to give desired results. They actually recognize images on the basis of associate pixels of an image to another pixel. Most of us already unknowingly carry an artificial neural network enabled device or application with us. For example, voice command systems in Android smartphones use artificial neural network techniques to take the voice command from the users.

Emotions and Sentiment Analysis Based APS

Emotions are an essential part of human endeavor, which influence cognition, perception, and other day-to-day activities such as learning, managing oneself, and communicating with oneself and others. Also, it has major contributions in rational decision-making. Traditionally, technologists have largely ignored emotion at workplace and business. Also, only few services and products are available in this space, which would integrate verticals, horizontals, and other business areas with emotions. After the boom in the Big Data analytics and machine learning technologies, enterprises which are dealing with business like, retail, healthcare, marketing, banking, and financial

services have started adopting “emotion based APS”. Because enterprises realized the fact that humans carry emotions with them and it is an integral part of their decision making so if someone wants to purchase some product, then his or her emotions would definitely play their role in decision making. Hence integrating emotions with APS would give business the new opportunities to explore. Some of the pioneers of this area are [Emotient](#), [RealEyes](#) and [Affectiva](#). They all use facial expressions to infer emotion, largely (it appears) for marketing purposes. Companies like, [CogitoCorp](#) and [BeyondVerbal](#) concentrate on understanding emotional cues in voice to conduct market research and to deliver better customer experiences.

Other Intuitive Applications, Products, and Services (APS)

Other applications include personalized and individualized care and education. Systems which take care of conflict resolution and negotiation, provide customized training. There is a separate category of games which monitor and learn your habits and customize games for you, called adaptive games. There are enormous business opportunities in this area.

Prediction, Digital Assistance, and Recommendation APS

The predictive and forecasting APS falls under this category. Machine learning in collaboration with cognitive computing potentially offers a lot of smart products and services which the world “only” imagined. Just few years back, this type of APS was limited to the subject matter of the science fiction books, films and research labs. For example, your phone being able to offer you suggestions and recommendations for things even before you think of doing them or your phone being capable of suggesting you that there is a need to buy a new wardrobe that would suit your job profile and personality type, was no near to reality just few years back.

As mentioned earlier, “smart” systems are capable of making predictions, providing suggestions, and giving digital assistance. For example, assume you are planning to host a party for some happy occasion for you and your family, then cognitive computing system powered by machine learning algorithms come into action and generate guest list based on the people you’ve been interacting, communicating and collaborating with, it would also factor the “guest list” on the intensity of your relationship with them. The demand of this type of APS is increasing day by day. Hence, enormous business opportunity exists in this area. The following sections describe the broader segregation of APS of this type.

Recommendations Based Applications, Products, and Services (APS)

Smart APS are heavily used for recommendations. Its uses are diverse. For example, when you visit an e-commerce site (like Amazon) or look up on phone for an ice cream parlor, or see a film on Netflix or on YouTube, chances are that you see recommendations based on your tastes. Actually, machine learning algorithms embedded in this APS pick up “appropriate” recommendations for you on the basis of your visit history and other parameters (factors used by model to group patterns or make decisions).

Virtual Digital Assistance

These applications work as an intelligent and smart digital assistance for individuals. For example, you have an urgent meeting scheduled at 9:30 am in the morning or your flight is scheduled at 12:30 midnight and you are a forgetful person. You generally miss these types of assignments. Need not to worry, your digital assistant like Goggle's Allo/Now or Apple's Siri are here to help you. They read through your email and SMS and calculates the time taken to reach office or airport. Compares it with the ideal time taken to reach office or board flight. After that it sends notifications on when you should start for office or airport.

Advertising

Machine learning algorithms also work as technically smart virtual salesman and advertiser. For example, a woman who buys maternity clothes online is likely to land up with a discount on buying diapers in bulk. Because machine learning algorithms which are running in background of this overall buying process, would gather and process the perching behavior of the customer and accordingly advertise relevant content as and when needed.

Photo-tagging

Social media giant Facebook analyzes and uses facial features for its marketing, suggestions, and recommendations. It determines the distance between the eyes and nose to identify faces. It also uses profile pictures and photos which you have tagged to narrow down to an identifiable face. All the areas and categories mentioned previously are highly recommended for finding business opportunities. Prospects are growing with the speed of thoughts for creating APS and rollout.

Domains Specific APS

It is evident that the developments in Big Data analytics and machine learning affect almost all the areas of our lives and business. These areas offer strong business opportunities for enterprises in the different vertical and horizontal sectors to streamline their processes, reduce costs, increase efficiencies, and provide better and/or new products and services. This ends up providing tremendous business opportunities and avenues for all. There are enormous tractions from businesses existing in these areas. The following sections show the broader segregation of APS of this type.

Financial and Insurance Services

Business opportunity exists in these areas:

- Algorithmic enabled trading and management of stocks for better profitability. APS opportunity for dynamic tracking of funds and its flow.

- BFSI (Banking, Financial Services, and Insurance Industries) related fraud anticipation and discovery. BFSI maintenance and prediction applications.
- Customer segmentation based application.
- Predictive injury assessments and valuation in the insurance and related industry.
- Automated claims authentication, validation, and verification APS for insurance industries.
- Customer understanding generation (insight) and relationship management from the integration of transactional and other data.
- Sentiment analysis based APS.
- Portfolio, risk exposure assessment, and management based APS.
- Real-time customer profiling, locating, targeting, and optimization of offers and services for cross-selling.
- Data based customer and call center efficiency optimization and management.
- Predictive brand reputation and valuation APS.

Telecom Network, Products, and Services

Business opportunity exists in the following areas:

- Dynamic and predictive network optimization for customer and network service providers.
- Customer preservation or retention to the native company based on call data records, predictive machine learning analytics (Machine Learning Analytics = Machine Learning + Analytics).
- Customer activity optimization in subscriber's networks management through smart APS.
- Customer scoring, churn identification, and mitigation based APS.
- Optimization of offers made to customers for cross-selling to improve efficiencies and effectiveness.
- Real-time customer and call center efficiency and effectiveness improvement and management.
- Fraud analysis, prevention, and management.
- Location based services improvements through the use of GPS data and analytics.
- Customer center and call center efficiency.
- Bandwidth allocation based on use patterns.

Professional Services

Business opportunity exists in the following areas:

- Advertisement target analysis through deep and machine learning algorithms.
- Social media attending, real-time sentiment/emotion analysis and targeted marketing on the basis of machine learning analytics.
- Effective and efficient campaign management and injection of on time loyalty programs based on predictive analytics. There are enormous opportunities exists in this space to create APS.
- Real-time crime identification, detection, and prevention for providers of security APS.
- Personalized pricing for travel based on the behavior analysis of individual/groups.
- Real-time IT infrastructure monitoring and management. Provisioning of self-healing services, predictive maintenance, and management in IT.
- Real-time security breach pattern detection through machine learning to create customized rules engine in IT.

Public Sector and Government Initiatives

Business opportunity exists in the following areas:

- Enhancement in citizen's lifestyle and quality of life. For example, enhancements in patient services and highway management based on machine learning.
- Improvement opportunities in weapon and war intelligence systems to counter terrorism with the help of machine learning (predictive analytics) based APS.
- Smart taxing systems through machine learning based APS.
- Fraud identification, detection, and prevention in the public domain and government departments.
- Enhanced cyber security of public network and government organizations and departments.
- Enhanced surveillance and response programs for public and government organizations.
- Efficient, effective, and optimized health informatics, bioinformatics, and pharmacogenomics with the proper use of analytics.

- Real-time treatment assessment and prediction based on the population density.
- Enhanced clinical decision support systems.
- Intelligent and smart pollution control management through machine learning enable APS.

Retail and Wholesale

Business opportunity exists in the following areas:

- Real-time store location and layout management through the use of machine learning APS.
- Supply and value chain enhancement and optimization.
- Real-time RFID tracking and management.
- Price and cost optimization. For example, providing dynamic suggestive pricing based on Big Data analytics and machine learning.
- Customer behavior, social media persona mapping, and sentiment and emotion analysis based on social media feeds.
- Generating actionable customer insight and feedback based on analysis of heterogeneous data. For example, providing micro-segmentation of customer behavioral data.
- Customer loyalty and promotions analysis and prediction.
- Real-time discount optimization based on customer buying patterns and behavior.
- Real-time marketplace cart analysis and prediction based on demographics cultural orientation.
- Fraud detection, identification, and prevention in e-commerce to physical shops.

Transport

Business opportunities exist in these areas:

- Real-time logistics, passenger, goods tracking, management, and optimization.
- Location based analytics for improving transportation services and assets using GPS data.
- Customer loyalty identification through relevant analytics and marketing.

- Predictive maintenance and management of transport services.
- Real-time capacity, efficiency, and pricing optimization for public and private transport systems.
- Intelligent and smart taxi management systems.
- Chauffer behavioral analytics.

Utilities, Oil, and Gas

Business opportunity exists in the following areas:

- Smart and intelligent meter monitoring. Identification of real-time usage patterns through analysis and optimization of energy consumption and pricing based on that.
- Prediction of load and forecasting of uses through the use of predictive analytics.
- Real-time sensor monitoring for condition-based and predictive maintenance.
- Smart and intelligent energy grid optimization, weather pattern forecasting in real time, and real-time usage and distribution of the resources.
- Effective and efficient operational modeling.
- Real-time distribution load forecasting and optimized scheduling.
- Targeted customer offerings.
- Real-time and effective disasters and outages management.
- Effective and efficient compliance checks and audits.
- Real-time customer feedback gathering and call detail record analysis though the use of machine learning technologies.
- Effective and efficient natural resource identification and exploration in the oil and gas industry.
- Real-time seismic data processing.
- Efficient and effective drilling surveillance and optimization.

Manufacturing

Business opportunity exists in the following areas:

- Predictive maintenance
- Process and quality analysis

- Effective warranty and policy management
- Optimized factory automation
- Effective automatic detection and prevention of adverse drug effects in the pharmaceutical industry
- Intelligent real-time sensor monitoring for the maintenance of automobile, buildings, and machinery
- Real-time smart meter monitoring for optimized energy consumption and management
- Smart and effective location based analytics through GPS data analytics
- Predictive analysis of social media comments, feedback, and sentiment analysis for vehicle quality and efficiency management in automotive
- Social media listening for marketing in consumer industries
- Effective and need based concurrent and effective engineering and product lifecycle management
- Design-to-value based product implementation
- Smart analytics based crowd sourcing
- Demand forecasting and supply planning
- Digital factory for lean manufacturing
- Distribution optimization
- Quality management based on social media feed

The next sections discuss three specific areas of business opportunity.

Machine Learning for Legal Activities

Legal documents are generally too complicated to comprehend. Large organizations have their team of lawyers check the legalities of any issues or deals. However, new and evolving enterprises do not have this luxury. Machine learning plays its role in both scenarios. It can help organizations decode the legal documents, with or without assistance. Machine learning systems use deep learning algorithms. For example, Legal Robot built a legal language model that translates “legal language” into a big string of numbers, which in turn is translated into the plain language. This enables decision makers to understand the “legalities” quickly. Legal Robot also helps their customers to establish what’s missing from a contract or SOW. Also, it would help them determine if there are missing elements/information in the document. For example, the system can determine if royalty fee section is present in the non-disclosure agreement or not. If not, then in that case it would suggest the action steps to be taken to cope up with such a situation.

Machine Learning to Prevent Money Laundering

For government organizations, banks, and other financial institutions, money laundering is a big issue. Traditional instruments are not usually successful at preventing it. However, by the combined power of deep and machine learning, companies are successfully distinguishing between legitimate and fraudulent buyers and sellers. Because ultimately it is all about anomaly detection. PayPal is using deep learning to avoid fraud and money laundering. There are big opportunities in this area.

Improving Cybersecurity

For organizations, security is one of the very important areas of concern. Machine learning systems help them handle this concern effectively. The machine learning based systems monitor and measure traffic coming from and being exchanged between workstations and servers. In case of identification of any anomalous behavior, it circulates automatic notification to the stakeholders and tries to remove the “anomalies” based on its knowledge repositories. For example, Israeli communication services provider Orange is using machine learning applications to protect its business and customer data. Recently, the system detected malicious code in a video file that an employee had downloaded. The security team instantly notified the employee.

Science and Technology

Machine learning has impacted all the areas of industries, organizations, enterprises, research organizations, science, and most importantly, humans. In this section, I cover the business opportunities created by machine learning technical ecosystem for the areas that broadly affect all walks of life. Again, it covers human psychology to space science and cosmology.

Hence, I have included “diverse science” under this heading. Because science affects almost everything and mixture of multiple science creates some unique business opportunities for building APS and doing research. Therefore, it is natural that mashups of technology, sciences, and social studies have created new business avenues. Science is a wide term and it covers stories of past, projections, and possibilities of the future. At the same time, it provides a glimpse at the present human successes, struggles, and failures.

Science is a big business as well. A couple of decades back, stories like space travel and trips to moon were confined to scientific communities and government agencies like NASA and ISRO. But now companies like SpaceX are trying to make this possible for average people. The vision to enable people to live on other planets was alien just a few years back. But with the advent of a new generation of entrepreneurs and companies, this is becoming a reality. Similarly, medicine and medical science is a huge business now. The new generation of pharma companies are incorporating inputs from multiple sciences while creating/modifying drugs. They try to come up with holistic personalized treatment strategies to help their customers fight a disease. This is a paradigm shift in the way that traditional medical science used to operate. For example, allopathy is known for a way to treat patients having diseases. Doctors are now referring it as modern medical science because it covers wider thought processes and a mixture of multiple sciences like psychology, physics, and chemistry. Likewise, treating cancer is not the subject matter of allopathy only. The treatment combines nuclear physics (radiation/chemotherapy) followed by rehabilitation (psychology).

Machine learning has enormous business and commercial implications in mashup science and ideally it is a subject matter of one separate book. It is not possible to cover all the opportunities in one small section of a chapter.

Medical Science

Machine learning has the capability to become an excellent and powerful tool in surgery. This could enable surgeons and physicians to use complex clinical data (with the help of analytics) to make critical decisions. For example, machine learning and Big Data and analytics could potentially contribute heavily to progress in plastic and reconstructive surgery. Machine learning fundamentally could analyze historical data and develop algorithms/models that could provide insight to the doctors through knowledge acquisition. This is not news, as machine learning has already been applied to process huge chunks of complicated data in medicine and surgery with a great success. IBM Watson is an excellent example of integrating machine learning with medical science; it is capable of providing real-time diagnoses and suggesting treatment.

Here are the areas of surgery (plastic) where the business opportunities are explored, as machine learning is already playing a role:

- *Burn surgery:* A machine learning based approach has been generated to analyze and predict the therapeutic time of burns. Also, it can provide exact healing time based on the depth of burn.
- *Microsurgery:* Monitoring and predictive devices to monitor blood perfusion of tissue flaps, based on smartphone photographs and by using deep learning algorithms would be developed. Individualized suggestions for surgery based on the patient history is another area where a lot of opportunity exists.
- *Craniofacial surgery:* Future algorithms may be useful for identifying known and unknown genes responsible for cleft lip and palate.

Machine learning would not only help in the decision-making process but also in finding patterns and correlations that might not be visible by analysis of smaller data sets or anecdotal experience. It might help stop the disease before its symptoms pop up.

Space Science

There are terabytes of data analyzed every second by the companies like SpaceX and organizations like NASA for getting the correct picture of galaxies and stars and for analyzing the possibilities for sending missions on planets. For example, for cataloguing stars in our galaxy and finding their position, NASA is using [evolving machine learning techniques](#) to speed up the overall process. To make its analysis perfect, the organization has been using machine learning to "teach" computers how to spot patterns in new stars and galaxies based on data. Machine learning is used by space based companies for multiple purposes like the following:

- They are developing machine learning algorithms and models for automating manually intensive processes and tasks.
- They are developing new tools, frameworks, capabilities, and automated infrastructure to improve propulsion based data crunching, analysis, and review.

Physics

At times, physics deals with complicated problems and with lots of data. For example, in the Large Hadron Collider (LHC) experiments at CERN, machine learning became very useful in understanding the impact of collision. It analyzed every collision and provided useful insights to the scientists. Machine learning algorithms beat physicists in regression or classification related tasks by 25 to 30%.

- Machine learning algorithms and models are profoundly used to process satellite data. Also in atmospheric physics, machine learning is used for weather forecasts and predictions.
- Machine learning is routinely used in astrophysics to classify and organize huge amounts of data. For example, clustering algorithms is used on Kepler data to sort, locate, and identify star systems that would meet the requirements for steady surroundings suitable for occupancy.

Biology

Machine learning algorithms and models like Markov models, support vector machines, neural networks, and graphical models are used frequently in handling and managing randomness and uncertainty of data. These are the key techniques for the analysis of the human genome. They are specifically used for forecasting coding or non-coding area of genome; other uses include RNA prediction. There are a number of new and established companies in this arena.

For example, DuPont Industrial Biosciences is doing extensive work in protein engineering of enzymes and metabolic engineering of microbes for protecting our environment. They are analyzing the proteins and enzymes and extracting insight with the help of machine learning algorithm and models. A few other areas where business opportunity exists include the following:

- *Gene finding algorithms:* By using Markov Models, Hidden Markov Models (HMM); Viterbi Algorithm, Parameter Estimation providing personalized and individualized genetic information.
- *Finding miRNA sites:* Through hidden Markov models for enabling research in the areas like hepatitis C. Companies like Rose pharmaceutical are using this technique frequently.
- *Classification and prediction:* Integrating various biological data and selecting the best model for doing classification of the data and prediction.

The business opportunity not only exists in the areas mentioned previously, but it spans through other disciplines as well like astro-biology, environmental science, socio-biology, psychology, and so on. However, the point to call out these areas here is to just highlight the spectrum of opportunities of machine learning in scientific field.

Types of Machine Learning

There are multiple types of machine learning algorithms in the world of data science. This chapter concentrates primarily on three types of algorithms—supervised, unsupervised, and reinforced. I have already covered the basic concepts and workings of supervised and unsupervised learning in the first chapter of the book. Here, I elaborate a bit on reinforcement learning. Let's take a quick look at reinforcement.

Reinforcement Learning

Reinforcement learning is a category of machine learning algorithm used to train the system by rewards and penalties. In other words, it is used to train a system just like humans train a pet. For example, if you dog obeys and acts according to your instructions, you encourage her by giving her rewards and maybe punish her when she disobeys. Similarly, if the system does well, the trainer gives it positive reward (positive points) and punishment (negative points) when the system does not perform well. The learning system that gets negative points has to improve itself exactly like the dog does.

Therefore, we infer that it is a trial and error mechanism/process. Also, the reinforcement learning algorithms selectively retain the outputs that exploit the acknowledged reward over period of time. Broadly, reinforcement learning algorithm tries to mimic how the brains of humans act on punishment and rewards. Therefore, same as human they select actions, which would provide them the greatest reward. Reinforcement learning is also used to select the best possible option from the set of available possible actions. They select the best option, based on their understanding, and get feedback after each action in an iterative manner. The feedback mechanism enable reinforcement learning to identify that the action taken was good, neutral, or a huge mistake.

Typically, reinforcement learning algorithms are best fit for automated systems. Because there they make small decisions without a human's guidance through self-learning programs. Automated elevators, escalators, heating systems, cooling equipment and lighting systems are excellent candidates for implementing reinforcement learning algorithms. Reinforcement learning algorithms were originally developed to control robots (an automated system). Anything that moves on its own without human intervention, ranging from automated drones to vacuum cleaners, probably runs on reinforcement learning algorithm. Reinforcement learning algorithm based programs or systems always answer the question of what action should be taken, although the action is usually taken by a machine.

Here is the example of questions that a reinforcement system can typically answer:

- What are the appropriate places in a web page for a particular advertisement to be placed, so that it has the best chance of being noticed by the user?
- Should I increase the temperature of the air conditioner or lower it based on the current environmental conditions?

- Is this the right time to purchase shares; if yes, how many shares of ABC stock should I buy now?
- Should I remain driving my car at the same speed or apply brakes or accelerate through this traffic signal?

Reinforcement learning algorithms typically need more effort to make them functional than other algorithm types. The reason behind this is tightly integrated and bound with the overall of the logic of the system. The upside of reinforcement learning algorithms is that it can start working without any data. It accumulates or gathers data as it goes. In Figure 2-3, the general working of reinforcement learning is explained. In this type of learning algorithm, the learner collects the information during his course of action by interacting with the environment. This is unlike supervised learning, where pre-defined labeled data set already exists.

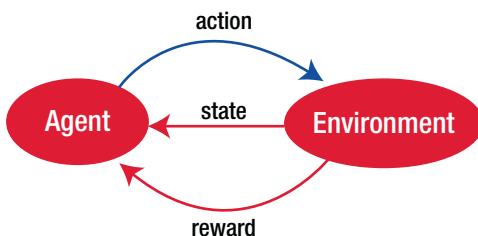


Figure 2-3. Reinforcement learning

In reinforcement learning, the reward would relate to the tasks and its associated goals. The objective of the agent is to maximize its rewards. Hence, it is natural that it would determine the best course of action or policy to achieve maximum reward (same way that rats/monkeys/humans work as well). The information the agent receives from the environment is the immediate reward (related to the action just taken). No futuristic or long-term reward feedback is provided by the environment.

Two scenarios are important in the case of reinforcement learning:

- The case where the agent knows the environment model. In this case, his objective is to maximize the reward he received.
- In the other case, the agent is not exposed to the environment model and it is unknown to him. Obviously, in this case, he faces a learning problem.

In the second case, the agent has to learn from the state and has to optimize the reward information gathered. This can be used to gain information about the environment and determine the best action policy. The Markov Decision Processes (MDPs) model of the environment and interactions with the environment is widely adopted in reinforcement learning. For completeness, let's take a quick look at supervised, unsupervised, and semi-supervised learning (I keep them short as they are covered in Chapter 1).

Supervised Learning

In supervised learning, input data is called training data and technically it has a known label and a known result/output. A model is generated or created through training data in a two-step process (model and prediction). The model is used to make predictions and is corrected when predictions are incorrect. The training process (of model) continues until the model achieves a desired level of accuracy (in iterative manner) on the training data.

Unsupervised Learning

Input data is not labeled in unsupervised learning and in this type of learning algorithms, the target data is not known. In unsupervised learning, the model would be prepared by inferring structures and patterns present in the input data. It could be done either through a mathematical process of systematically reducing redundancy or through rules or by organizing data by resemblance.

Semi-Supervised Learning: A Quick Look

I have not covered this type of learning algorithm in this book. However, it would be helpful for you to know about this. In semi-supervised learning, input data is a combination of labeled and unlabeled data set. Here the model would learn from the structures based on organizing the data and must be capable of doing predictions. In semi-supervised learning, few data sets are labeled, but most of them exist in unlabeled format. A combination of supervised and unsupervised modeling and other techniques are used in this.

All the learning algorithms have subtypes. I do not explain these subtypes here, because they are the subject matter of Chapter 3. However, it is worth having a look on the different subtypes available under each learning algorithm (see Table 2-1).

Table 2-1. Categories of Machine Learning Algorithms

Supervised Learning	Unsupervised Learning	Reinforcement Learning
Artificial neural network	Artificial neural network	
Bayesian statistics	Association rule learning	Q-learning
Case-based reasoning	Hierarchical clustering	Learning automata
Decision trees	Partitional clustering	
Learning automata		
Instance-based learning		
Regression analysis		
Linear classifiers		
Decision trees		
Bayesian networks		
Hidden Markov models		

Machine Learning Models

The machine learning model refers to the model that is created in the training process. The training process contains the following steps:

1. Providing input training data source
2. Providing the name of the data attribute that contains the target to be predicted
3. Providing required data transformation instructions
4. Providing training parameters (factors used by the model to group patterns or make decision) to control the machine learning algorithm

Training ML Models

The process of training a machine learning model includes providing an ML algorithm (that is, the learning algorithm) with training data where it learns from. The training data is supposed to contain the correct answer. This is commonly known as the *target attribute* or in short, the *target*. The machine learning algorithm finds the patterns in the available training data set. After that, it maps it to input data attributes to the target (the answer or result that you want to predict), and it outputs an ML model that gathers or captures these patterns.

At this point, it is necessary to clearly understand the difference between machine learning algorithm and model. Learning algorithm gives the model as its output. Let's consider an example to understand this. Linear regression algorithm is a technique to fit points to a line $y = mx + c$. Once the fitting happens, you get the result, in this case for example, $y = 12x + 6$.

Different Types of Algorithm Based Models for Machine Learning

Your model will run iteratively and give you the result. So technically you can create multiple models based on the algorithms. A few famous models are discussed next. This gives you insight into how these models work based on algorithms. The rest of the models and their algorithmic association are discussed in detail in the next chapter.

Binary Classification Model

The binary classification model predicts a binary outcome. Amazon machine learning uses the industry-standard learning algorithm, logistic regression, to train binary classification models. The next sections list some examples of binary classification problems.

It enables the system to answer these questions:

- Is this email message spam or not?
- Will the stock price go up?
- Was this file review written by a customer or a robot?

Multiclass Classification Model

This model permits you to produce predictions for many classes (it can predict one out of more than two outcomes). For providing training to multiclass models, organizations generally consume learning algorithms like multinomial logistic regression. Here are some examples of multiclass problems.

They enable systems to answer these questions:

- Is this product a car, a bicycle, or a bag of chips?
- Is this book an action, thriller, or a love story?

Regression Model

These models are generally used to predict a numeric value. For training regression models, enterprises use learning algorithm known as linear regression. The basic assumption in this model is that the output variable can be articulated in the form of linear amalgamation (weighted sum) of a group of input variables. Here are examples of regression problems:

- What will Delhi's temperature be tomorrow?
- For this share of this company, how many units would be sold?

As mentioned earlier, multiple important models do exist apart from these, and they are covered in the next chapter.

Tools for Machine Learning

Google, Microsoft, IBM, and Amazon and a lot of other innovative companies are offering machine learning APIs and tools via their respective cloud platforms. This actually makes life easier and APS (applications, products, and services) are built quickly. Tools are one of the most important parts of the machine learning ecosystem. Choosing the right tool depends on multiple factors including requirements. Also, it is as significant as working with the finest available algorithms for executing your project or strategies. Machine learning related tools equip you with capabilities to deliver results smoothly. In the current scenario where deadlines are stringent and stiff, appropriate selection of tools serves as an integral weapon. Also, they are the important part of architectural decision and strategies. At the project level, selection of the appropriate tool plays a very important role.

JARGON BUSTER

API (Application Programming Interface): A list of instructions as well as the setup of those instructions that one application can send to another. Also, it is a description of how a software application/component may intermingle or communicate with other software application/components. It is used in a way so that an individual program can interconnect with another directly and use each other's functions in a well-defined way.

Platform: A complete all-in-one solution for a very extensive range of problems. For example, Microsoft .NET or Windows platforms provide a solution for multiple problems. Multiple vendors are providing “cloud” based platform, commonly known as Platform-as-a-Service (PaaS) solutions. A platform may include a number of tools and components. In turn, tools and components may be helpful in solving wider ranges of problems like persistence, security, concurrency, etc. Generally, a good platform would fulfill all your needs that are desired to build your system. A platform comes with a pre-selected set of technologies, tools, components, and libraries and you have to choose among them what you want to use for your system (which you are going to develop/modify). A platform is a fundamental entity; think of it as a service provider. The platform provides services to run/install tools and frameworks; once that is done, things run on top of that.

Framework: Uses the features and functionality provided by the underlying platform(s) to achieve the job. For example, a framework may serve as a tool for the developers to gum the various parts and sections of the logic. A framework offers a layer of abstraction over multiple parts of the underlying platform. You can run multiple frameworks on top of a platform. For example, based on your project requirements you could run the same framework on dissimilar platforms. For example, you can run .NET core framework on Windows and Linux (platforms), whereas .NET framework 4.5 will run only on the Windows platform.

Tool: An apparatus for doing specific functions in software while coding or performing specialized tasks while doing system design. It has predefined inputs which deliver predefined outputs. A toolkit is like a software development kit—it is a collection of tools that includes code libraries and components as well, and it generally saves coding efforts because it has complied and organized tools and libraries.

Library: A portion of code that you can call from your program to perform tasks more quickly and easily. For example, an input and output (I/O) library will provide facilities for loading and manipulating input, output, and file (in the form of pre-coded and compiled code chunks). This enables you to complete your tasks fast and saves time because you need not write all codes/programs by yourself.

Tools can be helpful in automating tasks and steps in machine learning process so that human intervention is less in the overall process. Also, this makes development faster. The time you save by using tools can be invested in more productive tasks. In both the cases, either you choose to complete your tasks by tool or on your own—you have to research and invest time. However, the difference is the return and value you achieve on your invested time is more in the latter case.

Before selecting a machine learning tool, it is always good to evaluate the tool based on some trial and tested parameters. These parameters are applicable to almost (until you do not have very specific requirements) any tool selection and not limited to only machine learning tools.

- *Intuitive and intelligent interface:* As it is understood that machine learning involves a lot of complex activities. For example, mapping of subtasks to the main tasks, model creation and execution, associating training data set with the selected model and algorithm, and monitoring the progress. Hence, intuitive and intelligent interface becomes very important. So, while selecting any tool, it should be kept in mind and considered.
- *Alignment with best practice and standard:* Tools must be aligned with the best practice, standard, policies, and the prevailed patterns and practices. Without these, the output generated by the tool is of no “standard” value.
- *Updated and supported by the community:* While selecting tools for machine learning projects, it is important to check that it must be well-supported by the community, contains good documentation, and is updated on a frequent basis by vendor/open source community. All this is bare minimum for a good tool. As machine learning itself is an evolving and dynamically changing technology, selecting an appropriate tool that contains the “bare minimum” increases its value.

A machine learning tool generally provides the following:

- *Application Programming Interface (API):* Machine learning based tools generally provide a huge collection of an application programming interface, which gives you the flexibility to decide what elements to use and exactly how to use them within your own programs/code/software.
- *Graphical User Interface (GUI):* Machine learning tools generally provide a GUI, which simplifies the tasks you are doing by giving you access to interacting windows, timely alerts, capability to see the data visually, associate, integrate and map, providing information and facts in visualized form, etc.
- *Command-line interface:* Apart from GUI, there are scenarios when you need a lighter version of productive tools which enable you to perform your tasks quickly. Hence, a good machine learning tool generally provides interactive command line interface. This includes facility for doing and executing programs and commands through the command line. Also, it enables command-line parameterization.

Frameworks for Machine Learning

A large volume of data and computational power is required to create, perform, and execute machine learning based systems. The cloud is an ideal environment for developing and hosting machine learning applications. Several companies are already offering these applications and services. For example, Microsoft is doing this through its Azure ML frameworks in pay-as-you-go mode. To perform tasks in the cloud environments, you need good frameworks and toolsets apart from other important ingredients, like libraries, API, and SDKs from the technical side and good working business model and strategies from the business side. However, whatever you do or get, having a good framework that's up and running is one of the "bare" minimum requirements for your machine learning related endeavors. Machine learning frameworks allow you to create and train models. Once the model is created and trained, it provides functionality to turn them into APIs that can be used or consumed by other services. New generations of machine learning framework offer a wide range of facilities to convert or transform algorithms to models.

The following list presents a snapshot of machine learning tools, libraries, frameworks, and APIs.

- *Caffe*: It is a deep learning and machine learning framework. It was developed by keeping expression, speed, and modularity in mind. Companies who uses this: Flicker, Yahoo, and Adobe.
- *Google TensorFlow*: Implements data flow graphs, where batches of data ("tensors") can be processed by a series of algorithms described by a graph. Companies who uses this: Arm, Google, Uber, and Airbus.
- *Matlab*: It is a high-level technical computing language and interactive environment. It is commonly used for algorithm development, data visualization, data and numerical analysis. Companies who uses this: Shell, Netflix.
- *Microsoft Azure ML Studio*: Allows users to create and train models in real time. It also enables users to turning the models to APIs, so that they can be consumed by other services. Companies who uses this: ESSAR GROUP, CloudMunch, and ICICI Lombard General Insurance Company Ltd.
- *Spark*: A fast and general-purpose engine for large-scale data processing and analysis. Spark exposes its APIs in Java, Scala, Python and R. Spark also provides the feature of batch and streaming API. Companies who uses this: IBM, Google.
- *H 2 O*: A math library that's open source. It is written in Java and provides support for native Java API drivers for R, Python, Excel, and Tableau REST APIs. Companies who uses this: IBM, Google.
- *Sprinkling Water*: Sprinkling Water is a framework that is generally used for integrating Spark and H2O. It provides flexibility of transparent use of H2O data structures and algorithms with Spark API and vice versa. Companies who uses this: Netflix, IBM.

Distributed Machine Learning

Modern machine learning algorithms work with any type of data. But when the data is large, it takes a lot of time for processing and predicting. However, there are a few techniques available to make algorithms run faster.

- Reducing algorithm's complexity
- Implementing optimization techniques
- Reducing the amount of data, wherever possible
- Writing distributed algorithms that run on different machines and "distribute" data and processing load on multiple machines
- Using efficient tools to reduce the processed chunks of data

Out of all these techniques, applying distributed algorithms is most practical because you are not compromising on anything. Also after commoditization of hardware, the price of hardware will come down, so the cost impact will be minimal. In fact, this way of processing allows you to use your resources most effectively and efficiently. This processing paradigm is known as *distributed machine learning*. Here are the few characteristics of distributed machine learning:

- Data-centric because it enables you to train the model over large data set, and split the data over multiple machines in the distributed environment.
- Model-centric because a large number of models are involved in data crunching and training.
- Distributes models split over multiple machines. However, a single training iteration spans over multiple machines.
- Graph-centric because mapping (of different machines) is done in a graphical way.

Large-Scale Machine Learning

The tremendous increase of (Big) Data requires a robust machine learning system whose models are capable of handling millions to billions of parameters effectively and efficiently. The system must have the capacity to digest enormously big data sets and offer accurate predictive analytics. Traditional machine learning systems that processes the data sequentially in consignment or scholastic fashion by using typical iterative ML algorithm are inefficient in handling huge data. Hence, it is natural that the demand for large-scale machine learning (ML) systems is picking up because they are capable of learning from complex models with millions to billions of parameters in order to support the processing needs of machine learning algorithms at this large scale. The system needs to operate on distributed clusters with 10s to 1000s of machines.

Large-scale machine learning is very different from traditional machine learning because it involves relatively huge amounts of data. It manipulates a high number of training/test instances, features, or classes. For example, Flickr, Instagram, and Facebook use machine learning systems which possess 10s of billions of images at any given point in time. Large-scale machine learning involves data sets that have:

- More than 100 billion training examples
- More than 100 billion features
- Approximately 100 features present per training example
(sparse data)

A lot of traction is given to the research from enterprise and academia to develop large-scale machine learning systems that would provide scalable, efficient, fault-tolerant, parallel systems that perform learning tasks on huge amounts of data. This results in some great systems, algorithms, and techniques, like Petuum and MapReduce.

Programming Languages for Machine Learning

Selecting a programming language to program “critical tasks” for any technology is a difficult and intelligent decision. It depends on multiple factors based on the requirements and relevance of a particular business scenario. It becomes more challenging when it is associated with machine learning and cognitive computing because the process of programming involves imbedding intelligence in the raw program and a lot of data manipulation and crunching capabilities. However, while making coding strategies, if the factors described next are considered, it definitely helps as they provide insight and guidelines to choose the appropriate language. Parameters like speed, programmability, library support, built-in functionality of the language, open source community support, and scalability are discussed in brief.

- *Speed of developing program:* Speed is very important whether programs are developed individually or by a team. Factors like how long it takes you to write code become crucial in tight deadlines. However, some other associated factors like how long it takes you to find a solution to the problem and the facility of finding the bugs quickly are also important.
- *Ease of programming, learning, and understanding:* The easier the programming language is to learn and understand for developers, the faster they become productive. For example, Java is an easier programming language to learn than C++, and C is probably even easier (however, this is very subjective and depends on the coder’s exposure to the particular programming language) as almost all the programs are written once and read multiple times. Thus, it is vital that the reader should interpret and understand the essence of the program easily and be able to understand what’s happening. Other important factor is syntax of the programming language, which is generally overlooked, but it can make a huge difference in the ease of learning to program and using the language.

- *Library support:* For machine learning programming languages, good software library support is very important, which must include support for data structures, interfacing with the operating system, and statistical and data crunching capabilities. The Perl programming language has a huge number of third-party libraries, which makes it a suitable choice for developing machine learning systems.
- *Built-in functionality languages differ in terms of the primitives that are available.* While choosing a programming language to perform a task, it is important to figure out its built-in functionality to support that task. For example, to accomplish machine learning related requirements, the language must support statistical, predictive analytics and graphics. Good built-in capabilities are mandatory.
- *Scalability:* It is where otherwise higher-level languages are often genuinely tested. While choosing a language for coding, one has to be careful about the scalability part of the language.

Apart from these parameters, portability, performance, and fit-for-purpose are some additional factors that you need to consider before making your choice. The sections that follow present a snapshot of the main programming languages for machine learning with the “pros” and salient features. It will help to quickly compare the available choices. The following sections can serve as a handy toolkit for making decisions.

R

R is a free software development environment for statistical computing, graphics, data mining, and machine learning based computing. It compiles and runs on a wide variety of available platforms, including UNIX, Linux, Windows, and MacOS. R is termed as one of the most popularly used software packages and programming languages. It is popular among statisticians, industries, enterprises, and researchers for providing excellent and elegant statistical coding/programming features. R provides more than 4000 specialized packages, which are primarily targeted to leverage statistical features. In a nutshell:

- R is data analysis software package.
- R is also used as a programming language.
- R is an environment for statistical analysis and data crunching.
- R is an open-source software project.
- R is popular within the community of statisticians, data analysts, and data scientists across the globe.

Why use R?

- *Data manipulation capabilities:* R equips the data scientist to form the data set into a format that can be easily retrieved and analyzed by dividing large multivariate data sets.

- *Data analysis functionality:* A huge variety of statistical data analysis features can be available in R. R is an open source development tool/environment/programming language. It is supported by a large community of statisticians, programmers, hobbyists, and computer scientists. One of the reasons for its popularity is that it provides multiple efficient functions for hypothesis testing, statistical model creation, and fitting. It also provides several robust clustering techniques for efficient and effective implementation of machine learning algorithms.
- *Data visualization:* R is established as the “statistical package of choice” for data representation, analysis, and visualization. As a programming language, R provides a lot of ready-to-use functions for visualizing data in the form of graphs and charts. R equips developers to implement any visualization idea for any data set. R data representation is not limited to static representation of data visualization; it also provides capabilities for implementing animations and other innovative interactive visual techniques for representing data.
- *Excellent usability:* R programs have explicit capabilities to document the steps involved in the analysis. Hence it makes it easy to imitate and/or update analysis. This functionality enables developers to quickly try and test multiple ideas and, if required, correct issues instantly.
- *Integration facility:* R provides great integration features with other popular languages like C/C++, Java, and Python. Also, as it has native support for ODBC, which enables it to talk with multiple data sources, like Excel, Access, and other ODBC compliant databases (Oracle, SQL server parallel database) and so on, it integrates well with statistical packages (such as SAS, Stata, SPSS, and Minitab).

R is not only free, but is open source as well. This practically signifies that anybody (if they want) can inspect the available source code to see which code is implemented to perform a task and get insight out of it to explore it further.

Scala

The Scala programming language is a combination of functional and object-oriented programming language. It runs on the Java Virtual Machine. Its .NET version is also available, which empowers it to run on .NET environment as well. Scala is based on the idea that there are a lot of commonalities existing between functional and object-oriented programming languages. As a functional programming language, Scala provides pattern matching (which is very useful for machine learning bound programming) capabilities. Whereas as an object-oriented programming language, it provides functionality of object

orientation like facility of using class and polymorphism. Scala has inherited a lot of features from Java but apart from that, it has a lot of other features as well which are not in Java. In a nutshell:

- It uses revolutionary and innovative frameworks (e.g., AKKA, Finagle). These were developed in Scala itself and allow us to develop reactive systems.
- Scala provides excellent pattern-matching capabilities, which is very useful in machine learning based programming.
- Scala uses functions as a first-class object.
- Scala has great support for higher order functions. So, developing higher order functions in Scala is easy.
- Scala runs on top of the Java virtual machine. Hence, it provides seamless integration of the Scala code with code written in Java.
- Scala is easily integrated with .NET framework. The code written in Scala can be compiled into CLR byte code.

Why use Scala?

- *Functional language:* Most of the functional languages provide a toolset to developers, programmers, and data scientists to implement iterative computations and do predictive program development. Scala is not an exception, it too provides a rich toolset of functionality and capabilities to the developer community. You can see Scala as an extension of the MapReduce programming model for distributed computation. Scala handles large amounts of data very efficiently. Scala provides most of the vital elements, components, APIs, and tools required for doing machine learning programming. It is also a good choice for doing statistical analysis.
- *General-purpose programming language:* Scala is a general-purpose programming language. It is designed for rapid development of common programming patterns in a concise, sophisticated, and type-safe way. Scala effortlessly integrates features of object-oriented programming (OOP) and functional languages. Hence it makes developers productive to their fullest. As it is fully compatible with Java, it effortlessly retains full interoperability with Java and benefits from modern multicore hardware features. Scala fundamentally avoids a shared state, so calculation and computations can be readily available to be distributed across centers (cores) on a multicore server, and across servers in a data center. This makes Scala a good fit especially for contemporary multicore based CPUs. Also, it has excellent support for distributed computing architecture, so it best suits cloud-computing workloads. Cloud computing workloads require concurrency and parallelism which is easily achievable through Scala.

- *Compact:* Scala type inference and other compact and timely features make it a concise and elegant language for machine language. For example, it typically enables developers to reduce the size of source code by the factor of two or three compared to Java. Scala comes with a rich set of development and productivity enhancement tools. Therefore, developer productivity is much higher in comparison to the developer of the languages like Ruby or Python (if they use the features correctly).
- *Scalability:* Scala has multiple highlights, one of them is scalability. Whether it is a large development team, large codebases, or large numbers of CPU cores, Scala scalability is never compromised. Also, for multi-core and distributed computing models, the pairing of Scala with platforms like Lightbend reactive platforms enable it to develop even an industrial-strength implementation. A concurrency model called Akka combined with Scala provides it special power for handling large-scale machine learning based project implementations.
- *Interoperable with Java:* Since Scala is a Java Virtual Machine (JVM) targeted language, all the existing Java libraries and tools can be used seamlessly with it. It ensures that previous investments of effort, money, and intelligence are fully protected.
- *Programmability:* Scala programs are compiled directly to Java bytecode. In turn, bytecode runs on the Java virtual machine or JVM. JVM is very mature and stable. Scala leverages the Java virtual machine's great features like just-in-time compilation, automatic garbage collection capabilities, and excellent deployment techniques. These features make it a very efficient programming language. The learning curves for developers in Scala are easy and fast, as they keep working on their familiar tools and learn it in parallel without much effort. Scala enables developers to start writing code which is more concise, faster, scalable, and is even more fun.

Python

Python is known as an interpreted and interactive object oriented high-level programming language. It is called a strong general-purpose programming language. This language places strong emphasis on code reliability and simplicity so that the programmers can develop applications rapidly. It is a multi-paradigm programming language, which allows users to code in several different programming styles. In a nutshell:

- Python supports cross-platform development and is available through open source.
- Python can be easily integrated with C/C++, .Net, and Java.
- Most programs in Python require considerably fewer number of lines of code to achieve the same functionality, which requires more effort and lines of codes in languages like C.

Why use Python?

- *Readability:* Python has good code readability for fast software development. A high level of readability is at the heart of the design of the Python language. Python uses a complete set of code style guidelines and “Pythonic” idioms. It increases readability of code written in the Python programming language.
- *Less coding effort:* Python is a productive language as it uses less code and provides more productivity.
- *Good support for mathematics and statistics:* Python’s applications span across multiple areas including Web, GUI, OS, science, and statistics.
- *Fast growing:* It is a fast-growing programming language among open source communities.
- *Flexibility:* Python is extremely flexible.
- *Good numeric and symbolic features:* It provides numeric and symbolic computation features.
- *Good plotting features:* 2D/3D plotting is easy in Python.
- *Machine learning compatible:* Useful for scientific and machine learning related tasks.
- *User interface support:* Great support for user interfaces.
- *Support for advance computing:* Support for parallel and distributed computing.
- *Excellent pre-built libraries:* Special libraries for machine learning and image processing.
- *Developer friendly:* Game and web development functionality, which attracts all type of developers.
- *It is here to stay:* Python is not going away anytime soon.
- Python is easy to set up.

POV

Some valuable insight is provided by Adam Geitgey, Director of Software Engineering at Groupon:

<https://jaxenter.com/python-popular-programming-language-today-machine-learning-128942.html>

Latest Advancements in Machine Learning

Until now in this chapter, I have discussed breakthroughs in machine learning that happened in the last few decades. Also, I described how Big Data streams affect technologies like high-speed Internet and cloud computing. However, there is a lot of innovation happening in areas closely associated with machine learning, like deep learning. Deep learning keeps machine learning at its core, but its implication is wide. It spans across recommendation systems (Netflix and Amazon), face recognition technology (Facebook), email spam filters (Google and Microsoft), and speech recognition systems such as Apples Siri.

The depth of advancement is generally unknown to general users until it becomes public. But based on the speed of progress, we can say with high certainty that developments that happened in the past five years will be almost nothing compared to what we're going to see in the five years to come. Based on the current state of machine learning's technical development and traction, here are a few areas where we definitely see something exceptional:

- *Image-based recognition:* With the help of deep learning, the current state of image based recognition will take a quantum leap as a lot of research is happening in this area. For example, machine learning based system/application will recognize images and identify people and their actions within picture/image, with high accuracy. The best part of it is that the system or application will be able to do it based on the image alone with less dependence on external data. Modern deep learning algorithms and models will not only be able to recognize just new pictures but also they will gather insight from pictures of entire human history and video footage. This will transform the way these assets are organized, located, viewed, and shared. For example, YouTube might soon be able to intelligently find content related to parts of a clip or video footage that you watched and liked. It will be done only on the basis of visual content of the video itself.

CASE STUDY: FACE RECOGNITION

Challenge

Design a face detection and recognition algorithm for applications across multiple domains.

Approach

- Created a databases of faces and performed face detection using the Haar cascades algorithm.
- Matched captured face images in the existing database of facial images of people.

- Used face recognition algorithms using the principle component analysis.

Result

- Achieved accuracy close to 60% for face recognition and 70% for face detection.
- Can be applied to strengthen security measures in organizations or identify and provide offers to repeat customers in retail stores.

Source: *Blueoceanmi website*

- *Healthcare*: The ability of machine learning to analyze and store massive amounts of data (in association with Big Data technologies) will provide doctors and patients much-needed second opinions in real time. This will enable them to diagnose and provide treatment of medical illnesses in an on-demand fashion. IoT enabled smart, wearable computing devices or personal health monitoring systems that detect various health and fitness conditions in real time and send notification to you make you less prone to diseases. Latest advancements in this area will make these technologies widespread in the next five years. Wearing these devices might become a necessity as having a mobile phones today is. The researcher tries to bring these “intelligent” devices close to us because this would significantly quicken our desire to protect ourselves by increasing quality longevity. Machine learning is actually leading a silent revolution in the field of healthcare by fueling breakthroughs to its innovation.
- *Travel and communication*: Real-time translation technology is the area on which a lot of industries and enterprises are betting. In the near future, we will see applications on our phone that will instantly translate voice and texts (all types of conversations) of the listener or user to his/her native language. The applications would do it so flawlessly that the listener would not even be able to know the difference. After the shaping of the globalized world, the language lines have become blurred. Business/enterprises are in continuous pursuit of taking benefit of this new global market. Tech giants such as Google and Microsoft sensed the demand of the market and started taking the necessary steps to build such tools. A few early offerings from them are Google Personal Assistance and Microsoft Cortana. However, these are just the beginning. Based on the current state of research, be ready to be flooded with such applications/products and services in the near future.

- *Advertising:* Recent advancements in machine learning enables advertising firms to integrate augmented reality technology with branding. This will allow advertisers to seamlessly place products and service information into existing content by appropriately recognizing the depth, comparative and quantifiable size, and lighting and shading of the products and services. Also, this will not be limited to just new content; it will be extended to any content. Hence, this will enable advertising firms to fundamentally make any historical video property to be available for integration with new technology. For example, the computer vision technology firm Mirriad has already implanted this. This advancement in technology will revolutionize the capabilities of advertising firms.

JARGON BUSTER

Virtual reality technology provides facility for the creation of real-life simulations or reproductions. It generates an immersive involving environment for the users to make them feel as if they are interacting with their digital environment in the real life.

Augmented reality provides coatings for digital enhancements geared to supplement the prevailing real-life situation by appealing to the senses. The fundamental elements of virtual reality come to user's life through a headset/other VR devices worn by the user. Typically, these virtual reality devices display or project simulation of a real-life environment. The surroundings provided by the devices are immersive, interactive and give the feeling of a real-life environment. As virtual reality devices are available in a variety of price ranges and styles, it is easy for business companies and users to use this technology for their business purposes. For example, real estate industries can use these technologies to provide their prospective customers the real-life feel of a property for sale. Augmented reality is a powerful, sophisticated, portable and cost-effective technology. It enables consumers to access an interactive, rich and meaningful experience with a company or brand that promotes their services or product through augmented reality based technologies.

Machine learning based products, applications, and services are commercializing at a very fast speed due to this innovation driven market. These areas are only a few out of many others. Almost all sectors (verticals and horizontals) of the economy are affected enormously by the efficiencies and effectiveness of this new era of machine learning. We are already witnessing an increase in consumer demand for predictive applications and products which essentially require machine learning. At the moment, we are just at the surface of what is possible. If things continue on the trajectory we expect, the golden age of machine learning might very well make the next five years in technology the most exciting yet.

Case Studies

This section contains two final case studies.

CASE STUDY: MACHINE LEARNING TEXT ANALYTICS

Challenges

- The client is capturing consumer conversations from multi-channel sources (tech forums, call center agent transcripts, email, and chat).
- They are currently categorizing the customer experience (text data) manually on a minimalized sample basis, which does not provide a holistic view of customer experience insights.
- The goal is to automate text classification on the entire data population that will enable them to gather detailed insights on the customer experience.

Approach

- Data received had a breadth of topics and had six levels of classification for each row. Level 5 has the highest number of distinct nodes at 4277, followed by Level 3 at 616 nodes.
- Merged and cleaned the forum, agent transcript, chat, and email data to create 130,000 rows of training data.
- Initial focus of the work was to simplify the complex hierarchical structure to ensure appropriate classification as per business requirements.
- Designed a comprehensive natural language processing based rule set and developed a machine learning algorithm to build an auto code engine to ensure most categories would be captured.
- Business rules were created and combined with the synonym sets to build the model.

Result

- Achieved accuracy close to 70%.

Source: *Blueoceanmi website*.

CASE STUDY: AUTOMATION REDUCES RESOLUTION TIME BY 50 PERCENT

Challenges

With nearly half a million support cases and over 900,000 emails coming in over a seven-month period, a leader in the gaming industry needed to improve the efficiency of their customer support process. The support team relied heavily on response templates, but there were more than 8,500 response templates available. Also, there is no effective auto response mechanism or template selection process available for representative to help them quickly choose the best one. Although their support software recorded how often each response template was used, it didn't provide information about which template was used on which cases, leaving support technicians starting from scratch every time a ticket came in.

Approach

Wise.io worked hand-in-hand with this company to help make their template library much more usable and useful. By applying sophisticated natural language processing (NLP) techniques, Wise.io was able to identify duplicate templates that could be removed from the library. Wise.io then developed an application that recommended the most appropriate templates based on responses to similar cases in the past. Recommended responses were shown directly within the agent view so that customer service representatives were able to take advantage of the suggested templates without learning a new workflow.

Results

Using this automated identification approach, this gaming company was able to reduce their library of templates by over 90%, making agent training and usability much easier to manage. In addition, by presenting their customer service representatives with recommended responses, median resolution time decreased by over 50%, indicating that agents could resolve twice as many tickets in the same amount of time or could engage more deeply on the customer issues that really needed more attention.

Source: *Wise.io website*

Audio and Video Links

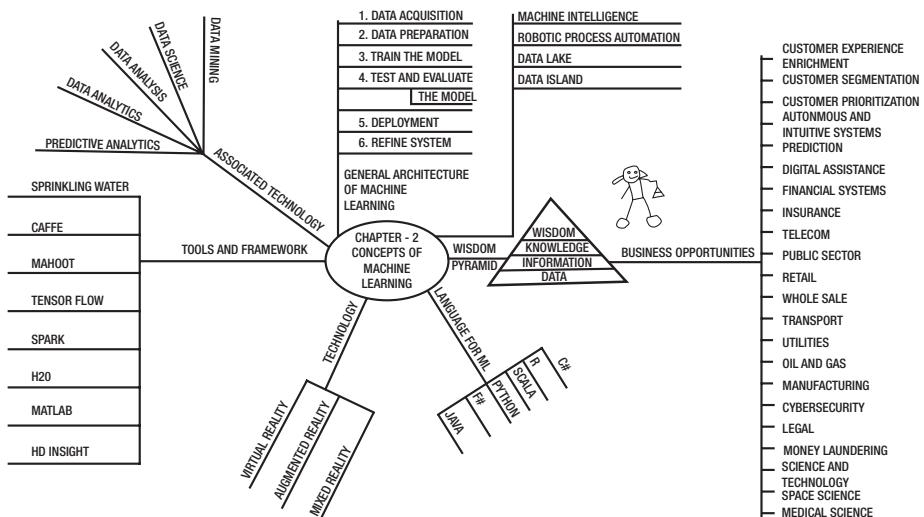
Watch these talks about some really interesting applications of Data Mining and Machine Learning:

- https://www.ted.com/playlists/56/making_sense_of_too_much_data
- <http://iasaglobal.org/3-iasa-august-esummit-machine-learning-101/>

Summary

This chapter presented a thesis of basic practical machine learning concepts in brief. At the same time, it was discussed evolution and history of ML in context of artificial intelligence and brain science. The chapter provided a snapshot of concepts like generalized machine learning architecture and discussed its associated components. Details of business opportunity in context of machine learning which exist in the multiple areas of industries, domains, verticals and horizontals were presented. With the help of innovative “WISDOM” umbrella of prospects, a futuristic look on the possible seen and unseen opportunities were discussed. This chapter also provided a glimpse of tools, frameworks, libraries and APIs of the machine learning ecosystem.

Mind Map



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- Hailin Jin. "Collaborative Feature Learning from Social Media" 05/28/2015 [Talk given @ GPUTech conference 2015](#)

CHAPTER 3



Machine Learning Algorithms and Their Relationship with Modern Technologies

In this chapter, I provide the executive summary of the machine learning algorithms. I do this because for any decision maker it is important to understand, analyze, and evaluate the ground level reality of the business and technological landscape. This is equally critical for managers, because proper understanding of algorithms and associated technologies will make them more confident to manage their projects in a better way. It becomes more crucial when it comes to machine learning based project implementations and strategies because of the high technical aspects of the subject. Hence, having a practical overview of the algorithms and their behaviors in real-time business scenarios will enlighten you to make accurate decisions and define thoughtful roadmaps for your teams and organizations.

Algorithms are the soul of machine learning process and technologies. But they are complex and difficult to understand. In this chapter, I have bridged the gap between complexity and understanding. I have explained algorithms in plain English with the help of examples, success stories, and practical scenarios, so that anyone can decode the underlying wisdom and use them.

Algorithms, Algorithms, Everywhere

An algorithm is sequence of steps that solves a problem. People generally associate them with computers. But why? To perform a task, computers need accurate instructions and steps. Thus, if we want a computer to solve a particular problem, we have to provide appropriate accurate instructions in the form of steps. In other words, algorithms are important for computers because they are the building blocks of their intelligence. More precisely, without algorithms, computers are just dumb boxes of materials and plastic. As a cell plays its role in a biological system, algorithms have similar significance in software. We can even draw a parallel between cells and algorithms for better understanding.

In the last few decades, hardware has increasingly become cheaper, more powerful, and more efficient. This advancement enabled mobile devices to run powerful machine learning, artificial and deep learning algorithms locally as well as in the cloud. This progression in hardware will bring deeper and more integrated machine learning algorithms to all the devices. However, to get the maximum benefit of ML, the cloud model is always advisable. Also, there is no hard rule of separation between local and cloud implementation of product and services. They work in conjunction. Algorithms have become a pervasive and indispensable part of business. For example, Shell uses algorithms for oil exploration and achieving market competitiveness, while Microsoft and IBM use them to provide innovative products to its customers. In these changing times, companies have started using machine learning algorithms for internal efficiency as well as to deepen consumer loyalty and trust. For example, viewers of Netflix trust algorithms to get personalized content for their enjoyment. Similarly, Amazon's customers believe in the algorithms to get some useful products and recommendations for their customized purchases.

The fact is that algorithms today are extraordinary echelons of productivity and intelligence to enterprises. Those that don't get on board soon with algorithms are at the risk. Metaphorically, it is similar to working on typewriters in the age of computer processors and keyboards. To reach this point of winning the confidence of the masses, algorithms have traveled an extraordinary journey (see Figure 3-1). It is good to look at evolution of ML algorithms.

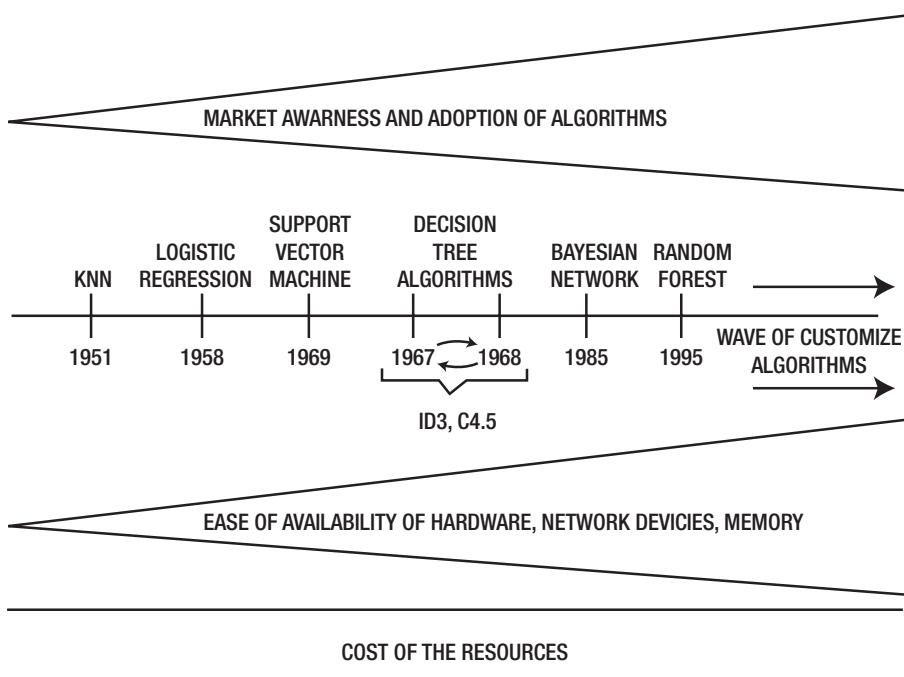


Figure 3-1. The evolution of machine learning algorithms and adoption

Classification of Machine Learning Algorithm

Data science or statistical algorithms are further classified into multiple machine learning specific algorithmic categories:

- Supervised learning algorithms (label and output known)
- Unsupervised learning algorithms (label and output not known)
- Reinforced learning algorithms (reward based agent action)
- Semi-supervised learning algorithms (mix of supervised and unsupervised)

These algorithms in turn again contain multiple sub-algorithms and types (see Table 3-1). For example, a few algorithms fall under the category of parametric, whereas others are non-parametric. In parametric algorithms, information about the population is completely known, which is not the case with non-parametric algorithms. Typically, parametric models deal with a finite number of parameters, whereas nonparametric learning models are capable of dealing with an infinite number of parameters. Therefore, when the training data grows, the complexity of nonparametric models increases. Linear regression, logistic regression, and Support vector machines are examples of parametric algorithms. K-nearest neighbor and decision trees are non-parametric learning algorithms. These algorithms are computationally faster in comparison to their non-parametric companions.

As Table 3-1 depicts, the machine learning algorithms are large in number.

Table 3-1. Machine Learning Algorithms

Supervised Learning	Unsupervised Learning	Reinforcement Learning
Artificial neural network	Artificial neural network	
Bayesian statistics	Association rule learning	Q-learning
Case-based reasoning	Hierarchical clustering	Learning automata
Decision trees	Partitional clustering	
Learning automata		
Instance-based learning		
Regression analysis		
Linear classifiers		
Decision trees		
Bayesian networks		
Hidden Markov models		

Algorithms can be further grouped into four categories for convenience and practical reasons:

- Clustering
- Regression
- Classification
- Anomaly detection

This grouping is helpful in understanding the algorithms and providing clarity. You can find additional classifications and categorizations in the literature available for machine learning. However, I follow and stick with previously mentioned categorization throughout the book. So, let's start the journey of exploring the wonderful world of algorithms with clustering.

Clustering

Clustering is the activity of collecting samples into groups according to some predefined similarity or dissimilarity measures. In simple words, in clustering, data in a particular cluster must be similar to the other members of that particular cluster (see Figure 3-2). Due to its peculiar properties of grouping of similar samples, for example, it is used for bundle customers into different market segments for a marketing or e-commerce company.

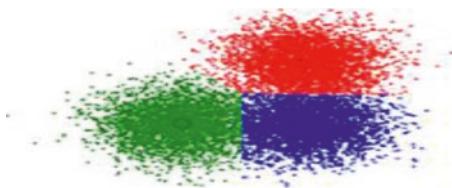


Figure 3-2. Clustered data

Some clustering types are mentioned here:

- *Hierarchical clustering*: Produces a tree of groups/clusters in which each node is a subgroup of its mother. It is a form of a parent-child relationship between clusters.
 - Pros: Preferable for detailed data analysis
 - Cons: Less efficient than non-hierarchical clustering
- *Non-hierarchical clustering*: The relationship between clusters is often left unsettled. Most non-hierarchical clustering algorithms are repetitive. They start with a set of original clusters and then repeatedly improve them using a reallocation arrangement.
 - Pros: Preferable if data sets are very large

- *Exclusive clustering:* An item belongs to one cluster not many.
- *Overlapping cluster:* One item belongs to many clusters.

K-means is one of the most widely used clustering algorithms.

Applications and Use Cases for Clustering

Here are some use cases:

- Does grouping based on similar functionality.
- Used for summarizing or reducing the size of large data sets.
- Customer segmentation.
- Image and video processing to identify objects in the video.
- Classification of plants, animals, and humans based on specific categories.
- Identify probable areas of oil exploration based on the type of seismic data.

When to Use Clustering

When the requirement is to discover structure in data sets, clustering is a good approach.

Regression

Regression is used for predicting values. For example, this category of algorithms provides you answers to questions such as, “what will the temperature be tomorrow” or “what was the total score of a sporting match”. Regression algorithms fall under supervised learning. Regression analysis is used to estimate the connection among two or more variables.

There are hundreds of regression types. The main ones are discussed here:

- *Linear regression:* A statistical modeling technique. It is used to examine the relationship between a dependent and independent variable. It is one of the oldest types of regression.
- *Logistic regression:* It is a statistical modeling technique. It is extensively used in the industries for multiple purposes, including fraud detection.
- *Polynomial regression:* A type of regression analysis that deals with the association between the independent variable x and the dependent variable y, which is modeled as an nth degree polynomial in x. In turn, the polynomial is defined as an appearance of more than two arithmetical terms, particularly the summation of numerous terms that comprise dissimilar powers of the same variables. It is used for cross-validation.
- *Ridge regression:* A modeling technique used for dealing with multiple independent variables that are highly correlated.

Here are the pros:

- Prediction and forecasting
- Used to find outliers
- Ease of use
- Uses data efficiently
- To provide support to business decisions based on data analysis
- To discover hidden and new insights

Now the cons:

- Sometime outputs lie outside of the range
- On long range assumptions are required
- Very sensitive to outliers

Applications and Use Cases of Regression

Some use cases:

- Forecasting
- Optimization
- Assessing risk in the financial services and insurance domains
- Analyzing the marketing effectiveness
- Demand forecasting in business and in government organizations
- Analyzing the effect of proposed radiation on tumors for reducing its size

When to Use Regression

When the requirements are to predict and forecast values, regression is a good fit.

Classification

Classification is used for predicting a category. For example, when an image needs to be classified as a picture of either a human or a machine, the algorithm to do so would fall under this category. It contains supervised types of algorithms. In case you have only two choices, the classification is known as two-class or binomial classification. When more than two categories are available, the set of algorithms used for their classification is known as multi-class classification. For example, while answering the questions like, “which car needs service most urgently”? Or “which flight will go from Delhi to

Atlanta"? For answering these questions, multiple choices are available. These types of scenarios are subject to study of multi-class classification. The sidebar provides a broader explanation of the differences between the classification and regression algorithms.

DIFFERENCE BETWEEN CLASSIFICATION AND REGRESSION

Classification	Regression
Classification algorithms group the output into classes. For example, it is used to find the answers of the questions such as, is this identified tumor cancerous or not.	Regression algorithms are used to predict the values using the training data. For example, it would be used in predicting the share price of a particular share of a company.
Disconnected and categorical variables are used in a classification problem.	Number and continuous variables are used in a regression problem.

The broader category of classification algorithms is:

- *Artificial neural networks (ANN)*: A computational model that mimics human brain functionality. It is created on the basis of the structure of biological neural networks.
- *Decision trees*: Broadly, a decision tree is a support instrument. That provides tree-like graphs or models for decisions. It also explains the various probable significances of the decisions, which includes but is not limited to chance event outcomes, resource outlays, and usefulness. It is one of the ways to present an algorithm.
- *Ensemble learning*: A machine learning based model where various learners are trained to solve the same problem.

Some examples of classification algorithms are:

- Linear classifiers
- Support vector machines
- Quadratic classifier
- Kernel estimation
- Boosting
- Decision trees
- Neural networks

- Random forest
- Naïve Bayes

Classification algorithms contain multiple sub-categories and therefore lots of algorithms. All the algorithms and categories have their own pros and cons. Here however, I have compiled some general pros:

- Super simple and easy to interpret and explain
- High accuracy
- Strong theoretical foundation regarding overfitting
- Easy correlation between data sets

Now the cons:

- Not very effective with huge data sets
- Easily over fit
- Hard to tune parameters
- Takes time to build the model

Applications and Use Case for Classification

Some use cases:

- Video, image, and audio classification
- Web page classification
- Product categorization
- To forecast likely bank loan defaulters based on behavioral and financial history of the customers
- Identify customer churn

When to use Classification

When the requirements are to predict and forecast categories, classification is a good tool.

Anomaly Detection

An *anomaly* is defined as something that diverges or deviates from what is standard, normal, or expected. There are scenarios when it is required to find and observe anomalies in the available data set. That “identified unusual” data point would help in detecting unique behavior (see Figure 3-3). For example, you could detect or identify a change in employee behavior that points to potential security breach committed by an employee. This activity would alert your employer to take corrective actions well before

the damage happens. Anomaly detection is also helpful with fraud detection. For example, any exceedingly uncommon credit card expenditure patterns would be suspected.

The method that anomaly detection takes is to learn from normal actions or activities. In the previous examples, algorithms analyze historical data of non-fraudulent transactions and recognize anything that is significantly different.

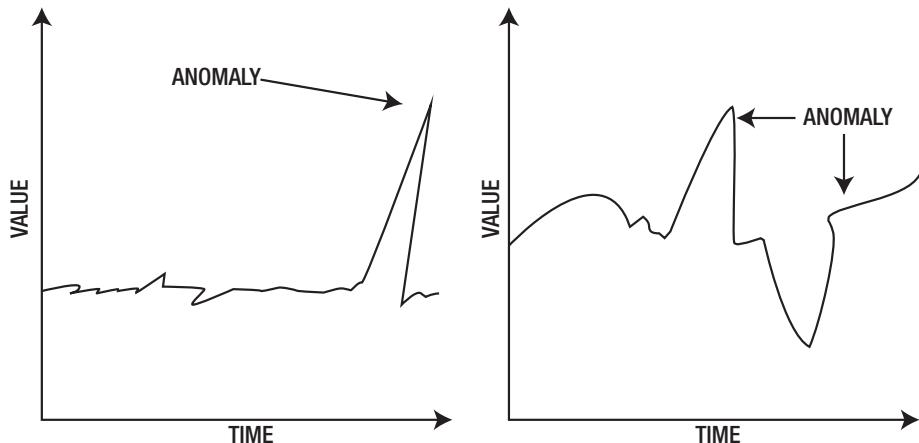


Figure 3-3. Anomaly detection

The broader category of classification algorithms is:

- *Supervised anomaly detection*: A set of techniques that detect outliers in the labeled data sets. Labels are available for both normal data and outliers.
- *Unsupervised anomaly detection*: A set of techniques that detect outliers in the un-labeled data sets. Labels are available only for normal data.
- *Semi-supervised anomaly detection*: A set of techniques that detect outliers in the unlabeled data sets. No labeled data set exists.

As anomaly detection algorithm contains multiple sub-categories and therefore lots of algorithms. All the algorithms and categories have their own pros and cons. Here however, I have compiled some general pros:

- No need to be supervised
- Easily adaptable in online mode
- Suitable for anomaly detection from the temporal data

Now the cons:

- Computationally expensive
- Cluster the data into groups of different densities, which leads to easy manageability

Applications and Use Cases of Anomaly Detection

- Credit card and other financial fraud detection
- Telecommunication and retail fraud detection
- Fault detection
- Unusual instance discovery
- Identifying incorrect data
- Network intrusion detection

When to Use Anomaly Detection

When the requirements are to find unusual data points, anomaly detection is the tool to use.

How to Select the Right Algorithm/Model for Your Requirements

Typically, model development and maintenance include multiple stages starting from collection of data to preparing and staging them. Again, applying different machine learning techniques and algorithms to find the most suitable model for the given need is very important. Continuously tweaking the parameters of the algorithms based on changes in the data set and refining the outcome is foremost important. Traditionally, to accomplish all this, a data scientist has to do lots of work. He has to code the model, select the appropriate parameters, including the runtime environment. Data scientists also have to train the model on data (including batch), monitor the process, and troubleshoot errors wherever required. Keeping track of all the steps in complete cycle is monotonous, as the flow repeats itself iteratively.

Finally, data scientists, in collaboration with other teams compare multiple models. They do so on the basis of the parameters like accuracy and performance. Best performing models are selected and deployed. Multiple teams and individuals are involved in overall model conceptualization to development to validation to deployment. In a nutshell:

1. Business expert define the problems.
2. Based on that data, experts identify the sources of data and provide a mechanism to gather and store the data using process, intelligence, experience, and technology.
3. Data scientists create actual models through the help of algorithms and then test and deploy the application or product. They do this with the use of process, intelligence, experience, and technology.

4. Business experts validate that everything is working fine or not.
5. This complete flow happens in an iterative manner.
6. Iterative execution of the flow helps to remove any errors and helps refine the model.

Using the right algorithm at the right place, time, condition, and scenario is very important. Also, associating algorithms with the specific requirements that fulfill them effectively and efficiently is an art and a science. The following sections present the summary of the algorithms.

Approaching the Problem

For implementation of any machine learning algorithms, there are many well written, tested, flexible, robust, and efficient libraries available in the new generation of programming languages. Also, they are customizable. Therefore, you can very well tailor them according to your needs. However, picking the best machine learning algorithm is a very subjective endeavor. It mostly depends on your requirements, tasks, domain, business needs, and available technical situations.

Moreover, selection an algorithm is based on the problem someone is confronting. For example, if the requirements are to work on a text classification problem, then a support vector machine is probably a good choice because it provides accuracy and efficiency. Whereas for recommendation based situations decision tree algorithm would be the good candidate for selection and proceeding. Thus, finding the best algorithm and method is a relative decision that's based on the domain and situation related to your specific requirements and depends on the problem and business need.

Choosing the Correct Alogorithm

When you have fewer options, making a decision is easy. For example, if you have continuous problem you need to solve, using the regression model is a straightforward choice, whereas if you have to select from binary options, using the logistic regression algorithm is advisable. However, this not always the case. We encounter multiple complex problems and requirements that we are supposed to resolve. Generally, the standard algorithm or customized/modified versions of them are applied to solve problems or requirements. Here are some best practices, guidelines, and standards that can definitely help you choose the right algorithm or model.

1. Data investigation and finding relationship between variables.
2. Rational choice and efficient comparison of algorithms and models.
3. Cross-validation.
4. Proper researched, carefully studied, and purified data.
5. Tool selection, ease of use, availability of infrastructure, talent, and other resources.

6. Determining appropriate objectives and business value.
7. Learn to translate business problems into machine learning algorithms.

Step 1: Data Investigation and Finding Relationships Between Variables

While selecting an algorithm, knowing the nature of data is very important, so that appropriate algorithm can be attached to the data set. For example, if the business requirement is to analyze unstructured data available in the form of video and image files, the associating algorithm(s) would have to efficiently handle unstructured and semi-structured data, such as text, time series, spatial, graph data, and images. Appropriate selection of algorithms will never be possible if you do not know the nature of your data.

Data investigation is an unavoidable part of building a correct, effective, and efficient predictive model. For the choosing right algorithm and model for your requirements, identifying the relationship and assessing the impact of the variables on each other and on the overall environment is required. To get a prefect model, the method and the parameters pertaining to that method must be selected well.

Finding the best values in order to get the highest possible accuracy in a given data set lead to intensive data investigation and finding the relationship between the variables. Intuition and experience help in getting the best results. Typically, a data scientist trains a large number of models, looking at their cross-validated scores and putting some thought into deciding what parameters to try next. They also do proper clustering or grouping for the best results. Multiple tools are available in the market that can be used for doing data investigation, including Microsoft Azure. However, manual methods and processes are also effective, provided the data set is less bulky.

Step 2: Rational Choice and Efficient Comparison of Algorithms and Models

One algorithm cannot fit all the requirements, so a logical, rational, and statistically supported (mathematics driven) comparison is required. The analysis of different metrics like statistical significance of parameters plays an important role here. For example, decision trees are a popular learning algorithm for doing prediction and suggesting recommendations. Hence, they are widely used by enterprise practitioners due to their accuracy. However, despite the popularity and adoption across industry, decision trees should not thoughtlessly be pickled as the algorithm for every problem. Instead, you should always use the algorithm that best fits according to the characteristics of the data and problem type.

Step 3: Cross-Validation

Cross-validation is a method for evaluating ML models by training multiple machine learning models on subcategories of the presented input data and assessing them on the matching subcategories of the data. Dividing data sets into two clusters or group and cross-validating them is an excellent way of getting the right model and algorithm for

the requirements. Cross-validation splits the training data into a number of partitions, commonly known as *folds*. Folds are nothing but splitting the input data into subcategories of data. After splitting, all the ML models are trained except one (all-1) of the subcategories.

The next step is to evaluate the model on the subcategories that were not used for training. This process is repeated multiple times (actually equal to the total numbers of folds), with a different subcategory kept for evaluation (and excluded from training) each time. Finally, the best performing model is selected. Cross-validation can take a long time to run if lots of data is used. Therefore, using the cross-validate model in the initial phase of building and testing is advisable. Cross-validation is often used to detect overfitting. Cross-validation is also one of the best ways to assess models that are used for prediction and forecasting.

Step 4: Proper Researched, Carefully Studied, and Purified Data

A study of the historical performance of a model and algorithm in a similar situation is helpful. Machine learning algorithms performance depends on data quality; they are as good as the data. Hence, improper data collection and cleaning methods will have a negative impact on your ability to build a good predictive, generalizable machine learning model. On the other hand, when carefully studied data is integrated with the automated tools in the supervision of subject matter experts would guarantee to provide excellent insights. Often following this process of data cleaning can be helpful in identifying data quality issues related to records, features, values, or sampling.

Step 5: Tool Selection, Ease of Use, and Availability of Infrastructure, Talent, and Other Resources

Selecting a tool to implement an algorithm is a very important step. Also, ease of implementation, availability of proper talent, and infrastructure/resources need to be considered before choosing an algorithm for a particular project. For example, the more data an algorithm processes, the more accurate, efficient, and effective it becomes. So, selecting a tool that would capable of handling huge data sets becomes the most critical aspect. Now, even if you selected the best tool, if you do not have the proper talent to use that tool, effectively the tool is of no use. Therefore, these interlinked aspects must be considered before making any decision.

Step 6: Determining Appropriate Objectives and Business Value

Understanding the hidden features in the data and then improving on them by creating new features and eliminating irrelevant ones has a high influence on predictability. Machine learning algorithms and methods are meant for handling the raw data and converting them to a rich feature space that can be effectively and efficiently exploited by companies for the appropriate business purpose. Hence, finding the collection of features used to characterize the data which would better capture various complex characteristics of it, such as nonlinearity and interaction/interdependence between multiple features, are required. These are also important for the succeeding in learning processes. Selecting the appropriate algorithms for determining appropriate

objectives would affect the business value is very important for definitive success for the applications and projects. Hence, while selecting an algorithm or model, this aspect must be considered.

Machine learning algorithms must be selected based on business problems. For example, some business problems—like fraud detection, product suggestion/recommendation, spam email detection, and ad targeting,—have “standard” machine learning formulations and algorithms available with a proven track record in those specific situations. However, even for these well-known problems, there are lesser-known but yet more powerful formulations available that can lead to higher predictive accuracy. So, selection based on knowledge, business objectives, and research is key.

Step 7: Learn and Develop Flexibility, Adaptability, Innovation, and Out of the Box Thinking

Some important business problems of our time—like fraud detection, product recommendation/suggestion, and advertisement targeting—are typically associated with standard machine learning algorithmic formulations. They are attached to specific formulations because those formulations are reasonably successful in practice. However, there are lesser-known but more powerful methods that have capabilities that could lead to higher predictive accuracy. Therefore, an innovative approach and out of box thinking is very important. Machine learning by nature is a very creative and experiment oriented field, so flexibility and adaptability is an important parameter for success. Lastly, translating business requirements to the actual implementation is an art and science, and it is the by-product of these qualities (flexibilities, adaptability, innovation, and out of the box thinking).

EXPERT OPINION

When a new technology is as pervasive and game changing as machine learning, it's not wise to let it remain a black box. Opacity opens the door to error and misuse. Amazon's algorithm, more than any one person, determines what books are read in the world today. The NSA's algorithms decide whether you're a potential terrorist. Climate models decide what's a safe level of carbon dioxide in the atmosphere. Stock-picking models drive the economy more than most of us do. You can't control what you don't understand, and that's why you need to understand machine learning—as a citizen, a professional, and a human being engaged in the pursuit of happiness.

—Pedro Domingos, a professor at The University of Washington, and a leading researcher in Machine Learning. He authored a book called *The Master Algorithm: How the Quest for the Ultimate Learning Machine Will Remake Our World*.

A Review of Some Important Machine Learning Algorithms

When an algorithm is considered for business or project requirements, a few aspects always need to be considered. This includes usefulness of the algorithm in different critical business scenarios, frequency of its uses, and so on. Finding the answers of questions like, “what is use of this algorithm in a specific project?”, “how efficient and effective is it?”, “how easily would it be to implement it?”, and “does this algorithm help in achieving business competitiveness?” become very important.

I picked a few algorithms on the basis of their popularity and on their prospects in the coming time. In the process of coming to a final conclusion, I asked multiple questions from the decision makers, developers, data scientists, and business analysts. I collected opinions of data scientists, business leaders, and project managers from varied sources, including market research, technical and process document crunching, company news analysis, market projections, financial insights, etc. This data is then analyzed before coming to a final conclusion. A couple of questions asked of them include:

1. Intensity of uses in the industry and enterprises
 - a) Poor
 - b) Average
 - c) Good
 - d) Very Good
 - e) Excellent
2. Future prospects in industries
 - a) Dull
 - b) OK
 - c) High
 - d) Very High
 - e) Bright

The basis of my analysis is the primary and secondary source of data available on the Internet, university libraries, and enterprise repositories. Some other sources included industry interviews, vendor briefings, insights from conferences, and product demonstrations given by companies. The case studies, whitepapers, research papers, technical articles, and historical performance of these algorithms in specific situations were also important sources of my research. In a nutshell, almost all the available quantitative and qualitative data was used for this purpose. My research is supplemented by the review and analysis of all other secondary information available on the topic, which includes available technology specifications information, product attributes, government economic data and technical vision documents, and industry reports and databases from third-party sources.

Based on responses to these questions, user answers are recorded. This was validated by the other sources of the information. Also, insight was generated by the use of careful studies of reports, case studies, product documentations, etc. On the basis of all this information, the future prospect of these algorithms was calculated.

The following sections discuss advantages, disadvantages, and applications of nine algorithms, along with other details, such as their history and creator. To provide practical insight, whenever possible, I included success stories. The top nine algorithms commonly used across the industry are discussed.

Random Forest Algorithm

Random forest algorithm uses a “catching” approach to create a group of decision trees with random subsets of data. Once the trees are created, their outputs are combined to make final predictions. The final prediction of the random forest algorithm is derived by either polling the results of all decision trees or by just going with a prediction that appears most of the time in the decision trees. One can say that a random forest is a group of a specific type of decision tree.

- Developed by: Tin Kam Ho in 1995. Its extension was developed by Leo Breiman and Adele Cutler.
- Type of algorithm: Classification/Supervised
- Intensity of uses in the industry and enterprises: Good
- Future prospects in industries: Bright
- Why use this algorithm: Random forests algorithm can be used for both classification and regression types of problems and requirements.
- When to use: When accuracy is important
- Who would use the Random forest algorithm: Teams/enterprises/organizations who are in online businesses and where categorization is important.
- How do we implement the Random forest algorithm: We can implement it through multiple ways, as many tools are available. However, Apache Mahout and Microsoft Azure ML are popular choices.
- Applications: Click stream analysis: e-commerce companies are using random forest algorithms to analyze and predict customer purchases based on the users' click history and current patterns. It is also used for voice classification and identification. For example, Google used it for Siri.

Advantages of Random Forest

- It is good in maintaining accuracy when there is missing data and for resisting outliers.
- It is efficient in saving data preparation time, as it does not require any input preparation.
- It provides benefits of implicit feature selection, as it estimates which variables are important in the classifier.
- It is generally effective on operating on large data sets. When the data set is large, random forest algorithms are advisable, because it is difficult to build bad random forest algorithms.
- It has a higher classification accuracy.
- Multiple random forest algorithms can be grown in parallel.
- It can handle thousands of variables without variable deletion.

Disadvantages

- It is easy to use this method practically but its theoretical analysis is difficult.
- It often tends to underestimate the high values and overestimate lower values. Also, it does not predict beyond the range of response values in the training data.

Success Stories

Baidu is a Chinese web company. Their artificial intelligence software called WRAP-CTC is used to improve speech recognition capability in their E2E speech recognition program called Deep Speech 2. The software recognizes English and Mandarin. In some cases, it is observed that the software performed better than humans. It is very difficult to say exactly which algorithm they use internally for achieving these functionalities in the software program. However, for classification and speech recognition related functionalities, Random forest algorithms are one of the choices along with other machine learning algorithms. The software is available for the open source community on GitHub. Source: Baidu research website (<http://research.baidu.com/institute-of-deep-learning/>)

Netflix is one of the pioneers in adopting machine learning technologies. They took a holistic and integrated approach toward ML. Netflix is using multiple algorithms for their business. Netflix is applying these algorithms to improve their customer experience.

Decision Tree Algorithm

Decision tree algorithms are a decision support tool/algorithm that use tree-like graphs to provide decisions. It is a branching methodology that demonstrates possible outcomes of a decision based on some condition. A decision tree is a simple depiction of classifying instances. Decision tree machine learning algorithms are one of the most widely used techniques for supervised machine learning.

A decision tree creates a type of flow chart, which consists of a node (known as leaf) and a set of decisions to be made based on the node, known as branches. The internal node (non-leaf) represents the attribute (labeled with input features). The arcs coming from a node are marked with a feature and used to represent each of the possible values or outcomes of the feature. Each leaf of the decision tree is marked with a class or a probability distribution over the classes. The classification rules are represented through the path from root to the leaf node. The leaf and branch structure form a hierachal representation that mimics the form of a tree. Decision tree is one of the most widely used algorithms for machine learning. It mirrors human decision making more closely than other algorithms. Three basic algorithms that are widely used under decision tree ecosystems are ID3, C4.5, and CART.

- History and development: Decision tree was developed by J. Ross Quinlan while he was associated with the University of Sydney. His first algorithm for decision tree creation was called the Iterative Dichotomiser 3 (ID3).
- Type of algorithm: Classification/Supervised
- Intensity of uses in industry: Good
- Why use this algorithm: Decision trees can be the best candidates for the linear decision boundary type of problem.
- When to use: When accuracy and speed are important
- Who would use the decision tree algorithm: Teams/enterprises/organizations who are in online businesses and where categorization/grouping is important.
- How do we implement the decision tree algorithm: We can implement it multiple ways, as there are many tools available. However, Apache Mahout and Microsoft Azure ML are a couple of popular tools to implement this algorithm. But again, it depends on the project scenario and requirements.

Advantages of Decision Trees

- It is fast, accurate (compared to other classification techniques), simple, and inexpensive to construct and classify unknown records.
- Generates understandable and easily interpretable rules.
- Gives a clear picture of which fields are most important for classification and predictions.

- C4.5, which is a decision tree and extension of ID3, is used in multiple industries for its ability to provide quick qualification and high precision.
- CART, another important decision tree algorithm, is very efficient in generating a regression tree, which is used in many industries where quick decision making is required, like the e-commerce industry.
- It is able to handle numerical and categorical data. This quality gives it an edge over the other algorithms because most of them are usually specialized in analyzing data sets that have only one type of variable. For example, relation rules can be used only with nominal variables, while neural networks can be used only with numerical variables.

Disadvantages of Decision Trees

- Decision trees performance is not good if there are lots of uncorrelated variables in the data set.
- Computationally expensive to train as it forms many subtrees, which are compared.
- Decision trees are generally easy to use, but making them, particularly huge ones with numerous divisions or branches, is complex. It is a time-intensive endeavor.

Applications of Decision Trees

- Used for multiple purposes during decisions making. For example, widely used for risk identification and analysis.
- Used for process optimization. For example, Shell uses it for their oil and gas based process optimization.
- Efficient and effective in classifying objects, products, and goods, therefore many e-commerce organizations use it. Some of the leading organizations that use these algorithms are Amazon and FlipKart.
- Used in the financial domain for optional pricing. Also, financial institutions like banks use these algorithms for classifying loan applicants to separate good customers from bad ones.
- Used in remote sensing based applications for pattern recognition.

Success Stories

The stock market is based on supply, demand, and economy growth. In the stock market, prediction is very important and several mathematical and statistical techniques are typically applied to stock market data to get better results and insights. Traders and analysts use an array of different approaches for predictions based on financial and customer landscapes, which are derived out from fundamental technical and psychological analysis. In the era of machine learning, multiple decision tree machine learning algorithms are used for price and share prediction. Typically, the traders and brokers use software powered by a combination of algorithms, like LR and SVR, along with decision tree algorithms to get effective and efficient results.

Logistic (Classification) and Linear Regression

Logistic regression algorithms are used to model the relationship between dependent and independent variables. They also look at the fitness of the model as well as the significance of the relationship of the dependent and independent variable being modeled. In linear regression, the relationship between the dependent and independent variables is linear, and this assumption is not made in the logistic regression.

Regression models are developed and built on the basis of historical data that contains dependent as well as independent variables. Typically, a dependent variable is a feature or quality that's measured using independent variables. Once this (generalization of dependent/independent variables) is done this can be used for future predictions using new cases.

Linear regression is used when the response is a continuous variable. Determining a figure of product sales or finding/predicting company revenue are examples. Logistic regression is used when prediction of categories is required (for two or more levels). Such as predicting a gender of a person on the basis of historical data or outcome of a cricket match. There are multiple types of regression algorithms, apart from logistic and linear. A few of them are:

- Polynomial regression
- Stepwise regression
- Ridge regression
- Lasso regression
- ElasticNet regression

However, logistic and linear are general purpose algorithms and most commonly used in the industry. Others are specialized and used for specific purposes.

- History and development: Regression techniques originate from the method of least squares, which was proposed by Legendre in 1805 and by Gauss in 1809. However, the term “regression” was used by Francis Galton in the 19th century to explain a biological phenomenon. Later, Udny Yule and Karl Pearson extended his work to a more general statistical context.

- Type of algorithm: Classification/Supervised
- Intensity of uses in industry: Good
- Future prospects in industry: Bright
- Why use this algorithm: Regression algorithm is best suited to the situation where prediction of the continuous values is desired and classification is not that important. Also, it is used for optimization of the result.
- When to use: When you need to determine factors that influence output. Regression algorithms could be used for impermanence studies as well.
- Who would use the regression algorithm: Any individual/team/enterprise who is interested in establishing relationships among data types. Logical regression is used by anyone who wants to generate insight from large, but simple, data sets.
- How do we implement the regression algorithm: We can implement it through multiple ways. For example, all major statistical packages and libraries provided by machine learning programming languages can do regression, including F# (Microsoft), R, and Python. Also, Classias, which is a collection of machine learning algorithms for classification, would be used for its implementation apart from Apache Mahout and Microsoft Azure ML.

Advantages of Logistic Regression

- Regression-based forecasting techniques are used for research and analysis for predicting what will happen in future. Thus, a lot of companies are using these to find out what will happen in the next quarter, year or even farther into the future. Regression-based analysis serves as a forecasting tool that can provide insight into how higher taxes, for example, would be managed.
- Regression and forecasting algorithms are also used as decision support tools because they bring a scientific and statistical angle to businesses management by reducing large amounts of raw data into actionable information.
- Forecasting and regression can lend experimental support to management intuition. These algorithms can potentially correct management decisions when the evidence indicates otherwise. For example, a retail store manager may believe that extending shopping hours will greatly increase sales. A regression analysis, however, may demonstrate that longer hours do not significantly increase sales to justify the increased operating costs, such as additional employee labor.

- Large data sets have the potential to uncover valuable new information and provide wisdom about businesses and their way of operation. However, the data does not speak for itself, making analysis necessary. Regression and forecasting techniques can yield new insight by uncovering patterns and relationships that managers had not previously noticed or considered.

Disadvantages of Logistic Regression

- While solving problems, sometimes models become complicated, due to the complexity of the mathematical equations. As for creating models, multiple equations are required.
- Linear regression is only concerned about the linear associations between dependent and independent variables. It accepts in theory that there is a straight-line association among variables. However, this is not always the case and proves to be incorrect in many scenarios. For example, it would not be accurate to apply linear regression between the income and the age of an employee of a company.
- Linear regression assumes that data is independent, which is not always true. So, a careful approach and strategy would be needed when this algorithm is considered for implementing critical requirements. For example, assume a group of students in a class are similar in multiple ways—for instance they may come from the same area, they have the same teachers, etc. However, they may also have differences, such as culture, religion, level of intelligence, and financial status of their parents, which could affect their overall behavior. Hence, they are not completely independent. In the situation like this, regression algorithms based prediction can be wrong.

Applications of Logistic Regression

- Used for multiple purposes during decisions making. For example, it is widely used for risk identification and analysis.
- Used for process optimization. For example, Shell uses this for their oil and gas based process optimization.
- Efficient and effective in classifying objects, products, and goods; therefore many e-commerce organizations are using these algorithms. Some of the leading organizations that are using these algorithms are Amazon and FlipKart.
- Used in the financial domain for optional pricing. Also, financial institutions like banks use these algorithms for classifying loan applicants to separate good customers from bad ones.
- Used in the remote sensing based applications for pattern recognition.

Success Stories

PayPal is a respected financial company that provides third-party services for financial transactions. It is necessary for them to come up with fraud prevention technologies on a regular basis and then continue to refine and advance their use of complex algorithms to manage extraordinary amounts of data efficiently and effectively. PayPal uses a combination of linear and neural network machine Learning algorithms, for collating and analyzing huge amounts of data in an intelligent way. Also, they extract insights about buyers and sellers from available data mountains with the help of intelligent algorithms. Their collected data contains network information, machine based information, and transactional data. They use all this data to safeguard their customer's financial identity and transactions. In a nutshell, the smart way of using algorithms equips them in their pursuit of the ultimate brand objective, trust. PayPal is also using neural net machine learning algorithms to implement deep learning techniques in their organizations.

Source: Extracted from 2015 article from InfoWorld. Based on the option of Dr. Hui Wang, Senior Director of Risk Sciences for PayPal.

Support Vector Machine Algorithms

Support vector machine algorithms are used to analyze data and find patterns. For example, given a set of training examples, each marked in one of two categories, the SVM training algorithm builds a model that assigns new examples into one category or the other, making it a non-probabilistic binary linear classifier. The SVM model is a representation of the examples as a point in space, which is mapped in a way so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped to the same space and predicted to belong to a category based on which side of the gap they fall.

- History and development: Developed by Vladimir N. Vapnik and Alexey Ya. Chervonenkis in 1963 in its original form. However, using nonlinear classifiers by applying the kernel trick to maximum-margin hyperplanes, which is more specific to machine learning, was developed by Bernhard E. Boser, Isabelle M. Guyon, and Vladimir N. Vapnik in 1992.
- Intensity of uses in the industry and enterprises: High, as it is among best performers for classification related tasks. Works equally well with text and genomic data.
- Type of algorithm: Classification/Supervised
- Industry prospect: Bright
- Why use this algorithm: Good for binary classification types of problems.
- When to use: For simple classification and when speed is a priority.
- Who would use the SVM algorithms: When the practice sets are exposed well before the decision. E-commerce companies use it for classification.

- How do we implement the Vector Machines (SVM) algorithms: We can implement it through multiple ways, as many tools are available. However, SVMlight and its associated tools/algorithms/methods are specific to SVM (for academic and scientific purposes) implementations. For commercial purposes, one can use Microsoft Azure ML, Apache Mahout, etc.

Advantages of SVM

- Flexibility in the choice of the threshold form
- Robustness toward a small number of data points
- You can do almost anything with the right kernel (tricky!)
- SVM works very well when the structure is not known
- Performs better when the number of dimensions is higher than the number of available samples

Disadvantages of SVM

- Although SVMs have good generalization performance, they may be terribly slow during the test phase. This problem needs to be addressed in a proper manner for getting good and optimized solutions. By using clean and accurate data, this would be optimized.
- The most serious problem with SVMs is the high algorithmic complexity and extensive memory requirements of the required quadratic programming in large-scale tasks.
- If the points on the boundaries are not informative (e.g., due to noise), SVMs will do not do well.
- Can be computationally expensive.

Applications of SVM

- Handwritten character recognition
- Facial recognition
- Applied in multiple scientific fields for categorization purposes. For example, protein and genome classification.
- Applied in the field of medicine for classification of tumors. For example, grouping cancerous cells of a particular type.
- Text and hypertext classification.
- Used by e-commerce companies to compare shopping sites. For example, extracting product and pricing information from many sites.

Success Stories

Netflix is using multiple machine learning algorithms for many purposes—popularity and rating prediction are a couple of them. By using these algorithms, they achieve ranking improvement. Typical choices include logistic regression, support vector machines, neural networks, or decision tree-based algorithms, and gradient boosted decision trees (GBDT). Netflix uses its wealth of source data, innovative measurement techniques, and experiments to create a culture of a data-driven organization. Data has been part of Netflix's culture since the company was conceptualized. They call it consumer (data) science. Broadly, their prime goal is to provide a consumer science approach in an innovative way to their members (customers) effectively and efficiently.

Naïve Bayes

Naïve Bayes falls under classification categories of algorithms. It is not a single algorithm and signifies a group of algorithms. All the algorithms of this group share the same set of properties and principles. A Bayesian network is a graphical model that encodes probabilistic relationships among variables of interest. Naïve Bayes are one of the most commonly used groups of algorithms in the machine learning world. Although Naive Bayes is based on the simple principles of the Bayes theorem, it is very effective in scenarios like spam detection.

For example, a vegetable may be considered to be a carrot if it is orange, short, and about 5" in length. A Naive Bayes classifier considers these features (orange, short, 5" in length) to contribute individually to the probability that the vegetable is a carrot, regardless of any correlations between features. But generally, features are not always independent. Treating problems in this way is often considered a shortcoming of the Naive Bayes algorithm. This is one of the prominent reasons why it's called naive. In short, the Naïve Bayes algorithm allows us to predict a class, given a set of features using the theory of probability.

- History and development: Bayes theorem was named after the great mathematician Reverend Thomas Bayes, who lived between 1702 and 1761. Bayes work is a landmark in binomial distribution. After Bayes' death, his friend Richard Price edited and presented his work in 1763. However, in machine learning, Naive Bayes classifiers are a family of simple probabilistic classifiers based on applying Bayes theorem with strong (naive) independence assumptions between the features.
- Intensity of uses in the industry and enterprises: High, as it is among best performers for classification related tasks. Works equally well for text and genomic data.
- Type of algorithm: Classification/Supervised
- Industry prospect: Bright
- Why use this algorithm: When the features and variables are conditionally independent of each other, Naive Bayes is a good choice. Also, it is simple to implement.

- When to use: For simple filtering and classification through machine and algorithms.
- Who would use the Naïve Bayes: E-commerce, software products, and manufacturing companies.
- How do we implement Naïve Bayes: We can implement it through multiple ways, as many tools are available. However, implementing this through Apache Mahout is common. Other tools include Microsoft Azure ML, Weka, jBNC, etc.

Advantages of Naïve Bayes

- It's comparatively simple to comprehend and build
- It's effortlessly trainable, even with a small available data set
- It's fast
- It's not sensitive to irrelevant features

Naïve Bayes algorithms are especially effective in the following conditions:

- If you have a moderate or large training data set.
- If the instances have several attributes.
- Given the classification parameter, attributes that describe the instances should be conditionally independent.
- Equally effective in text classification and spam filtering.
- Recommender systems apply machine learning and data mining techniques for filtering unseen information and can predict whether a user will like a given resource.
- Online applications.
- Simple emotion modeling.

Disadvantages of Naïve Bayes

- It assumes every feature is independent, which isn't always the case. Dependency often exists among variables.
- Computation intensive.

Applications of Naïve Bayes

- Sentiment analysis: It is used at Facebook to analyze status updates expressing positive or negative emotions.

- Document categorization: Google uses document classification to index documents and find relevancy scores, i.e., the PageRank. The PageRank mechanism considers the pages marked as important in the databases that were parsed and classified using a document classification technique.
- Also used for classifying news articles about technology, entertainment, sports, politics, etc.
- Email Spam Filtering: Google Mail uses Naïve Bayes algorithm to classify emails as spam or not spam.
- Credit approval and target marketing.
- Medical diagnosis and treatment effectiveness analysis.

Success Stories

Microsoft SQL server 2005 uses Naive Bayes algorithm for classification in Analysis Services (SSAS). It is used for predictive modeling there. The main reason behind that is the algorithm is good at computing the conditional probability between input and predictable columns. In doing so, the algorithm assumes that the columns are independent of each other. However, the downside of this is that algorithm does not consider any dependencies between the different columns even if they exist. The algorithm is used in analysis services for achieving data mining capabilities because of its lower computational qualities in comparison of other available algorithms. SQL Server 2005 uses this algorithm in its “analysis services” engine along with other algorithms to do initial explorations of data. NB algorithm provides the results of initial stages to another set of algorithms, which they use to create additional accurate mining models. Because in the later stages of analysis of data mining, more computationally intense processing is required (where NB is weak) to provide more accurate results. Apart from this, it is used by several e-commerce companies to do classifications, including Amazon, Tesco, and so on.

k-means Clustering

k-means clustering algorithms are used to discover categories. k-means clustering is an investigative data analysis technique/algorithm. It is a non-hierarchical way of grouping different objects together. By definition, cluster analysis is the technique of grouping a set of objects. In general, clustering allows you to put objects in the same group (known as a cluster) that are more alike to each other than to those in other groups or clusters. For example, retail stores categorize or cluster similar objects or things in their stores, like women's wear and men's wear. Also, online e-commerce sites like Amazon groups and showcases personalized products to their customers by combining personal information with purchase histories.

k-means clustering performs clustering tasks using a very direct logic. First, it randomly selects k (number of partitions) points in the available data set. After that, it maps every outstanding sample in the data to the closest "mean". After that, for each and

every cluster or group, a different mean is calculated by taking the midpoints mapped to that cluster. These different new means will lead to an altogether different mapping of data to the clusters or the groups. This process continues iteratively until it reaches a reasonable partitioning of the data.

- History and development: James MacQueen developed it in 1967. It is also referred to as Lloyd's algorithm, because Stuart Lloyd in 1957 used for pulse-code modulation at Bell Labs.
- Type of algorithm: Clustering/Unsupervised
- Intensity of uses in industry: Average
- Future prospects in industry: Normal
- Why use this algorithm: k-means clustering algorithms are useful when grouping of data is required.
- When to use: When a large number of groups are present for classification.
- Who would use the k-means: Groups or individuals who have a good understanding of algorithms.
- How do we implement the k-means: We can implement it through multiple ways, as many tools are available. However, implementing this through Apache Mahout is one of the common ways. Other tools include Microsoft Azure, IDL Cluster, MATLAB k-means, etc.

Advantages of k-means

- Generally, k-means provides faster results when the order of time complexity is linear for the given data set. It works great if clusters are spherical. It does not work well with non-circular cluster shapes. Also, for getting better results, the number of cluster and initial seed values need to be specified beforehand.
- Provides easily interpretable clustering results.
- Fast and efficient in terms of computational cost.
- Excellent for pre-clustering in comparison to other clustering algorithms.
- Typically, faster than hierarchical clustering (if k is small).
- Items are automatically assigned in the k-means algorithms.
- The simplest algorithm and easy to analyze and implement. All you need to do is identify k and run it a number of times.

Disadvantages of k-means

- Strong sensitivity to outliers and noise. Sometimes it is difficult to predict the k-value.
- Doesn't work well with non-circular cluster shapes. Also, the number of clusters and initial seed values need to be specified beforehand.
- Low capability to pass the local optimum.
- For global clusters (wider and distributed), it doesn't work well.
- Different initial partitions can result in different final clusters.
- It does not work well with the original raw clusters of different density and size of data. Reorganization of data according to need and then separating them into logical groups is required for better results.
- Fixed number of clusters can make it difficult to predict the k number.

Applications of k-means

- Used in search engines like Bing and Google to cluster similar web pages to make searches relevant.
- It can be applicable to any scenario whereby someone wants to make groups of similar things from a randomly spread collection of things. For example, In enterprises, document clusters are required as they have to categorize a lot of documents on various different topics (Java, ERP, and ETL) for several purposes.
- Applying k-means algorithms to a group of pictures and cluster categorize them based on similar tests of the user.

Success Stories

Salesforce, through its Salesforce1 Platform, uses the k-means algorithm for clustering records of customers and users. For example, one of their client's, Acme Inc., sells different cooling and heating equipment and has over 100,000 customers. They use the Salesforce1 Platform, which in turn uses k-means for splitting their customers recodes into groups and profiling them. They can better market and sell their products to each group. This algorithm also helps them understand profiles of the group members.

Source: https://developer.salesforce.com/page/Machine_Learning_With_Apex

Apriori

Apriori is a “separate and concur” class of algorithm used for unsupervised learning. It helps you determine recurrent item sets in a given data set. Apriori works well when big transitional data is available. For example, Amazon uses it to provide recommendations to their customers based on the crunching of huge data done by Apriori algorithms. This class of algorithms actually tries to find patterns in the data set. They take historical transitional data of the users (typically stored in the data stores) so that they can identify frequently occurring items or sets of items that can then be formulated to some meaningful rule.

For example, if someone purchases a laptop then there is high possibility that he/she will purchase a carry bag. Apriori algorithms are the best candidates for identifying and predicting these type of transactions.

- History and development: Developed by Agrawal and Srikant in 1994. Apriori is basically designed to function on database stores comprised of transactional records.
- Intensity of uses in the industry: High, as it is among the best performers for classification related tasks. Works equally well for text and genomic data.
- Type of algorithm: Classification/Supervised
- Industry prospect: Bright

Advantages of Apriori

- Efficient and effective while dealing with large item sets
- Easily implementable
- Provides real insight on affinity promotion (which product customers may purchase based on analysis of his previous purchase behavior)

Disadvantages of Apriori

- Assumes transitional database is memory resident
- Requires many database scans
- Slow
- Higher runtime for execution

Applications of Apriori

- For generating insight about which products are likely to be purchased together and providing suggestions to the customers.
- For IntelliSense/suggestion for auto completion of text (search) type of applications.

- To carry out customer analysis by applying empirical analysis on consumer purchase behavior. Also, applied to identify the frequency of consumer behavior or inclination of particular purchase.
- Used for market basket analysis and grouping sets of products. Also, used for finding regularities in shopping behavior.
- For predicting crime behavior by doing network forensic analysis.

Success Stories

Apriori is a typical traditional predictive analysis machine learning algorithm for finding association rules through association analysis techniques. Association analysis is a technique to uncover the unseen patterns and correlations. For example, through association analysis, we understand which products and services customers are looking to purchase and then can also predict future behavior of the customers.

SAP HANA is using this algorithm for their predictive analysis by processing large chunks of in-memory data in real time. Also, companies like BestBuy, Amazon, and eBay are using the Apriori algorithm for multiple purposes. For example, to give personalized recommendations and suggestions based on clicks.

Markov and Hidden Markov Models

In Markov models, the state of the model is directly visible to the viewer or observer, so the state change probabilities are considered as the only parameters. However, in Hidden Markov model (HMM), the observer cannot observe the state directly. In HMM, the output dependent on the state is visible.

Markov models are probabilistic sequence models. A Markov model runs through a sequence of states emitting signals. If the state sequence cannot be determined from the single sequence, the model is said to be hidden. Hidden Markov models are used for pattern recognition, for example, in handwriting and in speech analysis. In a Markov model, the system being modeled is assumed to be a Markov process with hidden (unobserved) stats.

- History and development: Andrey Markov developed the model in 1906 in the form of Markov chain. The Hidden Markov Model was developed by L. E. Baum and coworkers in the second half of the 1960s. Speech recognition may be considered the first application of HMM.
- Type of algorithm: Classification/regression
- Intensity of uses in industry: Good
- Future prospects in industry: Bright

Advantages of Markov Models

- The models are fairly readable and understandable.
- Well studied and established algorithm.
- Useful in problems having sequential steps.
- Can handle variations in record structure like the following:
 - Optional fields
 - Varying field ordering

Disadvantages of Markov Models

- Can only observe output from states, not the states themselves.
- Not completely automatic.
- May require manual mark-up.
- Size of training data may be an issue.

Success Stories

AbsolutData is one of the company who works on lawsuit-recommendation problems, which will provide the solutions for answering the common questions like, how much time a particular case would take, what is the overall cost of the case and several other questions like this. Around 15 million lawsuits would be file in US on yearly basis (2016 Data, Source: Common Good). Lawyer faces the problems of taking appropriate case which suits their credential and also having higher chances of winning, as out of filled cases some cases would have winning potential, whereas others having chances of rejected by judge. AbsolutData is developing an analytic system for categorizing the characteristics of lawsuits based on data from 20+ years of cases and lawsuits, which company pulled from the public repositories where they are stored, like PACER for this purpose. The enterprise then applies text analytic techniques to digitize the words into major concepts. After that it uses machine learning algorithms, like hidden Markov models, to find correlations in the data.

Bayesian Network and Artificial Neural Network (ANN)

Bayesian network is based on the theory of probability, precisely on Bayes theorem. Bayesian networks established the relationship between events in context of probability. In a nutshell, it maps the existence of certain events' influence over the probability of different events occurring.

Whereas neural networks are a computational method, it is based on a huge assembly of neural elements roughly modeling the way a biological brain works and resolves problems. In this, the artificial network of connected electronic components works the same way as the large clusters of biological neurons work in the human brain.

In general, artificial neural network (ANN) based algorithms are a machine learning approach that models human brain and consists of a number of artificial neurons. Artificial neuron in ANNs tend to have fewer connections than biological neurons. Each neuron in ANN receives a number of inputs. An activation function is applied to these inputs which results in activation level of neuron (output value of the neuron). Knowledge about the learning task is given in the form of examples called training examples. An artificial neural network is specified by three things—the neuron model, which is the information processing unit of the NN, an architecture, which is a set of neurons and links connecting neurons, and a learning algorithm, which is used for training the NN by modifying the weights in order to model a particular learning task correctly on the training examples.

- History and development: Named after Thomas Bayes, who proposed the Bayes Theorem. His friend Frank Rosenblatt in 1958 proposed this name.
- Intensity of uses in industry: High, as it can solve problems involving both categorical and continuous valued attributes.
- Type of algorithm: Supervised
- Future prospects: Bright
- Why use this algorithm: ANN algorithms are the good choice for multi-class classification problems. They also perform well where non-linear boundaries are encountered. For achieving human-like decision making, neural networks have been a good choice. It is also used in chatbots and robotics. For achieving data classifiers functionality, neural networks are a good choice.
- When to use: When we have sufficient time, processing power, and technology to simulate parallel processing, neural networks are a good choice. We can use an artificial neural network when we have the time to train the system. Additionally, if we have a sufficient array of processors with which we can go significantly parallel, neural networks make a great deal of sense.
- Who would use the artificial neural network: Industries, enterprises, and organizations that need to do forecasting, data analysis holography, and apply neuro-dynamic factors.
- How do we implement the artificial neural network: We can implement it through multiple ways, as many tools are available. Most of the machine language targeted programming languages support it. However, many specific tools are also available in the market, including NeuralWorks, NeuroShell Predictor, Xerion, etc.

Advantages of ANN

- Neural networks are quite simple to implement.
- Neural networks often exhibit patterns similar to those exhibited by humans. Therefore, it is appropriate to use these algorithms to mimic human specific tasks.
- Artificial neural networks provide effective and efficient solutions in feature selection, density estimation, classification, and anomaly detection.
- ANN is good for online learning, as it is capable of reflecting the information of new instances on a model very efficiently by just changing the weight values.
- ANN methodology proves itself superior as a modeling technique, in comparison to classical statistical modeling methods, especially for data sets showing non-linear relationships.

Disadvantages of ANN

- Takes a long time to be trained. Neural networks cannot be retrained. If you add data later, it is almost impossible to add to an existing network.
- Handling time series data in neural networks is a very complicated.
- Generally needs a large data set due to the training time being significant.

Applications of ANN

- Speech, face, and image recognition
- Natural language processing
- Recommendation systems
- Classification and clustering
- Pattern association and forecasting
- Optical character recognition
- Stock-market prediction
- Navigation of a car
- Applied in intelligent security systems

Success Stories

Baidu uses Hierarchical Recurrent Neural Networks for their video paragraph captioning program. It is technique for generating one or multiple sentences (based on situation and demand) to label a realistic video with appropriate caption.

Also, for their “conditional focused neural question answering with large-scale knowledge bases program,” which is commonly known as CFO, different variants of neural network algorithms are used. Compology uses neural networks for waste removal. Netflix and Amazon also use it.

Machine Learning Application Building

As machine learning becomes an integral part of our life (knowingly or unknowingly), making the application around the technology is not an easy task. From getting to know the requirements from stakeholders or deciding on the purpose of the application, to deploying, the application goes through various stages. Here are the various stages of application building:

1. *Understanding the requirements:* This involves breaking down the business perspective into workable realities. Basically, this step is all about understanding the end users and what they expect from the application when the application is in their hands. For example, is the application meant for kids, teenagers, adults, or is it broader, like Facebook or Netflix?
2. *Doing user research:* As part of the practical research, about 5 or 10 percent of people who could potentially be users of the product or application must be interviewed before starting of the work. This provides insight about what they need and how the application/product must feel, etc.
3. *Coming up with basic flow:* At this stage, a user's journey is planned. The first step is to sign up, the next can be introduction of the application, then searching the products, and finally completing the task.
4. *Creating an informational architecture:* How should the application look? What information should be most visible? what can come next? Where should a certain task be placed? Why there? Etc.
5. *Getting stakeholder feedback:* After each major step, the designer, developer, and architects (through a coordinator check with the stakeholder) check if any course correction is required.
6. *Creating a design prototype:* A prototype of the end product is created, so as to get approval from the stakeholders.
7. *Developing the application:* At this stage, the application is created.

8. *Testing:* The application is tested so that the developers can be sure that it works on all sorts of the environment with the same efficiency. The best practice is to do testing after each major step.
9. *Deploying and releasing:* The application is finally released into the market.
10. *Maintaining the application:* Maintenance of the application takes place here. This is an ongoing process.

Following the Agile methodology is one effective way of implementing effective machine learning projects. Let's take a look at this methodology.

Agility, Machine Learning, and Analytics

Traditionally, analytics and analytics based data visualization are created by using a waterfall approach. In a waterfall approach, a client/team/expert gives the requirements to the IT team in the so-called *requirement phases* of the process and verifies the final outcomes with the requirements at the end of the phase called *implementation*. In Big Data, however, the Agile approach is much more suitable, whereby the stakeholders and the IT team work together to build a solution in a more collaborative fashion. An Agile process is dynamic and time boxed in nature. Also, visibility to the development of tasks and overall transparency is very good in the process. The following sections provide a brief summary of the Agile approach and its comparison to the waterfall approach.

Agile methodologies are a repeat/iterative, incremental, and evolutionary way of developing project. It works in short iterations that are typically one to three weeks long. The goal of every iteration is to provide user-valued features (what actually matters for user). Each developed feature must be fully tested during the development of a specific iteration. Agile development methodology is not about creating dull examples that have no value in the real world. Also, one of the expectations from the implementation of the Agile methodology is to automate routine processes wherever possible. Test automation is possibly the most important among them. Agile exists in multiple variants and types, like extreme programming, SCRUM, LeanUX, Kanban, ScrumBan, and so on. All these approaches have their own benefits, suitability, and drawbacks. Scrum, Kanban, and XP are the most common.

For more information, the following link is useful: <http://blog.crisp.se/wp-content/uploads/2016/10/Agile-poster-2016-ver10.pdf>.

Why Do You Need Agile?

Analytics and machine learning projects are complex in nature, and if you track it well you could potentially develop it better. If not, you could fall under the following:

- The project is overbudget.
- The schedule has slipped.
- Some expected functionality was not implemented.
- Users are unhappy.

- Performance is unacceptable.
- Availability of the warehouse applications is poor.
- There is no ability to expand.
- The data and/or reports are poor.
- The project is not cost-justified.
- Management does not recognize the benefits of the project.

These happen because of:

- Lack of experience.
- Ambitious and unrealistic goals.
- Domain knowledge and subject matter expertise don't exist.
- Unrealistic expectations from the project.
- Focus only on technology not on business.
- Lack of collaboration.
- Lack of specialized skills.
- Lack of multiple skills in the project/organization.
- Difficulties in implementing the Agile approach.
- Tool support: There aren't many tools that support technical practices such as test-driven machine learning development.
- Data volume: It takes creative thinking to use lightweight development practices to build high-volume data warehouses and BI systems. You need to use small, representative data samples to quickly build and test your work.
- Lack of knowledge: Not enough knowledge of the end to end Agile development practice.

Show Me Some Water Please ...

The waterfall software development lifecycle, or SDLC, is a traditional methodology. In waterfall development methodology, every stage of a product's lifecycle takes place in a sequential manner. It is known as waterfall because progress flows steadily downward through these phases like a waterfall. The waterfall software development model operates in a phased manner and is often rigid. Typically, it contains phases like Define, Develop, Test, and Implement.

Making changes in Waterfall projects is comparatively costly. Whereas in Agile, the changes to requirements can be generally incorporated at any point in the process. Even at the advanced stage of development, Agile is willing to accept and accommodate changes. Therefore, this is less costly.

Agile's Disadvantages

- It requires stakeholders' availability, involvement, and cooperation on continuous basis.
- It requires customers with clear priorities and vision, which sometimes is not possible. Noncompliance sometimes leads to off-tracking and failure of the project.
- Senior and experience programmers with decision-making capabilities are required during the implementation process. Hence sometimes, inexperienced programmers may feel uncomfortable if experienced resources are not available to help.
- It is hard to quantify the total effort, estimation, and cost due to the qualitative nature of process.
- It's difficult to execute in distributed teams.

Agile Usage

- Best suited if the deadlines are aggressive.
- Good for a project with ambiguous requirements. It is excellent in accommodating changes in the latter part of a project.
- Good for complex projects.
- Good for innovative projects.

Some Machine Learning Algorithms Based Products and Applications

There are multiple applications and products available that use machine learning and artificial intelligence technologies for assisting humans. Their spread is everywhere, i.e., from our daily life to the workplace, from spaceships to the chessboard. This table shows a snapshot of some products:

Product	Company	Description
Siri	Apple	The voice/personal assistance application from Apple. The application got its name from a Norwegian woman who was the co-creator of Siri known as Dag Kittlaus. Apple also introduced a male voice option a year after Siri's launch. Siri launched in October 2011.
Cortana	Microsoft	Microsoft's personal assistant application. It was launched in April 2014. Cortana is named after the 26th-century female artificial intelligent character in the hugely popular Halo videogame franchise.

(continued)

Product	Company	Description
Deep Blue	IBM	Deep Blue is an AI chess playing machine. IBM's Deep Blue is known for its chess fight with Chess grandmaster Garry Kasparov. In February 1996, Deep Blue became the first machine to win a game against the ruling winner. This grand chess-playing machine is heavily dependent on massive parallel processing and artificial intelligence based technologies and was named on the basis of a "naming contest" conducted by IBM.
Jarvis	Facebook (Mark Zuckerberg)	This is newest on the block. As a new year's resolution, Mark Zuckerberg embarked on a personal challenge and built this simple artificial intelligence application to control different things around his house. The home assistant took its name from the science-fiction film <i>Iron Man</i> 's assistant. It is powered by the voices of Morgan Freeman and Arnold Schwarzenegger.
Alexa	Amazon	Echo is an Amazon product. It is a combination of wireless speaker and voice-command device. It uses a woman's voice for communication, named Alexa. Amazon actually was trying to replicate the concept of an all-knowing computer on the TV series <i>Star Trek</i> , which was activated with a single voice-based command. The name Alexa was chosen out of respect for the Library of Alexander, which was one of the largest libraries in the ancient world.
Watson	IBM	Watson is a cognitive system from IBM. It took its name from the first CEO, Thomas J. Watson. Watson as a cognitive system took part in the popular quiz show <i>Jeopardy</i> and won. This advanced software/system is being used in the treatment of lung cancer, and is doing predictions for multiple other areas using machine learning algorithms. Companies like Capgemini using it to provide efficient solutions to their clients. Now, the cut version of Watson, called "Baby Watson," is also available.
Donna	Incredible LabS	Donna took its name from the fictional character Donna Moss. Donna Moss works as a White House assistant in the TV show <i>West Wing</i> . Incredible labs was acquired by Yahoo in 2013. Yahoo decided to shut down its services in February 2014.

(continued)

Product	Company	Description
Google Home	Alphbet	Google Home highlights the fact that it's intended for the home. It is a voice-activated WiFi speaker powered by the Google Assistant. It also works as a smart home control center. The philosophy behind it is to provide an assistant to the whole family. Google Home will be used to provide entertainment to the entire house. This voice assistance will be able to smoothly manage your everyday tasks. Google Home is different from Amazon's Alexa, as it is virtually a Google in your hand.

Algorithm Based Themes and Trends for Business

Change is a reality. Society, technology, process, business, and, moreover, life is changing at a rapid speed. New thoughts are accepted and old thought pyramids are destroyed. For example, just a few years back, no one thought that driverless cars and intelligent clothing could become a reality. The stories related to them were part science fiction movies and novels. However, driverless cars are a reality and are all set to hit the road. These real examples of breakthrough technologies are making their way from the laboratory to workspaces very quickly. Also, business leaders and consumers are ready to rapidly adapt to these fast changes. The following sections contain some realistic insights and business themes and trends that could impact the way we do business and live our lives in the coming years.

The Economy of Wearables

The inclination toward intelligent Internet of Things (IoT) wearables started with smart watches and wrist bands. Now they have grown to a level where they have become part and parcel of one's life. Now we have smart eyewear, smart clothes, clip-on devices, and helmets. Clothing brands and electronics companies are now coming up with the more intuitive smart clothing that connects to the cellular network for accessing or transmitting enormous amounts of data generated by humans. IDC reported that the worldwide wearable devices market would reach 101.9 million units by the end of 2016 and around 214 million units in 2020. IoT, Big Data analytics, and machine learning algorithms created and continue to generate a huge opportunity for businesses across sectors related to consumer products.

New Shared Economy-Based Business Models

Businesses no longer have to own assets to run the business (for example, Uber does not own a single taxi). AirBnB has not a single owned hotel but they changed the economics of the market like no other. Lyft, a company that provides application based ride-sharing facilities in over 200 cities in the United States, is working in the model which would

change the philosophies of car ownership. They are providing car polling services and encourage people to use them instead of owning a car. This is becoming a major transportation trend.

In a thought-provoking article written by John Zimmer, cofounder of Lyft, he projected that by 2025, private car ownership in main U.S. metropolitan areas will end. These trends are not limited to the United States. Across the world, business, people, and entrepreneurs are adopting and inspiring themselves with these ideas. For example, in India, people are opening up their homes to vacationers through Oyo (an Internet based hotel and property booking platform). They provide a facility to convert your property to a holiday destination. This strategy is compelling hostels and private guesthouses to rework their business strategies.

Connectivity-Based Economy

The dynamic and anytime-anywhere connectivity between devices, machines, and other resources across the globe is the backbone of today's businesses. One Cisco report said that by 2020, 50 billion devices will be connected. This intelligent network is a recent development. Now a new economy is created around this, as doing business anywhere in the world is as simple as doing it in your neighborhood. For example, Practo, a Bengaluru (India) based company, is now known as the world's largest appointment booking platform. It handles roughly over 40 million appointments annually.

New Ways of Managing in the Era of Always-On Economy

Technology-enabled services are evolving and taking place in our life so quickly that we actually take them for granted. For example, standing in the queue for booking railway tickets or withdrawing money from a bank was actually the reality sometime back.

Things have changed so rapidly that we started believing that "net-banking" and "online booking" have always been part of our lives.

Online banking, withdrawing money from ATMs, mobile banking, and digital wallets have changed the traditional ways of money transactions. The driving forces behind this digital economy are transaction cost, speed, ease of use, time savings, and security. In-app payments solutions like Paytm, Apple Pay, and Android Pay and proprietary multiple retailer-based payment solutions are invading our economy at the speed of light. Retailers provide innovative solutions that are integrated with robust backend processes to permit customers to do safe and seamless transactions.

Macro-Level Changes and Disrupted Economy

In the past few years, we have seen that businesses and their policies were impacted by change in geopolitical environments such as advent of Brexit or the crisis in the Middle East and its impact on the world (for example, fuel prices). Regulatory changes also affected businesses. For example, changes regarding Sarbanes-Oxley or Solvency II or demonetization in India or the proposed diesel cab ban in Delhi affected businesses.

Natural disasters and diseases and illness such as tsunamis, earthquakes or the spread of Ebola in Africa or Zika in South America also affect businesses.

These macro-level deviations are beyond anyone's control and loom to disrupt the world and business to their stated objectives. Enterprises, companies, organizations, and governments are working on multiple strategies to get rid of these problems or provide effective solutions. As most of these require manipulating data in effective ways, machine learning plays a central role. Machine learning, (algorithm based), along with Big Data analytics technologies are at the heart of these macro-level solutions and can heal disrupted economies.

The Marriage of IoT, Big Data Analytics, Machine Learning, and Industrial Security

IoT is a familiar concept now and we treat it as not the next big thing. However, its marriage with machine learning and cognitive computing is evolving and is interesting to watch. The duo (IoT and machine learning) already started driving innovation across businesses. The amalgamation of machine learning, IoT, and Big Data is slowly becoming an integral part of IT infrastructure and innovation. Businesses, as well as general users, are extensively adopting intelligent algorithm based connected devices. This is one of the biggest driving forces behind increased collaboration and productivity. This hyper-intelligent connectivity across levels will potentially expose everything that's connected to the Internet in an enterprise, so security becomes very important. Also, this forces enterprises to adopt severe safety protocols. They understood that if the required security measures are not followed, it would end up in the disasters. Examples such as DynDDoS attacks have showcased to the world and, hence to enterprises, that unsecured IoT can be manipulated and breached.

The automobile industry also promises to become a security battleground between manufacturers, users, and developers. As a greater number of smart parts become affiliated within vehicles, they can easily be manipulated and hacked. Moreover, with driverless cars also poised to hit the roads soon, security breaches in this case could eventually end up causing physical damage. As self-driven cars become a near time reality, automobile hacks also have become the talk of the market. Examples of this include cars being held for ransom, which could be done by obtaining the location of the car for hijacking. This will also lead to a question of liability between the software vendor and automobile manufacturer, which will have long-term implications on the future of connected cars. Having mentioned all this, it is defiantly worth watching the future in this regard. In today's globalized world, businesses anywhere can be affected and need to stay attuned to market changes and align their models accordingly.

STARTUP FOR THE THOUGHT: BELONG

Traditionally most of the hiring in India (or in the world) happens through job portals. The process candidate selection goes like this: Candidate needs to be active on job portal then recruiters take/fetch their CVs from there and supply them to appropriate companies based on their understanding of the candidate's profile. They organize the candidate's interview with interested companies. Finally, based on the interview results, the candidate is selected or rejected. This is a time-consuming process and

does not guarantee the candidate's trustworthiness. It does not provide any insight into the behavioral traits of the candidate. Companies and recruiters want to know that the candidate is being truthful about his/her records. But mostly they have no clue. The current process is unable to answer these questions/concerns. Now machine learning is changing everything.

Companies are also facing lots of challenges to select the right candidate from the market because of the limited availability of the "best fit resources," competitive talent markets. Recruiting costs and the time to hire is a big concern as well. Therefore, recruitment firms are facing increasing pressure to overcome these roadblocks. Hence, they are looking for a new set of technologies, processes, and capabilities to overcome these challenges and establish themselves as market leaders.

Bengaluru-based startup Belong chose machine learning and Big Data technologies to make a difference in this space. Their innovative way of using machine learning is helping companies achieve what they want. They are connecting an employer and potential employee. They are enabling this connection to the next step, which is beyond skills and experience. They are trying to synchronize the values and culture of the employee and employer. To make this happen, Belong through Big Data and machine learning technologies, analyzes the behavior and responses of the candidate available on platforms such as Facebook, Twitter, Quora, GitHub, blogs, and more. To analyze candidate's likes and dislikes, they are using that information for employment perspectives and fitting them in the perspective culture for potential employers. This helps to create a more holistic profile of a candidate, which is then matched using machine-learning algorithms to relevant companies and jobs. Belong's proprietary predictive analytics platform identifies the "DNA" of each candidate's profile—the most suited ones are featured on the first page of results, much like a ranking. The company's algorithm ensures that no two companies see the same set of candidate profiles for the same role.

For the complete story, see Subramanian Senthamarai Kannan/December 3, 2016, published on LinkedIn.

Industry 4.0: IoT and Machine Learning Algorithms

Wikipedia defines industry 4.0 as the current trend of automation and data exchange in manufacturing technologies. It includes cyber-physical systems, the Internet of things, and cloud computing. Industry 4.0 is all about connecting everything centrally and using it in a better way through algorithms. This includes services, products, and matters that a company might not provide itself or outsource. In Industry 4.0, computers or generally intelligent processing and automation will be integrated in an entirely new way. The systems (including robotics) connected remotely to information systems powered by machine learning algorithms would learn and control the automated system with very little input from human operators.

This section considers the bigger ecosystem of industry 4.0 from a technical perspective, which includes but not limited to machine learning technologies, analytics, and IoT. These technologies complement each other. For example, IoT based technologies are used to share simple information with third parties and all connected systems. Whereas through cloud-based portals, end users can access all the data of collaborating parties and systems. Analytics and machine learning is used to make sense of this data. Ultimately, with the use of IoT, analytics, and machine intelligence, many previously unavoidable production processes, stepping stones as they were, can now be skipped. This has created space for the company to review their existing business models and tune them to deliver custom service at the price of a mass product.

At an overview level, if we think about implementing industry 4.0 systems this requires a robust information technology system which must have capacity to process and analyze a huge amount of data. Also, a technical infrastructure and process is needed for recording the transmission of the data and information exchange 24/7. The industry 4.0 model is very useful in dangerous working environments, where the health and safety of human workers is at stake—their quality of life will be improved dramatically with the use of it.

With the industry 4.0 model based techniques and procedures, manufacturing companies can control their supply chain more efficiently because data is collected, analyzed, and processed at every level though automated connected systems. This will enhance the manufacturing and delivery process. Computer control could produce much more reliable and consistent productivity and output. Proper implementation of the industry 4.0 technical ecosystem helps businesses increase revenues, market share, and profits. From agriculture to retail, the industry 4.0 models and IoT are changing the way companies in many industries do business. Here are the areas where the industry 4.0 model has showcased its potential:

- *Agriculture:* One of the impacts of implementation of industry 4.0 model in agriculture is installations of automated and IoT based devices in the agriculture based products (tractors and cropping machines). The market is estimated to grow from around 30 million in 2015 to around 75 million in 2020. Through automated systems, farmers can collect data about their crops in real time and with cloud, analytics, and machine learning techniques, that information is converted into insight. The results are used in multiple ways to optimize yields.
- *Healthcare:* Connecting the healthcare industry through automated systems means not only more efficient businesses, but it also means better service for the patient. For example, by connecting an MRI machine to the Internet and the information systems, hospital employee get notifications when their help is needed.
- *Manufacturing:* The biggest industry being impacted by industry 4.0. Manufacturers across the world will invest around \$70 billion on IoT and industry 4.0 solutions in 2020. This enables factory workers to not only see when a part of equipment needs repair or modification, but it also provides insight on how to make the entire system work more efficiently.

- *Energy:* The combo of industry 4.0, IoT, and machine learning technologies is changing the way energy companies do business. Energy and utility companies across the world, for example PG&E, are beginning to use smart technologies. Because of the smart and effective communication through the devices, energy and utility companies can better predict demand, spot outages, and schedule repairs.
- *Transportation:* From supply-chain logistics to public transit, the combination of industry 4.0 and IoT solutions is being used to better business in many ways. For example, by connecting shipping vehicles with sensors to monitor temperature, enterprises can help to deliver goods, especially food, in a safe condition. Sensors and machine learning enabled software can be used to collect data in an automated fashion, which can help the driver function the vehicle in a manner that helps save fuel. In the future, connected, efficient, effective, and smart infrastructure will also work with other connected systems to help reduce traffic and prevent accidents and other harmful incidents.

The Audio and Video Links

1. Pedro Domingos talks at Google, “The Master Algorithm”.
Source: <https://www.youtube.com/watch?v=B8J4uefCQMc>
2. How to read the genome and build a human being.
Source: https://www.ted.com/talks/riccardo_sabatini_how_to_read_the_genome_and_build_a_human_being

Before Winding Up

There are two final things for you to consider:

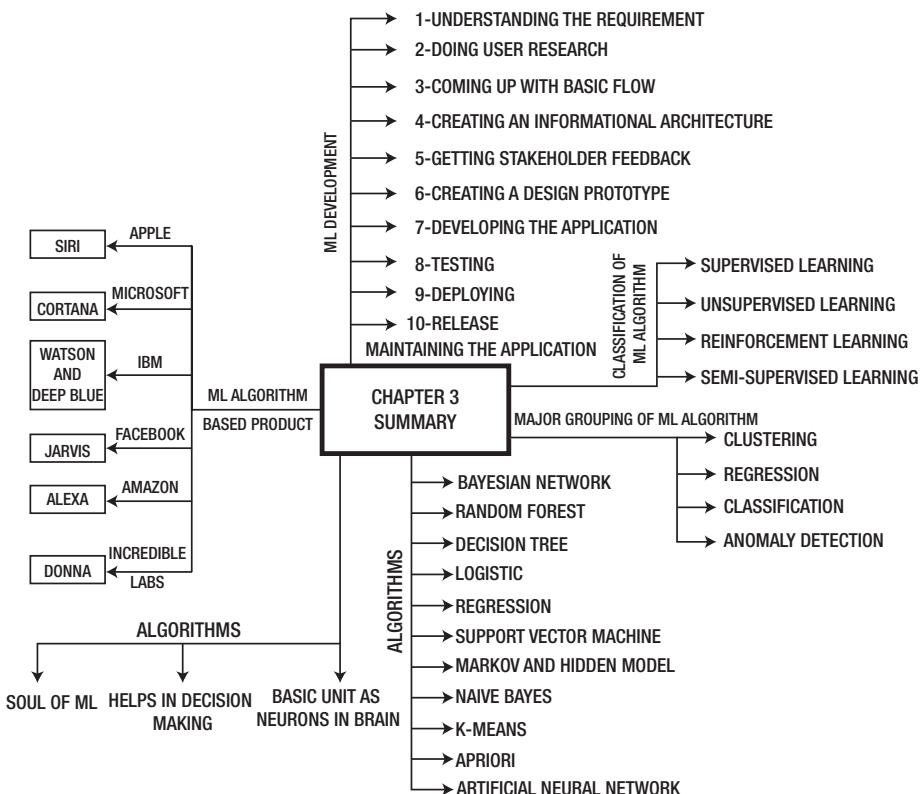
- Tesla makes car that's 100% auto-pilot ready. Self-driving cars can improve our lives in the following ways:
 - Reduced carbon emissions
 - Lives would be saved as thousands of people dies every year through accidents (1.24 million) because of the fault of drivers
 - Reduced traffic congestion
 - More free time due to the reduced traffic
 - Increased productivity
 - Mobility of people will improve
 - No more hunting for parking spaces

- Artificial intelligence and virtual reality will get bigger as adoption of smart technologies accelerates, but people also risk being cocooned in silos, unaware of opposing ideas and a diversified view of the world, says an Ericsson report on future consumer trends. Here's a peep into the future.

Summary

This chapter discussed some important algorithms and their uses. It also provided some guidelines for using algorithms and machine learning models in effective and efficient ways. While discussing the important aspects of algorithms, the chapter provided success stories associated with particular algorithms/models/techniques. The end of the chapter included some vital machine learning based trends and impacts on business.

Mind Map



CHAPTER 4



Technology Stack for Machine Learning and Associated Technologies

Machine learning is a large and evolving field. The expectations from machine learning and its associated fields are for multiple reasons. Machine learning is full of potential and there are enormous possibilities to exploit it. In the last few chapters, we explored some of the important and relevant aspects of machine learning.

At all levels, technology plays a crucial role because without it (almost) nothing is possible. Business strategies are made in the boardroom but when it comes to realization, technology serves as the enabler. Technology contributes to making a product or application and helps with its marketing including physical or virtual supply chains. The lion's share of technology plays its role throughout the lifecycle of the product or application in the development, maintenance, and support phases.

Due to the nature of the technologies involved in machine learning ecosystems, such as IoT, Big Data analytics, and cloud and cognitive computing, there is natural overlap of a technologies and technical discussion. For example, if someone wants to discuss data analytics, this subject is appropriate in all discussions of its associated technologies. The IoT technology stack and Big Data analytics are both part of it all.

Before adopting or developing IoT and machine learning based product or services, industries must assess, create, or revisit their company's strategy. Planning and strategies must be the top most priorities. There is a reason for this, as it relates to almost everything, from product conceptualization and design to sourcing and production (manufacturing). It is also very important when implementing effective sales and services. Industries must fine tune their virtual and physical logistics and supply chain management systems, so that they can securely collect and respond to data from customers and suppliers. We are in an era where even the products themselves collect the data and transmit it to places where it is required in an automated way.

Going from traditional to data first strategies is difficult initially, but it is required to stay competitive in the market. Also, it necessitates the development of advanced analytic capabilities. Netflix is most commonly cited example in this case. To capture, explore, and exploit the significantly available economic opportunity that exists in the fields of IoT, Big

Data, and machine learning, a new technology infrastructure and mindset is required. This allows companies to fast-track the time to market for smart connected products and operations. IoT enables a range of capabilities and components that will empower industries to achieve the following:

- Deploy applications that monitor, manage, and control connected devices.
- Collect, process (Big Data analytics), and analyze (machine learning techniques) machine and sensor data in a business context.
- Secure connectivity between devices and real-time data streams.
- Provide effective device/sensor management and enable remote device updates.
- Create an application environment that supports rapid, fast, continuous, iterative IoT based solution creation.
- Effective and efficient integrate with third-party systems.
- Effective use of augmented reality (AR) for next-generation marketing, selling, servicing, and training in dynamic industrial environments.

Let's accept the fact: technology stack is key.

Software Stacks

Any software application can be developed with the use of a technology stack, as it is the foundation for any engineering work. When selecting a technology stack for building an application/product, a careful approach is required, because revision of the technology stack is generally difficult. This chapter discusses multiple technology stacks available for machine learning and their associated fields. This chapter includes a comprehensive view on the machine learning technology stack. This chapter is confined to information technology specific details only, due to the scope of the book and chapter.

This chapter also discusses the technology offerings from multiple vendors, like Apache, IBM, Microsoft, and others wherever relevant. Additionally, the mapping between different layers and technologies is described. Technology stacks are generally linked to specific concepts and their associated ecosystems. For example, IoT is associated with one set of technology suite, whereas machine learning and Big Data are associated with other. However, for practical reasons, such as overlap of technology (the same set of technologies applicable to realize multiple concepts on the ground level), business need, way of implementation, financial dependencies, and client demand, most of the time, the reality is different. Therefore, this chapter provides a holistic and integrative view of technology stacks. Having said that, wherever possible, technology specific views are also given. Some generic technical concepts are also described. For example, MapReduce is described in detail in this chapter.

CHAPTER MAP

The comprehensive model discussed in Chapter 1 contains multiple layers and each layer is somewhat dependent to other layers for input and output. Hence, overall the model is a layer of layers. Each layer or sublayer deals with a specific technology. However, most of the time overlap among technologies exists. In this chapter, I extended that model and proved a detailed view of it. I went to the level of “technical mapping” and described the technical detail of each layer. For example, IoT is mostly about getting data from multiple devices and sensors and transmitting it to the cloud or to an on-premise infrastructure for further utilization and processing. After that, Big Data technologies takes control and, with the help of a specific technology stack, they deal with the challenge of storing, managing, processing, and making sense of that data. If required, they present the processed data in a proper way to the wider audience. Also, the Big Data analytics technology stack passes its inputs to the machine learning frameworks to achieve intelligence from the processed data. However, you can associate Big Data technologies to part of a specific IoT stack and the same is true with machine learning, Big Data analytics, and cognitive computing.

A few important points about the structure and content of the chapter.

- *Technical discussion:* Overlap of the technical discussion happens. However, it happens only when it is required. For example, data gathering and networking technologies are discussed during the explanation of Big Data and IoT technology stack. Processing technologies are discussed under Big Data technology stack. For completeness, these concepts are again touched on under the connector layer of machine learning. The same is true with processing/store technologies under data processors and store layers of machine learning.
- *Rule of thumb:* If a concept is discussed in detail earlier, the chapter does not go into the details of the same thing again. Recall that brief descriptions of some important machine learning frameworks, libraries, and tools are provided in Chapter 2. If you are interested in knowing about the technologies used in the processing of Big Data, go back to the Big Data section while reading the machine learning technology stack.
- *The purpose of discussion and the structure of the content:* The technology stack discussed in the chapter can be visualized in two ways.
- *Layer specific disconnected view:* Layer specific technologies are discussed. For example, Big Data analytics is treated as one layer. Technologies related to Big Data analytics are mentioned in

that section. So, if you just want to know the about the Big Data technology stack, you can refer to that section only, by following the data acquisitions ➤ analytics ➤ machine learning ➤ presentation layer hierarchy. Similarly, if you want to get an idea about the ML technology stack, you have to follow the connector ➤ storage ➤ data processing ➤ model and runtime ➤ presentation layer hierarchy.

- *Composite connected view:* This provides a connected view. It does not go into the details of the sublayers and treats layers as components of the comprehensive model.

Before going into the details of the technology stack, let's look at the concepts and technology map. Technology and concept map are nothing but tabular representations of which concept appear where in the chapter.

Technology Stack	Layer Name	Layer Discussed in Detail	Technology and Concepts Discussed
Internet of Things (IoT)	<ul style="list-style-type: none"> • Device and sensor layer • Communication, protocol, and transportation layer • Data processing layer • Presentation and Application layer 	<ul style="list-style-type: none"> • Device and sensor layer • Communication, protocol, and transportation layer 	Sensors, Devices, Gateways, Communication technologies,
Big Data Analytics	<ul style="list-style-type: none"> • Data acquisition and storage layer • Analytics layer • Machine learning layer • Presentation and Application layer 	<ul style="list-style-type: none"> • Data acquisition and storage layer • Analytics layer • Presentation and Application layer 	OBIEE, Cognos, Infographics, HDInsight, Apache Spark, Apache Solr, Apache Storm, MongoDB, NoSQL, HBase, YARN, MapReduce, Hive, Pig, HiveMall, Amazon Simple Storage Service (S3), HDFS, HCatalog, Oozle, Avro, Ambari, ZooKeeper

(continued)

Technology Stack	Layer Name	Layer Discussed in Detail	Technology and Concepts Discussed
Machine Learning	<ul style="list-style-type: none"> • Connector layer • Storage Layer • Processing Layer • Model and Runtime Layer • Presentation and Application layer 	<ul style="list-style-type: none"> • Connector layer • Model and Runtime layer 	Logic App, Apache Flume, MQTT, Apache Kafka, Apache Sqoop, Apache Mahout, Amazon's Deep Scalable Sparse Tensor Network Engine (DSSTNE), Google TensorFlow, Microsoft Cognitive Toolkit, Video analytics
Cognitive computing	<ul style="list-style-type: none"> • Data gathering layer • Data preparation, extraction, and conversion layer • Data processing layer • Analytics, machine learning, and cognitive layer • Presentation and application layer 	Most of the layers are discussed in the IoT, Big Data analytics, and machine learning sections. Therefore, as the concepts and functionality of layers remains the same, they are not discussed in this section.	anticipative computing
Cloud computing	<ul style="list-style-type: none"> • Infrastructure-as-a-Service layer • Platform-as-a-Service layer • Machine Learning-as-a-Service • Software-as-a-Service 	These layers are mainly discussed in Chapter 1. They are not mentioned here again.	Infrastructure-as-a-Service, Platform-as-a-Service, Machine Learning-as-a-Service, Software-as-a-Service

In the next sections, we discuss the main technologies and technology stacks (wherever required) of the machine learning ecosystem, which we called “pillars” in the first chapter.

Internet of Things Technology Stack

It is very difficult to come up with the generic technology stack for IoT, because diverse industries have their own requirements and require different applications, products, and services to fulfill their needs. However, this section shows a generic snapshot of the main ingredients of implementing IoT technologies across industries and provides a technical level of details for IoT technology stack. Further customization may be done on the specific requirements of the individual/users/enterprises or organizations. But, the basic structure of the stack remains the same. The Internet of Things (IoT) brings enormous possibilities and promises a bright future; it is here to stay.

The volume of sensor-based devices and equipment is growing a breakneck speed and the developments in this field are enormous. Therefore, the existing business model is expected to align itself with this rapidly changing technology. Hence, the business world needs to educate its workforce in this regard, which includes but is not limited to projects, products, and technology managers, because on the ground these minds are making strategic for business. Also, they are involved in collecting information to provide the input to the higher levels of management. On the basis of data and insight provided by middle management (project/product and technology managers), the top layer of the organization (CTO/CFO/COO) can make decisions.

Middle management is an integral and important part of overall ecosystem of the organization, and they ensure the success of products/applications or service of IoT based systems (or any system). In these changing times, it is clear that managers who are equipped with technical capabilities will rule and provide direction to the organization. Therefore, roles and responsibilities of managers are also changed. More technical alignment and innovative mindsets are mandatory criteria for success. The technical journey of a manager starts by understanding the technology stack. Therefore, only those who understand the stack can evaluate the complexity of the requirements and the project. As managers are the targeted audience of the book, let's start this knowledge gathering exercise with the IoT technology stack.

IoT's technology stack is divided into layers. First, we look at the layers and then discuss them.

- Device and sensor layer
- Communication, protocol, and transportation layer
- Data processing layer
- Presentation and application layer

Tiers represent the physical separation of the presentation, business, services, and data functionality of design across separate computers and systems. *Layers* are the logical groupings of the software or hardware components that make up the application. They segregate the variety of tasks performed by the components in a logical way. This makes it easier to create a robust and reliable design that supports reusability of existing components. Also, each logical layer may contain a number of separate component types. The component types are grouped into sublayers, where each sublayer performs a specific type of task to achieve a certain functionality.

IOT, YOU, AND YOUR ORGANIZATION

Building a complete IoT system or solution is a costly and business-critical decision for an organization. It requires modern technical skills, expertise, time, and money. It needs to be planned properly before implementation. If the resources are not utilized in the proper manner, the solution may go through the long IT project cycles and end up with a low return on investment. Therefore, identifying an effective and efficient IoT platform is mandatory. An effective IoT platform equipped with the proper technology stack will simplify the development of IoT solutions. Hence, factors like scalability, robustness, and performance are essential for a good platform. Whenever needed, the platform can easily accommodate continual growth and change.

These must-have features enable enterprises to develop systems and solutions (on top of platform) that help industries/organizations/enterprises develop robust IoT solutions that have capabilities to easily connect to a diverse set of devices and sensors. They can benefit from the seamless information flow between systems and operational assets and deliver solid business value to their customers through IoT/IoE/IoT (Internet of Everything/Industrial Internet of Things). Today's customers are well educated about technologies, their future, and use cases. Therefore, having a good platform provides confidence to users about fulfillment of their requirements.

Device and Sensor Layer

This is the starting point of an IoT system. From here, things start their journey (technically). This is the point at which data originates from one device and is passed to multiple other connected “things” or to a larger network (or to a network of networks). Also, this layer is responsible for interacting with the physical world. The following list explains some important highlights about this layer from a technical perspective. This section belongs to IoT and specifically to devices, things, and gateways. Hence the section provides a glimpse of the technical landscape, technology frameworks, and other details of IoT devices and sensors.

- Objects or things are generally small in size and capacity. Hence, these objects and things are programmed using microcontrollers because they are lightweight and less resource hungry. Microcontrollers are specialized for performing particular sets of technical tasks.
- The software running on the IoT enabled devices typically consists of a very lightweight operating system, a software layer that enables objects to access the feature of hardware (MCU).
- The device or objects support wired or wireless protocols, like Bluetooth, Z-wave, Thered, CANBus, CoAP, and MQTT. Typically, these are used for connecting devices.

- The IoT devices generally have remote management capability. This functionality comes in handy when “things” are required to be managed remotely. One example is software upgrades or correcting minor issues remotely.

FACTS FOR YOU

- Google's operating system for IoT is called Android Things. It is built for connected devices and used for the Internet of Things. It is tuned to take advantage of Intel's innovative architecture. IoT application development on Android Things is fast and robust.
- Windows 10 IoT Core is a cut down version of Windows 10. Windows 10 IoT Core targets and is optimized for smaller devices. It works for devices that have a display functionality or not. It runs on devices like the Raspberry Pi 2 and 3, Arrow DragonBoard 410c, and MinnowBoard MAX. Windows 10 IoT Core can be extended to use the features of Universal Windows Platform (UWP) through the uses of their API for building next generation solutions. Windows 10 IoT Core also supports Arduino Wiring API, which is used in Arduino sketches and libraries for direct hardware access. Window 10 IoT application is developed by using Visual Studio Community Edition. Visual Studio Community Edition comes with excellent quality development tools that include universal app templates, a code editor, a powerful debugger, and rich language support. With the help of frameworks like Connect-the-Dots, the Windows 10 IoT Core targeted devices can be integrated with the Microsoft Azure cloud platform. Microsoft Azure allows you to leverage advanced cloud based analytics services.

While choosing the technology stack, you need a focused thought based practical strategic direction, mainly in terms of what kind of data needs to be collected and the type of hardware required. Business models and requirements clearly need to be charted out for this technology stack. Also, the support models and execution plan must be defined and validated well in advance.

This type of planning is of great help and handy throughout the lifecycle of creating, modifying, maintaining, and phasing out the stack. This approach works as an enabler to keep in synchronization of IoT technology stack with the creation of any solution. If these factors are considered, the technology stack can handle any type of practical requirements. Either it uses a simple data collection through a single smart sensor or a more complex scenario like gathering data from industrial computers and processing systems that hosts many sensors, powerful processors, advance storage systems, and gateway systems.

Some typical characteristics of sensors are measuring values and sending raw data and consuming low power. Sensors can be embedded in any device or object. This includes smartphones, watches, wristbands, coffee machines, cars, satellites, toothbrushes, contact lenses, fabric, and so on. They can be worn or implanted in the body or skin. For example, Nokia recently patented a method and system for magnetic tattoos having capabilities to embed in our skin. The tattoos would vibrate on incoming calls or when a message arrived. Their method description says that the patented technology sprays a ferromagnetic material onto the user's skin. Once this is done, then it is paired with any mobile device to do the communication.

Another example is Fitbit's new advanced sleep tracking device, which uses sensors to measure how much time during the night the user is restless, in deep sleep, or awake. It has a built-in heart rate monitor which can break and analyze data into clinically defined stages. The Indian institute of technology, Bombay team developed a prototype of a wearable baby wellness monitor. It helps parents track their kid's clinical and general well being with the help of multiple sensors. The team created an IoT enabled device that is easily embeddable/attachable to a kid's diaper. This is an innovative way of monitoring a baby's movements, including their body temperature, blood pressure, and so on.

Microsoft, in association with the University of Washington, came up with an innovative contact lens to analyze and provide real-time updates on biochemical instabilities in the human body. With the advancement in the microelectromechanical systems, which is commonly known as MEMS, the size and cost of these sensors has dropped significantly. Therefore, MEMS based devise are becoming part of the mainstream. MEMS work on a tiny level of electronics. They use the combined power of electronics, physics, chemistry, and mechanical engineering to integrate sensors and actuators. Sensing information and sharing and transporting that information or data over a network was traditionally tackled by separate components in a device. However, recent technical advancements make it possible to integrate sensing, networking, and power into one unit. Thus, they can be used easily and in many environments, as they work as a single unit.

Huge power source requirements and networking capability are no longer constraints. For example, a lot of devices and sensors equipped with global positioning capabilities are available in the market that have excellent networking abilities. They can track an individual's location and help them find a missing pet, car, hospital, shopping malls, or a parking spot in real time.

The nature and type of sensors and the basic communication technique is almost the same in all devices. They communicate with each other via a wireless mesh network protocol. This capability of devices fueled some very ambitious plans of multiple companies. For example, A project from Hewlett-Packard called Central Nervous System for the Earth (CeNSE) combines advances in materials, nanotechnology, and MEMS to develop a planet-wide sensing network. They are using tons of inexpensive sensors to get a holistic view of the world by integrating physical and digital worlds. This "Nerves of silicon" basically maps the whole Earth. In turn, this mapping is used to monitor the conditions of bridges, highways, rivers, forests, and the air people breathe.

IoT enabled devices use a computing processing unit, but they are not general-purpose computers. The main purpose of these devices is to serve as the eyes and ears of the targeted IoT system. Low power consumption, mobility, ease of use, working in adverse conditions, good in using low throughput communication channel, and communicating with the network through radio interface are some of the salient features of these IoT devices. Sensors and gateways and their interplay create some very useful use cases.

The following sections discuss some main technologies that are used in IoT and described within the layers.

Communication, Protocol, and Transportation Layers

Communication and transportation layers are used to share the sensor information (incorporated in device or things or objects). In plain English, this refers to all the different ways of exchanging information/data. When it comes to the technical world, it broadly implies “exchanging” information through devices. However, in IoT terminology, it refers to exchanging information through “things” with the rest of the world. This exchange of information happens over a network, which includes physical and virtual networks, and uses different types of protocols for achieving it.

The communications mechanisms consist of an interplay of devices or things, including hardware and software. Hence, selecting the right communication mechanisms, which include all types of transportation and protocol requirements, is very important while someone is conceptualizing and thinking about constructing an IoT stack. This layer signifies and determines how to interact with the underlying infrastructure. This in turn provides answers to questions such as, which type of platform would be best for your solution, a third-party platform or on-premises or cloud infrastructure? If you want to go with cloud based solutions, this layer is responsible for data management. For example, how do you put data in and take it out from the cloud infrastructure. It does this with the help of a wide area network, a local area network, WiFi, and other related technologies.

The gateway is an essential part of the IoT environment. An IoT gateway is an “in-between” equipment and it connects sensors, devices, systems, and the applications. It provides tremendous value as it filters and passes data gathered from sensors and devices. The gateway enables an IoT ecosystem to efficiently collect and securely transport data from devices and equipment to destination systems or infrastructure. The gateway is not essentially a singular component. It may be designed as a network/combination of gateways that can connect all the distant devices and is capable of scaling with device growth. The gateways, in combination with IoT sensors and devices, play an important role in the IoT ecosystem, as they provide abilities to achieve, secure, manage, and maintain the overall system. The gateway can be used for multiple purposes, but a couple of them are very important:

- It is used to migrate meaningful data to the cloud and reduce the volume of available data on its way to the cloud by filtering out junk data.
- It is used as a data processor.

A few highlights of the communication, protocol, and transportation layer are mentioned here:

- IoT gateways are integration points for the sensors/group of sensors.
- Acts as an actuator to connect things or devices to each other or to the external networks.
- An IoT gateway can be a physical piece of hardware or functionality that can be incorporated, built, or attached to the devices.

- An IoT gateway is used to gather data from sensors.
- Some important protocols for gateways are
 - CoAP
 - MQTT
 - HTTP
 - XMPP
- An IoT gateway is capable of processing data at the edge and can have some storage capacity for dealing with network latency.

Now is a good time to look at some of the popular communication and networking terminologies. Proper understanding of these terminologies is helpful in understanding IoT technologies better. A few of them are used today, and others are emerging at rapid speed (see Table 4-1).

Table 4-1. Wireless Networking Options

Type of Network	Description
Cellular mobile network	It is available in multiple variants, including 2G ,3G ,4G , and 5G (the newest addition), where “G” stands for generation.
Bluetooth and Bluetooth low energy	Wireless personal area network (WPAN). It is a standard for transferring data short distances.
ZigBee	A wireless mesh networking protocol. Excellent for low data rate and high battery life.
Z-Wave	Wireless protocol for home automation.
MAN	A metropolitan area network is similar to a LAN. However, its reach extends to a city or large campus or multiple campuses. Typically, it is designed for a city or town.
PAN	Personal area network is a network that revolves or organizes around an individual or person. It can potentially enable wearable computer devices to communicate with other nearby computers or smart devices and exchange data digitally.
WAN	Wide area network is span across large or big geographies. It potentially connects smaller networks, including LAN or MAN.
6LoWPAN	IPv6 over low power wireless personal area networks.
WiFi	A wireless technology used for local area networks. It is the integral part of most of the devices available now, including mobile, tablets, and PCs. However, it is not limited to devices only and extends its reach to electronic goods as well (refrigerators, washing machines, etc.).

Data Processing Layer

The cloud platform is the backbone of modern IoT solutions. It is one of the biggest enablers of the boom in data science and machine learning. As per principles of data processing, data can theoretically be processed anywhere, provided the technical infrastructure is available. However, companies prefer to process data over the cloud for obvious reasons. Here are some of the critical aspects related to this.

- *Data collection and management:* Smart devices can stream data to the cloud easily, including junky and noisy data, with the help of modern data streaming technologies. Data may come from a variety of sources with fluctuating internal arrangements, formats, and structures. Also, the data may need to be preprocessed to handle or find lost and unwanted data. Additionally, data needs to be assimilated with different data sets that come from different sources to come up with an amalgamated representation before being directed and stored in the data store. Therefore, while defining the requirements of the IoT based stack, having a good idea about the type and volume of data is important. A unambiguous acquaintance of daily, monthly, and yearly data requirements is one of the important steps for designing and creating a robust, effective, and efficient stack. Defining scalability parameters properly and well in advance helps the architects, data scientists, and data administrators define the right and appropriate data management solution and associate ecosystem.
- *Analytics:* Analytics is one of the key components of any IoT solution. Analytics, in the context of IoT, refers to the ability to crunch data in meaningful ways, find hidden patterns, and generate insights into intelligent and smart mode. In order to perform business critical forecasts, the technical interplay of machine learning and Big Data analytics comes into the picture. Also, it equips the overall ecosystem with the ability to extract cognitive insights (understanding the way humans interpret and infer in an automated way) from the available data. This stage also incorporates the constant reclamation and investigation of actions performed and deposited to archived data in order to get an understanding of past data and forecast upcoming movements, or to perceive irregularities in the data that may prompt additional examination or action. Remember, raw data alone cannot make any solution valuable for the business. It is analytics based insight powered by modern data driven technologies and machine learning that turns soil into gold. Therefore, we can infer from the previous discussion that any IoT technical stack must be capable of incorporating analytical capabilities and facilitate building effective and efficient solutions.

- Cloud APIs: The Internet of Things is all about connecting multiple devices or objects to each other, to the network, or to a network of networks. The purpose of creating this network of devices is to share data for effective utilization for different needs, including business and personal requirements of enterprises and individuals. In and around IoT solution, data is universally available. It travels from things/objects/device to the cloud infrastructure from the cloud to backend systems, from multiple handlers or users to their objects or devices. At the heart of this traveling of data are APIs that enable all the communication and collaboration among devices. This seamless communication among multiple objects, things, devices, and networks is usually done by consuming exposed APIs at either the cloud level or at the device level. These APIs are exposed by the vendors and providers as one of basic elements of the cloud offering. APIs allow users to interact with devices or to exchange data among themselves. Remember that opening an API to target audience is not a technical decision, it's a business decision. Proper API administration enables the movement of data with security, which helps guard sensitive data.

Presentation and Application Layer

This layer provides a means of interaction with the users of applications. Software installed on devices/objects works as an interface for communication. The layer also contains applications and interactive products through which end users communicate. This layer sits on the top of the technology stack and most of the technical complexity is underlying. Hence, this layer is easily interpretable by almost everyone. To people who are exposed to a bit of technology or even to the layman, this is the “layer of use” because it contains applications and products that they use without knowing the hidden complications.

Enterprises earn most of their revenue from here. Technical and product managers easily relate to this layer. The applications, products, and services that sit here are generally web-based. However, this is not the mandatory criteria and it depends on the user’s needs. The APS (Applications, Products, and Services) are meant to target the desktop, mobile, and wearables. Also, many applications or apps are made available to fulfill customers or users needs and demands. In changing times, customers and users are more inclined toward cloud enabled applications or products, because they provide flexibility to access information from smart IoT enabled objects in an “anytime anywhere” manner. This “anytime anywhere” access aligns with the ultimate goal of IoT to provide freedom and agility to users.

Industry specific applications also sit at this layer. Consumers use this layer to fulfill home, lifestyle, and health related needs. Business and industries are using this layer for their professional needs.

IoT Solution Availability

Microsoft is one of the end-to-end solution providers of IoT based technologies, products, and solutions (there are multiple others, including IBM). IoT is in demand. Many companies are helping their clients and stakeholders in this area. They are continuously innovating and introducing breakthroughs in the market. In today's world, doing only research and innovation will not work. Proper positioning of products, branding, marketing and articulation of research, innovations and associated offerings to the right people is all equally important. These factors help customers make informed decisions about products or applications for a particular purpose that serve their needs.

REAL-LIFE SCENARIOS

Nanotechnology Sensors

Nanotechnology is a field of study where particles are studied at the nano scale (a very small scale). It has been widely used in medical science and to treat illnesses in early stages. When nanotechnology is integrated with IoT, Big Data analytics, and machine learning it becomes very effective.

1. Injections of nanoparticles are given to the patient to be released into the bloodstream. The nanoparticles identify biological or chemical changes. This activity monitors the chemical and physical changes in the patient's body to detect illnesses in the early stages. This is based on the simple principle that unexpected changes in the internal biological, chemical, and physiological mechanisms of the body may be a sign of disease.
2. The nanoparticles interact with wearable devices to proactively indicate changes made by foreign particles interfering with the normal flow in the body. Wearable devices receive data on an ongoing basis from the nanoparticles.
3. The wearable devices use this data for disease diagnoses, which in turn uses predictive and prescriptive analytics.
4. Machine learning, in combination with cognitive modeling and computational algorithms, learns the process of change and behaviors of the internal bodily mechanisms and diagnoses any disease effectively and proactively.

This overall process increases the effectiveness and efficiency of disease diagnosis. Therefore, it helps reduce hospitalization time and costs. It also generates intuitive and effective reports.

Monitoring

Machine learning takes the monitoring to the level of cognitive intelligence. Machine learning provides these benefits to the IoT system:

- The wearables provide alarms and notifications on health around the clock. They generally not as effective at tracking the actions for these alarms and notification and properly recording them.
- Machine learning, with the support of neural networks, can track activities based on human actions and record the responses.
- The recorded data will be forwarded to the doctor.

Here are the steps in an interesting future use case:

1. The patient gets out of bed and the sensors in the floor and bed record this event.
 2. The sensor-enabled toilet examines the patient's stool and urine, before uploading the details to the cloud. A sensor-enabled toothbrush examines the oral health of the patient.
 3. Important health indicators such as pulse, blood sugar levels, and blood pressure are recorded and uploaded to the cloud.
 4. Sensors in the wall and floor assess the risk of a fall based on the patient's movements.
 5. Diuretic medicine contains tiny transmitters that sends signal to wearables that the patient has taken the medicine.
-

Big Data Analytics Technology Stack

Creating a Big Data technology stack revolves around the requirements and specific needs of the business. Also, while making decisions about a Big Data technology stack, you must consider the three Vs (velocity, variety, and volume; for further details refer to Chapter 1) as well as the availability of the analytics infrastructure. The technology stack for Big Data creates value from the data. However, data cleanliness is guided by the requirements, rules, business logic, and analytical capabilities as well.

Typically, Big Data technologies are divided into layers for the separation of concerns and logic (see Figure 4-1). Logical subdivision of complexity in the form of layers serves as the building blocks for the Big Data technology suite. Some redundancy exists across layers, because isolated layers cannot serve this purpose.

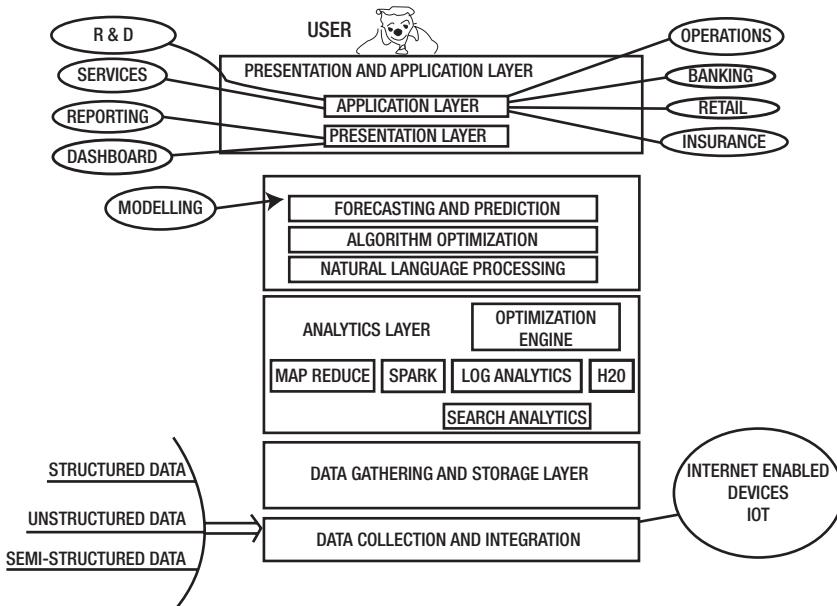


Figure 4-1. Big Data analytics stack

Note Data processing and analytics are one of the important steps during “insight” generation and are tightly associated with machine learning. Machine learning and data analytics can be treated as one layer. However, for clear segregation, it is always good to keep them separate (at least logically). Machine learning, including its workings and relationships with the technologies, is discussed in the greater detail in the “Machine Learning” section. Figure 4-1 shows one way that machine learning and Big Data analytics are tightly bound.

Table 4-2 shows the Big Data analytics technology and process suite in a nutshell. In next section explains some important software, frameworks, and libraries that are closely associated with the Big Data technology suite. Table 4-2 also provides a summary of the bare minimum technological implementation of Big Data.

Table 4-2. Main Technologies of Big Data

Name of Technology	Description
Hadoop	Implementation of MapReduce. Can work with diverse data sources. Also known as an enterprise data operating system (for details, refer to the Hadoop section).
Hive	Allows traditional data-driven applications like business intelligence (BI) to run queries against a Hadoop cluster. Also, visualized as a data warehousing service that provides facility of reading, writing, and managing large data sets. It's an abstraction layer (which hides internal complexities of the technologies) on MapReduce (for details, refer to the MapReduce section).
Hive QL	It is a SQL-like language used to submit MapReduce jobs.
Pig	Also allows applications to run queries on the Hadoop cluster. However, it is a Pearl-like language instead of a SQL-like language (Hive). For details, refer to the Pig section.
HDFS	A distributed file system technology. Generally used for storing unstructured data (for details, refer the HDFS section).
MapReduce	It is a distributed computation framework. However, it is slow in computation in comparison to newly evolving frameworks (for details, refer to the MapReduce section).
HBase	Column-based storage service that stores data in a tabular format.
ZooKeeper	Distributed coordination service.
Yarn	Yarn stands for yet another resource navigator. In Big Data analytics systems, its role is to act as a central operating system that provides and manages resource and application lifecycle management to the technology stack.
Ambari	Used for provisioning, managing, and monitoring the Hadoop cluster.
Avro	A data serialization system. Its .NET flavor also exists in one offering from Microsoft, called HDInsight, which is a Hadoop distribution from HortonWorks. It is also visualized as Apache Hadoop running on Microsoft Azure (a cloud platform as a service offering from Microsoft).

(continued)

Table 4-2. (continued)

Name of Technology	Description
HCatalog	Provides a relational view of the data on Hadoop cluster. Tools like Pig and Hive run on the top of HCatalog and it serves as a layer of abstraction.
Oozle	It is an application used for coordination of workflow of Hadoop jobs.
Tez	It is an application framework for doing high performance batch and interactive data processing. It makes the Hadoop job faster and maintains MapReduce scalability and robustness. It generally operates on petabytes of data.

Data Acquisition and Storage Layer

This is the bottom or the lowest layer in the Big Data technology stack. This layer is responsible for the collection of all types of data (structured/unstructured and semi-structured) and storage. The data comes from multiple sources, including IoT enabled devices, social media, and RSS feeds. Because of the volume, velocity, and variety of data received at this layer, some firms are use data lakes as a source of their Big Data repository. A [data lake](#) is a data-acquisition and storage approach. It stores and embraces raw data in its natural setup, form, and format. Its main purpose is to store data and not to apply any type of intelligence and sophisticated operations to it. For example, the how/why/where the data is stored data is not an area of concern for data lakes. Its technology also not care about governance and security aspects of the data.

Providing a solution for Big Data technologies is a huge, open, and evolving market. Many companies are offering their solutions in this space. The major players are Apache, HortonWorks, IBM, Amazon, and Microsoft. HortonWorks and others provide a compressive set of tools and technologies for Big Data, Big Data analytics, and machine learning. Refer to these links for more details.

- Technologies offering from Apache (Source: <https://hortonworks.com/products/data-center/hdp/>)
- Technologies Innovations at Apache (Source: <https://hortonworks.com/products/data-center/hdp/>)

There are multiple technical offerings in this space from a variety of companies. Therefore, a brief look at the main ones will give you a good understanding of data acquisition and storage.

Hadoop Distributed File System (HDFS)

A distributed file system (DFS) is any file system that allows access to files from multiple hosts sharing via a computer network. A distributed file system may include facilities for transparent replication, capabilities to deal with large data set, write once/read many times and fault tolerance. It is used for storing large volumes of data in inexpensive commodity hardware. Hadoop Distributed File System (HDFS) is used as the main data storage system by Hadoop suite of applications/ecosystem.

HDFS is a scalable, robust, fault-tolerant Java based distributed file system. HDFS creates multiple replicas of data blocks and distributes them on compute nodes throughout a cluster of enable reliable, extremely rapid computations. HDFS stores system metadata and application data separately. It stores metadata on a dedicated server, called the *NameNode*, and application data on other servers called *DataNodes*. All servers in HDFS are fully connected and they communicate with each other using TCP-based protocols. File content in HDFS is replicated on multiple DataNodes for reliability, and it has the advantage that data transfer bandwidth is multiplied, so there are more opportunities for locating computation near the needed data.

The Core Hadoop Architecture

Hadoop cluster is based on a masters and slaves (see [Figure 4-2](#)) architecture. However, the terminologies are different in comparison to the traditional master/slave architecture. In Hadoop terminologies, the NameNode is the master of a Hadoop cluster and it is responsible for the file system namespace and access control for clients. A JobTracker distributes jobs to waiting nodes. NameNode and JobTracker are the masters of the Hadoop architecture. The slaves contain the TaskTracker, which manages the job execution. It takes complete responsibility, from starting, monitoring, and capturing the output of the job. It also notifies the master about the job completion. The DataNode is the storage node in a Hadoop cluster and it represents the distributed file system. The TaskTracker and the DataNode work as slaves within the Hadoop cluster.

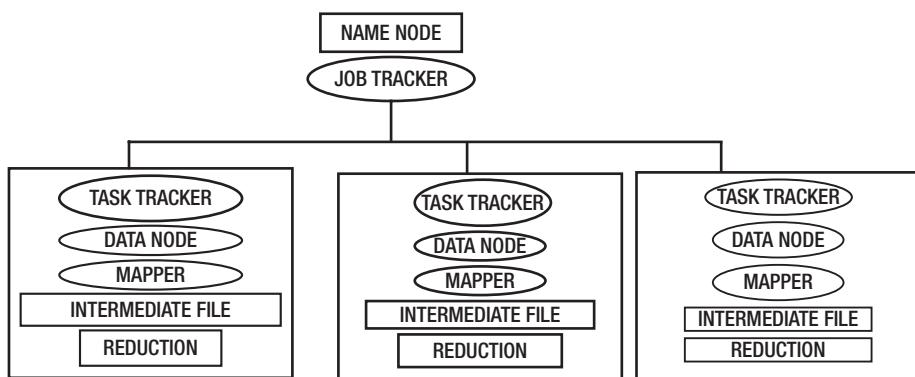


Figure 4-2. Elements of a Hadoop cluster

Hadoop has flexible, efficient, and robust architecture. Hence, it is equally effective in supporting a single node cluster, where all objects exist on a single node or a multi-node cluster. That way, JobTracker and NameNodes are distributed across thousands of nodes.

Salient Features of HDFS

Here are the most interesting features of HDFS:

- *Reliability and fault tolerance:* It is designed to store very large data sets reliably (fault tolerance), because of feature of replication of data in the cluster or in multiple clusters. Typically, one set of data is dependably deposited on the machine cluster. Therefore, if one machine is down, the data is still available on the other. It also streams data sets at high bandwidth to user applications to achieve high performance.
- *High availability:* Even if some machines or hardware is not working or has crashed, the data can be accessed through another path.
- *Distributed storage:* HDFS provides excellent results in the distributed storage environment and performs computation across multiple heterogeneous servers. Its effectiveness remains intact even if the resource can grow with demand (scalability). Also, it remains economical at every size.
- *Open source:* It is an open source project, so it enables the modification and customization of code according to need.
- *Scalable:* It is highly scalable, which means adding new hardware is easy. Hardware can be added to the nodes effortlessly. It can be horizontally scaled, which enables addition of the new nodes on the fly without downtime.
- *Flexible:* Hadoop enables accessing new data sources without effort and taps into dissimilar kinds of data, including structured, semi-structured, and unstructured data to produce value from that data.
- *Fast:* Hadoop's imitable storing technique is based on a distributed file system that fundamentally maps data wherever it is positioned on a cluster.
- *Economical:* Hadoop provides cost-effective storing solutions for the huge data sets. Hadoop-based solutions are cheap because it runs on clusters that are installed on the commodity hardware. It does not need a dedicated machine. Therefore, Hadoop offers enormous price savings.

Amazon Simple Storage Service (S3)

S3 is a cloud based scalable, robust, and file tolerant system. It is a distributed file system offering from Amazon. It can be exploited as the data layer in Big Data and analytics based applications and to build the architecture. However, it may require additional components. Amazon S3 provides a simple web service based interface. It can be used

to store and retrieve any amount of data, at any time, from anywhere on the web. It also provides a highly scalable, reliable, fast, inexpensive data storage infrastructure. Amazon S3 is used by Amazon to run its own global network of web sites.

Analytics Layer

This layer typically organizes and prepares data for analysis. It processes huge and diverse sets of data that it gets from the data acquisition layer, with the help of different processes, technologies, and algorithms. There are a variety of analytical tools, frameworks, technologies, and robust algorithm available with varying capabilities. Depending on the requirements and market demand, any one or combination of technologies is used. This layer converts raw data into actionable insights. This is the layer that deals with multiple types of analytics, including descriptive, diagnostic, predictive, and prescriptive. Technically, many authors take machine learning as one of the ingredients of this layer. However, this chapter discusses those concepts in the machine learning section because machine learning libraries, frameworks, and tools sit on the top of analytics layer.

Apache is no doubt the leader in providing Hadoop based Big Data solutions. Figure 4-3 presents the Hadoop stack, which shows the positioning of HDFS and MapReduce in the overall stack.

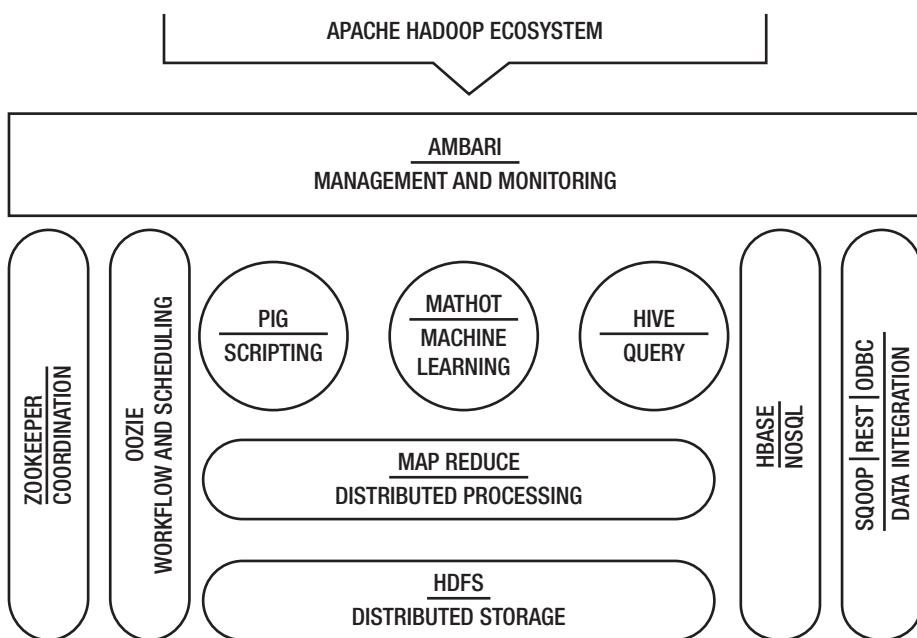


Figure 4-3. Positioning of HDFS and MapReduce in the overall Hadoop stack (which covers all layers of Big Data analytics)

Multiple vendors are providing their solutions in the Big Data space, starting with gathering data to presenting it, which includes offerings from Apache, IBM, and Microsoft. However, it is difficult to cover all the offerings of these vendors. Therefore, this chapter confines its discussion to Apache/Hadoop based products and touches on the products of other vendors at few places. Let's start with the revolutionary technology called MapReduce.

Hadoop MapReduce

Hadoop MapReduce is an excellent software framework for processing large data sets in a distributed computing environment. MapReduce is the heart and soul of the Hadoop framework. It is a programming model that permits and facilitates massive scalability across hundreds or thousands of servers in a Hadoop cluster. It works on compute clusters of commodity hardware. The framework is used by organizations, enterprises, and companies to schedule tasks, as well as monitor and re-execute any failed tasks. Since it's a sub-project of HDFS, its working style has inherited the basic philosophy of HDFS.

The term *MapReduce* refers to two separate and different actions that a typical Hadoop program performs. A MapReduce job usually splits the input data set into independent groups of data, which is processed by the map tasks in a parallel way. The "map" job takes a set or chunk of data from the available data store and converts it into another set of data, where individual elements are broken into key/value pairs. The framework categorizes the results of the maps, which become input to the reduce tasks.

Then, "reduce" job takes the output from a map step as input and combines those data key/value pair into a smaller set of tuples (a commonly used synonym for the key/value pair). As the name MapReduce implies, the reduce job is always performed after the map job. Typically, the input and output of the job are warehoused in a distributed file system. (Figure 4-4 shows the overall architecture of MapReduce.)

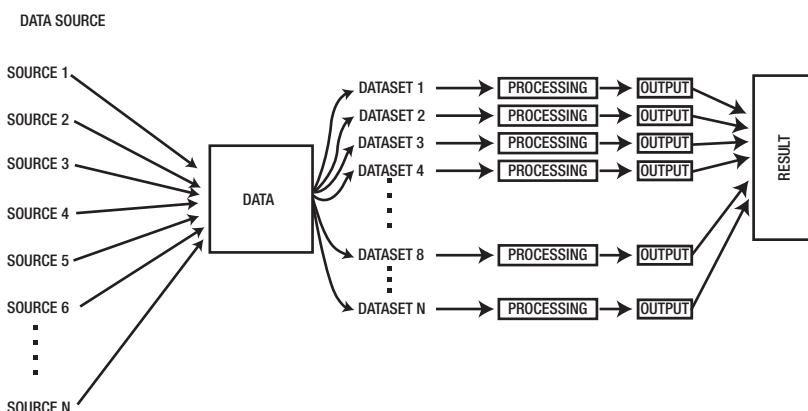


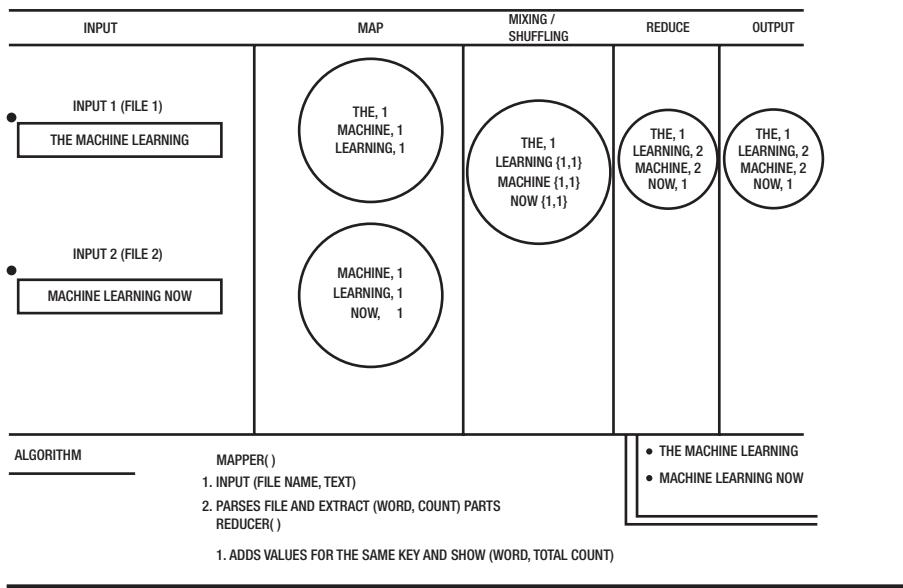
Figure 4-4. MapReduce architecture

MAPREDUCE WORD COUNT EXAMPLE

Challenge: Count the number of different words in a provided document.

The Map() and Reduce() functions run in parallel on the Hadoop cluster machines to solve this challenge in a parallel manner. Input to and output from these functions are key/value pairs. The following steps are involved:

1. Mapping
2. Reducing
3. Overall computation



QUICK FACTS ABOUT MAPREDUCE

MapReduce is the main algorithm that changed the way Big Data is processed.

Google was a pioneer in MapReduce. The two main papers are:

- The first paper was Sanjay Ghemawat et al., (2003) on *The Google File System*. It describes that how the files are processed on Google clusters in a distributed manner.

- In 2004, Jeff Dean et al., (2004) also discussed details about MapReduce in their paper: *MapReduce: Simplified Data Processing on Large Clusters*. It describes the programming model used on Google clusters.

MapReduce is the framework used by Google internally to index the WWW to support Google searching.

Pig

Pig sits on top of the Hadoop framework and processes large data sets without the users having to write Java based MapReduce code. Pig is a high-level platform for creating MapReduce programs used with Hadoop. Apache Pig allows Hadoop users to write complex MapReduce code by using Pig script, which is a simple, easy-to-understand scripting language. Pig translates the Pig Latin script into MapReduce, so that it can be executed on the data.

Various coding approaches and technologies exist to solve Big Data problems. Apache Pig can be thought of as one of the options of Hadoop MapReduce. Every coding approach and programming language has some advantages and disadvantages. Pig is not an exception. It is up to the developers to evaluate and choose which coding approach or programming language will best fulfill their needs and requirements.

However, based on the general guidelines, programmers who are not well-versed with the technicalities of Hadoop MapReduce will find Pig easy. It is easy to start with and less chaotic. Pig can be potentially extended by following UDF (user defined functions). It enables users to write code or program in the language of their choice, including Java, Python, JavaScript, and Ruby. These can be called directly from the programming languages.

Apache Hive

Hadoop was developed to organize and store massive amounts of data of all types and formats. Data analysts, enterprises, and companies uses Hive to query, summarize, explore, and analyze data, which can be potentially converted into actionable business insights. Table 4-3 shows the features of Hive.

Table 4-3. Features of Hive

Benefits and Features of Hive	Details
SQL-like scripting	Provides flexibility to query through SQL scripting. Users can use <ul style="list-style-type: none"> • Subquery IN/NOT IN • Permanent user-defined functions • Stream data into Hive from Flume. Apache Flume is a distributed service for gathering, integrating, and moving huge volumes of streaming data into the HDFS. • JOIN keyword in WHERE clauses
Speed	Provides <ul style="list-style-type: none"> • Faster query planning features and cost-based optimization • Interactive queries through Hive
Integration	Easily integrate with the traditional data source and ETL (Extract Transform and Load) tools
Supports scalable and extensible architecture	Easily extensible and scalable. This feature comes in handy when the data volume grows in a heterogeneous environment.

One of the important extensions of Hive is HiveMall, which is an open source scalable machine learning library that provides a collection of machine learning algorithms as Hive UDFs. UDFs permit you to modify how Hive assesses data and manipulates queries. HiveMall makes machine learning easy for developers by providing interactive and stable APIs w/SQL abstraction. It supports regression, classification, recommendation, anomaly detection, k-nearest neighbor, and feature engineering algorithms. Also, HiveMall runs on the top of Hive and does not need programming for performing machine learning based development activities. It is based on Hive so it is easy for Hive users to learn.

Table 4-4 presents a comparative study of MapReduce, Pig, and Hive.

Table 4-4. Summary of the MapReduce, Pig, and Hive Technologies

Pig	Hive	MapReduce
Scripting language	SQL like query language	Complied language
Higher level of abstraction	Higher level of abstraction	Low level of abstraction
Fewer lines of code in comparison to MapReduce	Fewest lines of code in comparison to Pig	More lines of code in comparison to Pig and Hive Lines of code, MapReduce ► Pig ► Hive
Less development effort in comparison to MapReduce	Least development effort in comparison to Pig and MapReduce	Development effort, MapReduce ► Pig ► Hive
Less exposure to bugs	Least amount of bugs	More exposed to bugs
Less efficient in handling unstructured data, such as images, videos, audio, and text that is vaguely delimited, as well as log data	Efficient at handling unstructured data, such as images, videos, audio, and text	Effectively handles unstructured data, such as images, videos, audio, and text
Code efficiency	Code efficiency	High code efficiency in comparison to Pig and Hive

HBase

HBase is a non-relational NoSQL database that runs on top of the Hadoop Distributed File System. NoSQL database technology is designed to support the changing requirements of cloud-based applications, which contain and deal with a very large volume of unstructured data. HBase is designed to take care of those requirements. It can overcome the existing problems of traditional databases, such as poor scaling, slow performance, ineffective data model, and data distribution of the large volume of data.

The parameters and bottlenecks mentioned previously are the typical limitations of relational databases. HBase provides real-time read/write access to large data sets. HBase scales if required to handle huge data sets in a linear fashion. It efficiently deals with a large number of rows and columns. When it comes to combining multiple data sources that use a wide variety of different structures, formats, types and schemas, HBase is very handy. HBase has native support to integrate multiple data formats with the Hadoop framework and technical ecosystem.

It works flawlessly with other data access engines through YARN, which commonly known as the operating system of the Big Data system. YARN and HDFS are the foundational components of the HortonWorks Data Platform (HDP). While HDFS provides scalable, fault-tolerant, cost-efficient storage for Big Data stores, YARN is designed to provide a centralized flexible, robust, and scalable architecture. It enables users or automated applications to process multiple jobs at the same time. YARN also takes care of resource management activities. YARN's plug-and-play architectural design facilitates a wide variety of data access methods. Table 4-5 shows interesting information about NoSQL and relational databases. It is good to take a brief look at the comparisons between NoSQL and RDBMS.

Table 4-5. Multiple Aspects of NoSQL Database, RDBMS, and MongoDB

RDBMS vs NoSQL

Benefits

RDBMS

Structured and transitional. Efficient at handling high-performance workloads.

Good for relational data.

Constraint based.

Rigid, mature, and stable.

Drawbacks

Rigid schema defined for the organization of data. Difficult to scale.

Cannot handle very high volumes of data, pictures, or videos efficiently.

Examples: SQL server, Oracle, and MySQL.

NoSQL

Semi-structured, schema less architecture allows for frequent change and provides features of varied addition of data to the system.

Object oriented and good for non-relational data.

Eventfully constraints.

Flexible, emerging, and scalable.

Not mature. Hence, difficult installation and toolset availability.

Slower response time.

Examples: MongoDB and Amazon Dynamic DB

Table 4-6 shows a summary of NoSQL databases.

Table 4-6. Types of NoSQL Databases, Vendors, and Uses

NoSQL Database	Properties	Uses	Example and Vendors
Graph based	<ul style="list-style-type: none"> Highlights connections between data elements. Stores data in related node. 	<ul style="list-style-type: none"> Spatial data storages Recommendation engine 	<ul style="list-style-type: none"> Infinite graph NodeJS
Column based	<ul style="list-style-type: none"> Deals with a large number of columns. Good for Internet based searches. Good for large web based applications. 	<ul style="list-style-type: none"> Read and write extension Effective in storing large data Efficient with distributed environments 	<ul style="list-style-type: none"> HBase SampleDB Hypertable Cassandra
Key/value based	<ul style="list-style-type: none"> Uses key/value concept to store data. Typically associates one key with one value. Excellent for click stream types of applications. 	<ul style="list-style-type: none"> Efficient and effective in small read and write operations Good for high availability systems Good for large database requirements 	<ul style="list-style-type: none"> Riak Oracle BDB RADIS
Document based	<ul style="list-style-type: none"> Stores data in document like structures. Typically uses JSON formats. Good for content management. Excellent for web based applications. 	<ul style="list-style-type: none"> Used for consistent data Efficient and effective at storing unstructured data 	<ul style="list-style-type: none"> Couchbase MangoDB

Providing NoSQL-based solutions is a big business. Thus, multiple vendors have offerings in this area, apart from Apache. For example, Cassandra is an open source distributed NoSQL database that's highly scalable, fault tolerant, and used to manage huge volumes of data. It is based on Amazon's Dynamo. Deciding on relational database systems or on the NoSQL system is guided by multiple factors and requirements.

Table 4-7 shows some conditions that play a critical role in that decision making process.

Table 4-7. Specific Business Uses of RDBMS and NoSQL Systems

Use an RDBMS When You Need/Have	Use NoSQL When You Need/Have
Centralized applications (e.g., ERP)	Decentralized applications (e.g., web, mobile, and IoT)
Reasonable to high availability	Continuous availability; no downtime
Reasonable velocity data	High velocity data (devices, sensors, etc.)
Data coming in from one/few locations	Data coming in from many locations
When data is primarily available in a structured form	Structured, with semi/unstructured
Complex/nested transactions	Simple transactions
Primary concern is scaling reads	Concern is to scale both writes and reads
Philosophy of scaling up for more users/data	Philosophy of scaling out for more users/ data
To maintain moderate data volumes with purge	To maintain high data volumes; retain forever

MongoDB

The other popular NoSQL database is MongoDB. It is fundamentally a distributed database. However, MongoDB is also used as a document database because of its excellent features like scalability and flexibility. It also provides querying and indexing features. Here are some interesting features of MongoDB.

- Great for general purpose uses
- Excellent as a document database
- An open source product

MongoDB is great for dealing with time series (sets of values detected at different timestamps) data, including sensor data. This feature makes MongoDB one of the main choices to use in applications targeted to:

- Financial market prices
- Sensors (temperature, pressure, and proximity)
- Industrial fleets (location, velocity, and operational)
- Social networks
- Mobile devices

In the era of cloud computing, MongoDB as a company came up with its “cloud specific offering” known as MongoDB Atlas. It is a cloud targeted and hosted database-as-a-service offering. The package works in pay-as-you-go mode and primarily permits users to deploy their applications on Amazon Web Services (AWS). It has also support

for Microsoft Azure and Google Cloud Platform. Recently, MongoDB also came up a connector for Spark, which gives the users an analytics processing engine that enables them to query live MongoDB data.

Apache Storm

Storm is a distributed real-time computation system for processing large volumes of high-velocity data. Storm is a free and open source distributed computation system. It is fault-tolerant and effective in the real-time environments. Its real-time capabilities make it easy to process unbounded streams of data. It is different from traditional batch systems. Traditional system work in store and process fashion, whereas Storm uses an unbounded sequence of tuples (core unit of data). Storm makes it easy to reliably process unbounded streams of data, doing for real-time processing what Hadoop did for batch processing.

An application is defined and identified in Storm through a topology. The topology explains its logic as a DAG (directed acyclic graph) of operators and data streams. In Storm terminologies/context, a graph is an assemblage of nodes that are linked by edges. The nodes denote executable tasks and the edges are task dependencies. In the most simplistic form, the DAG can be visualized as a flow chart that tells the system which tasks to perform and in which order. Now let's take a look at the two most important components of Storm—Spouts and Bolts.

- *Spouts*: Sources of data streams. Their role is to read data from external sources (e.g., Twitter or the Facebook API) or from physical/virtual disks and emit or pass the data into the topology.
- *Bolts*: Process input streams and (eventually) produce output streams. They represent the application logic.

Apache Solr

Apache Solr is the open source enterprise search platform that is based on Java search servers. It is used for multiple purposes and applications related to search. Typically, it is used for searches of data stored in HDFS on a Hadoop cluster. It is one of the prime applications of Solr in the enterprises. Solr is popular because it's flexible and easy to integrate into machine learning and Big Data technologies. It is a scalable, fault tolerant, mature, and reliable open source enterprise search platform. Solr is built on Apache Lucene, which is an information retrieval software library.

Solr is widely used with enterprise content management systems to provide full-text and near real-time indexing to big Internet sites. For example, Alfresco and Drupal use Apache Solr to incorporate search capabilities and provide benefits to the end users. It is excellent in finding tabular, text, geo-location, or sensor data stored in Hadoop and is optimized for handling high volumes of web traffic.

Apache Spark

Apache Spark is an open source cluster computing based processing framework for large-scale data processing. It is built on in-memory compute engines. Spark can run up to 100x faster than the older technologies like Hadoop MapReduce in memory. Also, it can be 10x faster on disk for program execution.

Spark provides in-memory computations (processing happens in local memory), which means it achieves increased speed and data processing over MapReduce. Spark empowers high-performance querying on Big Data. It takes advantage of a parallel data processing framework that persists data in-memory and disks if needed. It runs on top of the existing Hadoop cluster and would access HDFS, and also process structured data from Hive. It streamlines data from HDFS, Flume, Kafka, Twitter, and other sources (Flume and Kafka are explained later in the chapter). Spark is mostly supported by the Big Data vendors and open source community. However, Microsoft Azure implementation of Spark is easy and cost effective. One of the prime reasons to deploy Spark and Spark based solutions on Microsoft Azure is that no hardware needs to be procured and no software needs to be configured, due to its cloud based nature. Azure also facilitates third-party integration of Spark with business intelligence tools.

HDInsight

Microsoft and HortonWorks are working together to help companies realize the advantages of Big Data analytics through HDInsight. HDInsight is an Apache Hadoop distribution powered by the enormous potential and efficiencies of the cloud. It scales horizontally and vertically, based on dynamic demand. This capability allows HDInsight to deal with any volume of data. It also natively integrates with Azure Data Lake Store. Azure HDInsight is intended to make Hadoop and Spark simple with lower manageability costs. It provides higher developer productivity for making Big Data based solutions. It provides 63% lower total cost of ownership (TCO) to the customers. Practically speaking, HDInsight is offered as Hadoop-as-a-service, hence no additional hardware is required for it.

Azure HDInsight uses the HortonWorks data platform and easily integrates between on-premise and cloud solutions. It also makes hybrid deployments easy over on-premises and the cloud. By addressing both environments with a common platform, Microsoft is guiding users on a path that delivers the advantages of the public cloud while respecting the complexities of today's on-premises large data initiatives. When customers want to move code or projects from on-premises to the cloud, it's done with a few clicks and within a few minutes without buying hardware or hiring specialized operations teams typically associated with Big Data infrastructure. It is a managed Hadoop service and it has the most Apache projects in the cloud. It benefits from core Hadoop offerings like HDFS, YARN, MapReduce, Hive, Tez, Pig, Sqoop, Oozie, Mahout, and Zookeeper and advanced workloads, including Spark, Storm, HBase, and R Server.

Microsoft Azure HDInsight is an integral part of the Cortana intelligence suite, which is a Microsoft machine learning solution that provides an end-to-end solution, from information management to machine learning, dashboards, and cognitive services. Azure HDInsight is based on architecture that supports redundancy. This provides it with high availability. It is available 99.9% of the time and provides support 24*7 to the enterprise.

Presentation and Application Layer

This layer is an integrative layer which means it combines multiple layers. However, segregation is still possible. I discuss the presentation and application layers separately here.

- *Application layer:* This layer provides user interfaces for using Big Data applications. Applications from different areas like transportation, retail, healthcare, manufacturing supply chain, and governments sit here.
- *Presentation layer:* This layer presents the insights and intelligence generated with the help of machine learning and data analytics layer to the targeted audience, including users and decision makers. Clear, brief, graphical, understandable presentations are available through this layer. Also, critical communication to the decision-makers is provided through this layer. Data and facts without proper presentation and articulation has no meaning, especially for people who do not have a background in statistics. The communication and presentations are done through the interactive reports, charts, figures, key recommendations, and suggestions.

The major technologies associated with this layer are described in this list. Apart from them, there are multiple other offerings that can be considered for specific needs.

- *SQL Server Reporting Services (SSRS):* This tool is an offering from Microsoft. SSRS provides a platform for creating and delivering reports that can be viewed in a wide range of electronic document formats, including Excel, Word, PDF, image, and XML. It can also be integrated through HDInsight to Hive tables to fetch and display data.
- *Excel/Excel BI/Power BI:* Facts and data can be represented in multiple ways to the users, managers, and decision makers. Microsoft Excel, Excel BI, and power BI offers many features, including:
 - Bar graphs
 - Line graphs
 - Pie charts (multiple options)
 - Scatter plots
- *Oracle Business Intelligence Enterprise Edition (OBIEE):* An excellent offering from Oracle corporation. It can be easily integrated to Big Data store like Hive to fetch and showcase data. OBIEE works seamlessly with the traditional data stores as well. Therefore, it can be used as one data visualization tool for both types of data, structured and unstructured. It also provides

Hadoop access to users without programming knowledge. It is good at doing federated queries across Hadoop and Oracle to avoid constant data movement. If required, it can be tiered together with the other data stores like SQL Server.

- *IBM Cognos:* IBM created a group of Big Data and analytics tools on top of the Hadoop architecture. They call it BigInsights. It contains tools for scaling and managing the Big Data and machine learning platforms. Cognos is the part of that suite and it uses Hadoop as a data source. Cognos connects to Hadoop using Hive.
- *New data visualization tool:* Good presentation of the data is not enough if it makes no sense. Therefore, presenting data in a meaningful way is equally important. With the evolution of Big Data, multiple new data visualization tools emerged that can be used for this purpose. The only criteria is that they effectively present or display maps, text, data connections, behaviors, and emotions.
- Google Maps, Earth, and Places are a few options to present maps in several ways. D3.js, which is a JavaScript library, can be used to display data in multiple formats and types, including box plots, bubble charts, bullet charts, non-contiguous cartograms, chord diagrams, contour plots, dispatching events, spline interpolations, and dendograms. Tools like Crazy Egg are used for multiple purposes to capture and present user behaviors and emotions like tracking visitors' clicks on a web site. It also generates heat maps that indicate which part of site/page gets the most attention of the users. Multiple tools and their online versions are available for displaying connections, including Microsoft Knowledge map and Ayadsi. Connection tools typically help establish relationship between different available data sets, so that holistic insights can be developed.
- *Infographics:* Infographics is one of the new ways of presenting Big Data. As the name suggests, it is a combination of information and graphics. In infographics, the fact is presented in the form of charts, texts, or graphics, which provide a snapshot of facts to the users. Typically, this is a one-pager to get the user instant information.
- Data and information is scattered in multiple places and in multiple forms. For example, it resides in Excel sheets, several reports, emails, charts, and databases. Busy managers and decision makers cannot go through it to get insights. Infographics become handy here, as they provide the desired information on one page. Therefore, a good infographic must be visually attractive and carry useful content.

- *Many other tools on a dashboard:* This is one way of presenting information visually to management. Strategic decision making becomes easy for management with the help of a dashboard, because all the desired information is available to the user/decision makers in a consolidated format. Dashboards need not be associated with strategies. They can be extended to the operational level or present operational information. KPIs (key performance indicators) can be integrated into it, to provide a snapshot to the users.

This layer is very useful, as it provides the freedom, flexibility, and opportunity to see and analyze a holistic picture quickly in a graphical format. Therefore, it enables quick decision making. All this useful only if it is targeted to the right audience.

Offerings from Vendors in the Big Data Space

While discussing Big Data and Big Data analytics based technologies, the Apache offering is the main one discussed. Apart from Apache, there are other companies who provide end-to-end solutions. This includes IBM, Google, and many more. Discussing offerings and solutions from all vendors is not possible here due to space constraints. However, we do take a quick look at a couple of big offerings. This will help you while making decisions.

An excellent decision tree available at <https://biz-excellence.com/2016/09/13/machine-learning-dt/> provides an overview of decisions related to Big Data implementation. The graph depicts the situations and provides suggestions from the Microsoft perspective.

REAL-LIFE SCENARIOS

Big Data found its role in many areas. A few use cases are provided here:

- Anti-money laundering and Big Data: Anti-money laundering is one of the important areas financial institutions. By the use of effective transition monitoring, anti-money laundering solutions and systems are enhanced and work well with Big Data analytics solutions. They are used to develop complex detection models by leveraging additional transaction data using structured, semi-structured, and structured data. This type of developed model can effectively handle data that exists in inconsistent formats. Along with machine learning technologies, the models are tuned based on need. Unsupervised machine learning is applied to find out undiscovered new attributes, which may be related to the anti-money laundering related risks. Also, behavioral modeling model creation is possible

due to Big Data analytics, which ultimately helps in the discovery of uncommon behavior. This would further extend to notification and alerts based on the anomaly.

- Smart reporting for decision makers: Decision makers need intelligent and insightful reports because raw data is of no use. Also, to explain company performance and offer forecasts, they need good reports. Machine learning, along with Big Data, did the quantum shift to reporting. By connecting multiple processes in an end-to-end fashion and using the right digital technologies and analytics, organizations can start delivering quicker, more insightful outcomes. This results in increased market confidence. On the ground level, they present the forecast of the company's performance in a confident way by using intuitive and smart reports. Machine learning analytics based reporting solution provides a new style to data organization, authentication, and understanding. This happened because of automating annotations and report generation using cutting-edge digital technologies and analytics.

The integration of Big Data and machine learning makes the cloud-based reporting solution an excellent option to pull and integrate structured, unstructured financial, and non-financial data from in-house and exterior data sources. It also automates reporting using innovative process-centric technologies, like natural language processing, machine learning, and cognitive and predictive analytics. The machine learning reporting solution presents influential insights for decision makers with the help of the following key components of the technology stack.

- *Data sourcing:* The solution identifies and extracts data from the relevant internal sources.
- *Data preparation:* Data is prepared here for analysis using machine learning. This permits automated report creation with personalized reporting views.
- *Data analytics:* At this layer, business rules are defined and the analytics happens. Also, hundreds of “what if” scenarios and trend analysis capabilities are incorporated here.
- *Commentary generation:* Using natural language processing and generation, the solution automates variance analysis and commentary scripting in a methodical and organized way.

Machine learning enables better-quality prediction or anticipation or forecasting, rapidity, and correctness by reimagining reporting results and implanting the intelligence reporting solution in their finance and other support functions. Using Big Data and machine learning enables reporting enterprises to influence:

- *Investor confidence:* Understanding that business act with additional information helps increase the faith of stakeholders.
 - *Quickness and dynamism:* Support functions can produce actionable insights by reporting data quicker to allow real-time decision making. Automation also helps decision makers become accustomed quickly to fluctuating business requirements and demand, which would significantly increase quickness in the decision.
 - *Proficiency:* Enterprises, especially decision makers, take advantage of efficient and real-time reporting in multiple ways, including the quick reaction time to the market sentiment and aligning their business functions and decisions accordingly.
-

Machine Learning Technology Stack

The primary ingredient for building machine learning solutions is data. The source of that data is obviously the IoT devices, social medial, and so on. The data gathered from sensors is stored in the cloud or on-premise or a mix of both. Typically, these systems are designed in way so that they scale and handle huge amounts of data of all types. Then machine learning specific algorithms and models, which are capable of learning from the data, make implications about the new data. After that, mathematical and machine learning libraries, frameworks, and programming languages like R, Python, or C# are used to realize requirements through code. There are many technologies, frameworks, processes, and skills that are involved in building effective machine learning solutions and we will discuss them in detail in this chapter. However, it is good idea to take a look at the overall flow of machine learning from a technical perspective first.

The success of machine learning projects, applications, and products is based on multiple aspects. Therefore, selecting the best technical stack, including hardware and software, becomes critical. The good choice would lead to extraordinary results, whereas a bad choice can lead to disastrous situations. For example, from a technical perspective machine learning projects require massive computational capabilities to crunch and process data in real time, which would bring down the time to train the system and make overall response time faster. Parallel processing of vast amounts of unstructured data, like video streams or sensor data feeds in real time, enables machine learning systems to provide just-in-time reliable results.

Speed, agility, and utilization of underlying hardware are important criteria for building a good machine learning platform. Hence, while you are considering building a technology stack for a machine learning system, you need to think about the development systems (hardware and software) equipped with processors with multiple integrated cores and faster memory subsystems. They must process good architecture that can parallelize processing and contain excellent concurrent multi-threading abilities.

The platform must have built-in flexibility to support scalable clusters (if the complex solution needs to be built) that you would use to train complex machine learning models.

Selecting specialized hardware is critical. Betting on offerings like Intel® Xeon Phi™ would be excellent choice because it's the first bootable host processor specifically designed for highly parallel workloads. It is also the first of its type to integrate memory and fabric technologies. Machine learning applications developed on frameworks like Caffe and Theano are good choices. Then, selecting the software framework that would be in tune with the underlying hardware is important.

The selection of the software, libraries, frameworks, and hardware are must be based on need, ease of use, and requirements. For example, selecting the tools that provide good drag-and-drop interfaces to enable data scientists and programmers to create high-performance machine learning applications is a prime factor of the success of your machine learning projects. Microsoft Azure ML is easy to use and fast. If the requirements, infrastructure, and cost permits, Azure ML is a good choice. Lastly, but most importantly, people are an important factor of success. Ultimately, people are the real resource who realize the vision of an enterprise and serve the stakeholders. Therefore, their well being needs to be considered and incorporated as an integral part of the product vision.

As discussed in Chapter 1, machine learning layer takes inputs from the Big Data analytics layer. This concept could be visualized in multiple ways. For example, machine learning technologies may be part of the data analytics layer or they can be incorporated into the separate layer dedicated to machine learning. However, segregation or division of the concern has multiple benefits, as it equips an enterprise to tune the technical architecture to synchronize with their requirements and need. This fulfills the overall motive to present an architecture that's decoupled and extendable.

From a platform perspective, a machine learning technology stack can be divided into multiple layers. Each layer in turn is supposed to perform and coordinate some tasks. The main layers and associated technologies are described here:

- Connector layer
- Storage layer
- Processing layer
- Model and runtime layer
- Presentation and application layer

Connector Layer

This layer collects data from applications and other data sources available in the cloud or from on-premise systems. This opens the gates to get data from enterprise systems, including ERP, CRM, HR, marketing automation, business intelligence, procurement and financial systems or from the IoT devices. For example, lets say an enterprise uses multiple sources to gather and process data from systems provided by the vendors, including Salesforce, Oracle, NetSuite, Workday, Birst, Concur, and Coupa. That data would be pulled and passed to further layers through this layer. Technologies like BigML from Informatica or tools like Kafka, MQTT, or even REST (a few are discussed in Big Data section) would be used here. There are tons of offerings available from multiple

vendors in this area and they all have pros and cons. It is very difficult to summarize all the technologies available in this space to one place or even in one chapter. However, some important ones are described in the next sections. Let's start with the new kid on the block—Logic Apps from Microsoft.

Logic Apps

Logic Apps is a hosted piece of integration logic in the Microsoft Azure cloud based platform. It does hosting on Azure in a similar way as would be achieved for any web application(s) by other online/offline means. It also provides the facility to build the logic by creating a trigger followed by a series of actions similar to creating a workflow. The advantage of Logic Apps is that Microsoft provided many connectors that enable applications/products to connect quickly through various protocols. It enables applications to connect to a wide range of applications as well. Logic Apps runs on the cloud, so hosting, scalability, availability, and management are not bottlenecks.

Apache Flume

Apache Flume is used for efficiently and effectively gathering, combining, and moving large amounts of streaming data. The data may be comprised of application logs or sensor and machine generated data on a Hadoop distributed file system. It works in a distributed manner. Flume enjoys a robust and flexible architecture based on streaming data flows. It has excellent fault tolerance, failover, and data recovery capabilities.

MQTT

MQTT is a binary messaging transport protocol. It follows the OASIS standard and uses the client-server specific publish and subscribe model. It is an open, simple, and easy to implement messaging transport protocol. The best part of MQTT are its lightweight features. Therefore, it becomes a perfect option for IoT based devices. For IoT devices, the HTTP protocol is too bulky. MQTT is designed with a minimal protocol overhead. Thus, it has become a perfect option for machine-to-machine (M2M) and IoT-based applications/devices/objects. MQTT is also good at utilizing low network bandwidth and inherited most of the characteristics of the TCP transport. For MQTT, a TCP stack is the bare minimum.

Apache Kafka

Kafka is a high quantity distributed messaging system. It is an excellent fault-tolerant tool that stores and processes streams of records as they occur. It is generally used for building real-time streaming applications that require transformation or quick reaction time on the data. It runs as a cluster on servers. The servers may be one or combination of servers.

The Kafka “organizations” organize records into multiple categories, known as topics. Each record consists of a key/value pair and a timestamp. Consumers in Kafka are processes that subscribe to topics and in turn process the feed of published messages. Kafka runs as a cluster comprised of one or more servers, each of which is called a broker.

Kafka get its work done through four main APIs:

- *Producer*: Allows an application to publish a stream record to one or more Kafka topics.
- *Consumer*: Allows an application to subscribe to one or more topics and process the stream of records produced by them.
- *Streams*: Makes an application work as a stream processor. It does this by absorbing a stream of input data or records from one or multiple topics (depending on design and architecture) and in turn produces an output stream to one or several output topics. Basically, it transforms the input streams to output streams.
- *Connector*: Generally used for construction and running reusable producers and consumers for the other uses. Kafka basically provides the ability to connect to topics for producers and consumers who already use applications or data systems/sources. For example, if a connector works on a relational database, it must gather and capture changes that happen to a table.

Apache Sqoop

Apache Sqoop is used to transfer data between unstructured data sources to a relational database system. It can also be used to transfer data to mainframe systems. It transforms the data using technologies like Hadoop MapReduce. Also, it provides functionality to export the data back into the RDBMS.

Storage Layer

Most of the details and technologies related to this layer were already discussed under the IoT and Big Data technology stack. However, if you want to know about those technologies, you can refer back to the specific details in those sections.

Processing Layer

Most of the details and technologies related to this layer were already discussed under the IoT and Big Data technology stack. However, if you want to know about those technologies, you can refer back to the specific details in those sections. Many technologies are discussed in the Big Data analytics section. On top of that, other data processing and analytics tools and techniques are available. Covering all of them is not possible, but a brief discussion follows.

Model and Runtime Layer

This layer contains, facilitates, and uses frameworks, tools, and runtime systems that manage the entire lifecycle of the machine learning models. Machine learning models must be trained, validated, and monitored before deploying them into production. This requires many steps in order to operationalize a model's lifecycle. Managing a machine learning model in a systematic way is a challenging task. It involves lots of complexity and dependencies on factors like monitoring, retraining, and redeployment.

The next sections discuss some of the relevant technologies in this layer.

Apache Mahout

Mahout is a scalable machine learning library from Apache. It uses the MapReduce paradigm. With combination of other Hadoop technologies, it can be used as an inexpensive solution to solve machine learning problems. It is implemented on top of Apache Hadoop. Mahout serves as an excellent tool to find meaningful patterns by running on the underlying data set. Once Big Data is stored on HDFS, Mahout runs automatically on them and extracts meaningful patterns from the big diverse data sets. Apache Mahout converts Big Data into information and then to knowledge in faster and efficient ways. Mahout performs all the important machine learning core activities, including the following:

- *Collaborative filtering*: Used to provide product recommendations by mining user behavior. Technically, collaborative filtering (CF) is a technique that uses user information such as ratings, clicks, and purchases to provide recommendations specific to the site users. The uses of collaborative filtering (CF) vary, including recommending consumer items such as music and movies based on design and targeting audiences of a particular business.
- *Clustering and classification*: Performs clustering activities. For example, it takes items from a particular group (web pages, newspaper article, emails, and phone calls) and organizes them into similar collection sets (web pages of same type, emails of similar type and so on). Also, it can organize and reorganize things from a particular class and categorize them into naturally occurring groups. Organizing items into groups belonging to same cluster that are similar to each other is very helpful. Clustering and classification techniques are useful in acquiring knowledge from existing groups.
- *Item set mining*: This activity is about analyzing items in a group (e.g., items in a shopping cart or terms in a query session) and then identifying which items typically appear together.

Mahout supports multiple algorithms. A few of them are listed next:

- Clustering: K-means, Fuzzy K-means
- Classification: SVM, Random forests
- Recommender
- Pattern mining
- Regression

Amazon's Deep Scalable Sparse Tensor Network Engine (DSSTNE)

This is an open source software library for training and deploying recommendation models. DSSTNE has been used at Amazon to produce custom-made and individualized product endorsements for customers. It is intended for production deployment of real-world applications that need to stress speed and scale over investigational elasticity. It is also capable of extending deep learning beyond speech, language understanding, and object recognition. It takes deep learning to areas like search and recommendations.

Google TensorFlow

Google initially developed TensorFlow to create its own machine learning systems. Later, they released the framework for general and commercial use. It is open source software. Google wants to use TensorFlow in their existing and upcoming projects like next generation of Gmail, video intelligence, and image and speech recognition applications. As of now, it is retrieved through Python or C++ interfaces. Therefore, knowing how to code in Python or C++ is necessary in order to use TensorFlow.

Microsoft Cognitive Toolkit

This tool allows users to make neural networks portrayed in focused graphs. While principally made for speech recognition technology, it is now used as a general machine learning and cognitive toolkit that supports image, text, and RNN training. It also allows users to infer the intelligence within enormous data sets through deep learning without compromised scaling, speed, and accuracy with commercial-grade value and compatibility. It does all this with the help of programming languages and algorithms that users already use or are familiar with.

It is constructed with sophisticated algorithms to work consistently with huge data sets. Skype, Cortana, Bing, Xbox, and industry-leading data scientists now use the Microsoft Cognitive Toolkit to create high quality artificial intelligence applications and products. The Microsoft Cognitive Toolkit also provides the greatest communicative, easy-to-use architecture. It allows working with familiar languages and networks. For example, users can use languages like C++ and Python to play with MCT (Microsoft Cognitive Toolkit). It also permits users to modify any of the built-in training algorithms, or to use their own customized versions.

Apart from these offerings, multiple others are exist and a few of them are covered in Chapter 3.

Other Solutions

There are multiple vendors and companies that provide machine learning solutions. For example, there is an offering from Spark in the form of Milab machine learning library and Azure ML from Microsoft. A few offerings overlap or borrow technologies from each other in order to provide good solutions to a wider audience. For example, Mahout and MLLib both have a common execution engine. However, Mahout focuses on machine learning and has a rich set of algorithms, while MLLib only adopts some mature and essential algorithms. Google's TensorFlow, Nervana System's Neon, and IBM's deep learning platform, Caffe, Torch, and Theano are some of the existing technical offerings from vendors in regards to machine learning. However, the list does not end here and it is increasing day by day.

A number of startups and established software companies have been developing their own machine learning frameworks and applications. For example, Microsoft came up with [Distributed Machine Learning Toolkit](#) and Intel offered [Trusted Analytics Platform](#). Netflix, Pandora, Spotify, and Snapchat also provide machine learning-centric products. A few lesser known startups, including Teradeep, Enlitic, Ersatz Labs, Clarifai, MetaMind, and Skymind, have provided lots of innovative features in their machine learning based products. The following section discusses the comparative study of some of the frameworks centered around machine learning.

Presentation and Application Layer

The details about this layer are covered in the previous section. Refer to the appropriate section for further details.

REAL-LIFE SCENARIOS

Video Analytics

This is used for the analysis of streaming video feeds received from cameras. It makes real-time analysis available about the activities of people, objects, or things. It can help recognize the activities or change around any boundary in real time. Smart video analytics is capable of catalog alerts, notifications, and other actions across cameras and sensors. Therefore, a complete set of characteristics can be indexed covering every incident. One of the main reasons for using this technology is the area of emotion recognition, where video analytics is used to analyze emotions in real time. It also found its application in one of the most happening areas of self-driving automobiles.

Digital Adoption and Client Engagement

As mentioned earlier, banks can use machine learning analytics to build stronger client relationships. Especially in situations when the correlating different data points about client relationship and trading history analysis is required. The solution provided next will also cater to the requirements of personalized client offerings and provide the global view of the customer. This case study highlights the use of specific technologies at each level of customer engagement application. This technology stack for the application takes care of multiple use cases at the same time, such as client behavior mapping and analysis, targeted advertisement recommendations, etc.

Automated Intelligent Machine Learning Based Email and Chat Management System

A machine learning application interprets and understands incoming emails and chats to understand customers and provide relevant responses. This can help agents provide quick, effective, and efficient customer service. This overall process of providing thoughtful results is based on the solid foundation of technology and sentiment analysis. The machine learning solution would automatically separate and categorize the incoming emails and chats.

1. Automatically separate and categorize the incoming emails and chats.
2. Analyze the email and chats based on context in order to understand intent and emotions imbedded in the email.
3. After analysis, provide insights and give recommendations.
4. Take feedback and utilize that for the further improvement of the system.

The intelligent and smart machine learning targeted automation of email and chat management helps advisors deal with the back and forth with clients and provide them more time for other purposes.

Other Use Cases

- Machine learning based forecasting systems anticipate power requirements, especially peaks and troughs in real time. They adjust the system accordingly to maximize the use of the available power grid. These same techniques can be used to maximize the use of intermittent renewable power.

- Facial recognition techniques incorporated in the software, along with machine learning, natural language processing, and deep learning, enable virtual agents and physical agents to provide context based information. Based on your mood, situation, culture, and geographical conditions, the virtual agent can adjust the greeting style. They can “anticipate” orders and provide personalized directions and guidelines.
 - Computer vision and deep and machine learning identify the items brought by customers in the retail store. Based on the context, they can add more relevant data available through the sensors. After that analysis happens on a machine learning based system, which allows non-stop checkout and automatic payments.
 - Interactive screens and household devices enabled with computer vision and machine learning technologies can identify/recognize goods and then suggest complementary products that match the customer lifestyle.
-

Role of Cloud Computing in the Machine Learning Technology Stack

Cloud computing has affected businesses in a big way in the recent times. Nearly all functions in enterprise IT are influenced by the cloud computing paradigm. From development and testing to resiliency and backup, the IT ecosystem cloud computing appears everywhere. It established itself as a new paradigm of building and managing applications. Cloud computing not only affects everyone in the IT department, but affects the enterprise as a whole. Having said that, the reality is that not everything has been migrated to the cloud. On-premise systems and infrastructures are here to stay. In coming times, the mix and match of cloud and on-premise infrastructure is the reality. A machine learning or Big Data analytics solution will be developed, developed, tested, and validated on these hybrid models. Vendors like Google, IBM, and Microsoft offer excellent products and services in the cloud computing space. They provide end-to-end solutions to achieve almost anything on the cloud, from small retail applications to high performance machine learning and cognitive computing solutions.

Worldwide companies have either started or are starting to implement and use distributed technology platforms like Hadoop and Mahout in cloud based environments to fulfill machine learning specific needs. They are doing this to run increasingly advanced experiments and business logic on larger data sets. Technical teams are constrained by the explicit maximum amount of available on-premise resources (e.g., compute, disk, memory, network). This situation is the by-product of dynamically changing data sets and requirements. Therefore, if they use the on-premise infrastructure, they are limited either by their computer's components or by the available resources of the cluster.

These limitations affect the productivity of project teams in many ways, including loss of productivity, lower accuracy, wasted resources, and limitations of capacity planning. Data is the raw quantifiable resource for the product of the cloud and machine learning. Data sizes are rising at the degree of ten folds every five years. Using this rolling flow to attain a modest advantage is powering the growth of Big Data analytics and machine learning techniques.

Cloud and machine learning analytics (Big Data analytics and machine learning) are two topics that have almost merged in recent times. The cloud permits enterprises to subcontract maintenance and hosting of their business applications. Also, they are doing the same with their IT infrastructure. This saves lots of money because they are paying on a “use” basis and not investing in procuring, maintaining, and scaling the infrastructure per their needs. This has led to dramatic decreases of prices, ease of scale, and higher readiness or availability. However, for achieving the benefits and robustness of the cloud, companies have to migrate their data to the cloud service provider’s data center. In the initial days of the cloud, this was an issue with data security. But the systems and overall cloud ecosystem has matured enough that this is not a compromise any more. The cost benefits and ease of use lead companies to provision the machine learning and Big Data technology stack on the cloud. With the help of the cloud based provisioned technology stacks, they can not only store but do analytics on huge volumes of data. This permits them to generate deeper insights (including cognitive and anticipative cognitive insight) on the data. A machine learning technology stack can be hosted privately, as a hybrid, preoperatory, or on a public cloud.

Cognitive Computing Technology Stack

Cognitive computing systems gather and process structured and unstructured data in a natural way with the help of natural language processing (NLP) technologies. They take the inputs from the analytics and machine learning enabled APS and then reason, learn, and generate contextual patterns and associations out of that. This capability of cognitive computing allows humans to connect the dots faster and in smarter ways to take more informed decisions and drive better outcomes.

COGNITIVE COMPUTING VS. MACHINE LEARNING

Cognitive computing APS are different from typical machine learning APS in the following ways:

- Cognitive computing is based on context-driven dynamic algorithms. Typically, they are excellent at automating pattern discovery, and matching understanding knowledge. For example, researchers at the University of Boston developed a cognitive computing based algorithm that enables robots to ask intelligent questions if they are confused while they are trying to get the best available objects. They can quantify the “want” of the user. When the certainty of the “want” is high, they supply the desired object,

whereas if it is not “that certain” the robot makes a best guess about what the person wants and asks relevant questions, like “this one?” for confirmation.

- They can reason and learn instantly based on data in a dynamic fashion. In a nutshell, they are typically good at making sense of things. For example, scientists at the University of Rutgers developed a system for a smartphone when the user wants to be interrupted or left alone. The phone can predict the user's approachability to smartphone disruption by gathering, analyzing, and processing the user's personality traits.
- Cognitive systems can infer, hypothesize, adapt, and improve over time and data without explicit programming.
- They can interact with humans in a natural language, like English.

Machine learning is about creating intelligent APS and machines. However, the industry is slowly moving away from developing merely intelligent devices and APS. They are looking and thinking about intuitive APS and machines that are more like humans. Technology companies and researchers across the industries, research labs, and in an enterprise, are developing decision making APS and devices that will make decisions on the users' behalf based on data and other types of natural inputs. Cognitive computing can achieve this. This is a big motivation for companies to innovate and develop solutions that resemble the human brain.

The cognitive computing technology stack is defined in multiple ways (most of the layers are already discussed in the previous sections). The basic characteristic of cognitive computing system is that it must be able to make sense of enormous volumes of data, apply reasoning, provide context based insights, and continuously learn while interacting with people, machines, or the other systems. Based on these characteristics, it can be broadly divided into three layers:

- *Data processing layer:* At this layer, huge data sets are processed to facilitate intelligent human support and enable smart business decisions. At this layer, technologies related to hyperscale computing, high performance searches, and natural language processing come into the picture.
- *Deduction and machine learning layer:* At this layer, the machine simulates human thinking process in an automated way. Here, technologies like neural networks, statistical modeling, and machine and deep learning come into the picture.

- *Sensory perception layer:* This layer enables and simulates sensory feelings generally associated with the living organism (usually humans). Sensations such as touch, sight, taste, and smell are simulated here. Also, emotion simulation is one of the activities that happens here.

If you want to generalize this discussion and want to visualize these layers, you have to consider the other version of the explanation, described next.

- *Data gathering layer:* This layer gathers data from all the available sources, such as structured, unstructured, and semi-structured. Technologies involved include Applogic.
- *Data preparation, extraction, and conversion layer:* Here the raw data is prepared in a usable format by extracting it from data stores and converting it to the desired format. The technology used here includes ETL based systems like Informatica.
- *Data processing layer:* The converted data is processed here. The technology involved here includes Hive, Spark, and other processing technologies.
- *Analytics, machine learning and cognitive layer:* Here insight is generated by applying multiple analytics and machine learning technologies. Technologies involved here are Apache Mahout, Microsoft Azure, and so on. Also, multiple types of analytics, including descriptive, predictive, prescriptive, and cognitive analytics, are performed here.
- *Presentation and application layer:* This layer presents the insight to the decision makers in a usable way so they can make business critical decisions. This layer also contains applications that use context-based information. IBM Watson's user interface and Microsoft Cortana are examples. All the graphs and BI tools fall under this "logical" layer.

In a cognitive computing technology stack, data flows in the following order.

Data gathering layer ➤ Data preparation, extraction and conversion layer ➤ Data processing layer ➤ Analytics, machine learning and cognitive layer ➤ Presentation and application layer

The data starts its journey from the data gathering layer in the raw format in cognitive computing technical stack and, by the time it reaches the presentation and application layer, it becomes gold. Decision makers use this information through multiple BI tools for making business critical decisions. Also, the applications that exist in this "logical" layer are useful for decision makers and individuals alike.

USE CASES

Smart Assistance

With the help of cognitive computing, smart digital assistants and knowledge management activities can provide enormous benefits. For example, the content separation and dynamic content arrangement with analytics permit the business to produce leads using a dashboard and comprehensive reports of unidentified user access. This is accomplished by monitoring segmented research reporting and contextual regulatory reporting and rating, which in turn results in better-quality employee efficiency.

Innovative Monetization

A cloud-based cognitive solution that manages images and videos with smart enterprise federated keyword search and smart learning management system is very helpful in getting a business advantage. For example, it could enable the business to create a single administration console with forward-thinking image processing and document organization proficiencies. Also, it could provide bulk upload and download capabilities to exploit better-quality cross-sell/up-sell opportunities.

A Case of Anticipative Computing

Anticipation, machine learning, and artificial intelligence are closely related concepts. Anticipative cognitive computing refers to the area that deals with the prediction of the future, not just based on historical data but also on behavior, specific gestures, movement of the body, walking patterns, gait, and other biometric individualities before making any decisions in an automated fashion. It signifies the data and corrects it based on the feedback received from all the available sources. The combination of anticipative cognitive computing and predictive analytics is the future. User not only want to know “what is the best action” but they also want to know “what to do next”. Anticipative cognitive computing answers both of these questions. Anticipation is based on a the predictive model of the system. Visualize the game of cricket and imagine a wicketkeeper behind the wickets. A fast bowler is bowling, now the wicket keeper would move in the direction by anticipating that the ball is “going out to the wicket” or “coming toward the wicket” to gather the ball. It's a responsive action. Now imagine the same situation during the “super over” in T20 match of cricket. The wicketkeeper would dive in a direction to gather the ball by anticipating the bowler's and batsman's foot movement, eye movement, and past data about the specific player. This is a practical example of anticipation.

Cognitive systems are not very responsive in nature but are anticipative and predictive along with behavioral characters. If a bot, for example, is powered with the ability of anticipation, it could technically read, comprehend, and understand a person's facial expressions and gestures against some elementary queries and then come up with suggestions and recommendations for the client. It is worth taking a look at a few important aspects of anticipative cognitive computing.

The key stages of cognitive anticipation are as follows:

- Stage 1 - Gesture capturing
- Stage 2 - Emotion recognition
- Stage 3 - Face recognition
- Stage 4 - Social networking data analytics
- Stage 5 – Real-time integration and analysis of the previous stage with the help of Big Data analytics and machine learning technologies
- Stage 6 – Anticipate the behavior

Anticipative cognitive computing is the mix of the following:

Psychology + Neuroscience + Linguistics + Artificial Intelligence + Social Science

Cognitive anticipation evolved in this order:

1. Descriptive computing
 2. Predictive computing
 3. Perceptive computing
 4. Cognitive computing
 5. Anticipative computing
-

The Cloud Computing Technology Stack

The cloud computing technology stack is discussed in detail in Chapter 1. However, for completeness, I am providing a brief snapshot of it from the machine learning perspective. Cloud computing is the biggest enabler of the revolution in the field of machine learning because it is capable of solving two main roadblocks—the availability of low cost computing resources on the go and access to massive volumes of data. All machine learning systems need these two to be operational. Here is the main layer of cloud computing.

- *Infrastructure-as-a-Service layer:* It makes infrastructure available, which contain hardware, networking, and storage solutions.

- *Platform-as-a-Service layer:* It makes platforms available in the cloud infrastructure. Platforms like operating systems, databases, and middleware fall under this offering.
- *Machine Learning-as-a-Service:* At this layer machine learning based technologies are available in a pay-as-you-go mode. Therefore, using and leveraging their benefits has become easy for anyone, including individuals and enterprises. Technologies such as Big Data analytics, speech recognition, computer vision, and natural language processing are available here.
- *Software-as-a-Service:* Finally, at this layer, software is offered as a service, which uses the underlying technologies of all stacked layers. Software like ERP, CRM, mobile games, video, and FinTech exist in this space.

Audio and Video Links

Microsoft Cognitive service:

Source: <https://azure.microsoft.com/en-us/resources/videos/build-2016-microsoft-cognitive-services-give-your-apps-a-human-side/>

Machine Learning: Google's Vision - Google I/O 2016:

Source: <https://www.youtube.com/watch?v=Rnm83GqqPE>

THE LATEST RESEARCH

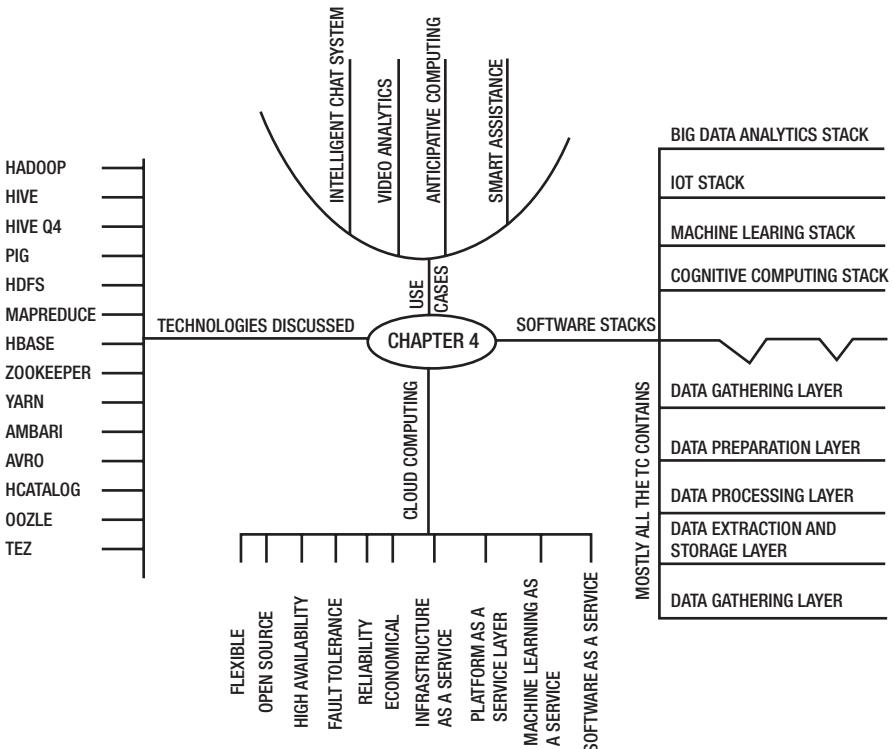
- The new iPhone has augmented reality. Having a 3D camera would allow the device to measure how far things are away from it. This is one of the basic and mandatory steps for placing computer graphics in the real world so that they can integrate with each other seamlessly.
- Researchers at the Georgia Institute of Technology have come up with innovative ways of controlling smartphones. They used LG and Sony smart watches for their experiments. Researchers showed that smartphones are “controlled” using swipes of the watchband, skin-taps, and breaths. Using a combination of microphone and machine learning systems, a newly developed technique called “whoosh” can identify and recognize blowing, exhaling, shushing, sipping, and puffing in an independent manner. If users hush on their smart watches to calm an incoming call, that means they are not interested in taking the call. If they have to take a call, they blow on the phone twice to accept the incoming call.

- Snapchat developed smart glasses called Spectacles and at the moment they are in the final stages of research. This glass contains a camera in the frame and users can capture videos with the help of this and upload these on Snapchat. Spectacles record 10 seconds of circular video of 115 with built-in 115 degrees of lens. The captured videos automatically are transferred to the local machine as well on the cloud.
 - The dating app called Hinge comes with a personal assistant, which will message you with the most appropriate dates. The VA is called “Audrey”.
-

Summary

This chapter explained in detail the technology stacks available for IoT, Big Data analytics, machine learning, and cognitive computing. It provided a glimpse at all the main technologies available for these stacks. It also discussed the perceptive of technology in current business scenarios.

Mind Map



CHAPTER 5



Industrial Applications of Machine Learning

Machine learning is set to unleash the next wave of digital disruption. Enterprises are expected to prepare for it. The companies who adopted it early are getting benefits from it. Technologies like robotics and autonomous vehicles, computer vision, natural language processing, virtual agents, deep learning, and machine learning are the technologies of the future. The new generation of machine learning applications are based on digitization. In most of cases, sectors that adopted digitization are leading the machine learning space as well. Also, they are predicted to drive growth. Machine learning is likely to quicken the changes in market share, revenue, and profit pools. All of these are trademarks of digitally disrupted sectors, products, and applications.

There are multiple ways to classify machine learning technologies, but it is problematic to draft a list that is mutually exclusive and collectively exhaustive. The reason for this is that humans generally fuse and match multiple technologies to produce resolutions for separate problems. These formations every now and then are treated as autonomous technologies, sometimes as subcategories of supplementary technologies, and sometimes as applications. A few frameworks group machine learning technologies by fundamental functionality, such as text, speech, or image recognition, and others group them by commercial applications such as commerce or cybersecurity. Therefore, sector-by-sector adoption of machine learning is highly uneven, at least at the moment. This trend in the acceptance of technology is not new; we have encountered this behavior in companies accepting social technologies. This suggests that, at least in the coming times, machine learning deployment is expected to fast-track at the digital frontier. The end result is the increasing the gap among adopters and stragglers across enterprise, sectors, and physical regions.

A conventional statistic in IT literature is that big companies typically are early adopters of innovative technology, while smaller companies are generally unenthusiastic to be the first movers. This digital divide exists in the machine learning space as well. Bigger companies have very advanced rates of acceptance and responsiveness related to machine learning adoption. Industries, applications and products in the big companies,

especially those that have bigger strengths in terms of employee count, are more likely to adopt machine learning technologies than smaller companies. One of very evident reason is that bigger companies generally have access to additional and better-structured data. Further they have staff with the appropriate technical skills required to comprehend the business case for machine learning investment and to effectively involve dealers. Larger companies also have an additional benefit to do fixed-cost investment, which is generally required for machine learning implementation. Because it initially needs a superior base of prices and revenue, it tends to generate higher returns. Commercial drivers also differ between sectors, industries, applications, and products. Businesses more likely to adopt machine learning technologies are those with multifaceted processes and geography. Their action is motivated by prediction, fast and precise decision making, and custom-made customers.

This chapter discusses the business implications of machine learning. Machine learning impacts commerce and economics in a unique way. It changes the way we plan, act, and do things. The data centered machine learning and analytics based economics is booming. I call it “datanomics”. This economy is different from the traditional economy which is based on land, labor, machine, and industries. It is also different from the knowledge-based economy. This economy is based on data and its intelligent use. It effects all walks of life, and all types of individuals, groups, societies, and countries—ultimately the whole world.

Data, Machine Learning, and Analytics

There has been an exponential growth in data in recent times. It fueled analytics and machine learning based industries, technologies, and services. Traditional industries like manufacturing, healthcare, and retail are ailing and adopting the best part of machine learning and analytics at super-fast speed. At the same time, relatively new industries like cloud-based customer care are fundamentally using machine learning as the base of their business models. However, analytics and machine learning do not confine themselves to business, industries, and enterprises. On the border level, government policies and world politics are also impacted by it. For example, before establishing a “smart city,” governments must perform a lot of data crunching and data based technological assessments. For making people friendly policies or to prevent crime, data analytics and insight generation is slowly become mandatory for government agencies. In the near future, all the policies, social welfare activities, and infrastructure developments will be guided by Big Data (see Figure 5-1).

ECONOMY					
TRADITIONAL ECONOMICS		DATA BASED ECONOMICS			
T R I G G E R	<ul style="list-style-type: none"> * LAND * LABOUR * MACHINE 		<ul style="list-style-type: none"> * DATA * INFORMATION * KNOWLEDGE 		
ENABLERS					
 PEOPLE STABILITIES ENVIRONMENTAL GOVERNANCE EFFICIENT GOVERNANCE POLITICAL WILL TECHNOLOGY CONSTRUCTIVE THOUGHT BUSINESS NEED					
PRIORITIES					
GOVERNMENT PRIORITIES		BUSINESS PRIORITIES			
<ul style="list-style-type: none"> ➢ INFRASTRUCTURE DEVELOPMENT ➢ SOCIAL WELFARE ➢ PEOPLE WELL-BEING ➢ PEOPLE WELFARE ➢ PEOPLE HEALTH 		<ul style="list-style-type: none"> ➢ BEST INCLASS TECHNIQUE ➢ COLLABORATIVE ECONOMY ➢ BUSINESS ADVANTAGE ➢ INNOVATION ➢ PRODUCTS AND SERVICES ➢ REVENUE GENERATION ➢ CUSTOMER SATISFACTION 			
SHIFT FROM TRADITIONAL ECONOMICS TO DATANOMY: FACTORS					
<ul style="list-style-type: none"> ➢ NEED OF AGILITY ➢ GLOBALISATION ➢ CHANGING WORLD POLITICS AND ECONOMICS 					
TECHNOLOGIES WHICH IS DRIVING THIS					
ARTIFICIAL INTELLIGENCE, BIG DATA ANALYTICS, IOT, MACHINE LEARNING, COGNITIVE COMPUTING, CLOUD COMPUTING, COMMODITY COMPUTING, STORAGE, INTERNET, DIGITIZATION					

Figure 5-1. Traditional and data based economics

There is a clear shift visible in most of the world's governance and business ecosystems. Data-based decision making is not only a elite and niche capability, it is the reality and it is here to stay. States, subcontinents, and governments are using machine learning analytics to raise the lifestyle of their population. Business houses, enterprises, and companies are using this for acquiring marketshare, and are improving their profit margins and revenue. Data is the new blood on the economic systems and it's changing its DNA and RNA.

The plan of this chapter is to provide you with an integrative summary of the functioning, workings, and future of industries in the context of machine learning. Also, the chapter investigates the benefits of applying machine learning to the core business model and its impact on wider perspectives like government policy making. It also presents relevant use cases specific to these particular industries. The chapter discusses a new term, "datanomics". The chapter tries to establish a case for how data can play a critical and central role in the economics of a country, business, or enterprise.

What Is Machine Learning Analytics?

The scope of analytics is very wide and it's a multidisciplinary science (in fact, it is often called data science). It contains lots of good elements from several fields, ranging from mathematics to psychology to visual science. Therefore, it requires people who are good with logic and imagination. People who are capable of using both parts of their brains are more successful in analytics. Overall, machine learning analytics equates to machine learning, plus other types of analytics (see Figure 5-2).

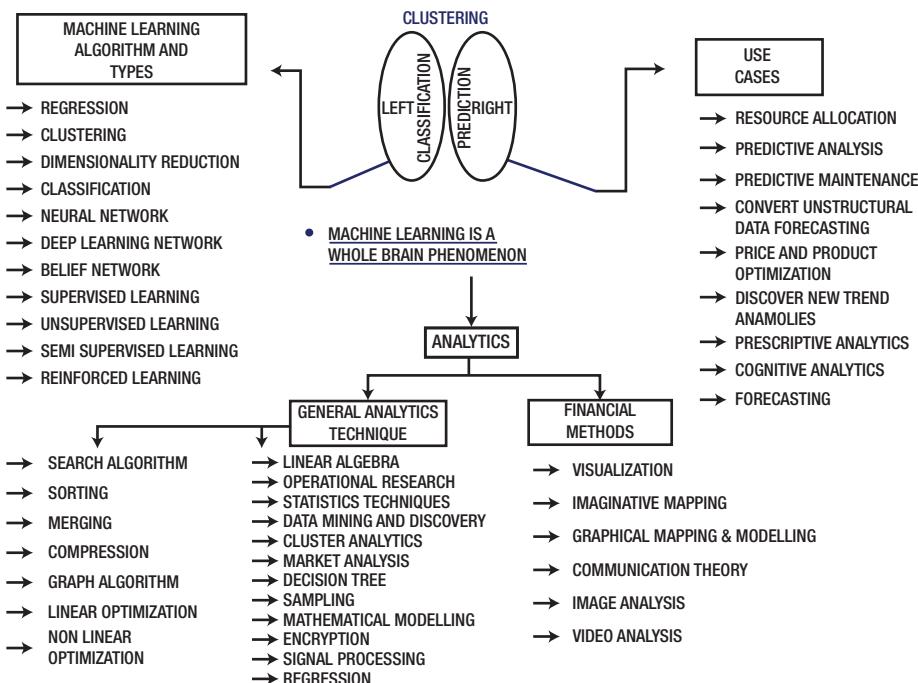


Figure 5-2. A conceptual view of machine learning analytics

Need for Machine Learning Analytics

Machine learning analytics is the need of the hour; there are lots of market and business factors demanding it. For example, there is continuous change in dynamics of global economy, increasing cost of knowledge workers, and consistent pressure from the clients to reduce overall cost. These are forcing companies to look for some innovative way to cater to these issues. However, implementing the machine learning analytics to the space where you want it to function is not an easy task. There are existing forces that oppose it.

Eventually, organizations have to use information technology (Big Data or not) to enhance their analytics efficiency as they transition to provide value-based service/products to their customers. Moreover, with machine learning based on predictive analytics, companies can bring better outcomes, encounter fewer compliance and legal issues, and reduce unnecessary operational burdens. This will enable companies to experience higher levels of satisfaction in their customers at a lower cost. In a nutshell, if machine learning analytics are applied correctly, then the following benefits can be achieved.

- Improved and dynamic organization strategy based on data
- Improved customer and stakeholder engagement
- Improved and transparent data-based governance
- Improved service delivery model
- Improved fact and data-based outcome measurement
- Improved competency
- Less fraud loss
- Optimal pricing, which contributes to profitability
- Increased marketing ROI
- Less credit loss

Challenges Associated with Machine Learning Analytics

Here are some of the main challenges that organizations encounter during the preparation and implementation stages of machine learning analytics:

- Integrating different forms of data together in the uniform way.
- Managing the tremendous volume of data, which organizations receive from heterogeneous sources.
- Integration and interoperability of technologies.
- Refine and define the need of the data across organization.

- Cultural shift and resistance to change.
- Lack of appropriate talent.
- Lack of uniform data model.
- Lack of security models/frameworks/standards.
- Appropriate infrastructure.
- Lack of compliance standards.
- Defining appropriate metrics to measure effectiveness of implementations.

However, With the proper explanation, reasoning, and education to the effected parties, these “resisting forces” can be reduced or removed. The complications of realizing improved business results, regulatory compliance, and strategic goals means organizations need to become more proactive in their customer care. Present technologies have been permitting solution providers to perform data analytics across dissimilar systems running databases, data warehouses, and structured or unstructured data sets, without affecting regular daily operations or accessing available data. There are organizations who have already implemented analytics, while others are in a more advanced phase in the process.

Business Drivers of Machine Learning Analytics

Organizations always have motivation to cash on market potential and earn profit out of that. However, achieving that goal is not a cakewalk. The goal to earn profit and become a leader is driven by multiple factors. This includes social, political, and environmental factors. The most important factors are price, revenue, effectiveness, and efficiency drivers. Here are some important drivers that organizations are considering to excel in the market.

Cost and revenue drivers:

- Achieve effective pricing for the proved service and products
- Minimize losses
- Obtain efficiency and utilize capacity to its fullest
- Get marketshare
- Establish the brand
- Get a spike in demand

Efficiency and effectiveness drivers:

- Demand and supply forecast accuracy
- Inventory management

Organizations are betting on machine learning analytics because they understand that in the data-driven world they can achieve success by using them.

Industries, Domains, and Machine Learning Analytics

Machine learning based analytics can potentially be applicable across all industries and domains. The following sections discuss a few areas already using machine learning based analytics as a solution.

Machine Learning Based Manufacturing Analytics

The manufacturing industry is known for its strict process orientation and documentation, procedural compliance, process matrices, risk and quality frameworks, and detailed reporting. There has been a boom in the field of technologies, especially in the areas of digitalization, manufacturing organizations/enterprises, and supplemental production and technical logs with gritty information from telemetry, sensors, and other machine-generated data. They are using machine learning, IoT, cloud computing, and data science techniques to help their clients. A silent revolution is happening which is turning data into a valuable tool for multiple types of uses, including profitability and productivity. Its uses include chemical, meteorological, automobile, and lots other areas of manufacturing. Historically, the manufacturing industry is not very enthusiastic about adopting machine learning technologies in comparison to other industries like finance, customer service, and healthcare. However, widespread success of machine learning analytics across industries has motivated leaders of manufacturing industries to adopt it.

Challenges in Implementing Machine Learning in the Manufacturing Industry

- Lack of appropriate infrastructure and sense of applying machine learning to the business problem.
- Lack of appropriate and quality data.
- Lack of commitment to apply machine learning across organization due to lack of adequate knowledge and clarity of business requirements
- Lack of data culture and mindset in the organization so that machine learning implementation can cater to day-to-day work.
- Lack of appropriate talent having sound knowledge of machine learning.
- *The integration of legacy systems:* Manufacturing organizations are traditionally using old and legacy systems. Therefore, they depend on that because their processes and production are dependent on them. Introducing new systems and technologies and integrating them with the existing technical process ecosystem is a challenge.

- *A unified data model:* Unifying different data models and making them share data with each other is a challenge. However, with the advent of new business and process models like analytical operations (on the lines of DevOps), this will be resolved.
- *Security challenges:* Scattered control systems that are connected and linked to each other via networking, especially through the Internet, is excellent for quickly responding to changing situations and scenarios. However, it potentially exposes the systems to illegal, unauthorized, and unsolicited access by hackers who could damage the system or cause outages. IoT devices connect to each other and to the network through gateways, which potentially allows control and access of systems, machineries, equipment from anywhere. The use of smart software and systems can mitigate this risk efficiently.

Drivers of Machine Learning Analytics for the Manufacturing Industry

Mixing Big Data analytics and IoT technologies and techniques with Machine Learning can benefit the organizations and the manufacturers. The capability to analyze and predict failure before it occurs will be a useful feature of machine learning and some manufacturing companies are already utilizing it to minimize production loss, as well as risk and financial loss. The timely prediction leads to achieving higher levels of efficiencies and effectiveness in production and planning. There are hundreds of applications and use cases of machine learning techniques found in the manufacturing industry.

One of the important uses of machine learning analytics is to provide powers to its users to track demands in real time and predict fluctuations. This will help organizations optimize their demand and respond accordingly in the timely manner. This actually increases efficiencies in managing demand and supply in a balanced way. Ultimately these will trigger minimization of cost, scrap, and redundancies. Machine learning analytics can be applied to multiple areas of manufacturing, starting from production planning to output optimization. Here are a few areas working as drivers of the adoption of machine learning analytics.

- Effective and efficient production and operation management
- Plant optimization
- Effective demand forecast
- Accurate and proactive error detection
- Efficient performance management
- Better predictive maintenance and interoperability
- Prediction of equipment failures
- Meaningful pattern reorganization

- Increased revenue and profitability
- Employee motivation
- Staying relevant and ahead in the market through adoption of technology

Machine Learning Based Analytics: Applications in the Manufacturing Industry

Machine learning analytics can potentially be applicable to all levels of manufacturing, starting with reductions in cost to improving efficiencies. Here are some uses:

- *Machinery monitoring and prediction:* Continuous monitoring of the machinery/equipment and prediction of its health and condition. With the help of machine learning analytics, all information regarding equipment and machinery is collected and benchmarked. This in turn compares machines, lines, and plants to drive continuous improvement.
- *Forecasting, demand and marketing management through predictive analytics:* These features of machine learning benefit help manufacturing organizations find appropriate launch time of specific machinery based on market demand. Also, they make specific marketing plans. Machine learning can also be used as an effective campaign tool for manufacturing organizations.
- *Intelligent quality assurance:* With the use of machine learning analytics, continuous monitoring in real time will become a reality. It became very important for monitoring sold or in-process products. This makes performing quality checks easy and effective. If the product is faulty, it's more likely this will be identified early on. Therefore, machine learning contributes to reducing the need for testing by gathering, identifying, and alerting quality issues well before the damage done. Machine learning based analytics increases the efficiencies and effectiveness of the machinery/equipment/products by improving overall quality.
- *Energy consumption optimization:* With the help of real-time tracking, and powered by prediction capabilities, modern generation machine learning equipment is capable of capturing demand fluctuations and forecasting energy consumption patterns. These insights are used for energy consumption utilizations.

- *Predicting parts failure with the right analytical model:* Composite analytical models add an exploratory step prior to applying statistical distributions to predict failures. The amount of data to be explored is vast, and it involves identifying relationships between various data elements, as well as identifying similarly performing devices, common causes of failures from data, and so on. Techniques, such as association analysis and decision trees robustly aid in performing such analyses. This in turn helps reduce maintenance costs and increases product success rate and ensures customer satisfaction
- *To get a deeper understanding of root causes:* To resolve complex plant issues by finding the true root cause. Therefore, frequently appearing problems/issue would not affect the productivity and efficiency. What-if scenario analysis and simulation are one way of doing this. When they are paired with machine learning analytics, they provide great results.

Other Uses of Machine Learning Analytics in the Manufacturing Industry

Machine learning is used in the manufacturing industry on multiple levels. Therefore, its uses cases also exist at all the levels, ranging from maintenance of an equipment to predicting and forecasting future occurrences. Here are some of the events that are captured.

- Manufacturing process optimization and improvements.
- Supply and value chain optimization.
- Reduction of research and development costs by predicting outcomes based on data.
- Intelligent and smart meters and grid management.
- Predicting asset failure.
- Using historical data, trends, and manufacturing specific algorithms to proactively manage potential asset failures.
- Reducing downtime. Insight into the most frequent downtime reasons helps focus on the downtime that hurts the business most.
- Increase capacity utilization of the machines/systems. Also, real-time asset utilization and downtime smart statistics allow organizations to maximize the usage of the right assets at the right time.
- Excellent at monitoring regulatory information, birth certificates, and to track and trace equipment.

- Helps maintain comprehensive and accurate information about products.
- Real-time manufacturing yield optimization.

Machine Learning Based Finance and Banking Analytics

The financial markets are always very dynamic, evolving and ready to adopt changes. This industry always welcomes technologies and new systems that are effective in analyzing market behavior, sentiment, and attitudes of financial professionals. Recently a new financial paradigm has emerged, in which the psychological features considered by the advocates of behavioral finance and the quantitative techniques favored by the practitioners of established neoclassical finance are brought together. Machine learning analytics is an excellent way to analyze, merge, and use behavioral aspects with the quantitative aspects of finance. Machine learning analytics have thousands of applications in the finance and banking industry. Proficient and intelligent mobile banking apps, smart chatbots, and search engines are examples of a few. Maintaining and gathering high volumes of customer data, keeping accurate historical records, and understanding the quantitative/number based nature of the financial world are the triggers for machine learning implementations in finance and banking.

Challenges of Implementing Machine Learning Analytics in Bank and Financial Institutions

Machine learning analytics implementation involves strategic, financial, process-oriented, and technical aspects. Therefore, the path of implementation is not rosy and some really serious challenges occur. Here are some of the challenges to this industry when implementing machine learning analytics.

- *Forecasting errors:* Manual forecasting brings error.
- *Handling uncertainty:* Data exists in isolation and correlating, analyzing, and getting insight out of it is the biggest challenge.
- *Unified view of data:* Facts, figures, and numbers come from various areas and from different systems within the organization and exists in various forms. Combining these statistics presents a massive challenge.
- *Collaboration and communication:* Integrating inputs received from multiple sources, analyzing them, and communicating results or output in the format that is understood and makes sense for decision makers is another big challenge.
- *Real-time results:* Everyone wants to be updated in real time with the available information. Providing desired information instantly when required is a massive challenge.

- *Data security:* Most of the data exists on a cloud infrastructure and sometimes not on even private cloud due to multiple unknown reasons. Thus, there is an increased risk of data manipulation.

Drivers of Machine Learning Analytics for Financial Institutions

The driver for extensive use/implementation of machine learning analytical techniques is to come up with perfect solutions for customers. The industry is aggressively looking for the solution/product that contains excellent value propositions. To create this they are integrating the best elements of different products, customer behavioral data, marketing strategies, available financial inputs, geographical details, and diverse channels analytics. However, this also leads to one of the biggest challenges for banking and financial institutions. Designing new products and services that target appropriate customers by the effective use of data science is crucial. Therefore, banks are using machine learning analytical techniques to come up with flexible and integrated processes for understanding the customer better. They do this by analyzing their buying habits and getting insight about the engagement channels. This is important for banks to sell their products in effective and optimized ways. Applying machine learning to personalized product offerings is key to success for the next generation of banking.

- *Improving business strategies:* With the help of data based dynamic modeling through machine learning, financial institutions can make more profitable and customer centric strategies. To remain competitive in the market is one of the biggest drivers. Data is the soul of the interruptions happening in the boardroom and is documented and recognized as a critical business strength. Decision makers should know what data they now have access to and where they can get more data appropriate to their enterprise's future achievement. Google, Amazon, Netflix, and Facebook are the most commonly used examples of companies who created strategies around data and disrupted the market in a big way. They essentially transformed their culture and shifted from a traditional business operating way to data and innovation based operation. This started paying off and now most of their income is based on smart and intelligent use of data. They extract insight from the enormous quantities of data their customers generate on a daily basis by using their services and in turn use that data to make profitable strategies.
- One important capability will be making data usable that is not available in a relational format or that cannot be analyzed with traditional methodologies. So much of the data being produced today is "flat data," which means it has no relational structure. An estimated 90 percent of data is flat. Making this data usable requires new approaches that can efficiently handle large volumes of different types of data—for example, the NoSQL and Hadoop technologies.

- *Robust risk management:* Financial institutions are the prime targets of hackers, attackers, and frauds. Therefore, robust risk management is mandatory. Machine learning analytics are one way to achieve this, by the use of automatic anomaly detection techniques and implementing other algorithmic approaches.
- *Better marketing:* Techniques like customer segmentations, campaign managements, and lead generation help financial institutions perform better in this capacity.
- *Channel execution:* Providing net available best offers to the customers potentially increases the profitability and sales performance of an organization. Hence, this is also a prime driver for the implementation of machine learning based analytics.
- *Excel in customer experience management:* In changing times, engaging customers by providing them with instant information in real time is one of the biggest challenges. With the advent of virtual agents (chatbots), suggesting the next best action based on their demand, behaviors, and financial status helps create customer loyalty. Therefore, it is one of the drivers for implementing machine learning analytics.
- *Customer insight:* Getting an edge in the market though sentiment, social media, and customer profitability analyses are important drivers for financial institutions.

Machine Learning Based Analytics: Applications in Financial Institutions

Machine learning based analytics plays a crucial role in the financial and banking ecosystem. Its application is widespread and multidimensional and includes fraud detection, loan approvals, handling risks, and securing online transitions.

- *Defaulting loan identification and prediction:* Machine learning is used by the financial giants to predict bad loans. The reason is simple, as learning algorithms are easily trainable on customer data, if applied correctly. For example, algorithm based models can use data related to customer ages, jobs, marital status, financial status, and historical and current loan payments to generate insights. The data is collected and analyzed by the system. After that, processing happens. This flow of execution determines facts about the customer's financial behavior by finding the answers of questions such as, has the customer paid his loan on time or has he defaulted, how is his online behavior, has he ever been involved in any type of financial or other type of fraud, etc.

- *Good decision making:* Machine learning analytics potentially automate end to end processes from data gathering to generation of actionable insight to suggesting the best action from the available options. Predictive, perceptive, and cognitive insight goes way beyond just providing the idea of “what to do” to “when to do it” to “how to do it”.
- *Fraud detection:* Financial frauds are a major area of concern for financial intuitions. Machine learning systems can identify unique activities or behaviors or detect anomalies and flag them. Typically, the machine learning fraud detection solutions can analyze available historical transaction data with an algorithm based model that would identify fraudulent patterns in the transactions and activities performed by the customer. However, the challenge is to train systems to detect false-positives situations. False-positives happen when legitimate transactions are identified as risks and are flagged.
- *Trading algorithm:* In the background of currently prevailing market conditions, algorithm based trading is becoming popular. The concepts of algorithmic trading are multi-faceted and are relevant across all financial markets across the globe. They cover almost all the important areas like equities, fixed income, and currencies. Machine learning analytics is finding its role in making algorithms for profitable trading decisions. Algorithmic trading, alternatively known as high-frequency trading, is helpful to automate or create systems that are smart enough to find useful patterns in the massive data sets to get profitable decisions related to trading decisions. Machine learning analytics are extremely efficient in getting patterns through tools to extract any hidden insight of market trends. Machine learning trading systems generally make millions of trades in a day, and financial institutions become technical in nature in recent times.
- *Customer service:* Finance specific chatbots are becoming popular as they are helpful in providing answers to customers. These chatbots are also known as virtual assistants. They communicate to the customers in a natural language like English. They contain smart and effective natural language processing engines and tons of data of finance-specific customer interactions. Chatbots are not only confined to the banking and customer service sectors; they are used in a lot of other industries as well. (For details, refer to the chatbot section in this chapter.)
- *Sentiment analysis:* This is emerging as one of the more important soft technology tools and with time it will establish itself as one of the important factors/technologies to handle business intelligence and performance evaluation of organization, market, and commodities in effective ways. Sentiments captured on the

basis of news of the prices of different commodity futures are used for making profitable sentiment-based trading strategies. News and opinions are very important in the financial domain, as market dynamics are heavily dependent on them. Structured and unstructured data is analyzed, processed and presented to give valuable insights to the respective stakeholders. For example, to improve the performance of traders and marketers, sentiment mining is effectively applicable to text mining of news, microblogs, and online search results. During the process of sentiment analysis, huge quantities of data is purified and information is extracted out of that. This information in turn is applied to make an actionable roadmap. From a financial perspective, sentiment analysis finds its role in trading, fund management, portfolio development, share dynamics crunching, and in risk assessment and control.

- *Recommendations of financial and insurance products and services:* Financial companies/institutions, banks, and insurance organizations have now started using robo-advisor for recommending products and services to their customers on a frequent basis. Even for the areas like suggesting portfolio changes, switching from one service to other based on the current financial status, and behavioral situations, companies are using machine learning technologies. In the next few years, these features will become more reliable and the customer will take them more seriously, as they believe in the e-commerce product recommendation sites, like FlipKart.

Other Uses of Machine Learning Analytics in Financial Institutions

Machine learning analytics can potentially be applicable to all levels of banking and financial organizations, starting with reduction in costs to improving efficiencies. Here are some uses:

- Comprehend and analyze the financial performance of an organization in automated way.
- Help manage and maintain the value of physical and virtual properties of an organization based on data.
- Intelligently and smartly manage the investments of the company.
- Forecast and predict the variations in the market on the solid foundation of data based decisions, which intensifies the functionalities of information systems. When it is paired with the data-based culture, the results come in the form of groomed business processes and profits.

- Machine learning analytics is the key technology for sharpening compliance and regulatory requirements. It is used for trade scrutiny, which identifies unusual trading patterns and behavior.
- Customer segmentation is another area where machine learning is very useful. The vision of banks and financial institutions change from product-centric operation to customer-centric businesses. Therefore, machine learning analytics are implemented to realize this vision by crunching data and detecting useful information.
- Enterprises are using machine learning analytics for personalized marketing. Financial institutions provide personalized products to customers with the help of analytics. Also, it is used to create a credit risk valuation of a customer or property. This provides insight to financial institutions to understand whether to go ahead with a deal/transaction.
- For better risk management. For example, to provide real-time warnings (if a risk threshold is exceeded). Other example is to find new complex interactions in the financial system and do advance risk modeling.
- To increase sales and revenue in banking, because it helps them identify the churn related risk early and implement renegotiation strategies accordingly.
- For optimization of skilled labor. This helps financial institutions use the available skills in an optimized way and reduce the operational costs across the organization, including frontend and backend.
- Optimization of branch and ATM centers.
- Route calls appropriately to the call centers based on customer preference, which they get from analysis of multi-model/multi-channel data (social media, mobile, web). This ultimately helps them increase customer satisfaction and reduce overall cost of the operation.

Machine Learning Based Healthcare Analytics

The healthcare industry affects us all. New and innovative technologies are changing the way traditional healthcare establishments work. In just a few years, it moved from doctor specific to technology enabled industry as technologies including analytics play a crucial role in managing the health of the patient population. Machine learning analytics is an excellent way of improving treatment outcomes and results while keeping cost under control. Machine learning and deep learning paired with artificial intelligence are giving

new meaning and directions to healthcare by transforming it. For example, deep learning algorithms are used to teach computers to read medical images, by integrating imaging database with algorithms and models that will automatically notice and identify medical conditions. Accurate imaging diagnoses help millions of people receive appropriate medication in a timely manner. Therefore, this contributes to saving millions of lives.

This change is adopted by the doctors as well because it enhances their ability and potential to deal with life threatening challenges of our time, like cancer, AIDS, and so on... With the help of all the information available, systems try to find patterns and correlations in the available data points and compare them with the relevant data sets (see Figure 5-3). This complete process is done in few minutes and it ends by suggesting appropriate treatments to the doctor.

The suggestion provided by the machine learning systems in turn could be customized by doctors as per your need and personalized health conditions. Sounds like fiction but it's not. Watson and Baby Watson (a cognitive computing system) from IBM are already doing something similar to this. Also, a company called AiCure's artificial intelligence based platform can confirm that a patient took the desired dose of medicine using facial recognition technologies. Additionally, it provides real-time ingestion confirmation and automatic medicine identification. AiCure is a clinically validated platform that works on the smart phones. AiCure is very popular among drug companies, who run clinical trials, where taking medication on time is crucial.

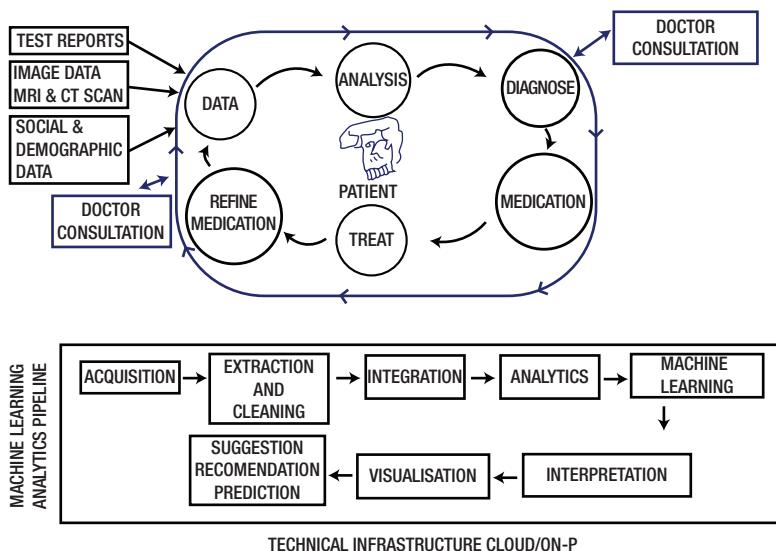


Figure 5-3. Working with healthcare analytics

Challenges in Implementing Machine Learning Analytics to the Healthcare Sector

Machine learning analytics can potentially be applicable to all levels of healthcare, starting with reduction in costs to improving efficiencies. However, it has its own challenges to implementation, especially with a traditionally disorganized sector like this. Here are the few challenges that exist in healthcare machine learning analytics.

- *Lack of centralized information:* A centralized database of information in a healthcare organization is required for keeping the records of patients. This helps healthcare organizations manage their data in a better way. An Enterprise Master Patient Index (EMPI) is a database used for this purpose in healthcare organizations. It preserves consistent, correct, and up-to-date, health, demographic, and vital therapeutic data on patients. The database is built by collecting and storing the data that a particular patient generates by visiting several departments of healthcare institutions, and it could be social, personal, and other forms of data. Typically, a patient is assigned a unique identifier that is used to refer/identify him across the enterprise. The EMPI would be useful only if it helps in identifying patient records uniquely across all data sets. The real challenge is implemented in the correct way because this is not true everywhere due to multiple reasons such as incorrect technical implementation, lack of integration of new systems with the legacy systems, and so on.
- *Different format:* Medical and clinical data contains codes that are different from the prevailing coding schemes. The coding schemes are used for clinical purposes—generally, CPT, ICD9, ICD10, or NDC. As these codes contain non-standard coding schemes, they require translation in order to have a common dictionary for data analysis.
- *Unstructured data:* Data sources from healthcare systems are mostly unstructured (80%) and are available in flat file formats like HL7, which needs to be de-serialized before it's useful. Once it is de-serialized it must be converted for the clinical processing pipeline. Also, data is normally split across multiple flat files contain millions of rows. Therefore, there is a need for robust, effective, and efficient Extract-Transform-Load (ETL) processes.
- Healthcare organizations are keeping patient health records and health information for record and analyses purpose in their digital data store (sometimes in the traditional way as well). Obviously, this data comprises sensitive content. Therefore, information protection is key. Just imagine if there is a data breach on information that contains patient information

occur. Life-threatening data must be as protected as possible. Machine learning analytics are important weapons to safeguard information. Machine learning algorithms/systems/solutions are capable of identifying automatically unusual behavior on the network or in the data store. This happens when someone who is not authorized to access the data tries to manipulate or steal it.

Drivers of Machine Learning Analytics in the Healthcare Industry

Machine learning analytics become critical predicting and forecasting adverse conditions. Based on the prediction and forecast the notification/alert received by the healthcare professional and the relative of patient enable them to take proactive preventive measures for the benefit of the patient. Therefore, the outcome and results of the cure and prevention of diseases or the health condition of the subject improve. Further, it can be applied in dynamic evaluation of current policy, protocols related to healthcare to come up with new or modified ones. Also, the patient information is available through several channels and sources, so analysis of the data becomes comparatively easy. Here are some important sources of information about the patient. Correlating this information/data provides hidden insights about the patients, which will greatly enhance treatment.

- Scan reports
- Fitness trackers
- IoT devices
- Gene sequencing
- Drug research
- Clinical trials
- Geographical records
- Cultural information
- Social media
- Treatment records
- Other patient related records (like doctor/nurse conversations related to a specific patient)

All these factors enable and drive analytics to apply in the field of healthcare. Application of machine learning analytics helps multiple stakeholders at the same time, which includes but is not limited to patients and their relatives, insurance companies, doctors, and so on.

Machine Learning Based Analytics: Applications in the Healthcare Industry

Machine learning analytics can potentially be applicable to all levels of the healthcare organization, starting with reduction in costs to improving efficiencies. Here are some of the applications:

- *Imaging analytics:* Machine learning analytics can be used to automatically process and diagnose patients based on their basic medical imaging data, by training computers to automatically read, process, and diagnose medical imaging data. For example, Zebra Medical Vision, a machine learning analytics company, is come up with the clinical research platform that provides next generation imaging analytics services to the healthcare industry. Its imaging analytics technology helps institutions figure out patients at risk of a particular disease. This enables healthcare professionals to provide preventative treatment roadmaps to improve patient care. Their vision is simple, medical imaging and machine learning, which leads to transforming healthcare. Their platform, called the “Zebra platform,” has already started contributing to the medical community by generating imaging insights that have been validated using millions of cases. Their algorithms are working in the fields of bone health, cardiovascular analysis, and liver and lung indications.
- *Drug development:* One of the challenges of the development of drugs is proper testing. Drugs under development may contain harmful chemicals whose side-effects are not known. Therefore, they need to be tested on real subjects before being rolled out to the market. However, availability of subjects is a challenge for the drug companies due to multiple reasons, like threat of life and ethical issues. Machine learning analytics provide very handy solutions with the use of predictive modeling. It will accurately forecast what effect drugs will have on individual patients with specific reactions from specific medical conditions. For example, Life Extension™ and Insilco Medicine together developed anti-aging technologies based on artificial intelligence, to find nutraceuticals (pharmaceutical-grade and standardized nutrient) that mimic the tissue-specific transcriptional response (cell regulates the conversion of DNA to RNA) of many known interventions and pathways associated with health and longevity. This in turn provides actual human tissues simulation, which would be helpful in testing the drug.
- *Compliance:* Machine learning is excellent in finding patterns. Therefore, companies are using machine learning for detecting pattern to stop unidentified access and legal implementation of access control of patients' medical records and histories in clinics and hospitals. For example, Proteus, a health data protection

startup, is building a system that's intelligent enough to figure out when patient data and records are accessed inappropriately. Their product helps health systems understand the purpose of how and why medical records are accessed.

- *Real-time monitoring and care of patients:* Traditional medicine, in association with smart IoT-enabled sensors, opens up new possibilities and avenues for medical science and healthcare. Machine learning, analytics, and IoT help real-time collection and seamless aggregation of disease and medical data. Medicine is operating as part of a larger ecosystem of connected devices, sensors, and technologies. The sensory data extracted or captured from patients is transmitted through a network to cloud infrastructure. Machine learning analytics then gets real-time insight from that data. The use of sensors in medical science and healthcare is not new. Thermometers, blood pressure monitors, and urine and pregnancy analysis strips are sensors that have been used in the field for a long time. However, these sensors are dumb, and incorporating intelligence into these devices through the use of machine learning analytics is the new phenomenon which benefits the industry a lot.
- *Decision support for critical diseases:* For infectious diseases, machine learning based dynamic models are very effective. The model created by the use of algorithms like Markov Decision Process (MDP) and optimized reinforced learning can generate patterns, and after that doctors have better data points to treat diseases. This strategy can be helpful in making effective decisions quickly.
- *Effective use of unstructured documents:* Diseases develop chronologically. General patients have restricted information about the exact time that a condition related to disease progresses or regresses. Hence, the regular checkups and other forms of data gathered by the patients are helpful. But the challenge is that they are available in unstructured formats (prescriptions, scan reports, test reports, etc.). However, if they are interpreted correctly and efficiently, they can help clarify and understand chronological pathways of disease. They can do that by performing analytics on aggregated Big Data sets. Here machine learning analytics comes to rescue by effectively decoding and getting insight from the data set. Once the data is analyzed it can even predict what types of disease a patient may encounter in future. For example, based on his abdominal ultrasound reports paired with the lever function and kidney function test reports, machine learning enabled system can predict about the chance of developing kidney disease and when that may happen to the specific patient. The physician can use those insights for answering the patient's question as well.

- *Linking historical and current data to get health insights:* The analysis of the data of all the events, treatments, behavioral aspects and wellness trends helps with the proper diagnosis of disease. The analysis of historical prescription information in association with the latest wellness data gives the real picture of a patient's health. Also, algorithmic pattern extraction and machine learning analysis reveal patient groups that are not identified for a particular disease but their medical journey shows that they may suffer from or are suffering from a specific disease.
- *Conducting effective clinical trials using intelligent analytics:* Analytics is now used by drug companies to analyze the impact of integrating enclosure and prohibition conditions of the patient before selecting them for a particular clinical trial.
- *Treatment and drug market sizing:* This is the analysis of the current condition of products in the market by considering the factors like their usage, switch-over, provider types, and on/off label prescribing patterns to understand the potential market size machine learning analytics. Based on the results of the analysis, opportunities would be identified.
- *Remote healthcare:* Machine learning solutions would analyze patients health remotely via mobile devices or other portable devices and then compare it in real time with the relevant medical records, forecast health conditions, and suggest a fitness routine or caution of probable illness.
- *Smart diagnosis devices:* Using machine learning and other artificial intelligence technologies to do simple medical tests like blood sugar tests, blood pressure monitoring, identifying levels of "fever" without human intervention or assistance. This helps doctors, nurses, and other medical support staff do more important work instead of doing routine activities related to patients.
- *Accurate diagnostics:* Machine learning powered analytical tools identify and categorize diseases quicker and with superior accurateness, using historical medical data and patient archives.
- *Identifying public-health intimidations and the utmost at-risk patients:* Primary healthcare workers will have information to patients about precautionary actions that include medical services, lifestyle and environmental factors such as nutrition, workout history, and pollution avoidance. Also, the hospital officers will be well armed to predict spikes in admissions in intelligent and smart ways that are not available today. They will be able to better track the occurrence of infectious viruses. Moreover, combined with personal medical records, weather data, and geographical, cultural, and other information, this will help a machine learning tool make intelligent guesses about how many people will need hospitalization.

Other Uses of Machine Learning Analytics in the Healthcare Industry

- Predict the lifetime value of the patient.
- Risk of churn of diseased customers.
- Track behavioral changes of the patient to provide suitable medication.
- Effective emergency systems based on data received from wearables.
- Analyze severity of disease in real time.
- Analyze performance of doctor in real time and suggest appropriate improvement inputs.
- Improve and track wellness of elderly persons through personalized messaging, alerts, and sensor based observation.
- Predict the area with the highest need in a hospital.
- Better management of drugs and their timely movement through automated tracking.
- Predict the admission rate of people and patients in the wellness center and hospitals.
- Optimize staffing and allocation of resources.
- Identify, predict, and forecast fraud, theft, anomalies, and waste by the analysis of heterogeneous available data (clinical/operational/administrative).
- Diagnose diseases before they actually occur with the help of accurate analysis of biopsy, tests, scans, MRIs.
- Fast DNA analysis and mapping.
- Reduced research and development costs for drug testing, development and marketing.
- Optimize and develop accurate drug launch strategies based on past and present data.
- Innovate and discover new uses of drugs.
- Optimize pricing strategies for the drug portfolios.
- Provide invaluable information for medical insurance companies.
- Give a much more accurate idea of the PSSP (Patient Specific Survival Prediction).
- Assist radiologists in discovering unusual indications.

- Help physicians in understanding the risk profile of their patients.
- Improve genomic analysis.
- Machine learning algorithms enhance hospital processes, employee timetables, and accounting by using medical and environmental factors to predict patient actions and illness possibilities.
- Intelligent and smart communicating kiosks catalog patients and direct them to suitable doctors, improving their involvement and reducing waiting time.

UNIQUE APPLICATIONS OF VR IN HEALTHCARE

Machine learning integrated virtual reality is found its applications in the magnitude of sectors and industries, including gaming, manufacturing, interior design, customer support, properties, banking, finance, and fashion. Here is a link to an article that is an excellent read for decision makers:

<http://economictimes.indiatimes.com/small-biz/security-tech/technology/a-virtual-revolution-in-the-head/articleshow/57932219.cms>

Machine Learning Based Marketing Analytics

Marketing is all about adaptation. New generation marketers are using social technologies that help them measure and understand potentially influencing customers. Web analytics technologies empower organizations to track people across the web and to understand their browsing behaviors. Advancements in understanding and tracking technologies are the by-product of intelligent machine learning technologies. Machine learning analytics helps marketing in multiple ways. For example, in the areas of personalize messaging and product recommendations, the potential is huge. This transforms customers from a mere site visitor of a specific site to an engaged customer of that site or business. Customers can relate to the company because it seems like that business cares about him. The result of successful, highly-relevant marketing is increased customer loyalty, engagement, and spending.

Machine learning based analytics enables marketing organizations to collect, analyze, and process a huge volume of data flowing from diverse sources (e.g., purchase behavior, website visit flow, mobile app usage, and responses to previous campaigns). Implementing marketing machine learning analytics bridges the gap between data, information, and analytics. Machine learning based analytics provide organizations with the power to use data to their competitive advantage by generating insight out of that. Data science, data mining, predictive modeling, based “what if” analysis, simulation, new generation of smart statistics and text analytics would identify meaningful patterns and correlations in the data. The generated insight would anticipate changing conditions and assess the attractiveness of various courses of action.

Challenges for Machine Learning Analytics in Marketing

Some of the big marketing/marketing analytics challenges are mentioned here (most of them are self-explanatory or explained earlier in the chapter, hence they are discussed in more detail here):

- Integration of data
- Finding right talent and support from top
- Competition in the industry
- Threat of substitute products
- Determine which kinds of customers exist for the products/group of products
- Implement segmentation and do optimization on the products/services for specific segment
- Fail to focus on a specific business initiative due to wrong or inappropriate utilization of data
- Invest in tools that produce little or no revenue
- Fail to operationalize findings

You can overcome these challenges by following these steps.

1. Identify and clarify the problem area that you want to solve.
2. Collect, store, process, and analyze the data necessary to solve the problem.
3. Establish what information is available and what is not available in the process to solve the problem.
4. Acquire the information that is not available.
5. Select the appropriate tools, technologies, and strategies required to solve the problem based on the available information and knowledge.
6. Solve the problem.

Drivers of Machine Learning Analytics for Marketing

Today's business is fueled by data. Technologies like Big Data, cloud based delivery models, and machine learning are driving data-driven marketing and sales. Thus, predictive analytics garners an incredible amount of attention. Early adopters of machine learning analytics are appreciating noticeable return on investment. Machine learning and scoring technologies are used to identify and prioritize financial records, leads, contacts, and clients at specific points in the marketing and sales pipeline. To take advantage and increase return on investment, marketing organizations are looking to

machine learning analytics as a new, non-negotiable component of their marketing technology stacks. Here are some of the business drivers for machine learning analytics for marketing:

- Improve customer retention
- Target most suitable customers for the product/business
- Lead generation
- Sales development
- Opportunity management
- Consolidate social media strategies
- Engage customers in real time
- Visualize success across the enterprise
- Treat data as a strategic asset
- Identify the next best action for the customers to engage them

Machine Learning Based Analytics: Applications in Marketing Analytics

Marketing is a very dynamic and adoptive field. Because customers understand the product, service, or strategies through the marketing campaign. Some applications are explained here.

- *Customer segmentation:* Customer segmentation models are very efficient at mining small, similar groups of customers containing the same behaviors and preferences. Successful customer segmentation adds value.
- *Customer churn prediction:* By determining patterns in the available data set produced by customers who churned in the past. Learning analytics enabled systems can accurately predict which associated customer or customers are at a high risk of churning. This **churn prevention** can equip markets with actions to retain and engage the high-risk customer. Therefore, if marketers become successful in doing so, they can contribute in increasing revenues.
- *Customer lifetime value predication:* With the combination of machine learning and customer relationship management (CRM), businesses can predict the **customer** (LTV). LTV is used for segmenting customers, and for measuring their contribution in the increasing or decreasing future value of a business by predicting growth and associativity.

- *Customer value maximization:* With the implementation of customer value maximization techniques and the actions suggested by it, the business can encourage customers to surge the occurrence and expanse of their transactions. It also increases the duration the customer remains active and associated with a business.
- *Customer behavior modeling:* Customer behavior modeling is used to determine communal behaviors and patterns observed among specific groups of customers. Likewise, it is used to predict how similar customers will perform under similar conditions or situations. Customer behavior models are constructed on data mining of customer data. In customer behavior model, each model is designed to respond to one question or query at one point in time. For example, a specific customer model could be applied to predict or forecast how a specific group of customers react to a particular marketing action. This will provide the necessary insight to take the necessary action.
- *Digital marketing:* Machine learning analytics allow digital marketers to predict, classify, and segregate customers at the point of entry, and individualize content to maximize business outcomes. Ultimately, due to this effort, customers are affected in a positive way. The advertising and offers they see becomes more relevant and customized per their needs.
- *Ranking customers:* One of the important uses of machine learning analytics is to rank the customer based on the business value. This will help the company customize their product/services as per value of the customer. For example, e-commerce companies customize and personalize page designs, offers, posts, and content dynamically based on the rank of customer with the help of machine learning algorithms, which have the means to assess the expected value of each visitor.
- *Virtual assistance:* Used to provide support to all levels to everyone and are becoming smarter and smarter. For example, chatbots can now make out the semantic resemblance among two replies. Also, they suggest responses that are dissimilar not only in phrasing but in their fundamental meaning as well.
- *Making user-generated content valuable:* For example, Yelp uses user uploaded photos for semantic data about individual photographers.
- *Improving customer service:* Smartly identify useful data sets from the sea of data and generate insight to provide excellent customer service. Also, machine learning algorithms find deep insights hidden in data about customers. Moreover, it turns them into a data asset by finding the answers of the questions like what to offer, when to offer it, and to whom.

Jargon Buster *Market sizing:* Market size analytics is about providing insight regarding market potential for your products and services, such as how large the market is for a particular product. It also provides information about the growth prospects of the product. Market size analytics is important for understanding the size and forecast of the potential market for a product. It is essential to know where your products are in their lifecycle and whether you are competing in a growing market or a declining market.

Other Uses of Machine Learning Analytics in Marketing

Machine learning analytics can be applied to multiple areas to get business and competitive advantages. Here are some use cases:

- To design marketing strategies based on the prediction of in-store customer traffic.
- *Customer behavioral analytics for payment security:* With the help of anomaly detection techniques, malpractices can be identified in real time even in very high volume of data/transactions/communications.
- Create, analyze, and optimize real-time operational metrics.
- Identify and analyze the root cause.
- Design futuristic data based business and operational key performance indicators.
- *Real-time data based sales forecasting and predictions:* Models can be developed for forecasting and predicting customer churn, credit risk, or train/bus/flight delay.
- *Predicting the success of fundraising campaigns:* For example, it provides you idea about the success and failure of particular fundraising campaign based on metadata.
- To predict suitable selling and buying time, make effective product recommendations, and classify best customers for the business.
- Prevent data breaches.
- Perform social semantics.
- Speech and language recognition.

AUDIO AND VIDEO

AN interesting series of videos that provide insights about the role of machines in online advertising campaigns today. Include the role of digital media in changing times and more. See:

<http://exponential.com/trust-the-machine-video/>

Machine Learning Based Analytics in the Retail Industry

Machine learning is changing the retail industry in a constructive way. It is allowing retailers to identify critical action areas that are hidden under the sea of unused data and opportunities. Also, it provides them with the power of consuming and analyzing the data that they thought beyond the processing capabilities of human ability (at least manually). It enables retailers to predict the future with the help of customer churn analytics and enables them to take useful decisions. Due to advancement in data capturing and storage technologies, mountains of data is available related to products, price, sales, performance, consumer behavior, logistic details, and so on... Organizations are using this to decode consumer's purchase and financial DNA.

Challenges in Implementing Machine Learning Analytics in the Retail Industry

As the retail industry is growing, its associated challenges are increasing. The challenges are multidimensional and will impact the people, processes, and technology. The discussion in this chapter is confined to machine learning based analytics related challenges. Here are some of the critical ones:

- *Right data:* Gathering quality data is one of the biggest challenges.
- *Data oriented management:* Once you get the data its management is critical. Most of the data that organizations get is heterogeneous in nature and typically comes from multiple sources.
- *Technical expertise:* There is huge scarcity of the right talent. Finding people for roles like data scientists and data engineers and the technology managers who specialize in managing machine learning or analytics project is difficult.
- *Integration:* In most cases the decision of implementing machine learning based analytics in the organizations are taken as new initiative. However, if some new startups are opened around the same then the story is different. But in both the cases integration of multiple systems and technologies, so that data and in turn wisdom from in the right way, is far most important. Therefore, right strategies, talent, and expertise are required at all the level.

This enables organizations to reduce the discrepancies among “isolated” systems and empower the smooth flow of data among core business applications.

All projects are unique and need solutions as per situation, requirements, and demand. Hence, the challenges are also different. However, there are some guidelines that definitely help in coping with difficult situations and make appropriate strategies. Here are some of the best practices/guidelines. Here these are presented in “retail industry” context, but could be applicable in almost all other industries.

- Incorporate information technology in the DNA of organization.
- Be Agile and translate vision to reality quickly through pilots.
- Ensure that received data is of good quality before it moves forward to sophisticated systems or is filtered in a proper and intelligent way by the effective use of the available tools. Also, create easy data access policies.
- Reuse existing process, processes, technologies, and people skills. Cross-train people wherever required.
- Follow basis like, before starting understanding the problem by asking the right questions and documenting the opinion.
- Build effective and efficient teams who are able to understand and interpret the problem. Also, work toward putting the right people in the right place.
- Select the technologies as per your need, not based on hype.
- Produce insights that can be put into action easily and effectively.

Drivers of Machine Learning Analytics in the Retail Industry

- Bring a reliable, tailored, customized product mix and pricing to customers and increase sales.
- Excel in the market.
- “My first” approach to become a differentiator in the market and offer innovative products for differentiating customer experience.
- Increase customer loyalty by understanding behavior and shopping patterns.
- Use targeted marketing campaigns based on the customer characteristics and psychology.
- Reduce cost by improving inventory, value, and supply chain management.
- Increase conversion rate of customers who come to know about the product and services through multiple channels.

- Manual data analysis is becoming absolute now. Because even most experience retailers are finding it difficult to get value from existing data through the use traditional technologies like databases, spreadsheets, and old warehousing techniques. There are multiple reasons for this, including the high volume of data, requirements of on-demand analytics, and dynamic change in infrastructure capabilities. However, with the use of machine learning analytics, the retail industry can ensure that even single bit of data is analyzed and provides effective insights to them.

Machine Learning Analytics Based Analytics: Applications in the Retail Industry

The retail industry was one of the earliest adopters of machine learning analytics. It helped adopters excel in the market and take competitive advantages on the competitors. Here are some of the applications of it in the retail industry.

- *Pricing:* Machine learning analytics enable retailers to manage the price of their product in real time by comparing and considering competitors prices. A smart algorithm based on the predictive pricing model can crunch all forms of data and provide accurate information in real time. For example, it can analyze sales data and dynamically optimize prices for a particular point in time.
- *Inventory management:* Smart, efficient, and effective inventory management are the keys to the success of retailers. Whereas inefficient management leads to a loss in business. In sales for example, predictions made on inaccurate past data give inaccurate demand projections create the wrong demand for certain items, whereas predictions done on an appropriate mix of historical and real-time data help generate the right demand of items and ultimately help move inventory. Retailers can use predictive analytics to decide what to store and where to store it, based on sensitivity and environmental and regional differences in preferences, weather, and customers.
- *Recommendation engines:* To recommend appropriate and most suitable products to the customers, e-commerce companies are using recommendation engines. However, this is not only limited to e-commerce companies; traditional retail industry uses them as well.
- *Smart revenue forecasting:* The retail industry is using machine learning analytics for accurate forecasts based on the buying habits of customers.

Other Uses of Retail Machine Learning Analytics

- Optimize in-store product variety based on customer demand to maximize sales.
- Next best and personalized offers to the customer based on the his/her data.
- Real-time data driven stock optimization through dynamic inventory management.
- Predict and forecast hyperrational sales, demand, supply, and other relevant business insights using real-time data.
- Analyze, predict, and innovate in market sizing and potential.
- Optimize spend.
- Optimize market mix through process optimization.
- Enhance capabilities to understand customer through sentiment, emotions, review, video, and voice analytics.
- Predicting, forecasting, and deciding which products to transport to relevant and most suitable stores based on demographics, customer perception, and other data inputs.
- Optimize in-store product placements based on customer data, so the possibility of getting attention increases.
- Optimize advertisements in real time as per customer preferences to increase sales and customer loyalty.

Customer Machine Learning Analytics

Customer analytics provide power to companies to predict and anticipate what they do for their customers, which customer is at risk, how to add customers to their business, which customers is loyal to their business, and which are not. Also, it helps organizations do proper segmentation of the customers so that they can implement the best business plan to retain and acquire customers. It also finds answers to questions like which high value customers are at risk or to determine what offer to make to a particular customer segment.

When a huge quantity of data is available, applying machine learning based analytics to customer data is essential to making appropriate business decisions. However, the success of machine learning based analytics depends on having the right strategies, quality data, plans, and implementations of proper solutions.

Customer data is readily available to organizations, as they are smart in collecting data from multiple sources. However, availability and storage of the data is useless, unless some intelligent processing and analytics happen. Hence, organization focus shifts to extracting “insight” from the mountain of the data instead of collecting it. By applying machine learning techniques, the organizations understand their customers in the better way, and they make the company’s products and service more relevant to the customer.

To attach, associate, and build intimate customer relationships, Big Data and machine learning technologies play a critical role. They took central stage in the organizational journey to make customer-centric business strategies. However, the basic principle of customer satisfaction—that every customer is different and they need to be treated differently—is still relevant. This is important because every individual carries a different intensity of emotions, habits, and preferences. Analytics paired with machine learning play an excellent role by categorizing and segmenting customers into different groups and treating them uniquely. The most important goal of a perfect and successful segmentation is to achieve optimization.

Challenges in Implementing Customer Machine Learning Analytics

There are some challenges to implementing machine learning analytics in the customer space. Here are some of them:

- *Top-level leadership vision and support for analytics strategies:* While implementing customer analytics, top-level leadership support of the analytics vision is required. It requires big changes across organizational policies, frameworks, and thought process. For example, customer collected data resides in multiple heterogeneous systems and lots of people/groups accessing and using the data. Strong leadership vision and support ensure that the analytics strategy is properly implemented and aligned across the entire organization. This ensures that everyone in the organization moves the same direction and has clarity about how data will be gathered, analyzed, processed, and used to achieve business results.
- *Selecting the right data:* To make the customer analytics effort successful, the first and foremost important step is selecting the appropriate data for the organization. It is a resource-intensive effort but it is critical and worth investment. In the era when a lot of competition exists, clear data strategies and roadmaps need to be defined and created. If a gap exists, it will then be filled on time. This will allow organizations to effectively transform data into insights and then into wisdom.
- *Infrastructure readiness:* Machine learning analytics projects are different from general software or hardware projects. Thus, their need, requirements, and demands are different. Building the infrastructure may require additional investments and leadership must be willingly able to accept it.
- *Right resourcing:* Choosing the right resource that will convert the organization's vision, strategies, and thoughts to actionable steps is very important. However, finding the right resource and talent is difficult, as customer analytics is a multi-disciplinary

field. Determining which data set is important and relevant is very important to success, and finding so-called data scientists who have these capabilities is difficult. Developing business-oriented (with the knowledge of sociology, business, psychology) scientists is essential, as they provide the business with a competitive edge.

- *To create data culture within the organization:* This is very important. The data culture means that everyone in the organization must have a mindset to respect the data. The organization on the whole and the employee must understand the importance significance of the data. All the groups, especially the data intensive analytics groups, must be integrated. There must be availability of tools that help them integrate the data and communicate seamlessly. All the lines of business must collaborate and share data though a uniform platform. Even the non-technical user will have opportunities to work with the data. In a nutshell, a data-aware enterprise invests in tools at all the levels that allow business people to use data to drive decisions.

Drivers of Customer Machine Learning Analytics

Data from machine learning analytics needs to be presented in the form of actionable steps and must be simple enough to be put into action. However, only knowing about what to do is not sufficient. The decisions must be available in a format that allows involved parties to understand it. The final decision to take action is up to the decision makers, such as the CIO, CEO, and product managers. Hence, the action steps needs be clear and accurate. Only then will decision makers have confidence in implementing the steps in real-life scenarios. Decisions like providing or suggesting appropriate products or services to a particular individual or group or innovating something unique for customers on the basis of behavioral data analytics to the customer need a careful approach. Any decision that is taken on the basis of all these parameters is crucial. Failure or success of any decision typically impacts the business and the branding of the company. Hence proper testing and retesting of any data based decisions needs to be performed before acting.

- To understand customers better
- To improve products and services
- To create new revenue streams
- To improve the detection and prevention of fraud

Other Uses of Customer Machine Learning Analytics

Machine learning analytics finds its uses in the customer support/service space at its fullest. Here are some of examples.

- Sentiment analysis
- Best next offer analytics

- Customer churn analytics
- Predict customer wallet share
- Perpetual customer loyalty
- Customer experience and sales analytics
- Virtual customer care assistance
- Identification and management of best customers
- Customer retention
- Cross-channel behavior tracking
- Access of minute transactional data
- Fast onboarding of the customer
- Quality of service
- *Mapping of full view of the customers:* There are multiple channels available that enterprises are using to get data about customers. With the use of kiosks, call centers, mobile, partners, e-commerce, and social media channels, data can be gathered and used to get a full view of the customer.
- *More proactive and effective organizations:* Machine learning based marketing analytics helps organizations predict customer and market behavior. Accordingly, they make strategies to the respond proactively and appropriately.
- *Personalize customer marketing and engagements:* Machine learning based marketing analytics enable organizations to predict the probability of a customer reply to dissimilar offers. Hence, they are better prepared and know customers.

MACHINE LEARNING ANALYTICS IN REAL LIFE

- Google came up with the new voice recognition technology and incorporated in its “next” handset. Apple’s Siri and Microsoft’s Cortana are other examples.
- Google Gmail spam detection and email tagging are both based on machine learning.
- E-commerce companies are using machine learning to predict which products customers might return.
- Extracting insights from the user comments to understand the customer better and to understand the rating system better.
- Answering complex queries from customers in an automated way.

- Fraud and duplicate detection, for instance, automatically identifying if someone is using a duplicate image instead of an original one for authorization.
 - Assessing the quality of the customer rating.
 - Recommending and forecasting repeat purchases.
 - Product classifications.
 - Apple iPhone uses machine learning analytics to extract the background sound from the talker's voice.
 - Apple iPhone's virtual keyboard technology is using machine learning analytics to determine the tap area of each key.
 - Microsoft, Android, and iOS's spelling correction technologies use machine learning analytics.
 - For identifying faces in iPhoto apps and in Facebook social media sites.
 - IBM Watson uses it for Cancer diagnoses. Many other companies are using it to detect disease on the basis of scans and MRIs.
-

Machine Learning Analytics in Other Industries

Machine learning analytics has been applied to many industries/domains, ranging from fashion to aerodynamics. The following sections describe some of industries/areas where it is used.

Video Games

Although it's not yet extensively used by gaming companies, it has started showing its presence there. For instance, gesture recognition in Microsoft Kinect is one example of its mainstream uses.

Disaster and Hazards Management

Machine learning has found a role in controlling and predicting natural digesters, such as geological, biological, hydrological, and climatic problems. By analyzing and processing geophysical and biological data, it provides insight to control them or at least to take proactive measures. The integration of IoT, Big Data, and cloud computing help organizations and governments as follows:

- Monitoring hazards
- Anticipating the intensity of disaster risk

- Tracking effects of calamities and monitoring recovery efforts
- Controlling the disaster exposures
- Detecting earthquakes, floods, and hurricanes, as well as forecasting future occurrences of such hazards with the help of sensors and analytics

Transportation

Transportation companies are using machine learning in a big way to make accurate predictions in real time. A few of its uses are listed here:

- Choosing optimum/most profitable networks for transport services
- Predictions of future incidents/timely feedback about transport systems
- Vehicle delay analysis
- Mode choice and trip assignments
- Travel pattern behaviors of various modes, including time, location, and demand
- Tracking congestion and saving drivers time and headaches

Hospitality

In this field, machine learning analytics are applied in very mature ways. Many companies are using a wide variety of machine learning techniques to solve their respective issues. They collect huge volumes of data in different forms, including video, audio, and web data. They use them for areas like customer segmentation, loyalty information, dynamic pricing, and allocation of the resources (rooms), customer profiling, site selection, room availability forecasting, customer relationship management, menu engineering, personalized marketing web site optimization, providing the right room at the right rate, and even investment management. Moreover, machine learning analytics are used to provide customer value and improve hotel operations.

Aviation

Machine learning analytics have been adopted by the aerospace industry in efficient ways. Traditionally, airplanes have used sensors to collect data. This is integrated within the plane's systems to gather information during its flight. That data/information is used to monitor the health of the airplane and maintenance schedules. Now, machine learning analytics can more diligently predict weather conditions and identify faulty parts before they fail, making the overall system more secure.

Fitness

Many health and fitness companies are using machine learning in their fitness products to get a better understanding of their users. Atlas devices, for instance, detect which type of exercise the user is doing based on their gestures and movements. There is a wealth of devices available that gather sleep patterns and diet choices, monitor heart rate, and check sugar level, all to offer recommendations toward healthier lifestyles. Fitbit is one company that provides a range of the devices. Apple, Microsoft, and Samsung all have their own variants, which are incorporated into their devices/software.

Fashion

The fashion industry has social and economic impact across the world. This industry uses machine learning technologies to their fullest to provide value to the customer. Technologies like data mining, knowledge discovery, deep learning, computer vision, and natural language understanding with structured and unstructured fashion are transforming the way this industry works. Luxury fashion houses are recreating physical in-store experiences for their virtual channels. Also, many technology startups are providing trending, forecasting, and styling services to the fashion industry.

Oil and Gas

Oil and gas is traditionally a data intensive industry and generates tremendous amounts of data during oil and gas exploration. Machine learning analytics, with IoT and Big Data technologies, are used to processing data related to operational activities, monitoring, pressures points, mud properties, hardness of the surface, seismic waves, and temperature. This ultimately helps the algorithms understand exactly what's going on downhole at that specific well. This data is investigated in an automatic way to understand the current situations related to exploration. Further, the analysis of a non-optimal event such as a kick, blowout, or wellhead failure is done. Potentially, an algorithm's capabilities of understanding what contributes to non-optimal events are identified. Recommendations can be performed. Oil and gas companies are also using machine learning algorithms to develop better models for drilling, maintenance of tools, etc.

Advertising

Online advertising is using advanced machine learning technologies to handle issues like how to select the right viewers for an ad, how to price an ad, or how to measure the effectiveness of advertising. The two broad categories of advertising and search and display are betting big on machine learning analytics.

Entertainment

While creating a trailer for the horror movie *Morgan*, machine learning techniques and experimental APIs of IBM's Watson platform were used extensively. The producer and directors of the film wanted to use something different for the viewer. They, in collaboration with IBM, took Watson to film school. There the system analyzed hundreds of existing horror movie trailers. They incorporated the insight generated out of that research. The program selected the 10 most intense moments in the film. Finally, a human editor created the finished trailer using those clips selected by the Watson.

Agriculture

Uses machine learning analytics and IoT to provide benefits to the farmers. For example, Caterpillar Inc. uses sensors on its machines for farming uses. The machine provides insight on the quality of soil and suggests which crop is best for that type of condition.

Telecommunications

One of the most important criteria for success in the telecommunications sector is to reduce customer churn. Customers switch service providers on a frequent basis and in unpredictable ways. With the help of machine learning analytics, analysis of structured and unstructured data becomes easy. Therefore, companies can precisely predict and forecast which customers are at risk of leaving. This insight helps them to reduce churn. Measures like marketing personalization and customer experience measurement, guided by machine learning, help to manage and engage customers.

Insurance

Machine learning analytics helps insurers review analyses and process all forms of data, including pictures, videos, and audio. The insight generated is used to improve compliance and prevent inappropriate selling of products and services. The other benefits include:

- Product personalization and endorsement through machine learning analytics of customer data.
- Risk classification on the basis of analytics on heterogeneous data sources, like social media, click streams, and web.
- Faster claims processing through automated image classification (deep learning algorithms).
- Customer churns forecasting in real time.
- Fast and accurate insurance fraud identification and detections.
- Increased revenue and profitability.

A CURIOUS CASE OF BOTS AND CHATBOTS: A JOURNEY FROM PHYSICALITY TO MINDFULNESS

Touchkin came up with the “happiness buddy” Wysa. It is an emotional wellness and wellbeing machine learning based chatbot. This chatbot comes in the form of a loveable, cute, and “caring” penguin that can talk to users about their feelings and try to understand them. Once the inputs are collected from the user, it guides the user by providing personalized mindfulness meditation based suggestions, or recommending appropriate exercises based on the specific need of the user. The penguin chatbot was designed and developed to understand one's emotions and mood. It efficiently tracks the emotional state of the user. Therefore, it can motivate the user through the appropriate and most suitable mechanism of suggestions. It also equipped with the general features of the fitness apps like capability of tracking sleeping patterns through mobile phones. For completeness, the chatbot provides weekly reports with an overall summary of the wellness to the users. These reports provide insight as to how they were doing the entire week.

At present, chatbots are quite underutilized but they definitely will go far beyond texting purposes. New generations of machine learning enabled smart and intelligent chatbots are coming. They will be used to build the relationship with the stakeholder and take this exciting relationship to the next level. As the interface evolves over time, the interactivity will also improve. Personalized and individualized bots will be used to make long-term connections with the stakeholders, users, and customers and help enterprises to establish their brand. In the next few years, the convergence of technologies around bots will bring revolution in the industry. The way we consume and process information will change. Interactive voice response (IVR) technology, cognitive computing, and machine learning technologies will bring a new way of consuming information for the bots.

The uses of bots are enormous. For example, they will become very useful for combating loneliness, such as when no one is available to talk to an elderly person or parents do not have time to talk to their children. Bots come to the rescue.

One of the uses of bots in the recent news was to help visa applicants. A bot called Visabot, developed by Andrey Zinoviev and Artem Goldman, can help applicants with the process of procuring a U.S. visa. Initially, it was tested with B-2 tourist visas and O-1 visas applications. It works in a very natural way, by starting with questions about nationality and the purpose of the visit. Once the information is gathered it is processed and then suggests the appropriate visa type to the specific user. After that, it suggests the relevant documents and fills out the forms. Once the forms are filled out, it checks for their correctness and order. Just imagine how much time, effort, and unnecessary headache Visabot could remove. People like it and the data itself shows this. As of this writing, Visabots are being used by 40,000 people (February/march 2017). Use is spread out over the globe, including the Middle

East, Europe, Latin America, India, and China. Hence it is natural that its promoters are planning to extend its reach and have ambitious plan around this. In the coming time, you will see Visabots that process H-1B to help a wider audience.

By analyzing the projections of the market demand of bots, tons of enterprises, including service providers, are betting on Internet robots/chatbots to use have conversations with customers. One school of thought says that a rise in the demand for automated robots and chatbots puts many low-level jobs at risk. Particularly, the information technology-enabled services sector will be impacted with this rise of chatbots. Another thought, however, says that bots can actually create more jobs, especially the high-end jobs. In reality, bots will bring momentum to dynamically changing markets and improve the efficiency of existing processes. It will definitely affect jobs at the lower level of the pyramid. An Indian private sector bank called HDFC came up with the chatbot called Eva. to handle customer chats. It has an excellent ability to scale up its capabilities based on demand. So, when more demand comes, it uses the technique of concurrent chats ,which roughly handles 150 customers at a time. Eva is a machine learning based web based chatbot software designed to simulate conversation with humans. It is actually employed by the HDFC bank to help customers and visitors who are looking for the best products and service online.

One reason for the popularity of these bots (95% of bots are in use are chatbots) in the businesses community is that they are easy to integrate into existing communication platforms. Voice bots (speaking bots) may take more time to become operational because of technological challenges like understanding different languages, accents, tone, and emotions associated with voice. All over the world, software based enterprises, research organizations, and labs are trying hard to create bots that are close to humans, especially in terms of understanding and mimicking humans. The ultimate vision and philosophy behind chatbot is that it serves a as communicative and collaborative gateway. This is the reason why private banks, telecom companies, and service providers, travel companies, e-commerce portals, private insurers, and drug manufacturers are betting big on bots.

Bots are being adopted across geographies within organizations. Gone are the days when only developing countries and the big enterprises are looking for a solution to their problems. Due to its potential and usability bots went beyond the boundaries of developing and developed countries. For example, Asian companies are adopting bots at a higher rate than their peers in Europe and the United States. Enterprise/companies based out of Asia, like China and India, are the biggest buyers of chatbots. The major reason for this is the proliferation of mobile phones and other portable devices. It enables easy “installation” of bots. Also, bots are cost effective in the long term and their return on investment is good compared to traditional investments and cost cutting methodology. For example, establishing a dedicated customer care center is more expensive and challenging than finding the right

fit in term of bots. To serve and handle customers' needs on a daily basis is very expensive. Also, day-to-day tasks are routine, boring, and monotonous and generally employees are not very engaged with this type of work. Hence, it makes more business sense to employ bots to perform routine and monotonous work. If this strategy is implemented correctly, it will significantly bring down operational costs. Multiple research showcases that in performing monotonous tasks, "machines" are more efficient and able to serve a wider population (in this case customer) at a time.

How Bots Work

A bot (an Internet robot) is a software based application that executes automated scripts (written in some programming language) on the web/Internet. Bots are used to perform simple and structurally repetitive tasks. They perform them at a much higher rate in comparison with humans. For example, humans are not good at executing concurrent tasks and they therefore find it difficult to answer multiple questions/queries at the same time. However, a single bot can easily handle multiple queries (concurrently) from numerous customers in any format (voice, chat, or email) effectively and efficiently. A typical bot does this with the help of automated scripts, which are typically executed on servers and provide responses based on data manipulation and input provided by the users. Data is plugged into data stores and reside on extra-large capacity servers on the cloud infrastructure. To provide an answer to the user, it communicates with knowledge banks periodically.

Once the chatbot receives customer queries, it reads and tries to understand and interpret the same. Based on understanding, it looks in to the knowledge base (in layman's language, an intelligent data store/database) to find the answers. Once the chatbot gets the answer, it provides a suitable response to the user/customer. However, for smarter bots, the mandatory criteria are to updating the knowledge bank on the consistent basis and the growth of the quality content whiten it. Hence, over the time knowledge base become wider with having more content in it. This would help the bot to answer complex user queries. The smartness and efficiencies of bots are dependent on the quality of the data stored in the knowledge base.

With the help of evolving technologies, frameworks, and APIs, chatbots are being customized to bring a "human touch" in their responses. For example, Watson cognitive APIs or Microsoft cognitive API both have capabilities to incorporate vision, picture, and emotions. In order to connect better with the customer, companies do not want just mere mechanical bots. They want bots that sound human and are more cultural and language sensitive. Therefore, they incorporate cultural information in the bots, which is one of the biggest challenges. However, over time, with the help of knowledge base and machine learning technologies, the bot learn and process local sensibilities and are more context aware. Hence, their responses become more appropriate. To become more human like, bots needs to understand informal terms apart from formal ones. For example, they need to learn some slang or local greetings, so their conversations have an human element.

Data orientation, machine learning, and artificial intelligence technologies are the basics. To get the maximum from a bot, the company has to collect and store quality data. The variety of heterogeneous data makes the bot intelligent, smart, more intuitive, and better equipped to have a human like conversation. Business are using bots to improve internal efficiency as well. For example, customer care executives use bots very effectively to answer the queries of the customers. Bots can help executives offer suitable solutions to customers and establishes a meaningful, effective, and efficient dialogue with them.

Usability of Bots

In order to do the holistic mapping of customers to understand them better, companies are feeding customers' behavioral data into the bots. On the basis of those bots, they can understand and capture behavioral patterns of the customers. Therefore, they can find the "odd" information regarding the behavioral changes of the customers. This capability of the bot is seen as a quantum step to prevent fraud by anomaly detection.

New generations of chatbots can measure and predict customer mood, sense wider emotions, and predict future thoughts on the basis of a typed language. For example, if someone types "WHY YOU DID NOT PROVIDE ME THE INFORMATION TILL NOW!!!" to a bot, the bot would predict that the user is angry and automatically go to alert mode, as the statement contains uppercase letters and exclamation marks. It replies with something like this, "It looks like your mood is not good today. I will connect you to a customer care executive, who will help you out". This is not an alien thought, as bots already contain these features and functionality.

Bots based advisory services, like "Robot Advisory" financial services (investment advice), have become popular across the globe. In India, a few companies like FundsIndia.com, Scripbox, and MyUniverse are some of the popular robot advisory platforms that are creating momentum. Advisory bots are one of the areas where bots have done significantly well. These bots are helping customers make correct investment decisions. These programs provide information after factoring in lots of technical and basic parameters and the best part is, unlike human investment advisors, bots are not guided by emotions, prejudice, or greed.

Telecom companies are also using bots to accomplish their day-to-day operations and to provide customer services. Telecom companies are running trials to put their bots on various communication and collaboration platforms. Industries that have more business to customer interactions tend to invest more in the implementation of bots. Hence, across the globe there is an increasing number of e-commerce startups. Travel firms and insurance companies are using bots to fulfill their customers' needs.

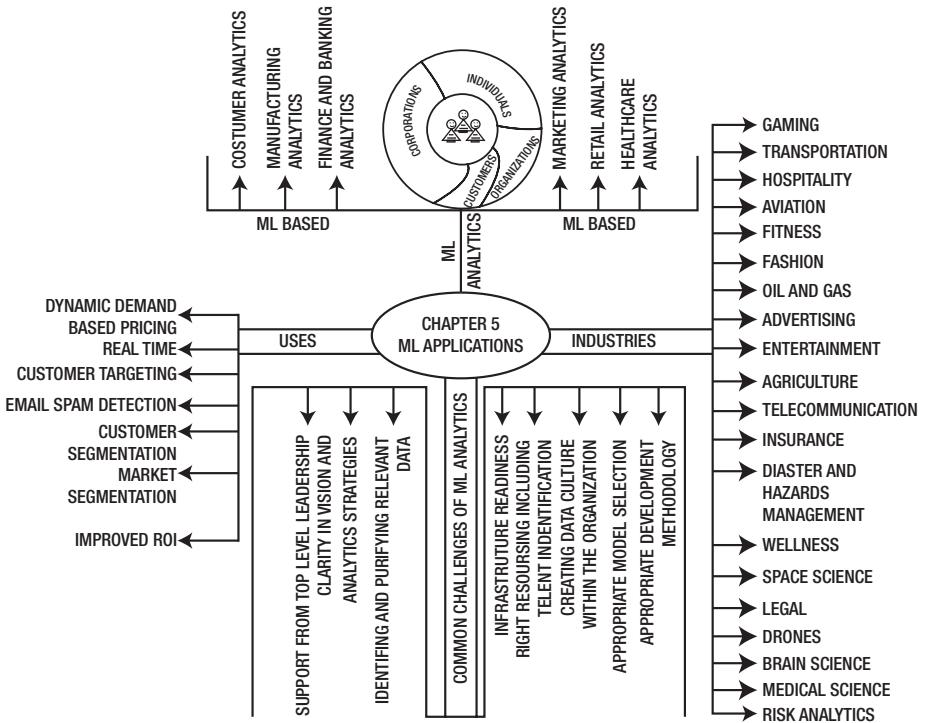
Listen, I Will Not Give My Job

There is an increasing fear of bots taking over the jobs of human beings. Industries and services like BPO and voice processes-based call centers may be impacted due to the monotonous nature of their work. Businesses and enterprises employ bots to reduce their operation costs and protect/increase profit margins. Business use bots for lower level transitional and operational work; therefore, they need fewer workers. In the BPO industries, chatbots can allow enterprises to work more efficiently and efficiently by minimizing repetitive work for agents (call center). If they are used properly, they can reduce wait times of the customers. They can even reduce the average customer-handle time by suggesting responses while the agent is speaking with the customer, leading to faster resolutions. Most of this type of work is repetitive and can be automated and handled though bots. So, at this level, there is a definite possibility that bots may obviate routine jobs performed by less skilled workers. The reason is straightforward—monotonous and routine work bots can be easily trained. However, on the other hand, advanced bot technology will definitely boost more high-value jobs where human intelligence is required. Bots will not replace humans in the foreseeable future. When they do, the idea is that humans will have other high-value, high-paying jobs.

Summary

This chapter discussed machine learning analytics in detail. It broadly discussed the uses, applications, challenges, and use cases of machine learning analytics in areas like manufacturing, retail, marketing, sales, banking, and finance. Apart from that, the chapter took some of the important sectors like video gaming, agriculture, disaster management, oil and gas, fashion, hospitality, travel, and aviation and briefly discussed the role of machine learning analytics. Today, almost all industries need agility in their functions and operations. Machine learning itself is a very agile and iterative field of study. The chapter included a section on the Agile software methodology. A brief comparison of Agile and waterfall methodology was also included.

Mind Map



CHAPTER 6



I Am the Future: Machine Learning in Action

As the acceptance of fresh or renewed technologies like machine learning and artificial intelligence gains momentum, companies are revisiting their understanding of their business requirements. In order to recognize the business functions and business need that will lead to the highest value, decision makers have shown the readiness to invest in fresh technologies. During this journey, most of them discover that these technologies have huge value and potential. They also learn, that without disruption, their businesses will fail.

Disruption is the newest slogan of the changing and innovating business of today, and for good reason. It is shaping new directions. Enterprises are watching disruptive technologies to empower new development prospects and to be pertinent in the viable market. Enterprises are also looking to become more efficient and effective through the flawless ride of technology, but, in the short-term, they are confronting challenges in applying them in a seamless fashion. These challenges are mainly due to:

- Higher price of investment
- Skill gap in maintaining technology
- Quickness in imbibing novel technology
- Digitizing has exciting prospects but offers greater risks
- Worldwide legal and regulation changes

Vendors started offering off-the-shelf technology solutions to these issues. Multiple companies and vendors are offering solutions that are trial and tested. Also, if someone wants to develop something that suits their specific needs, customizable variants are available as well. This chapter deals with a few of them. However, caution has to be taken before deciding on any one solution. Here are some pitfalls to be aware of:

- Machine learning must be treated as business led rather than IT led. This strategy is helpful in developing robust partnerships with the IT, cyber security, risk, HR, and other enterprise functions.
- Emphasis must be given to business cases and preparation before pilots.
- Categorize the accurate processes whereby such technology can produce value.
- Focus must be on amplifying employee potential and innovative priorities.
- Focus must be on empowering everyone to do fewer manual tasks rather than looking to cut costs.

In a nutshell, machine learning exists in nearly all environments. It may be incorporated into industrial robots, intelligent applications, and other products. Its form, shape, size, uses, and utilities change based on demand and uses. While adopting the technology, factors like size, capital, and availability of other resource matter, but in the longer run, the technology itself is guided by innovation. That means acceleration happens in a natural way.

Adopting early to anything, especially technology, makes a difference. This chapter discusses the uniqueness of machine learning solutions and their widespread range. This discussion ranges from voice assistance technologies to cognitive technologies. It also takes a deep look at the driverless car, VR technologies, and brain computer interfaces. There are multiple offering from vendors in the machine learning space in the form of readily available platforms, but decision makers are often not aware of them. This chapter discusses SAP's Leonardo and Salesforce's Einstein.

State of the Art

Companies like Apple use machine and deep learning to track and detect fraud on the Apple Store and to get feedback about their products from testers and users. They extract insight from thousands of reports in the automated way. Apple also uses these technologies to establish whether an Apple device user is exercising or simply resting.

Facebook uses machine and deep learning to recognize faces and locations from the photos of users. Through machine learning technologies, Apple devices can determine whether you will become fat in the next few weeks or remain thin. If you want, your apps can quickly compile snapshots and videos you took into a mini-movie at the touch of a button. The Apple provided apps and devices will remember where you parked your car and provide information about that, all in real time. They give you reminders from your appointments based on the content of your emails. They provide real-time suggestions while you are typing, and so on....

Siri

The natural way it responds to queries after understanding them is one of the features that makes Siri so popular. Siri does this with the help of the deep learning technology. Deep learning is the field of study that facilitates machine learning to perform human-like tasks in smart and intelligent ways. Machine learning techniques level out sounds of individual words, which makes Siri sound like an actual person. Siri is capable of the following:

- Speech recognition capabilities: Converting human speech to text
- Excellence in natural language understanding: Interpreting what a human says
- Perfect execution: After understanding the questions, fulfilling a query or request
- Excellence in response: Replying to the responder

Siri uses machine learning techniques such as deep neural networks, convolutional neural networks, long short-term memory units, gated recurrent units, and n-grams in association with deep learning technologies to cut error rate by a factor of two in all the languages it supports. Also, it detects the voice of the user and spells out the user's name and password instead of typing them. Here is the basic working procedure of Siri:

1. User provides input/asks a question to Siri, such as "Who won the 1983 cricket world cup?"
2. Phone app translates the speech to a format that Siri understands (binary code). Typically, it does that by collecting the analogue speech and converting it to an audio file.
3. Once done, it will send the data to the Apple servers. Once the data is submitted to the Apple servers, an appropriate response is generated there. Siri does not process the data locally (on the phone); it does this on the Apple cloud. Therefore, if you do not have an Internet connection, you face problems communicating with Siri.
4. The server returns the response. The data is processed on the server with the use of natural language processing. An appropriate response is returned to your device through the servers and Siri converts it into text and speech.
5. Siri responds to the user. "India won the 1983 cricket world cup." The text would flash on-screen, and at the same time the speech is played back to the user, provided the audio feedback option is on.

IBM Watson

IBM called it more than artificial intelligence and they coined the term “cognitive computer” for one of the most talked-about products of the recent times, known as Watson. Watson uses natural language processing capabilities, machine learning, and the vast quantities of data fed into it to directly answer questions posed in everyday human diction in seconds.

Watson is one of the most powerful artificial intelligence computing systems. It learns from the environment in three ways:

- One form of its learning is reading. For example, to enhance its knowledge on cancer, it “read” more than several millions of pages from a variety of sources.
- Another way it learns is by answering questions or in the “teach phase”. For instance, in the cancer project, doctors put questions to Watson, and then tweaks the responses if Watson’s answer was not perfectly accurate.
- Lastly, it learns by doing, or from its own mistakes. It finds new patterns about the work, similar to what humans do.

Watson at a very high-level view looks like this:

- A huge amount of unstructured and semi-structured data that is publicly available is feed into the Watson database.
- The questions are put to Watson in the form of text or through voice commands.
- The questions are used as a search query to search the database. This is similar to how searches happen on Google or on another search engine like Microsoft Bing.
- The search results plus the question are further used to get the supporting evidence from the available knowledgebase.
- Each search result used to answer the question forms a hypothesis. In turn, the hypothesis is assessed on the retrieved evidence. Thereafter, the answer is scored on many dimensions.
- The high dimension scored answers are ranked by a built-in algorithm.
- If Watson is confident enough with its final answer, it flashes or says the answer to the user.

Watson is a highly sophisticated and complicated system. Almost all the steps mentioned here involve a complicated net of machine learning algorithms that run on a parallel platform to provide the answer as soon as possible to the user.

Humans make mistakes and are not perfect. Also, with the availability to digital devices/media to the mass, information is flowing from all the sources. For example, the amount of available medical information doubles every five years. Every day around 130 research papers are published on oncology. However, physicians and other medical professional don't have enough time to update themselves on most of the latest advances, which can result in poor diagnoses. For instance, in the United States, it is projected that one out of five diagnoses were incorrect or incomplete. Also, approximately 1.5 million medicine mistakes are made every year.

Watson can potentially increase the correctness of diagnoses, advance the excellence of patient care, and reduce the cost of patient treatment. Many companies have started using Watson for their own benefits. For example, WellPoint, one of the leading medical insurers in the United States, is using Watson to improve the accurateness and rapidity of insurance approval and authorization.

Capgemini, a European software service company, is using Watson to improve their services and bring efficiency to the organizations. In India, the Manipal group of hospitals is using Watson to assist doctors and provide healthcare benefits to their customers/patients. The hospital recently started offering the service to patients and a medical test report from Watson comes at no additional cost. IBM Watson is also helping farmers understand when to fertilize and how much fertilizer to use for the optimal crop. They can get assistance from Watson on the basis of crop yield, weather patterns, and soil moisture to figure out what is really going on. This is relevant if we consider the reports that clearly show how thin the average profit margin of the farmer is. The decision of how much fertilizer to use can make or break profit for an entire year.

Microsoft Cortana

"Cortana is designed to help you get things done. Ready on day one to provide answers and complete basic tasks, Cortana learns over time to become more useful every day. Count on Cortana to stay on top of reminders and work across your devices. Cortana is great at reminders and helping you keep your commitments. She can remind you to do things based on time, places or even people. You can also add a photo to your reminder as an easy visual cue."

<https://www.microsoft.com/en-in/windows/cortana>.

Microsoft is always good at sensing market potential. They realized that analytics and machine learning are here to stay. Therefore, to cater the market need, they came up with a machine learning based analytics suite known as The Cortana Analytics Suite. Machine learning is the foundation of Cortana. Its unique instant unlimited data storage and real-time processing capabilities in coordination with perceptual intelligence helps it realize the vision of "transforming data into intelligent action".

Cortana helps you forget less and become more productive. Cortana is the best at reminders and making sure to deliver them at the right time and place. Cortana is excellent in helping users organize their tasks by sending emails, arranging events, and searching on devices, the cloud, or the network. Cortana's way of search is called the multistep search, and it layers query upon query to accomplish complex tasks by voice alone. Cortana assistance "uses" analytic suites while making decisions about user queries. Therefore, a holistic view of their innerworkings would help users understand the complete picture (Figure 6-1).

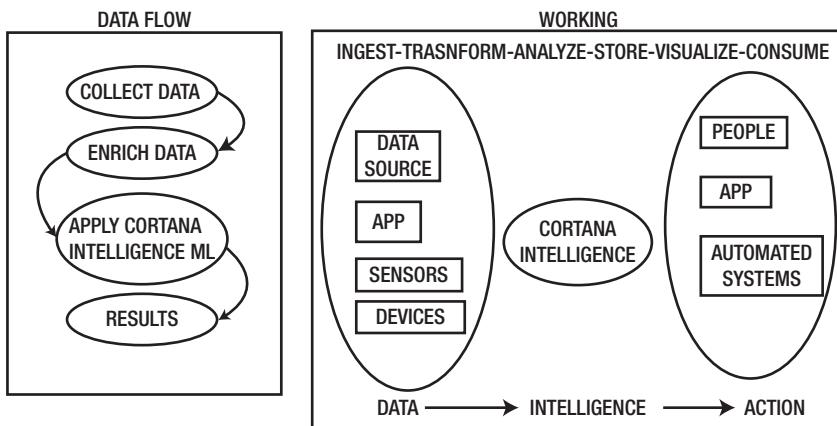


Figure 6-1. How Cortana works

Cortana proactively provides a heads up to users when there's something important waiting and needs their attention. In a nutshell, Cortana is a voice activated search engine, or an "interactive personal assistant". It falls under the same category as Apple's Siri or Google Now. On Microsoft devices, it effectively integrates with Bing searches to capture usage behavior. On the basis of that, it suggests things of interest to the user. Therefore, it makes the computing experience better and smoother.

Cortana continuously learns from the user's habits and interests. Also, alongside regular web searches for information, Cortana acts as the primary way to discover and search for information on the Windows 10 environment/ecosystem. One of the exiting features of Cortana is its capability to create activities based on actions, something similar to the popular web service IFTTT. For example, saying "Remind me the next time I call my son that we need to talk about Simba" will create a reminder that is activated when you next go to call your son or he calls you. No doubt it is a very powerful feature.

Cortana took some great ideas from Apple's Siri and Google in-house product and incorporated them. However, the challenge from Microsoft is to leverage Xbox, Windows, and other products to incorporate Cortana everywhere. The road for Cortana to reach

everywhere is not that difficult and challenging because with Windows 10, Kinect, Azure, and MS Office products, Microsoft is everywhere. A few highlights of Cortana are mentioned here:

- Sends out emails and texts
- Makes calls based on the user's contacts
- Keeps track of the calendar events
- Sets alarms
- Provides timely reminders
- Launches applications on the user's behalf
- Searches content on the Internet based on the user's commands
- Types conversions
- Modifies settings as per the user's needs
- Checks out movies and flight times and provides appropriate notifications as and when required
- Gets directions for the user based on their needs

It seems that there is a lot of similarity between Cortana and Siri, because both provide voice based assistance. However, there is a thin line between them—Cortana works as a personal assistant and provides the assistant based on the context, whereas Siri is voice command executer.

Cortana is closer to your thought process and understands your personal context. For example, when you ask questions of Cortana, it looks for connections among available historical data. It makes connections between your history of questions and provides accurate answers that are relevant to your given scenario and context. When you ask a question of Siri, she provides the best available answer based on the data available on Apple's cloud data store.

Connected Cars

Connected cars use telemetrics, mechanics, electronics, machine learning, or broadly artificial intelligence technologies in a holistic and integrated way to interact with the surrounding to provide better service, safety, entertainment, and connected life experiences. The connected car branches out into several areas of consumer suitability, such as all-in-one urban mobility, assisted driving, driverless cars, and car-sharing.

According to analysts and multiple reports, it is expected that the connected car market will exceed \$40 billion by 2025. The evolution and growth of the connected car must be seen as a natural extension of the consumer selection process.

Connected cars are preferred by individuals for multiple reasons, including the strong urge to get deal with issues like road congestion, driving stress, and better mobility for seniors and differently-abled citizens. Customers are willing to spend money on connected cars because they want the same experience and connectivity while they are driving the car as they enjoy in life. Enterprises are conceptualizing and building solutions to address current and future challenges. However, these solutions obviously require a sound understanding of manufacturing, telematics, and in-vehicle systems. On top of technical and domain expertise, practical knowledge of consumer psychology also plays an important role in the overall solution design.

There are many solutions that started coming up in regard to vehicle-to-infrastructure communications (V2I) and vehicle-to-vehicle communications. These technology-led services are enabling cars to frequently exchange data/information with the surroundings and environment they interact and pass through. Benefits are not one directional, because multiple industries and sectors benefit from this evolution as well. Industries like insurance, banking, finance, retail, and agriculture are now in a better position to collect and process customer data and use it for their purposes. For example, insurance companies can now get more accurate data about car health. This enables them to develop more customized and personalized products for their customers.

Highlights of the Connected Car System

- Get directions in real time
- Accurate and connected mapping system
- On-demand entertainment
- Dynamic real-time route information
- Accident alerts
- Reduced carbon footprint
- Optimal speed assistance
- Car breakdown warnings
- Automatic call for assistance in case of an accident
- Maintenance notification
- Optimize insurance; pay only for uses
- Vehicle lifecycle management
- Driver performance analysis and suggestions

Driverless Cars

Traffic accidents happens mostly due to driver error and carelessness. The demand for more entertainment features, cell phone integration, and music in the cars are distraction factors that make drivers less attentive and more prone to error, which leads to accidents.

However, these are not only the culprits. On top of this is more traffic and haphazard and bumpy road systems (especially in developing countries) are other catalysts of accidents. These distractions and complications are not going away, so who will “focus and concentrate” on the driver’s behalf? Well... technologies are here to do this for you. You sit and enjoy music and entertain yourself and the technology drives the car for you. This is the ultimate promise of the driverless car. Auto companies (not exactly ... Google) are developing cars that drive themselves. The promise of delivering driverless cars/trucks is coming to the masses in an iterative phased manner. For example, features like self-parking and pre-safe systems have already been realized by the automakers.

The driverless car has gained a lot of traction in recent times. However, the concept itself is not new. The idea of a driverless vehicle is nothing new and has existed for a long time. It has always been part of the James Bond and Bat Man movies. The cars that work and operate automatically with intelligence have always fascinated people. However, it is no more imagination than it is reality now.

In the 1980s, anti-lock brakes (ABS) could be thought as the first step toward this idea. Anti-lock brakes prevent brakes from locking up during quick hard presses. The car does this in an automatic way, with the help of speed sensors associated with the wheels. Auto manufacturers used these sensors to take the next step and make the car driverless by incorporating something called “traction and stability control”. These systems are improvements to ABS. These sensors enable the wheels to detect when a car might skid (dangerously) or roll over and signal to the ABS and engine management to keep the car on track. As these systems are intelligent and smart, they apply the brakes at the right time and increase or decrease intensity to individual wheels as needed. This smart technique is obviously better than applying breaks to four wheels in a panic situation.

Many auto manufacturers are working toward driverless cars. Google is leading these initiatives. Their prototypes are heavily based on this technology. Google calls it the Chauffeur system. They use lidar, which stands for “light detection and ranging”. Lidar inherited the concepts from radar and sonar, but it is more accurate. It charts out points in space by using 64 rotating laser beams. It takes more than a million measurements per second. In turn, on the basis of that, it forms a 3D model through the incorporated machinery, which locates things within accuracy levels of centimeters.

By using preloaded maps, the car can accurately locate traffic lights, crosswalk, telephone poles, shops, and bumpers. The lidar identifies moving objects too, like humans. On top of lidar, it also has regular radar, an intelligent camera, and GPS to precisely locate obstacles and objects in its way. Cars are advancing every passing day, but the driver role will not be completely automated. Driverless cars still need drivers to take over sometimes. For example, pulling the car out of or into the garage or driveway or managing tricky highway exchanges. Trucks, helicopters, and bikes are also in transition and, in the near future, all will ride or fly automatically and be driverless by an enabling technology called machine learning.

Google is not the only player in the automated and driverless car market. Manufacturers like Tesla, Mercedes Benz, and Audi are working on automated cars as well. For instance, BMW plans to roll out a level 5 autonomous car in the market by 2021. This means that the vehicle will be capable of handling any driving related situation by its own intelligence, without any human intervention. At the moment, most of the auto manufacturers are working on level 4 cars. Apple recently submitted a plan to train operators of self-driving cars to California regulators and got permission. This clearly showcases their positive intention toward self-driving cars. The driver-assistance levels are defined as follows:

- Level 1: Most functions are still controlled by the driver. However, a few explicit functions are handled by the car, such as acceleration. The level 1 car is intelligent enough to keep an instructed or set speed, slow down automatically to avoid other cars, and stay in its defined lane. But it is not able to handle any disastrous conditions and in adverse situations the driver has to take full control.
- Level 2: At this level, drivers are disengaged from the actual “basic” operation of the car. For example, the driver could leave his hand off of the steering wheel or foot off pedal at the same time. However, the driver of the car is expected to be ready to take control of the vehicle in complex adverse situations.
- Level 3: Cars are able to make decisions based on data. Drivers are still compulsory in the car, but their responsibilities have changed. Their intervention is required only due to “safety-critical functions,” which involves highly complex traffic or disastrous environmental conditions. Level 3 cars are not currently available on the market. However, a few prototypes are in the final stages of prototype. For example, Audi’s prototype A7 can fulfill some of the expectations at this level. These cars don’t just stay in their lane and away from other cars; they also make decisions.
- Level 4: This is a fully autonomous car. Level 4 cars are intended to take care of almost all security and life-threatening driving situations. They can monitor and analyze road The drivers are nonessential.
- Level 5: This refers to a fully-autonomous system that have equal driving capabilities of human drivers. The act like real “human” drivers in every driving situation. Google and Tesla are targeting this level of car. Ideally, the car at this level could go anywhere without a driver. They don’t need monitoring, s steering wheel, or pedals.

Machine and Human Brain Interfaces

A company called Neuralink, which is backed by Elon Musk, is working on linking the human brain to a machine interface. They are planning to come up with the micro-sized device to help people with brain injuries communicate better. Riding on artificial intelligence and machine learning technology, the company is creating systems that help humans implant “neural links” into their brain in order to communicate.

This is based on the idea that the brain compresses concepts into low data flow activities like speech. Likewise, if two brains could perform uncompressed direct conceptual communication through interfaces, a communication channel would need to be established. With their technologies, Neuralink would do that. Neuralink is attempting to merge biological intelligence and digital intelligence. If this concept is realized by Neuralink, it will ultimately help humans take a leap with the quick developments in AI. This initiative is to realize mixing AI with human awareness.

Neuralink would fundamentally allow humans to use AI as a supplementary ability on top of their senses. For example, to use our sense of selves or other higher in-brain thought faculties for constrictive purposes. It would be possible to connect high bandwidth directly into the brain and assimilate cloud-based AI computing with our brains in a way that's indistinguishable from our core selves.

A machine or device that reads the human mind by observing and analyzing brain waves is something on which lot of other company and research laboratories are working. For instance, Japanese scientists at the Toyohashi University of Technology have developed a system with a 90 percent success rate when trying to recognize numbers from 0 to 9 and a 61 percent success rate for the syllables in Japanese. The scientists also claim that these devices are easy to operate and can be controlled through a mobile app. In a nutshell, an electroencephalogram (EEG) is used to track human brain waves while people spoke. Brain wave patterns were then matched to syllables and numbers using machine learning. The subjects or participants then spoke the numbers and system guessed in real time based on the real-time readings of an electroencephalogram (EEG) brain scan. The researchers are now going one step further to develop a so-called “brain computer interface” that would identify and recognize words that would be thought and not uttered by humans. This could be achieved through a device with fewer electrodes and a connected smartphone in as soon as five years.

Virtual, Immersive, Augmented Reality

SLAM (Simultaneous Localizations and Mapping) is one of the ways to generate a map using a robot or unmanned vehicle that directs that environment while using the plan or map it produces. It generally refers to the problem of trying to simultaneously localize sensors with environments. The majority of SLAM systems are based on tracking a set of “points” through successive camera frames. These camera frames or tracks are used by the systems to identify and locate the “points” on a 3D position. With the assumed map of the environment, SLAM alternates between tracking and mapping and calculates the *pose* (position and rotation). Once the pose is found, it corrects the map and then again estimates the pose. This keeps happening in the loop until the mappings are accurate.

Due to markerless AR (augmented reality), it is possible to apply AR to solve bigger problems. For instance, it can be implemented to plan and design homes, furniture, offices, and to a level visualize data in interesting formats. The algorithms for markerless AR go hand in hand with machine learning algorithms. The algorithms play their role while analyzing varying sets of parameters, such as camera position, environment mapping, and visual content. This relates to position and environments. However, due to dynamic conditions developing and implementing an algorithm, delivering a markerless AR experience is a complex task.

START-UP FOR THOUGHT: ABSENTIA

Absentia was founded with the mindset of coming up with the first virtual reality operating system. Again, as college dropouts are generally behind the great ideas, Absentia is not an exception. Three computer science dropouts from BITS Pilani on the Goa campus conceptualized and founded it. The aim was to develop an artificial intelligence engine that would generate interactive content for games, with a faster rate and with negligible human intervention. Absentia started in early 2015, and from then the company has integrated a virtual reality technology with digital video content. They developed their own headset, similar to the Oculus Rift virtual reality system. At the moment, the company is working on an artificial intelligence product called Norah AI. Norah AI is basically a bot that can develop game designs and constructions based on the simple instructions given to it. The instructions or commands can be machine-generated stories, interchanges, characters, weapons, and various game scenes based on text or graphic inputs.

It could be specifically helpful to the individual who does not have coding capabilities. They can communicate with Norah AI based on text-based input. For example, commands like “Create a fat man with a moustache” would trigger the functioning of Norah AI and the character is made. The bot will help to generate up to 80 percent of the game design and construction within a span of two or three hours. This is a huge improvement in automated content design and could potentially decrease game creation time to approximately 15 days. Norah AI would be able to generate a novel set of collaborating contents for colonnade games, casual games, puzzles, animations, and graphics. Technically, the Norah AI interactive engine platform and framework consists of a huge neural network. The interplay of the neural network behind the scenes enables interactive content designers to create games, GIFs, and simulations in less time.

Facebook is betting big on these technologies. They are making a camera as the first AR platform. Their Camera Effects platform would potentially transform smartphone cameras into the AR platform. It might mean that artists and developers can develop effects through the Facebook camera. The Facebook platform contains two creative tools—Frame Studio and AR Studio. They enable Facebook users to create camera effects,

which range from simple frames generation to interactive AR experiences. This platform allows artists and designers to connect art with data to bring AR into commonplace life through the Facebook camera.

Traditionally, machine learning has not been a part of artwork. However, in changing times, it is extending its reach to areas like art. The Facebook extension to AR, VR, and markerless AR is one example of this. Also, recently 29 printings created by a neural network architecture based Google computer were auctioned in San Francisco with an \$8000 winning bid. The computers learned from example data before creating the artwork. The computers were fed a large number of images over time, which enabled them to recognize visual patterns (source: <https://news.artnet.com/market/google-inceptionism-art-sells-big-439352>). Samsung, also working on enriching immersive video quality, claims that their recent Gear 360 product enables shooting 4K 360-degree video content. For more information, see the pictures and content available at https://en.wikipedia.org/wiki/Projection_augmented_model.

Google Home and Amazon Alexa

Google Assistant is a voice-controlled digital assistant. It runs on a variety of devices, including phones, Google Home, and smart TVs. It gives users context-aware help. Google Assistant has slowly started appearing on Android phones and a few other IoT-based devices like Android Wear-based smart watches. Google Assistance is integrated into Google Allo (integrated chat apps) as well. However, the Google Home device is the only smart and intelligent speaker to feature Google Assistant.

Amazon Alexa (AI assistant speakers) is built on the Echo, and is made available to any third-party licensee that's associated with the Echo family of products. Amazon is making effort to integrate it with cars, washing machines, and with other devices. Amazon's connected home speaker has gained in the recent times as it positioned Alexa in a very good way and loaded it with a magnitude of features. The Alexa includes more than 3,000 voice-driven capabilities. While consumers might not be aware of how to use a smart home, they can use voice commands with the assistant to turn on lights, play certain songs, record a television program, or perform any other number of tasks.

Google recently announced that the smart speaker would provide recipes for cooking for over 5 million types of dishes in step by step instruction format. It will read out the recipes for you. You simply need to locate the recipes through Google assistance or and then press the button to "send to Google home" to shuttle the instructions to your speaker. Alexa, Google Home, and Google Assistance are the by-products of machine learning technology. Machine learning sits at the core of these devices/technologies.

Google Now

Google Now and Google Assistant are two separate things. Google Now enables users to quickly search the Internet and do a collection of tasks such as schedule events and alarms, adjust device's volume based on a voice command, and post information to social media by using natural-sounding voice commands.

Google Now is a good choice when users want to search the Internet on a mobile device without lifting it up to use it, something similar to Siri and Cortana. One of the excellent features of Google Now is its hands-free accessibility from the lock screen, which is enabled by a simple voice command—“OK, Google.” Google Now enables you to search the Internet and access information in your personal Google accounts. It is not context-aware and does not connect to or know the user, whereas Google Assistant is context-aware and actually “knows” you. This is the main difference between them. Both use machine learning technology to its fullest and incorporate some of the best ingredients of it.

Google Now is not platform specific and works with the Google Android and iOS, whereas Google Assistant is targeted to Google’s Allo chat app. Google Assistant is integrated into Google Home and Google’s Pixel phones. Theoretically, Google Now works on the iOS and Android seamlessly, but practically its hardware-controlling capabilities are limited on the iOS.

Brain Waves and Conciseness Computing

Facebook is working on a technology that enables users to type with the help of their brain. Facebook is in the process of creating a system that would type 100 words per minute by converting brain signals (scientists have already achieved eight words typing/-texting through brain waves). The system will not include any type of transplant into the user’s body, and it’s done only by “monitoring” the brain. Facebook is collaborating with several universities and academia. As per their briefing, the system will provide users with the capability to interact (text to) with friends without talking on the phone. For example, you could send an email just by thinking of the content. The technology may not require thinking in the terms of letters to frame the sentence, but just by thinking about the content, the text would be typed. Apart from this research, Facebook is also working to make it possible so people can hear through their “skin.” These research findings were shared at the Facebook developer conference.

Machine Learning Platform and Solutions

This section covers some of the machine learning platforms.

SAP Leonardo

Leonardo is a digital innovation system that contains multiple technologies, including machine learning, blockchain, data intelligence, Big Data, IoT, and analytics to enable business competitiveness. It is helping companies innovate on business models and processes and change the way people work. SAP Leonardo connects things with people and process through data. It delivers an extremely ground-breaking IoT and machine

learning based solution ecosystem that encompasses the digital essential with adaptive applications, products, and services, including Big Data management and connectivity, to enable the following:

- New business processes (for example, industry 4.0)
- New business models (for example, cloud computing)
- New work environments

SAP Leonardo has an excellent innovation portfolio, which helps business provide services and build applications from things/objects/devices to outcomes. For example, in the manufacturing industry, it could provide the following benefits:

- *Live insights*: Provides information like condition monitoring, location tracking, environment, usage, and consumption patterns
- *Predictive analytics*: In real time, it analyzes equipment health, remaining lifetime, demand and supply forecast, and time of arrival
- *Optimize processes*: Lower maintenance cost, higher efficiency, reduced waste, fewer claims, faster response, and shorter cycles
- *New business models*: Usage-based pricing, product-as-a-service

SAP Leonardo works on the philosophy of “intelligently connecting people, things, and businesses”.

One business problem where Leonardo does excellent work is with customer retention:

- Takes incoming dynamic data from various channels and builds an overview of the customer's journey
- Sorts, classifies, and routes events and then identifies critical events/churn indicators, including identification of customers who are about to churn
- Identifies customers who are about to churn and takes proactive steps to prevent customers from churning

Another is service ticketing:

- *Categorize tickets*: Read ticket content, determine category, and automatically route the ticket to appropriate agent or department.
- *Suggest solutions*: Provide potential solutions to an agent.
- *Boost customer experience*: Improve resolution rate, time to resolution, and closure rate by automated intelligent workflow.

Some benefits the SAP Leonardo provides to business include:

- Increases revenue
- Re-imagines processes
- Increases quality time at work
- Increases customer satisfaction
- Enables innovations

Salesforce Einstein

This does not fall under the category of a “general AI” solution offering, which typically targets human like insight and thoughtfulness. Instead, Einstein is an intelligence competency assembled into the Salesforce platform. It focuses on bringing smarter and more intelligent customer relationship management (CRM). It is intended to discover hidden insights, predict results, endorse actions, and automate tasks. Einstein focuses on helping users deliver seven outcomes related to artificial intelligence:

- Perception
- Notification
- Suggestions
- Automation
- Prediction
- Prevention
- Situation awareness

Salesforce termed its solutions as the world’s smartest CRM. It is able to incorporate extraordinary machine learning capabilities into applications. Therefore, ideally any app is able to deliver individualized experiences and predictive customer capabilities if it is integrated with Einstein. Salesforce Einstein is tuned to automatically discover appropriate insights, predict future results, and proactively recommend the best next steps.

Einstein is developed on the top of the Salesforce platform, so can help anyone create machine learning powered apps. Einstein offers multiple features, a few of which are mentioned next. They are available through the Salesforce cloud offering and are further categorized into sales cloud, service cloud, community cloud, marketing cloud app cloud, commerce cloud, and analytical cloud.

- *Einstein Supervisor Insights:* Empower managers with real-time, omnichannel insights and AI-powered analytics to efficiently manage service operations at scale.
- *Einstein Opportunity Insights:* Know which opportunities are most or least likely to close and why.

- *Einstein Account Insights*: Always know what's impacting your customers' companies.
- *Einstein Activity Capture*: Automatically log customer engagements and spend more time selling.
- *Einstein Email*: Provide tailored content for each customer email.
- *Einstein Recommendations*: Serve up personalized recommendations to every shopper.
- *Einstein Commerce Insights*: Transform customer data into actionable merchandising insights.
- *Einstein Experts*: Help members find certified experts on the topics that matter most to them.
- *Einstein Trending Posts*: Intelligently display the most interesting discussions within your company.
- *Einstein Social Insights*: Gain deeper insight into your customers by analyzing social conversations.
- Einstein Segmentation: Build the best audience for every campaign.
- *Einstein Journey Insights*: Uncover the optimal sequence of events to optimize every journey.
- *Einstein Data Discover*: Automatically analyze millions of data combinations in minutes.

Salesforce Einstein is available through Salesforce clouds. Some innovative and new features powered by excellence and elegance of Salesforce Einstein comes with an additional charge. However, the basic feature exist as a part of standard Salesforce license and editions.

Security and Machine Learning

In the next 10 years, the amount of data in the world is projected to reach a mammoth 163 Zettabytes. A report from Seagate claims that, of all this data, most of it is created by enterprises of all kinds, including some critical sectors like finance, banking, and insurance. To visualize this growth of data you could imagine it is equivalent to seeing the entire Netflix catalog 489 times.

Verizon recently collected data from 65 organizations across the world and analyzed it on 42,068 incidents and 1935 breaches. The findings are surprising; it clearly indicates that phishing attacks, malware installation, and financially motivated breaches are on the rise. Ransomware saw a 50 percent increase as well.

The burning question is how organizations control all this and get rid of it. The answers lie in Big Data and machine learning analytics, because they have the capability to find anomalies in the data. These technologies can analyze huge mountains of data

automatically and provide alerts to the respective team in the organization before something bad happens. It could detect malware installation, phishing through email, or a malicious machine learning enabled systems, and then heal the system automatically.

INDIAN SOFTWARE INDUSTRY AND MACHINE LEARNING

The Indian software services industry is worth \$146 billion, which has been achieved in the last two decades, mainly by helping their global clients by managing their technology requirements. However, commoditized back-office maintenance work is not lucrative any more, and comes under strong pricing pressures. Indian IT giants like TCS, Infosys, Tech Mahindra, and Wipro Ltd are feeling this pressure and they are looking at building new platforms and services to retain their profit margin and serve their customers better. The platforms like Infosys Nia, Mana, Wipro's Holmes, and Tech Mahindra's TACTiX are machine learning based innovative products and are the by-products of this mindset. Typically, these platforms integrate machine learning with deep knowledge of an organization and their existing knowledgebase. IT companies are betting on their automation platform to bring differentiation. For instance, Wipro recently launched HOLMES, TCS make their presence by launching Ignio, and Tech Mahindra by TACTiX (they are calling it an integrated automation platform). However, the basic motive is the same—help clients automate their projects by improving efficiency and effectiveness. Fundamentally these platforms would help automate back-office work and support jobs.

Machine learning is all about finding deep insight and value for the user, if you see it from business perspective. These deep insights essentially lead organizations to the discovery of new frontier of opportunities to enhance, simplify, and mechanize complex business processes. Now, customers demand that machine learning and AI be incorporated into their service and products. Therefore, almost all the major Indian IT companies are coming up with products to cater to the demand and need for machine learning/artificial intelligence. It may be in the form of platforms, services, or products. However, the basic principle remains the same. In turn, systems use the knowledgebase to automate repetitive business and IT processes. This equips enterprises to use their human resources to solve higher-value stakeholder problems that require creativity, passion, and imagination.

The target business and customers are also different for these products. For example, Ignio is not meant to compete with Watson. It is an artificial intelligence powered product that recognizes, diagnoses, analyzes, and learns from issues in the IT infrastructure/support. In turn, it automates basic technology work. Also, this product helps TCS use their talented human resources in an effective way by assigning them valuable and intelligence/creativity intensive work and releasing them from the monotonous and repetitive work. Watson, on the other hand, was created with the value driver to help clients across multiple industries by making sense of large sets of unstructured, structured, and semi-structured data sets.

Tech Mahindra's machine learning enabled product AQT is used to drive intelligent automation use cases using technologies. The platform integrates RPA (robotic process automation), autonomics, natural language processing, machine learning, and predictive analytics. Again, the basis intent is to address the needs of customers. For example, their automation framework AQT (Automation, Quality, Time)™ consolidates all their existing automation platforms, practices, and tools. AQT is used by Tech Mahindra to holistically deliver increased business efficiencies to their stakeholders. Practically, AQT brings many benefits to the customers and helps to deliver faster and better results, because of its excellent capability of the implementation of intelligent automation and automation thinking. Also, AQT makes Mahindra's value chain efficient because it impacts their processes, quality, user experience, time to market, and cost to deliver in a positive manner.

Infosys Nia (new artificial intelligence) is an artificial intelligence and machine learning platform. It is seamlessly integrated with their previous AI platform called MANA. This increases the scope of the first-generation AI platform beyond IT universalization and optimization. It enables clients to bring AI to their core business and achieve transformation. Infosys clients used Infosys Nia to power their organizational knowledge, produce deep insights, and determine opportunities to enhance, simplify, and automate complex business processes.

Use Cases for These Products

Incident management and the way to automation: A top food supplier wanted real-time visibility into product guides, costs, and pricing information in their customer order assignment system. Also, they needed a Sarbanes-Oxley-compliant user process. With the help of Nia, Infosys provided a “zero touch” automation resolution for provisioning and de-provisioning access. It also provided a solution that would take care of automated synchronization of data across multiple enterprise systems.

Highlights of this solution:

- 24 percent decrease of incidents across all groups, leading to a 16 percent decrease in overall IT support efforts
- 70 percent improvement in turnaround time in compliance-related audit reporting and failure resolution for data requests
- 6 percent service needs and 11 percent incident solutions were automated

Level 3 automation and way to automation: Level 3 support professionals, who realize that application enrichments and issues fixes are the most important talents in an IT enterprise. However, these talents take up a substantial percentage of their time (60-80 percent) in monotonous manual activities. For example, performing root-cause analysis, impact analysis, and test plan creation and testing. This actually triggers low employee productivity, extended lead periods on doing change requests, and bug fixes.

Infosys Nia solves this problem in very innovative way by ingesting source code, historical incident tickets, and other documentation. It creates a knowledge model of the source code that maps across all available modules. Then natural language processing, text analytics, and machine learning techniques are applied to accomplish bug localization, root-cause identification, and impact analysis, and test plan generation in an automated way.

Highlights of the solution:

- Improved employee competences
- Amplified employee productivity and utilization
- Dropped regular handle period of the tickets
- Dropped mean period of resolution of tickets

Source: Uses cases inspired by the content available on the web sites of Infosys and Tech Mahindra.

Quantum Machine Learning

Quantum physics is field of study that deals with atoms and their interplay at the microscopic level. Atoms contain electrons, protons, and neutrons. Therefore, quantum machines deal with them as well. New near term quantum devices can advantageously resolve computationally inflexible problems in simulation, optimization, and machine learning.

Quantum machine learning (QML) is a subdivision of quantum information science that tries to solve entire machine learning problems with the help of quantum algorithms. These algorithms/methods and models are run on quantum computers. These algorithms may include nearest neighbor algorithms, neural networks, and Bayesian networks. A quantum computer is dependent on an atom's state. Quantum computers explore a feature of quantum machines called *superposition*, which fuels ultra-fast parallel computation and simulations.

On a silicon chip on which classical computers are based, data would be rendered in two states—0 or 1. Whereas on a quantum computer (QC), data exists in both the states simultaneously. The quantum computer's basic processing unit is called a *qubit*. It has the special quality of acquiring two states at the same time. Hence, its processing speed grows exponentially.

Quantum mechanics offers provocative predictions to improve machine learning. It offers benefits like decreased computational difficulty to enhanced generalization performance. For instance, quantum boosted algorithms for principal component analysis, quantum support vector machines, and quantum Boltzmann machines enjoy benefits of both the fields together. Development is happening at a superfast speed. Chinese scientists have already built the world's first quantum machine at the Shanghai Institute of Advanced Studies. In the near future, QCs will definitely be outperforming their classical peers. QCs can potentially solve large-scale computation problems with

ease. Therefore, due to the enormous potential of QC, Europe and the United States are collaborating on the research related to this. Companies like Google, Microsoft, and IBM are working on QC. Also, people started believing the theory that indicates the extension of natural boundaries of learning due to this.

Practical Innovations

Here are some examples of practical innovations:

- *Augmented reality Shiseido's virtual makeup glass:* It gathers a photograph of your face and lets you examine different appearances and colors. There are many other companies working on similar ideas with their own versions, such as American Apparel's color-changing app.
- *Cross-merchant location based offers:* Visa and Gap have teamed up to run a trial of a location-based marketing capability that triggers offers to frequent shoppers when cardholders swipe their card within the vicinity of a Gap.
- *In-store gamification:* Target 9 has announced a game that children can play when shopping with parents called Bullseye Playground. The game, played on a handheld device, discloses "Easter Eggs" unseen in the store.
- *Remote/machine ordering:* Amazon8 Dash is a button that a client places in the kitchen, bath, laundry or anywhere a customer stores recurrently obtained products. When running low, the client pushes the button and the item gets added to the customer's online shopping cart. The client then obtains an notification on his or her handheld device to order the product.
- Machine learning that helps forecast before epidemics happen: AIME uses Big Data and machine learning algorithms to pinpoint the geolocation of dengue fever outbreaks three months before they occur.
- *Ross Intelligence:* Created on top of IBM's Watson, it usages natural language processing to answer legal questions of the users.
- *Player XP:* Uses machine learning technologies to get productive feedback in mobile video game reviews.
- *Pefin:* A machine learning based financial consultant that analyzes more than two million data points to deliver decisions.
- *Chile-based NotCo:* Replicates the taste and texture of animal food products using machine learning technologies biochemistry and plants science. They use machine algorithms to create nutritious vegetarian meals.

Machine Learning Adoption Scorecard

There are multiple platform/tools and products available, so it is a good idea to look at the adoption strategies. From a consumer perspective, machine learning adoption strategies are very important. Because if they do not strategize their adoption and proceed in a planned way, consumers might end up paying more for less effective and efficient solutions/products. Adoption strategies are multifaceted, which means price, planning, need, are requirements must be evaluated before going for it. It is worth mentioning here that the “consumer” may be an organization/enterprise or an individual.

Now, since the cloud infrastructure is readily available, it makes sense to use cloud-based analytics and machine learning solutions. There are many reasons to do this, including reduction of cost to 100 percent availability of infrastructure and service. However, not all applications and services can be adapted to cloud-based machine learning. Every available cloud analytics service need not be adopted by every consumer. It needs to be evaluated first. The evaluation of adoption strategies is a combination of subjective and objective analysis.

Table 6-1 shows an assessment questionnaire for 10 key areas for consideration. Each area is assessed and an objective score is obtained. You can use this template for the assessment. The cumulative score gives an indication as to the suitability of cloud-based machine learning/analytics adoption. The template is self-explanatory and simple, so that a quick assessment can be done by the decision makers even with moderate knowledge of the application/product/service that is being considered for cloud adoption.

While evaluating a project for cloud adoption, users need to perform a subjective analysis to determine the proportional weight that each of these key areas possesses. However, those types of details are not covered here. Multiply the raw scores by the weight you apply to each area, in order to arrive at a total score that meets your specific needs. The cumulative score will give you an indication on the suitability for adoption.

Note that this method is not conclusive in any way, but it may act as a good starting point for machine learning based cloud adoption assessment. There are many other considerations that come into play depending on the technology, business, industry verticals, etc.

Table 6-1. Ten Key Areas for the Consideration and Evaluation Questionnaire of Cloud Adoption

SI #	Key Areas	Details	Legend for Score (Use the guidelines to calculate the score)
1	Business Area	What is your primary area of business? Technology or Service? If you are in the service business or a start-up, it may be advisable to focus your attention to service areas and embrace cloud analytics as an enabler for business.	1- Technical Service Offerings. 2 - 3 - 4 - 5 - Non-Technical Service Provider.
2	Criticality of the Application	How critical is your application/service? Before moving mission critical and business critical applications to the cloud, think twice. Also, on-premises solutions are a good option. However, due to ease of use, reduced cost, and less overhead burden if you want to move to the cloud based analytical solution start with a less critical service.	1 - Mission Critical 2 3 4 5 - Non-Business Critical
3	Frequency of Usage	How often do you use the application? How many users use the application? Less frequent applications are preferable for cloud analytical adoption.	1 - Very frequent usage with a large user base. 2 3 4 5 - Less frequent usage with a small user base.
4	Customization	Are your customization needs high? Do you need highly customized interfaces? The cloud vendor may not be able to cater to high customization needs.	1 - Very high customization needs. 2 3 4 5 - No customization needs and can operate OOB.

(continued)

Table 6-1. (continued)

SI #	Key Areas	Details	Legend for Score (Use the guidelines to calculate the score)
5	Compliance Needs	Does your application require special compliance (apart from standard cloud compliances provided by vendor, such as FISMA)? Special compliance may include compliance standards for secondary, federal, government, and governing body policies.	1 - Mandatory special compliance required from statutory bodies. 2 3 4 5 - No special compliance required.
6	Integration Requirements	Does the application need to be closely integrated with other applications in the organization? Heavy integration poses a challenge for cloud analytical adoption.	1 - Strong integration required with other org systems and processes. 2 3 4 5 - No integration needs.
7	Costing/ Expense Planning	How do you want your expense to be allocated? Do you prefer a low recurring expense over a one-time large investment? If so, cloud adoption may be the preferred option.	1 - Willingness for one time, huge investment. 2 3 4 5 - Prefer low and recurring type of expense.
8	Privacy Needs	How stringent are your privacy needs/policies of sharing/storing data outside the corporate network? Some industry verticals and lines of business may have stringent needs that prevent cloud adoption.	1 - Strong privacy needs. 2 3 4 5 - Low privacy needs.
9	Performance Service Level Agreements	How stringent are your performance SLA needs? If you have a committed strict SLA for service delivery to your customers, cloud deployment may not be able to help you. Inherent issues of Internet connectivity may provide hindrance to high performance SLA adherence.	1 - Stringent performance SLAs, extremely low downtime tolerance, very low response lags. 2 3 4 5 - Relaxed performance SLAs.

(continued)

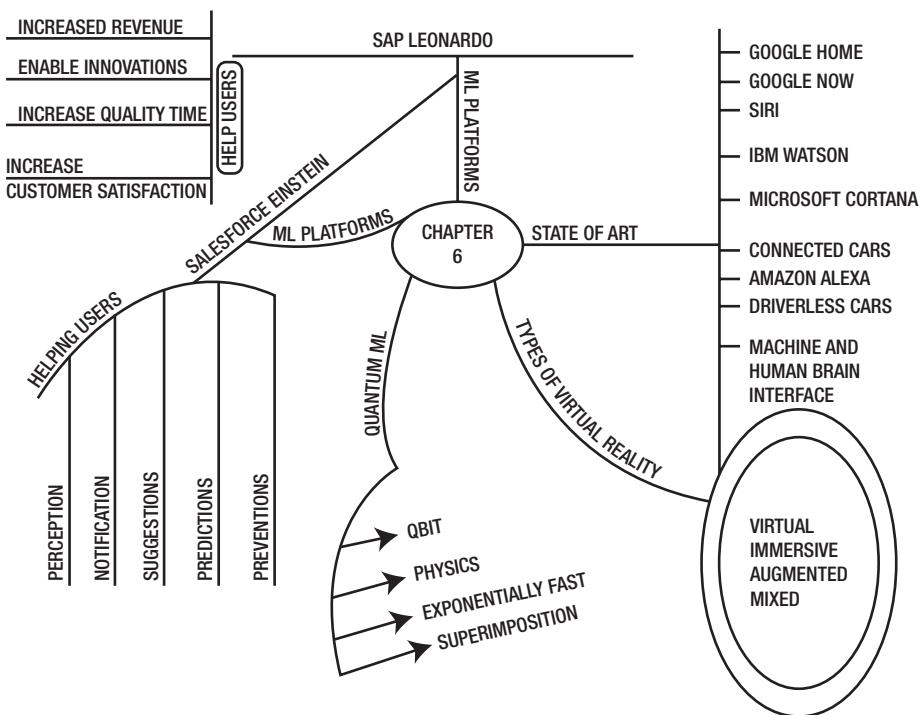
Table 6-1. (continued)

SI #	Key Areas	Details	Legend for Score (Use the guidelines to calculate the score)
10	Infrastructure Requirement and Availability	Is your infrastructure requirement high? Do you already have underutilized infrastructure available? If yes, you can use the same for deploying your application/software instead of adopting the cloud.	1 - Large infrastructure is required and underutilized infrastructure is available. 2 - 3 - Existing infrastructure can be streamlined to be made available. 4 5 - Large infrastructure is required, but none available and needs to be procured.
Total Score for Adoption			> 40 - Suitable 20-40 - Moderate < 20 - Not Suitable

Summary

This chapter covered lots of important information about the machine learning products, services, and applications that are offered and popular in the market. The chapter contained a detailed discussion on some established products, and was centered around machine learning, such as Siri, IBM Watson, Microsoft Cortana, and connected and driverless cars. It also presented a primer about some of the existing startups that are popularizing new ideas. The chapter concluded by looking at quantum machine learning, which is the ultimate direction of the technology in next 10 years.

Mind Map



CHAPTER 7



Innovation, KPIs, Best Practices, and More for Machine Learning

This chapter provides insight by highlighting how the traditional business model is changing and a new model is taking its place in the mainstream industries and markets. It also provides a brief overview about how “traditional IT vendors” are adopting a new mindset and betting on the thought partnership way of working instead of the order and deliver model. The ranges from setting the context of the transformational state of the current IT vendor to their adoption strategies to new and evolving technologies like microservices and blockchain.

The chapter provides a view on how the process of thought partnership plays its role in the overall changing scenario. It also covers risk, compliances, best practices, and KPI in the context of the machine learning ecosystem and provides some insight about how the technologies would potentially transform the future state of the industry, the domains, and ultimately the world. Guidelines for identifying some KPIs across the domains and technologies are provided in the chapter.

The chapter also highlights the process of innovation and the importance of building culture around it. This discussion is very relevant because ultimately it is innovation that fuels a simple, average-performing organization to the best performing organization. Especially in the last couple of decades, it is innovation that powered organizations to excel. For example, Google’s driverless car, Amazon’s cloud services, and Tesla’s mission to create reusable rockets established them in the market of the future.

IT, Machine Learning, Vendors, Clients, and Changing Times

Information Technology (IT) forms a major part of the core strategic investments for all the growth-oriented institutions in this ultra-modern era of accelerated growth and dynamic decision making. Therefore, companies are increasingly banking on innovation, technology, and agility for their fast-tracked growth and success. Organizations with

double-digit growth typically bet on their unique offerings, higher productivity, or niche area of expertise and often keep pure innovation on the back seat until the competition catches up with them and forces them to dedicate a good percentage of their revenue toward innovation.

Organizations utilize this time to clean up the ample amount of cash surplus or achieve a desired level of size to grab the attention of their prospective and current customers. Organizations that have crossed all these hurdles and established themselves in aggressive completion have a tougher path to sustained growth. Hence, they look forward to doing something new and put innovation on driving seat. They are investing heavily on innovative technologies like machine learning, Big Data, IoT and bringing novelty in product/service offerings, business processes, and customer management.

The same trend is seen in major and minor processes that are well established having led to the organization's success until it's time to cope with the changing times. The concept is simple. Any delay or failure in innovation will lead to hasty death of the organization. The cut throat competition with ever increasing alternatives to the end customer and user force the organization to innovate.

Innovation and automation become the growth enabler for these organizations and there are multiple reasons for this. These parameters become growth enablers because innovative technologies like machine learning and Big Data need new mindsets for the traditional technologies (mainframes). Moreover, these are liked to profitability, growth, and productivity. Innovation is no more a luxury than a necessity. However, innovation involves cost and time to established itself in an organization. Therefore, commitment from the top management regarding its implementation and building culture around it are very important. Some important line items are mentioned here:

- Ensure all innovative ideas have an equal opportunity—being neutral to the source.
- Establish a mature culture and an ability to encourage, monitor, and develop ideas. It comes by potential of tapping innovation from multiple sources.
- Develop the ability to spot, assess, mentor, and incubate ideas with business value. Implement the proper process for it.
- Develop a framework and team that can take early investment decisions on new ideas.
- Involve employees/partners in an engaged exercise. Organizations have to encourage them to tap their ideation potential.
- Form a robust and sustainable platform for employees/partners to receive rewards/recognition for their ideas.

In the wake of such intense competition, organizations look for avenues to innovate in every possible opportunity. They ask and desire their employees, management, vendors, business partners, channel partners, and other stakeholders to help them to innovate. They willingly take help or support stakeholders to do innovation in their respective areas. Since IT and innovative technologies are the growth accelerators, organizations have highest priority assigned to innovation in IT. Routine delivery excellence, cost reduction, productivity benefits and the “take orders and deliver” approach are now expected by any IT vendor by default. Any company proposing value addition only through these so-called default benefits will be referred to as an IT vendor, whereas organizations (especially large ones) are looking for IT vendors who can showcase benefits that are superior in scope, wider in thinking, and bolder in approach, with clear articulation of business value in measurable terms.

These organizations are referred to as IT partners and these are the ones who will fetch higher remunerations, larger projects, and greater respect from the market. IT companies have to continuously revisit their approach toward partnering with clients and bringing in superior thought processes to cater to the knowledge and innovation needs of the market. These companies have to transform themselves into “thought partners”.

The result of this comes as the co-creation of the products and services. Co-creation is not strictly about clients (in subjective terms) and vendors own something, but it is about continuous collaboration where the client and partner work together to create excellence in terms of services and products. For instance, generally vendors have good a setup for R&D and testing centers of new generation technologies. Also, they run center of excellence and thought leadership initiatives, whereas clients are domain-centric. Therefore, clients can take these “services or expertise” and create outstanding services and products in close collaboration with vendors. This strategy enables vendors and partners/clients/stakeholders to test APS in real time and provide instant feedback to vendors. Continuous collaboration is the backbone of this idea. Also, the same strategies could be used as a feedback mechanism and continue until the finished APS (application, product, and service) is delivered appropriately to the stakeholders.

Organizations will have a wide range of enhancements, upgrades, implementations, and other strategically important initiatives going on in parallel, apart from regular technical tasks. Taking all these parallel activities to a successful closure with clear ROI measurement will require a huge amount of skilled resources and management time. In most cases traditionally, these initiatives are broken into smaller chunks of work and handed over to multiple vendors, leading to unwarranted coordination issues, non-compliance issues, and cost and time escalations. Although there are advantages of this typical model in terms of reduced dependency on a single vendor, availability of multiple sets of skilled labor and risk distribution, a larger partner can singlehandedly provide all these advantages using their expertise and prowess.

Clients have to choose their partners very carefully by examining their abilities to offer a platter with the perfect mix of high-end IT/business consulting and a wide range of rudimentary IT services. This is a huge upgrade for emerging IT services companies because they have a steep challenge of offering high-end consulting services along with their regular services, which they have to acquire in order to cling onto their client’s value chain as partners. This model is different for the existing model that has existed for years. However, it is the need of the hour because to get excellence, clients want that brilliance to be incorporated in the DNA of their work culture.

This desire to achieve superiority and acquire excellence brings the need for automation, automation of automation, and smart and intelligent applications that assist the organization in managing their tasks with fewer human resources. It helps them implement efficiency and effectiveness with reduced cost, increased profitability, and increased ROI. Machine learning and its associated technologies fit appropriately in this ask and desire. Moreover, if the solution around the machine learning ecosystem is created and implemented then there is no need to overdistribute the work. Some routine and repetitive tasks can easily be performed by the machine learning enabled smart solutions. However, for highly technical requirements there is still a need for an intelligent workforce and robust infrastructure readiness, as well as other factors for which vendors may be one option.

Building a machine learning solution focuses on a technical, process, people, and governance based approach. Therefore, appropriate cautions need to be taken on time. It requires a proper evaluation of existing process, metrics, design considerations, and measurements. Also, before, during and after implementation of the machine learning solution some standard guideline needs to be followed. Otherwise, the overall effort will be in vain.

These guidelines include risk management, making sure of funding, compliance alignment, and lots of other factors. Here are some of the prerequisites of machine learning solutions and strategies:

- Design the machine learning implementation process (from the idea generation stage to the rapid prototyping stage)
- Design the machine learning project and organization governance structure, which includes roles and responsibilities of the people involved
- Bring together the design enablers
- Support in implementing the machine learning solution and continued program management
- Enable the incubation of ideas with a rapid prototyping factory

Designing Key Performance Indicators (KPIs) for Machine Learning Analytics Based Domains

KPIs are measurable and computable metrics generally matched to enterprise goals and objectives. There are the various key process points that influence the overall performance of an organization and the projects. Performance measures would help in ensuring that what the process delivers would be aligned to a set of business objectives and meets the stakeholder's expectations. Therefore, the KPIs should be designed to measure individual contributor, project, and department level activities. They must be aligned to each other. The KPIs should be identified and defined with respect to business drivers and benchmarks. These KPIs should be continuously monitored to track the service performance.

Eventually, these performance parameters can be aggregated to business performance parameters. While defining KPIs the five Ws: Who, What, When, Where, and Why (and How) would serve as a guide to get and achieve efficiency. Designing KPIs for measuring machine learning based projects/individual contribution/organizational capabilities or unit performance to measure it is always a big challenge. However, the following guidelines help. It is always good to start by answering these questions:

- Who is the user?
- What is the business going to deliver?
- When do the stakeholders need the solution?
- Where and for which purpose do stakeholders need it?
- Why do the stakeholders need this?
- How can the business optimize the process and technology?

A performance measurement mechanism plays an important role in helping an organization measure the performance and formulate a future strategy. It is also helpful in keeping track of current performance status. Also, performance measurement becomes critical in projects like Big Data and machine learning due to the magnitude of factors like heavy investment requirements, time to market, and customer experience. Periodic performance measurement of business and operations is a key task that must be carried out. It is critical for simple reasons.

For example, unless performance monitoring and measurement is done, it is impossible to introduce improvement or control measures. There are several statistical techniques and methods used by enterprises to measure performance against the set KPIs from time to time. The main objective behind measuring the performance is to:

- Understand how well the business, projects, and operations are performing against the set parameters
- Combine data points in one place to see the bigger picture
- Set targets for improving performance on an ongoing basis
- Do proactive planning and forecasting to stay ahead of competitors

The process of defining key KPIs and performance measurement also helps enterprises and decision makers prepare charters and formulate strategies for expansion and future growth. Mandatory criteria for the success of any KPI or performance management system is that it must be realistic. It should not be theoretical in nature because, if it happens that way, it is impossible to measure and report metrics and KPIs that are not related to a given process/operation. Here are the few points related to KPIs and the metrics measurement framework that should take into consideration for effective execution of KPIs:

- Any contractual obligations that may have been agreed with the customers and vendors
- Measures important from a people, process, and technology standpoint
- Measures that top management will want to see, for example, revenue growth, year on year profitability, etc.

Designing Effective KPIs Using a Balanced Scorecard

There are multiple ways by which KPIs and metrics are defined. One effective way of doing this is using the balance scorecard method. The balanced scorecard principles are helpful and effective when defining KPIs and an overall performance management system. In a nutshell, balanced scorecard (BSC) is a strategic development, planning, forecasting, and management scheme that enterprises and organizations are using to:

- Communicate what they are trying to achieve
- Align the day-to-day routine and regular work that everybody is undertaking with a strategy
- Prioritize and order projects, products, and services
- Measure and monitor growth and improvements toward strategic goals

The balanced scorecard technique is not only about measuring performance against the pre-decided KPIs, but it also helps organizations develop or revise its strategies efficiently. Here are the basic steps in KPI definition that need to be followed:

- *Start with stakeholders including customers:* Prioritize the customer expectations critical to quality.
- *Top-down view:* Start from service and decompose it further to the lowest levels involved. This provides a comprehensive view.
- *Establish key, consistent metrics:* This provides insight into which metrics are required on the dashboard.
- *Determine a baseline:* Identifying current status is required because it provides insight into the key indicators in current processes.
- *Benchmark processes:* Determine who is doing the same or similar things better.
- *Set goals:* Define the new parameter to be achieved.

Some of the key attributes that should be kept in mind while defining KPIs and metrics for any process are:

- *Relevance and validity:* Selecting relevant KPIs for a given process is one of the key aspects. Unless relevant KPIs have been identified, the purpose of performance reporting will not be served.
- *Controllability:* The KPI definition should be done in such a manner that they can be measured and controlled. It is important because the overall effectiveness of a process and its operations is largely dependent on this.

- *Completeness:* KPIs should be quantitative to the extent possible. Performance metrics should be complete in nature because it will be difficult to measure performance unless the key KPIs have been agreed on by all concerned parties. This completeness will ultimately leads to higher accuracy and yields the desired results.
- *Logic/consistency:* KPI and metric definition should be done using mathematical formulae. There should a logic that helps in the measurement and the overall performance validation process.

Preparation

The following broad points should also be taken care of before the KPI and metric definition exercise commences:

- How the KPIs will create value for the current and future customers/business.
- Whether the KPIs will help in measuring performance of operational processes and IT systems and help in deriving the conclusions for business performance.
- There should be deep dive sessions to develop, discuss, and formulate the strategy for developing the performance management system, including KPI and metrics definition.
- Communication is a very important aspect that plays a pivotal role during this exercise. The defined and agreed strategy should be socialized with the concerned parties so that all the parties are on the same page.
- While formulating the KPIs, it is also key to take into account role of any third parties, or other internal teams who may be directly or indirectly involved in delivering a part of the service.
- Even before the KPIs are introduced, it is important to distribute them to all the concerned parties. Improving the business is everyone's prerogative as well as responsibility.

Measurement Categories

Here are some important categories of measurements in context of the balance scorecard method:

- Financial
 - Sales and Service
 - Cost of Service
 - Return on Net Assets
 - Operating Margins

- Ratio of Margin to Revenue—Service offering profitability
- Ratio of Operating Expenses to Capital Expenditures
- Ratio of Operating Expenses to Revenue
- Customer Experience
 - Customer Satisfaction
 - Product Quality
 - Usability
 - Accuracy
 - Availability
 - Security
 - Service Quality
 - Timeliness
 - Preferred Access: The channels and touch points available to customers such as real people, the web, and the storefront
 - Pricing Flexibility
- Internal Business Operations
 - Process Re-Engineering
 - Unit Cost
 - Time
 - Defects
 - Capacity vs. demand
 - Simplicity
 - Process Flexibility and Automation
 - Resource Utilization
- Learning and Growth
 - Retention
 - Workforce Diversity
 - Training Hours
 - Expenditures
 - Performance Reviews
 - Employee Satisfaction

Benefits of KPIs

Here are some benefits of KPIs:

- *Continuous improvement:* Through an efficient performance management system, efficient tracking of process, people, and technology becomes a reality. Also, the customer experience and end user's perception about rendered services can be tracked very closely.
- *Business planning and budget/revenue forecasting:* Performance measurement enables organizations to introspectively look at their performance on a periodic basis and make meaningful conclusions in terms of a revision in the budget and revenue forecasts from time to time. This can also be used by demand and planning teams for future business planning.
- *Competitive edge:* It becomes easy to compare the performance with rivals in the market and continuously upgrade in order to stay ahead of the competition.
- *People management:* Employees play an important role in success and growth of an organization. In current times, it has become a practice to link bonuses and performance pay-outs with employee performance KPIs. This also motivates employees to perform to the best of their abilities and constantly raise the bar to give the best possible output.
- *Regulatory and standards compliance:* Many customers want the vendor to comply with certain industry standards. A performance management system that's aligned to industry standards and best practices will help comply with regulatory standards.

KPIs help judge, measure, and improve the performance criteria of an organization and they flow down to all the departments. Machine learning and Big Data could be technically domain agnostic. It is applicable in all the domains, either it retail, manufacturing, fashion or any other field of interest. We discussed this in detail. However, it is good to look at an example that shows practically how this works. The following section describes a case of selling KPIs in the retail industry.

Some Important KPIs from Specific Organization and Industry Perspectives

KPIs can be designed to measure almost anything. This discussion is mainly based on machine learning. This section includes some important KPIs that provide measurable benefits to an organization that can be used to generate revenue. Other KPIs measure important aspects of global phenomena related to the machine learning industry perspective. This helps companies evaluate the relevance and impact of machine learning across their sectors.

Organization/Enterprise Specific Machine Learning KPIs

- Percentage of projects in a specific organization using machine learning technologies.
- Percentage of specific machine learning specific technology used in an organization. For example, how many projects across the organizations are using Mahout or MS AzureML.
- How many products, services, and applications in the organization are built using machine learning and how many of them are new. Also, how many are enhancement projects.
- What is the ratio of success of the machine learning projects in the organization.
- What is the percentage of machine learning based project staff efficiency versus non-machine learning based project staff efficacy and effectiveness.

Industry-Specific KPIs

- Percentage of firms using machine learning and associated technologies in the fields of retail, hospitality, healthcare, education, and so on
- Percentage of organizations using machine learning in customer services, sales and marketing, finance, banking, and insurance and operations
- Percentage of firms using the cloud, Big Data analytics, cognitive computing, and machine learning

STOCK AND CUSTOMER ANALYTICS KPIS

Objectives: Reduce costs, eliminate the unnecessary expense of stock-outs and overstocks, understand important customers to target, encourage loyalty, and make powerful, rapid decisions.

Retailers face huge challenges to keep track of goods in real time and synchronize them with in-stock locations by supplying the goods optimally. Being in constant touch with all stakeholders, logistics, and connectivity is the key to responding to consumer demand quickly. Keeping track of seasonal trends and fashion styles ensures that customers get the right products at the right time. Stock analysis will improve inventory related decisions. Machine learning based analytics can enable quick shipments by evaluating top-selling products in real time. Predictive analytics can help in making quick decisions by analyzing data for seasonal sell-through, canceling shipments for bottom-selling products, and communicating more effectively with vendors.

A list of stock analytics:

- Department Contribution
- Hot Item Report
- In Stock Percent
- Inventory Turns
- Lineal Feet
- Mark Down Percent
- Pull-Through
- Reallocations
- Seasonal Buying
- Sell-Through
- Weeks of Supply

Customer analytics:

- Behavior profiling
 - Preference Modeling
 - Affinity Tracking
 - Attachment Rates
 - Basket-Register Correlation
 - Brand Switching
 - Customer Loyalty
 - Demographic Baskets
 - In-Basket Price
 - Items per Basket
 - Revenue Contribution
-

Differences Between KPIs and Metrics

It's vital to differentiate between KPIs and metrics. KPIs can be thought of as metrics that collectively provide a report card. Metrics are simply a summary of an activity. A healthcare analogy makes it clearer, whereby KPIs provide the details of the overall health of a person, whereas metrics include measuring temperature or shortness of breath of a patient. KPIs are like hidden variables in programming languages, which store value in the background.

Risk, Compliances, and Machine Learning

History is full of the instances where organizations fail due to frauds and non-compliance. This is a global phenomenon. For instance, Enron in the United States, Satyam in India, and South Korean President Park's frauds. Fraud can be done at any level and by anyone. It may happen in the form of misleading accounting practices or submitting wrong proof of investments by an employee in the organization to some big army weapon deal of government officials.

Ultimately, all these wrong practices take away shareholder's wealth. This also leads to adulteration of manpower and potentially ruins careers. These incidents trigger modifications to the current regulatory policies and lead to the introduction of new acts, such as the Sarbanes-Oxley Act, to put more control in place. A report from the Association of Certified Fraud Examiners (ACFE) projected that up to 5 percent of an enterprise's profits vanish due to fraud.

Regardless of tighter regulations over the past few years, money laundering and financial scandals occur on a continuous basis. A projection from the Financial Action Task Force said that over one trillion dollars is laundered yearly. In recent times, financial services industries fell under increased examination. Therefore, banks were instructed to implement full measures to avoid financial corruptions. Watchdogs progressively need bigger oversight from institutions, including closer monitoring for anti-money laundering initiatives and implementations. Most of such fraudulent actions go undetected. Detection of fraud has become more challenging in the current world because the amount of data that machines generate is enormous. With the changing times in the era of technology, fraudsters are always one step ahead. Therefore, connecting the dots using an old-style technique will be useless.

Older technologies for detecting money laundering use business rules, neural networks, or statistical approaches. Pattern-recognition techniques are also used to detect fraudulent behaviors. To generate meaningful insight, these technologies require a massive amount of historical data. As the nature of fraud could be classified in the broader categories, large repositories of confirmed fraudulent behavior are available and are used to train these supervised technologies (the label/output is known). However, with money laundering there is no labeled data to learn from. Also, apart from the lack of historical data, each money laundering case is exclusive. Rule-based systems apply the same logic to every entity because they do not have the ability to learn in the real time. Therefore, depending on the older approaches of detection, money laundering results in low positive rates of success. Also, deploying legacy models often requires costly hardware and databases. Even on top of that, the resulting solutions are unable to provide real-time performance.

New generation anomaly detection techniques—enabled by Big Data analytics, IoT, and machine learning—are changing the way risk, audit, and compliance functions work. These technologies are becoming very useful in the areas such as intellectual property theft, workforce compliance, fraudulent employee claims, accounts payable, and insurance claims processing. The implementation of machine learning based systems provides substantial improvements in proficiency and the capability to recognize high-risk and distrustful transactions quicker than before. Also, it enables employees and staff such as the back-office and audit teams to focus on other important tasks. They can be more productive in coming up with ideas that ultimately help in investigation and unraveling new fraudulent schemes.

Historical data related to money laundering is not available readily and is generally rare and unreliable. Therefore, it is crucial to use unsupervised machine learning techniques to extract insight from the data without any previous knowledge of what to look for. Technically, unsupervised learning uses progressive clustering, connection analysis, associative learning, and other techniques to enable customers to track transaction unpredictability, entity interactions, and behavioral changes.

However, to use unsupervised learning to its fullest for detecting money laundering, gathering and integrating data from multitude sources is crucial. Only then will data be consumed by the system correctly. Once this is implemented optimally, then tracking individuals and the money/assets laundered becomes easy. Some essential data elements to monitor are:

- Inflow and outflow
- Links between entities and accounts
- Account activity, such as speed, volume, and anonymity
- Reactivation of inactive accounts
- Deposit mix
- Transactional activities in alarm areas
- Use of multiple accounts and account types

Detecting money laundering activities is a complex task, so it's important to apply a technology that potentially tracks the actions of each individual or person or groups involved and links them to each other. With the help of machine learning, virtual reality, and artificial intelligence technology, it is easy to analyze the behavior of each specific entity (card holder, merchant, account, computer, etc.) and their activities over time and generate a compressive view of anyone who might attempt money landing.

Organizations execute the machine learning based project. They take care of a lot of activities. Broadly, those activities are seen as on the organizational and project level. From a typical mid-level manager project, specific activities are very important. From the organizational perspective, as well for the flawless execution of projects, timely identification of risks is mandatory. The ultimate organization vision is to get a sense of realization through the projects.

One major concern for technology managers and teams is to execute the projects with minimum or no risk. This is not easy due to the complexity of the risk portfolios and multi-dimensional nature of them. Hence, proper identification, analysis, planning, assessment, and responses are key to minimizing risk.

Risk and Risk Management Processes for Machine Learning Projects

Risks are here to stay. Therefore, attaching the appropriate mitigation plan to the identified risks is important to execute risk-free projects. Identifying risk early and keeping track of it throughout a project's lifecycle is important. Identifying, analyzing, and implementing risk is always a challenge. Machine learning can potentially automate this

overall process within an organization. It starts happening in pockets. However, manual risk management has its own importance (at least as of now). Therefore, the following section provides a brief of it. Figure 7-1 shows the overall risk-management process.

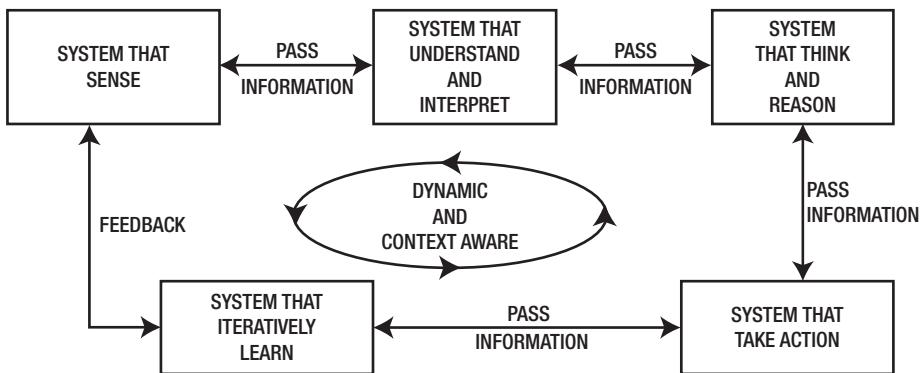


Figure 7-1. Risk management process

Risk Identification

Risks can be of multiple types and it can be identified by any member of the team or any person in the organization. Having risk-free environments/projects/organizations is everyone's responsibility. However, this chapter confines its discussion to project risk (see Table 7-1).

Table 7-1. Types of Risk

Project				
Product	People	Process	Management	Financial
Integration	Training	Quality	Customer/vendor/partner relationship	Compliance
Scalability	Availability	Manageability	Cooperation	Confidential
Usability	Training	Quality	Schedule and cost	Legal
Performance	Adoption	Traceability	Financial	Schedule and cost
Security	Technical knowledge	Measurability	Management process	Value realization

If risk is identified by a team member, then before documenting the risk, the team member should communicate this issue with their lead to ensure that the situation fits the definition of a project risk. If the risk is validated, an owner should be assigned to the risk. The owner is usually a person who is interested in the resolution of the risk or will be primarily impacted if the risk materializes. After that, risk assessment takes place.

Risk Assessment

An assessment of the overall threat must be done based on the probability of the threat occurring and the severity of the impact (if it should occur). This is estimated during this phase by using this formula:

$$\text{Risk Exposure (RE)} = \text{Probability} \times \text{Impact}$$

Once this assessment is complete, a risk response plan is developed.

Risk Response Plan

This is a plan, or course of action, to be implemented prior to risk occurrence. This eliminates or reduces the probability of the risk occurring or reduces the impact (if the risk should occur). You must determine the strategy to mitigate the risk and develop a clearly defined set of steps. Here are the main activities:

- Identifying potential risk responses
- Selecting the risk response
- Adding the risk responses to a risk log
- Assigning ownership
- Assigning due dates

Monitoring and Controlling Risks

Monitoring and controlling risk are done in this phase. Consider these tasks to monitor and control risk:

- Monitoring residual risks. These are risks that remain after implementation of mitigation plans.
- Ensuring the execution of risk plans.
- Evaluating effectiveness of risk responses.
- Re-evaluating the risks.
- Holding status meetings.

Best Practices for Machine Learning

Best practices are very important in the context of machine learning. Machine learning is a very specialized field. Therefore, it needs technical expertise, process excellence, and proper and timely application of the appropriate methodologies and framework. Hence, the best practices become critical and take central stage. Here are some important best practices:

- Identify your need and understand the business requirements.
- Be specific about your requirements and tune them with your needs.
- Keep your development approach simple.
- Identify a reliable source of data. Gather desired the data and make that noise free.
- Normalize data before using algorithms.
- Identify the appropriate language, framework, and libraries as per your needs.
- Define strategies to train models, including hardware infrastructure and licensing.
- Define execution strategies like implementation of parallelism and iterations.
- Test infrastructure and software independently and then in combination. This enables holistic testing.
- Design and create an appropriate model. Also, do not forget to ensemble such models.
- Start with an independent model to help in testing.
- Train multiple single-threaded models in parallel.
- Make your code portable and try to be environment independent. Using a cloud environment is the best way to achieve this.
- Iterate your model to purify and make it accurate based on the changes to the underlying data.
- Measure the outlet between the models.
- Business problems change over time, so keep the model in tune with the requirements. Monitor models for decreasing accuracy.
- Keep track of predictions and forecasts.

Evolving Technologies and Machine Learning

There are many changes happening in the field of machine learning with rapid speed. Therefore, it is natural that multiple supporting technologies would evolve around it to make it better and more efficient. However, machine learning alone is not the driving factor for these technologies to come into the mainstream. The cloud, Big Data, IoT, and cognitive computing are also the driving factors. It is always good to be in synchronization of the latest technological advancements. Consider these upcoming technologies:

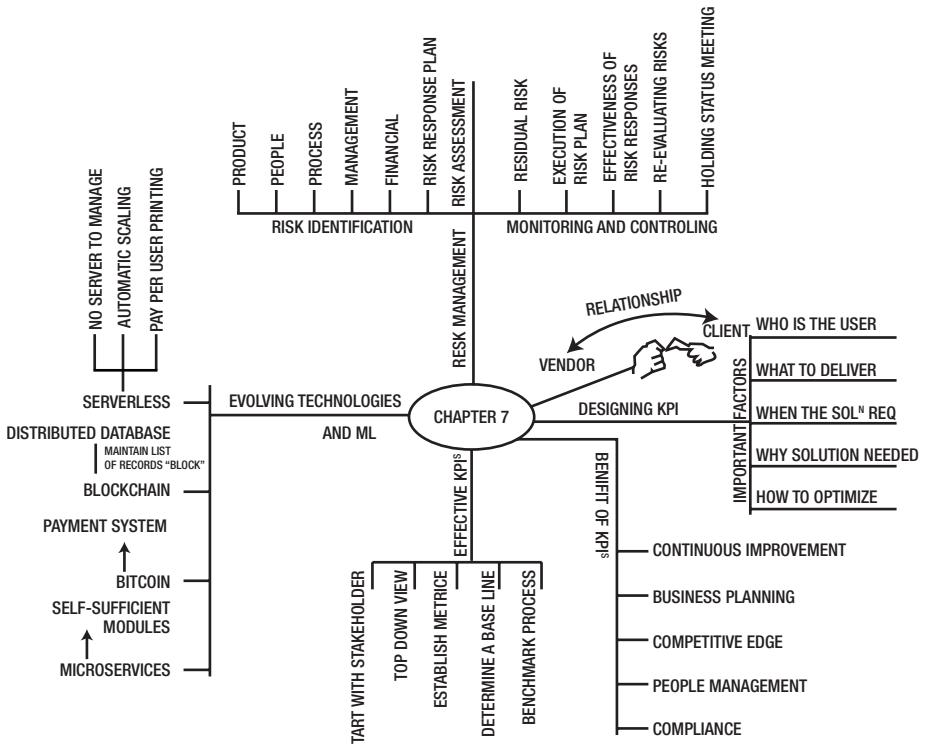
- **Serverless:** According to the serverless computing concept, you can develop, build, and run applications and services without the headache of infrastructure management. In the serverless environment (cloud infrastructure) applications can still run on servers, but all the server management is done by the vendors or cloud service providers. Amazon is a pioneer of serverless architecture. Amazon Web Service (AWS) implements serverless computing through AWS Lambda. AWS Lambda runs the users code without provisioning or managing servers. Lambda provides with you facility to virtually run any type of application or backend service and it takes care of everything required to run and scale (up and down) your code with high availability. The advantages of going serverless are many:
 - *No servers to manage:* No infrastructure management headache for the users, and they can just concentrate on functionality. It one of the reasons that the serverless paradigm is also known as function as a service.
 - *Automatic scaling:* Depending on the requirements of the application, application scaling would happen by getting an application trigger (for example, an event).
 - *Pay per user pricing:* If you use the services for 10 seconds, you pay for 10 seconds.
- **Blockchain:** The blockchain is a distributed database that maintains a continuously growing list of ordered records called blocks. Each block contains a timestamp and a link to a previous block. By design, blockchains are inherently resistant to modification of the data. Once it's recorded, the data in a block cannot be altered retroactively. By the use of a peer-to-peer network and a distributed timestamping server, a blockchain database accomplishes autonomously. Blockchains by concept can be defined as "an open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way". The ledger itself can also be programmed to trigger transactions automatically.

- ***Bitcoin:*** Digital money and payment system. Roughly, it is open source software. This means that no individual, enterprise, or nation maintains this network similarly as no one preserves the Internet. This is peer-to-peer system where individuals can execute transactions directly without an in-between system or person like a bank, a credit card organization, or a clearinghouse. Transactions in bitcoins are tested by a net of nodes and logged in a public distributed ledger, known as a blockchain. It is also known as the currency of the blockchain.
- ***Microservices:*** Tier-based architecture tells you to divide your code into multiple tiers so that you have clear segregation of code. Hence its execution and management is easy. For example, in three-tier architecture you divide your core in to three tiers—presentation, business logic, and data—and achieve cleanliness and separation. Even after dividing your code into different tiers, the tiers are still dependent on each other for passing, processing, consolidating, and presenting holistic information. Microservices provide a mechanism to cater to this problem, as you divide your application on the basis of functionality and develop and deploy the tiers in one self-sufficient module, so that they work independently. If the project has customer, invoice, CRM, SCM, and user interface modules, you must break each service into an independently deployable module. Each module must contain its own maintenance, monitoring, application servers, and database. Therefore, with microservices, there is no concept of a centralized database, as each module is self-sufficient and contains its own database.

Summary

This chapter discussed the technical relationship between vendors, clients, and organizations. It also highlighted the importance of innovation in context of machine learning, IoT, and cognitive computing. After a brief discussion on KPIs, risk and compliance was discussed. Finally, the chapter included an overview of the best practices related to machine learning and read some insights into the evolving technologies around machine learning, including serverless architectures, blockchains, and microservices.

Mind Map



CHAPTER 8



Do Not Forget Me: The Human Side of Machine Learning

This chapter is the master of all the chapters but it does not discuss machine learning or related issues. How does a chapter in a book of machine learning that does not discuss the technology become the master of all the chapters? The plain and simple answer is that this chapter considers the people who realize machine learning on the ground level. This chapter considers the people who make strategies about machine learning implementation and its future in the organization. This chapter is important because it covers how to manage machine learning projects and train the human resources who are involved in the overall process.

In a nutshell, the chapter discusses the following issues:

- Why is social and emotional intelligence important for machine learning teams?
- What are basic qualities team members should have to better plan and execute projects?
- What are the lean project management principles? Why they are required in machine learning projects?
- How will innovative technologies like gamification enhance the productivity of the team and why are they required?
- How do you achieve optimal performance and commitment from the team members in a machine learning project?
- What are the techniques for thought and innovative leadership and why are they required in machine learning projects?

Economy, Workplace, Knowledge, You, and Technology

The workforce is comprised of humans and their complex social, moral, emotional, behavioral, and psychological interactions. High technical skills do not automatically generate high performance unless the team's members are committed, motivated, and enjoy their work. It is also important that they handle stress and conflicts and communicate and collaborate in the workplace.

Alignment of employee values, skills, competencies, and goals with the organization, clients/vendors, and the philosophy of technical methodologies is needed to achieve excellence. In fact, many academic and professional viewpoints have recognized the significant contribution of being aware of and managing emotions (emotional intelligence, EI) in the workplace. The ability to navigate and facilitate social relationships (social intelligence, SI), and the ability to apply universal principles to one's values and actions (moral intelligence, MI) generally lead to success in the workplace. That way, organizational efficiency and effectiveness can be achieved. In highly technical teams, implementing these innovative motivational methodologies has become very important.

In the current knowledge-based economy, many have noted the shift of corporate market value creation toward intangible assets. As early as 1995, the IT, medical care, communications, and education industries, whose primary value-adds are from intellectual and information processes, counted for 79 percent of all U.S. jobs and 76 percent of all U.S. GNP (Quinn, Anderson, & Finkelstein, 1996).

There is an enormous potential to expand intellectual assets. By using employee potential the right way, and by using employee capability and their minds to the fullest, you can maximize employee potential. Knowledge, critical reasoning, emotional, moral, and social competencies, as well as spirituality are all involved in the creative and technical process. Most companies know the technical skills and knowledge they require in their employees, but are unclear as to the emotional, social, moral, and spiritual intelligence required.

Numerous results have established that these measures are more important than IQ. Daniel Goleman and Danah Zohar, in their landmark books (*Emotional Intelligence: Why It Matters More Than IQ* and *SQ: The Root of All Intelligence*), explained in detail the importance of these competences and skills in the workplace. With the changing times, companies started realizing that honing emotional, social, moral, and spiritual dimensions of a resource/talent is important for optimal performance.

Machine learning and its associated technologies are highly technical, so they need creativity and an innovative approach. Therefore, a knowledge worker who can use his intellectual as well as psychological capability together has a better chance at success than one who only has very good mathematical skills. For instance, a data scientist who is excellent at problem solving but not good in articulating, presenting, and creatively linking the analysis to the bigger picture is probably not a good pick for an organization. Therefore, organizations and in turn projects need many people who are good at mathematics, logic, and problem solving, and at the same time, they must possess good communication and social skills.

Likewise, a bank deals with account holders whose financial data is available in their databases. In this typical case, misuses of this data are possible because ultimately a small

set of employees have access to it. Hence, moral values and ethics comes into the picture. Technologies and processes are here to help, but only to an extent. Finally, the manager who is dealing with this is the most important. If the employees are morally strong, all this is taken care automatically.

Spiritual intelligence is basically about understanding one's core potential and desires. It is about finding one's true sense, value, and meaning of life. It forces one to ask fundamental questions like, "why" am I doing this. What is the purpose of it? Am I the right fit for this? The answers to these questions are very important, especially in specialized fields like machine learning. If someone is not fit for a particular role and does not want to do the job, it will hamper everyone. The negativity spreads in all directions, starting from the individual to the team to the organization. The end result of this can be disastrous, including project failure.

Half-hearted efforts lead to inefficient and ineffective work. In turn, bad quality deliverables are delivered to the customers, which affects the organizations branding and capabilities of revenue generation and profitability. Also, in the upcoming era of machine learning, where the tasks and activities are being automated quickly and machine learning enabled APS are becoming main stream, these skills help the employees and the organization. These tasks can be automated, but automating emotional and social skills is definitely not easy, if not impossible.

The latest research (McKinsey & Company: MGI-A-future-that-works_Full-report.pdf) showed that people with excellent interpersonal skills, social intelligence, and vocational interests may be less likely to be affected by the automation of jobs and hence are less likely to lose their jobs. These are unique human skills that lead to flexibility and commitment.

In conclusion, the organization that's betting on highly technical projects needs to be careful in selecting their people resources. They have to select highly self-motivated people with a mix of technical and psychological qualities. This is possible only if they consider people with qualities like EQ, SQ, and MQ, all apart from IQ. The good news is that these qualities can be taught. They are not "fixed" like IQ. They can be learned with the help of appropriate training and a positive environment.

JARGON BUSTER

- *Emotional Intelligence (EI) and Quotient:* The capability to find, practice, appreciate, and accomplish one's own emotions in constructive ways to release stress, communicate effectively, empathize with others, overcome challenges, and resolve conflicts. This skill also enables one to identify and appreciate what others are feeling emotionally. This is mostly a nonverbal process that affects thinking and influences how well one connects with others. Emotional quotient (EQ) is a way of measuring one's EI in any form. Measurement may happen in multiple ways. One way of doing it is to circulate a questionnaire.

- *Moral Intelligence(MI)*: The ability to appreciate right from wrong in a rational and empathic way. It is ability to have solid ethical beliefs and to act on them positively. It enables one to behave in the correct and honorable way. Moral Intelligence (MQ) is way of measuring one's MI in any form. Measurement may happen in multiple ways. For example, one way of doing that is to circulate a questionnaire.
 - *Social Intelligence (Social I)*: The aptitude to connect with others and to encourage them to collaborate with you positively. It also called in some literature “people skills,” but SI is more than just that. Social intelligence is about mindfulness of the situations and awareness of the social forces at work that lead to them. This competency enables people to be aware of communication styles, strategies, policies, and practices that help them attain desired objectives in the context of dealing with others and with society. Social intelligence helps us get insight and awareness. Social quotient (Social Q) is way of measuring one's SI in any form. One way of measuring it is to circulate a questionnaire.
 - *Spiritual Intelligence (SI)*: The intelligence with which we address and solve problems of meaning and value, the intelligence with which we can place our actions and our lives in a wider, richer, meaning-giving context, and the intelligence with which we can assess that one course of action or one life-path is more meaningful than another. SQ is the necessary foundation for the effective functioning of both IQ and EQ. It is our “ultimate intelligence” (Zohar & Marshall 2000, pp 3-4). Spiritual quotient (SQ) is way of measuring one's Spiritual Intelligence in any form. One way of measuring it is to circulate a questionnaire.
-

Key Characteristics of Intellectual Assets

The key characteristics of the corporate climate that foster intellectual assets creation are discussed in this section. This is relevant at the organizational level, as well as the unit and team level.

Bottom-Up Innovation

The importance of innovation in today's business cannot be overstated. Knowledge creation has been proposed with two types— by combining elements previously unconnected (incremental) or by developing novel ways of combining elements previously associated. Because intellectual assets are generated from each level of the organization, innovation also needs to happen in a bottom-up fashion. Employees throughout the organization contribute improvements and novel ideas, perfecting

operation details at all levels (incremental). This adds up to big, transforming ideas (radical). It rests on two enabling factors—an innovative organizational culture and creative individuals.

Teamwork and Knowledge Sharing

As stated, creation of new knowledge depends on combining different ideas and knowledge. Therefore, the more exchange there is between different parties, the broader expertise and experiences can be brought into the creative process. In fact, knowledge grows exponentially when shared. Sharing and collaboration within the team, between partners, and through external knowledgebases can all accelerate growth. However, since the end product is intangible, the effectiveness and feasibility of sharing relies heavily on high moral standards, social relationships, and mechanisms to protect intellectual property and information security.

Adaptability to Change

Most of the benefit of knowledge-based organizations derives from constantly creating market needs and following up on changing demand promptly. As a famous example in the electronic devices industry, innovative leaders like Apple created an ever-expanding market for smartphones in a matter of a few years. Others in the industry cannot survive without adapting to the new demand by providing their own alternatives or something more innovative. To continue producing value, the organization is mandated to detect and adapt to the latest external market changes, be flexible and act promptly while maintaining quality during internal change, and be able to manage the enormous pressure brought with each change.

Customer Focus

The quality of the product is no longer the only concern of customers for today's knowledge-based business. The whole service experience is at play. Whether it is identifying and serving the future need of the customer, a supreme communication experience, or even the social responsibility and integrity demonstrated in the organization's conduct, these all can generate vast amounts of intangible assets. Only through providing an outstanding customer service experience will the corporate attain a unique identity and reputation, build trusting relationships, and thus win a competitive advantage.

Spirituality

Researches and experts in the subject have recognized that employees need to find meaning and purpose in the workplace. This can no longer be underestimated (Danah Zohar and Ian Marshall: *SQ: Spiritual Intelligence, the Ultimate Intelligence*). Here, spirituality refers to the harmony between one's self and one's spiritual pursuits, knowledge, and social/natural environment. Employees get motivation and inspiration

to create when they're connected to and allowed freedom of their authentic selves and can integrate knowledge from different perspectives. High spirituality of the organization is also shown to have a positive impact on the customer's experience, when employees perceive their work as a way to contribute to higher purposes for the community or society.

Key Performance Drivers of Individuals

What is required of each employee to form the desired corporate climate analyzed in the previous section? Six performance drivers for individuals can be summarized from understanding each aspect of the corporate climate, as shown in Figure 8-1.

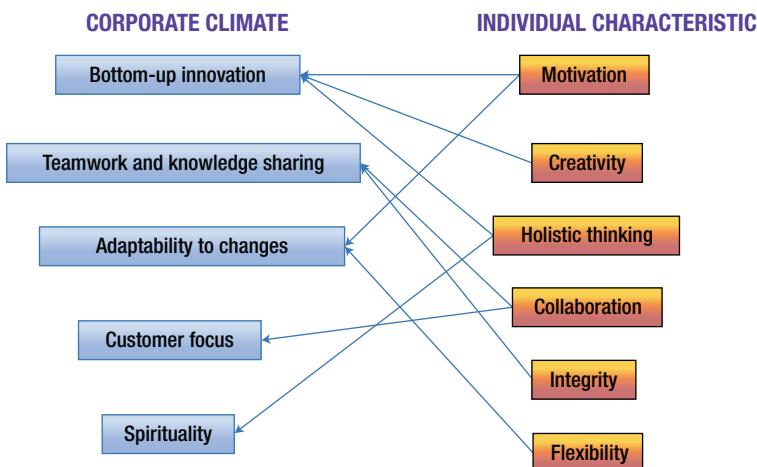


Figure 8-1. Key Performance drivers of individuals

Measuring Intelligence

The performance drivers for individuals listed in Figure 8-1 are complex skillsets that require integration of one's emotional, moral, social, and spiritual competencies. Table 8-1 shows how one's psychological competencies work together to enable the desired motivation, flexibility, integrity, creativity collaboration, and holistic thinking skills.

Table 8-1. Emotional, Moral, Social, and Spiritual Competencies for Personal Performance Drivers

Competency Metrics	Motivation	Integrity	Collaboration	Creativity	Flexibility	Holistic Thinking
Emotional Competencies	Confidence, Emotional awareness, Emotional management, Sustained motivation, Endurance, Drive for achievement	Emotion and Impulse control, Confidence in one's values and principles	Healthy self-regard, Optimism, Impulse control	Optimism, Emotional management, Confidence	Stress management, Emotion and Impulse control, Stable self-esteem	Emotional awareness
Social Competencies	Motivating/ managing others' emotions	Empathy, Understanding complex social relationships	Empathy, Situational radar, Resolving conflicts, Change catalyst, Moving others toward oneself, Responsiveness, Authenticity, Sincerity	Self-expression, Influencing others	Building bonds, Effective communication, Situational radar, Resolving conflicts	Empathy, Situational radar
Moral Competencies	Responsibility, Self-control	Moral judgment, Standing up against injustice, Keeping promises	Respect, Tolerance	Social responsibility	Tolerance	Social responsibility, Applying universal principles to personal actions
Spiritual Competencies	Self-understanding, Access to deep values and will, Inner harmony, Purpose seeking	Intrinsic drive to serve and give, Access of deep values of self, Meaning seeking and being led by vision	Embracing diversity, love, and unity with people	Spontaneity and energy, Seeking truth, Curiosity, Flexibility of perspectives	Time-management, Flexibility of perspectives	Seeing the fundamental and essence, Love and unity with nature/universe

The goal and motivation for the organization to develop employees' emotional, moral, social, and spiritual competencies is to generate intellectual assets (see Figure 8-2). This figure presents a view of the final objective of capturing intelligence and then measuring it. It is targeted to employees to improve the overall performance and then provide a competitive advantage to the organization by tuning the organizational objective, the corporate climate.

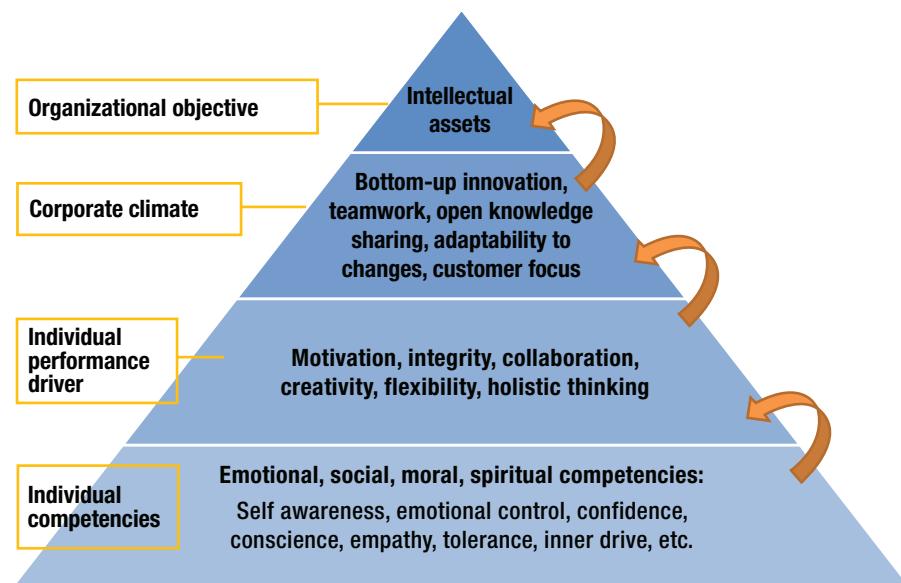


Figure 8-2. The hierarchy from employee emotional, moral, social, and spiritual competencies

Measurement is important. EI, SI, and MI are very subjective in nature. It is not like $2+2 = 4$. Therefore, defining key performance parameters for these competencies is one of the criteria for success. There are multiple ways to measure the performance of the resources based on competencies and parameters explained in Tables 8-2 to 8-5. For example, one way of measuring is to create a questionnaire. Questionnaires contain specific questions with weight associated with each question.

Table 8-2. Highlights of the Key Performance Parameters for EI

Key emotional intelligence performance parameters			
Emotional Self-Awareness	Emotion Management	Self-Attitude	Motivation
<ul style="list-style-type: none"> Aware of the emotion being experienced Understand how the emotion is linked to one's thoughts and behaviors Understand how the emotion is related to one's values and goals Insight as to what and how environmental factor has triggered the emotion 	<ul style="list-style-type: none"> Impulse control Controlling negative emotions: distress, jealousy, etc. Intentionally eliciting and sustaining feelings when needed Mental adaptability to changes Stress management Optimism 	<ul style="list-style-type: none"> Confidence in individual values and principles Trust in individual abilities and judgment Self-regard: Not inferior/superior to others Stability of self-esteem Take environmental factors into consideration: expertise and familiarity in the field 	<ul style="list-style-type: none"> Need for achievement Drive for self-improvement Sustain motivation/endurance Take environmental factors into consideration: management, team, commitment/interest for this particular project/team/field

Table 8-3. Highlights of the Key Performance Parameters for MI

Key Moral Intelligence performance parameters			
Integrity	Responsibility	Respect	Tolerance
<ul style="list-style-type: none"> Act consistently with universal principles, values, and beliefs Tell the truth Stand up against injustice, corruption, etc. Keep promises 	<ul style="list-style-type: none"> Committed to carry out assigned work Take responsibility for results of decisions and conducts, especially mistakes Embrace responsibility for the welfare of the team/organization Social responsibility 	<ul style="list-style-type: none"> Respect and take interest in others' feelings, work, culture, and welfare Treat others courteously Not harm others Treat others fairly 	<ul style="list-style-type: none"> Handle constructive criticism well Tolerate disagreeing opinions Tolerate different abilities and personalities Forgive others' mistakes

Table 8-4. Highlights of the Key Performance Parameters for SI

Key Spiritual Intelligence performance parameters			
Integration of Self	Integration of Knowledge	Love and Unity	Some Additional SQ Qualities
<ul style="list-style-type: none"> • Access of deep values and will of self • Holistic: Understanding/ evaluation of self's tendencies, abilities, and position in relation to the world • Purpose seeking and vision-led inner harmony of will and reality • Compassion: Having the quality of "feeling-with" and deep empathy • Celebration of diversity: Valuing other people for their differences, not despite them • Positive use of adversity: Learning and growing from mistakes, setbacks, and suffering 	<ul style="list-style-type: none"> • Seeking truth and being curious • Seeing the fundamental and essence • Flexibility of perspectives • Time management • Ability to reframe: Standing back from a situation or problem and seeing the bigger picture or the wider context 	<ul style="list-style-type: none"> • With people and nature/universe • Intrinsic drive to serve and give • Empathy • Competitiveness • Humility: Having the sense of being a player in a larger drama, of one's true place in the world • Tendency to ask fundamental "why" questions: Needing to understand things and get to the bottom of them 	<ul style="list-style-type: none"> • Self-awareness: Knowing what one believes in and values and what deeply motivates one. • Spontaneity: Living in and being responsive to the moment. • Being vision- and value-led: Acting from principles and deep beliefs and living accordingly. • Holism: Seeing larger patterns, relationships, and connections; having a sense of belonging. • Field independence: Standing against the crowd and having one's own convictions. • Sense of vocation: Feeling called upon to serve, to give something back.

Table 8-5. Highlights of the Key Performance Parameters for Social Intelligence

Key social Intelligence performance parameters			
Empathy	Effective Communication	Influencing Others	Positive Psychology
<ul style="list-style-type: none"> Interest in others' concerns and feelings. Understand other's feelings, concerns and perspectives Able to reconcile conflicting opinions by incorporating other's needs and feelings 	<ul style="list-style-type: none"> Assertiveness Provision of feedback Authenticity, sincerity Express own feelings Show sympathy Good listening skills 	<ul style="list-style-type: none"> Impression management Move others toward you Change catalyst Motivating/ managing others' emotions Building bonds 	<p>Numerous research has proven that positive emotions are linked with improved well-being, extended life, and better well-being, whereas, long-lasting anger, anxiety, and aggression upsurge the risk of generating heart illness and other emotional disorders. Individuals respond to these feelings with elevated blood pressure and thickening of blood vessels. However, it not easy to uphold a healthy, positive emotional state all the time. One reason for this is individuals, generally miscalculate what would make them joyful and gratified. Positive Psychology is a branch of psychology that studies the positive aspects of human behavior and can be extended to organization and life. It actually connects the influence of pleasure and mindfulness to the inner strength of an individual. Practices of it enable individuals to find well-being and happiness. There are multiple ways to assess and improve it, including self-assessment tests and exercises that help to maximize the positive emotion in one's life. Machine learning project teams are going through stress because they are dealing with the challenge of a large data volume and tight delivery lines. Therefore, organizations must enable their employees with these skills to cope with these situations in the better way</p>

Finally, all the weight would be added and a composite score would be achieved. Those scores would indicate which areas need improvement in the resource and where is the employee is performing fine. In the area where the resource needs improvement, typically a training plan would be attached and appropriate training would be given. Another approach is to provide performance coaching to fine-tune the resource. The same exercise is repeated for all the competencies:

- Assessment:
 - Understanding strengths and weaknesses of self and others
 - Orientation workshop on EI, MI, social intelligence, and spiritual intelligence
 - Discussion and sharing with the team
- Goal alignment
 - Introspection: Aligning actual self with ideal self and team goals
 - Team discussion about shared values and goal alignment
 - Input to tracking system
- Action plan
 - Suggestion of new behavior
 - Recording of action plan
 - Sharing on forum
- Implementation
 - Pairing up to practice new behavior
 - Finding and building coaching relationships
 - Tracking progress

Holistic intelligence and competencies presented in this section are not limited to “only” improvement of the team members. Its applications and scope are very wide. Figure 8-3 presents an integrative and comprehensive view of emotional, social, moral, and spiritual intelligence and shows that these competencies are applicable to almost all areas, including finance, customer satisfaction, internal process, and employee learning and growth. All these areas are actually part of the balance scorecard methodology, which is one of the ways to measure the performance of the organization and its employees. However, it can be extended to measure virtually anything, including the performance of one’s life activities.

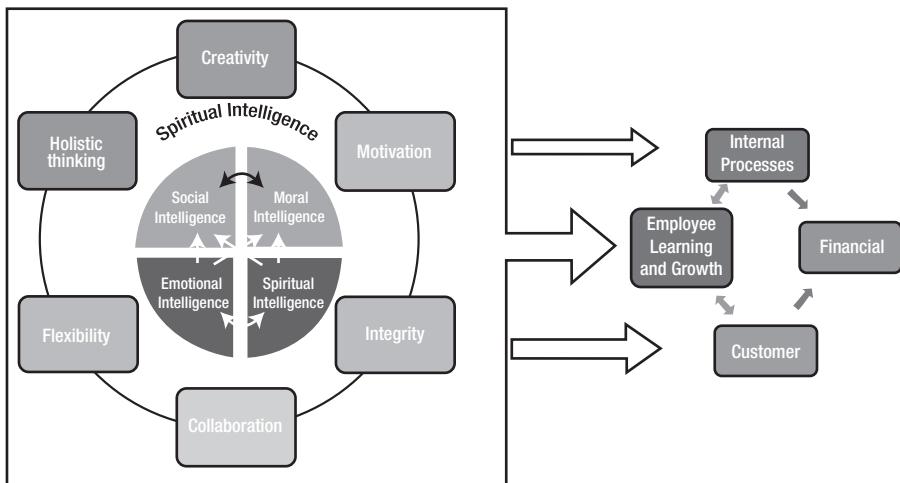


Figure 8-3. Holistic and comprehensive view of emotional, social, moral, and spiritual intelligence, and their diverse application areas

Benefits of These Competencies

Equipping individuals with these competencies is helpful at all levels of an organization. They provide benefits to individuals, project teams, and organization. Figure 8-4 provides a snapshot of these benefits.

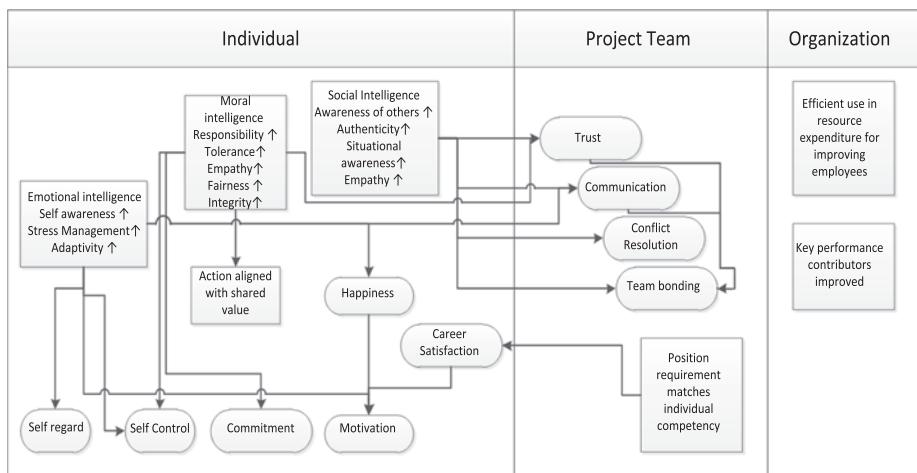


Figure 8-4. Snapshot of benefits provided by the multiple type of intelligence

Some thoughts:

- EI, Social I, MI, and SI have a meaningful impact on the performance of human resources.
- Increased EI, Social I, MI, and SI correlate with profitability via customer satisfaction.
- EI, Social I, MI, and SI can inculcate service quality that improves customer satisfaction.
- These competencies can be used for improving team performance and human behavior in totality in all the dimensions, including intellectual capabilities.
- Theory and practice of management science, human resource development, organizational behavior, and industrial psychology can be integrated with these competencies and could be applied to the team through the proper use of appropriate methodology and frameworks.
- These competencies can be integrated with gamification, storytelling (automated and manual), and concept comics. In turn, these can be used to improve efficiency and effectiveness of software development and support teams.

GAMIFICATION

Gamification is the process of making game science work in non-game contexts to derive desired behavior. Smart gamification taps into innate human motivators.

Some highlights of gamification:

- Organizations always find it difficult to engage their workforce, engage their customers, and provide users with a good experience with service transactions. It is estimated that this issue cost enterprises billions of dollars annually. The good news is that gamification is helpful here due to its unique approach to take advantage of human psychology.
- Garter reports are indicating that global organizations are using gamification and successfully deriving business value out of it.

Comics and Gamification

Comics are used by enterprises to promote their products and services, either directly (as a form of advertising and marketing) or through product placement in a comic strip. Organizations can also use comics to clarify how to use an application/product/services, because they are easy to use and understand and most

importantly involve both hemispheres of the brain during interactions. Therefore, user engagement is more compared to text-based explanations. The latest research has established the importance of visuals during interactions or broadly communications. (Scott & Vargas, 2007, p. 342) and mentioned in his research that cartoons convey more detail, analogous to “writing in more detail”. Many enterprises started using comics to educate employees about internal organization procedures and process. Also, they are using them as to explain technical details in a more engaging way. Hence, gamification and comics can be used to achieve employee motivation, customer loyalty, and service improvement. They can be used to manage the project in the better way and make it risk free with the use of gamification.

Corporate Storytelling

Telling stories for entertainment, engagement, education, and enlightenment is not a new concept. With corporate storytelling, the philosophies are similar as with old-style stories. However, the key transformation is that you are utilizing them to encourage an application/product/service or to promote a brand. Stories generally appear in the form of text. However, to tell a good story about the enterprise/organization/company, video could be also be used. Stories can be automated or appear manually. The form of stories depends on the need and availability of infrastructure, budget, and other resources.

EQ, SQ, MQ, and Social Q and Building an Efficient ML Team

MQ, SQ, and other types of intelligences discussed in the chapter are helpful in building a world-class machine learning team. World-class technical teams require courage, persistence, and the ability to deal with ambiguity. Also, giving a freehand to the team members is one of the mandatory criteria for an effective and efficient team.

Consider this general criteria to build a great team from the machine learning perspective:

- Senior executive participation in setting up the team
- Continuous support from the senior management
- Alignment of team’s goals with vision and mission of the organization
- Machine learning team must be a mix of business and technology specialists. Because requirements and business need to be understood before going for technical implementation.
- The team must be able to work in cross-functional environments and situations.

- The team has freedom to develop its own working style and create internal roles.
- Clear guidelines about how to measure the success of the team and team members.
- Team members and leaders must be selected on the basis of diversity, knowledge, and competencies.
- Team must be a mix of people who are newly hired from outside the organization and who are already working in the team. That gives the team different perspectives.
- Continuous learning, effective knowledge management, and development environment.
- Proper communication process and infrastructure availability.
- Proper reward and recognition mechanism for the team, leader, manager, and individual team members. Value addition must be appreciated at all the levels.
- Repetitive, timely, and effective feedback and performance evaluation mechanism.
- Proper training for evolving technologies, team skills, problem solving, and decision making.
- Wellbeing and health frameworks alignment with team members.
- Clearly defined RASCI matrix. RASCI matrix is a tabular representation of Responsible, Accountable, Supportive, Consulted, and Informed attributes of roles in the team/organization/project.
- Must know how to communicate visually. They must communicate their insight from the data to the stakeholders through graphs, infographics, animation, and reports. Mere raw facts are of no use in business.
- Team members must have curious minds and they must be able to answer the how, what, and why of a problem.
- In a nutshell, the team and therefore the team members must process mathematical, statistical, computational, programming, data management, and positive psychological, communication, and change management skills.

In an organization, a team has multiple dimensions and includes multiple roles. It is good to discuss a few important roles and their qualities. A few roles—like organizational leadership, decision making, and data scientists—need full and efficient use of both the hemispheres of the brain. Therefore, Figure 8-5 shows how these skills and roles fit from a brain science point of view. The following sections discuss the key roles on each team.

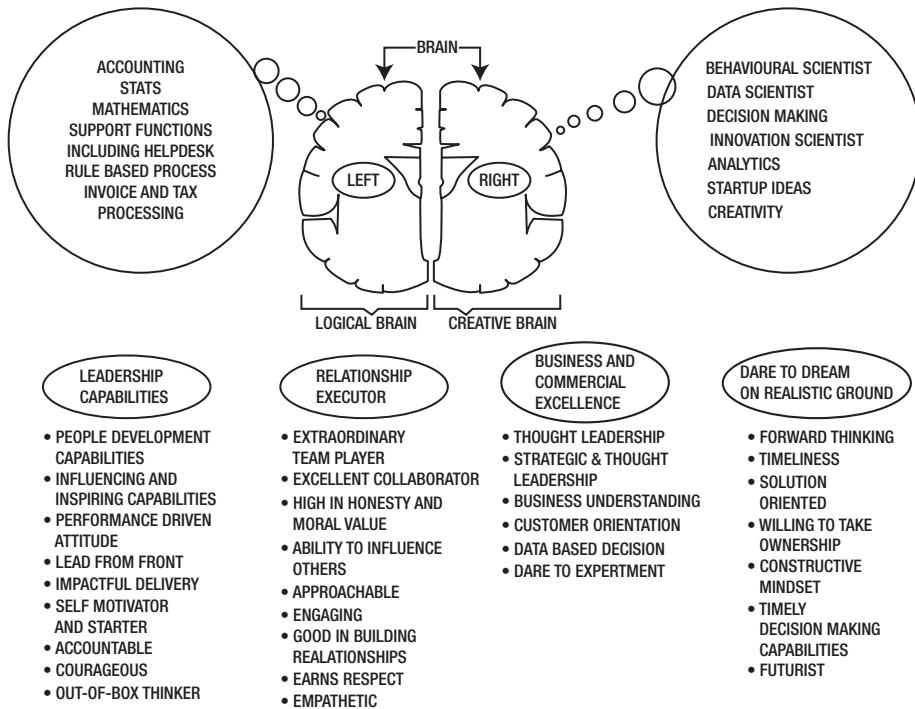


Figure 8-5. Brain science

Team Leader

A good team leader must:

- Be aligned with the business perspective and issues.
- Be aware of the organizational level frameworks, processes, and the goals of the company.
- Be aligned and updated with the technical, process, and people issues that team is facing and be able to solve them.
- Have good leadership and intermediate managerial skills.
- Have good project management skills.
- Have good problem solving, conflict resolution, and team management skills.
- Have good collaboration and communication skills (including inter- and intra-personal skills).
- Be passionate, creative, and innovative.
- Be self-motivated and good with time management and administrative work.

- Know the business.
- Be able to lead and guide a multi-disciplinary team of technical experts.
- Be good at statistical analytics techniques and with mathematical concepts.
- Be experienced in the Agile software development methodologies, like SCRUM and extreme programming.

Technology Manager

A good technology leader must:

- Have excellent communication skills.
- Lead with transparency and honesty.
- Support employees with clear direction and remove their roadblocks for them.
- Embrace technology.
- Motivate with positive feedback and recognition.
- Be an expert in the field.
- Mediate with productivity and calmness.
- Promote cross-level and cross-functional collaboration.
- Create a productive and lively work environment.
- Trust her employees.
- Be experienced in machine learning projects and able to distinguish between normal technical projects and machine learning projects.

Team Members

A good team member must:

- Be technically excellent in his work.
- Have multi-task management skills.
- Be capable of doing individual as well as group decision making and be good at conflict management.
- Be open about taking feedback.
- Be good at planning and organizing.

- Be good problem solving and have analytical and mathematical skills.
- Have good collaboration and communication skills.
- Be able to take initiative.
- Be flexible.
- Be passionate about data crunching
- Be good at adopting the concepts.
- Be good at handling unstructured data and able to do analysis.
- Have knowledge of high computing and multithread programming models.
- Have knowledge of Agile software development methodologies.

Organizational Leader

A good organizational leader must:

- Have good social, moral, ethical, and emotional intelligence skills.
- Be a visionary who is committed and has the ability to inspire others.
- Be honest and self-aware.
- Be good at making decisions.
- Take actions with responsibilities.
- Be productive, innovative, and thoughtful at work.
- Have the ability to simplify the things and communicate/present information in an understandable way.
- Have a positive outlook toward work, life, and self.
- Be realistic at work.
- Have clear thinking and good judgment skills.
- Be aware and considerate and show sensitivity.
- Be able to lead by example.
- Have a desire for excellence and for getting things done.
- Have excellent coaching and motivational skills.
- Be a good listener and strong executor.
- Have an excellent understanding of business, process, and people skills.

The Difference Between a Leader and a Manager

A world-class team is built on the directions and guidelines provided by the leader and, on the ground level, it is managed by the project/development/support/technology managers. There are occasions when people are confused with line of separation between these roles and mistakenly think these are the same role and use them interchangeably. However, there is huge difference between these two roles:

- The manager administers, whereas the leader innovates and encourages it.
- The manager always implements and continues with the status quo; the leader however always develops.
- The manager focuses on systems, processes, and structure; the leader focuses on people and their enablement.
- The manager relies on control; the leader inspires trust.
- The manager has a short-range view and believes in getting things done; the leader has a long-range perspective.
- The manager has his eye always on the bottom line; the leader's eye is on the horizon.
- The manager copies; the leader creates.
- The manager accepts the status quo; the leader challenges it.
- The manager is the classic good soldier; the leader is his own persona.
- The manager does things right; the leader does the right thing.

How to Build Data Culture for Machine Learning

Machine learning projects are technical in nature. However, the behavioral aspects of the involved stakeholders also play an important role. The most important aspects in machine learning based projects and organizations is the data. Therefore, it is expected that data based culture would be developed within the project and company alike. Classic examples of this are Amazon and Netflix, which are pioneers in their field. Here are some guidelines for building and training a data-based culture in an organization:

- Train your team (almost everyone) on data dynamics, datanomics (data based economy), and statistics. Provide a refresher course on these issues to the stakeholders.
- Provide knowledge of domain, information flow, data flow, storage capabilities, and external and internal data sources to the stakeholders.
- Establish and educate stakeholders about the importance of data within and outside of the organization.

- Explain technology to relevant people in deep and to loosely coupled people at the 200 feet level. This must include the architecture.
- Leaders must be involved in the projects.
- Proper reward and recognition must be provided to the people.
- Encourage research, innovation, and thought leadership at all levels.
- Knowledge sharing sessions must be incorporated into the DNA of the organization.
- Create a culture of shared success celebration that brings people together.
- Teams must not be bothered about the organizational policy and changes. Essentially, they should be free from the organizational bureaucracy and hierarchy.
- Equip the teams with the latest technologies and tools. Give them challenging work and encourage them to solve the issues.
- Encourage teams to publish their work on internal and external forums like, including conferences, filling patents, and writing whitepapers.

In addition to these general distinguishing qualities, the following points are some “must have” characteristics of machine learning teams and team members.

- They must process data science skills, be good at statistical, numerical, problem solving, analysis, data crunching, and modeling techniques, and have a process research and innovative mindset.
- Be exposed to handling large volumes of data, knowledge of diverse sources of data and gathering techniques.
- Have knowledge of tools, framework, and libraries related to machine learning.
- Have knowledge of the business process, company specific policies, and business jargon.
- Have an excellent capability to present complex ideas in easy ways to the lay audiences with the help of data visualization tools.
- Be flexible, adaptable, learning, innovative, and self-motivating skills.

A team is a complex entity as it revolves around humans. Therefore, managing a team is always a challenge and satisfying its need for organization is a big responsibility. Every team member wants to excel. They always want to perform better if the surrounding environment supports them. They have some questions. If the proper

answers are provided, it will motivate them to work better. The sidebar contains a list of questions that every team member wants to be answered. If these questions are answered in the proper way, it brings transparency across the board.

QUESTIONS FOR BRINGING TRANSPARENCY TO THE TEAM AND ENTERPRISE

What business challenge is the team supposed to solve? Who selects the team leader? How is the team related to other organizational units? Who assigns work to a team member? What are the roles and responsibilities of the team members and the team leader? What are the roles and job descriptions of the team members and team leader? What are the selection criteria of the team members and leader? What are the technologies, tools, and programming languages that the team members and leader need? How will individuals allocate their time to the team versus their other functional responsibilities? Who measures the overall team member performance and what are the metrics for that? What is the appraisal cycle for the team members and leader? What is the optimum size of the team? Who establishes the team's priorities? Who manages the team boarders with the other areas in the organization? What authority and responsibilities are implied by the dotted line reporting structure? How will cross-functional and cross-cultural conflicts and priorities be resolved?

What process help teams improve productivity, efficiency, and effectiveness? How can the team improve internal and external communications? How often should the team meet and in what format should they share the minutes of meetings? What are the locations the teams reside on? How they can meet if face-to-face meetings are not an option? What are the technical means of communication and collaboration (video conferences)? What are reports does the team have to produce and who is the audience? What processes can be used to help team members evolve and improve continuously? What is the team value?

How is the team motivated? How can team loyalty be increased? How should team results and individual's performance be measured? Who evaluates the team members and what is the criteria? How is individual and team performance linked to the company's performance and to salary?

What training programs exist to develop the skills?

Ultimately, the goal is to align team members with the higher value and with the vision of the organization. After processing the skills and competencies mentioned here, the individuals and the groups become highly effective in delivering and creating high-quality products and in dealing with team dynamics. They achieve individual and organizational effectiveness. Figure 8-6 depicts this process.

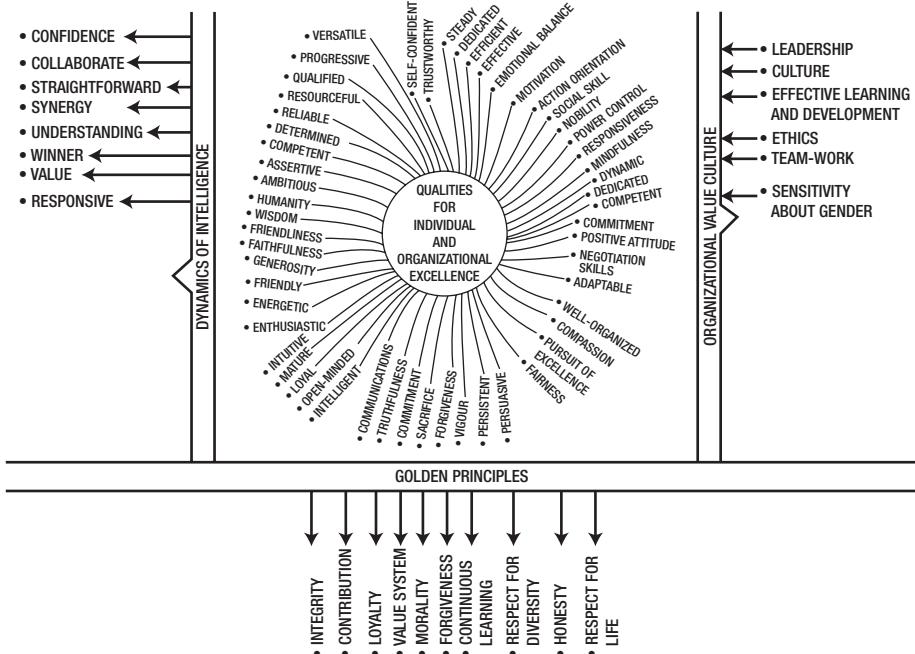


Figure 8-6. Effectiveness

Machine Learning Specific Roles and Responsibilities

A good and successful project needs a mix of technical and behavioral capabilities at least at the talent level. Therefore, there are many other factors that need to be considered. Factors like business domain knowledge, challenging the status quo, and visual communication skills in a resource are equally important. A successful machine learning team contains some typical role and naturally there are some responsibilities associated with those roles. Now, after having a wider discussion about generic roles and responsibilities, it is good time to summarize the practical roles that exist in the world of machine learning.

This information is helpful for the decision makers/managers to hire the best fit for their projects. This will also help organizations create and organize an effective team. Let's take a quick look at some of the important roles.

Role 1: Deep Learning/Machine Learning Engineer

Typical designation:

- They are very innovative and always thinking. They are strong at solving problems, analyzing data, and programming.

Role and responsibilities associated with this designation:

- Collecting, analyzing, understanding, and interpreting the qualitative, mathematical, statistical, and quantitative aspects of data with established statistical theories, frameworks, libraries, and analytical methods.
- Able to develop innovative, intuitive, and customer-oriented user interfaces.
- Serve data through APIs to data scientists (another/designation). Data scientists in turn use them for the query.
- Develop useful insights from raw data and “must have” the working experience on big data

Skills and talents:

- Ability to apply established algorithms in business specific scenarios. Knowledge of ML specific libraries.
- Capability to understand the strengths and weakness of different machine learning algorithms.
- Knowledge of predictive modeling, machine learning, and data mining techniques.
- Understand database technologies.
- Knowledge of machine learning friendly programming languages like, R, Python, C/C++, SQL, and NoSQL.
- Able to do sentiment and what-if analysis.
- Knowledge of object oriented programming including multi-threaded and high-performance computing environments.

Psychological and behavioral skills:

- Calm and composed, innovative, and creative.
- Logical genius, emotional and social intelligence.
- Aptitude to comprehend business jargon and across the enterprise.

The best way to find a machine learning engineer is to find a quality data engineer that you can groom in your organization. For that, you have to find a good engineer or developer and train him or her on the specific machine learning technology and techniques. Other way is find them through a job portal. If the organization is okay with hiring the service of a freelancer engineer, they can be found via that mode as well.

Role 2: Data Scientist

Typical designation:

- Someone who is inquisitive, shares and analyzes data, and can spot trends. Also, he or she can identify anomalies and data associations. Data scientists are typically good at detecting data patterns and dependencies. Typically, they can balance research and business outcomes. They cross-over multiple discipline such as statistics, mathematics, engineering, psychology, sociology, linguistics, and business management.

Role and responsibilities associated with this designation:

- Analyze, understand, and interpret the qualitative, mathematical, statistical, as well as quantitative aspects of data using established statistical theories and analytical methods.
- Solve business/data learning problems. Create ML solutions to achieve an organization objective.
- Clean existing raw data and build models to predict future happenings.
- Look at data from multiple angles and make sense out of it.

Skills and talents:

- Knowledge of distributed computing and data visualization.
- Capability to understand the strengths and weakness of different machine learning algorithms.
- Knowledge of predictive modeling, machine learning, and data mining techniques.
- Understanding of database technologies.
- Knowledge of machine learning friendly programming languages, such as R, Python, C/C++, SQL, and NoSQL.
- Knowledge of object oriented programming, including multi-threaded and high-performance computing environments.
- Knowledge of data mining and data warehousing.
- Overall understanding of artificial intelligence, deep learning, and neural networks.
- Experience in high performance, natural language processing and distributed computing.

Behavioral and PSYCHOLOGICAL Skills:

- Calm and composed, innovative, and creative.
- Logical genius, equipped with emotional and social intelligence capabilities.
- Aptitude to comprehend business jargon.
- Ability to comprehend corporate mission, vision, and strategy and the accompanying KPIs.

Quality data scientists are not easily available. Therefore, finding them is a difficult task. You can find experienced data scientists through job portals or by references. However, they are typically expensive. The other option is to hire them from academic institutions and universities. The perspective candidate would must possess an advanced degree in computer science, mathematics, and statistics. PhDs are preferable. Also, the candidates may be hired from fields like space science, bio-informatics, or neuro-science, where a lot of data crunching and any analytical skills are present. Once these candidates are hired, training specific to machine learning and project requirement would be helpful.

Other Important Roles

Apart from these important roles, there are multiple other roles on machine learning teams and in organizations. A few of them are so unusual that we never hear about them. The technical roles require more or less the same types of competencies. Therefore, this chapter will not discuss each and every role in detail. However, it's good to look at them briefly.

Analytics practice leader	Data architect	BI analyst
IOT specialist	Data hygienist	BI solution architect
Machine learning coach	Data miner/Statistician	Big data researcher
Machine learning expert	Metadata administrator	Big data solution architect
Information architect	Data modeler	Big data visualization specialist
Hadoop developer/Engineer	Visualization tool developers	Predictive analytics developer
Big data loading specialist	Java developer	OLAP developer
Algorithm expert	Machine learning researcher	Innovation lead
ETL architect and developer	Security and archival specialist	Change leader
Infrastructure specialists	Application developer	Experimental analysts
Project manager	Technology manager	Development manager

This list is not complete. However, it should give you a feel for the related roles that exist in the organization from a machine learning perspective. Along with these roles there are lot of other “leadership and decision maker” roles. Now let’s have a look at them as well.

CEO—Chief Executive Officer: The highest policymaking position in an enterprise. Their principal responsibilities comprise making business decisions. They are accountable for managing the complete operations and resources (including the funds) of an enterprise. They generally act as the main point of communication among the board of directors and corporate operations, including executives. Here are the main directs of the typical of CEO.

- *CRO—Chief Risk Officer:* The highest level of authority regarding risk practices and policies creation related to the risks of the organization. This role defines and provides a roadmap for the implementation of the risk strategies at the enterprise level.
- *CFO—Chief Finance Officer:* The leader who provides and manages the financial roadmap and strategies of the organization. The CFO is responsible for the inside and outside the organization, especially to the stakeholders.
- *CMO—Chief Marketing Officer:* The highest level of authority regarding marketing practices and policies related to these marketing strategies. Defines and provides a roadmap for the implementation of the same at enterprise level.
- *CIO—Chief Information Officer:* The highest level of authority regarding information technology practices and policies creation for the organization. Defines and provides a roadmap for the implementation of the IT strategies at the enterprise level.
- *CAO—Chief Analytics Officer:* The highest level of authority regarding business intelligence-related policies creation across the organization. Broadly takes care of analytics related activities, including Big Data and machine learning related strategies. Defines and provides a roadmap for the implementation of the same at the enterprise level.
- *COO—Chief Operating Officer:* The executive who creates operational strategies for the organization. The COO is tasked with the routine management and operation of the business. Responsible for making sure that business will run as usual.

- *CDO—Chief Data Officer:* The highest level of authority regarding data practices and policies creation related to the data. Defines, architects, and provides a roadmap for the implementation of the data strategies at the enterprise level. The CDO and CAO coordinate with each other on a regular basis to create strategies around the following:
 - Data security and privacy
 - Data architecture
 - Data integration
 - Data management

Again, there are no hard and fast rules that these roles “must” exist within an organization. Sometimes these roles merge into each other.

Lean Project Management and Machine Learning Projects

Software systems are, by their very nature, flexible and will change over time (except for many legacy systems which, by definition, are not very flexible). Integration with each of these domains therefore is not just a one-time activity; it's an ongoing activity. Lean principles applied to IT focus on the goal of delivering value to the customer with minimum possible resources and zero defects. Multiple types of waste can be reduced by using the Lean tools and techniques, but it's a continuous process and not a one-time initiative. At a broader level, Lean might help IT partners support innovation, with skills to deliver IT-enabled capabilities quickly that drive top- and bottom-line growth for business.

The Lean IT process also tells us how to improve efficiency and minimize waste in a knowledge intensive industry and reduce unevenness to enhance process capability effectively. The basic idea of Lean is to give maximum value to the customer by minimizing waste. Simply put, Lean means creating more value with fewer resources with the ultimate goal to meet the customer requirements perfectly through a value creation process that has zero waste.

Value is defined as any action or process that a customer is willing to pay for. The Lean idea was originated from the manufacturing sector, and now has extended to many other domains. Today, Lean has deep rooted implementations in the Information Technology sector to improve information processing capability, cost optimization, IT process management, and provide higher IT value to core businesses.

Lean project management has become attractive to team leaders looking for fast results on critical turnaround assignments. Most project managers decide to “go Lean” when faced with budget cuts or other constraints. Tasked with eliminating waste throughout a project or a process, managers must discover how to make their teams more effective using fewer resources. Some project managers find themselves attracted to Lean project management, thinking that “eliminating waste” means shortening or abandoning the traditional project cycle.

In fact, Lean teams rely more heavily on the project cycle and on their organizational processes than traditional project teams. The idea is to eliminate extra effort and replace processes with lower efficiency with better and more optimized ones by identifying and reducing waste. Lean project management can be summarized by seven principles:

- *Eliminate waste:* Anything that does not add value to the customer is considered to be waste.
- *Amplify learning:* The learning process can be sped up by involving all stakeholders into short and iterative feedback sessions. Less documentation/planning and more direct reviews of the action items in quick succession will amplify learning.
- *Decide as late as possible:* Lean suggests holding the decisions to be made by facts and not on the basis of assumptions and predictions. For that, sometimes decision making should be delayed if all the required facts and information are not available. Better results can be expected with an options-based approach with more available information in hand. Thus, delaying certain crucial decisions until the customer understands their needs better. This reduces waste of resource, time, and effort in terms of rework and change request communicated after significant advancement in development. This minimizes the risk of failing delivery schedules and last-minute possibility of committing errors.
- *Deliver as fast as possible:* Delivery of items on time is most crucial in IT, quickly recognizing specific client requirements and environment by proper planning and distribution of work is necessary to accomplishing the needed result for a specific iteration. The sooner the end product is delivered without considerable defects, the sooner feedback can be received and incorporated into the next iteration. Project scheduling must have the required buffer time to plan the delivery on time to ensure business continuity and testing the quality of deliverables.
- *Empower the team:* There has been a traditional belief in most businesses about the decision-making in the organization, in that the managers tell the workers how to do their jobs. In a Lean work-out technique, the roles are turned, and the managers are taught how to listen to the developers so they can explain better what actions might be taken as well as provide suggestions for improvements. The Lean approach favors the aphorism “find good people and let them do their jobs,” by encouraging progress, catching errors, and removing impediments, but not micro-managing. People need motivation and a higher purpose to work for within the reachable reality, with the assurance that the team might choose its own commitments.

- *Build integrity:* The customer needs to have an integrated and holistic experience of the system to identify the value delivered to him by any solution. How it is being advertised, delivered, deployed, and accessed, how smart the utility is, the price, and most importantly how well it solves problems. This is called *conceptual integrity*. It's important to understand how different components of the system work together as a whole to create value. Clients must have an integrated view of the system and for that solution team management should ensure smooth information flow. One big chunk of information shared after an interval raises confusion, smaller bits of information shared and analyzed on shorter intervals renders a detailed understanding. In Agile software development at the end of a phase, a more in-depth and integrated knowledgebase is created. This reduces repetition, isolation in understanding, and the gap between expectation and actuality. Building and sharing an integrated view of the system helps maintain the balance between flexibility, maintainability, efficiency, and responsiveness to the best possible extent.
- *Optimize the whole:* A system should have the clarity and a defined standardized structure so that by decomposing the big tasks into smaller tasks, and by standardizing different stages of development, the root causes of defects can be found and eliminated. The big picture should be crystal clear to all the stakeholders.

How to Do the Right Resourcing and Find the Best Match

Before wrapping up, let's look at the pearls of right resourcing for machine learning teams. Both the perspective organization and the potential candidate has to look at some important factors related to onboarding of candidates in the organization. For example, candidates must process important characteristics like not being afraid of failure and taking ownership. Whereas organizations have to look at the culture fit with the candidate. Here are some important points to consider:

- *Make it right:* In any professional commitment, your attitude matters the most. There is no doubt that skills have their own importance, but attitude is more important. One important part of the right attitude is ability to see things differently, because it gives you a different perspective. Machine learning projects need different perspectives all the time. They demand continued learning, trying new approaches, and flexibility. Therefore, attitude counts here.

- *Change is the only constant:* To be successful in machine learning projects, you need readiness to learn, the capability of acquiring new thoughts, and the ability to change. In this technology space, change is the norm. So, no one can be an expert at everything. Therefore, willingness to adapt is key. Intellectual and behavioral humbleness are the building blocks of having a learning attitude.
- *Welcome to my culture:* Creating an appropriate culture of innovation is necessary, not the requirement for the companies who deals with machine learning. There is a paradigm shift needed to create a data culture if it is not prevailed within the organization. In the journey of adopting new thoughts, people have to accept change and motivate themselves to fit into the framework of the changing culture of the organization. One of the mantras of achieving this is to that each individual can attain something great or at least keep trying to do so. High energy and enthusiasm are the other requirements for effective machine learning professionals. This culture fit becomes so important that companies have started testing this in their prospective hires. For example, a company called Chumbak has a team of people who are explicitly skilled to administer a culture test. They conduct this test once the particular resource has clears all the rounds of technical and managerial interviews. One of the common questions they ask during their test is, “If money were not an object, what would you be doing instead?”. This panel of interviewers has veto powers. If they are not convinced that the culture fits the candidate, they have the right to reject this person, even if the candidate is excellent from the technical perspective.
- *Please own it:* Finding problems by analysis and then completing the tasks with minimum intervention of others within timeline is the key. Therefore, this one of the “must have” skills for the machine learning professional.
- *I love failures:* Failure is a reality and here to stay. How one copes with failure is very important. In machine learning projects, these “coping” skills are mandatory. There are times where you will be trying multiple things and waiting for results. While success at previous roles is good, answers to questions like “When was the last time you failed?” makes sense. Finding a candidate who does not repeat mistakes is excellent, because they know what they’ve done wrong and ensure that they don’t repeat those mistakes.

DevOps

DevOps (a portmanteau of development and operations) is a software development method that bridges the gap between software developers and information technology (IT) professionals. It stresses the interdependence between software development and IT operations. DevOps seeks to establish the communication channels between development and operations on software projects that increase the time and labor involved in delivering and maintaining software systems. It helps a company continually deliver highly stable features, faster and more often. As a result, a business asks more and more from its IT organizations, which in turn requires that the two traditionally separate teams work together to enable the business to deliver more features while continually ensuring the stability of its systems.

Development methodologies adopted across organizations follow and adopt a traditional approach with separate departments for development, deployment activities, and QA. These activities do not have integration across departments. DevOps promotes a set of processes, methods for communication, collaboration, and integration between departments.

DevOps is about cultural change, therefore, it is useful for you to be aware of the concepts. It is all about bringing behavioral and technical aspects together. We talked at length about building data culture and an effective team, so DevOps is relevant in this aspect.

The Need for DevOps

Here are some reasons why DevOps is needed:

- Multi-platform requirements
- Just-in-time solutions for frequent delivery of software
- Code complexity and increasing application complexity
- Business requirements and frequency of releases
- Collaboration among teams and the gap between development and deployment processes
- To reduce frequent changes and reduce the gap for release planning
- Security and increasing compliance and control such as security, availability, and performance
- Requirements for consistent, faster delivery at reduced costs

The Benefits of DevOps

The benefits of DevOps are many:

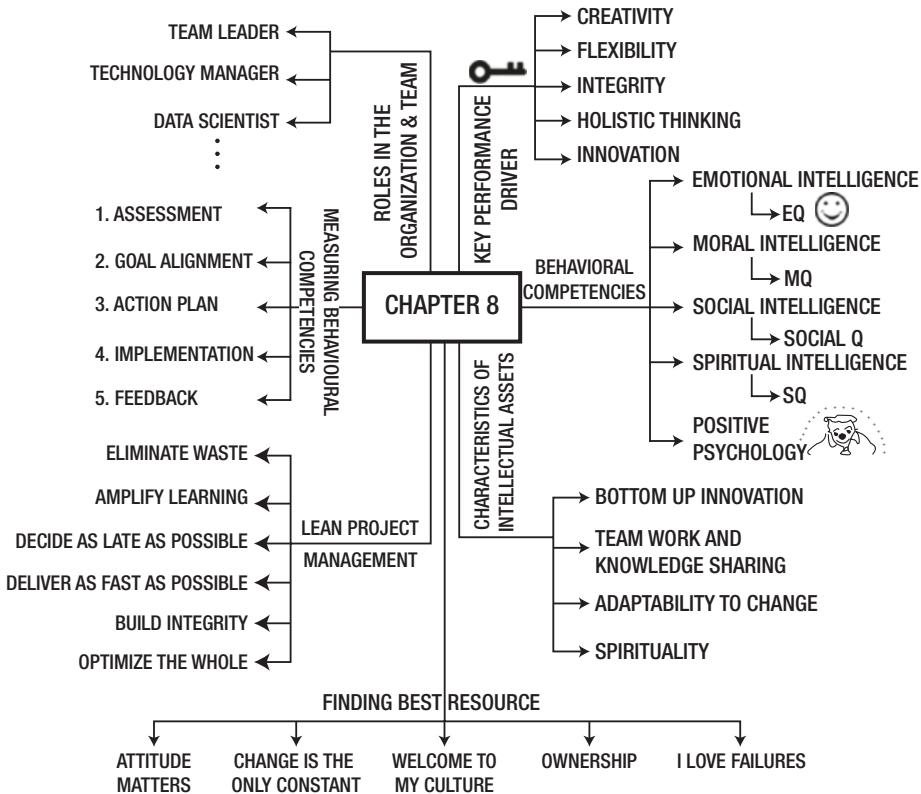
- It accelerates software delivery.
- It eliminates wait times and delays in manual processes.
- It increases the capacity to innovate by reducing/eliminating rework.
- It gives an advantage to capture markets with time to value based on software-based innovation with improved success rates.
- It emphasizes fast and continuous iterations.
- It balances risk, cost, quality, and speed.
- It reduces the time to customer feedback.
- It optimizes risk management with delivery analytics.

Summary

This chapter dealt with the people aspects of machine learning. It explained some of the most important competences that a machine learning team needs to possess—emotional, social, moral, and spiritual intelligence. It also discussed ways to measure them. Apart from those concepts, the chapter discussed the basis of building great teams and the different roles associated with that. For example, it explained the basic characteristics of team leaders, team members, and technology managers. You can have a great team that's not managed properly. If so, that team is of no use.

This chapter discussed Lean project management principles in brief. There are many new and evolving technologies associated with machine learning, including gamification and comics. This chapter took a quick look at those concepts as well.

Mind Map



CHAPTER 9



Let's Wrap Up: The Final Destination

You are now at the end of this book. It was a great journey for me and I enjoyed it a lot. There is a reason behind writing this book—machine learning and its associated technologies are very vast, complex, and challenging. I like challenges, so I choose to write it. Presenting a purely mathematical subject to a population that actually does not need mathematics is a challenge in itself. However, I tried my best to present the facts in the lucid language and make it an equation-free book. My goal was that it could be understandable to all.

The goal of this book was to provide an overview of the appropriate tools and techniques. Chapter 1 set the context for machine learning and its associated technologies for business users. It also provided a brief explanation of technical details, business cases, and their importance in the present business ecosystem in the context of machine learning. The chapter discussed, cloud, Big Data, Big Data analytics, machine learning, and cognitive computing in brief. In a nutshell, the chapter provided a holistic and integrative view of these technologies. The chapter explained how technologies work together to provide solutions to solve business challenges.

Knowing the flow of technologies is not enough to grasp the command of the subject matter, so Chapter 2 presented a thesis of basic practical machine learning concepts. At the same time, it discussed the evolution and history of ML in the context of artificial intelligence and brain science. The chapter provided a snapshot of concepts like generalized machine learning architecture and discussed its associated components. It also showed users how to build or architect a machine learning solution. It also presented details of business opportunity in the context of machine learning, which exist in the multiple areas of industries, domains, verticals, and horizontals. The chapter introduced some innovative models, which essentially give a futuristic view on the possible seen and unseen opportunities and dimensions of machine learning and its associated technologies. In the process, the chapter provided a glimpse of tools, frameworks, libraries, languages, and APIs of the machine learning ecosystem. Machine learning is a highly mathematical and algorithm based subject.

Chapter 3 discussed some important algorithms and their uses. It also provided some guidelines for using algorithms and machine learning models in effective and efficient ways. While discussing the important aspects of algorithms, the chapter provided some success stories associated with particular algorithms/models/techniques. In order

to ensure that users are aware of vital machine learning based trends and the impact on business in the current times, the chapter provided a brief of these topics. Almost every industry today needs agility in its functions and operations. Machine learning itself an agile and innovative field of study. Therefore, a section on the Agile software methodology is provided in Chapter 3.

Chapter 4 explained in detail the technology stacks available for IOT, Big Data analytics, and machine learning and cognitive computing. It explained nearly all the main technologies available for the respective stacks. It also provided a perceptive of technology in current business scenarios. However, that is the challenging task because of the complex nature and availability of multiple products in the same areas. There is also a lot of overlap of products and services among the technologies like machine learning, cloud, Big Data analytics, and cognitive computing. Hence, drawing a clear line between the technologies is difficult.

Chapter 5 built the house on the foundation that the previous chapters laid. It discussed machine learning analytics in detail. It broadly discussed the uses, applications, challenges, and use cases of machine learning analytics in multiple domains, such as manufacturing, retail, marketing, sales, banking, and finance. It provided a comprehensive view of the some of the important sectors of our time, such as video gaming, agriculture, disaster management, oil and gas, fashion, hospitality, travel, and aviation. It also briefly discussed the role of machine learning analytics.

It's important to see these concepts in action, which is where Chapter 6 comes into play. Chapter 6 covered the "real action" of machine learning and its associated technologies. This chapter covered lots of important information on working on machine learning and associated technologies. Chapter 6 contained a detailed discussion about some of established products centered on machine learning, like Apple Siri, IBM Watson, Microsoft Crotona, and connected and driverless cars.

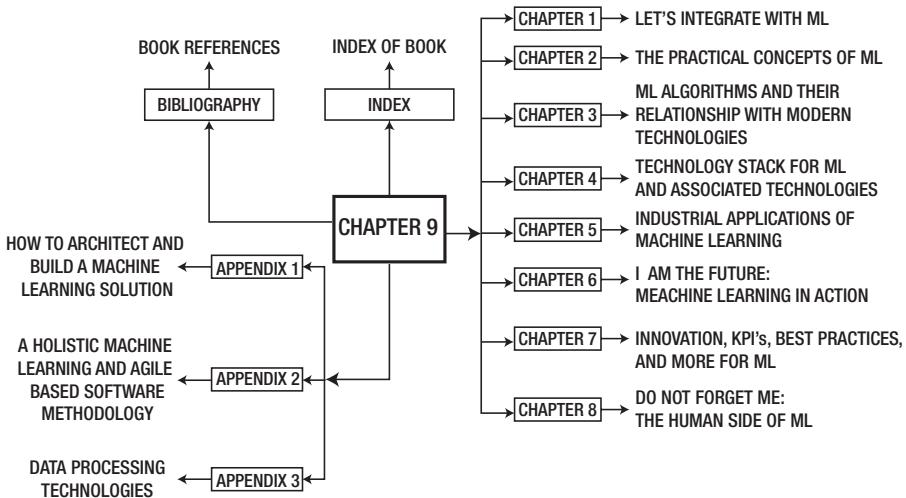
The IT industry is going through transformation, there is absolutely no doubt about it. Numerous reports, trends, and projections indicate this fact. Hence, understanding the current business dynamics is important. Also, understanding the interplay of thoughts and business models between the vendors, clients, and partners is important. Hence, Chapter 7 provided transformational states of current IT vendors to their adoption strategies to new and evolving business models. This is based on the technologies like machine learning. It provided a view of how the process of thought partnership would play its role in the overall scenario. It also covered risk, compliances, best practices, and KPI in the context of the machine learning ecosystem and provided some insight into how the technologies can potentially transform the future state of information technology and business.

Finally, as we all agree that "people" are the most important aspect of this compressive discussion, any thought would not be realized by just mere thinking about them. Ideas need proper support from the people and stakeholders involved in the process. Also, shifting from traditional IT to data driven IT, requires a change in mindset. Therefore, Chapter 8 discussed the people aspects of the organizations and enterprises. It discussed how an effective team is essential for the implementation of machine learning projects and the ingredients required to build that. This is done through the psychological and technical aspects of data culture in the organization, because that is mandatory criteria for a successful organization.

Most of the time we think and believe that our professional and personal lives are different and must not overlap. This is true in some ways, but with the condition that we are all humans, not machines, and therefore, we all carry emotions wherever we go. The workplace is not an exception. However, with the proper management of emotional, moral, and social intelligence of individuals, teams and in turn organizations can get exceptionally good results. The good news is these skills can be learned; they are not like intelligent quotient, which remains mostly fixed throughout to one's life. So, if organizations facilitate their employees to hone their MQ, EQ, and SQ skills, they can achieve multiple benefits, such as better commitment, motivated workforces, and excellent team dynamics. Chapter 8 discussed the important aspects of people and organizational psychology—the cultural and behavioral part of organizations and enterprises.

There are certain critical skills that need to be honed that can potentially lead to excellence in four critical dimensions of human endeavors—physical, emotional, social, and spiritual:

- Complex problem-solving skills
- Critical thinking skills
- Design thinking
- Creativity and passion to excel
- People and talent management
- Communication, collaboration, coordination, and inter- and intrapersonal skills
- Emotional, social, moral, and spiritual intelligence
- Instant judgment and decision-making capabilities
- Service orientation
- Negotiation skills
- Cognitive flexibility
- Right attitude toward work
- Capabilities to apply mindfulness techniques to work, life, and so on



APPENDIX A



How to Architect and Build a Machine Learning Solution

Organizations are looking at technologies like machine learning, IoT, and Big Data to be more relevant in the market and attract customers in the competitive age of technologies, process, and the war of talent. However, the only way to achieve their goals is to provide effective products and respond to market needs in a timely manner. In order to effectively and efficiently take advantage of these technologies, an organization must have a strong foundational infrastructure to store data, execute analytical jobs, and defend its data assets from unforeseen modification or compromise.

Cloud-based infrastructures provide organizations with a flexible platform for data storage, management, and processing. They are also easily scalable (horizontally and vertically) based on need. However, to build a good machine learning solution, the requirements, needs, vision, and practical specific use cases must be clear. A well-designed cloud-based infrastructure can easily add new capabilities.

In the recent times, machine learning implementation has become less expensive through the use of cloud infrastructure. Therefore, chances were high that technology would be misapplied. Cloud providers often highlighted that machine learning would provide companies with huge benefits, but this is a subjective statement and depends on multiple factors. Therefore, making a proper, rational decision is the key. The value and benefit of a machine learning solution will not be realized if it is applied to systems where it is not required. For instance, if it is applied to the system where prediction capabilities are not required at all or appropriate data is not available.

Generally, a machine learning solution should not be implemented to replace existing systems or replace an existing data store. However, to build a machine learning solution, organizations need a solid data strategy, infrastructure, architecture, and workflows. These help ensure the high-quality data availability across organizations (LOB, UNITS), which are linked to rapid analysis and do not expose the organization to risk through data compromise. This also helps them meet compliance challenges.

Here are the common steps an organization must take before and after kicking off machine learning projects. These must be addressed for an effective and efficient machine learning project implementation:

- Define the scope.
- Review the existing system and data governance structures.
- Revisit security policies and tune them per current needs.
- Generate a map of existing workflow and relationships between applications and data stores.
- Create infrastructure, process, and technology maps and highlight strong and weak relations among them.
- Define the business vision for machine learning.
- Determine the suitability of technologies for the solution, define business drivers, call out risks, and establish business cases.
- Define migration strategies for the application, infrastructures, and services.
- Secure the budget and resources.
- Define the operational model.
- Create an implementation roadmap.
- Determine the implementation plan.
- Implement it.
- Evaluate the implementation.
- Incorporate feedback iteratively.
- Modify and fine-tune the strategies based on the analysis of feedback.
- Follow the usual cycle.

The primary value of Big Data and machine learning is to bring flexibility and insight through analysis of complex data sets. Many associated technologies will be part of this suite, including predictive analytics tools, IOT, and cloud technologies, as well as data modeling, data quality, and cognitive computing frameworks. However, the most important step of any analytical workflow is an efficient data process.

The following steps should generally be followed to convert data to insight to its consumption. Following these steps involves confirming that high quality data is considered. Also, these would help data scientists analyze the prepared data in the correct manner.

These steps help to convert raw data to insight:

1. Gather: Gathering data from heterogeneous sources.
2. Discover relationship: Discover the relationship in the existing data set.
3. Organize: Organize and then reorganize the data set for efficient and effective utilization.
4. Analyze: Identify and analyze the relationship.
5. Generate insight: Generate insight after the analysis of data.
6. Report: Report the insight in user understandable format.
7. Consume: Consume the insight for the business purpose.

Architectural Considerations

The technical architecture for a machine learning solution must be built around need and requirements. Therefore, while designing the machine learning solution, the key design considerations must align with these factors:

- Know your need: Identify your need and define the use cases accordingly. This will enable proper prioritization of work, section of technology, scalability considerations, seamless systems, and data integration.
- Define operational strategies: Define the operational strategies beforehand in order to execute the solution effectively.
- Be optimistic about scalability and performance: While creating machine learning solutions, an optimistic approach is required. You have to believe as time passes that your organization will grow and evolve. Therefore, while you are designing the solution or architecture, your platform must be capable of incorporating the growing demand of data and must take care of analysis without much change. It must be able to handle data expansion effortlessly.
- Strong data access and retrieval strategies are key: Easy to understand interfaces, effective tools for storing data, optimized platforms, and excellent handling capabilities of unstructured data are some of the parameters that must be considered during the design. These parameters facilitate efficient and effective ingestion and processing of data.

- Security controls, logging, and auditing: Security is a key consideration for machine learning solutions. Identity management, auditing, and access controls must be designed to cater to the risk levels of the organization and be efficient enough to handle compliance needs. Access control implementation must be consistent between access methods.
- DevOps and Analytics Ops (refer to Chapter 7 for details on these concepts): Incredible operational value comes from storing and processing heterogeneous sources of data in a machine learning solution, especially in the cloud environment. Therefore, it is difficult to manage them manually. Hence, the preferred solution is to automate deployment and recovery. This would lower the operational problem on the IT team when making changes and responding to incidents.
- Be synchronized with advanced capabilities: Implementing advanced capabilities, like APIs, parallelization, and cognitive capabilities is the key to an effective machine learning solution. Therefore, synchronization with the latest advances is a must.

Cloud Adoption of a Machine Learning Solution

When organizations are planning to put their machine learning solution on the cloud, they need to adopt a few specific steps and strategies. In cloud-based environments, ensuring environment availability, reliability, and scalability becomes important. It is more relevant in a Big Data/machine learning scenario because of the real-time demand for insight. Therefore, to provide analytics and machine learning as a service, this is a high priority.

Blueprinting is a very important activity for designing any architecture. Therefore, a brief description it is provided in the next section. However, these are high-level views. If you need more detail, consider dedicated literature for the appropriate setup.

Blueprinting and Machine Learning Projects

Blueprinting an IT project involves the following:

- Brainstorm with business and technology stakeholders to elaborate, align, and document the scope of the stated business problem
- Translate this problem further to high-level requirements.
- Come up with various possible technical solutions (including high-level costs and timelines).
- Align and secure sign-off with the best solution.

Subsequent to this exercise, the budget is secured for the implementation project and a project team is identified and installed. The team refers to the blueprinting documents as high-level requirements that furnish the technical requirements, followed by subsequent SDLC phases.

It is extremely important to spend time in the brainstorming sessions to understand the business problem in detail from the business stakeholders.

The business stakeholders have a tendency to state the problem at a very high level. Create a questionnaire to probe for the necessary details. That questionnaire should cover aspects such as:

- What is/are the base issue(s)?
- How is it impacting the business or performance of duties?
- Are there any financial impacts of this issue?
- Is the stated functionality actually going to solve the base issue or create new ones in the future?
- Has the business tried to solve these issues before?
- If yes, what were the shortcomings of the previous solution?

For a successful blueprinting exercise, it's imperative to include all the relevant stakeholders. Here is a typical list of stakeholders and the area of contribution.

Individuals/Groups	Contribution
Business teams	Sign off on the requirements and the chosen solution.
Architect/Architectural group	Sign off on proposed solution compliance to organization technology architecture.
Designer/design group	Provide input on current state of the system design and contribute to proposed solutions.
Project manager	Manage budget, resourcing, talent, timeliness, and coordination of the project.
Technology manager	Provide roadmap of the technology to the project. Interact with the architect/architecture groups to make sure technical smoothness of the project.
Business analysts	Help to understand current business logic and process and give the current state and data flow.

APPENDIX B



A Holistic Machine Learning and Agile-Based Software Methodology

Workforces in the IT/IS industry are comprised of humans and their complex social, moral, emotional, and spiritual behaviors. When employees come to work, they bring their psychological state of minds with them. This affects their interactions with the stakeholders and other activities at work. Having high-level technical skills do not automatically mean high performance, unless the team members are committed, motivated, and enjoy their work. Therefore, organizations and in turn managers and leaders have to understand the importance of team members' psychology and behavior at the workplace, which includes their stress and conflict-handling skills.

Employee communication and collaboration abilities in the workplace (especially in the IT industry) play a critical role in project success. Alignment of employee values, skills, competencies, and goals with the organization and with clients is important for good results. Also, proper understanding of the philosophy of technical methodologies is one of the factors for achieving excellence in the deliverables.

Many academic studies and professional viewpoints have recognized the significance of managing emotions (emotional intelligence, EI) in the workplace. The ability to navigate and facilitate social relationships (social intelligence, SI) and the ability to apply universal principles to one's values and actions (moral intelligence, MI) toward workplace success and organizational efficiency and effectiveness has gained recognition in professional cycles (for details, refer to Chapter 8).

Several emotional intelligence training programs have been established to tune employees to the organizational culture and vision, but no framework has been developed (so far) to address employees' emotional, social, moral, and spiritual competencies holistically.

The rationale behind this appendix is to underline the importance and application of emotional, social, moral, and spiritual intelligence in the software industry and with technology companies. It also highlights how these competencies can contribute positively toward an organization's quality of service and deliverables, which will ultimately lead to organizational success.

It also discusses an integrative software development methodology based on holistic intelligence (= IQ+ SQ+ MQ+ EQ+ Social intelligence+ ingredients of positive psychology). Technologies are changing dynamically. Every day, something big is happening in the technical space. But the software methodologies have not changed over the last few decades. They are forced to fit to the existing ones with the small changes to accommodate new generations of technical project demand.

The Goal

This appendix presents a software methodology that's based on the Agile software development principles and psychological concepts. The proposed methodology is effective in designing, executing, and testing highly technical, complex projects, which often need motivation, focus, and commitment from all levels, starting from programmers to clients to leaders. Big Data and machine learning projects fall under this umbrella (however, they could be applicable to any project). This framework uses integrative and innovative methods and models to diffuse different leadership techniques with information technology (IT) and software development.

Proposed Software Process and Model

Agile is a fundamental change in how people manage projects if it is compared to waterfall techniques. Delivering workable software on time is what actually measures the success of a project. However, software delivery is not enough. The quality of the delivered project, stakeholder satisfaction, and workforce happiness are also very important. If the workforce is happy, they will be more productive, creative, and innovative and therefore be able to create more robust solutions. Existing software methodologies typically cater to the few administrative and technical success factors of software development projects, like timely delivery of workable software and keeping projects within budgets. Often, behavioral and psychological success factors are not being accommodated in the project in any considerable way.

Thus, the overall existing process, including the software methodologies, need to change the fundamental way of thinking. Organizations have to change or fine-tune the old management style by making it more dynamic and customizable, per project need and demand. One standard management style across the organization will not be of much use. Customized and personalized management styles on a project basis are the need of the hour. The behavior of the programmers—their psychology and skills—needs to be adjusted or modified based on the need of the project. This can be done by using machine learning, Big Data, and cognitive computing techniques.

The machine learning analytics based software development methodology is capable of bringing dynamism and agility to the development methodology itself with continuous learning and adaptability. The expectation is that the model must learn from the continuous changing behavior of the people who are the part of the project and in turn with the organization. The model can analyze all the data available in the organization in all forms and suggest the appropriate customized software process and methodologies based on the availability of skills, processes, technologies, and people.

This includes charting out the guidelines for planning, developing, and executing in an automated way with no or very little human intervention.

The model will also suggest the appropriate customized software methodology based on the requirements. For example, the machine learning and predictive analytics techniques will enable the model to evaluate and analyze the requirements, including inputs from similar projects that the organization delivered in the past. The model can study the scope of work by using SOW documents, accessibility of the self-components, present talent availability, time to deliver the project, character, and behavioral analysis of the stakeholders/team members, and then determine that the project needs a mix of Agile, waterfall, and Kanban methodologies. Then it would generate customized methodologies with the guidelines for implementation, process, and other action items. It then can predict its success percentage on the solid foundation of data, statistical techniques, and analytics.

Problem State

Most software methodologies are based on mathematical and statistical techniques and not on the people factor. Therefore, several problems occur. Although all methodologies are implemented by humans, they do not consider the psychological state of the human being on work during the overall project lifecycle. It is well known that overall productivity and project success depend heavily on the psychological well-being of the individuals and of the group. For any project to be successful, we have to take into consideration the human factors along with the technical factors.

Solution

Holistic intelligence maps the complete personality of humans. People having holistic intelligence can communicate with the outer world effectively and efficiently, and also with their inner world (their own minds) with confidence. The proposed software development methodology is the integration of holistic intelligence with Agile methodology.

Holistic intelligence is applicable everywhere—during the requirements gathering, design, testing, and implementation phases of software development. It deals with humans and their psychological states and human intervention and involvement exists at all phases of the software development lifecycle. Therefore, to make the methodology more robust and efficient, there is a need for holistic thinking, which includes technical, behavioral, and intellectual skills. Proper application of this proposed methodology will increase the knowledge workers' productivity. For example, in the process of implementing software, the programmers' emotional and social competences become important, because if these competencies are present in the programmers, it will help them better interact with team members, clients, and other stakeholders.

The humans/programmer/knowledge workers are not necessarily equipped with all these competencies. You must be aware of all of their hidden potential at the start of the project. So, once the team is onboarded with the bare minimum qualifications, the desired competencies should be incorporated in the progress of the project. This can be done in an iterative way, whereby the core competencies are cultivated first in the people involved and the rest later... exactly like the Agile methodology.

As projects proceed, training is added to the cycle to improve the holistic intelligence parameters of employees, resulting in more efficient and well-prepared individuals. The training program will be done again in an iterative way: training ► evaluation ► performance ► feedback ► more training. That way, the right feedback can correctly assess individuals' progress and competency without having an adverse effect on the project.

Working

This methodology can be technically implemented in multiple ways. One method of applying it is described next.

The Process

When companies or organizations recruit employees, they ask for all the information to determine if the prospective employee is the right person for the job. The information ranges from grades to professional experience. In time-based projects, it is very important to pick the right set of people; hence, this information matters because it provides insight on the person's technical expertise. These information in turn could be mapped to the professional expertise of the resource to the specific needs of machine learning, cognitive computing, and Big Data analytics-based projects.

Also based on these techniques, a model could be created that provides appropriate suggestions based on the project requirements. This "insight" is generated on the basis of information stored in the database that defines an individual's intellectual capability. It also helps an organization pick people who are suitable for projects in the centralized way.

Many organizations have similar databases; however, they do not contain all the behavioral data of an individual. This ranges from individual details scattered at multiple places, including social media and other unstructured data. This need justifies the importance of integrative database or "organizational professional database". The "integrative database" or "organizational performance database" will contain all the content of the employee/ perceptive employee to the extent of behavioral history, personality type, strength and weakness, and emotional and spiritual parameters.

In Agile methodology, when teams develop software, they use pair programming for coding. Pair programming is a software development technique in which two programmers work closely together at one workstation. The driver transcribes code while the navigator analyzes, accesses, and reviews each line of code as it is typed. In this way, while reviewing, the navigator can deliberate the strategic path to the coding work. The navigator also comes up with ideas for improvements and provides insights on future glitches to address. The driver's main responsibilities are to focus on the "tactical" aspects of implementation of the present task. In this process, the driver generally uses the navigator as a safety net and guide.

The integrative database can be helpful in this type of situation, in order to pick the right resources that would play these roles based on the gathered insights on the data stored. Picking the right resources will result in cooperative and more efficient teams, because team members are selected on the basis of behavioral patterns. This is just one example of applying the database to many development methodologies.

Relevance and Future Direction of the Model

No attempts have been made to date to combine social and spiritual intelligence with Agile software development methodologies. These factors (social and spiritual intelligence) help develop one model/framework and innovative methods/calculations, which will provide a new dimension to software development techniques. To improve this methodology, multiple tools need to be developed. A few are mentioned in Figure B-1.

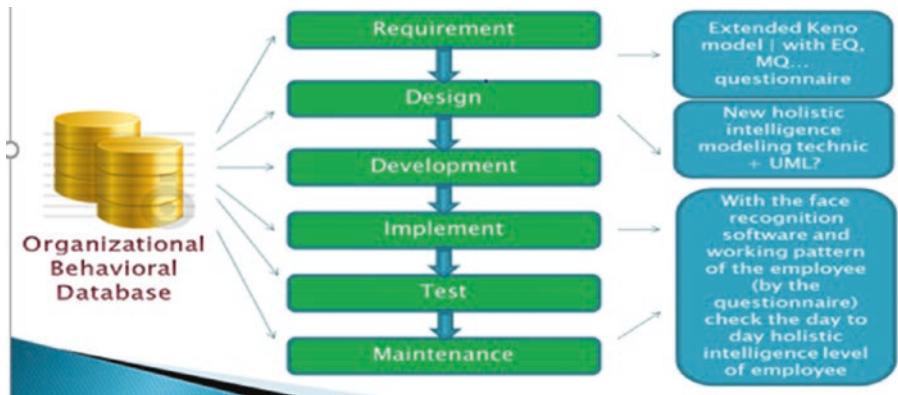


Figure B-1. Combining social and spiritual intelligence with Agile software development methodologies

The best way to change problematic behavior is to understand the issues that drive it and then design a plan to combat it. For example, violent conduct may be motivated by distress and anxiety, by cluelessness, or by a wish to govern and control team members. The workplace should be a place of peace and positivity in order to enable quality work and innovation. Teams/individuals are supposed to contribute toward and maintain that peace. One of the prime reasons for emotional imbalance, including aggression, is fear and insecurity.

These toxic behaviors can be controlled if managed with tolerance and reassurance. Unmanaged emotions worsen all types of problems. Therefore, better understanding of emotions and social behavior is required even in the workplace. The better you comprehend how other individuals see the world and what inspires them, the better you will be able to motivate them to perform in helpful ways. The more you identify, analyze, and understand what inspires individuals of different personality types, the better you will be able to shield yourself and inspire them to collaborate with you and provide the work per the requirements. Toxic behaviors generally create problems in software development environments/teams, because ultimately software development is a team activity. Individual-based projects generally fail. The chances of success of team-based projects are high, no matter how complex they are.

This proposed model can be helpful in understanding difficult people and then correcting their behaviors. The goal is to align them with the organization's vision, mission, and propose. Ultimately, this harmony will percolate down to the project level.

APPENDIX C



Data Processing Technologies

Multiple tools and technologies for data processing are described under the Big Data analytics technology stack in Chapter 4. However, many other technologies exist as well, and it is good to know about them for a complete understanding. Covering all the tools is beyond the scope of this book, but the tables in this appendix provide brief explanations of some of them.

Table C-1. Data Gathering and Processing Tools and Technologies

Purpose	Tools
Data integration • Enterprise data warehouse • Enterprise reporting	SAP, BDOS Oracle DI, IBM Data Stage, IBM Information Analyzer, Business Glossary, IBM MDM, DB2
Data modeling • MDM data conversion/migration	Trillium, D3JS, IDL, Riverstand, TIBCO Spotfire, 17 Tableau, SSRS, SSAS, PowerTools
Data profiling • Data quality • Data governance	Erwin, ER/Studio, Visio, DB Designer
Data integration • Enterprise data warehouse • Enterprise reporting	SAP, BDOS Oracle DI, IBM Data Stage, IBM Information Analyzer, Business Glossary, IBM MDM, DB2
Text mining • Data streaming • Complex event processing	SAP MDM, Oracle MDM, 18 Oracle Essbase, 19 IBM, COGNOS, MicroStrategy, SAP BO, Oracle OBIEE
Big Data • Social media	SAP HANA, Oracle Exadata, Oracle Times 10, Terradata, IBM Netezza, HP

Table C-2. *Analytical Tools and Technologies*

Purpose	Tools
Cluster analysis • Statistical testing, such as t-test, chi-square, and ANOVA • Latent class analysis • Discriminant analysis	SAS, SPSS, R, Python, Knex, Knime, Weka, MiniTab, Mahout, ilog, Matlab, Statistica, Evolve
Descriptive analytics • Univariate analytics • Bivariate analytics • Multivariate analytics	Hadoop, HBase, Hive, Spark, Storm, Splunk, Pig, Oozie
Monte Carlo analysis • Conjoint analysis • Retention analysis • Survey analysis • Lifetime value analysis	MondoDB, CouchDB, Neo4J, Infinitie, MarkLogic, Amazon Dynamo, TITAN
Campaign analysis • Pricing analysis • Survival analysis • Pareto analysis • Quality control analysis	UIMA, Rapid Miner, Tesseract Café, Brandwatch, Crimson Hexagon, Radian6, Symosis, Lithium
Chaid analysis • Regression analysis • Decision trees • Neural network	Apache, Cloudera, 16 Hortonworks, MapR, IBM, Cassandra, Hypertable, Amazon

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Consultant	Solutions	C2G Partners	Consultants
Data Mind	DataInsight	CAC group	Dextro Analytics
Data Miners	DataLab	Cambio	Differentiated Analytics
Datalya Consulting	DataMine Lab	Technologies	Directing
Data Mining Experts	DataMineIt(SM)	Capgemini	Discovery Corps Inc.
Data Mining	Datamotus	Caserta Concepts	divis intelligent solutions
Technologies	Datascope	CBIG Consulting	DLabs
Data Science	Analytics	CDO Advisors	Nest
Partnership	DAYCHE Data	Centre of Excellence	Fitzgerald Analytics
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