A Survey of Machine Learning Methods for Network Planning

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ABSTRACT: In this chapter, machine learning, artificial intelligence, network planning, and the connection between these concepts are discussed in general terms. In order to generate new predictions, machine learning models attempt to exploit the fundamental relationships and patterns in your data. Image recognition serves as a common illustration. We are aware that the connections between image pixels and labels (such "dogs" or "cats") are intricate. It is highly challenging to find this intricate relationship using an equation that takes the image of a cat or a dog as input, and it constructs a new equation for each label, making it a scalable solution. Instead, machine learning techniques look for situations where the pixels and labels don't match. The goal of machine learning is to identify if an invisible image depicts a dog or a cat by removing probable patterns using a training set that includes several instances of any type of cat or dog. Similar to this, machine learning techniques may eliminate the relationship between chemical systems and properties when given sufficient examples, as well as the ability to otherwise dissolve extremely complex equations.

Keywords: Machine learning, artificial intelligence, networks, and network planning.

1. INTRODUCTION

Our lives now depend heavily on technology. Every day, it keeps evolving. It will continue to be very important to us in the future and will demonstrate changes. People lead more pleasant lives when technology is thus advanced. People are employed in this industry to preserve this comfort. Defining the technology of the future is another name for artificial intelligence, which is a technological capability. It is made up of the words "artificial," which is used to characterize human-made copies of natural things, and "intelligence," which refers to the capacity for understanding and thought, rather than being naturally occurring. Although it is a popular misconception, the idea of artificial intelligence is not a system. Systems now include artificial intelligence. In general, artificial intelligence is the study of human thought processes and the creation of artificial commands that are comparable to these processes; in other words, we can characterize computers as having the capacity to carry out human activities. It enables machines to tackle challenging issues in a manner akin to humans. Effectively uses computers to solve problems that call for intelligence and thinking. However, the roots of artificial intelligence were formally laid in 1956 at the "Dartmouth College Artificial Intelligence" conference, which was led by John McCarthy. At the Massachusetts Institute of Technology (Massachusetts Institute of Technology), John McCarty and Marvin Minsky established the first Artificial Intelligence Laboratory in 1959. You will be seriously mistaken if you think of machine learning as just another definition of the idea of artificial intelligence due to the connotation of its name. Though essentially a subset of artificial intelligence, machine learning denotes a more specialized area of research.

Machine learning is an artificial intelligence application that enables the system to automatically learn from experiences and develop. It allows the machine to learn freely without programming and constant control. With some developments in artificial intelligence, machine learning has advanced. The initial innovation involved teaching computers how to learn and how to carry out any conceivable task once it was realized that providing the information required accomplishing the tasks. The development of the Internet ranks as the second-biggest innovation. The development of the Internet opened up a previously unheard-of potential for the storing of information. The machines could now access the data that was previously unavailable to them owing to storage constraints. It is now more effective to instruct computers to think for themselves rather of relying on them to perform tasks due to the growth in the amount of data they can handle. By enabling computers to learn, machine learning algorithms act as their brains, making them smarter. Classification enables big tasks to be completed in a variety of activities related to the study of the estimated modeling and the analysis of data. Regular exposure to new data and experiences of these algorithms. The introduction of instructional data, such as examples, first-hand experience, directions, and observations to look for patterns in the data, marks the beginning of the learning process. New input data is added to the machine learning algorithm to verify that it is functioning properly. The results and estimation are then verified. By feeding the computer more data, one can activate the algorithms that lead to "learning" and enhance the output.

The algorithm is repeatedly retrained until the intended output is discovered if the estimate is not what was anticipated. As a result, the machine learning algorithm is able to continuously learn on its own and produce the best response, which will progressively improve its accuracy over time [1–5]. After the algorithm has finished its learning phase, it can apply the knowledge to tackle related issues based on various data clusters.

2. EXTENT OF PAST WORK

Depending on your source, you may have heard a lot of positive or terrible things about machine learning (ML) and artificial intelligence (AI) in the modern day. The majority of us immediately think about artificial intelligence when it is brought up. 2001: Samantha in Her (the movie), C-3PO, Data from Star Trek, or HAL from A Space Adventure. And many people have never even heard of machine learning as a distinct field. Although they are frequently presented in a fashion that allows for interchangeability, these expressions are not the same. We might claim that machine learning has evolved from AI in the broadest sense. Google trend graphs show that before machine education overtook AI in September 2015, searches for AI were more prevalent. Even if it was not an artificial intelligence practice, machine learning has become one of the key ones. Some people define machine learning as a means of obtaining a branch of artificial intelligence. It's shameful if you're still having dreams about killer robots that were sent to Earth from the future. The impact of AI and machine learning goes well beyond what is "just" the future of humanity.

A type of artificial intelligence known as machine learning enables computers to learn without the need for programming (Samuel, 1959).

Machine Learning History (Timeline)

1950s: Early machine learning research was carried out using straightforward techniques.

Bayes approaches for probability in machine learning were first introduced in the 1960s.

AI Winter in the 1970s was brought on by skepticism over the efficacy of machine learning.

Backpropagation was rediscovered in the 1980s, which led to a resurgence in machine learning research.

1990s - Machine learning work has switched from an information-oriented approach to a data-

oriented approach [6–10].

Scientists start to develop computer systems that can process massive volumes of data, generate outcomes from results, or "learn" from data. Recurrent neural networks (RNNs) and support vector machines (SVMs) have gained popularity. Complexity fields were first calculated using neural networks and super Turing computation. Support-Shooter Clustering (SVC), other nuclear approaches (kernel), and erratic machine learning techniques gained popularity in the 2000s. 2010s - Deep learning is now feasible, which has made it a crucial component of the machine learning software services and applications that are extensively utilized.

3. Why Machine Learning

Machine learning has shown to be useful since it can solve issues at a speed and scale that the human intellect is unable to match. To recognize patterns and correlations between input data and to automate repetitive tasks, it is possible to train the massive computing power behind one or more specific tasks. As stated in the beginning, it is impossible to assign labels like "good" or "bad" to those who approach a system with malicious intent. The burden is decreased and scenarios that people cannot capture or detect can be solved without any issues if a model is constructed using a data set in which the genuine processes are real and fictitious transactions are labeled with a fictitious label [22] [23].

Application of machine learning and work environment

First and foremost, data science domains including data analysis, data processing, data visualization, and feature engineering should be well-known in order to apply machine learning approaches to any field. The environment in which the code will be written is another need. Jupyter notebooks are one of the most frequently utilized environments in this division.

Workflow for machine learning

The overall workflow for machine learning changes depending on the kind of problem you are attempting to address from the data set at hand:

- Discovery Modeling,
- Data Analysis,
- Data Cleaning,
- Data Processing

4. Network Planning Using Machine Learning Methods

Network design

Since the network is at the core of most contemporary businesses, network design may have a significant impact on the bottom line. It takes a special blend of project management and technical expertise to strike the correct balance between network performance, safety, backup, and cost. We will delve further to assist you with your next Network Design project, offer a fundamental framework you can use, and go over some best practices you should keep in mind as you proceed. The use of planning and designing communication networks is known as network design. Prior to network application (when you really distribute and configure what is created), network design begins with the identification of business and technical needs [11–15]. network planning, network analysis, hardware selection, IP addressing, and application planning. Network design is usually a straightforward process in households and small offices. The network design process is frequently extremely complicated in large business networks and involves numerous parties.

PPDIOO and other Network Life Cycle Models information

Let's review the network life cycle model before getting into how to create a network. Network

life cycle models are useful in the context of network design because they help to clarify where and how the network architecture, network components, and overall structure fit into the larger life cycle.

The Cisco PPDIOO (Prepare, Plan, Design, Apply, Run and Optimize) model is one of the most widely used network life cycle models.

Prepare: Here is where high-level requirements and strategies are defined. Your contribution at this point can, for instance, contain specifications and fundamental research.

Plan: Based on the data gathered during the planning stage, this step deals with specific network requirements.

Design: The design phase involves developing a comprehensive network design using the data from the preceding two stages.

Apply: The distribution and setup of the network infrastructure take place at this point. Typically, the test is run at this point to validate the design.

Run: This is a phase in the network's life cycle for use in production. At this point, monitoring is crucial to ensuring that the network operates as intended and that issues can be fixed quickly.

Optimization: Most networks need to be adjusted and optimized at some point in their life cycles. The definition of the change occurs at this point. The loop begins at the beginning when planning and implementing significant changes.

Network Design - PPDIOO

Cisco's PBM (Plan, Create, Manage) and NDLC (Network Development Life Cycle) are two other network life cycle models. The general phases (information gathering, design, application, and improvement) and cycle structure are the same regardless of the model you select. Understanding any network life cycle and how the network architecture fits in is crucial.

Step -by- Step Network Design

Let's explore the procedure for constructing a network infrastructure now that we are familiar with the principles underlying the network life cycle model. Although the scale and complexity of your network design details vary, this fundamental framework can guide your decision-making.

1. Set the requirements

Any network design project should begin with information gathering and the development of network and technical requirements. The rest of the design falls apart in the absence of clearly stated goals.

Work requirements help you define what you need to do this means:

- Support the new office
- Improve the end user experience
- Cutting Costs
- Follow new regulations
- Improve business continuity

Business demands are compatible with the preparation stage when viewed through the lens of the PPDIOO life cycle model. To ascertain business requirements, you should collaborate extensively with stakeholders. It's time to talk about the technical/functional needs after outlining the job criteria. Sample requirements include:

- Band width
- Security Requirements
- Special protocols that need to apply the project

- RTO/RPO (Rescue Time Target/Recovery Point Target) Number
- Working Time SLA (Service Level Contract)

When establishing requirements, do not disregard the constraints. Budget constraints, for instance, will apply to business requirements. Technical specifications could contain restrictions, including the necessity to support legacy programs.

2. Evaluate the current status of the network
You generally won't start from scratch in the majority of networks. Making life simpler can occasionally be beneficial, but it can also make projects challenging. For instance, there is no need to be concerned if wiring is already there for all setups. However, the present cable is now a problem that needs to be fixed if you are just using Cat5 cable and require Cat6A to handle 10GBaset. It is crucial to know this at the start of the design process, regardless of the state of the network. You should assess the network's present state before recommending any special designs. You should know about network performance, data flow, applications and services on the network, network security, and physical and logical order by the time you complete this phase. Examining current network diagrams, policies, and monitoring tools can be done for this segment. In other situations, you need to employ safety browsers and automatic network mapping tools to get a complete view.

3. Design your network topology
You can begin blocking the operational network components after understanding your requirements and the present state of the network. You must take into account both the network's logical and physical elements in this stage.

Consider the following while designing a physical network:

- Operation of copper and fiber optic cables
- Required number of key port points
- WiFi Access Point Position
- Shelf layout
- Cooling and Power

The logical network design performs the following:

- IP addressing/sub -network
- VLAN
- Data flow

4. Network topology
You ought to be able to produce the static maps of the logical and physical networks you designed after completing this step.

5. Tip: Keep in mind cloud networks and workloads. Internal and cloud data streams must both be considered in your network design. Let's examine the idea of two fundamental network designs before going on to the next stage: hierarchical network layers and design from top to bottom and from bottom to top.

5. How are the core, distribution, and access layers organized in a hierarchical network

design?

Three fundamental network layers are the foundation of the conventional hierarchical network design. Each layer controls a different area of the network's data flow. Layers [16–20] include:

Core layer: This layer controls traffic flow between various geographic areas. In other words, it serves as the network's support system. High-performance, pricy core routers perform best in the core layer.

Distribution layer: Between the access layer and the core layer comes the distribution layer. It serves as a barrier and uses networking concepts to control or permit data flow between various sub-networks in the network. The distribution layer partners include less expensive routers and L3 switches.

Access layer: The layer comprising user computers, printers, and VOIP phones is known as the access layer. The packages in this layer are changed and traffic is directed by smaller "access switches". You might not always require three layers. For instance, numerous network distribution layers entirely exclude

From top to bottom and bottom to top design

From top to bottom and from bottom to top are the two methods used for network architecture. When developing your network from top to bottom, you begin with the application layer, build the model, and then reach the physical layer. The layout is reversed from bottom to top. The idea that working your way down from business requirements is preferable is frequently held. Though it typically takes longer from top to bottom. Starting with the physical components of the network and moving higher, the network design works from bottom to top. Because it locks you to particular results before getting to the application layer on the users, creating a network from bottom to top may be faster, but it also forces you to compromise on the missing needs or expected results.

Select hardware and software

You must specify the gear and software you'll be using in this phase. In some circumstances, this happens concurrently with step 3. In other circumstances, some software or hardware can be predetermined at the start of the project. After learning what the network should be able to achieve, choosing specific hardware and software to employ typically gives you the most freedom. At this point, specific cables, racks, network hardware, servers, apps, cloud services, etc. are needed to realize your concept. You'll decide. Think about any supply chain issues that could arise from large or customized orders. Your project's completion may be delayed if you don't have your access switches or structural cables in a timely manner.

Application plan and beyond

Now that you've chosen your gear and software and designed your network, you may plan the application and more. To complete this step, a distribution, configuration, and testing strategy must be developed. A small-scale test distribution may be included in some circumstances (often larger nets) in order to confirm the viability of the concept before scaling it up.

Rigorous The important components of creating a plan successfully are project management and communicating with stakeholders. Network distribution involves a lot of moving pieces, so your plan should consider project milestones, change management, and significant outputs. You will also require a transition strategy if the network is to be run by a different team from the one that created it. If you are in charge of managing an advanced network, it's critical that you have a strategy for monitoring and maintaining the network.

Network Design Application

Now that we have a framework to follow, let's look at some network design best practices to help

us make more informed choices.

1. Integrate security early

The notion of "shifting security to the left" in the Devops community is well-liked for a reason: it is effective. You may lessen the likelihood of running across security vulnerabilities at your security position by prioritizing security from the start of a project. Additionally, because the majority of decisions are already made, security will not be applied inefficiently, increasing network performance is more likely. Prioritize and establish performance and security requirements at the project's outset. In theory, we should all understand that "security is everyone's responsibility," but in reality, this isn't always the case. Stakeholders that care about safety are typically a good idea for projects.

2. Know when to use from top to bottom and from bottom to top

When you start from scratch, the design from top to bottom is typically a "better" choice. You can concentrate on company requirements and increase your chances of making the right decision by designing everything from top to bottom. Many network design initiatives, however, do not make financial sense to invest in from top to bottom. Efficiency is significantly more efficient, for instance, if you are already aware with the basic business requirements of your company and you merely need to grow your network or boost the bandwidth.**3. Standing everything**

If you can standardize, standardize. In the long run, troubleshooting, patch, care and asset management will greatly simplify. Some examples of what you can standardize and standardize:

- Home computer name (for example, Printer 5. office2.lan3)
- Hardware model
- IP address scheme
- Cable color (eg. single color for VoIP, single color for data, etc.)
- Security strategy

4. Growth plan

After a year, the amount of network bandwidth used today will have changed. You should consider how much bandwidth demand is anticipated to increase over the network's lifetime and design for this scenario. The solution is simple: just add more bandwidth in accordance with your needs. However, it is more crucial to make sure the network is adaptable and modular enough to quickly accommodate growth. Even if you cannot predict your future needs, you can build your network with the possibility of having to scale it in mind.

5. Create and continue network documents

Missing, outdated, or missing network documents result in time loss, frustration, and significant technological debt. Make sure your network design and application output contain 1-3-layer network diagrams as a favor to you or your friendly neighborhood network administrator. After making them, make sure to move on with them.

Matters to be considered when designing computer networks

Some of the most crucial considerations in network design are copper and fiber, logical architecture, IP addressing, VLANs, capacity, and WiFi scope. In network design, a lot can happen, and it is simple to miss some details. Here are some crucial ideas to bear in mind when working on your next project.

Editorial request

Regulations that have an impact on the logical and physical design of the network should be taken into account while designing a network. Local construction codes, for instance, may have an

impact on how you manage structural wires. The National Electricity Law in the United States includes specifications for the amount of power needed by your network hardware. Logically, agreements like HIPAA, PCI DSS, and GDPR impact both transfer data and still data. You should take into account these needs when designing a network in order to achieve harmony.

Cyber durability and backup

Corporate networks need some degree of error tolerance since network usability is crucial for business operations. Therefore, current network architecture typically includes n+1, 2n, or 2n+1 backup (or higher). Of course, extravagance and durability come at a financial expense. Your network architecture needs to strike a compromise between backup cost and durability. It would be fantastic if you could consistently obtain five to five (99,999% of working time), but that is not inexpensive!A decent method to balance this is to consider the cost of the deduction time (i.e., how much money you would lose every minute/hour if the network fails) and compare it to the possibility that your present backup strategy won't work properly.

Cloud and internal

The optimum location to perform a specific workload is no longer always locally. Once your job and technical requirements have been established, you should carefully assess if cloud networking is a solution in and of itself. However, when the cloud is more suited (and vice versa!), be sure to lock yourself into an internal solution. We won't revisit the entire cloud and internal topic here.

Cooling and Power

It is simple to ignore the network's cooling and power needs. Don't commit this error! Your power distribution system won't ever function properly if you don't supply for your power needs. Your new network equipment may overheat and break down before its time if you do not consider the overall cooling of the equipment. Observations on power and cooling

- Verify that the electrical boards and plugs you have are appropriate for your new appliance.
- Keep Power over Ethernet (Poe) loads in mind when sizing your UPS (battery backup) and other power sources.
- Check that the server room's cooling system can handle the extra heat generated by the new network hardware, or make cooling-related investments.

No one dimension can be used to describe the complete network design. But if you take the appropriate technique, you may produce a design that meets your company's requirements. Of course, as PPDIOO demonstrates, a network does not come to an end after the design phase, as the life cycle model demonstrates!

The creation and use of networks is just the beginning. The real business begins once the network is broadcast. Active network monitoring aids in network maintenance and records your choices for network upgrades or expansion.

6. RESULTS AND DISCUSSION

Estimated maintenance with IoT and IIOT

Equipment maintenance is a difficult and time-consuming operation that consumes the majority of field workers' time and costs businesses money. The Internet of Things (IoT) and the Internet of Industrial Objects (IIOT) employ sensors to gather data about systems and machines, then transmit it to users across a network. In order to assess data like temperature and humidity, the system uses machine learning algorithms to estimate performance and anticipated outcomes. Caterpillar analyzes data from devices and equipment to find trends using machine learning and IoT. Caterpillar discovered a correlation between fuel meter values and the amount of power needed to cool the ship's containers.

Logistics planning

The proper individual receiving the appropriate amount of stuff at the appropriate location is ensured by logistics planning. The management of suppliers and the commodities they send to a company is the main emphasis of incoming logistics. The management of orders, delivery, storage, stock control, and use all involve a number of intricate operations. Businesses may predict and suggest future transactions by gathering information about current planning and fostering a machine learning model. Walmart employs machine learning to boost operational effectiveness. Real-time modifications can be performed and any deviations in the supply chain can be found with the help of the Retail Link 2.0 system.

Retail trade

Large amounts of data are being gathered by retailers and businesses who sell things online. It contains information on consumer demographics, spending patterns, and preferences. In this regard, the main difficulty was to gather data both online and offline and to identify the trends that could have a favorable impact on data pricing, inventory, customer experience, and profitability. Retailers can use machine learning to find patterns in data so they can act on what they learn and improve their interactions with customer brands. Users of websites for shopping and browsing can submit data to e-commerce businesses, who can then utilize this information and market trends to offer customized product recommendations that will boost sales. One of the first businesses to use personalized product recommendations based on shopping and purchase history is retail behemoth Amazon. The strength of these features comes from machine learning. One of the businesses that makes use of Alexa to swiftly access information from its data is the upscale clothing retailer Rebecca Minkoff. In under one second, Minkoff was able to receive the correct answer when he asked Alexa which item from the spring collection was the most popular.

Autonomous vehicles

Future transportation will be safer and greener thanks to autonomous vehicles. The use of machine learning and deep learning by software engineers strengthens computer algorithms that enable a vehicle to make decisions that are comparable to those made by humans. For instance, Drive.ai, one of the industry's most potent software tools, employs the deep learning algorithms of autonomous vehicles to "build the brain." To ensure road safety, the study team adds definitions for features like pedestrians, traffic signals, and road signs to the software. By combining unedited photos with raw data, it evaluates how well an object will be recognized and how to maneuver around an obstruction while travelling on the road [24].

Teaching of writing

Even for seasoned academics, subjects like how to write an article and how to draft an essay might be difficult. Additionally, the supervisor-author relationship can be challenging and lessen motivational slumps. With the aid of machine learning techniques, the automatic writing assessment program ECREE can accelerate this procedure. For instance, the algorithm can swiftly point out the draft regulations to analyze when a student prepares and submits Ecree's review. The computer program evaluates student work based on 36 factors and may provide students feedback in under a minute. Any number of students may submit messages to Ecree. Each pupil may be examined fairly and according to the same standards thanks to the vehicle.

7. CONCLUSION

A area of computer science known as machine learning was created in 1959 as a result of artificial

intelligence research on numerical learning and model recognition. A system called machine learning looks into the development of algorithms that can forecast data and learn as a structural function. Such algorithms work by creating a model from sample entries to make data-based estimations and judgments, as opposed to merely obeying static program instructions. Life has been revolutionized by artificial intelligence and machine learning. The application of machine education is strengthened by the historical evidence. New data mining, curation, and management strategies have also given recently developed modeling algorithms crucial support. In conclusion, machine learning offers a great potential for a relaxed and problem-solving lifestyle that will eventually effect humanity.

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