

Does machine learning have a positive or negative impact on Healthcare?

Anay Chaturvedi

-----ABSTRACT-----

Machine learning is a brand-new frontier in healthcare. Yet, it is unclear if the introduction of machine learning would have a favorable or detrimental impact on the healthcare industry. This paper thoroughly examines this argument. This is accomplished by looking at data that was gathered via an online poll that included 10 questions asking medical professionals about the impact machine learning has on various aspects of healthcare. The results of the study share how automation enhances operational efficiency, communication, and reduces medical error, etc.

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I. Introduction

Machine learning has the potential to revolutionize various parts of human life and nowhere is it more evident than in healthcare. Machine learning is the use and expansion of computer systems that can learn and adapt without following explicit instructions. It runs on decisive data in which algorithms and statistical models create an analysis. This analysis can draw inferences that can be transformed into a data-driven conclusion.

Some examples of real-life applications are internet search engines, email filters to sort out spam, websites that track purchases to make personal recommendations, banking software that recognizes unusual transactions, and voice recognition systems. With this in mind, machine learning has eased its way into the medical world. Some aspects where this is being used are X-rays and MRI scans as it develops better diagnostic tools that can analyze medical images. Another major example is the use of systems that are dedicated to monitoring the patients' conditions. If drastic changes occur the system will create alerts to medical devices. The use of machine learning has evolved and changed the medical staff and the patient's experience in the hospital. It helps with processing large amounts of patient data which then can accurately convert patterns into medical understanding. This then can help doctors strategize and deliver better-informed care.

As AI and the building of models bring positive factors into everyday life, it also has some negative aspects. Some cons that are present: it's expensive and highly error-prone. Meaning the model relies on factual numerical data to get the correct output. Many flaws aren't presented due to error analysis and lots of testing. Moreover, machine learning can help manage the efficiency of healthcare systems. By analyzing patient data and resource utilization, algorithms can optimize resource allocation, reduce wait times, and improve the overall patient experience. Additionally, machine learning can assist in streamlining administrative processes, such as appointment scheduling, insurance claims, and billing, making the healthcare system more efficient and accessible to all. In conclusion, machine learning has the potential to revolutionize healthcare and improve the lives of people all over the world.

II. Review of Literature

Machine Learning has been used for many years as the primary goal was to learn data and provide it to a model. This model will then be able to predict and perform tasks exclusively based on known patterns. In 1952, Arthur Samuel, a computer scientist at IBM and a pioneer in AI and computer gaming, created the term "Machine Learning". That was when he designed a computer program for playing checkers. Samuel developed it to be played on the IBM 701 and eventually demonstrated it to the public on television. The computer improved at the game the more it was played as it learned new inputs and can understand a variety of moves. The brilliant checkers master Robert Nealey played the game on an IBM computer. The computer won. This was considered a milestone for artificial intelligence and offered the public in the early 1960s an example of the capabilities and power a computer has.

As machine learning smoothly transitioned into our world we see new technology in our lives that was never thought possible. One example is Tesla's creation of the self-driving car which is mainly enforced by machine learning. In order for these cars to drive on their own they have to interpret images from their sensors and machine vision cameras allowing the car to understand its environment. The car digests this information to make the best possible decision on what to do next. "They use AI to understand and anticipate the next

movements of cars, pedestrians, and cyclists. This data helps them plan their moves in a split second, and decide what to do from moment to moment. Should the car stay in the current lane, or change lanes? Should it pass the car in front of them, or stay where it is? When should the car brake or accelerate?" These are the important decisions the car has to make, meaning Tesla has to collect the right data to train the algorithms and implement them in their AIs. The more data and occurrences the AI learns the more independent the car will become. The main question is how Tesla receives this large amount of data. The answer is "they crowdsource all their data from the hundreds of thousands of Tesla vehicles that are currently on the roads. Internal and external sensors monitor what Teslas are doing in all kinds of situations." All these scenarios from millions of drivers are transformed into data and eventually fed into a machine-learning model. This results in a super-intelligent autonomous car. As these unique features provide an efficient performance users around the world love it. Users experience something never thought possible on the roads as the car also has advanced technology embedded in it. Some examples are a touchscreen control center with streaming services and a web browser. Tesla has gained popularity throughout the years causing CEO Elon Musk to be the second richest man in the world with a net worth of 140.1 billion USD.

Another example of a real-life application for machine learning is Amazon Alexa. Alexa also known as echo is a natural language processing system structured off of artificial intelligence. You first say the keyword "Alexa" to receive its attention. You then ask a question for example "What's the weather like today?" The device will then record your voice and send it over the internet to Amazon's Alexa Voice Services. The system will send over the relevant and correct output back to your Alexa. An audio file is sent and your Alexa provides you with the information. All this happens in an instant so the user doesn't wait for a response. Data and machine learning are the foundation of Alexa's function so the more data it collects the more accurate it will become. One example is "Every time Alexa makes a mistake in interpreting your request, that data is used to make the system smarter the next time around. Machine learning is the reason for the rapid improvement in the capabilities of voice-activated user interface." This is an important part of Amazon Alexa's success as this product requires high-quality data because the machine has to understand verbal human language. Alexa not only answers user questions but is also connected to smart home devices. Alexa can turn on your TV, turn on lights, lock your doors, set a certain temperature, and more if used with applicable technology. This brings a new experience to the user as most household items can be controlled by Alexa or even through their app. As the Echo has gained attention from around the world, Amazon has released multiple smart speakers and displays including the standard Echo, the compact Echo Dot, the Echo Studio, and a few models of the video-enabled Echo Show smart display. This device also brings entertainment like jokes, stories, games, and music. This makes the product more appealing to families with children and babies. Echo always brings a new way of communication as the user can make hand-free voice or video calls to anyone who has a supported Alexa-enabled device or the Alexa app. Overall the device is very useful as it brings automation and new aspects to a household. This is also a big jump in the machine-learning world.

Machine learning has inspired many new areas and technologies: customized health care, security, advertising, credit loans, etc. Sharing the fact of how beneficial this is to our world today. Throughout the year technology has been involved in our everyday life. As it has enhanced communication and amusement it shares how vital it is to have a device to stay connected in this society. Also is the easiest way for communication as it is instant even if you are across the world from the other person. As this is one aspect of a positive impact something else to consider is the expansion of security. CCTV, access control systems, and alarms, as well as integrated IT management systems can support the security operation to keep companies and their people safe. For example, the ring is a perfect example of how technology increases security in civilian homes. "The Ring doorbell came about in 2011 because Siminoff wanted to know who was at the door when he was working in the garage. He kept missing mail deliveries because he couldn't hear the doorbell ring from out there. Siminoff was working on his next act, after selling his first firm, which converted voicemail to text. He sought a doorbell that would connect to his phone. He couldn't find one, so he decided to build it." The ring is a doorbell with a built-in camera. This device connects to your phone so you can see who is at the door and talk to the person. This gadget enforced security throughout many neighborhoods. With this mechanism at your door, people have seen a reduction in burglaries and crimes. Sharing the main idea of how the use of technology has increased and how beneficial it is to have.

As we are in an era of technological enhancement where we implement this in our everyday lives, we see an increase in jobs surrounding this topic. Technology has continually led to the creation of new jobs and opportunities for people wanting to be involved in this area. Automation has not only creates opportunities but increases output productivity. When technology is involved in workplaces, companies have been able to increase their production rate and performance at an exponential rate. Procedures that were once manual and time-consuming can now be accomplished in a quick and adequate manner with digital tools, applications, and systems. Learning and understanding the importance of technology leads to success and being more efficient.

One example of an application that diminishes time and increases organization is Microsoft Excel. This application is “a spreadsheet developed by Microsoft for Windows, macOS, Android, and iOS. It features calculation or computation capabilities, graphing tools, pivot tables, and a macro programming language called Visual Basic for Applications.” When understanding the role of this application one may ask how this increases organization within a large company. This system enables users to format, organize and calculate data in a spreadsheet. By organizing data using software like Excel, data analysts, and other users can make information easier to view as data is added or changed. Excel is important in office administration for assisting with day-to-day duties such as invoicing, paying bills, and contacting suppliers and clients. This software is user-friendly and easy to learn, causing many people to be involved. Worldwide, more than 2 billion people use spreadsheet technologies such as Excel and companies hire candidates with significant Excel skills because the use of spreadsheets is considered standard for daily business in this era.

To understand machine learning it is important to learn all the vocabulary and know the right definitions as it will help you comprehend the challenging topic better. Machine Learning techniques are divided mainly into 3 categories. The first type of learning is Supervised Learning, this is applicable when a machine has sample data, i.e., input as well as output data with correct labels. These labels are used to check the correctness of the model using some labels and tags. This technique helps us to predict future events with the help of past experience and labeled examples. The second type of learning is called Unsupervised Learning where a machine is trained with some input samples or labels only, while the output is not known. The training information is neither classified nor labeled. Causing the machine to not always provide correct output compared to supervised learning. The final type of learning is Semi-supervised Learning, an intermediate technique of both supervised and unsupervised learning. It performs actions on datasets having few labels as well as unlabeled data. However, it generally contains unlabeled data. Causing a reduction in the cost of the machine learning model as labels are costly, but for corporate purposes, it may have few labels. Further, it also increases the accuracy and performance of the machine learning model. This concludes the overall types of learning and techniques that are implemented in a model. There is also key machine learning terminology that plays a major role in the automation world. These words are relationships, labels, models, training, inference, and features. Machine learning systems use relationships between inputs to produce predictions. The inputs are called features and the predictions are known as labels. When using the word model in machine learning it defines the relationship between the label and the features. For example, more square feet means a higher price for the property. We are understanding how the model functions as it comprehends the relationship between the feature (amount of square feet) and the label (price of property). The final word, inference, is the process of running data points into a machine learning model to calculate an output such as a single numerical score. In other words, putting the model into production or operationalizing a machine learning model.

To build a machine learning model there are many steps to take into consideration. The first step is to know the data and the goal of the model. It is important to know what your data is showing and the obvious trends that occur. Know what you have to predict and make sure it's well-defined. The second step is to organize your data and make sure there are no missing values. This will make the building process smoother and little flaws will affect the model's accuracy, so it is important to review the data. The third step is identifying variables and training the model. This means identifying variables that affect the outcome. Then feeding it to a model so it can learn and classify many patterns. The fourth step is to evaluate the model and test its accuracy. Making sure the model is accurate is important because it results in better decisions. The cost of errors can be huge, but optimizing model accuracy mitigates that cost. This concludes how each prediction can be useful and impactful. The final step is to test the model, this helps spot problems in models that regular evaluation metrics might miss. These problems can come from the code that enables each element of the ML system to function or from the data where outliers and an uneven distribution split causing an effect on the model's performance.

As this unique learning has progressed throughout the years many people began to give their input about the topic. Some share how they are concerned about this idea. One considerable point that was presented was there the high chance of error. There should be no room for error due to the involvement in healthcare and transportation. If the model is not accurate it will cause havoc. Machine learning depends on two factors which are data and algorithms. Meaning all the errors are dependent on these two variables. Any mistakes in the variables would have major repercussions on the output. But this idea of inaccurate systems isn't relevant anymore due to the various ways to evaluate a model's performance. Some examples are Confusion matrix, Precision, and Recall, which are built-in functions that give you feedback about your model. After lots of testing and modifications, the model is ready to go public. Another negative aspect shared was the cost. The software is costly and many developers charge heavily to complete the tasks. This a major problem as it should be more accessible to the public. Sadly is hard to reduce the cost of these computational resources and the salary wanted by the scarce population of ML engineers. This serves as one of the biggest problems in the Machine Learning field.

We turn to theories to describe what we see and explain connections between concepts. Theories enable us to understand what we observe and choose how to effect change. Theories are a tool that allows us to recognize issues and create plans for solutions. There have been several theories and ideologies regarding the topic of machine learning.

Some of the most popular theories included:

1. Statistical learning theory: The idea of minimizing the expected prediction error of a model by learning from a given set of examples. The goal is to find a model that can generalize well to new data.
Ex. Predict whether a patient, hospitalized due to a heart attack, will have a second heart attack.
2. Deep learning: This approach involves building complex neural network models with many layers to learn representations of data that are useful for prediction or classification tasks.
Ex. Virtual assistants of online services and Alexa.
3. Decision tree learning: This theory involves constructing a decision tree that models the relationship between input features and output labels.
Ex. More square feet and a pool directly correlate with the property's price.

III. Methodology

To receive more knowledge regarding this topic a survey was conducted on 40 people who are involved in the medical field. I created a google form and asked them open-ended questions about machine learning's influence on health care. I asked questions in this format to acquire precise details and insight from professionals.

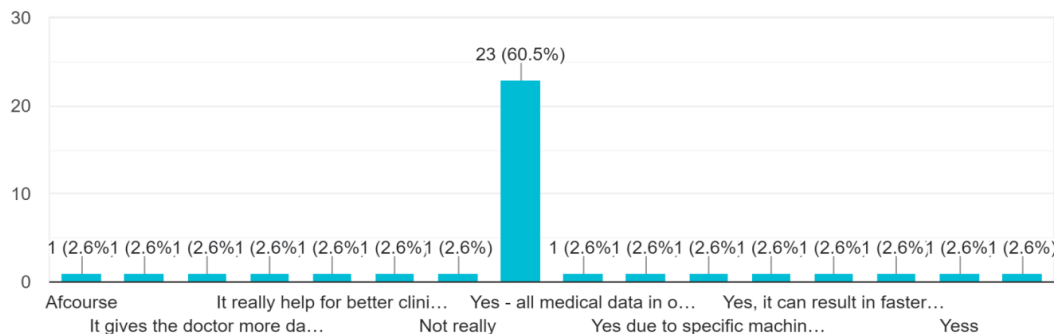
After reviewing the findings and data collected the results concluded that machine learning has a positive impact on healthcare.

The following questions asked about logistical and operational concerns when involving machine learning. The results shared positive benefits like an increase in efficiency and productivity when the systems were implemented in their clinical setting. Many of these healthcare workers shared positive details but some provided negative points. One major negative aspect that was well evident in this form was the cost of the systems. This is an understandable factor because many hospitals and clinics don't want to spend tons of money on this area.

Data Analysis

Did the automation [by machines and software] help make better diagnosis and provide better clinical decision support?

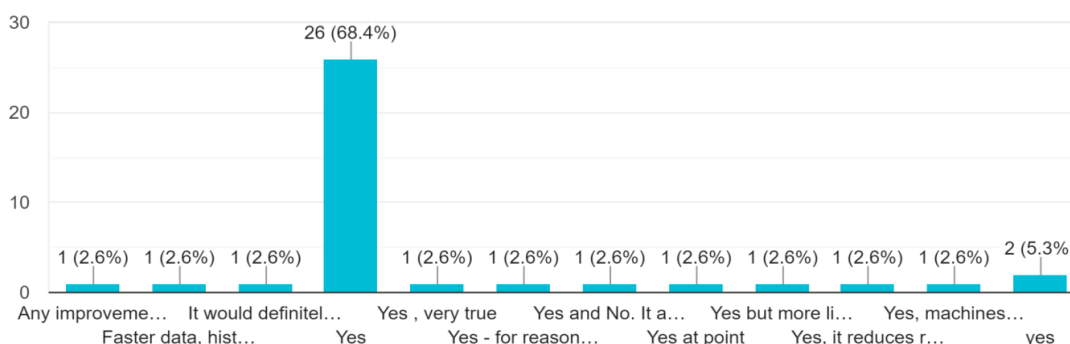
38 responses



This question was designed to understand the influence automation has on healthcare's main objectives (appropriate diagnosis and well-informed clinical support). With the various answers received a conclusion was made that machine learning automation has a direct impact on these objectives.

Did it help with operational efficiency?

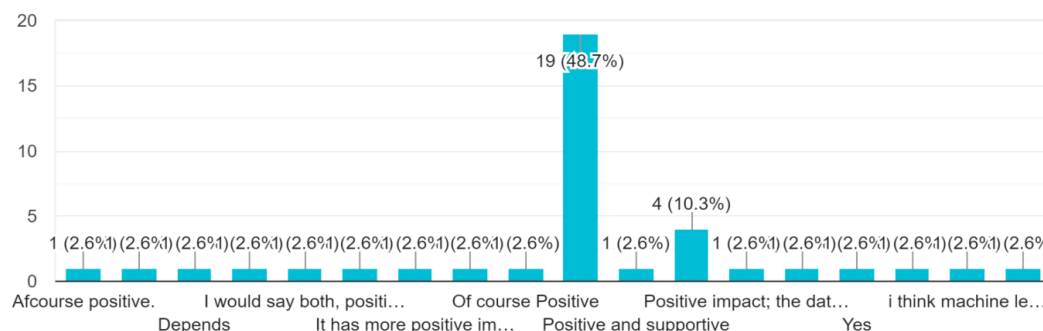
38 responses



The information from this graph shares the importance AI has in the overall operational side of healthcare. Many professional workers shared the idea of how it reduces multiple tests and other time-consuming trials. Maintaining operational efficiency is important because of critical patients and their need for service as soon as possible.

Finally, do you think machine learning has a positive or negative impact on healthcare?

39 responses



The final question in this survey was do you think machine learning has a positive or negative impact on healthcare? The question was intended to get a final summative answer from these doctors and healthcare workers. Based on the graphs and answers received from this questionnaire the outcome is that machine learning has a positive impact on healthcare.

IV. Results and Discussion

The sample was represented very well. It had participants from different fields and experiences. In question 1 (asking participants how did the use of automation make the recovery time faster) some responses shared how systems operate around the clock meaning they don't need breaks and always work. Others shared that the idea dismisses tedious work and stated there is less room for error because the systems are designed to operate with specific rules with no room for deviation. This reflects the Decision tree learning theory because it shares how systems are trained to take certain inputs and produce a logical output. These are rules the systems will follow causing minimal to no room for error. The amount of time saved due to automation creates more time for healthcare workers to spend with the patient. This directly results in a faster recovery time. Based on this theory there is some confirmation with question 5 (asking if automation [by machines and software] help make better diagnosis and provide better clinical decision support). Healthcare professionals responded by saying it does through analytics and digestion of input data. Machine learning operates as stated by the theory via building a decision tree that simulates the link between input characteristics and output labels. With this

functionality, outputs can be received directly with efficiency and accuracy. The information from these two questions supports this claim.

Was the data aligned with the hypothesis?

It is evident that the data I received from my questionnaire matches my hypothesis. My data shows the potential for machine learning to enhance patient outcomes, which is one way it supports my hypothesis. My research has demonstrated, for instance, that machine learning algorithms can be used to predict patient outcomes more accurately than standard approaches. This may result in earlier disease detection, more focused treatment, and improved general patient outcomes. The concept creates pleasant aspects all around.

Throughout the collected data I have seen a strong emphasis on automations making better diagnoses and providing better clinical decision support. The main goal of healthcare is to enhance the health and quality of life of individuals. With the performance of automation, these factors have increased not only in efficiency was also in accuracy. The objective of healthcare is significantly influenced by these variables.

I have also noticed a consistent focus across the data on automation roles in operational efficiency. In the healthcare industry, operational effectiveness is crucial since it has a direct impact on patient outcomes, financial stability, and staff satisfaction. With many healthcare professionals sharing how software and machine boosted productivity during operations, it is possible to conclude the overall impact it has on healthcare.

Limitations

Some limitations included the lack of direct communication with these medical professionals. I was unable to go to a hospital and discuss my questions regarding machine learning. This factor may have caused me to miss out on valuable insights and nuances that are not easily captured through secondary sources. These insights could have been a unique experience with machine learning or seeing the machinery in action. This could have given me a better understanding of my topic. Not being able to speak with medical experts directly also may further restrict my ability to ask follow-up questions or get clarification on any ambiguities in their responses.

Another limitation was the access to participants. I had difficulty accessing a large sample size of medical professionals with the desired characteristics and cooperation. With some lack of participation, I encountered minimal issues with data quality. This happened as a result of incorrectly interpreting the questions and the available responses.

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