

**HOW ARE RECENT
ADVANCEMENTS
IN COMPUTER
SCIENCE
PERCEIVED BY
SOCIETY?**

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ABSTRACT

The advancement of technology and computer science and its incremental impact on our daily lives and society as a whole is an inevitable outcome. However, many people have reservations towards these advancements due to how seemingly simple and ineffective they sound. This research paper primarily focuses on illustrating the impact that various improvements and advancements in computer science, robotics, and recent technology in general have had on society. In addition, the primary focus is also to examine how certain areas in computer science plan to progress in the future, and the impact they will have as well. The secondary focus of this essay is to analyze the various impressions and potential misconceptions that exist and are held towards these technological advancements. This analysis is conducted by examining various responses to an online survey about societal connections and notions regarding computer science. This survey is a 10 question multiple choice survey. The central goal of this survey is to illustrate how the public views advancements in technology and computer science.

INTRODUCTION

A multitude of issues surround present day society. Environmental changes (specifically a decline) are extremely critical to daily life, and can potentially pose many catastrophic issues (ex: decline in national health). Examples of these changes include global warming, increase in greenhouse gas release, atmospheric and aquatic pollution, and a diminishing number of areas of nature (forests, rainforests, etc.) Poor prediction of the weather (earthquakes, hurricanes, tsunamis, etc.) is another major aspect of concern in the current society. Approximately 45.5 billion dollars are spent on disaster relief and recovery expenditures in the United States. Not only does this raise the price level, resulting in high inflation, causing an increase in the price of consumer goods and services, it also results in the death of many people and the destruction of numerous households. Epidemics and infectious outbreaks are another major concern in society. As recently demonstrated by covid-19, viruses possess the potential to spread like wildfire, covering vast areas or multiple regions in a time frame that is unpredictable even to the government, presenting various safety and health related issues. Economic instability during a recession or a period of inflation tends to rise, which is another major issue in the current society. Aside from affecting the total output produced by the region, it also affects the purchasing power of consumers due to a fluctuating price level. While there are a large variety of topics that cause multiple societal issues in the current society, the issues described above are a few of the most important areas that require improvement. While most of the issues mentioned above are solved by various entities such as the government, businesses, banks, or healthcare companies, many view the potential solutions of the future to stem from computer science.

Machine learning is a method of data analysis through the use of automated graphical models. In Layman's terms, Machine Learning is the ability of a bot, algorithm, or software to use previously acquired data and learn from it. The intention of Machine Learning is to enable learning algorithms (algorithms that learn from past or previously acquired data) to predict future outcomes. The goal of Machine Learning algorithms is to be able to learn similar to how a human would, but at a much higher rate, therefore increasing not only the number of solutions, but the rate or speed at which those specific solutions are derived. While a popular assertion is that Machine Learning algorithms are incapable of solving complex problems along with issues that are highly impactful to society, such as the ones mentioned above, this claim is highly false.

Machine learning can be used indirectly to solve various issues of varying degrees. For example, a possible solution to the issue regarding environmental decline could be the following. Data can be collected by various parts of a region, regarding various actions of the different members in society. A Machine Learning algorithm can then measure the impact that those actions have on the environment by graphing a correlation between a certain action, and a certain environmental change that occurred within the same time period. By doing this, those algorithms can draw conclusions as to how certain actions benefit or serve as a detriment to the environment. After drawing these

conclusions, these findings can be applied and can be used to prevent certain actions that are more harmful than others from being repeated, therefore benefiting the environment. A similar approach can be used for the other two issues described above. For the issue regarding excess disaster relief expenditures and the large number of deaths during natural disasters, the main cause is that people do not know about these natural disasters far enough beforehand. If data is collected from past natural disasters, specifically their date, level of severity, and geographical location, a structured analysis by weather reporters and scientists can take place. An analysis of this data can be used to predict potential natural disasters that may occur in the future and warn people about them far enough in advance. Not only will this help save more lives, but it will benefit the government and the economy by reducing the multi billion dollar value of disaster relief. For the issue regarding the rapid spread of highly infectious viruses, once again, a similar strategy can be applied. Once the virus forms and starts spreading, data can be collected on past viruses with similar symptoms. The data can be based on which areas the virus has spread to, and an in depth analysis of life in those regions to understand their safety procedures. After the collection of this data, a group of individuals can converse about the potential regions the virus might spread to, and the level of safety precautions that their own region along with others must incorporate to prevent further spreading.

While the solutions based on the concept of Machine Learning mentioned above are a highly oversimplified version of the actual processes required to solve these issues, the purpose behind explaining the solution was to address the falsified claim held by society that Machine Learning is incapable of solving issues of similar magnitude. In other words, despite providing a number of wide ranging benefits to society, the overall impact of the integration of Machine Learning into society is often overlooked by a large majority.

REVIEW OF LITERATURE

Once again, Machine Learning is a form of programming and artificial intelligence that is devoted to the development of a program or algorithm's ability to "learn". Machine Learning programs or algorithms are primarily used for analytical purposes, where programs that are trained or untrained by the provision of a data set(s) are applied with certain metrics or parameters to make future predictions based on the provided data set or previously gathered data. There have been many stages in the development of Machine Learning and the various algorithms it entails. While it was initiated at an elementary level, current Machine Learning algorithms can make use of thousands, if not millions, of specific data points to make a prediction, illustrating the exponential improvement and advancement that has taken place in the last few decades.

Machine learning is a relatively new topic in computer science and computer programming. Its earliest forms emerged in the 1950's. Its first documented usage was during a game of chess, in which a program incorporated a learning algorithm which enabled it to generate moves based on its opponent's and its own previously made moves. In 1952, Arthur Samuel, a computer scientist at IBM and an avid explorer and pioneer of artificial intelligence, developed a computer program which would be able to play chess with an opponent. The main function of Samuel's program was to calculate the probability of winning the game based on the current position of the pieces on the board. Samuel's program took in a variety of inputs to pass through his algorithm/program. One of the most critical inputs included the specific positions of each separate piece, along with each possible move its opponent and the program itself could make as input parameters. While this may seem insignificant, the gathering of this data was crucial for the program to function correctly. The core of Machine Learning is to use previously gathered data to make optimal predictions or future decisions. In this case, the previously gathered information or the data set that was being passed through the program were the items listed above (positions of the pieces, possible moves, optimal moves, etc.). These pieces of information, formally known as input parameters, were the most critical component of Samuel's program as they enabled the program to calculate the move associated with optimal probability of winning.

The information listed above was used by Samuel's program to conduct a Heuristic Search. In Machine Learning, a Heuristic Search is the process of deriving a solution or decision by conducting a "search" through a step by step analysis which is performed by a learning algorithm. The use of algorithms is the basis of Machine Learning. As a result, the Heuristic Search was one of the initial algorithms or concepts developed during the early stages of Machine Learning. The Heuristic Search in this game of chess, took in the data provided (the input parameters) to calculate the probability of winning for each possible move. The Heuristic Search would conclude by finding the move with the greatest probability of winning. Due to the fact that the program did this, or could do this for every possible and previously made move, it repeatedly made moves of an optimal nature. In addition to that, the program was "learning" from every single one. Therefore, the program underwent a transformation, initiating as a

predictable program which had little experience or data to calculate the probability of winning from, to developing into one that was unbeatable due to its vast collection of previously made moves.

The implementation of a machine learning algorithm in a program that played chess gave rise to the commencement of the initial developments in Machine Learning. Another prime example of one of the earlier programs that implemented Machine Learning was the Perceptron in 1957. In 1957, Frank Rosenblatt, a researcher at Cornell University, designed a program called the Mark I Perceptron. The primary purpose of the Mark I Perceptron was image distinction and recognition. However, despite seeming promising at first, the Perceptron had numerous flaws, the most important of which was that it lacked the capability to recognize visual patterns (in faces for example). While image recognition is a commonly used feature in infrastructure today, the Perceptron's flaw illustrates and reinforces the fact that it was a program created in the adolescent stages of Machine Learning. Another example of one of the initial programs that incorporated Machine Learning was the Nearest Neighbor Algorithm. This program was designed to map routes to a specific destination. Its main purpose and its learning feature was to find the most efficient route from the users current location, to their intended destination. Once again, this program reinforces the fact that it was created during the initial stages of development in Machine Learning. This can be concluded by the fact that mapping technology, or apps, are extremely common (google maps, apple maps, etc.) and are frequently used in society.

In the past, due to being in its early stages of development, Machine Learning was mainly used at a rudimentary level. Current applications of machine learning are far more widespread. They not only target common issues faced by members of society, but they are focused towards societal issues as a whole. In addition, they are incorporated in a vast multitude of businesses due to its capacity for data analysis. Machine Learning is used in hospitals, businesses, apps, and various other areas of society.

One major and extremely impactful application of machine learning occurs during the process of cancer detection. To reiterate, Machine Learning is the use of an algorithm which predicts future outcomes based on previously gathered information. This is extremely important for cancer detection for a multitude of reasons. These reasons primarily relate to the fact that cancer is a genetic disease, meaning that it can be inherited, or developed instantaneously or over an extended period of time. Machine Learning can aid in cancer detection through tumor differentiation, thorough genetic and inheritance analysis, and predicting the likelihood and occurrence of cancer cells/tumors forming in the future.

One of the primary methods that Machine Learning is used in cancer detection is through the use of a learning algorithm that can differentiate between a malignant or benign cancer cell or tumor. These learning algorithms have the sole purpose of identifying whether a cancer cell or tumor is harmful and must be removed, or whether it is benign and harmless to its host. In other words, these algorithms assess the size, growth rate, shape,

population, and location of the cancer cell/tumor in order to efficiently and accurately identify whether or not it is or has the potential to be harmful. Learning algorithms which incorporate this method of detection require information to be entered beforehand. This information includes unspecified data regarding a variety of cancer cells that have been previously acquired by different people. This data consists of the various metrics that are associated with tumors (size, rate of growth, total population, etc). In addition to entering in the specific information about the cancer cell itself, whether or not the cancer cell turned out to be harmful, and when in its lifetime did it become harmful must also be entered. This information will enable learning algorithms to develop an understanding of which cancer cells turn out to be harmful or not. Based on this previously gathered knowledge regarding the specifics of various tumors and their eventual outcomes, this differentiating learning algorithm attempts to accurately predict whether or not a tumor is harmful by comparing it to the cancer cells/tumors and their respective outcomes of which it has previously gathered or acquired (the data that was passed through beforehand). However, after assessing its previously gathered data, one more piece of information is essential for the algorithm to function as intended. The next piece of information passed into the learning algorithm is a graphical assortment of the tumors that are predicted to be malignant, and those that are predicted to be benign along with the previously gathered tumors and whether or not those tumors are harmful or not (Malignant tumors are generally grouped together, and the same goes for benign tumors). The learning algorithm then identifies the tumors in the individual that are malignant and those that are benign in relation to the tumors that have already been analyzed. This method of Machine Learning is called Classification, where data is organized into groups, and is “classified” by the learning algorithm based on its graphical or numerical grouping. This method of application is extremely impactful, because not only does it save many lives by providing individuals with a timely warning of whether or not they need treatment, but it also saves families or individuals thousands of dollars in medical bills if the tumor is accurately detected as benign.

Another method of Machine Learning that is used in cancer detection consists of a thorough analysis of an individual's and their family's genes. Once again, cancer has been proven to be a genetic disorder, which on occasion occurs from an acquired genetic mutation or defect that was inherited by a family member or relative. Annually, there are approximately just under 20 million cancer cases worldwide. According to the National Cancer Institute, around 10 to 12 percent of the total cancer population are diagnosed with genetically inherited cancer. While this may present itself as a miniscule percentage, this number still indicates that around 2 million people still suffer from this form of cancer yearly, which is not a small number by any means. Machine Learning is used for this type of cancer in one particular way. The algorithm analyzes the individual's genetic background, inheritance, and relations. If it detects a relative or family member with a history of cancer, it will mark them and analyze the genetic composition and inheritance of the individual in relation to the relative with a history of cancer. If the algorithm detects any unusual or close relation between both people, it will mark the relative. In Machine Learning, this process is called Anomaly Detection. Anomaly Detection is when an algorithm is used to identify any “anomalies”, oddities, or data points/input parameters that might stick out from the other data points. Depending on the identified relation and if an “anomaly” was identified or not, the algorithm will be used to identify whether or not the individual in question has cancer or has the potential of getting cancer. Applying Machine Learning during this

process is extremely helpful and critical to do, primarily due to the fact that cancer is a genetic disorder which can travel through families just as easily as forming in an individual. This method of Machine Learning is beneficial to cancer patients due to the fact that it warns them of potential hazards ahead of time, saving them from a multitude of risks and desperation.

In addition to being applied as a medical aid, Machine Learning (or forms of Machine Learning) is most commonly used in areas of business. The main goal of businesses that create and sell products is to make money by selling as many of their products as possible. In order to do so, they must create products that consumers desire. Learning algorithms aid in this process by using previous information or data collected regarding the business's past performance and success/failure as a result of previously made products. Learning algorithms will use this data to predict future success rates for new products that the business intends to create by evaluating certain characteristics based on the business's historical information and societal trends.

The process of creating a desirable and marketable product is a deeply intricate process, requiring a variety of information regarding the consumer or the targeted group of consumers. This information primarily consists of the success rate of the business's/company's previous products. This information is entered into the learning algorithm, which distinguishes the data points (success and failures) using a method called a Decision Boundary. The Decision Boundary generated by this algorithm will distinguish the data points on a graph, separating the cluster of successes to the cluster of failures of the business with a line to indicate the grouping or separation. By assessing its previous successes and its failures, the Learning Algorithm enables the business to develop an understanding as to what products seem to succeed, and what qualities do those products consist of. Not only will this help businesses create products that will generate profits, but it will also provide adequate satisfaction for the consumer by creating a product that is closely associated with their interests and desires.

While only two applications of Machine Learning in society are described above, they have numerous additional benefits. By aiding in cancer detection, not only does the probability of potentially saving thousands of individuals who are diagnosed with cancer increase by warning them far ahead of time, but life expectancy increases as well. By increasing life expectancy and the success rate of cancer treatment, an increasing number of people have a newfound sense of trust in healthcare established within them. The application of Machine Learning in business does benefit the business itself, but it also has lasting effects on the economy. By aiding in the creation of desired products, Machine Learning in business indirectly promotes the consumption of consumer goods and the investment of businesses in

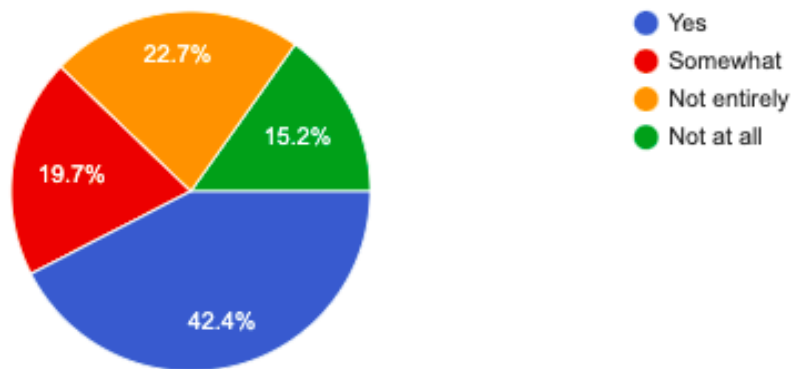
capital. Not only does this increase the GDP of the nation, but it also increases the standard of living by providing consumers with the product they desire. Despite only two applications described above, Machine Learning is present throughout society. Facial or fingerprint recognition scanners, audio or speech recognition, image recognition, and many more applications of Machine Learning are present in current society.

DATA ANALYSIS

In the following section, specific questions pertaining to the topic at hand (machine learning in society) and the hypothesis, along with their respective results, will be summarized, analyzed, and explained. The survey and the graphical/statistical representation of its results were conducted on google forms.

Advancements in computer science are trending towards developments that make use of previously collected data in order to make predictions about future outcomes(machine learning). Do you feel this will impact your daily life?

66 responses



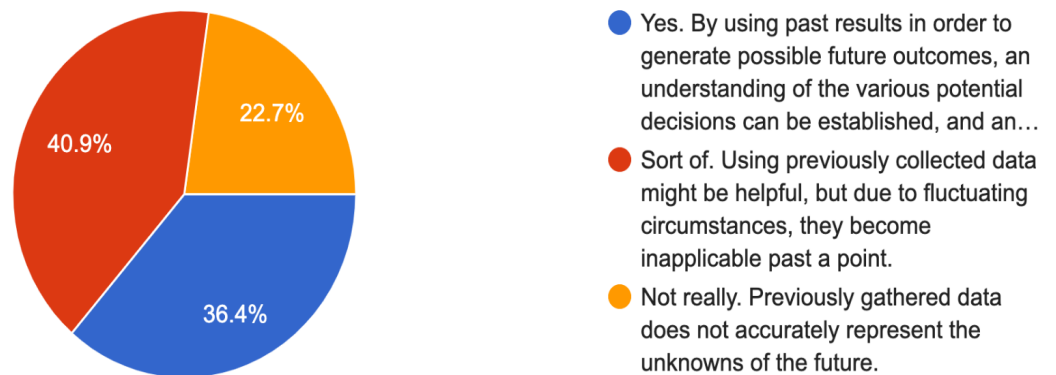
This question pertains to the trends in the numerous advancements in computer science, along with societal interpretations of the impact that those advancements may have. The question initially explains that advancements in computer science are trending towards the use of previously gathered information in order to predict or anticipate future outcomes. In other words, the advancements in computer science are advancing in the direction of Machine Learning. After describing what these developments and advancements are trending towards, the question then asks if the respondent feels that the type of advancement mentioned above - machine learning - will have any impact on their daily life.

A large portion of the respondents chose “yes” as the answer. Approximately 42% of the respondents believe that machine learning will impact their lives in some way. While nearly half of the respondents

chose “yes”, 57.6% of the respondents chose answers that display some sense of hesitation towards Machine Learning, with a large portion of that 57.6% choosing “not entirely” or “not at all”. This indicates that many people do not believe that advancements in Machine Learning will be greatly impactful, if at all. The results of this question support the hypothesis that society is skeptical and unconvinced of the developments in and towards the field of Machine Learning.

The analysis of data in order to make future predictions is gaining popularity at a rapid rate in the computer science community. Do you believe that u... predictions about future outcomes is beneficial?

66 responses

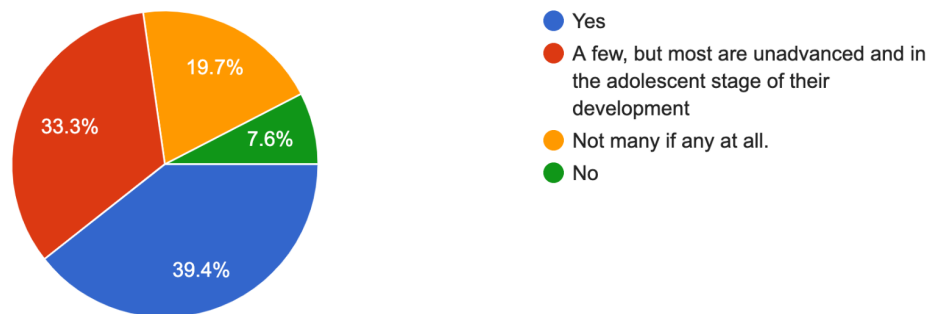


This question pertains to the respondents interpretations of the impact of Machine Learning in society. The question restates that the use of Machine Learning in the computer science community is growing, one again explaining its primary concept (use past data to predict future data). It then asks the respondent whether or not they believe that Machine Learning - the use of past data to predict future outcomes - is beneficial or not and why.

Just over a third of the respondents chose “yes”, agreeing with the statement that by using past results to generate future outcomes, optimal decisions can be made in a timely manner. However, almost 64% of the

respondents chose answers that indicate skepticism towards the benefits of Machine Learning. 41% of the respondents chose “sort of”, agreeing with the statement that due to constantly differing situations, the use of previously gathered data becomes redundant or obsolete. The remaining 23% of respondents that showed skepticism towards the benefits of Machine Learning chose “not really”, agreeing with the statement that due to the future being unknown and highly unpredictable, using previously gathered data is a futile attempt at predicting any future outcome.

Artificial Intelligence is the automation of a computer system or an algorithm that entails a similar learning process to that of a human, but at an exp...stems and algorithms exist in the world currently?
66 responses



This question pertains to the use of Artificial Intelligence in society (Machine Learning is a branch of artificial intelligence). The question explains that algorithms that display artificial intelligence contain learning capability of a similar nature but far beyond that of a human. The question goes on to ask whether or not the respondent believes such algorithms truly exist or if they are simply theoretical.

Over a third of the respondents - 39% - chose “yes”, agreeing with the statement that algorithms that inhibit artificial intelligence exist and are used in current society. However, the remaining 61% chose answers that displayed hesitation or disagreement with the statement that artificially intelligent softwares, programs, and/or algorithms exist. 33% of the respondents chose the answer that agreed with the claim that a few of these algorithms exist, but are at an early stage in their development. Just under 20% of respondents chose the answer “not many, if any at all”, agreeing with the conclusion that artificially intelligent algorithms do not exist in current society or are extremely rare. A small minority of the

respondents - just under 8% - chose “no”, implying that such algorithms are purely theoretical, and do not exist in society at all.

The results of this question, once again, serve to support the initial hypothesis that many people display skepticism towards the usage or existence of these types of algorithms. Not only does this indicate that a large portion of society is unaware of these concepts or advancements in computer science, let alone their usage in society, but some also do not even believe in their existence.

METHODOLOGY

The primary focus of this research paper are the misconceptions or notions that society has towards the incorporation of Machine Learning and Artificial Intelligence in society. The quiz/survey conducted on google forms is divided into 5 sections, with a total of 10 questions that pertain to various topics about computer science. The questions are primarily opinion based questions targeted towards the beliefs, notions, and potential misconceptions of the respondent. The first section consists of only one question (the first question itself). This question asks if the respondent believes that technology has progressed over time throughout the last few decades. The second section (question 2, 3, and 4) targets the personal information about the respondent regarding their involvement and usage of technology in their daily lives. The third section (question 5 and 6) asks the respondent specific questions about computer science (what is its primary purpose, has it become more secure, etc.) The fourth section (question 8,9 and 10) focuses towards Machine Learning and Artificial intelligence. These questions explain the broad concept of ML and AI to the respondent, and then ask whether or not the respondent believes that such topics exist in society or not, and if they feel as if the topics described would be helpful or not if integrated into society. The overall population of this quiz are international high school students (ranging from 14 to 18 years of age) who make substantial use of technology (phones, computers, tablets, the internet, etc) in their daily lives.

RESULTS AND DISCUSSION

The survey on which this research paper is predicated, asks the respondent(s) a variety of questions regarding personal and societal applications of technology and the impact that those technologies have on daily life. As mentioned previously, while the initial parts of the survey target the respondents' personal technological involvement, the primary goal of the survey is to analyze the results and responses of the respondents and assess whether they confirm or refute the hypothesis that a majority of society is unaware and skeptical of the advancements in Computer Science that are primarily focused towards AI and Machine Learning.

The first question of the survey asks the respondent if they believe that technology has improved over the past few decades (infrastructure, physical/online security/privacy, personal devices, modes of transportation, etc.). The responses to this question shows that most of the respondents strongly believe that technology has improved over time, with only a small portion showing some, and very mild, hesitation, choosing "somewhat" as an answer. There were no respondents that chose answers indicating blatant refusal or skepticism ("Not entirely" or "Not at all"). This goes to show that most, if not all, of the respondents recognize and acknowledge the change that society has undergone due to technological advancements over the last few decades. These changes are numerous and have proven to be exceptionally beneficial. An example of extremely beneficial advances were the ones made in communication. Improvements in effective communication include the ability to call, text, or mail other people spontaneously. Effective communication is a critical aspect in current society, from being able to call a relative, to relaying communications during a time of crisis. By having the ability to communicate with another individual instantaneously, a multitude of benefits arise, such as that information can be relayed faster, preparations can be made in a timely manner (for hospitals, nursing centers, etc), and healthy relationships can be maintained with one's family and/or friends by communicating regularly. Another example of an extremely beneficial advancement in technology is the accelerated exponential growth of computational power. Computing power has approximately doubled every two years since 1990, indicating a rapid growth of the computer power of present and future devices. Increased computational power not only means higher accuracy, but also far greater efficiency. The specific benefits that arise from this include highly accurate architectural models, quickly solved equations of a highly complex nature, and the capacity to store and process more information. While there are many more changes that have taken place in the last few decades, the results of the survey show that the respondents recognize and acknowledge these changes.

Over 83% of the world's population own a personal device, indicating that technology plays a central role in the daily lives of a large majority of the world's population. When technology plays a major role in an individual's daily life, the likelihood of them understanding the changes made by technology and its impact are much higher than if technology was a minor or nonexistent part in an individual's life. Due to the importance of analyzing the number of devices the respondent has - in other words, the role that technology plays in their lives or their technological involvement - , the second question of this survey asks the respondent how many personal electronic devices they have, or how many examples of technology they have in their daily lives, in order to gauge the relevance of technology in their life. The results of this question proves that technology is a prominent part in the daily lives of many of the respondents. Most of the respondents own 2-3 personal devices, with a few respondents having more than 5 devices, indicating that the majority of the respondents have access to use of technology. From this it can be inferred that the impact of technology on society is unlikely to be overlooked past a point by majority, if not all, of the respondents.

Technology has changed the world in a vast multitude of ways. It has shaped modern forms of entertainment, economics, and education. The rise and development of technology has given rise to visual forms of entertainment such as various television networks that show cartoons, sporting events, movies, along with numerous streaming platforms such as Prime Video, Netflix, Hulu, and many more. The advancements in technology have also impacted how businesses conduct product selection, providing businesses with a way to analyze their past products and their corresponding profits in previous years to assess the best way to advance. Modernized technology has also made the access of online education feasible and efficient. Due to modern advancements in technology, studying from textbooks is not the only way to increase one's knowledge anymore. The internet contains vast catalogs and digital libraries of information that any individual can use to expand their knowledge of a particular topic. In addition, technology has made holding online classes and lessons from teachers possible. Due to the evident improvements and benefits to society caused by advancements in technology, The primary purpose of the third question in the survey was to assess whether or not the respondents believed that technology has made as significant an impact on their daily lives as described above. The results of this question show that a large majority of the respondents feel that technology does impact their daily lives, with only a small portion displaying slight hesitation.

As described above, technology is useful in numerous ways. Therefore, in support and further examination of this indubitable fact, the fourth question of the survey attempts to assess which particular aspect of technology fulfills its primary role in society. This question does not ask IF the respondent feels

that technology is impactful, but under the assumption that it is, this question asks HOW technology is impactful. The answers to this question provide some sort of guidelines in order to prevent confusion within the respondent when answering the question. The results of this question indicate that all but an extremely small portion of the respondents believe that technology is primarily beneficial or helpful in their daily lives, indicating that many of the respondents recognize the beneficial effects that technology has in general.

The fifth question of the survey asks the respondents what they believe to be the primary reason for the usage or incorporation of technology in society. Due to there being a vast number of reasons, the answer choices to this question provide guidelines for the respondents to prevent confusion when answering the question. The answer choices summarize four key methods of how technology is used in society. The first answer choice states that technology is used mainly due to the level of efficiency it entails. This means that technology can be accessed and used in an extremely easy and quick manner, while performing complex and intricate tasks. For example, searching for something or a piece of information has become exponentially quicker to do. Nowadays, through the use of search engines like Google Chrome, Firefox, Apple's Safari, etc., one can simply enter in the information they wish to find and receive thousands to millions of results that either contain the information they are looking for, or are pertaining to it in some manner. The second answer states that technology is used mainly because it contains a "wide scope of digital libraries that contain various catalogs of information to learn from." In layman's terms, this essentially means that individuals now have access to an incredibly large amount of information that is contained by technology. The third answer choice states that technology is used because it provides a sound and efficient means of communication to people. For example, instead of writing a postcard, delivering it through the mail service, and waiting days if not weeks for a response, one can simply call or message another individual instantaneously depending on their mood. The fourth and final answer states that technology is used in society because it is extremely useful in daily workspaces in addition to providing various uses and benefits in a classroom setting. For example, technology can be used in the workplace to calculate various forms of money flow, conduct profile analyses on new employees, predict total revenue and profits margins, along with many other things. Technology can also be used to assist businesses with product selection and creation by analyzing data regarding past products. Technology in the classroom can be used to help students conduct research efficiently, write essays, communicate with teachers and peers online, etc. The results of this question indicate that the respondents hold differing views on how technology is mainly incorporated in society. The largest portion of answers believe that technology primarily increases overall efficiency (45.5%). The other 54.5% of the respondents are split between the remaining three answers, which believe that

technology contains a wide range of information (16.7%), is a sound means of communication (27.3%), or that it is mainly used for educational purposes (10.6%).

A major area of concern regarding technology in the past few years has been the safety of an individual's online personal information. In September 2018, Facebook, one of the largest social media platforms in the world, had a massive digital security breach, exposing the personal information of over 50 million users worldwide. As a result, the users of social media platforms like Facebook have been weary and skeptical of the security of their online information and accounts. To address this issue and societal interpretations of any improvements in this matter, question 6 asks the respondents if they believe that recent advancements in cybersecurity and CS have made their digital information more secure. The results indicate that more than half of the respondents believe that technological and online security has improved since the past due to recent developments in CS. 21.2% of the respondents chose the answer “yes”, and 45.5% of the respondents chose the answer “somewhat”, both agreeing that digital security has improved. The other third of the respondents display mild to strong hesitation in regards to the improvements made by technology in online security, with a small portion choosing the answer that recent advances in CS have not improved online security at all (6%) and just under a third choosing “not entirely” (27.3%).

As the world of computer science progresses, a vast multitude of new concepts are explored almost daily. For the past few decades, one major advancement and topic of exploration undertaken by Computer Scientists is the concept of Machine Learning. It is an incontestable fact that advancements in computer science are trending towards the field of Machine Learning, along with the fact that it will have a wide range of impacts on the members of society. As a result, question 7 attempts to gauge how society views the potential of Machine Learning and whether or not it will impact their lives. This question asks the respondents if they believe that the recent developments in CS which attempt to make use of previously collected data in order to make predictions about future outcomes (machine learning) will affect their daily lives. Question 7 is structured in two portions; it initiates by providing the base definition of Machine Learning: algorithms that make use of previously collected data to learn from and make future predictions. The question then asks if the respondent feels that this concept will impact their daily lives.

The results of this question indicate that the majority of the respondents are ignorant towards the potential impact that Machine Learning might have, along with its current impact in society. While 42.4% of the respondents chose the answer “yes”, agreeing with the claim that these advancements will be impactful, the rest of the respondents chose answers that portray skepticism towards that claim. 57.6% of

respondents chose answers “somewhat”, “not entirely”, “not at all”. In other words, answers that display hesitation towards the fact that Machine Learning is impactful in a multitude of far reaching ways.

Not only does this show that people are ignorant of the potential impact of Machine Learning, but this also shows that they fail to recognize the impact made on society by current incorporations of Machine Learning, which are numerous in quantity. The most prominent incorporations include learning algorithms on social media platforms, analytical programs for businesses or data science companies, programs that manage traffic alerts, algorithms that perform facial recognition, and algorithms that recommend specific products, just to name a few. The results of this question serve to support my original hypothesis, that many are ignorant, hold reservations, and/or are skeptical towards the societal impact of Machine Learning.

As mentioned in the previous paragraph, many recent advancements in CS pertain to ML. Question 8 addresses attempts to assess whether or not the respondents view these advancements as beneficial.

This question states the fact that Machine Learning is rising in popularity at a quick rate in the world of Computer Science. The question then asks the respondent if they believe that these new advancements towards Machine Learning will be beneficial overall. The answers to the questions provide accurate but broad examples that cover a wide scope of applications of Machine Learning in order to prevent the respondent from developing confusion when answering the question. The answer choices are split into 3 categories: Yes - machine learning is beneficial because it provides an array of possible decisions, solutions, or remedies to a certain problem or situation; Sort of - machine learning is beneficial but is limited and redundant past a point since circumstances are constantly fluctuating and therefore cannot be accurately predicted beforehand; Not really - machine learning is a flawed concept that cannot accomplish the claim made about its capabilities to predict future outcomes since the future is unknown to all.

The results of this question once again indicate that a large portion of the respondents do not recognize the benefits that the concept of Machine Learning brings to society. While over 36% of the respondents answered “yes”, supporting the claim that Machine Learning is beneficial and useful due to its sound ability in decision making and predicting accurate future outcomes, the remaining 64% of the respondents are skeptical about the capabilities of Machine Learning, supporting the claim that Machine Learning is useful but redundant and limited in its capabilities to predict future outcomes. 40.9% of the respondents chose “sort of”, and 22.7% of the respondents chose “not really”.

While there is merit to the belief that the use of past data is an ineffective and inaccurate means of predicting the future, and as a result, not providing any real benefit, there are a multitude of examples that

disprove this misconceived notion. A primary example includes the numerous businesses that produce products and sell them to consumers. Due to varying social preferences, many businesses that endeavor to create new products must ensure that their product corresponds to what the *current* consumers are looking for. Prior to developing their new product, Businesses use past information about their previous products and their respective success rates. For example, businesses assess the characteristics that made a previous product successful/unsuccessful and how societal preferences caused that success/failure. By using Machine Learning to analyze past data about the business's products, along with using an algorithm to analyze consumer preferences and correlate them to characteristics that can be included in the product itself, businesses are able to optimize their production and design products that have the highest chance of success amongst *current* consumers. The two main benefits this example results in is an increased consumer satisfaction and a thriving economy due to increased profits for the business(es). While this is only one example of how the incorporation of Machine Learning in society does, in fact, entail a multitude of benefits, there are a variety of different applications of Machine Learning present in current society that are beneficial as well.

Once again, the results of this question go to support my original hypothesis, that society is primarily hesitant and skeptical towards the potential and current benefits of Machine Learning in one's daily life, and in society as a whole.

Machine Learning is a facet of a much broader topic in Computer Science: Artificial Intelligence. Artificial Intelligence is the automation of a computer system or an algorithm that entails a similar learning process to that of a human, but at an exponentially faster rate. Machine Learning builds on this concept by applying it to much more specific situations, especially through the use of an algorithm. Machine Learning algorithms are trained to *learn* from previously gathered data, as stated numerous times previously. Since this is a fairly new concept in computer science, question 9 asks if the respondents believe that such systems and algorithms exist in the world currently.

This question is initiated by defining Artificial Intelligence: the automation of a system, program, or algorithm that entails a learning process similar to that of a human, but at a much higher rate. The question then asks the respondent if they believe that such algorithms exist in current society due to the fact that it is a newer topic of exploration in Computer Science which is still in its adolescent stages.

The results of this question show that while a large portion believe and acknowledge the existence of artificially intelligent algorithms or programs, a large portion - 60.6% - believe that systems or programs that inhibit this ability are scarce(19.7%) or in an early stage of development (33.3%), or that they simply do not exist at all (7.6%).

While a majority of the respondents are skeptical about the existence of such programs with the capability to learn, there are a multitude of prominent examples in current society. A primary example of a program that displays learning capability are the algorithms used by various social platforms (tiktok, instagram, facebook, tumblr, etc.) The algorithms used by these platforms process a wide range of parameters regarding the user's interaction and/or response to a particular post. Upon receiving the user's reaction to that post, the algorithm then analyzes that reaction/response and categorizes it as a positive, negative, or neutral reaction. Based on which of the three categories that response falls into, the algorithm will then suggest specific and corresponding posts. For example, if the user's reaction is positive, the algorithm will suggest more posts similar to the one analyzed and processed. Similarly, if there is a negative reaction, the algorithm will remove posts like the one analyzed from the user's feed, and suggest posts that have positive reactions. The learning capability of this algorithm is that based on the user's reaction, and the algorithm's own analysis of the user's response, the algorithm will start to put more posts corresponding to the data collected (the user's responses to previous posts) in the user's feed.

Once again, the results of the choices of the majority of the respondents support my hypothesis that people are skeptical and somewhat unaware of these types of technologies in current society (ML and AI). Despite this commonly held belief, there are multiple examples, such as the one provided above, of algorithms that portray extraordinary learning capabilities.

As stated above, the existence of artificially intelligent systems or programs is an indisputable fact. They not only encompass a multitude of benefits and wide ranging impacts to society, but they also entail numerous benefits that impact the individuals of society. Question 10, the final question in the survey, attempts to gauge the beliefs of the respondents on the matter regarding benefits brought by artificially intelligent systems. This question asks if systems that inhibit artificial intelligence will be beneficial in an overall sense, or at a more individual level. The answers provided for this question have supporting statements to guide the respondents in order to prevent confusion when answering. The first answer, "society as a whole", states that the use of multiple artificially intelligent systems in cooperation to one another can eliminate nearly all learning limitations and can have functionality that are almost boundless. This answer supports the statement that a use of systems that intermix and function simultaneously will be extremely beneficial to society as a whole. The second answer, "the individual", states that personal items, such as phones, watches, tablets, etc., that incorporate a form of artificial intelligence will be more beneficial, specifically to the individual. This answer supports the claim that by integrating artificial intelligence into personal devices, those devices can help the individuals analyze situations, compute complex problems, and make daily life far more efficient. The third and final answer, "neither", supports neither statement regarding who benefits from the use of artificial intelligence.

The results of this question indicate that the majority of the respondents believe that artificially intelligent systems will benefit society as a whole, rather than at an individual level. 56.1% of respondents chose the first answer, agreeing with the claim that AI in society is more beneficial to society as a whole. 33.3% of respondents chose the second answer, agreeing with the claim that AI in society is more beneficial to the individual. A small minority, 10.6% of the respondents, chose “neither”, disagreeing with both claims made in the other two answer choices.

CONCLUSION:

The fact that technology has played a central role in the progression of society is undisputed. Over the last few decades, a multitude of advancements have taken place, each facilitating the rapid upward trajectory of further usage and integration of technology into society. Computer Science, the forefront of digital or online advancements in technology, has undergone various changes as well within the last few decades. The latest advancements in CS are primarily focused on the exploration, development, and application of Machine Learning in society.

As mentioned earlier, Machine Learning is the automation of a software, program, algorithm, or bot. It is the entry of a data set, or an array of data points or values that have been previously collected, into any one of the items mentioned above (software, program, algorithm, bot) in order to generate accurate predictions regarding future outcomes. The applications of this concept are far reaching, as it has the capability of providing a remedy to multiple societal issues, such as environmental degradation, unwanted or unprecedented economic fluctuation, cancer research, and sound infrastructure, to name a few. As a result of the potential benefits of future developments that may arise due to advances in Machine Learning, the survey conducted via google forms, inquires respondents about their personal technological involvement, their broad-level beliefs regarding technology, and their interpretations and potential misconceptions regarding the societal application and impact of Machine Learning and AI.

The results of the survey serve to prove the original hypothesis, which was that society, or the respondents, are primarily skeptical towards the current and potential impacts of Machine Learning and AI. While there is a small portion of respondents that display acknowledgement towards the potential impact of Machine learning and AI, a large majority holds the misconception that the concept behind both topics (ML and AI) is flawed and redundant.

LIMITATIONS:

One limitation was that a large portion of the population of the respondents went to the same high school. As a result of being within a specific ranging age group and living an extremely similar lifestyle to one another, the fact that most of the respondents come from the same high school might prevent any accurate inference made about the results of the survey. In other words, this might serve to prevent generalization on a wider scale due to potentially biased answers, or answers that might not be representative of society as a whole. In addition, nine out of the total 11 questions in the survey contained answers that were not simply “yes”/“no”, or “agree”/“disagree”, etc. Many of these questions contained answers that fell in between a blatant approval and denial or disapproval. The formation of these answer choices included “to some extent”, “somewhat”, “not entirely”, “to little extent”, and many more. While this might serve to skew the data and results of the survey by providing hesitant respondents with ambiguous answers, these answer choices were added with the main intention of preventing the development of confusion within the respondent.

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