Critical Analysis of Risk Assessment and Pattern Recognition Algorithms in Healthcare Data and Algorithms In Healthcare



# Introduction

Google, Amazon, Facebook, all of these companies collect large amounts of data from its users to better analyze trends and develop marketing strategies, but how is Big Data used in an area like healthcare? According to Toews healthcare is the largest sector in the U.S. economy with close to $4 trillion per year being spent and accounts for 11% of all American jobs. With the size and importance of the healthcare sector, new technologies and techniques will inevitably be developed. The use of Big Data in healthcare is motivated by the necessity to solve both local organizational issues, such as reducing workloads and increasing profits of a medical agency, and the global problems of humanity, such as forecasting epidemics and combating existing diseases more efficiently. However, there are many challenges in implementing data algorithmic systems into healthcare, such as biases in risk assessment of individuals and forming false positives in pathology tests. In this paper we will highlight the use of both risk assessment and pattern recognition algorithms within healthcare. Moreover, we will dive into the moral considerations these algorithms enforce within the industry.

# Background

To gain an understanding of how algorithms within the medical field operate, one must gain an understanding of the data being collected and analyzed in such an important industry. Data is collected in various ways in the medical industry, including 360-degree patient views and personalized patient care. Healthcare organizations often implement integrated systems to receive a complete picture of the patient's journey. These institutions benefit from things like healthcare customer relationship management (CRM) which is the process of managing interactions with existing as well as past and potential patients, that provide reports, measurements, and analysis on various issues (Mullainathan 2017). Many hospitals implement

an electronic health record (EHR) which is the systematized collection of patient and population health information that is electronically-stored in a digital format. These records can be shared across different health care settings. Records are shared through network-connected,

enterprise-wide information systems or other information networks and exchanges. EHRs may include a range of data, including demographics, medical history, medication and allergies, immunization status, laboratory test results, radiology images, vital signs, personal statistics like age and weight, and billing information. Recent statistics reveal that 90% of all US-based hospitals and healthcare organizations are using EHR, and about 60% of private healthcare providers have also adopted the system (“Why Is Data Collection Important in Healthcare.” 2020). Adopting this system allows healthcare providers to translate this data into healthcare algorithms that provide comprehensive insights into patients' well-being.

Next, it is important to gain a grasp on how this data is used. Data can be used in an assortment of ways in healthcare, such as helping to make more informed and faster decisions. The in-depth research and analytics that algorithm systems provide healthcare works will make it easier to define the most efficient problems and sources that call for modification or improvement. Implementing algorithmic systems provides means for more accurate ways of using data and likewise making better informed decisions. The healthcare industry involves not only providers and physicians, but the industry also involves third parties of insurance companies, registries, etc. Secured and meaningful data that is provided by algorithmic systems provide these third parties opportunities to save money.

As seen, algorithms play an essential role in the healthcare industry as they affect healthcare decisions for tens of millions of patients each year. Now we seek to introduce risk assessment algorithms in the realm of health management. There is even an increasing push for

algorithms to assist in the delicate process that is health management. But as the health industry becomes more and more data-centric, the way the industry has begun to make decisions with algorithms has changed. For example, now hospitals can look at historical trends in patient data and use an algorithm to identify individuals who may be at risk of a health implication before they even experience the first symptom. This kind of algorithm is known as a risk assessment algorithm, an algorithm in which a risk score is predicted by evaluating a variety of variables that correlate with or cause a specific outcome. When a risk score reaches a predetermined threshold, preemptive action can be taken which can, in turn, save money and lives. One key assumption when using risk assessment algorithms to predict potential medical needs is that patients who require the most medical attention should be some of the most identifiable.

But what happens when algorithms do not actually predict which patients are in need of medical attention? Why wouldn’t this always be true? These are the questions researchers Ziad Obermeyer and his team asked when exploring healthcare data from a notable institution.

Obermeyer explored a program in which patients at the 97th risk percentile and above were automatically enrolled in a care management program and patients at the 55th risk percentile were referred to primary care physicians to discuss enrollment in a care management program. (Obermeyer, 2019) They found that there was a gap between medical needs and receiving the proper attention, and this gap correlated with the race of a patient. Findings also revealed that the risk assessment algorithm violated the key assumption of what it was meant to do, as the prediction on potential medical needs was actually a prediction on potential medical costs.

Specifically, the problem was black individuals at the same health level as white individuals had lower risk scores, leading to less identification of real health implications for black individuals. Knowing that the algorithm was predicting medical needs via medical costs, the researchers saw

that black individuals generated lower healthcare costs for reasons such as low access, barriers to entry, and lack of trust. This kind of deprioritization of people of color is sadly common in algorithms throughout all industries whether intentional or unintentional. However, this bias has a particularly catastrophic impact in the field of healthcare: the limit of access to potentially

life-saving healthcare management programs to an entire race of people. Obermeyer stated that removing this bias from the algorithm would more than double the number of black patients eligible for these beneficial healthcare management programs. This idea of flawed algorithms and their disparate impact applies to a variety of healthcare programs and is why it remains essential to address, especially in the context of racism and historical injustice for people of color. All of this raises moral questions regarding the data and algorithms used in healthcare. If a decision-making system is not fair to all it serves, or actively deprioritizes individuals consequence of skin color, should it be implemented on a large scale?

We now seek to introduce machine learning algorithms and their influence within the healthcare industry through pattern recognition algorithms. Machine learning algorithms are being implemented in the medical industry to take on many important tasks. Defined by Artur Samuel, ML is a field of study that allows the computer to learn without being programmed, it allows the computer to learn from experience as long as its performance at a task at hand is something that does improve with experience (Grote, 2019). ML is built on the paradigm that it doesn’t start with a predefined model which data is then fit to, instead it builds a model based on the data by detecting underlying patterns in the data, thus avoiding presumptions about the type of model being used. Hence, the application of ML to process clinical data enhances the clinical predictive power of our current models.

A promising application of machine learning algorithms to medicine is to use them in the context of disease screening. While a Heuristic is problem-dependent, as in it’s used for a given problem, a metaheuristic is problem-independent; it consists of several sub-heuristics that can be applied to a variable set of problems, and the metaheuristic algorithm decides which problem to apply which heuristic to. One such metaheuristic method is the Genetic Algorithm. It works by first generating a set of random individuals (solutions) based on properties (chromosomes) that are defined by the problem. Then, each successive generation creates more individuals with more diverse properties based on the laws of genetics such as mutations and crossovers. The possibility of reproduction in each generation depends on the fitness of the individuals or the correctness of the solution. This means that in each generation, all the correct solutions will “reproduce” to create even more solutions in the next generation, all with more diverse properties. Algorithms such as this can be used in several fields across medicine, such as for imaging techniques in radiology, cardiology, etc.

These pattern recognition algorithms can have a very important role in pathology.

Modern medicine today is built on finding patterns in data. And in a field such as Pathology, algorithms that can provide skill, accuracy, and reliability hold crucially important roles. When looking through slides pathologists look through samples of all sorts of cells. Normal cells and samples of the nastiest tumors are easy to find. They also look through atypical cells that may look a bit suspicious, samples of pre-cancerous growths, or even samples of cancerous cells that have not yet spread or grown large enough to see with the naked eye. Even expert pathologists can disagree on what the correct diagnosis is. There was a test run, and during that test and only 48% of the time did doctors agree on the diagnosis (Grote, 2019). When a coin flip could change your path of care, machine learning algorithms that are built to find these ambiguous patterns can

help provide better care to patients. Companies such as PathAI and Google Brain Team are some of the leading companies seeking to implement these pattern recognition algorithms into the industry.

When algorithmic systems are introduced into the medical field, an important discussion that needs to take place is about the vulnerability of patients' privacy. In healthcare, a lot of information is shared between patients and their respective healthcare providers. These healthcare providers include every person a patient will interact with directly and indirectly as they seek treatment. Healthcare providers have large data sets that house every patient's information that would be needed to provide patient care (Toews 2020). This information includes full names, contact details, past testing recommendations, past provided services, provider names, medical histories, patient IDs, social security numbers, financial accounts, past payment options, health insurance, Medicare numbers, dates of birth, physician locations, and many more (Davis 2020). Patients interact with healthcare providers with the trust that their information will be secure. A law that secures patients’ trust with their information is the Health Insurance Portability and Accountability Act. Recognized today as ‘HIPAA’, it requires standards to protect patient health information from being disclosed without the patient’s consent or knowledge (CDC). Furthermore, HIPAA Security Rules require healthcare providers to implement these standards administratively, physically, and technically (“Your Rights Under HIPAA” 2020). The immense amount of sensitive information that healthcare providers’ databases contain is vulnerable to ransomware attacks and, likewise, privacy breaches.

Ransomware attacks deploy malicious software that targets your computer system and prevent your system from working until a certain amount of money is paid (HealthITSecurity 2020).

When a ransomware attack occurs, patient information is accessed by the attackers and breaches

the assumed privacy security that patients grant themselves when they hand over their sensitive information to healthcare providers. When this breach occurs, patients have no idea where their information has gone. This is certainly worrisome when sensitive information, such as social security numbers, bank information, and home addresses, is accessed by an unknown identity. As more and more data and algorithms are being implemented into the healthcare industry, patients need to be aware of their privacy and the potential for their information to be leaked. Many existing algorithms will be strengthened, and new algorithms will be implemented to safeguard patients’ sensitive information; however, there will always be a risk of compromised records and sensitive information being used against patients. Not only is a patient's privacy at risk through hacking, but privacy may be breached for the public good. As health data from almost every individual is more accessible than ever, this data can be wielded to study trends in populations and even DNA (Fry 2019). These benefits can include new medical breakthroughs, allowing for better medical treatment for all. However, this becomes a problem when patients are not even asked for consent or given the ability to opt-out. Furthermore, the information that healthcare providers have may be used against patients who have pre-existing conditions or addictions when they seek insurance or furthermore medical treatment. When algorithms are implemented in the healthcare industry, there are certainly many benefits; however, patients must understand the privacy risks that these algorithms create.

Algorithms within the healthcare industry provide great means for advances in medicine by bringing better practices to both its workers and patients. Both risk assessment and pattern recognition algorithms allow for healthcare providers to know best when to intervene with a patient. However, there are both privacy and moral issues that must be discussed when

considering the impact that these algorithms can have on patients and even society as a whole. Next, we delve into a moral analysis of both algorithms.

# Analysis

The existence of bias within healthcare organizations and their significance on the allocation of care is reason for concern. No patient in a healthcare system should receive a lower standard of care due to inalienable characteristics. Unfortunately, risk assessment algorithms have had a negative influence on decision making systems resulting in bias against

African-Amercians. (Obermeyer, 2019) This hidden deprioritization of Black individuals leads to Black patients receiving less care than White patients. To achieve the goal of delivering equitable care, healthcare systems around the world must be actively resolving any kind of negative impacts they have that are linked to class, characteristic, or complexion. Asserting this means that risk assessment algorithms must be evaluated on moral grounds to see if their implementation is warranted.

Bias in risk assessment algorithms is a problem from the perspective of virtue ethics, specifically when considering the virtue of justice and the opposing vice of injustice. According to Timmons, “an action is right if and only if (and because) it is what a virtuous agent (acting in character) would not avoid doing in the circumstances under consideration.” (Timmons, 2013) A risk assessment algorithm serves as the decision making agent in this scenario. In the context of Ziad Obermeyer’s research, it is apparent that on the basis of justice and injustice the risk assessment algorithm made decisions that avoided the just choice of prioritizing patients by necessity of medical attention. This is the result of a predisposition within the algorithm to prioritize lower expected medical costs, inadvertently neglecting Black individuals. From Timmons Moral Theory Primer, “an action that a virtuous agent, acting in character, would not

fail to perform in some circumstance is morally required, an action the agent might or might not do at the agents discretion is morally optional, and one that the agent would avoid doing is morally wrong.” (Timmons, 2013) But there are other factors to consider before making a final decision on the morality of implementing such risk assessment algorithms in healthcare.

One point of consideration when applying virtue ethics is to what extent other virtues affect the agent. The virtue of justice may favor equitable care, but the virtue of loyalty (in the sense of serving the hospitals and their bottom line) may favor minimizing the cost of care. Here we must examine the particular details of the case at hand. What is at stake here? How important is justice in the form of equitable care? How important is loyalty in the form of lower costs for the institutions? These questions could require moral analysis within themselves. For the sake of scope we will return back to the goal at hand, that no patient in a healthcare system should receive a lower standard of care due to inalienable characteristics. Therefore we would prioritize justice over loyalty. In an ideal world, the algorithm would have the practical wisdom required to discern which virtue considerations, among competing virtue considerations, should hold the most weight. In the real world, an outside agent controls the algorithms and would therefore be responsible for implementing said weights.

After an all-things-considered examination from the perspective of virtue ethics, we can determine that the risk assessment algorithm would avoid doing an action that a virtuous agent, acting in character, would do. Therefore the risk assessment algorithm is morally wrong and warrants adaptation.

Alongside risk assessment algorithms, pattern recognition algorithms being used in the context of disease screening and diagnosis must also be evaluated to see if their current implementation in clinical settings is morally acceptable or requires adjustment. At current, the

problems posed by the usage of pattern recognition algorithms to diagnose diseases can be broken down into epistemic and ethical pitfalls at the individual level of healthcare, as defined by Thomas Grote in his study “On the ethics of algorithmic decision making in the context of healthcare.” At the individual level, the epistemological problem arises in cases of

peer-disagreement between a clinician and a machine learning algorithm. In such cases, where there are two diverging diagnoses for a sample by a clinician and a machine learning algorithm, how much weight should the clinician assign to the algorithm’s diagnosis when trying to make a well-informed decision? This question is further complicated by the inherent opacity linked to machine learning algorithms, in that such algorithms do not supply the clinician with an explanation of why they decided that way. Thus, in such cases of peer disagreement, the deployment of machine learning algorithms poses another source of uncertainty (due to the opacity of the algorithms being considered) to a clinician trying to make a well informed decision, thus challenging the “epistemic authority” of the clinician.

This epistemological problem also yields severe ethical implications when considering the question of how accountable a clinician can be held for an algorithm’s decisions. Let’s consider these in the context of peer-disagreements as described above. In such a situation, where the clinician’s and algorithm’s diverge, deferring to the algorithm provides her with a normative justification, essentially “shifting the blame” to the algorithm. In contrast, if the clinician tries to stick to her initial decision and turns out to be wrong, she might be seen as acting “irresponsibly” and not considering the algorithmic data at her disposal.

To more accurately understand if the use of machine learning algorithms as defined above is morally acceptable, an application of the Natural Law Theory is beneficial. As defined in Timmons’ Moral Theory Primer, “An action is right if and only if (and because) in performing

the action one does not directly violate any of the basic values,” with the basic values being defined as Human Life, Procreation, Knowledge, and Sociability. In this case, the action that is being evaluated by the theory is the action of the clinician considering the diagnosis of the machine learning algorithm in their decision, and the alternative option is that the clinician won’t consider the algorithm’s diagnosis. The action in question affects two of the four intrinsic goods mentioned above, Human knowledge and Life, though in different capacities. Consideration of the algorithm’s decision as mentioned above directly undermines the clinician’s epistemic authority, so the performing the action would directly and necessarily interfere with the intrinsic value of human knowledge, whereas not doing the action would avoid this. As for the action’s effect on the intrinsic value of Human Life, this effect is unintentional, indirect, and it’s destruction is possible irrespective of whether the action is done or not.

Since the Natural Law Theory states that we must first consider only the direct effects of the action and in this case the action directly results in the destruction of the intrinsic value of human knowledge, the consideration of pattern recognition algorithms’ diagnoses in clinical decision making is not supported by the Natural Law Theory. Thus, further modification of pattern recognition algorithms is required before they can be used by clinicians in disease screening/diagnosis.

# Critical Reflection

In this paper we have discussed the employment of big data in healthcare and the assorted moral complications of the use in practical situations. Throughout our research within various

articles and papers we found multiple sources of racial bias in algorithms used in medicine. We looked at a few case studies such as Obermeyer and Samuel where data algorithms have been used in healthcare and have produced mixed results along with some new moral discussions to be had. There have been revealed instances of discrimination and biases with these algorithms and it has been discussed their moral implication on individuals who seek treatment. However, it is not all bad news with these new algorithms. With more work in these fields the technology has a lot of potential to help create a more efficient and accurate treatment of patients.

In the analysis section it was revealed how risk assessment algorithms have a bias against certain people and create an unfair distribution of treatment. Risk assessment algorithms have therefore been deemed morally wrong. But maybe the effectiveness of the algorithms should outweigh their current flaws, as this would allow for future innovation, better algorithms, and more lives saved (Schwartzapfel 2019). There are ways to implement a risk assessment algorithm in medicine without including the bias that comes with it which can be seen with another case of risk assessment algorithms in courtrooms. As the Schwartzapfel article points out, these algorithms can be used alongside professionals in order to increase efficiency while also minimizing implicit biases. Schwartzapfel says “it’s about how we can use other tools at our disposal to create a suite of strategies to accomplish what we’re aiming at.” This could definitely be applied to healthcare the same way that it is being implemented in legal issues. The biases are clearly demonstrated in cases like the Obermeyer study, however, other professions show that there is hope to diminish these biases in the future and create a more fair and useful algorithm.

Pattern recognition may have it’s own set of challenges and shortcomings morally but it can also be used to benefit society just like with risk assessment. Pattern recognition is a tool in the medical industry that has become very accurate and precise in helping patients diagnose their

problems early. According to an empirical study done by Friedman “The quantitative research findings indicated that pattern recognition was significantly more likely to produce an accurate diagnostic outcome than analytical reasoning strategies during a physiotherapy history.” With the ability of pattern recognition to produce diagnoses better than most doctors it’s hard to argue against using them due to their obvious benefit to society. They do still have a long way to come as discrimination in the algorithms is evident, however, with some fine tuning and more studies this technology has a lot of potential to enhance the welfare of all individuals.

These two methods both create a safer and more effective care for patients in general.

Yet, personalized plans for individuals especially with more complex medical issues still leave a lot to be desired. All of this comes at a cost to individuals' privacy as well but the data collected helps create a better algorithm for the public. There is a decision to be made at what cost of our individual data collected and privacy invaded do we put up with in order to benefit the general population in better medical algorithms? The future is moving at a fast pace and it seems like these medical algorithms could be the next step in improving the healthcare system even with the cost to individuals.

# Conclusion

Big Data has been implemented in numerous ways to the healthcare field with some success and with some moral issues as well. With the size of the healthcare industry it is all but inevitable that these new technologies are developed and implemented to solve issues of patients and create a more effective analysis and streamlined approach to getting people help. Algorithms are used with various tools to increase healthcare effectiveness but throughout studies there have

been moral issues raised. With risk assessment algorithms we have seen biases in the treatment of African-Americans and their deprioritization of medical care even with the same health issues as other patients. Looking at the virtue ethics of the use of risk assessment algorithms we conclude that no patients should receive worse care based on things like race. With pattern recognition as well we saw epistemic and ethical pitfalls of the use of these algorithms in healthcare. Both of these have seen to be effective in getting better care to individuals and with future study and work they could become key in creating a better healthcare system for all.

However, there are still a lot of questions surrounding the algorithms in their early stages and it is yet to be seen if they can be used in the healthcare field without biases to anyone who needs treatment.

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