# **INVESTIGATING THE ETHICAL IMPLICATIONS OF USING MACHINE LEARNING ALGORITHMS IN DECISION-MAKING PROCESSES**

BY

DICKSON, SIMI HILLARY

BU/23A/PGS/8372

Being a Pre data report presented in partial fulfillment of the requirements for the award of Masters of Science (M.Sc) Degree in Computer Science,

Department of Computer Science,

Faculty of Computing and Applied Sciences,

Baze University, Abuja.

April, 2024

**TABLE OF CONTENTS**

Title Page

[Table of Contents](#_Toc8570)

**[CHAPTER ONE 1](#_Toc8087)**

[INTRODUCTION 1](#_Toc30112)

[1.1 Background of the Study 1](#_Toc9946)

[1.1.2 Evaluating Decision-Making Processes in Various Situations 1](#_Toc19422)

[1.1.3 Application of Ethical Frameworks in AI and Decision-Making 2](#_Toc31405)

[1.1.4 Understanding the Legal and Regulatory Environment of AI and Machine Learning 3](#_Toc31962)

[1.2 Statement of the Problem 4](#_Toc20978)

[1.3 Aims and Objectives 5](#_Toc27008)

[1.4 Significance of the Study 5](#_Toc8522)

[1.5 Scope of the Study 6](#_Toc30144)

[1.6 Limitations of the Study 7](#_Toc24401)

**[CHAPTER TWO 8](#_Toc7793)**

[LITERATURE REVIEW 8](#_Toc7049)

[2.0 Introduction 8](#_Toc11016)

[2.1 Ethical Concerns in Machine Learning-based Decision-Making 8](#_Toc1441)

[2.1.1 Fairness and Bias in Algorithmic Decision-Making 10](#_Toc16964)

[2.1.2 Transparency and Explainability in Machine Learning Models 11](#_Toc12291)

[2.1.3 Accountability and Responsibility in Algorithmic Decision-Making 13](#_Toc8447)

[2.2 Existing Frameworks and Solutions in AI Ethics 14](#_Toc28623)

[2.2.1 Ethical Considerations in Artificial Intelligence 15](#_Toc27843)

[2.2.2 Solutions to Ethical Issues in AI 15](#_Toc3499)

[2.3 Real-World Case Studies of Ethical Dilemmas 16](#_Toc10200)

[2.3.1 Case Study 1: Automated Resume Screening Tool 17](#_Toc22031)

[2.3.2 Case Study 2: Predictive Policing Algorithm 18](#_Toc15073)

[2.3.3 Case Study 3: Apple Card Algorithm and Gender Bias 19](#_Toc19703)

[2.4 Legal and Regulatory Landscape of Artificial Intelligence and Machine Learning 20](#_Toc26692)

[2.4.1 International and Regional Initiatives  21](#_Toc10273)

[2.4.2 National Regulations 21](#_Toc24560)

[2.4.3 Challenges and Considerations  22](#_Toc3137)

[2.5 Current Research and Trends in Ethical AI Development 22](#_Toc7747)

[2.6 Literature Review Matrix 25](#_Toc11474)

[2.7 Research Gap 26](#_Toc22292)

**[CHAPTER THREE 28](#_Toc11116)**

[RESEARCH METHODOLOGY 28](#_Toc30265)

[3.1 Research Approach 28](#_Toc15045)

[3.2 Research Design 28](#_Toc18680)

[3.3 Population, Sample, and Sampling Techniques 28](#_Toc27338)

[3.3.1 Population 29](#_Toc16452)

[3.3.2 Sample 29](#_Toc28275)

[3.3.3 Sampling Techniques 30](#_Toc31167)

[3.4 Data Collection Methods 30](#_Toc28989)

[3.5 Justification of the Method 31](#_Toc28109)

[REFERENCES 33](#_Toc369)

# CHAPTER ONE

# INTRODUCTION

## Background of the Study

In recent years, machine learning and artificial intelligence have grown rapidly, reinventing data analysis and computers to enable intelligent capability in applications. As a branch of artificial intelligence and computer science, machine learning focuses on using data and algorithms to imitate human learning processes and gradually improve accuracy. According to Hashemi-Pour & Wigmore (2023), a machine learning algorithm is a collection of mathematical procedures or methods that an artificial intelligence system uses to carry out tasks, such as obtaining patterns, insights, and predictions from input data that it has been trained on. Completing these exercises is essential to improving decision-making abilities and producing desired results. There are three different kinds of machine learning algorithms: reinforcement learning, unsupervised learning, and supervised learning (Bonnacorso G., 2017).

### **1.1.2 Evaluating Decision-Making Processes in Various Situations**

1. Financial Lending: Decision-making in financial lending involves a complex array of steps, encompassing crucial stages like credit decisions, loan approvals, risk assessments, and underwriting choices. Understanding these procedures is essential for lenders to evaluate borrowers' financial health and mitigate default risks (Karunakaran, K., 2023). The stages include:
2. Making Credit Decisions
3. Procedure for Approval of Loans
4. Evaluation of Financial Risk
5. Underwriting Decisions
6. Hiring Practices:Hiring practices involve complex decision-making processes that take into account a number of factors in order to pick the most qualified applicants (Raghavan, M., 2019). Effective navigation of these procedures is crucial for employers and hiring managers to make well-informed decisions and establish productive teams. The processes are:
7. Candidate Assessment
8. Interviewing Candidate
9. Verifying References
10. Decision-Making Criteria
11. Final Selection and Offer
12. Criminal Justice: The criminal justice system uses sophisticated and complex decision-making processes that take into account a number of steps and factors (Anna Maria College, 2023). These steps include:
13. Evaluation of Legal Decisions
14. Prosecutorial Decision-Making
15. Judicial Decision-Making
16. Penitentiary Decision-Making

### 1.1.3 Application of Ethical Frameworks in AI and Decision-Making

Artificial intelligence is becoming more and more ingrained in the decision-making processes of many different industries in the contemporary digital era, which raises ethical concerns concerning its application. To ensure that AI technologies uphold fundamental human rights and align with societal values, establishing and implementing ethical frameworks is crucial. These frameworks, emphasizing principles like beneficence, accountability, and transparency, guide the development, application, and decision-making processes of AI (Alagar, 2023). By incorporating ethical frameworks, stakeholders can navigate ethical dilemmas while promoting principles like fairness, transparency, and respect for human dignity in decision-making (MacCarthy, 2019). These frameworks, which emphasize principles like beneficence, accountability, and transparency, direct the development, application, and decision-making processes of AI. Incorporating ethical frameworks allows stakeholders to promote principles like justice, transparency, and regard for human dignity in decision-making while navigating moral quandaries.

### 1.1.4 Understanding the Legal and Regulatory Environment of AI and Machine Learning

The rise of artificial intelligence and machine learning (ML) technologies in recent years has prompted authorities around the world to consider the ethical and legal consequences of their application. This section looks into the legal frameworks governing AI and ML technologies in Europe, the United States, and Nigeria, with a particular emphasis on their impact on decision-making processes.

a. Legal Framework in Europe: The General Data Protection Regulation (GDPR), implemented in 2018, stands as one of the most comprehensive data protection regulations globally. It enforces strict regulations on the collection, usage, and storage of personal data, alongside guidelines for transparent and accountable algorithmic decision-making (General Data Protection Regulation (GDPR) – Official Legal text, 2022). Individuals have the right to explanation and transparency when automated decisions are made about them, imposing significant obligations on businesses utilizing AI and ML algorithms.

b. Legal Framework in the United States: In the United States, AI and ML technologies are subject to a patchwork of government constraints across various sectors. The Fair Credit Reporting Act (FCRA), passed in 1970, establishes standards for the fairness and accuracy of credit reporting systems and regulates the use of consumer credit information. Despite predating substantial AI and machine learning use, the FCRA's rules have an impact on automated decision-making systems employed by financial institutions and rating agencies. Furthermore, regulatory authorities like as the Securities and Exchange Commission (SEC) and the Federal Trade Commission (FTC) monitor AI and machine learning applications in financial markets and consumer protection (Federal Trade Commission, 2023).

c. Legal Framework in Nigeria: While there are a few important laws in place to handle privacy and data protection issues, the country's legal framework for artificial intelligence and machine learning is currently being developed. Nigeria's main IT industry regulator, the National Information Technology Development Agency (NITDA), was founded under the NITDA Act of 2007. Aiming to control the processing of personal data and advance data privacy in Nigeria, the Nigeria Data Protection Regulation (NDPR) was released in 2019 by the NITDA as a result of this act (Kashifu A., 2020).

## 1.2 Statement of the Problem

The expanding use of machine learning algorithms in decision-making processes across businesses has sparked serious ethical concerns. While these algorithms have the potential to increase efficiency and accuracy, their reliance on historical data and complex mathematical models raises ethical concerns about fairness, transparency, and accountability. This study intends to analyze the ethical implications of using machine learning algorithms in decision-making processes, namely prejudice, discrimination, and unanticipated consequences. By reviewing real-world case studies and ethical frameworks, this study hopes to shed light on the obstacles and opportunities related to the responsible use of AI technology in decision-making.

## 1.3 Aims and Objectives

**Aim:**

The aim of this research is to:

1. Examine the ethical implications of using machine learning algorithms in decision-making processes in different sectors and settings.

**Objectives:**

The specific objectives are to:

1. Determine the societal consequences of biased or discriminatory decision-making algorithms and investigate solutions for avoiding ethical risks.
2. Identify and analyze real-world case studies that exhibit ethical problems and dilemmas linked with the usage of machine learning algorithms.
3. Make recommendations to promote justice, openness, and accountability in the design and deployment of machine learning algorithms for decision-making.

## 1.4 Significance of the Study

1. Ethical Awareness: By examining the ethical implications of using machine learning algorithms in decision-making processes, this study raises awareness of potential biases, discrimination, and moral issues that arise in algorithmic decision-making. This understanding is critical for individuals, organizations, and politicians to make informed decisions and reduce ethical hazards.
2. Impact on Society: The study's findings can shed insight into the larger societal consequences of biased or discriminatory algorithms, notably in areas such as recruitment, financial lending, hiring practices, and criminal justice. Understanding these implications is critical to improving fairness, equity, and social justice in decision-making processes.
3. Guiding Policy and Regulation: By assessing existing ethical frameworks and norms and making recommendations for ethical algorithm design and implementation, this study can help shape policies and regulations controlling the use of AI technology. Such policies are important to ensure that AI systems follow ethical norms and respect fundamental human rights.
4. Promoting Responsible AI Development: The findings from this study can help to promote responsible AI development practices by emphasizing the importance of openness, accountability, and justice in algorithmic decision-making. This study's goal is to increase stakeholders' trust and confidence in AI technology by establishing a culture of responsible development.

## 1.5 Scope of the Study

The scope of this study includes an in-depth look into the ethical consequences of using machine learning algorithms in decision-making processes across a variety of sectors. It includes analyzing ethical theories, reviewing real-world case studies, assessing the legal and regulatory environment, and setting specific goals and objectives. By diving into these issues, the study hopes to shed light on ethical concerns, provide recommendations, and contribute to the larger conversation about responsible AI development and decision-making procedures. While the study admits several limitations, its findings are likely to influence stakeholders, governments, and researchers, resulting in a more ethically conscious and accountable approach to implementing artificial intelligence.

## 1.6 Limitations of the Study

Although this research aims to offer useful knowledge about the ethical implications of machine learning algorithms in decision making process, the following limitations were encountered:

1. Sample Size: The current study's dependence on a review of existing literature may limit the scope and depth of its investigation of the ethical implications of machine learning algorithms.
2. Generalization: The findings of this study may be limited in their generalization to broader populations or contexts. Since the analysis was based on a selected number of literature and case studies, the conclusions drawn may not apply universally to all scenarios involving machine learning algorithms.
3. Access to Data Sources: The availability of data sources for case studies may vary, potentially limiting the depth and breadth of the analysis. Constraints on access to proprietary data or sensitive information could impact the comprehensiveness of the case study analysis.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.0 Introduction

The objective of this section is to perform a thorough literature review with an emphasis on the ethical implications of machine learning in decision-making. This review attempts to examine the many aspects of prejudice and equality in automated decision-making by looking at previous studies and academic works. It is significant as it provides an understanding of the possibilities as well as the challenges associated with adopting machine learning technologies across a range of industries. Also, by placing the ethical concerns within the larger framework of the project, this investigation assists in demonstrating how important it is to address these problems in both the development and implementation of AI systems.

## 2.1 Ethical Concerns in Machine Learning-based Decision-Making

The growing use of artificial intelligence (AI) technologies in many industries' decision-making processes in the current digital landscape highlights how important it is to address ethical issues. The ethical issues surrounding the usage of AI technologies are becoming more and more important as they grow more sophisticated and commonplace. Ethical frameworks must be established and put into place to ensure that AI development and application respect fundamental human rights and are consistent with society's ideals. In order to address ethical concerns, this section explores the application of ethical frameworks in AI and decision-making, emphasizing particular principles and their applicability. It looks at a variety of ethical frameworks, each providing different perspectives on handling the ethical challenges of integrating AI, rather than restricting the conversation to just a few frameworks. Three key frameworks relevant to addressing ethical concerns in machine learning-based decision-making processes include:

1. Utilitarianism: This ethical philosophy places a strong emphasis on minimizing harm and maximizing overall benefits. When it comes to AI and decision-making, utilitarianism directs developers and decision-makers to put the welfare of people and society at large first. It promotes the development and application of AI technology in a manner that optimizes benefits and reduces drawbacks. Utilitarian principles, for instance, would put patient safety and health results first when creating AI systems for the healthcare industry, making sure that the advantages of AI-driven healthcare solutions exceed any possible dangers or drawbacks (Gregoire, J., 2013).

2. Virtue Ethics: Virtue ethics is concerned with how moral virtues and characteristics are developed. When it comes to AI and decision-making, virtue ethics pushes decision-makers to develop a sense of ethical obligation and look at the bigger picture before acting. Rather than concentrating only on the results of AI systems, virtue ethics highlights how crucial it is to cultivate a transparent, equitable, and morally upright culture in algorithmic decision-making processes. This approach fosters trust and accountability within AI ecosystems by ensuring that AI technologies are created and used in a way that is consistent with ethical ideals and principles (Gregoire, J., 2013).

3. Principles of Accountability and Transparency: To address ethical issues with AI and decision-making processes, it is important to stay true to the principles of accountability and transparency. To make stakeholders accountable for the effects of AI technology, accountability involves establishing different categories of accountability for AI decisions and results. On the other hand, transparency is giving users and stakeholders comprehensive explanations of how AI systems function and make decisions so they can comprehend the underlying algorithms and procedures. By complying with these guidelines, lawmakers and AI developers will alleviate moral worries and foster confidence among stakeholders and consumers, which will ultimately encourage the ethical advancement and application of AI technology (Gregoire, J., 2013).

### 2.1.1 Fairness and Bias in Algorithmic Decision-Making

As machine learning and decision-making continue to advance, it is becoming increasingly important to guarantee fairness and reduce biases in algorithmic systems. The widespread adoption of algorithmic decision-making systems in a variety of fields has sparked worries about how easily preexisting social prejudices could be reinforced or made worse. Machine learning models often inherit biases from the training data they are trained on, perpetuating societal prejudices and historical injustices (Bolukbasi et al., 2019). These biases can manifest as unequal outcomes for different demographic groups, leading to unfair treatment and reinforcing structural inequities. An approach that takes into account both technological and ethical factors is needed to address fairness and prejudice in algorithmic decision-making. From a technical perspective, practitioners and researchers are investigating ways to identify, quantify, and reduce biases in machine learning models. By recognizing and reducing biased decision-making processes, strategies including fairness-aware algorithms, bias detection frameworks, and fairness restrictions seek to promote equal outcomes.

However, achieving fairness in algorithmic decision-making requires more than just technological fixes; it also involves broader cultural and ethical considerations. It needs a thorough examination of algorithmic systems' societal effects, decision-making procedures, and underlying data sources. In addition, fostering equity requires accountability, transparency, and stakeholder involvement to guarantee that algorithmic decision-making procedures are consistent with moral standards and social ideals. Case studies from the real world demonstrate the difficulties and ethical issues that arise with addressing prejudice and fairness in algorithmic decision-making. These case studies emphasize the necessity for appropriate ethical frameworks and regulatory monitoring in order to protect against unfair or discriminatory outcomes, from biased predictive policing systems to discriminatory recruiting algorithms. In summary, fairness and bias in algorithmic decision-making are urgent issues that need coordinated efforts by stakeholders, practitioners, researchers, and legislators. We can endeavor to build and implement algorithmic systems that support justice, equity, and the welfare of society by fusing technological breakthroughs with moral considerations and legal protections.(MacCarthy, 2019)

### 2.1.2 Transparency and Explainability in Machine Learning Models

Transparency and explainability are key ideas in the field of machine learning (ML) models. Considering the growing reliance of society on machine learning algorithms for decision-making across multiple domains, we must understand the process by which these models arrive at their conclusions to promote ethical deployment, accountability, and trust. The simplicity and openness with which ML models function is referred to as transparency. Giving an understanding of the algorithms' inner workings, including their data inputs, processing stages, and decision-making processes, is what it encompasses. Stakeholders may examine and validate the model's behavior, spot any biases or mistakes, and judge the model's fairness and dependability thanks to transparency. Conversely, explainability goes beyond transparency by attempting to offer comprehensible justifications for the predictions or outputs of the model. It entails providing a human-interpretable explanation for the reasoning behind the judgments made by the ML system. Explainable AI (XAI) approaches aim to overcome the trust and cooperation gap between people and automated systems by bridging the gap between sophisticated machine learning models and human understanding (Baredo A., 2020).

Transparency and explainability are crucial attributes in machine learning models, impacting their real-world applications across various domains (Lipton, 2018). As society increasingly relies on machine learning algorithms for decision-making, understanding how these models reach their conclusions is essential to promote ethical deployment, accountability, and trust. In crucial fields like healthcare, finance, and criminal justice, where machine learning algorithms impact important choices, interested parties expect explanations and responsibility for the results generated by these systems. Transparent and explicable machine learning models, for example, are critical to guaranteeing patient safety and regulatory compliance in the healthcare industry. To make well-informed judgments on patient care, clinicians and other healthcare providers have to understand what factors are influencing medical diagnoses or treatment recommendations produced by AI systems.

Similar to this, transparent machine learning models are essential in the financial services industry to uphold equity and reduce the risks connected with algorithmic decision-making. Transparent and comprehensible credit scoring methods are essential to lenders' and regulators' ability to fairly evaluate borrowers' creditworthiness and stop discriminatory practices. Transparency and explainability in machine learning models are critical to maintaining due process and preventing unfair outcomes in the criminal justice system. To maintain fairness and equity in court proceedings, judges, prosecutors, and defense attorneys need to know what factors influence risk assessments or sentencing recommendations given by predictive policing algorithms. Transparency and explainability are, in general, core ideas that guide the responsible creation and application of ML models. These principles enable stakeholders to maximize the potential benefits of AI while reducing the dangers of unexpected consequences or harm by encouraging responsibility, trust, and ethical decision-making (Balasubramaniam et al., 2023)

### 2.1.3 Accountability and Responsibility in Algorithmic Decision-Making

The issue of accountability and responsibility is very important in the context of AI development and use. This subtopic explores the complex issues around determining who is responsible for algorithmic judgment and looks at the literature that supports accountability and transparency in the processes of developing and implementing AI. The question of who should be responsible for the decisions made by AI systems is complex when it comes to algorithmic decision-making. Because AI decision-making is decentralized and involves multiple stakeholders, including developers, data scientists, and end users, it brings more complexity than traditional decision-making procedures, where accountability usually rests with human actors. Furthermore, it is hard to assign blame because of the opaqueness of many AI algorithms, which makes it harder to pinpoint the reasons behind judgment.

Existing research endeavors to address these challenges by fighting for more openness and accountability measures throughout the AI development lifecycle. The goal is to make AI models easier to interpret so that interested parties can understand the underlying principles that guide algorithmic judgments. The goal of techniques like explainable AI (XAI) is to shed light on the decision-making process of AI systems, making it easier to spot any biases or mistakes. Initiatives supporting responsible AI development also stress the significance of legal frameworks and ethical considerations. Fairness, accountability, and transparency (FAT) concepts are encouraged to be implemented in AI systems using ethical rules and regulations, which operate as a set of guiding principles for AI practitioners. To guarantee ethical AI, regulatory agencies and business associations are essential in setting compliance requirements and implementing accountability mechanisms.(Horneber & Laumer, 2023)

In summary, important areas of research in the field of AI ethics are accountability and responsibility in AI decision-making. Scientists and developers can reduce the possibility of unexpected repercussions while fostering trust and confidence in AI technology by tackling the difficulties involved in establishing accountability and encouraging openness. Sustained investigation and cooperation are necessary to progress the moral creation and application of artificial intelligence (AI) systems in society.

## 2.2 Existing Frameworks and Solutions in AI Ethics

A variety of ethical frameworks in AI ethics emphasize principles like transparency, accountability, fairness, and the protection of privacy and human rights. These frameworks were created to tackle the ethical challenges presented by AI systems as well as offer a guide for developers and policymakers to deal with these complex issues. Ethical frameworks are essential guidelines in any field, but they are especially important in the rapidly evolving field of artificial intelligence (AI). As AI systems continue to be incorporated into various aspects of society, it becomes essential to develop durable frameworks that ensure the ethical and responsible implementation of these technologies.

### 2.2.1 Ethical Considerations in Artificial Intelligence

Artificial intelligence (AI) systems are developed and implemented with ethical considerations in mind. As AI technology advances, concerns regarding bias, transparency, and privacy are becoming increasingly prominent (Mittelstadt et al., 2019). These concerns stem from the potential for AI systems to perpetuate existing societal biases, lack transparency in their decision-making processes, and raise privacy risks associated with data collection and usage. The potential for AI systems to maintain or worsen already-existing societal disparities is one of the major ethical issues in the field. For instance, AI systems may generate discriminatory results and further marginalize some populations if they are trained on biased datasets. Various approaches and solutions have been presented by scholars and policymakers to solve these ethical concerns. These include putting in place stringent policies for the gathering and use of data, encouraging inclusivity and diversity in AI development teams, and guaranteeing accountability and openness in algorithmic decision-making procedures. Stakeholders can strive to guarantee that AI technologies are created and applied in a way that respects human rights and social values by abiding by these standards.

### 2.2.2 Solutions to Ethical Issues in AI

The creation and use of strong principles and norms for AI ethics is a crucial first step in resolving ethical concerns in the field. To guarantee that AI technologies are developed, implemented, and used in a way that is consistent with moral principles and accepted social norms, these frameworks seek to establish a set of guidelines. For instance, a set of ethical principles with an emphasis on responsibility, transparency, and societal effect has been produced by the IEEE Global Initiative for Ethical Considerations in Artificial Intelligence and Autonomous Systems (Gillespie T., 2019). Developers and other stakeholders can more skillfully negotiate moral dilemmas and create AI systems that give ethical considerations priority by following these recommendations. Furthermore, any ethical problems can be foreseen and avoided before they develop by incorporating ethical considerations into the design process through ethical impact evaluations. The AI community may protect social norms and values while advancing the ethical and responsible development of AI technologies by implementing these solutions.

In conclusion, a variety of frameworks and approaches have been established in the field of AI ethics to address the ethical issues raised by the development of AI technology. While some frameworks concentrate on developing moral standards and guidelines for the creation and application of AI, others stress the significance of openness, responsibility, and the defense of human rights and dignity. To guarantee that AI technology is created and applied ethically and responsibly, it is critical for industry stakeholders—policymakers, academics, and developers—to collaborate. We can maximize AI's potential advantages while reducing its drawbacks by integrating ethical issues into the development and application of AI systems.

## 2.3 Real-World Case Studies of Ethical Dilemmas

The increasing incorporation of machine learning algorithms into decision-making procedures in diverse fields has triggered important discussions regarding their moral consequences. These worries are related to the possibility of bias, discrimination, and unforeseen effects if automated systems are the only ones used. This section examines three real-world case studies—the Apple Card credit limit algorithm, the COMPAS risk assessment software used in criminal justice, and Amazon's automated resume screening tool—that highlight the moral conundrums raised by machine learning. Every case study explores the unique moral dilemmas, societal ramifications, and lessons discovered related to the application of these algorithms. The objective of this study is to acquire a more profound comprehension of the obstacles and factors required for conscientious and moral development and application using these different cases.

### 2.3.1 Case Study 1: Automated Resume Screening Tool

Amazon.com's machine-learning experts created a recruiting engine to automate the process of looking for top talent by reviewing job applicants' resumes (Iriondo, R., 2018). The experimental hiring tool used artificial intelligence to evaluate applicants on a scale of one to five stars, similar to how Amazon customers rate things.

**Ethical Dilemma**: The recruiting engine showed gender bias by favoring male candidates over females. This bias originated from the algorithm's training data, which was primarily made up of male resumes. As a result, the system penalized resumes with phrases like "women's" and demoted grads from all women's colleges.

**Societal Impac**t: The prejudiced recruiting engine contributed to gender discrepancies in the IT industry by reinforcing existing hiring biases. Amazon eventually canceled the initiative, highlighting the limitations and ethical issues with machine learning in recruiting processes.

This case study illuminates the ethical consequences of utilizing machine learning algorithms in decision-making processes, notably hiring procedures, and emphasizes the need for greater openness and responsibility in algorithmic systems. This scenario from Amazon's experience serves as a warning about the risks of depending only on machine learning algorithms in sensitive decision-making contexts like recruitment. It emphasizes the significance of rigorously evaluating the data and algorithms utilized in such systems to reduce bias and promote fairness and equity in decision-making processes.

### 2.3.2 Case Study 2: Predictive Policing Algorithm

ProPublica, a Pulitzer Prize-winning nonprofit journalism organization, did a study of the risk assessment software called COMPAS. This software is used in courtrooms across the United States to predict which convicts are most likely to re-offend. ProPublica's study indicated that, while COMPAS correctly predicted recidivism for black and white defendants at nearly the same rate, it made distinct types of errors for each group. Black defendants were nearly twice as likely as white defendants to be labeled as higher risk but not re-offend, whereas white defendants were more likely to be labeled lower risk but later commit further crimes.(Angwin J, et. al., 2016.)

**Ethical Dilemma**: The implementation of COMPAS created serious ethical questions, particularly about racial injustice in the criminal justice system. By disproportionately misclassifying black defendants as high-risk, COMPAS exacerbated existing biases and may have contributed to unfair sentencing. This bias was not only unethical, but it also violated defendants' due process rights, as the system's workings were frequently opaque and unclear to those affected.

**Societal Implications:** The prejudiced results of COMPAS risk assessments had far-reaching consequences for individuals and communities impacted by the criminal justice system. Not only did it have the potential to result in unjust verdicts for defendants, but it also damaged public confidence in the legal system's impartiality and integrity. Furthermore, the COMPAS controversy sparked larger worries about the use of automated decision-making systems in sensitive settings such as law enforcement.

This case study highlights the ethical concerns surrounding the use of machine learning algorithms in decision-making processes, particularly in the field of law enforcement. It emphasizes the significance of transparency, accountability, and justice in algorithmic systems to avoid perpetuating or exacerbating existing biases and inequities. The COMPAS case serves as a cautionary tale about the dangers of depending solely on algorithmic decision-making without sufficient oversight and security measures in place.

### 2.3.3 Case Study 3: Apple Card Algorithm and Gender Bias

Apple Card, which launched in 2019, promised a potentially innovative experience owing to its sleek form, mobile-first strategy, and connection with the Apple ecosystem. However, suspicions about possible gender bias in the credit limit algorithm cast a shadow over this innovative offering very quickly. According to data scientist Cathy O'Neil, women were consistently disadvantaged by the algorithm, which used machine learning to evaluate credibility, when compared to males with comparable financial backgrounds. This prompted an onslaught of criticism and brought up important ethical issues regarding the use of AI in financial decision-making.(Knight W., 2019).

**Ethical Dilemma**: Even in cases where their financial profiles were comparable, the Apple Card algorithm seemed to habitually grant male applicants greater credit limits than female applicants. Concerns regarding the objectivity and fairness of the algorithm's decision-making process were raised by this gender bias. The creditworthiness criteria and training data used by the algorithm were questioned because they appeared to favor some demographic groups over others.

**Societal Implications:** The gender bias found in the Apple Card algorithm strengthened discrimination based on gender in the financial services industry and maintained already existing inequities. Due to biases in algorithms, women, particularly those from underprivileged communities, experienced difficulties obtaining loans and financial prospects. This hurt not just specific customers but also exacerbated larger social problems like gender discrimination and economic inequality.

The case study emphasizes how algorithms used to make important financial decisions may be biased. Such prejudices, even when unintended, can have serious negative effects on people and perpetuate social injustices. The growing dependence on AI-driven systems requires a critical analysis of the algorithms to identify any potential bias and the implementation of effective countermeasures.

## ****2.4 Legal and Regulatory Landscape of Artificial Intelligence and Machine Learning****

Globally, both business and society are rapidly evolving as a result of the rapid advancements in artificial intelligence (AI) and machine learning (ML) technologies, which in turn bring with them new potential and problems. The proper development and implementation of these technologies require the establishment of strong legal and regulatory frameworks as they become more and more integrated into our daily lives. An overview of the changing laws governing AI and ML is given in this part, covering national laws, worldwide initiatives, difficulties, and factors to take into account.

### 2.4.1 International and Regional Initiatives

International organizations and regional agencies have started working to solve the legal and regulatory issues that come with the rapidly expanding use of AI and ML technology. The General Data Protection Regulation (GDPR) of the European Union is an innovative piece of legislation that establishes strict guidelines for the privacy and security of data. (General Data Protection Regulation, 2022). In a similar vein, the AI Principles developed by the Organisation for Economic Co-operation and Development (OECD) promote the development of AI that is morally and openly compatible with human values. Furthermore, the African Union's (AU) Strategy for Artificial Intelligence (AI), adopted in 2020, reflects regional priorities and objectives in leveraging AI for socio-economic development. Despite these initiatives, the adaptation and implementation of international and regional principles at the national level present challenges that require careful consideration and collaboration.

### 2.4.2 National Regulations

Governments from all around the world are struggling to create AI-specific laws that fit their own political and social environments. Talks about regulating AI are gaining more steam in the US, with proposals emphasizing algorithmic justice and responsibility. China, which leads the world in AI innovation, has put laws in place that prioritize data protection and national sovereignty. While comprehensive legal frameworks specifically addressing AI are still in development globally, nations are navigating the complexities of regulating AI within their existing legislative frameworks. In Nigeria, for example, existing laws such as the Nigeria Data Protection Regulation (NDPR) serve as foundational pillars for addressing AI-related issues, particularly concerning data protection and consumer rights. However, ongoing efforts are underway to formulate AI-specific regulations that align with the country's socio-political context and emerging technological landscape. Although challenges persist, including the need to balance innovation with risk mitigation and harmonize regulations globally, governments are actively engaging stakeholders to develop effective legal and regulatory frameworks for AI and ML (Kashifu, A., 2020).

### 2.4.3 Challenges and Considerations

It takes a lot of labor and intricacy to create legal and regulatory frameworks for AI and Machine Learning that work. Concerns about obsolete or ineffective regulations are raised by the frequent bypassing of regulatory efforts by the quick speed of technological innovation. Another crucial issue facing regulators as they work to promote AI research while protecting against possible damages like algorithmic bias and prejudice is striking a balance between risk reduction and innovation promotion. Furthermore, considering the various legal frameworks and national goals, harmonizing AI rules globally continues to be a challenging task (Bird E. et. al., 2020).

## ****2.5 Current Research and Trends in Ethical AI Development****

Concerns over the potential ethical implications of AI systems have led researchers and developers to focus more and more on ethical AI development in recent years. The current focus of this field's research and developments is to solve the ethical issues that were previously discussed, such as accountability, transparency, prejudice, and fairness.

1.Bias Mitigation: Scientists are working hard to find and fix biases in artificial intelligence algorithms. Algorithmic audits and fairness-aware machine learning are two methods that are being used to identify and address bias in algorithmic decision-making and training data (Raghavan et al., 2019). Researchers hope to lessen the possibility of biased outcomes by promoting justice and equity in AI systems by tackling bias.

2.Transparency and Explainability: Improving AI systems' explainability and transparency is a key component of ethical AI development. To enable stakeholders to comprehend the decision-making process and pinpoint possible sources of bias or inaccuracy, researchers are investigating ways to improve the interpretability of AI systems (Barredo A. et al., 2020). To improve trust and accountability, methods like explainable AI (XAI) and model interpretability are being developed to offer insights into AI decision-making processes.

3.Accountability and Governance: Creating systems for accountability and governance is another aspect of developing AI ethically. Scholars are examining models for evaluating the moral implications of AI systems at every stage of their development, from conception to implementation and assessment (Horneber & Laumer, 2023). Researchers hope to guarantee that AI systems follow moral guidelines and show respect for human rights by implementing responsible AI governance concepts.

4.Human-Centric Design: Using a human-centric approach that puts end users' and impacted communities' needs, values, and viewpoints first is a major trend in the creation of ethical AI. To guarantee that AI systems represent societal values and preferences, researchers are investigating ways to involve a variety of stakeholders in the design and review process. Through prioritizing human values in the creation of AI, scientists hope to build systems that improve human welfare and encourage moral decision-making (Horneber & Laumer, 2023).

## 2.6 Literature Review Matrix

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S/N** | **Author/Title** | **Year** | **Methodology** | **Findings** | **Limitations** |
| **1** | **Osasona et al., Reviewing the Ethical Implications of AI in Decision Making Processes** | **2024** | **An extensive review of the ethical dilemmas in AI decision-making** | **- Emphasizes the necessity of developing rules and regulations to handle ethical dilemmas caused by AI-driven decision making.**  **- Highlights how critical it is to lessen biases and promote accountability in AI decision making.** | Does not investigate specific methods to improve transparency or minimize bias. |
| **2** | **Lim & Taeihagh, Algorithmic Decision-Making in AVs: Understanding Ethical and Technical Concerns for Smart Cities** | **2019** | **Analysis of ethical considerations surrounding machine learning algorithms in autonomous vehicles.** | **- Examine the possibility of bias in the machine learning algorithms used in autonomous vehicles.  - Determined the possibility of biased AV operations leading to prejudiced results.  - Addressed approaches to minimize bias and encourage ethical decision-making in autonomous vehicles.** | Does not go into broader ethical concerns other than autonomous vehicles. |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **3** | **Nassar & Kamal, Ethical Dilemmas in AI-Powered Decision-Making: A Deep Dive into Big Data-Driven Ethical Considerations** | **2021** | **Literature review on ethical dilemmas in AI** | **Identified several ethical dilemmas in AI decision-making bias (bias, transparency, data privacy)** | **Does not look into specific methods or solutions for each ethical dilemma.** |
| **4** | **Amini et al., Artificial Intelligence Ethics and Challenges in Healthcare Applications: A Comprehensive Review in the Context of the European GDPR Mandate** | **2023** | **Review on ethical considerations in AI for health care** | **- Emphasizes the importance of ensuring that AI used in healthcare is understandable, accountable, and free from bias.  - Encourages the ethical application of AI in healthcare and human-centered design.** | **Limited scope to nursing within the GDPR framework, reducing generalizability to other healthcare professions or regions** |

## ****2.7 Research Gap****

**Even though the ethical implications of using machine learning algorithms in decision-making have received a lot of attention, there are still certain areas where more study can improve understanding and promote the development of responsible AI. Research gaps that might be present in this area are reviewed in this section.**

1. **Domain-Related Biases: Previous studies have indicated that machine learning algorithms may be biased. There is a lack of complete knowledge regarding how these biases materialize within particular industries. For example, what impact do past biases in loan applications have on using algorithms to make decisions in financial lending? Additionally, what potential for racial or gender bias may facial recognition algorithms introduce into recruiting procedures? More research into these domain-specific problems can help develop targeted initiatives to mitigate them.**
2. **Algorithmic Transparency and Explainability: Transparency in algorithmic decision-making is still a difficulty. Although the "black box" aspect of complicated models is concerning, there are currently not many resources available to explain their reasoning. Is it possible to create AI models that are easier to use and understand, especially for stakeholders like decision-makers? Investigations into human-understandable explanations for algorithmic results have the potential to greatly improve credibility and accountability in AI-assisted decision-making procedures.**
3. **Mitigating Unforeseen Consequences: More research is required due to the possibility of unexpected consequences with machine learning algorithms, especially in high-stakes sectors like criminal justice. Is it possible for researchers to create models that can better predict and minimize these possible adverse effects? This could include creating procedures for human beings to monitor crucial decision-making situations or stress-testing algorithms for unexpected biases.**
4. **Human-in-the-Loop Decision-Making: A change toward human-AI collaboration in decision-making processes will be necessary due to the growing use of AI. There is a lack of knowledge about the creation of ethical standards for these kinds of collaborations. Is it possible for research to have an impact on the development of standard procedures that use algorithmic outputs with human monitoring and judgment to guarantee ethical and accountable decision-making?**

# CHAPTER THREE

# RESEARCH METHODOLOGY

## ****3.1 Research Approach****

This study utilizes an exploratory research approach to gain insight into the ethical implications of using machine learning algorithms in decision-making processes. Exploratory research is particularly helpful when analyzing complex phenomena, such as ethical issues in technology. It makes it easier to conduct a thorough analysis of the subject, enabling the researcher to identify trends and potential areas for further study. By using exploratory research, this study facilitates the examination of several ethical problems related to machine learning algorithms and provides significant findings for subsequent research. This strategy aligns well with the study's goals of comprehending the ethical landscape that machine learning algorithms occupy.

## 3.2 Research Design

This section highlights the research design that was used to investigate the ethical implications of using machine learning algorithms in decision-making. The research will use a qualitative methodology, utilizing two main techniques for gathering data: literature review and case studies. The ethical issues surrounding machine learning algorithms are numerous and require knowledge of the perspectives and experiences of many different parties. For this reason, a qualitative method is ideal since it enables a critical analysis of previous studies and real-world situations, resulting in an in-depth investigation of these problems.

## 3.3 Population, Sample, and Sampling Techniques

### 3.3.1 Population

The target population for this study is the existing body of academic research that deals with the ethical implications of machine learning algorithms in decision-making processes. This includes academic publications (books, journal articles, and conference proceedings) that examine ethical concerns related to implementing machine learning algorithms to a variety of decision-making scenarios. The emphasis is on ethical issues related to fairness, bias, accountability, transparency (Bolukbasi et al., 2019; Lipton, 2018; Horneber & Laumer, 2023), and the effects of these algorithms on society.

### 3.3.2 Sample

A thorough examination of existing literature will be conducted in order to select an appropriate number of academic works from the target population. Some of the search terms used to find relevant academic databases include: "Machine Learning Ethics," "Algorithmic Decision-Making," "bias," "fairness," "transparency," and "accountability".  
To make sure that the papers selected directly address the research objectives, eligibility requirements were developed. The requirements include:

1. Publication Date: To stay updated with discussions and achievements in the field, the study focuses on research published during the last five years as much as possible.
2. Methodology:  The research takes into consideration studies that use multiple methods related to the research subject. such as case studies, empirical analyses, and theoretical frameworks.
3. Relevance to Ethical Concerns: The research ensures that the core ethical issues; "bias," "fairness," "transparency," "accountability" were directly explored

### 3.3.3 Sampling Techniques

Two sampling techniques will be used because of the qualitative structure of the study:  
1. Maximum Variation Sampling: A conscious effort was made to choose scholarly works that present a diverse array of viewpoints and experiences about the ethical implications of machine learning algorithms in the literature review. This could include studies focusing on various decision-making domains (e.g., finance, criminal justice, healthcare), research exploring various ethical concerns discussed in the literature review, and works from various academic disciplines (e.g., computer science, law, philosophy). This methodology guarantees that the research covers the complex nature of the ethical environment associated with machine learning algorithms.

**2. Snowball Sampling: To find potentially relevant studies that were overlooked in the first database search, snowball sampling will be utilized in addition to the original search method. This includes looking over the references in a few chosen publications' lists and checking up on references to relevant research that are found in those sources. This method can be extremely helpful in identifying areas of focus for future research in the subject of machine learning ethics.**

## 3.4 Data Collection Methods

The study utilized a dual methodology to gather data: a detailed literature review and an analysis of relevant case studies

1. Literature Review: A comprehensive search for relevant academic literature on the ethical implications of using machine learning algorithms in decision-making processes was conducted. This process involved searching databases such as Google Scholar and IEEE Xplore. The search utilized keywords and phrases related to machine learning ethics, algorithmic bias, fairness, transparency, and accountability. Peer-reviewed articles and conference proceedings were given preference in the selection process for sources. There were no predetermined restrictions regarding location or cultural background, ensuring a broad perspective on the subject.
2. Case Studies**:**To provide insight into ethical concerns surrounding machine learning algorithms, three specific case studies were chosen. They were selected based on their relevance to the research topic and their demonstration of potential ethical issues associated with AI-driven decision-making systems. The chosen case studies explored:
3. Racial discrimination in the criminal justice system using the COMPAS risk assessment program (Jung, J, 2020)
4. Gender bias in the recruitment process at Amazon (Iriondo, R., 2018).
5. Gender inequality in the financial decision-making of the Apple Card algorithm (Knight W., 2019)

Each case study underwent a thorough analysis to identify the ethical issues raised and their implications on society. By employing both literature review and case studies, this research aims to gather comprehensive data to explore and analyze the ethical implications of machine learning algorithms from both theoretical and practical perspectives.

## 3.5 Justification of the Method

The ethical implications of machine learning algorithms for decision-making are explored in this paper. The most effective method for thoroughly analyzing this environment is exploratory research. This method makes it possible to examine the complex ethical problems these algorithms raise in great detail. Through the examination of academic literature and real-world situations (case studies), recurrent themes and topics that need more research can be spotted.

Moreover, a qualitative approach that incorporates case studies and a review of the literature is especially beneficial. By definition, ethical questions include subjective components such as potential societal implications, judgments, and values. Qualitative methods are superior to purely quantitative ones in capturing these subtleties and yielding a deeper insight. Furthermore, the use of case studies and literature reviews for evaluating previous research and practical applications is made easier by the qualitative approach. This critical analysis is essential for exposing any biases and constraints in the body of current research and highlighting how ethical problems actually arise in real-world situations.

The two data-gathering strategies that were selected—literature reviews and case studies—offer complementary advantages. Through an analysis of accepted research findings and current controversies in the field, the literature review offers a comprehensive grasp of the ethical landscape. Conversely, case studies provide a more realistic viewpoint. Through the examination of particular cases where machine learning algorithms are applied to decision-making procedures, they demonstrate how ethical dilemmas arise in real-world situations. This combination enables an in-depth understanding of the ethical ramifications from both a theoretical and practical standpoint.

# REFERENCES

Alagar. (2023). The Role of Ethics in Machine Learning for Better Decision-Making <https://iabac.org/blog/the-role-of-ethics-in-machine-learning-for-better-decision-making>

Amini, M., Jesus, M. ;, Sheikholeslami, F., Alves, D. ;, Benam, H., Amini, M. M., Jesus, M., Sheikholeslami, D. F., Alves, P., Benam, A. H., & Hariri, F. (2023).

Artificial Intelligence Ethics and Challenges in Healthcare Applications: A Comprehensive Review in the Context of the European GDPR Mandate. Machine Learning and Knowledge Extraction 2023, Vol. 5, Pages 1023-1035, 5(3), 1023–1035. https://doi.org/10.3390/MAKE5030053

Angwin, J., Larson, J., Mattu, S., & Kirchner, L. (2016). Machine Bias — ProPublica. <https://www.propublica.org/article/machine-bias-risk-assessments-in-criminal-sentencing>

Anna Maria College. (2023). Decision Making in Criminal Justice. https://online.annamaria.edu/mpa/resource/art-of-decision-making-criminal-justice-professionals

Balasubramaniam, N., Kauppinen, M., Rannisto, A., Hiekkanen, K., & Kujala, S. (2023). Transparency and explainability of AI systems: From ethical guidelines to requirements. Information and Software Technology, 159, 107197. <https://doi.org/10.1016/J.INFSOF.2023.107197>

Barredo A, A., Díaz-Rodríguez, N., Del Ser, J., Bennetot, A., Tabik, S., Barbado, A., Garcia, S., Gil-Lopez, S., Molina, D., Benjamins, R., Chatila, R., & Herrera, F. (2020).

Explainable Artificial Intelligence (XAI): Concepts, taxonomies, opportunities and challenges toward responsible AI. Information Fusion, 58, 82–115. https://doi.org/10.1016/j.inffus.2019.12.012

Batool, A., Zowghi, D., & Bano, M. (2023). Responsible AI Governance: A Systematic Literature Review. ArXiv.Org. <https://doi.org/10.48550/ARXIV.2401.10896>

Bird, E., Fox-Skelly, J., Jenner, N., Larbey, R., Weitkamp, E., & Winfield, A. (2020). The ethics of artificial intelligence: Issues and initiatives. https://doi.org/10.2861/6644

Bonaccorso, G. (2017). Machine Learning Algorithms. In Packt Publishing.

Federal Trade Commission. (2023). Fair Credit Reporting Act. <https://www.ftc.gov/legal-library/browse/statutes/fair-credit-reporting-act>

Femi Osasona, Olukunle Oladipupo Amoo, Akoh Atadoga, Temitayo Oluwaseun Abrahams, Oluwatoyin Ajoke Farayola, & Benjamin Samson Ayinla. (2024).

Reviewing the Ethical Implications of AI in Decision Making Processes. International Journal of Management & Entrepreneurship Research, 6(2), 322–335. <https://doi.org/10.51594/IJMER.V6I2.773>

Fylatos, D., Efthymiou, I., Sidiropoulos, S., Emmanouil-Kalos, A., & Vozikis, A. (2022). Greece 2.0, Health Economics and Outcome Research and the Rise of

Artificial Intelligence: Another Missed Opportunity or it's Time for Brilliance? Journal of Politics and Ethics in New Technologies and AI.

General Data Protection Regulation (GDPR) – Official Legal text. (2022, September 27). General Data Protection Regulation (GDPR). https://gdpr-info.eu/

Gillespie, T. (2019). Final considerations for ethical autonomous systems. Systems Engineering for Ethical Autonomous Systems, 419–428. <https://doi.org/10.1049/SBRA517E_CH14>

Greene, E., & Ellis, L. (2007). Decision making, in criminal justice. Decision Making in Criminal Justice, 183–200. https://doi.org/10.1002/9780470713068.ch11

Gregoire, J. (2013). Counselling Ethics : Philosophical and professional foundation (C. M. Jungers, Ed.). Springer Publishing Company.

Hashemi-Pour, C., & Wigmore, I. (2023). What Is Machine Learning Algorithm? <https://www.techtarget.com/whatis/definition/machine-learning-algorithm>

Horneber, D., & Laumer, S. (2023). Algorithmic accountability. Business & Information Systems Engineering, 65(6), 723–730. https://doi.org/10.1007/s12599-023-00817-8

Howey, W. (2023). How governments are looking to regulate AI - Economist Intelligence Unit. Economist Intelligence Unit. https://www.eiu.com/n/how-governments-are-looking-to-regulate-ai/

Iriondo, R. (2018). Amazon Scraps Secret AI Recruiting Engine that Showed Biases Against Women - Machine Learning - CMU - Carnegie Mellon University. <https://www.ml.cmu.edu/news/news-archive/2016-2020/2018/october/amazon-scraps-secret-artificial-intelligence-recruiting-engine-that-showed-biases-against-women.html>

Jung, J., Concannon, C., Shroff, R., Goel, S., & Goldstein, D. G. (2020). Simple rules to guide expert classifications. Journal of the Royal Statistical Society. Series A: Statistics in Society, 183(3), 771–800. <https://doi.org/10.1111/RSSA.12576>

Karunakaran, K. (2023). The Role of Machine Learning in Automating Decision-Making Processes| LatentView Analytics. https://www.latentview.com/blog/the-role-of-machine-learning-in-automating-decision-making-processes/

Kashifu, A. (2020). Nigeria Data Protection Regulation 2019: Implementation Framework.

Knight, W. (2019). The Apple Card Didn’t “See” Gender—and That’s the Problem | WIRED. <https://www.wired.com/story/the-apple-card-didnt-see-genderand-thats-the-problem/>

Köchling, A., & Wehner, M. C. (2020). Discriminated by an algorithm: A systematic review of discrimination and fairness by algorithmic decision-making in the context of HR recruitment and HR development. Business Research, 13(3), 795–848. https://doi.org/10.1007/s40685-020-00134-w

L. M. Amugongo, Alexander Kriebitz, Auxane Boch, C. Lütge. (2023). Operationalising AI ethics through the agile software development lifecycle: A case study of AI-enabled mobile health applications. https://www.semanticscholar.org/paper/3f063ccf18e0c9d42f6ecff

Lim, H. S. M., & Taeihagh, A. (2019). Algorithmic Decision-Making in AVs: Understanding Ethical and Technical Concerns for Smart Cities. Sustainability 2019, Vol. 11, Page 5791, 11(20), 5791. <https://doi.org/10.3390/SU11205791>

MacCarthy, M. (2019). Fairness in algorithmic decision-making | Brookings. https://www.brookings.edu/articles/fairness-in-algorithmic-decision-making/

Maleki, F., Ovens, K., Najafian, K., Forghani, B., Reinhold, C., & Forghani, R. (2020). Overview of Machine Learning Part 1. Neuroimaging Clinics of North America, 30(4), e17–e32. https://doi.org/10.1016/j.nic.2020.08.007

Nassar, A., & Kamal, M. (2021). Ethical Dilemmas in AI-Powered Decision-Making: A Deep Dive into Big Data-Driven Ethical Considerations. International Journal of Responsible Artificial Intelligence, 11(8), 1–11. <https://neuralslate.com/index.php/Journal-of-Responsible-AI/article/view/43>

Pugliese, R., Regondi, S., & Marini, R. (2021). Machine learning-based approach: Global trends, research directions, and regulatory standpoints. Data Science and Management, 4, 19–

Raghavan, M., Barocas, S., Kleinberg, J., & Levy, K. (2019). Mitigating Bias in Algorithmic Hiring: Evaluating Claims and Practices. FAT\* 2020 - Proceedings of the 2020 Conference on Fairness, Accountability, and Transparency, 469–481. <https://doi.org/10.1145/3351095.3372828>

Ruehle, C. R. (2019). Ethical Considerations of Ml Adoptions 1 Investigating Ethical Considerations of Machine Learning Adoptions Within Organizations: A Systematic Literature Review.

Tobin, J. (2023). Artificial intelligence: Development, risks and regulation. https://doi.org/10.1093/OI/AUTHORITY.20110803095426960