Ethics of Artificial Intelligence: Research Challenges and Potential Solutions

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Abstract—Artificial Intelligence (AI) is a rapidly emerging paradigm with many applications in healthcare, industries, and smart cities. However, this rise of global interest in AI has fueled a renewed interest from the public sector and global policymakers. As AI networks (e.g., chatbots, automation systems, and helping agents) are paving their way as interactive household items, a critically important research issue is understanding the ethical impact of these autonomous agents. What is the explanation of the AI decision-making process? What are the legal, societal, and moral consequences of these decisions and actions? Should these AI systems be allowed to make decisions for human beings and to what extent? These questions along with some of the underlying concerns are the main research focus of modern societies and institutions. Contrary to the popular and frightening dystopic image of AI, this article aims to present recent research developments on the ethics of AI. In particular, a concise and brief introduction to different AI techniques is provided which is followed by a detailed discussion on the ethics of AI and its influencing components. Since data is the key to improve AI algorithms, details on developing high-quality data are also given. Finally, some solutions to the ethical issues of AI are discussed. This article is expected to act as a fundamental building block and as a comprehensive survey for ethical solutions of AI systems.

Index Terms—Artificial Intelligence (AI), Ethics, Policymaking, Societal issues

I. INTRODUCTION

The so-called Artificial Intelligence (AI) is emerging as a critical technology that has applications in myriad domains like microeconomics, biotech, and Internet-of-things (IoT) [1], [2]. It is not just a buzz word but one of the huge breakthroughs of the modern era that aims to alter the way we interact with everyday objects. However, this immense amount of interest was not always there, especially at the beginning of the AI research. In fact, the initial attempts to describe, understand, depict, and translate the wisdom of the human being into ancient times go back to several hundred years and have a long tradition in philosophy, mathematics, psychology, neuroscience, and computer science [3]. In many cases, attempts have been made to better understand and define the concept of intelligence - that is, the cognitive capacity of human beings. By contrast, the AI traditionally refers to a branch of computer science that deals with the automation of intelligent behavior. However, a precise definition is hardly possible since all directly related sciences such as psychology, biology, cognitive science, and neuroscience fail to come up with an exact definition of intelligence [4], [5].

In other words, it is an area of computer sciences that makes the machine able to work and react like humans. This technology is barely 60 years old and it all started when first digital computers were beginning to operate/ appear in university laboratories. It was assumed 30 years ago that AI will be a stand-alone system in the coming years. This has been proven right as we can see the mechanical devices produced from the AI system, i.e., speech recognition, language translator, handwriting recognition, face recognition, computer vision virtual reality and many more [6]. In the next 50 years, global progress is unpredictable because of the versatility of AI techniques [7]. AI requires more powerful hardware in the speed of operation and memory than conventional software.

A. Machine Learning

Machine learning has a direct connection with AI as it involves training programs into an expert system enabling the computer to learn and perform tasks. For example, we must provide the data to a computer that is unrelatable or unfamiliar to achieve the most successful outcome based on the computer's prediction [8]. There are several techniques used to train the algorithms and they are categorized as follows:

1) Supervised Learning: Supervised learning is performed when the algorithm learns from a set of pre-defined and pre-labeled data set. Most of the conventional learning techniques involve feeding data to the agent which learns the patterns and interplay of different parameters of data.

2) Unsupervised Learning: In this technique, the machine understands the data and identifies patterns/structures. However, the data provided need not to be labeled, thus, the agent tries to understand data in an unsupervised manner. The evaluation of these techniques is qualitative or indirect and often leads to vague results.

3) Reinforcement Learning: Reinforcement learning works on the principle of reward maximization. The agent is trained to maximize its reward by observing states taking specific actions [9]. However, it is important to balance the tradeoff between balance exploration and exploitation.

B. Deep Learning

Deep learning is a more evolved branch of machine learning. Due to inherent learning features of deep learning, it can automatically learn, extract/ translate the features from data sets such as image, video or text without introducing traditional hand-code or rules. The critical part of deep learning is neurons and they work together to create some serious magic. Thus, the neuron gets a sign or flag (input esteems),
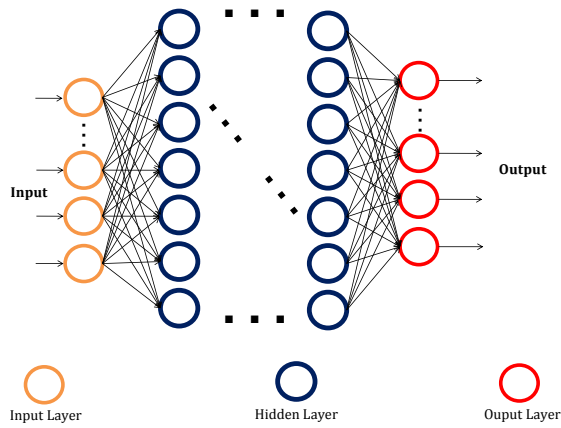
Fig. 1: Illustration of a deep neural network with input and output layers along with multiple hidden layers.

which goes through the neuron, and that conveys the produced signal, as shown in Fig. 3. There are also many applications of deep learning that use classification techniques for classifying different objects. These tasks might include; detecting faces, identities, and facial expressions in images, identifying objects in images like signal signs, people, animal, and lane markers, classifying text as spam, identifying speakers, etc.

C. Motivation and Contribution

Due to the increase in research interest in AI and its applications in everyday life, it has become necessary to identify its ethical impact on moral and societal issues. In the future, it is expected that the AI would play a pivotal role in decision making in a small (i.e., individual) and large (i.e., global) level. Its decision-making impact would cover all walks of life including education, hiring, health monitoring, marketing, and transportation. Under these circumstances, it is necessary to evaluate the performance, reliability, and accuracy of these algorithms and make necessary corrections if needed. With this object, we aim to provide a review of recent developments in the ethical issues of AI. More specifically, we highlight how AI has evolved over recent years, especially in the last decade, and identify the potential ethical issue in AI. We also shed light on the importance of high-quality data for training and testing the AI algorithms and indicate the necessary involved steps. Besides, some potential solutions to the ethical issue and research directions are provided.

D. Organization

The remainder of the article is organized as follows: Section II provides a review of some recent studies in AI ethics. Section III provides some ethical issues which are followed by Section IV which describes the importance of high-quality data. Next, Section V presents some key solutions to the ethical issues of the AI. Finally, Section VI provides some concluding remarks.

## II. RECENT DEVELOPMENTS IN AI ETHICS

In this section, we discuss some of the recent developments in the domain of AI ethics. The motivation for using AI comes from the fact that there are many use cases for AI in the modern world. Everyone wants to get maximum advantage and AI is performing in the best way to facilitate people. It brings several substantial benefits to make the lives easy. Humans get tired but machines do not. Moreover, they do not need breaks and refreshments to work all day throughout the year. Using machines, we can likewise anticipate a similar sort of results regardless of timings, season and so on. Smartphone has become human's 4th need after food dress and shelter, it has all we need on day to day basis, i.e, google map, food ordering apps, online shopping apps, etc. Just like this, we can recognize the plentiful numbers of medical applications that rely on AI. It is playing a vital role in the field of medicine as well. AI helps the patient to think about the symptoms of various drugs and carries on as close to home advanced consideration. The fake medical procedure test system is the extraordinary development part of the AI. The productivity of that consistently wants to use that test system by the professionals for the treatment. We now provide a discussion on some of the key recent developments on AI ethics.

In [10], [11], [12], the authors have focused on the governance mechanism and regulatory issues. They claim that the lives need to be governed in a transparent manner and accountability must be shared by all the stakeholders. They explain how algorithms can maintain the social contract. This is a pact between machines and human stakeholders. Identifying different societal values can affect the AI systems and hinder the progress of social contracts.

The authors of [4] provide an overview of AI ethics tools and methods. They ponder over the issue of trust between the machine learning developer community and that between the end-users. They also argued that these issues need time to resolve and more efforts are required to materialize a transparent AI. The authors of [13] propose that the research efforts need to focus on exploring the tension between practice and principles. By recognizing this tension, decision making can be improved for specific use cases and guidelines for AI ethics.

The authors of [6], [14], [15], [16] described that using AI in human societies is not a matter of descriptive ethics, rather it is a matter of normative ethics. Here, the question under the radar is not whether AI system should be given liberty to decide on the behalf of human beings. Instead, the authors claim that human societies constantly change artifacts and ethics. Thus, ethics are a set of behaviors that are limited to a particular region or group of people. Therefore, AI ethics should also be viewed as flexible and variable.

In some other studies [17], [18], the authors investigate the ethical issues of AI from the perspective of safety applications. They identify that many conflicting factors can affect the ethics and performance of AI systems. They propose to use a multiobjective decision-making framework to make the AI
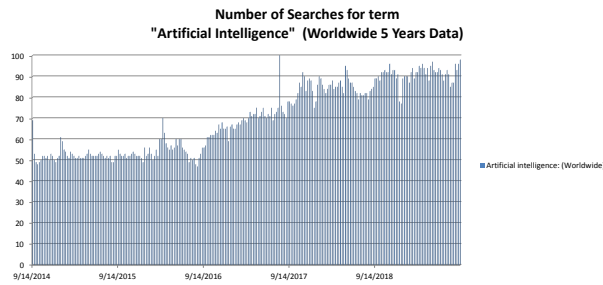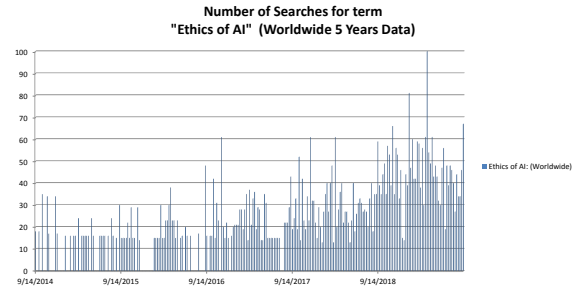
Fig. 2: Google trend search results worldwide for last 5 years (a) For term "Artificial Intelligence" (b) "Ethics of AI".

systems more reliable and secure.

The authors of [19], [20], [21] identified several ethical research issues for the AI systems. They argued that there is a need to develop the systems for identifying the quality of judgment of machines operating autonomously. They call this an ethical dilemma and present three ethical frameworks, i.e., the doctrine of double ethics, utilitarian ethics, and deontological ethics.

The authors of [22], [23] presented several issues of ethics in AI systems and discuss the utility of employing an emergency stop mechanism. They argued that this approach can be used to minimize the effects of those systems that have already gone astray. This mechanism is especially effective for autonomous systems that are directly affecting some human activities. For instance, a good example of these types of systems can autonomous vehicles on the road. They also provided a scenario-generation mechanism to avoid any uncertainties in the system. These scenario generation systems are also useful to predict the behavior of autonomous systems in advance before installing these systems in real-world scenarios. The emergency stop mechanism is also helpful in preventing or minimizing damage in case there is some sort of security attacks.

III. ETHICS OF AI

As human needs, ethics, laws, norms govern human behavior and develop reasoning and decision making. Similarly, machines also need some fundamental ethics to work effectively to avoid any possible damage. With the rise of AI in the coming years, it is essential to develop proper ethics for using machine learning algorithms. In fact, this increasing popularity of AI and the ethics of AI is evident in Fig. 2. If AI machines are designed to make some changes in the form of technical or other cultural products, then it is necessary to properly allocate resources to build such ethical machines. In simple words, civilization should gather moral and ethical qualities to avoid the inevitable and long rein of machines over mankind [24].

The AI has the potential to make ethical decisions, the market for driverless cars and reliability as a service are pre-decided to grow to 7 trillion dollars by 2050. It will reduce

the chances of accidents as well, which will be a huge relief for human drivers. Everyone wants to save as many lives as possible. When asked, people the majority chose to save the lives of people in driverless cars and a very few were willing to purchase a vehicle designed to harm [25]. The AI code of ethics additionally called an AI esteem stage, it characterizes the job of AI as it applies to the proceeded with the improvement of the human race. The reason for an AI code of ethics is to give partners direction when looked with an ethical choice in regards to the utilization of AI. The computer science and AI algorithms will impact society and there is a need to develop a guideline on ethics for our increasingly automated world [26]. Few ethical issues and domains in AI are mentioned below:

A. Unemployment

The most major issue which occurs is unemployment as the word has been shifted from physical work to computing system. For instance, driverless cars when the machines will run the car automatically drivers will have to find another job because their driving skills will be useless, the same situation can be created in offices too.

B. Inequality

Most of the companies are still dependent on wages/ hour based work systems but using AI companies can stop relying on the human workforce. Thus, if we compare the companies which are using the human workforce and on the other hand companies which are using AI. It is very clear that the companies that are using the AI system, will get all the profit and way faster than human workforce dependent companies.

C. Humanity

Bots made with AI technology are performing better day by day. In 2015 a bot name Eugene Goostaman won the Turing challenge held for the first time. In this challenge, the human was supposed to chat with the robot and they had to choose whether they are chatting with a machine or a human. Eugene Goostman fooled more than half of the human raters while talking to a human being. These bots act like a human but without feelings, which is another grey area to ponder over.

TABLE I: Comparative analysis of different frameworks for developing machine learning based solutions. Here, ★ refers to low, ★★ denotes average, and ★★★ refers to high.

Framework	Language	CNN capability	RNN capability	Speed	Community Presence	Usability and Architecture	GPU Requirements
CNTK	C++	★	★★★	★★	★	★	★
PyTorch	Python, Lua	★★★	★★	★★★	★	★★	★★
Caffe	C++	★★	★	★	★	★	★
MXNet	Scala, Julia, R, Python	★★	★	★★	★★	★★	★★★
Theano	C++, Python	★★	★★	★★	★★	★	★
Neon	Python	★★	★	★★	★	★	★
Tensorflow	Python	★★★	★★	★★★	★★★	★★★	★★

D. Commitment to Cause

Every individual working on AI wants to create a safe place where the maximum protection can be provided to save data. Only the data which is needed should be collected and the specific scenario in which the data will be used [27]. It is observed by the certain forum participants that the useful data which agencies have not been shared with researchers. Very few researchers highlighted that the safety data or the data for safety is not accessible to the researchers. According to the National Science and Technology Council Subcommittee, the data should be shared with the governmental and federal departments to improve the social problem. To improve safety and security, many participants highlighted the safety and security challenges and opportunities of system application including AI features. one of the participants mentioned that approaching the security breaches for accessing the data is costlier and policymakers need to design a system that protects expenses and liabilities [28].

E. Regulatory Approaches

Lawmakers and policymakers need to consider and address the issues which can be occurred from automated vehicle currently. The manufactures bear all the responsibility of crashes happened due to automated vehicles. A portion of the members at the discussion additionally raised worries about protection, incorporating manners by which AI could be utilized by law-requirement offices to violate civil liberties.

F. Biases

Data bias is a multifaceted idea including desirable attributes, for example, completeness, rightness, and timeliness. As a rule, data quality limits the inquiries that address the utilization of a data index. Specialists accumulating social information face frequent troubles in handling data quality due to increased biases in data.

1) Behavioral Biases: It plays a very vital role. It shows that how users are connecting and interact with each other how do they get the information and how they deliver it to the other user's behavioral biases, is dependent on content sharing and news spreading.

2) Population Biases: Different users are found on different social media platforms, which gives a different representation of gender, race, ethnicity, traditions on different social media platforms. For example, those who use twitter, significantly over-represent men and urban populations, while women tend to be over-represented on Pinterest.

3) Linking Biases: Linking biases influence the study of, e.g., social networks structure and progress, social inspiration, and information dispersion spectacles. On social platforms, they may also result in systematically biased perceptions about users or content.

IV. DEVELOPING HIGH-QUALITY LABELED DATA

One researcher mentioned the importance of data collection and how to produce high quality labeled/named data. As information becomes increasingly thorough and composed, or labeled, in a way that encourages AI. Besides, AI instruments can create progressively exact results. The selection of an appropriate framework is important to systemize things, as given in Table I. We need to put the social media system into a framework to analyze different aspects but the security of the user's account is also important. We preserve features such as efficiency, scalability (capacity to be changed in size or scale), interoperability (computer ability to exchange or make use of information). The framework is still in the design stage, our focus in this paper would be a guideline for policy processing, social media data access control and sharing the information. Therefore, the aim should be to highly improve/develop a social media system to analyze data more securely and spread privacy awareness analysis [29].

A. Framework Design

The architecture of this design includes an inference controller, data manager, and risk manager. It allows us to add a risk-based mechanism into the framework. Architecture checks the user's query and puts that into user defining a policy to design it according to the mindset of the users. The architecture built this design using a modular approach such that it is easy to replace modules with other application modules. A user application can be submitting to access the information and its related provenance. All of the module which helps in completing the work. It calls a global inference controller as it handles all the access control procedure data sharing.

B. Metadata Controller

Metadata is used to store other data items that are in control of the data controller. This controller keeps the record of other
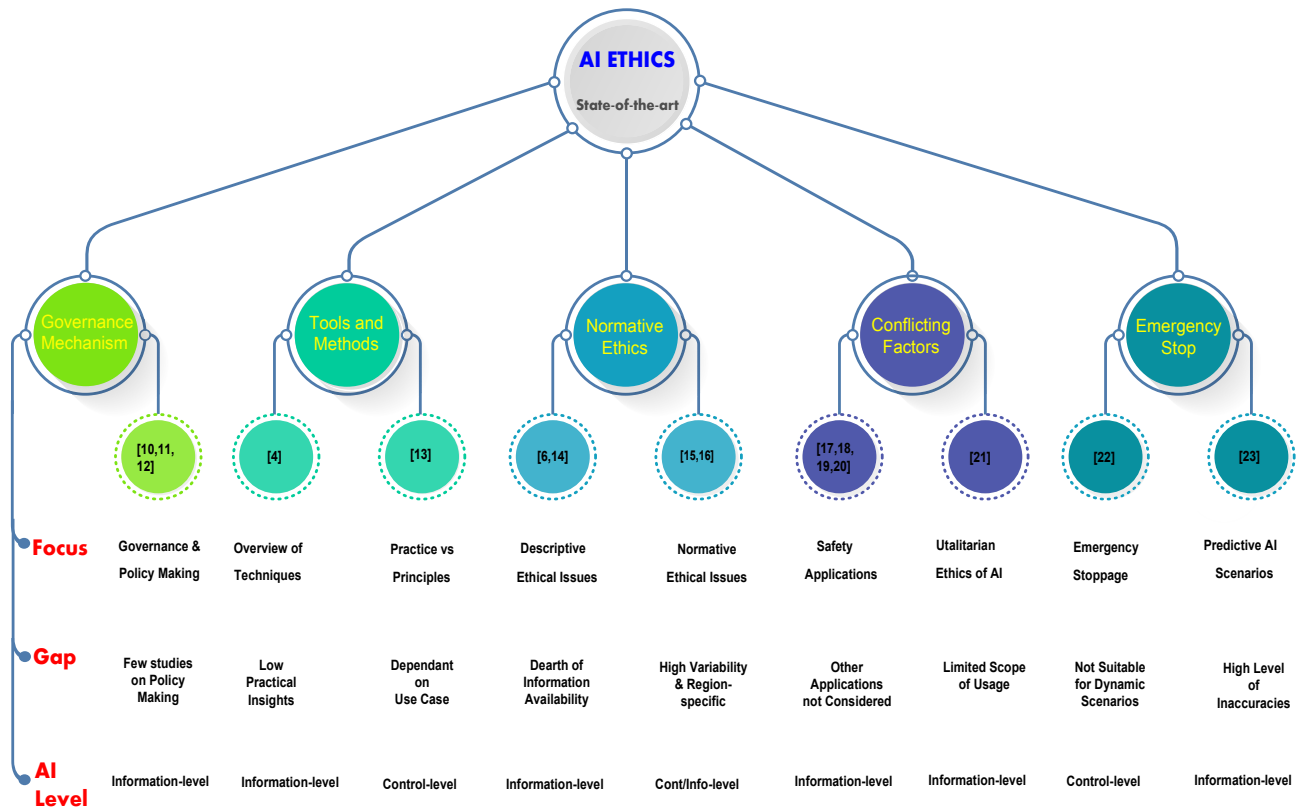
Fig. 3: Recent developments and gap analysis on the ethics of AI.

The figure shows a hierarchical tree with root "AI ETHICS / State-of-the-art" branching into five categories: Governance Mechanism, Tools and Methods, Normative Ethics, Conflicting Factors, and Emergency Stop. Each has associated references and three analysis rows (Focus, Gap, AI Level):

Reference	Focus	Gap	AI Level
[10,11,12]	Governance & Policy Making	Few studies on Policy Making	Information-level
[4]	Overview of Techniques	Low Practical Insights	Information-level
[13]	Practice vs Principles	Dependant on Use Case	Control-level
[6,14]	Descriptive Ethical Issues	Dearth of Information Availability	Information-level
[15,16]	Normative Ethical Issues	High Variability & Region-specific	Cont/Info-level
[17,18,19,20]	Safety Applications	Other Applications not Considered	Information-level
[21]	Utalitarian Ethics of AI	Limited Scope of Usage	Information-level
[22]	Emergency Stoppage	Not Suitable for Dynamic Scenarios	Control-level
[23]	Predictive AI Scenarios	High Level of Inaccuracies	Information-level

activities linked with data items kept in the data controller. If anybody asks for any information the data controller reexamines the data and then gives the answer to any query related to data [30].

C. Inference Engine

The inference engine is the heart of the inference controller as it is completely linked with multiple inference strategies that reinforced by a specific reason. It offers a feature of flexibility, we can select any tool for reasoning tasks. It is a software and can think over certain information description. For example, social model information or an RDF information model does not overweight our execution with limitation other information organizations are all around served by RDF information.

D. Query Manager

The query manager is responsible to accept user's query requests. After evaluating the queries properly, the query manager tells the user about the result. During this process, the query manager keeps all the data in written form to avoid any claim in future query managers allow the user to make view the errors in the queries to be fixed by the data manager.

V. SOLUTION TO ETHICAL ISSUES OF AI

In light of the gap analysis of Fig. 3, there is a serious need for focused efforts on providing reliable solutions and policies for ethical issues of AI. The automated systems are playing a vital role in the lives, thereby, increasing our reliability of algorithms. Thus, the questions like are we keeping in view equality, regulation and legislation are becoming more important than ever. This section, therefore, provides some of the primary solutions for the ethical issues of AI.

A. Minimizing Negative Side Effects

While operating the machine, the side effects may occur even if we think that everything is properly programmed. For instance, acquiring a newspaper from a robot may thump over a costly jar in transit to its goal. Regardless of whether the robot arrives effectively at its goal, the harm to the jar is an inadmissible negative result of the robot seeking after its objective.

B. Reward Hacking

Reward hacking is when optimization uncovers expected ways to maximize the fitness function which does not desire objective. For example, if the genuine target of a cleaning robot is to clean the workplace, yet its wellness capacity rewards for every individual wreckage the robot cleans, the robot may find that it expands wellness by making new messes that it can along these lines clean. Where in a robot learns how to copy expert demonstration of behavior; cooperate with humans to work according to their desires, or reward modeling where the machine learning model is trained to work according to human preferences.

C. Safe Exploration

Safe exploration evaluates how we can explore new solutions without ever taking disastrous action. It is necessary to mention that safe exploration will not remain a problem if the objectives are specified. During training, the trained agent could learn the dynamics of the objective and design the optimal policy to solve the issue. For example, the cleaning robot may suffer a fitness punishment over breaking a jar. Regardless of the myriad actions/ rewards, it needs to figure out avoid breaking the jar, during the training phase of the machine learning agent.

D. Robustness

The issue of robustness to distributional move is how to skillfully manage the truth that when AI frameworks are sent. They will frequently experience circumstances that go astray from the precise ones it was prepared upon. Mishaps can happen while experiencing new activities. Accidents can result in this paradigm if an agent's policy results in dangerous actions when encountering new situations. While these exploration networks give significant bits of knowledge to handling the distributional move, new benchmark undertakings might be expected to ground out the dangers from the certifiable distributional move and to figure out which of these strategies would help enhance them.

VI. CONCLUSION

Although the ethical issues of AI can slow the process of development of AI solutions on a commercial level, there are several guidelines and possible solutions to the ethical usage of AI algorithms. This article has presented some key insights on the state-of-the-art of AI ethics and highlighted the relevant issues. More specifically, it was shown that there is a lack of studies focusing on ethics for designing AI algorithms. In this regard, some fundamental steps for improving the quality of the data have been provided. Next, some key solutions to the ethical issues of AI have been presented along with some future research directions. The insight provided in this article would be helpful for future research efforts in this domain.

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