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Public Policy and Regulatory Challenges of Artificial Intelligence (AI)

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Abstract. Artificial Intelligence (AI) usage is rapidly expanding in our society. Private sector has already taken the leap of faith in using AI for efficiency and for generating better value for the customers and shareholders. The promise of AI is quite alluring for the governments as well. It promises to be the breakthrough technology which can catapult public sector to hitherto unseen efficiency and productivity. It has the potential to truly transform the public service delivery and the way government interfaces with citizens – from a demand driven model to a predictive model of public service delivery. However, there are a large number of pitfalls and blind-spots associated with AI, which make its adoption in government particularly challenging. For successful adoption of AI in public sector, governments must understand these challenges clearly and lay down regulatory public policies to ensure that the possible adverse impacts (such as exclusion, bias etc) of AI are mitigated. This paper attempts to systematically explore these challenges with a view to enable public policy makers to respond to them.

Keywords: Public Policy, Artificial Intelligence, Regulation of AI, Challenges of AI, IoT, Machine Learning, ANN, Regulatory Challenges of AI, Autonomous systems, Ethics, Safety, Privacy, Equity, Fairness, Bias.

1 Introduction

Quest for knowledge and using the acquired knowledge creatively has been the defining feature of human race. Human curiosity, what Berlyne calls the ‘epistemic curiosity’ [1], has resulted in some of the greatest inventions on earth. Humans have always been trying to create new knowledge and applying it to build machines to make life easier and more comfortable. Even though the field of Artificial Intelligence (AI) formally came into existence in late 50s, it is argued that designing machines was in some way a precursor to the formal AI [2]. Spector argues that creating intelligence (i.e. building machines) can be thought of as designing intelligence, and that in his opinion is the beginning point of human quest for AI. While one may or may not agree with this argument, the fact remains that humans have always been fascinated with designing autonomous intelligence – machines which could perform without supervision or at least with least amount of human supervision. In this sense we can treat a range of machines- from ordinary bread toasters to missile equipped drones – as examples of

machines which have built in logic (or intelligence) and are substantially free from active human supervision.

Of course, the definition of AI is continuously evolving as the technology keeps rapidly changing, and there has been an unprecedented growth and maturity in the area of AI in last one decade. We already have autonomous driverless cars, delivery drones, voice based personal assistants like Alexa, Siri etc, dexterous and intelligent humanoid Robots like those from Boston Dynamics, AI based machine diagnostics of medical images, among numerous other AI based machines and applications.

A PWC report [3] estimates AI contribution to the global economy at US \$15.7 trillion by 2030. Companies like Amazon, Google, Baidu, Alibaba, Netflix, Facebook, Apple, Microsoft, IBM are all using AI for delivering better value to their customers. From recommending products or movies to voice assistants (like alexa or siri) they are using AI. There is a slew of start-ups offering personalised online education, investment advisories, and healthcare diagnostics using AI. Oncora medical, Babylon Health, Butterfly network Atomwise and Enlitic are healthcare AI companies working in areas of cancer research, medical imaging, drug discovery etc [4]. While private sector has been leading the AI adoption, Governments around the world have begun experimenting with use of AI in public space. They have started exploring ways of using AI for better public service delivery to their citizens.

While the usage of AI might be similar for the public and the private sector, there are significant differences in their approach and consequences. While a poor recommendation by an AI system for a product or a movie would only mean one less customer for the company and the damages, if any, are reversible, an error by AI system in public service delivery may lead to an irreversible damage. A person may be unfairly denied a job, credit or bail. S/He can be wrongly classified as a delinquent or a trouble maker and can be wrongly convicted just because the AI system has been trained incorrectly. The consequences of these mistakes can be devastating for individuals, families and societies. Government initiated AI systems, if not carefully calibrated, can lead to systematic exclusion of marginalised and vulnerable sections of society. People may get shut out of the government support system based on their colour, race, gender, looks or simply because of their geographical location, which the AI system 'learns' to associate with say crime or delinquency. Poorly designed AI systems can exacerbate the inequality in the society and can potentially damage the social equilibrium.

Rolling out AI programs for public without understanding its challenges clearly, would be the surest path to failure. For example, a biased decision making or privacy intrusion into citizen's lives, would quickly lead to erosion of public trust and the system would have to be abandoned. For the governments its critical to understand these challenges and respond to them by appropriate public policy measures to mitigate their possible adverse impacts. This leads us to the research question-

RQ: What are the key public policy challenges of AI?

2 Literature review

2.1 Definition of AI

One of the earliest scientists to talk about AI was Alan Turing, the famous British mathematician credited with having cracked the codes of dreaded German Enigma machines during second world war. He wrote, in 1950, what can be termed as possibly the first paper on artificial intelligence, ‘Computing machinery and intelligence’ [5]. Even though he did not explicitly define machine intelligence or AI, he devised the famous ‘Turing Test’ of machine intelligence, which says that if a machine can remain indistinguishable from a human while in conversation with another human being then it is an ‘intelligent’ machine.

Professor John McCarthy of Dartmouth College, New Hampshire, USA, is credited with introducing the term ‘artificial intelligence’. He defines it as "the science and engineering of making intelligent machines."

UK Parliament Committee on Science and Technology has used the following definition of AI in its report on AI and Robotics [6]:

“...a set of statistical tools and algorithms that combine to form, in part, intelligent software that specializes in a single area or task. This type of software is an evolving assemblage of technologies that enable computers to simulate elements of human behaviour such as learning, reasoning and classification.”

ASSOCHAM (Association of Chambers of Industries) India and PWC in their joint report on AI titled ‘Artificial Intelligence and Robotics – 2017’ define AI as [7] -

“Artificial intelligence refers to the ability of a computer or a computer-enabled robotic system to process information and produce outcomes in a manner similar to the thought process of humans in learning, decision making and solving problems.”

Another definition of AI given in Stanford’s 2016 report - Artificial Intelligence and Life in 2030 – is by Nils J. Nilsson :

“Artificial intelligence is that activity devoted to making machines intelligent, and intelligence is that quality that enables an entity to function appropriately and with foresight in its environment” [8].

The Stanford’s 2016 report quoted above has also used another definition of AI, which states, “AI can also be defined by what AI researchers do. This report views AI primarily as a branch of computer science that studies the properties of intelligence by synthesizing intelligence” [8].

2.2 Evolution of AI

Subsequent decades, after Turing, were somewhat disappointing for the AI progress. The initial euphoria subsided as no ‘intelligent’ machine could be built successfully and most of the public funding for AI dried up. In 1965 Lofti Zadeh of University of Berkeley published his paper on Fuzzy Logic. This reignited the interest of scientific community in intelligent machines. However it was another two decades before Zadeh’s idea could be fully tapped into.

One of the reasons for these early failures of AI research was their focus on overambitious general purpose intelligence building. The available computing system of that time were too limited to try this. This barrier was successfully overcome by DENDRAL expert-system commissioned by NASA in 1971, for its mission to mars. The key was to take a very narrow and specific problem, in this case that of mass spectrometry, and build a rule-based intelligent system for it which would match the ability of a human expert.

This expert-system approach to AI started yielding handsome results. Expert systems like DENDRAL, MYCIN (a medical diagnostic expert system) and PROSPECTOR (a mining exploration expert system developed in Stanford in 1979) successfully took shape with this approach.

AI got a major boost in 1980s with the arrival of relatively powerful desktop computers. Artificial Neural Network (ANN), mimicking human brain's interconnection of neurons, became a popular choice for building AI systems. New algorithms and techniques were developed.

Today with heavy duty computational power available even in the hand held mobiles, and of-course the 'cloud-computing' has opened up new avenues of AI application and system design. Now speed of computation is not so relevant anymore in development of AI, instead the focus has shifted to writing cleverer software and designing of efficient algorithms.

AI can be said to have arrived on the world stage, when in March 2016, the Google's AI program Alpha Go defeated the world champion of Go – an ancient Chinese game which managed to elude the reach of AI for so long. This was possibly the watershed moment in AI development.

While discussing AI, it is appropriate to talk of Machine learning and IoT (Internet of Things) and their relation with each other. AI is essentially the outcome of Machine Learning. Machines (Software Models of ANN etc) are fed with huge amount of training data. This data is labeled (the actual output which should be generated by the machine given the input is told to the machine- this is also known as supervised learning system as opposed to unsupervised learning or reinforced learning) and the machine tries to identify a pattern in the data input and tries to predict the outcome. This process is called Machine Learning.

IoT or Internet of Things refers to a vast number of small (and some not so small) devices and sensors connected to the internet and transmitting and receiving relevant data. These devices can be cell phones, CCTVs, temperature or pressure sensors, pollution sensors, electricity consumption meters, refrigerators or even cars. IoT is an essential part of generating training data for machine learning for many AI applications. IoTs and Big-Data analytics are quietly transforming the entire human ecosystem in ways never imagined before. To safely harness this transformative power, Public Policy is one of the key tool [9].

2.3 AI in Governance

The increasing role of autonomous machines in human life is posing unique challenges to Public Policy. World Bank has estimated that two-thirds of all jobs in developing countries are susceptible to automation (World Bank 2016). For Ethiopia this number goes to an astronomical 85%. The proliferation of machines in critical areas of human life such as health care, education, geriatric care and transportation necessitates updating of extant Public Policies. In the chapter titled “Reclaiming Public Space: Drawing Lessons from the Past as We Confront the Future”, Chester Newland and Demetrios Argyriades write about the challenges ahead for public service professionals - “A new profile is needed for civil service professionals; a profile that combines deep knowledge and high-level skills with fortitude, forbearance, integrity, capacity to offer sound evidence-based advice but, more than anything else, steadfast adherence to constitutionally democratic principles and values in search for reasonableness and shared human dignity” [10].

It is not that the machines were absent from the picture earlier, but what makes the situation very different now that the new machines are autonomous, each equipped with necessary computational power to take unguided independent decisions. What makes the situation even more complicated is the fact that the decision making process of the AI driven machines tends to be opaque and sometimes the decision making process may not be understood even by the creators of the algorithm. To make matters worse, is a set of people and media who drive the fear that AI would dominate and rule the world [11].

These autonomous machines bring some very different dimensions to Public Policy and throw up new challenges. There are issues of ethics, responsibility, decision audit, and legality in AI enabled machines. Policy experts have opined that State must ‘filter-out’ such innovations that conflict with fundamental rights and public [12].

This is what makes AI and Public Policy a fascinating area to research in. Realizing the strategic importance of AI, Governments around the world have declared AI development as their national priority and have committed huge amount of resources with a stated aim of becoming the world leader in AI [13, 14].

China has started deploying SmarHS for public service delivery improvement [15]. Spain has created an Urban Platform for their smart-city project [16]. Dubai government has ‘Smart Dubai’ project which uses AI for citizen service [16]. UK National Health Service has adopted an AI chatbot- based triage system in 2019 [17]. US Food and Drug Administration (FDA) has categorised AI algorithms in health sector as medical devices - AI/ML SaMD (Software as a Medical Device) and a regulatory framework for them is proposed [18]. EU has built a Consumer ODR (Online Dispute Resolution) platform [16] which could harness AI driven dispute resolution. NITI Aayog in India in its National Strategy for AI has identified health, education and agriculture as priority areas for using AI [19].

This, of course, is apart from the phenomenal development in AI taking place in the private sector. Interaction of autonomous machines with humans at the levels we are likely to witness is un-precedented. With the computational power readily available and

smart algorithms possibilities of ‘malicious usage’ of AI is not at all remote. A systematic policy response to malicious usage is required which can tackle its multiple dimensions namely – expansion of existing threats, new threats, and mutating threats on digital, physical and political security [20].

3 Method

3.1 Literature Selection

We conducted the literature search using Google scholar. We limited ourselves to the published literature in English language alone. We ran searches using a combination of key words “Artificial Intelligence”, “AI Challenges”, “AI Public Policy”, “ AI Public Administration”, “ AI Public sector”, “AI principles”, “ AI Ethics” and “AI Governance”. We limited our search to 2017 to 2020 to keep the most recent research in focus. A total of 193 research papers, books and reports were found. We further filtered the results by three step filtering –

- De-duplication of papers and elimination of books and reports

- Title based shortlisting

- Abstract based shortlisting

We first removed all the entries which were appearing more than once. Then we removed the books and reports from the search results. Next we filtered the search result by relevance of the title. Since our purpose is to bring out the challenges of AI from public policy perspective, we first shortlisted only those articles which were about AI challenges. Thus article like “Trade secrets, big data and artificial intelligence innovation: a legal oxymoron?” which figured in the search result were dropped and entries like “Artificial intelligence and the public sector—applications and challenges” were retained. It is important to note that a large number of articles thrown up by the search were irrelevant. We had a large number of articles like -“Tstarbots: Defeating the cheating level builtin AI in starcraft ii in the full game”, “Cybersecurity and its discontents: Artificial intelligence, the Internet of Things, and digital misinformation”, “AI for medical imaging goes deep” - all these had to be discarded.

This reduced our shortlist to 72 articles. To narrow down our search further the articles were further shortlisted based on their abstract. Only the papers which focussed on either public policy issues or regulatory issues or social issues of AI were shortlisted. This reduced the total count to 48. The literature selection process is described in Fig 1 below –

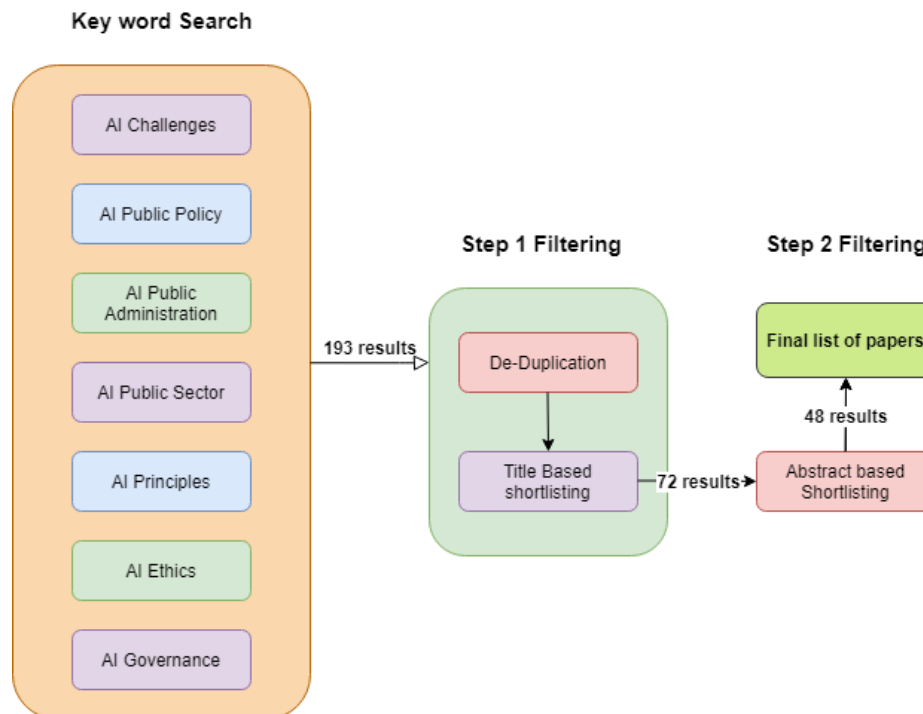


Fig. 1. Literature selection process.

3.2 Challenges identified

There has been a lot of research towards identifying challenges posed by AI systems (we use AI as an inclusive term which covers autonomous systems as well). However, every researcher has used her/his own terminology to describe them. For example ‘equity’ [21, 22] has been described using terms like ‘economic inequality’ [23], ‘shared benefit’ and ‘shared prosperity’ [24]. To be able to design a public policy response for tackling the challenges of AI is impossible unless there is an agreed set of challenges and terminology used in describing them is uniform.

A review of the literature selected above reveals a big list of challenges of AI systems

Asilomar principles list Liberty and Privacy, Transparency, Responsibility, Shared Prosperity, Value Alignment, Human Values, Safety, Shared Benefit, Human Control, Arms Race, control of Recursive self improvement and Non-Subversion - as key challenges of AI implementation [24]. British Standards Institute has identified explainability, transparency, safety, verifiability, security and privacy, controllability, resiliency, reliability, robustness, accuracy, as important challenges of AI [25].

Several national governments have also worked towards identifying the key challenges of AI. For example, Germany has identified transparency, privacy and ethics as key challenges for AI adoption [26], India has prioritized Fairness, Transparency, Privacy and Security as the key challenges of AI [19], Japan has listed Database Protection, Employment, Skilling, changes in Laws and Global collaboration as main policy challenges [27], Canada’s researchers are focussing on transparency, trust and accountability as prime AI policy challenges [28]. IEEE has undertaken to develop standards for safe and ethical AI, in form of IEEE standards 7000 through 7012 [29].

After the full text review of the shortlisted papers we have arrived at the following list of public policy challenges of AI –

Ethics	Equity	Accuracy	Personal liberty and autonomy
Bias	Explainability	Stability	Transparency and trust
Privacy	Rights and liberties	Shared benefit	Responsibility
Fairness	Labour and automation	Shared prosperity	Value alignment
Accountability	Use of force	Societal stability	
Human Control	Misuse protection	Human values (dignity, rights, freedom, cultural diversity)	

4 Result

Full text review of the shortlisted papers gave us an exhaustive list of public policy challenges of AI. We have listed these in section 3.2 above. If we carefully examine them we can see that these 22 challenges are not fully independent of each other. Many of them, even though worded differently, describe the same essential idea. If we club similar ideas into one broad category, we can identify a set of core challenges of AI. Since our focus in this article is to identify public policy related challenges of AI, we would examine each of the challenge from public policy lens and categorise them accordingly.

Our findings are best summarised in the table below. Even though, each paper cited has identified between 3 to 10 challenges, in the interest of listing as many different papers as possible, we have tried to limit listing of each paper to two or three themes only.

Table 1. AI Challenges for Public Policy

S No	Type of Challenge	Alternate terminology used	Papers
1	Ethics	-	[30], [31], [32], [33], [34], [35], [36], [37], [38]
2	Bias	Diversity, Data parity, Data asymmetry	[29], [39], [40], [41], [42], [43]
3	Privacy	Personal privacy	[44], [45],[46], [47],[48]
4	Fairness	No discrimination	[49],[50], [19], [51]
5	Accountability	Responsibility	[52], [53], [54], [55]
6	Equity	Societal stability, Economic Inequality, Labour and automation, Shared benefit, Shared prosperity	[56], [24],[45], [42], [57–59], [60], [13]
7	Rights and liberties	Personal Liberty and autonomy, Fundamental Rights	[38], [61, 62]
8	Transparency and trust	Auditability, Explainability	[63], [46], [7], [64]
9	Value alignment	Human values (dignity, rights, freedom, cultural diversity)	[26], [65], [32]
10	Human Control	Use of force under human supervision	[66], [41],
11	Misuse protection	Safety and certification, Hacking, Cyberattack, non-manipulation	[67], [53], [41], [24], [20], [68], [69], [70]

There is a strong need for laying of ground rules in form of Public Policy to keep the AI proliferation beneficial to the society. As of now there hasn't been much research on the intersection of AI and Public Policy, whereas individually they both have been studied well. Therefore it is an opportune time to work in this area and to help find insights which would keep the power of AI safe for serving humanity.

5 Discussion and Future research

As we saw in earlier sections, AI and autonomous systems pose a number of serious public policy challenges. A wide scale public roll out of AI (and autonomous systems) can not be done without addressing these challenges. So severe are some of these issues that few researchers have advocated completely avoiding AI in Government decision making [71]. It has been pointed out that it is the Government which is tasked with mitigating any adverse impact of AI on society [72]. To be able to lay down public policies which make AI ethical and safe to use in public domain, governments need to understand each of these challenges very well and accordingly create a robust regulatory framework.

Our literature search indicates that there has been very little research, towards comprehensively identifying challenges (or inhibitors) of AI adoption in the public services. There is a strong need to explore the following research questions:

1. To identify the contextual and hierarchical relationships among identified challenges (inhibitors) of adopting AI in public services
2. To group these challenges based on their dependence and driving power
3. To develop an integrated model to understand the dynamics of challenges for minimizing their impact and for encouraging greater AI adoption in public service.

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