AI Systems As Digital Public Goods : Exploring The Potential Of Open Source AI

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Abstract

This study aimed to understand the current state of AI in the view of social progress and development and what role it plays in social upliftment by being recognized as an integral part of public administration. The paper explored the theme of AI as a probable Digital Public Goods in prospect. Another important aspect of the study was to explore the synchronous relations adopted by countries in the purview of public policy and the stances taken in the larger geopolitical context particularly undertaking a case study of the European Union's "Roadmap for Ethical AI" and propose a possibility of a completely Open Source FOSS AI which is scalable however and list the reasons why it is not possible. In my closing remarks the paper discusses recommendations to create an AI model which is under the parameters of a Digital Public Good

Introduction

Francis Fukuyama in his work 'The End of History and the Last Man' claimed that post cold war and the emergence of Liberal capitalism as the dominant ideology, humans had not just reached a watershed moment in history but an epoch that would mean the end of the evolution of any sorts, however true but technology has changed that perspective. Gordon Moore, the co-founder of Intel claimed in his observation that the number of transistors in a dense integrated circuit doubles every two years, this was not only a reflection on the capacity of the motherboards but also what on whole their capacities and abilities were to become. Artificial Intelligence and its possible implementations have started to besiege the consumer technology industry and are being considered a similar epoch in advancement as to the democratization of the internet from military development to civilian usage. However, AI has had its issues during its first in a sense scaled preview with Google and Microsoft both running into trouble with their iterations giving out misinformation (1) (2), leading to criticisms from both the State and the individuals alike. States have already started to take a proactive approach to AI and its possible implementations and how likely it is that the dichotomy or co-existence is to be defined, whether be EU releasing a white paper on AI and its roadmap on probable policy issues, while FTC has censured companies for their "AI claims". (3)

Although the study of AI began in the 40s in the field of computer science, its applications and implementation have far-reaching consequences in different arenas.

In recent years, Artificial Intelligence has been contemplated by different nations. Several governments all over the world are beginning to study the implementation and potential benefits of technologies based on Artificial General Intelligence. Some countries have realized their potential and also have picked their sides, with the EU releasing its roadmap on how it is to create a policy framework for AI, followed by the USA. Governments and institutions are rapidly responding to the demands of a changing society. Among many significant trends, some facts, and pre-conditions which should be considered, AI in its current state is harmful, it gives out misinformation and is susceptible to manipulation. Government and public policy have to operate in this context added to the newer inventions due to the development of new chips, new materials, and increased computational power. Public administration has found lucrative uses for AI support in multiple flavors of public management such as decision-making in the handling of big data, public services, and public safety. Fears of relying on government systems often leave bitter reminders of the 80s Soviet Union when reliance on computer software trained by the country's best game theory economists made the entire economy collapse. Intensification-90 was to be the saving face of the Soviet economy as game theory economists created and trained software which was to meet the demand-supply needs of Leningrad in real-time, which ended up creating a haywire economy. (4)

Understanding AI

Artificial Intelligence as a concept has transcended from ancient Greek philosophy to cyberpunk literature to its current form emerging with thought experiments with Alan Turing, in his possibilities of machine developing self-sustaining systems, AI has been extensively debated and discussed throughout history. In the 21st century, AI aims to extend its help in maintaining nature and governance through intelligent machines with the ultimate goal being the mutual coexistence of machines and humans. Terminologies like Big Data, Deep learning, and artificial general intelligence or AGI have defined our current understanding of the technology. Google began to research NLP or natural language processing which changed the paradigm for machine communication in spoken languages, this debuted with LaMDA in Google I/O 2021, however, the seeds to this were sown earlier. (5)

The generation of software (algorithms) and hardware (machines) based on artificial intelligence (AI) uses different techniques. Some techniques are useful for generating learning, others evolve and others are based on data analysis, and robotics. However, AI applications are a mixture of different techniques, these techniques are developed in software and others in hardware, or a mixture of the two. There are various software-based techniques used in

artificial intelligence (AI), including but not limited to artificial neural networks, evolutionary computation (such as genetic algorithms, evolutionary strategies, and genetic programming), fuzzy logic, intelligent systems, multi-agent systems, natural language processing, expert systems, learning classifier systems, automatic learning, and deep learning. Other AI techniques, in software, are data mining, text mining, and sentiment analysis. In this manner, organizations will implement a series of emerging technologies that will be useful for mass process automation, cost, and error reduction, increase efficiency and competitiveness, the creation of value, and fraud avoidance. This situation will impact the performance and development of governments throughout the world(6). The design of artificial neural networks is based on the learning mechanisms present in the neural networks of the human brain. In these networks, neurons are interconnected through synapses, which can be modified to alter the connections between neurons. These types of techniques represent learning. Evolutionary computation techniques, such as genetic algorithms, are based on genetic operators such as crossing, mutation, selection, and adaptation: they are based on evolution and natural selection. This type of technique represents the evolution of the species in computational algorithms. Fuzzy logic is distinct from traditional logic in that it permits a spectrum or range of possibilities, as opposed to binary values (true or false). An example of its implementation is the Likert scale, wherein each value is within a range of possibilities, and certain values can exist on two scales concurrently. Intelligent agents are important for AI because the internal process of AI algorithms can be represented by an architecture of intelligent agents. An intelligent agent interacts with its environment and has sensors, effectors, and responses (reactively or proactively) to the stimuli of the environment. An intelligent agent is an intelligent system process. And a set of intelligent, interacting agents is called a multi-agent system. Some software techniques, such as text mining, sentiment analysis, expert systems, and machine learning base their operation on techniques such as genetic algorithms, artificial neural networks, and fuzzy logic. (7)

Digital Public Goods

Digital Public Goods according to Nicholas Gruen, a market economist who is the proponent of the term, refers to producing a slew of goods for public consumption concerning technological products created by the private sector (8)

As technological adoption among individuals has been rapidly increasing as mediums have been evolving, there is a certain risk of monopolies and an economically dominant class maintaining control over the resources. The idea of Digital Public Goods should be looked at

in such a context as well, wherein a significant part of the critical infrastructure of global technology should be open source which would eventually aid in greater accessibility, management, and collaboration. Developments that are likely to take such an ambit are to provide states and private sectors open access ensuring development for the public. Digital public goods primarily aim at the inclusion of those who have been ostracized and remain a minority in technological adoption. COVID-19 exacerbated these differences among people but also pushed them into dire circumstances. (9)

Digital public goods are essentially entities that can be used with the capability to resolve specific developmental challenges as listed among UN Sustainable Development Goals (SDGs) (10)

According to the Digital Public Goods Alliance which maintains a registry of Digital Public Goods that is widely acknowledged. The DPGA maintains 9 parameters for an entity to be effectively registered as a DPG. These 9 parameters can be divided into largely 3 archetypes, namely:

Open Source and ownership- This is highlighted by the licensing requirements as the fundamental requirement accepting only OSI (Open Source Intelligence) approved licenses and Creative Commons, this should also be reflected in the idea that digital public good if created with a mixture of the closed dependencies is largely unaffected by it. The ownership should be clearly defined and should be documented well with reflections on the source code and its use cases

Individual Rights- This is reflected by the aims of anonymization of data (non-personally identifiable information design), which should be in adherence with privacy and allied laws, data privacy, non-usage in inappropriate and illegal content distribution, collection, and storage and protection.

Sustainability: The digital public goods in question should demonstrate relevance in advancing the SDGs.

The traces of the current Digital Public Goods movement can also be seen in the larger context of the Free Software Movement which emerged in the 70s to restrict the promotion of proprietary software to promote freedom in the hands of the users with the help of free and open software (12). The state has started to adopt open source software and operating systems. Some examples are South Korea and India. Largely different definitions for FOSS have been

given over the years however we will accept the one given by Free Software Foundation, the body which gave birth to the FOSS movement. According to the FSF, a program can be considered free if users have 4 essential freedoms- 1. To run the program for any purpose, 2. Study how the program works and change it, access to the source code is a precondition, 3. Redistribute copies and 4. Distribute copies of the modified version.

South Korea

South Korea has historically leaned towards a FOSS (Free and Open Source Software, as dictated by Richard Stallman's famous manifesto) policy, particularly after the 1-24 computer disaster of 2003, which originally emerged as a fatal security flaw in Microsoft's web server software crippling the Internet system extensively. The government had been considering replacing Microsoft's dependency on the administration towards Open Source alternatives in 2007 itself. However, the FOSS moment was sustained to not foster much in the view of the political and legal conservatism determining national information policy. These conservative policies reflect the Korean Government's basic policy of setting up economic efficiencies in the national and international economic market rather than towards welfare and citizen-centric information welfare and community fostering developments in the IT industry for supporting economic 'efficiencies' (13).

Towards the end of the Windows 7 cycle system, the South Korean administration in a bid to reduce licensing and maintenance costs, decided to switch to indigenously developed Linux Based Distribution systems. All of these developments took place when the internal projections were measured for now a redundant Windows 7 to the newer Windows 10 would cost around ~ $655 million, including the issues surrounding privacy which changed post-2003 and 2013 South Korea Cyber Attacks. Maintaining a new Linux distribution system seems like a lucrative option considering the maintenance costs and operations per computer costs are almost negligible in comparison to licensed software. (14)

India

Many of the initiatives of the Union Government have been to promote and adopt FOSS however policy does not formally mention any principle or philosophy of FOSS.

The adoption of Open Source has been one of the most fundamental goals as reflected by the "Policy on the adoption of Open Source Software" (15). However, there has been some

contention that while the nature of compliance mentioned is mandatory, the language stipulates that it can be done at the whims and fancies of the administration, particularly reflected within the Clause 3- Policy statement "shall endeavor". The government has also rolled out the "Framework for adoption of open source software in e-governance systems", the primary aim being "opening the source code of Government applications to ensure a new and agile way of developing software, reuse and rapid roll out to other Government domains"(16). In recent times, policies like NODE or National Open Digital Ecosystems and India Digital Ecosystem Architecture 2.0 (InDEA). The InDEA has notable mentions of the adoption of Open Source such as GSTIN, Diksha, and the newly added UPI

A diverse range of FOSS has been developed within the country through social enterprises which are helping the marginalized tackle previously thought to be unsolved problems. One of the most apparent examples of open source in India which has been scaled would be UPI or Unified Payments Interface, built completely on top of open source like Java, TDB, and Cassandra (17). As of now, UPI handles more than ~₹12,000 crores of transactions every month. (18)

However, allegations against the governments' programs and APIs are considered 'open washing' for their use of 'proprietary technologies and fenced access control APIs".(19)

AI and State: A European study

Since 2017, with the progress in Artificial Intelligence (AI) and the emergence of AI policy documents and ethics guidelines worldwide, the European Union (EU) has been formulating its strategy toward AI. The EU's approach combines elements of both normative and market power, as reflected in its policy documents with focus particularly towards human centric approaches led by ethics and philosophy of 'trustworthy AI'. These efforts are closely linked to the EU's aspirations to be a Market Power, with appropriate regulation and investments that could bolster the implementation of its values and norms.

Ursula Von der Leyen after assuming office claimed that she will put forward "legislation for a coordinated European approach to the human and ethical implications of AI". This led to the formulation of a white paper on AI in February 2020 named "On Artificial Intelligence- A European Approach to Excellence and Trust" and launched a public consultation for the same (20). The main idea of this document was to outline a range of options available at hand and also suggest a clear regulatory framework to establish trust among consumers and businesses in

AI, therefore, speeding up the adoption of the technology. The main criterion of the paper is the distinction between AI being high-risk or not, the first criterion being focussing on sectors where significant at-risk factors are available such as healthcare, transport, and energy. The second criterion is areas of significant risks such as legal effects, injury, death, or damage. The white paper's focus on investment and regulatory approach suggests a strong presence of elements of Market Power Europe. At the same time, the document claims that this approach is grounded in fundamental rights, values, and ethics, with references, for example, to the ethics guidelines for Trustworthy AI. The EU has also demonstrated a strong interest in global cooperation, in particular in AI ethics guidelines. It has been involved in developing the OECD ethical principles for trustworthy AI, which were later endorsed by the G20 ministers (European Commission, 2020a: 8). The EU white paper on AI recognizes an important work on AI ongoing in other multilateral fora such as the Council of Europe and UNESCO and confirms the EU's interest in continuing cooperation with like-minded countries. It states that "Europe is well positioned to exercise global leadership in building alliances around shared values and promoting the ethical use of AI". The EU's approach to AI as a way to promote its values can be seen in the following statement:

"The Commission is convinced that international cooperation on AI matters must be based on an approach that promotes the respect for fundamental rights, including human dignity, pluralism, inclusion, non-discrimination and protection and privacy and personal data and will strive to export its values across the world. It is also clear that responsible development and use of AI can be a driving force to achieve the Sustainable Development Goals and advance the 2030 Agenda".

White paper on Artificial Intelligence, A European Approach; European Commission, 2020

Hence, in the global arena of AI competition and cooperation, the EU endeavors to present itself as a Normative Power in Europe that advocates for its value-based and human-centered approach, based on its ethical guidelines for Trustworthy AI. While discussions are ongoing regarding the EU's aspirations to become a Market Power in Europe through appropriate regulation and investments, there is currently no public debate on the potential development of a Military Power in Europe based on investments in AI within the context of emerging EU defense research. The EU's efforts to become a Normative Power in Europe in the field of AI have had some influence on international forums like the OECD and the G20. However, these efforts have also led to increased scrutiny of the EU's actions in this area and have faced opposition from some of its own ethics experts.

State of Open source AGI and the possibilities of scalable open source AI: Lacuna and Difficulties

OSINT or Open Source Intelligence refers to collecting relevant information which is within the public realm to be used in resolving issues within classified, unclassified, and restricted arenas, and has often been used extensively to support probable alternatives to proprietary software solutions. OSINT is an emerging field and so is AI. Synchronous existence between the two has often been initiated, which can be reflected by machine learning algorithms being more prominent in OSINT and how useful these are in extracting data and knowledge. It has often been contemplated how OSINT publications with an AI feature use natural language processing to extract knowledge from social media and Big Data to find important information about privacy, human trafficking, and cybercrimes. OSINT has been of large help with its co-existence with AI in Information Extraction, Natural Language Processing, Big Data analysis and scrapping, Sentiment Analysis, and Social Media Analysis. (22)

However, the recent conversion of the famed OpenAI from what it began as A Not-For-Profit organization to a capped-profit organization has shown how sustainable non-profit AI research is. This is reflective of the fact that how expensive it is to create a scalable AI model that can only be used in the public realm with access to consumer-centric and business-centric affairs rather than as a Digital Public Good for social upliftment.

Largely, the initiative of AI systems and their development and implementation has been taking place in the Global north at the behest of Big Tech- Apple, Google, IBM, Microsoft, and Meta. These institutions' modus operandi in beginning a not-for-profit research institution heading the AI research, institutionalizing it, and realizing profits have been in case. (23) (24)

Certain plausible reasons which restrict the creation of fully "Open Source AI" and in essence DPG parameters into AI can be classified into:

Unavailability of Open Data:

Working with personal data and using it for AI systems is a challenging task in the global South due to the absence of frameworks governing local data and privacy. Open datasets and open AI models are the pillars of a "digital public good," but the scarcity of datasets from countries in the global South creates a roadblock in defining AI systems as a DPG. Additionally, current AI

systems are often trained on datasets from the global North and may not account for social and cultural sensitivities when applied to developing countries. In sectors like banking, finance, and insurance, where high-quality data is essential for AI systems, start-ups, and SMEs face difficulties as most datasets are proprietary and not available for free and open use. Furthermore, large AI models such as GPT-3 and chatGPT are trained on internet-crawled datasets (25). The accessibility of high-quality filtered, refined, and fine-tuned datasets rests with the organization developing these large 3AI models, In case someone intends to work on a health-related use-case in a developing country and requires well-curated and finely-tuned datasets from large AI models, they won't find such datasets available for free and open use. The majority of AI systems being developed are not open data or open AI models, making them far from being a public good.

Issues of Opacity and Privacy:

AI global value chains lack transparency and accountability due to dominant Big Tech companies and public sector labs leading AI research and development. There are no legislations yet regarding AI systems Research and development that make it mandatory for Big-Tech companies to adhere to the privacy protection of personal data. For example, Google Health is licensing the mammography AI research model to iCAD to validate and incorporate the AI technology for use in clinical practices to improve breast cancer detection (26). In this case, two privacy challenges arise. Firstly, proprietary research by iCAD and Google makes the data usage, processing, and improvement of AI algorithms unclear. Secondly, iCAD's AI algorithms, trained on medical datasets from the United States, are not applicable to other regions with significant demographic variations, particularly developing countries. Due to the lack of transparency and privacy concerns in current AI global value chains, existing AI systems cannot be considered public goods. For AI systems to become public goods, they need to be open, transparent, and regulated in terms of the use of public datasets by Big Tech companies worldwide. Moreover, the example demonstrates that AI projects funded in Western countries may not adequately address the specific needs of developing economies. For example, the US Department of Agriculture generates an annual 'Cropland Data Layer' using Landsat and other satellite data, which helps in crop yield estimation (27). However, this would not hold for countries like India, where farmlands are smaller, there is a greater diversity of farm-level species, agricultural practices vary widely, and intercropping and crop rotations are more prevalent.

Recommendations and Closing remarks

Following are the recommendations to push AI systems into the realm of DPGs

1. Open-Source AI

The realm of open-source AI comprises pre-built algorithms, datasets, and readily available interfaces that can assist developer communities worldwide in leveraging open AI development. (28). Open-Datasets are often created using web crawling but as established earlier, most of these datasets are blindly biased towards the predominant white Global north population. Facilitating access to large AI models like GPT-3 (OpenAI) and ViT (Google) promotes innovation, particularly for AI start-ups that lack the financial means to develop such expansive AI models. Making large AI models accessible fosters adaptability and interpretability, ensuring equitable code access. Open-source software plays a crucial role in defining a DPG and the effectiveness of regulatory measures influenced by initiatives like Wikipedia indicates the feasibility of integrating and overseeing globally shared technical resources. As open-source inherently avoids discrimination against individuals or groups, it serves as a strong foundation for AI systems. Open-source AI is also subject to trust, reliability, and accountability issues regarding AI system output. The collective societal benefits outweigh the potential drawbacks. (29) The most fundamental application for any government is to furnish data sets in all their senses for the creation of a truly open-source AI, however, as of now the requirement of policy perspectives in the same is limited to the government maintaining a channel for providing data sets as freely within the public realm to resolve the issues which face developers.

2. Global Partnerships

A multi-stakeholder inter-governmental global partnership between wealthy and developing countries—such as the global partnership on AI (GPAI)— could set in motion the initial steps in deliberating the strategy of making AI systems, and public goods (30). GPAI's current mission is to encourage responsible AI development and usage, upholding human rights and democratic values. With data governance as its primary focus, GPAI can take the lead in fostering dialogue and research to transition AI systems towards the realm of digital public goods. With India assuming the presidency for GPAI in the most active year for debates and deliberations on AI, it would be interesting to see how the superpower is likely to view its stance on Open Source AI and how it is to provide a policy framework to sustain the same.

The Digital Public Goods Alliance (DPGA) has established criteria to determine if a digital solution meets the requirements of a Digital Public Good, which includes specifications for open data and open AI models. The DPGA is thus rightfully placed to lead discussions on AI system-specific standards, especially non-personal data AI systems. It can amplify the perspectives of developing nations endorsing Open-Source AI. Collaborative partnerships can enable AI governance initiatives to integrate AI systems into the ethos of non-exclusion and non-rivalry, garnering support for the creation of AI system platforms with a DPG mandate (31).

3. Sustaining research and development

Beyond public policy and legislation, it is necessary to understand the role of the State in furnishing an attitude for research and development in the field. Recently, IIT Madras developed an operating system by the name of "BharOS" for mobile phones. (32) Keeping aside all the fanfare, the OS is essentially a Custom ROM developed on the code base of Android Open Source Project (AOSP) but the potentialities of a free and open source android base certainly should be kept in the watchful eye. Recently the Competition Commission of India fined Google for Antitrust violations (Essentially meaning practices that inhibit competition from smaller players) in the context of its version of Android (Google owns all aspects of Android and its source code) which comes pre-installed with Google's suite of apps hence not in fairness to other competitors. ROMs like BharOS provide freedom to choose apps individually as well as a promotion by the state does help create a suitable environment for open-source developers for fruitful development. The Honourable Supreme Court's adoption of the SUVAS or the Supreme Court Vidhik Anuvaad Software in 2019 is another example of promoting AI in the Open Source arena. SUVAS is used to translate cases of different vernacular using neural engines (33). However what is rather interesting is the fact that the SUVAS engine is built using Anuvaad, an Open Source Neural network for translation in Indic languages (34). Such acts help in two primary ways- promoting the project for new developers to join in and enrich and secondly, opening up to a large dataset from the government for training purposes.

Sources

(1)Vincent, J. (2023) *Google's AI chatbot bard makes factual error in first demo, The Verge.* The Verge. Available at: https://www.theverge.com/2023/2/8/23590864/google-ai-chatbot-bard-mistake-error-exoplanet-demo (Accessed: March 9, 2023).

(2)Kelly, S.M. (2023) *Microsoft's Bing AI demo called out for several errors | CNN business, CNN.* Cable News Network. Available at: https://edition.cnn.com/2023/02/14/tech/microsoft-bing-ai-errors/index.html (Accessed: March 9, 2023).

(3)Staff, the P.N.O. *et al.* (2023) *Keep your AI claims in check, Federal Trade Commission.* Available at: https://www.ftc.gov/business-guidance/blog/2023/02/keep-your-ai-claims-check (Accessed: March 9, 2023).

(4)Ruble, B.A. (1990) "4. Organizing Leningrad's Science and Industry-The Intensification 90 Campaign," in *Leningrad: Shaping a soviet city*. Berkeley u.a.: Univ. of California Press, pp. 132–132.

(5)Liu, J. *et al.* (2018) "Artificial Intelligence in the 21st Century," *IEEE Access*, 6, pp. 34403–34421. Available at: https://doi.org/10.1109/access.2018.2819688.

(6)Valle-Cruz, D. (2019) "Public value of e-government services through emerging technologies," *International Journal of Public Sector Management*, 32(5), pp. 530–545. Available at: https://doi.org/10.1108/ijpsm-03-2018-0072.

(7)Valle-Cruz, D. *et al.* (2019) "A review of Artificial Intelligence in government and its potential from a public policy perspective," *Proceedings of the 20th Annual International Conference on Digital Government Research* [Preprint]. Available at: https://doi.org/10.1145/3325112.3325242.

(8)Gruen, N. (2018) *Building the public goods of the twenty-first century, Evonomics.* Available at: https://evonomics.com/building-public-goods-21st-century/ (Accessed: March 9, 2023).

(9) Guterres, A. (2020) *Secretary-general's roadmap for digital cooperation, United Nations.* United Nations. Available at: https://www.un.org/en/content/digital-cooperation-roadmap/ (Accessed: March 9, 2023).

(10) Mukherjee and Shankar Maruwada, A. and Maruwada Anit Mukherjee, S. (no date) *Fast-tracking development: A building blocks approach for digital public goods, Center for Global Development | Ideas to Action.* Available at: https://www.cgdev.org/publication/fast-tracking-development-building-blocks-approach-digital-public-goods (Accessed: March 9, 2023).

(11) *Digital Public Goods Standard* (no date) *Digital Public Goods Standard " Digital Public Goods Alliance.* Available at: https://digitalpublicgoods.net/standard/#:~:text=Digital%20public%20goods%20must%20demonstrate%20the%20use%20of%20an%20approved,Creative%20Commons%20license%20is%20required. (Accessed: March 9, 2023).

(12) Corrado, E.M., Moualison Sandy, H. and Mitchell, E.T. (2018) "Nullis in Verba: The Free Software Movement as a model for openness and transparency," *Technical Services Quarterly*, 35(3), pp. 269–279. Available at: https://doi.org/10.1080/07317131.2018.1456849.

(13) Lee, K.S. (2006) "From underground cult to public policy for citizens: Democratizing an open source artifact at a policy level in South Korea," *info*, 8(1), pp. 4–15. Available at: https://doi.org/10.1108/14636690610643249.

(14) Kim, S. (2021) *Will the South Korean government's bet on linux pay off?, Korea Economic Institute of America.* Available at: https://keia.org/the-peninsula/will-the-south-korean-governments-bet-on-linux-pay-off/ (Accessed: March 9, 2023).

(15) *F. no. 1(3)/2014 EG II Ministry of Communication & Information ...* (no date). Available at: https://www.meity.gov.in/writereaddata/files/policy_on_adoption_of_oss.pdf (Accessed: March 9, 2023).

(16) Policy On Collaborative Application Development Platform Policy On Collaborative Application Development by Opening the Source Code of Government Applications. (n.d.). Available at: https://www.meity.gov.in/writereaddata/files/policy_government_application.pdf [Accessed 9 Mar. 2023].

(17) John, S. (2023). How NPCI engineers made UPI so simple, affordable & reliable. *The Times of India.* [online] 17 Feb. Available at: https://timesofindia.indiatimes.com/business/india-business/how-npci-engineers-made-upi-so-simple-affordable-reliable/articleshow/98002264.cms?from=mdr [Accessed 9 Mar. 2023].

(18) www.npci.org.in. (n.d.). *UPI Product Statistics | NPCI - National Payments Corporation of India.* [online] Available at: https://www.npci.org.in/what-we-do/upi/product-statistics.

(19) Gupta, A. (2022) "Analysis of Foss Government Policies in India," *SSRN Electronic Journal* [Preprint]. Available at: https://doi.org/10.2139/ssrn.4146240.

(20) *A European approach to Artificial Intelligence* (no date) *Shaping Europe's digital future*. Available at:
https://digital-strategy.ec.europa.eu/en/policies/european-approach-artificial-intelligence#:~:text=The%20European%20AI%20Strategy%20aims,through%20concrete%20rules%20and%20actions.
(Accessed: March 9, 2023).

(21) Ulnicane, I.[0000-0003-2051-1265] (2022) *Chapter 14 artificial intelligence in the European Union : Policy, ethics and regulation, OAPEN Home*. Taylor & Francis. Available at: https://library.oapen.org/handle/20.500.12657/52622 (Accessed: March 9, 2023).

(22) Evangelista, J.R. *et al.* (2020) "Systematic literature review to investigate the application of Open Source Intelligence (OSINT) with Artificial Intelligence," *Journal of Applied Security Research*, 16(3), pp. 345–369. Available at: https://doi.org/10.1080/19361610.2020.1761737.

(23) Ahmad Hassanpour, An Thi Nguyen, Anshul Rani, Sarang Shaikh, Ying Xu, Haoyu Zhan (no date) *BIG TECH COMPANIES' IMPACT ON RESEARCH AT THE FACULTY OF INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING Research Ethics Course Report*. Available at: https://arxiv.org/ftp/arxiv/papers/2205/2205.01039.pdf (Accessed: March 9, 2023).

(24) Hao, K. (2022) *The messy, secretive reality behind OpenAI's bid to save the world, MIT Technology Review*. MIT Technology Review. Available at: https://www.technologyreview.com/2020/02/17/844721/ai-openai-moonshot-elon-musk-sam-altman-greg-brockman-messy-secretive-reality/ (Accessed: March 9, 2023).

(25) Brown, T.B. *et al.* (2020) *Language models are few-shot learners, arXiv.org*. Available at: https://arxiv.org/abs/2005.14165 (Accessed: March 9, 2023).

(26) Corrado, G. (2022) *Partnering with ICAD to improve breast cancer screening, Google*. Google. Available at: https://blog.google/technology/ai/icad-partnership-breast-cancer-screening/ (Accessed: March 9, 2023).

(27) Kpienbaareh, D. *et al.* (2021) *Crop type and land cover mapping in northern Malawi using the integration of sentinel-1, sentinel-2, and PlanetScope Satellite Data, MDPI*. Multidisciplinary Digital Publishing Institute. Available at: https://www.mdpi.com/2072-4292/13/4/700 (Accessed: March 9, 2023).

(28) *The GNU manifesto - GNU Project - Free Software Foundation* (no date) *[A GNU head]*. Available at: https://www.gnu.org/gnu/manifesto.en.html (Accessed: March 9, 2023).

(29) *Challenges and limits of an open source approach ... - european parliament* (no date). Available at: https://www.europarl.europa.eu/RegData/etudes/STUD/2021/662908/IPOL_STU(2021)662908_EN.pdf (Accessed: March 9, 2023).

(30)   *Working   Group   on   Responsible   AI*   (no   date)   *GPAI*.   Available   at:
https://gpai.ai/projects/responsible-ai/ (Accessed: March 9, 2023).

(31)Punita Bhatt a *et al.* (2016) *Social Innovation with open source software: User Engagement and
development   challenges   in   India*,   *Technovation*.   Elsevier.   Available   at:
https://www.sciencedirect.com/science/article/abs/pii/S0166497216000055?casa_token=UOHG2WI
qaRIAAAAA%3AyFGAS2P2KPTZYv6yTSKKKrz-9tkFh7fMr7qpuXQwC_nJWhJ6dBzr2X3EcUN
mW0G-isuXjFx3QQIp#bib109 (Accessed: March 9, 2023).

(32)*'Bharos', made-in-India operating system, tested. check out its features* (2023) *NDTV.com*. NDTV.
Available   at:
https://www.ndtv.com/india-news/made-in-india-operating-system-bharos-tested-check-out-its-featur
es-3719078 (Accessed: March 11, 2023).

(33)India (2019) *Software developed to translate SC judgments in 9 vernacular languages: Law minister
RS   Prasad*,   *Business   Standard*.   Business-Standard.   Available   at:
https://www.business-standard.com/article/pti-stories/software-developed-to-translate-sc-judgments-i
n-9-vernacular-languages-law-minister-rs-prasad-119121200851_1.html (Accessed: March 17, 2023).

(34) Mukherjee (Ibid)