Harnessing Machine Learning for Progress: A Case Study of Ghana

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Abstract

This study examines the evolution and impact of machine learning in Ghana. In this paper, we provide a comprehensive overview and assessment of the field and examine its prospects for various industries in Ghana. Data for this study was obtained through an online survey and expert interviews with various stakeholders. The findings of the data show that the field has transformed several industries and modes of work in many ways. Drawing insights from the findings, the paper concludes with key recommendations to guide policymakers and other stakeholders in harnessing the potential of ML for Ghana's sustainable development.

1 Introduction

Several facets of human existence, including health care [19], education [8], agriculture [13], and finance [21], etc. have undergone radical change as a result of the progress made in the field of artificial intelligence in recent times. This has instigated a discourse about the role and continuous influence of the field in substantially influencing and shaping the destiny of humanity. The introduction of chatGPT in the year 2022, and the subsequent emergence of other models like Google Bard, Microsoft Bing, etc has heightened the ongoing discussions about the potential impact of AI. These groundbreaking advancements have generated debates in many quarters, created new employment opportunities as well as enhance productivity in already established work, and prompted the establishment of specialized training programs in academic institutions, etc. In light of these advancements, it is imperative to examine the specific implications and contributions of AI to Ghana's economy, as well as the opportunities it presents and the challenges it entails. Ghana is a lower middle-income country located in the western part of Africa and has a population of over 32 million people. Approximately 57% of this population is under the age of 25 years Ghana Statistical Service. The developmental phase of the country and its demographic structure has implications for the uptake of new technology including AI. In this paper, we explore the responses of stakeholders in the AI space and AI enthusiasts in Ghana to assess the recent progress of the field in the country. Additionally, we evaluate the training and promotion of AI expertise as well as the challenges that are encountered in that regard in the country. Based on our findings, we provide key recommendations and identify areas where Ghana can further advance AI to harness its full potential to further the development of the country. To do this, it is important to understand the current state of AI adoption in the country.

2 Current State of AI in Ghana

Although the field of AI is actively broadening and several institutions across the board are utilizing AI in their works. It is important to acknowledge that a segment of the older generation is not abreast with and proficient in its application in Ghana. Nevertheless, this number may rise among students and/or other categories of the population including the staff of government, NGOs, and academic institutions Ampofo et al. [3], Botwe et al. [11] etc. The improvement in awareness and usage among students in particular could be due to the fact that they are more technologically savvy as well as the changing pedagogy in the educational systems especially at the tertiary level in Ghana which is increasingly witnessing the introduction of ML-related courses. Additionally, government policies such as the digitalization of most systems in Ghana have also raised interest in the AI sector and encouraged the use of AI technologies in some institutions and companies. Hence, though this has set the stage for further progress in the sector it also demonstrates the slow adoption of AI technologies in the country as a result of various technical and regulatory challenges. Even though the adoption of AI in Ghana presents numerous opportunities as already espoused in this paper, its uptake is fraught with several challenges. AI models learn best with data and having well-laid-down data processes, technologies, and data regulatory frameworks to ensure a smooth run of data collection, storage, and usage. Europe, for instance, has laid down personal data protection rules (GDPR) which stipulate strict rules and regulations to ensure the protection of the personal data and privacy of individuals. Unfortunately, such comprehensive laws and policies to regulate that space are yet to gain roots in Ghana. Additionally, quality data allows for the effective utilization of data to generate quality outcomes. Nonetheless, training talents in AI as well as training AI models can be very expensive. Averagely, it cost between $3 - $ 12 million dollars to train one large AI model and this figure could even be higher for larger datasets Binance. Hence, the technology companies in Ghana face significant obstacles in generating funds to incorporate new AI technologies into their operations. Aside from that, Ghana lacks adequate technological infrastructure which can hamper the development of AI in the country while several places in the country lack stable internet connectivity and power supply for the effective deployment of AI technologies. Training AI models can sometimes require allowing these models to train for hours. Hence, adequate and efficient stable internet and power supply are paramount in training such models. Moreover, funds and investment in AI research are inadequate in Ghana. Whereas AI research in the Western world is mostly supported by public and private grants or government subsidies, this unfortunately is not the case in Ghana. AI researchers in the country, therefore, compete with other sectors for the limited funds in the country.

Nonetheless, despite the slow adoption of AI in Ghana, the field has received some scholarly interest in recent times. Studies in the field in the country include research in NLP [6, 9], computer vision Robomua [1, 16, 18, 20, 12, 17], Health [4, 22, 2], Education [10] and Finance [5]. Such interest in the field shows that even though there is currently a gap in the uptake of AI in Ghana, there remains a huge potential due to the appetite of people in this industry. Nevertheless, this scholarly appetite needs to be matched with policy and regulatory frameworks which currently appear to be lagging behind. The hesitance in opening up the AI space from the policy perspective could be a result of some controversies in the sector including its deployment in the medical sector where "unmonitored" ML systems or "distrust" AI models for predictive diagnostics could go wrong. However, there is an urgent need to beef up regulatory infrastructure in Ghana because various sectors of the economy are feverishly embracing and adopting AI in their operations. With his background, this paper seeks to access the current state of the uptake among various segments of the Ghanaian population.

3 Methodology and Data Collection

Data for this study was collected data from stakeholders across various sectors including the Agriculture, Education, Banking, Mining, and Health sectors, etc. The data was obtained from online surveys and expert interviews. The survey was conducted using Google Forms which took about 10 minutes to complete. Expert interviews were conducted with individuals with specialized knowledge and expertise in their field of work. These interviews lasted between half an hour and one hour depending on the peculiarities of the specific discussion. Questions were asked from various broad domains including the following; 1) Professional and occupational categories of participants e.g. Banking, Education, Mining, Agriculture, etc. 2) Role and application of AI in their regular professions 3) Type of AI tools used in the line of work and 4) General challenges encountered professionally with the introduction of AI. Altogether, 40 responses were obtained from the Google form survey

while 3 expert interviews were conducted. The Google forms were distributed across various social media platforms. Experts for the interviews were persuasively targeted among persons known to the researchers from the AI community. The time frame for data collection lasted 3 months in 2022. For Google Forms, the data spans sectors including Banking, Education, Agriculture, Mining, Health, Technology, Information Technology, International Development, Software Engineering, Environment, and Insurance. Participants involved in the interviews were drawn from the education, healthcare, and agriculture sectors. For research ethical considerations, we ensured that only persons involved in this research had access to the data and the privacy of the participants was ensured.

Results from responses of participants from the Google forms show that more than a third of the participant did not currently apply AI in any form in their work. Out of the remaining participants, a proportion were not sure whether their current work involved the application of AI or not. This result is shown graphically in the following figure 1. Out of the participants who are either actively and/or
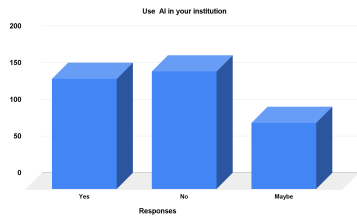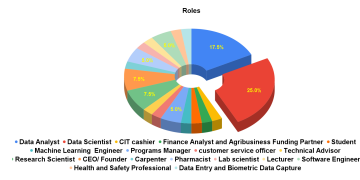

Figure 1: AI Usage

Figure 2: Benefit of AI

passively deploying AI in their scheme of work 2, almost half of them were engaged in work in the Data Science and Data analysis sectors. This means that among all professionals interviewed in this study, those in the data-related sectors form the bulk of people who currently apply AI in their regular jobs. Also, the most common AI platform used by the professionals in this study was the Google Cloud AI platform and Microsoft Azure AI platform **??**. Both platforms are basically designed for Data professionals to help in the analysis and training of models.
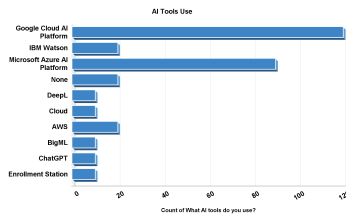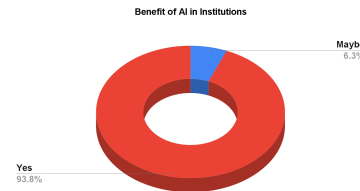

Figure 3: AI Tools

Figure 4: Benefit of AI

Among the professionals deploying AI in their operations in this study, almost all of them found it helpful in their work as it improved their productivity 3. However, they recounted several challenges their encountered in introducing AI. Some of the challenges that came up included the cost of the technology, the challenges in training the deserved human capital, and the inadequacy of resources for the deployment of AI technologies, etc. This assertion of challenge in training was corroborated by one of the experts who was interviewed in this research. During an interview, the expert who is engaged in the training of Ghanaian youth in data science at the tertiary level alluded to the fact that few institutions have sprung out with targeted programs and training to train the youth in particular. The expert explained that even though there is a high interest in AI among the youth, this enthusiasm is not matched with the number of companies engaged in AI in the country, and those involved are mostly engaged in descriptive analytics.

Even though the findings of this study show that there is a high appetite for the uptake of AI in Ghana and that the field has high untapped prospects, it is essential that the deployment of AI is Ghana is guided by high ethical standards. This is because AI models learn from historical patterns of data. Hence, having large datasets tend to have a positive influence on the performance of these models.

These datasets are often generated from humans from past actions, behavior patterns, buying patterns, etc. This, therefore, has raised serious ethical questions about how data is curated and used, and how we develop AI systems that will prevent the perpetuation of historical human biases. In this section, we explore the ethical and fairness aspect of these automated systems. There have been several reports of how automated AI systems have discriminated against some groups of people due to their sensitive attributes. It is wrong to discriminate against any person due to their gender, race, or the color of their skin. In 2016, it was discovered by some researchers that the machine learning model developed to account for recidivism was strongly discriminating against black people [14]. Also, a recent study showed how a healthcare algorithm offered less care to Black patients by identifying which primary care patients need the most care. The software recommended white patients with chronic conditions for special health care programs over black patients with similar health conditions [15]. Situations like this have raised serious questions about automated AI systems and a number of researchers have focused on finding solutions to these problems. However, finding solutions to such problems requires understanding the background of these problems. Recent works have shown that a huge part of biases in automated systems is from the training data since the output quality of any model is a function of the quality of data it uses [7]. AI models including large language models and generative models tend to reflect societal biases in the society. One of the major problems of historical bias which is reflected in these automated systems is the lack of representation of the dataset. This means that the data collection process, specifically what data is collected and how the data is collected is crucial to addressing the problems with such data. While the field of AI in Ghana is still infantile, no clear framework has been provided when it comes to data collection and how data should be collected to address such biases. The Ghana Statistical Service is the authorized state institution that is tasked with the collection of official national data like the nationwide Annual Household Income OpenAfria, OCHA Services, however, working directly with datasets off the shelf raises questions about whether these datasets are well representative of the Ghanaian economy.

3.1 Prospects of AI in Driving Ghana's Development

The impact of the adoption of AI in developed countries in particular is profound and this is evident in the existence and operations of Big-Tech companies in the private sector. At the state level, countries in the top percentile of leading economies in the world include those embedded with AI in different sectors. In this section, we highlight a few sectors in Ghana that can benefit from the adoption of AI technologies. Ghana is a country whose economy is heavily dependent on the extraction and export of natural resources including oil, gold, and bauxite etc. Additionally, agricultural exports such as cocoa, oil palm, rubber, etc. are the mainstay of the country's economy.`https://mobd.gov.gh/economic-sectors/`, Hence, AI technologies present useful resources that can transform the agriculture sector thereby enhancing productivity, improving livelihoods, and generating revenue for the state. By adopting AI tools, farmers can better detect the appropriate planting windows, the types of irrigation systems to use, and where they can best be deployed. Additionally, AI tools in the agricultural space can help farmers in effective and efficient pest and disease detection and control as well as fertilizer application. The healthcare system of Ghana can also benefit from AI to reduce the doctor-to-patient ratio and reduce the current queuing system in hospitals in places such as CT scan rooms, maternity wards, etc. Also, AI can be utilized for better medical diagnosis and recommending treatments. In finance and banking, AI can be useful for fraud detection, risk scoring models, online banking for facial recognition for security checks, etc., especially with the rampant fraud activities identified in mobile money services. Ultimately, the education system in Ghana can benefit from technologies like chatGPT, online task assignments, and feedback, connected campuses, and help teachers to analyze students' skills.

4 Key Recommendation and Conclusion

From the findings of this study, it is recommended that there should be extensive campaigns and awareness on the importance of AI and the benefits the field offers to the Ghanaian populace. This is because while it is presumed that a considerable proportion of the Ghanaian Youth has an awareness of the field, few of them know the career pathway as shown in this study. It is therefore important to facilitate workshops and programs that provide information on how to start in the field and showcase the benefits of the field to spark the interest and motivation of the youth. Organizing the IndabaX Ghana over the past 4 years and hosting the Deep Learning Indaba 2023 this year in Accra,

Ghana will help expand the reach and efforts of the field in this regard. Additionally, there needs to be a collaborative effort between governments, educational institutions, private sectors, and other international institutions to propagate interest in the field. Specifically, a pipeline of collaborative efforts between industries and educational institutions to help train students should be established. This could be facilitated by seamless and easy collaborative support between governments to subsidize the operation and production costs of industry. Setting up research funding grants by governments and also providing incentives to support local companies that are starting out AI projects will go a long in encouraging work in the area. Moreover, as explained in the previous section, AI models can only be as good as the data used to train them. Hence our key recommendation will be to encourage the government to set up or partner with private institutions in setting up data warehouses while clearly developing data privacy laws on the usage of the data similar to the GDPR. In conclusion, we acknowledge that even though the AI community is still at its rudimentary stages, and has some challenges in Ghana, the country still stand a good chance of ripping benefits from the industry if some or all of these recommendations are actualized. It is hoped that this paper sets into motion the conversation surrounding leveraging ethical AI for the benefit of the Ghanaian population.

References

[1] I. A. Aboagye, W. Owusu-Banahene, K. Amexo, K. A. Boakye-Yiadom, R. A. Sowah, and N. L. Sowah. Design and development of computer vision-based driver fatigue detection and alert system. In *2021 IEEE 8th International Conference on Adaptive Science and Technology (ICAST)*, pages 1–6. IEEE, 2021.

[2] D. Akogo, I. A. Samori, B. B. Jimah, D. A. Anim, Y. B. Mensah, and B. D. Sarkodie. minohealth. ai: A clinical evaluation of deep learning systems for the diagnosis of pleural effusion and cardiomegaly in ghana, vietnam and the united states of america. *arXiv preprint arXiv:2211.00644*, 2022.

[3] J. W. Ampofo, C. V. Emery, I. N. Ofori, et al. Assessing the level of understanding (knowledge) and awareness of diagnostic imaging students in ghana on artificial intelligence and its applications in medical imaging. *Radiology Research and Practice*, 2023, 2023.

[4] N. Y. Asabere. mmes: a mobile medical expert system for health institutions in ghana. *International Journal of Science and Technology*, 2(6):333–344, 2012.

[5] E. Awoin, P. Appiahene, F. Gyasi, and A. Sabtiwu. Predicting the performance of rural banks in ghana using machine learning approach. *Advances in Fuzzy Systems*, 2020:1–7, 2020.

[6] P. Azunre, S. Osei, S. Addo, L. A. Adu-Gyamfi, S. Moore, B. Adabankah, B. Opoku, C. Asare-Nyarko, S. Nyarko, C. Amoaba, et al. Contextual text embeddings for twi. *arXiv preprint arXiv:2103.15963*, 2021.

[7] R. Baeza-Yates. Data and algorithmic bias in the web. In *Proceedings of the 8th ACM Conference on Web Science*, pages 1–1, 2016.

[8] J. Beck, M. Stern, and E. Haugsjaa. Applications of ai in education. *XRDS: Crossroads, The ACM Magazine for Students*, 3(1):11–15, 1996.

[9] G. Boateng. Kwame: a bilingual ai teaching assistant for online suacode courses. In *Artificial Intelligence in Education: 22nd International Conference, AIED 2021, Utrecht, The Netherlands, June 14–18, 2021, Proceedings, Part II*, pages 93–97. Springer, 2021.

[10] G. Boateng, S. John, A. Glago, S. Boateng, and V. Kumbol. Kwame for science: An ai teaching assistant based on sentence-bert for science education in west africa.

[11] B. O. Botwe, W. K. Antwi, S. Arkoh, and T. N. Akudjedu. Radiographers' perspectives on the emerging integration of artificial intelligence into diagnostic imaging: The ghana study. *Journal of Medical Radiation Sciences*, 68(3):260–268, 2021.

[12] E. Effah, S. Kabanda, and E. Owusu-Adjei. Using motion detection and facial recognition to secure places of high security: A case study at banking vaults of ghana. In *Intelligent Systems and Applications: Proceedings of the 2018 Intelligent Systems Conference (IntelliSys) Volume 1*, pages 504–520. Springer, 2019.

[13] N. C. Eli-Chukwu. Applications of artificial intelligence in agriculture: A review. *Engineering, Technology & Applied Science Research*, 9(4), 2019.

[14] Northpointe. Compas risk & need assessment system: Selected questions posed by inquiring agencies, 2012.

[15] Z. Obermeyer, B. Powers, C. Vogeli, and S. Mullainathan. Dissecting racial bias in an algorithm used to manage the health of populations. *Science*, 366(6464):447–453, 2019.

[16] L. K. Odartey, Y. Huang, E. E. Asantewaa, and P. R. Agbedanu. Ghanaian sign language recognition using deep learning. In *Proceedings of the 2019 the International Conference on Pattern Recognition and Artificial Intelligence*, pages 81–86, 2019.

[17] M. M. Oliveira, B. V. Cerqueira, S. Barbon Jr, and D. F. Barbin. Classification of fermented cocoa beans (cut test) using computer vision. *Journal of Food Composition and Analysis*, 97: 103771, 2021.

[18] S. O. Oppong, F. Twum, J. B. Hayfron-Acquah, Y. M. Missah, et al. A novel computer vision model for medicinal plant identification using log-gabor filters and deep learning algorithms. *Computational Intelligence and Neuroscience*, 2022, 2022.

[19] M. Y. Shaheen. Applications of artificial intelligence (ai) in healthcare: A review. *ScienceOpen Preprints*, 2021.

[20] R. R. Sowah, A. R. Ofoli, E. Mensah-Ananoo, G. A. Mills, and K. M. Koumadi. An intelligent instrument reader: using computer vision and machine learning to automate meter reading. *IEEE Industry Applications Magazine*, 27(4):45–56, 2021.

[21] N. R. Tadapaneni. Artificial intelligence in finance and investments. 2019.

[22] A.-R. Wuni, B. Botwe, and T. Akudjedu. Impact of artificial intelligence on clinical radiography practice: Futuristic prospects in a low resource setting. *Radiography*, 27:S69–S73, 2021.