ARTIFICIAL INTELLIGENCE AND SOCIO-ECONOMIC DEVELOPMENT IN AFRICA

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Abstract
There is a high potential for artificial intelligence (AI) to become the enabling technology of the new socio-economic paradigm in Africa. Many have viewed Artificial Intelligence as a way forward in production and economic development as it can accelerate the process and improve the performance through which things are being processed. AI can generally enhance making conclusions by breaking down enormous amounts of a dataset which can give rise to the invention of new markets and industries, products and services and by that improving consumer interest that will spawn new income flow. No doubt, Africa possesses what it takes to promote the growth of its economic development by directing Artificial Intelligence in a way that will enrich her economy. The present study aims at the further exploration of the possibility for artificial intelligence to become the enabling technology of the socio-economic revolution in Africa. This paper burdens itself with the impact of artificial intelligence on the socio-economic development in Africa. It observes that artificial intelligence contributes enormously to socio-economic growth and development of any society and as such recommends proper application of AI in African countries in order to engender the needed economic development and liberation. The paper adopts the philosophical methods of analysis and dialectics.
Keywords: Artificial Intelligence, Economic Development, Africa, Growth, Technology

Introduction
Artificial intelligence (AI) is transforming the world, society and work. With the increased proliferation of artificial intelligence systems in the developed world, AI is seen as the main driver of the Fourth Industrial Revolution (4IR). It is projected that AI will generate a market that is worth over $35 billion by 2025, and double annual economic growth rates in economies around the world while promising a future where humans and robots will work in tandem to resolve some of the world's most difficult problems.[1] In Africa, the adoption of these revolutionary technologies has been sluggish, a trend that is attributed to a myriad of challenges including insufficient knowledge, infrastructure, and research capacities.[2] That said, significant steps have been across the continent to integrate AI and machine intelligence into different sectors such as healthcare and finance. However, this implementation remains subpar compared to the rest of the world. Researchers contend that Africa can unlock a full range of opportunities if its governments can fully leverage the capabilities and economic benefits offered by AI.[3]

This study is an attempt at bridging the knowledge gap hindering the adoption of AI in Africa as a whole by examining the economic impacts of AI technologies.

Artificial Intelligence: A Conceptual Clarification
Artificial Intelligence is a constellation of technologies that enable machines to act with higher levels of intelligence and emulate human capabilities to sense, comprehend and act. These human capabilities are augmented by the ability to learn from experience and adapt over time. In other words, AI enables machines to sense their environment, think and in some cases, learn to take action in response to the environment and the circumstances underpinning it. AI systems are finding ever-wider application across enterprises as they grow in sophistication. AI is still maturing as a technology. Today's AI systems still have a relatively rudimentary ability to understand human expression, tone, emotion and the subtleties of human interaction. Most of the progress to date have been in teaching computers to perform narrow tasks, to play a game, to recognize an

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[1] Accenture & Gordon Institute of Business Science (GIBS), "Artificial intelligence: Is South Africa ready?", | Accenture 22 / 22, 2017.

[2] Y. Travaly and K. Muvunyi, *"The future is intelligent: Harnessing the potential of artificial intelligence in Africa", Brookings.edu*, 2020. [Online]. Available: https://www.brookings.edu/blog/africa-in-focus/2020/01/13/the-future-is-intelligent-harnessing-the-potential-of-artificial-intelligence-in-africa/. [Accessed: 09- Dec- 2020].

[3] S. Russell and P. Norvig, *Artificial intelligence: A Modern Approach*. Harlow: Pearson, 2016.

image, or to predict traffic. There is still a long way to go before computers can really act as humans. While AI development has a long history of excitement followed by long disappointment, today we are experiencing an unprecedented period of technological innovation across various sectors that is driving the growth of AI. The two critical factors driving this growth are the increase of digitized data in the global economy and the unlimited access to computing power, and lower costs for data storage now available over the cloud.[4]The data explosion is at the heart of AI. Massive amounts of data from increasingly pervasive sensors, social networks, and mobile devices are unlocking new opportunities. By 2025, global data traffic will grow to 163 zettabytes (that is a trillion gigabytes). This exponential growth is constantly feeding AI improvements: "Data is to AI what food is to humans."[5]

Artificial intelligence can be defined as the ability of a digital computer or computer controlled robot to perform tasks commonly associated with intelligent beings.[6] The term, AI, is frequently applied to the project of developing systems endowed with the intellectual processes characteristics of humans, such as the ability to reason, discover meaning, generalizes, or learn from the past experience. Since the development of artificial intelligence in 1940s, it has been demonstrated that computers can be programmed to carry out very complex tasks as for example, discovering proofs for mathematical theorems or playing chess with great proficiency. Still, despite continuing advances in computer processing speed and memory capacity, there are as yet no programs that can march human flexibility over wider domains or in tasks requiring much everyday knowledge. On the other hand, some programs have attained the performance levels of human experts and professionals in performing certain specific tasks, so that artificial intelligence in this limited sense is found in applications as diverse as medical diagnosis, computer search engines and voice or handwriting recognition.[7]

Artificial Intelligence (AI) is one of the most promising technologies for growth today. According to recent data released by the consulting firm Gartner organizations AI implementations have grown from 4 to 14% between 2018 and

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[4] Ibid.

[5] Data Age 2025: *The evolution of Data to life- critical whitepaper by international Data corporation, 2017 in India's National strategy for artificial intelligence*, Discussion paper, June 2018, p. 14.

[6] See, E. J. O. Ndubisi, "The Problem of Human Mine and Artificial Intelligence: An Evaluation", *Tansian University Journal of Arts, Management and Social Sciences,* Vol. 7, No. 1, 2020, Pp. 34 – 40

[7] WWW. Internet source, *"Meaning of artificial intelligence"*, Britannica. Com/technology.

2019. In fact, the same consultancy firm includes Artificial Intelligence in its technology trends for the year 2020. Specifically, AI focused on improving IT security. AI is a key technology in Industry 4.0 because of all the advantages it brings to companies and all those who want to start a digital transformation process would have to adopt it in their processes.

The concept of Artificial Intelligence has been around for a long time. In fact, John McCarthy created the term Artificial Intelligence in 1950 and Alan Turing already started talking about this reality that same year in an article entitled "Computing Machinery and Intelligence". Since then this discipline of computer science has evolved a lot. For Massachusetts Institute of Technology professor, Patrick H. Winston, AI are "constraint enabled algorithms exposed by representations that support looping models that link thought, perception and action. Other authors, such as Data Robot CEO Jeremy Achin, define artificial intelligence as a computer system that is used for machines to perform work that requires human intelligence. For the head of Tech Target's technological encyclopedia, Margaret Rose, it is a system that simulates different human processes such as learning, reasoning and self-correction. As we can see, the three definitions of AI refer to machines or computer systems that think. They emit reasoning emulating human intelligence to perform tasks that only people can do. However, other sources go further and define AI as a computer system used to solve complex problems that are beyond the capacity of the human brain.

In this sense, AI harnesses the power of machines to solve complex problems that the human mind cannot reach. AI works through algorithms that act from programming rules and its subset Machine Learning (ML) and the different ML techniques such as Deep Learning (DL).

Machine Learning (ML): It is a branch of Artificial Intelligence and one of the most common that is responsible for developing techniques for the algorithms that have been developed to learn and improve over time. It involves a large amount of code and complex mathematical formulas to enable machines to find the solution to a given problem. This aspect of AI is one of the most developed for commercial or business purposes at present, as it is used to process large amounts of data quickly and deposit them in a manner that is understandable to humans. A clear example of this is data from production plants where the connected elements feed a constant flow of data on machine status, production, functionality, temperature, etc. to a central core. This enormous amount of data derived from the production

process must be analyzed in order to achieve continuous improvement and appropriate decision making, however the volume of this data means that humans must spend a great deal of time (days) on analysis and traceability. This is when Machine Learning comes into play, allowing data to be analyzed as it is incorporated into the production process and identifying patterns or anomalies in operation more quickly and accurately. In this way, warnings or alerts can be triggered for decision making. However, the ML is a relatively broad category. The development of these artificial intelligence nodes has given rise to what is now known as Deep Learning (DL).

Deep Learning (DL)
This is an even more specific version of Machine Learning (ML) that refers to a set of algorithms (or neural networks) that are designed for machine learning and participate in non-linear reasoning. In this technique the algorithms are grouped into artificial neural networks that are intended to act like the human neural networks present in the brain. It is a technique that allows you to learn in a deep way without a specific code for it. Deep Learning is fundamental to perform much more advanced functions allowing the analysis of a wide range of factors at the same time. For example, Deep Leaning is used to contextualize the information received by the sensors used in autonomous cars: the distance of objects, the speed at which they move, predictions based on the movement they are making, etc. They use this information to decide how and when to change lanes, among other things.

We are still at a stage where the DL is still in a very early stage of development of its full potential. We see that it is increasingly used in business by converting data into much more detailed and scalable sets.

AI is already used in many commercial and production applications, including automation, language processing and production data analysis. This allows that at a general level, companies are optimizing both their manufacturing processes, operations and improving their internal efficiency. AI works through different computer programming rules that allow a machine to behave like a human and solve problems. The interest of companies in implementing AI techniques in their processes lies in the advantages it brings.

AI as A New Factor Of Production

AI has the capabilities to enrich the workforce in the following areas:

Intelligent automation of the workforce

Intelligent automation means the ability to automate complex tasks in the physical world that previously required human abilities to navigate obstacles and solve problems. For example, warehouse retrieval has transformed from a labour-intensive task to an advanced automated system thanks to intelligent robots that feature advanced sensing capabilities. Whereas traditional automation technology is task specific, AI-powered intelligent automation is able to solve problems across industries. Further, intelligent automation allows for self-learning machines/software recognize gaps in their own knowledge and take steps to close them. Whereas traditional automation capital degrades over time, intelligent automation assets constantly improve.

Augment both labour and physical capital

AI can provide enormous value not just in substituting for human labour, but in complementing both labour and physical capital in ways that enhance productivity. By automating repetitive tasks, employees can instead focus on high value-add and more advanced cognitive functions of their jobs. For example, instead of spending time compiling data and crunching numbers, administrators, accountants and loan officers can instead focus on communication, relationships, and better assessing risk by leveraging higher quality data. AI also enhance the value of existing capital goods by enabling businesses to design ways to use them more efficiently, for example by reducing downtime in manufacturing.

Drive innovation.

By allowing creators and innovators to focus on where they add value, AI frees them to solve complex problems and scale their creative efforts. This results in new, more innovative products that diffuse throughout the economy, enhance growth, and improve outcomes for consumers. AI will have a significant impact by enabling faster and more profound progress in almost any field where (human) intelligence has a role to play. Businesses or organizations can use it to engage with customers, transform product development, optimize operations, and empower employees. But even more importantly, AI can help society overcome some of its most daunting challenges.

AI And Socio-Economic Development

AI has contributed immensely towards socio-economic development. These are very evident below:

AI and Education: Microsoft, in collaboration with the school district of Tacoma, WA, developed a solution that captures recent data from the district's student information system, containing student grades, attendance, health records and other data. These comprehensive data snapshots allow teachers and principals to predict dropout probability and enable them to provide additional learning assistance early enough to turn at-risk students around. Thanks to this solution, the district has already helped to improve graduation rates from 55 to 78percent.

AI and Oil and Gas: Hitachi has developed an IOT solution to enable more effective and sustainable drilling and transmission operations. The solution allows operators and service providers to remotely monitor and manage natural gas compressor skids to detect compressor shutdowns, maintain operational efficiencies, predict failures and provide multi-compressor analysis. Designed to monitor, analyze, and report on key performance indicators (KPIs) based on compressor runtimes, performance, reliability and costs, the Hitachi IOT solution integrates the entire natural gas production service provider ecosystem. Equally important, it helps companies optimize asset utilization, getting the most from their investment.

AI and the Automotive Industry: NVIDIA has developed DRIVE, an AI platform that enables automakers, truck makers, tier 1 suppliers and startups to accelerate production of automated and autonomous vehicles. The platform combines deep learning, sensor fusion, and surround vision to change the driving experience. It is capable of understanding in real-time what is happening around the vehicle, precisely locating itself on an HD map, and planning a safe path forward. Autonomous mining vehicles improve by 10% at Rio Tino and Anglo-Australian mining company.[8]

FUTURE OF AI IN AFRICA
In Africa, AI can help with some of the region's most pervasive problems. From reducing poverty and improving education, to delivering healthcare and eradicating diseases, addressing sustainability challenges and from meeting the growing demand for food from fast growing population to advancing inclusion in

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[8] http://www.economist.com/business/2017/12/07/rio-tinto-puts   -its-faith-in-driverless-trucks-trains-and-drilling rigs.

societies.[9] In addition, AI is fundamentally reshaping how work is done, allowing for a more efficient allocation of resources leading to increased productivity and in case of the government, improving the delivery of services to citizens. AI will also generate new, high-value jobs requiring technical skills, such as network engineers in the banking sector or web programmers in the retail industry. Demand for data scientists, robotics experts and AI engineers will increase significantly. Further, AI unlocks the value of data, enhances cognitive process, and improves predictive capabilities. This would allow government in the region to drive better policy and decision making.[10]

 AI is also used synonymously with "automation" and "robots" or even "machines", refered to as the automation of activities associated with human thinking such as decision-making, problem-solving and learning. In a broader view, AI can be conceptualized as a growing resource of interactive, autonomous, self-learning agency, which enables computational artifacts to perform tasks that otherwise would require human intelligence to be executed successfully. AI is further divided into two key areas including machine learning and deep learning. Machine learning is a subcategory of AI in which machines learn how to complete a certain task without being explicitly programmed to do so.[11] Deep learning, on the other hand, denotes a subset of machine learning in which the tasks are broken down and distributed onto machine learning algorithms that are organized in consecutive layers.[12]

Widespread adoption of artificial intelligence in Africa is expected to generate economic impacts regardless of whether AI applications are deployed as substitutes, complements or extensions of existing tasks.[13] The economic impacts of AI arise from the basic nature of AI, whereby it is digital in nature and therefore non-rivalrous, similar to other digital products and services, that is, digital services

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[9] Microsoft, Opt. Cit. p. 13.

[10] Hila Mehr, *Artificial intelligence for citizen services and government*, Harvard Kennedy school, ASH Centre for Democratic Governance and Innovation, 2017.

[11] J. Gillham et al., "*The macroeconomic impact of artificial intelligence*", PricewaterhouseCoopers, London, UK, 2018.

[12] D. Poole and A. Mackworth, *Artificial Intelligence*. Cambridge: Cambridge University Press, 2017.

[13] A. Agrawal, J. Gans, and A. Goldfarb, *"What to Expect from Artificial Intelligence*," *Sloan Management Review*, 2017. https://sloanreview.mit.edu/article/what-to-expect-from-artificial-intelligence/ [Accessed: 09- Dec- 2020].

can be used by more than one person without affecting each other.[14] Furthermore, the objective of AI is to provide individual solutions to economic problems by allowing for much finer price discrimination in markets rather than merely enhancing product and service diversification.[15]

The application of AI also helps to reduce matching frictions and subsequently creates increased opportunities for market exchange and interconnection.[16] Also, the very nature of AI systems embodies technological advancement, which for Africa, means advancement of the skill-based economic progress. The economic implication of AI has been established by various researchers across the globe. Granted, the majority of these studies have been conducted in the developed world, the identified implications are relevant for the future of African economic growth. In a study conducted by Accenture involving 12 countries, in the developed world, it was established that the application of AI systems could more than double the world economic growth rates by 2035.[17] The study identified three main ways in which AI can drive economic growth. In the first instance, AI is projected to drive an increase in labour productivity by approximately 40% because of state of the art technologies that facilitate efficiency in workforce associated time management.[18] Notably, within the African context, AI is set to drive an increase in productivity, particularly because, the majority of the countries, lack of finance, and other barriers have prevented the implementation and diffusion of existing technologies. In the second instance, the study notes that AI will result in the emergence of a new virtual workforce or 'intelligent automation' with superior problem solving and self-learning capabilities. In the third instance, AI will drive economic growth through the diffusion of innovation within various sectors, ultimately creating new revenue streams. According to the study, the next wave of the digital revolution will be anchored in data generated through the Internet of Things, which will be superior to data generated from the current 'Internet of People.[19] The result is increased standardization, widespread

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[14] A. Korinek, D.X. Ng, and J. Hopkins, *Digitization and the Macro-Economics of Superstars*. Working paper, Johns Hopkins University and University of Virginia, 2018.

[15] A. Ponce Del Castillo, *Artificial intelligence: A game changer for the world of work*, *Foresight Brief No. 5*. Brussels: European Trade Union Institute, 2018.

[16] J. Berg, M. Furrer, E. Harmon, U. Rani, and M. S. Silberman, *Digital labour platforms and the future of work: Towards decent work in the online world*. Geneva: International Labour Office, 2018.

[17] P. Daugherty, and M. Purdy, "Why Artificial Intelligence is the Future of Growth," *Accenture Canada*, 2016. [Online] Available: https://www.accenture.com, media/PDF.

[18] Ibid.

[19] Ibid.

automation and enhanced product and service personalization. AI was linked to short-term productivity gains as a result of increased automation of routine tasks especially in capital-intensive sectors including transport and manufacturing. Productivity will also be augmented because companies will supplement and assist their workforce to improve their performance and efficiency in their tasks using AI applications. For instance, training a machine to receive phone calls and provide 24-hour uninterrupted customer care support. This level of investment can also assist employees in focusing on high-on-demand tasks while delegating the robot to successfully carry out the said operation to concentrate on the high-cognitive functions of their job. This reduces the rate of human interference and the challenges attached to it and creates a demand for more skilled labour. Furthermore, it diminishes the cost associated with repetitive tasks. This means that the workforce has more time and opportunity to focus on further innovation and higher value-added activities. Similarly, a 2017 study commissioned by Facebook and published by the Analysis Group states that AI will impact jobs and productivity both indirectly and directly.[20] According to the study, the direct impacts of AI on economic growth will originate from increased revenues and employment in organizations or sectors that develop and manufacture AI technologies and applications. Indirect impacts will originate from the proliferation of AI technologies into other sectors which will apply AI to improve the efficiency of their work processes and increase information access.

Within Africa, AI is expected to have specific impacts on economic growth. One way that AI could drive economic growth is by improving both physical and economic security. For many years, the greatest problem facing Africa, in particular, is acts of terrorism and insurgency which have undermined economic and physical development infrastructure. Insecurity has become a stumbling block to private and public investments impacting the attractiveness of the region to potential investors and their attendant contribution to economic growth. Studies by Microsoft have demonstrated that artificial intelligence can be used to detect malicious inputs and subsequently mitigate the impact of these malicious acts on development and economic growth-oriented infrastructures. AI applications can be used to predict and isolate vulnerabilities in important systems such as financial and energy systems thereby guaranteeing the safety and effective use of investments. Notably, enhancing the security capabilities of the regional projects

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[20] http://www.economist.com/business/2017/12/07/rio-tinto-puts -its-faith-in-driverless-trucks-trains-and-drilling rigs.

a healthy investment environment to the rest of the world, thus opening it up for more opportunities from investors. Second, the main contributors to economic growth in Africa are the oil and gas sectors. The integration of AI into drilling and transmission techniques is set to improve the efficiency and sustainability of these systems, subsequently increasing production. The use of AI in these systems allows operators and service providers to remotely manage and control compressor skids including the identification and prediction of system lags, failures, and shutdowns and enhance maintenance of operational efficiencies. This will ultimately increase the efficiency of the oil and gas industry and enhance security in this industry which will attract more foreign direct investment into these projects. Also, AI offers numerous opportunities in other sectors such as microfinance and small and medium entrepreneurship. Al enables businesses to use resources more efficiently (through automated planning, scheduling, optimized workflows, optimized supply chains, optimized logistical pathways) and enables entirely new business models to be developed, often built around AI's powerful ability to interrogate large data sets. This is of particular benefit to small and medium entrepreneurs in Nigeria and Africa who can leverage the capabilities provided by AI to improve their production and operational processes, translating into greater opportunities for small entrepreneurs to develop new businesses. Likewise, AI systems have the potential of driving economic growth by facilitating the growth of the micro-finance sector in Africa. Dubbed, Fintech, many tech-entrepreneurs are capitalizing on AI-driven financial systems such as prescriptive analytics and credit technology to increase the integration of traditionally un-serviced or underserviced consumers into the banking systems. The integration of AI into micro-credit systems will eliminate the challenges faced by these systems such as the risk associated with potential clients lacking a traditional credit 'footprint' through prescriptive analytics. AI can also optimize operations for micro-credit firms while improving their fraud detection and creditworthiness determination capabilities. AI will allow micro-lending institutions to expand the depth and breadth of their due diligence and automate the credit decision making process with greater speed and accuracy. A good example of this is observed in Kudi.ai, a Nigerian AI application that uses natural language processing and other AI-based technology to provide mobile banking and conversational payment services to users who are unfamiliar or unable to interact with traditional browser-based online banking systems, but can interact with a familiar text-based messaging system. These advancement opportunities also inject dynamism into local economies by reducing transaction costs associated with a lack of information.

Another major problem affecting Nigeria and the rest of Africa relates to health and wellbeing. Africa has continually been dogged by major diseases including malaria, yellow fever, Ebola and cancer among others. The integration of AI applications into the health sector offers great promise in improving diagnostics and creating an intelligent, transparent and predictive supply chain. AI will ensure that health workers have information at their fingertips to support healthcare decision-making and patient care planning, subsequently boosting their efficiency and service delivery. This in turn reduces the loss of productivity among patients who often go for weeks without proper treatment and diagnoses. Also, increased efficiency of healthcare workers and medical supply chains translates into cost efficiencies in the expenditure allocated to the healthcare sector. Notably, Start-ups in Ghana and Nigeria are addressing doctor shortages and the lack of medical access for rural Africans. They have begun to use AI to empower doctors and leverage growing mobile phone ownership as a vehicle for collecting data, improving administrative efficiency, and to expand treatment coverage.

AI has the potential of improving education in Nigeria and Africa as a whole. Data collected through these systems can improve grading systems, develop student-oriented learning platforms, improve the teaching experience and drive superior research into the problems affecting Africa as a continent. The outcome of this is a workforce with superior skills and knowledge capable of competing at the global level.

AI and Growth in Key Sectors

AI is set to fuel new economic growth. According to a recent study on the long-term economic impact of AI around the world, AI has the potential to double a country's GDP growth rate by 2035.[21] The ability to harness even a fraction of this benefit would be a powerful tool for development and poverty reduction. This impact will be particularly strong in a few core sectors that are key for Africa, including agriculture, healthcare, public services, and financial services.

Agriculture: Agriculture is critical to Sub-Saharan Africa's growth; the sector employs over 65 percent of the continent's labour force, and accounts for 32 percent of gross domestic product (GDP). The World Bank estimates that African

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[21] Accenture report, why artificial intelligence is the future of growth.

food markets will be worth USD 1 trillion by 2030 up from the current USD 300 billion. Demand for food is projected to at least double by 2050, driven by population growth, rising incomes, rapid urbanization, changes in national diets, and more open intra-regional trade policies, all of which are helping create new opportunities for Africa's farmers. It is estimated that a 1 percent increase in crop productivity reduces the number of poor people by 0.72 percent in Africa.[22] However, the sector is burdened with important limitations: Degradation of land; Reduction in soil fertility; Increased dependence on inorganic fertilizers; Dropping water tables; Emerging pest resistance; and Increased vulnerability and unpredictability of global climate, its weak supply chain, low productivity, and vulnerability to climate heighten the risks of food scarcity and agricultural distress. Moreover, technology adoption has been slow and resource usage is inefficient. The sector would welcome and benefit from innovation. AI, along with machine learning, satellite imagery, and advanced analytics has the potential to improve productivity and efficiency at all of the stages of the agricultural value chain. These technologies can empower small-holder farmers to increase their income through higher crop yield and greater price control. For example, drone technology can be used to plant and fertilize seeds at a speed beyond human abilities. AI-powered analytics of crop data can also help identify diseases, enable soil health monitoring without the need of laboratory testing infrastructure, and facilitate the creation of virtual cooperatives to aggregate crop yields and broker better prices with suppliers. Artificial intelligence agricultural start-ups in South Africa include, Aerobatics, My Smart Farm, Drone Clouds. The adoption of AI will bring sporadic positive changes in agriculture and that will be the most important area in Nigeria and Africa. AI will bring more understanding to the farming business and reveal a new route in how farmers make a decision that will enhance harvest and hasten innovation in Africa. This is seen in Nigeria where an AI-based system is used to assist farmers to sell their produce and buy services via a bot platform that relies on SMS and other channels such as USSD, and Slack.[23] In recent years, researchers have focused on developing expert systems to assist, for instance, small-hold farmers to get better information on what, when, and how to seed to improve the agricultural yield. Specifically, in certain semi-arid regions in

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[22] Colin Thirtle, Lin and Jenifer Piesse, "*The Impact of Research-Led Agricultural Productivity Growth on Poverty Reduction in Africa, Asia and Latin America,*" World Development (Vol 31 Issue 12), 2003.

[23] M. Rimmer, *"Artificial Intelligence in Developing Countries."* 2016. Available: https:// [Accessed 9 December 2020].

Africa, accurate advice on meteorological conditions alongside proper farming and irrigation techniques has been shown to yield substantial potential for productivity gains through water savings and more appropriate seeds.[24] AI is also being used to improve crop production by helping farmers to access key information about crop diseases. For example, in Uganda, Micro crops is a diagnostic tool for diagnosing viral crop diseases in cassava plants.[25] Sick plants are flagged in real-time, which allow farmers to take action and stop the spread of the disease.[26] AI is also being integrated into livestock production to drive genomic precision in livestock production models and the creation of intelligent breeding programs. The agricultural sector remains the leading economic growth driver in Africa and therefore, such productivity increases will potentially shift, by a large margin, the development potential and income opportunities of countries such as Nigeria.[27]

Health Care

Health systems in Africa face several structural challenges. National medical systems often suffer from shortages of qualified healthcare professionals or supplies, resulting in divergent outcomes for patients depending on the facility and service that they need. In addition to accessibility barriers and rural and urban disparities, lack of awareness on health issues can be a barrier to seeking care, to receiving more effective treatments, and to more effective public health policies. Even when facilities and staff are available, affordability can put needed services out of reach of patients. AI can help plug these gaps and enhance outcomes, and large corporations and startups alike are developing AI-focused healthcare solutions for these challenges. There are rich use cases for AI in the healthcare field:

• **Empower and supplement staff**: AI solutions can help scarce personnel and facilities do more with less by speeding initial processing, triage, diagnoses, and post-care follow up, thereby stretching their limited time to serve more patients and increasing accessibility.

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[24] World Wide Web Foundation, "Artificial Intelligence: The Road Ahead in Low and Middle-Income Countries", *Web foundation.* 2017: https://webfoundation.org/docs/2017/07/AI_Report_WF.pdf. [Accessed: 09- Dec-2020].

[25] Ibid.

[26] Ibid

[27] Ibid.

• **Improve public health policy**: AI technology can be used to better understand patterns in the spread of disease, as well as design more effective public health measures in response.

• **Improve healthcare delivery**: AI-based healthcare solutions can help to make healthcare services more proactive. Instead of "sick" care that reacts to serious problems, advanced data analytics can help practitioners identify potential problems early and tailor better preventive care in response. Earlier interventions — before a health problem becomes a health crisis — mean that health-care delivery can be cheaper, easier for the patient, and result in better health outcomes.

• **Better diagnostics and detection**: By analyzing patterns in health and testing data, such as machine vision analysis of x-rays, AI can be a critical assistance that makes faster and more accurate diagnoses. It enables health workers to interpret findings and to identify specific problems and interventions amid complex scenarios with different variables interacting at one time.

• **Improve access**: AI tools, such as online conversation agents and machine vision, can extend access to millions of people and remotely diagnose various health conditions using images from the cameras of everyday smartphones.

CHALLENGES OF ARTIFICIAL INTELLIGENCE ON SOCIO-ECONOMIC DEVELOPMENT IN AFRICA

Artificial intelligence (AI) is doing a lot of good and will continue to provide many benefits for our modern world, but along with the good, there will inevitably be negative consequences. The sooner we begin to contemplate what those might be, the better equipped we will be to mitigate and manage the dangers. There are some certain challenges which hinders artificial intelligence from contributing enormously to our economic development in Africa. Some of them are articulated below:

Bias of AI Algorithms: AI algorithms can show biased results when written by developers with biased minds. Since there isn't any transparency about how the decision-making processes run in the background, the real users cannot be sure about its fairness. So, this can result in algorithms that yield biased results. Since AI algorithms are built by humans, they can have built in bias by those who either intentionally or inadvertently introduce them into the algorithm. If AI algorithms are built with a bias or the data in the training sets they are given to learn from is biased, they will produce results that are biased. This reality could lead to

unintended consequences like the ones we have seen with discriminatory recruiting algorithms and Microsoft's Twitter Chabot that became racist. As companies build AI algorithms, they need to be developed and trained responsibly.

Lack of Privacy: Most companies love data and they like to keep it. The privacy of citizens is constantly put at risk when companies collect consumer data without taking any prior permission and this is made easy with the use of AI. Facial recognition algorithms are widely used across the world to support the functionality of different applications and products. Such products are collecting and selling huge amounts of customer data without consent.

No Transparency: Artificial Intelligence involves complex programming of products that cannot be explained to the common people. Moreover, algorithms of most of the AI-based products or applications are kept secret to avoid security breaches and similar threats. Due to these reasons, there is no transparency about the internal algorithms of AI products making it difficult for customers to trust such products.

Poor Governance and Accountability: When an AI system or product does something unethical, it is challenging to assign blame or accountability. Earlier governance functions had to deal with static processes, but AI and data processes are iterative. Thus we need a governance process that can similarly adapt and change.

The Cost of Data Annotation: A major chunk of artificial intelligence is based on the fact that tech companies train their computers using labeled data. Data Annotation/labeling requires a large human force and big tech giants like Google/Facebook hire a massive workforce who spend hours labeling the data. The irony here is that tech companies are trying to make smarter systems but they require substantial manual labor.

Massive Training Datasets: The current AI-based applications not only require labeled data but also massive data. If you think about the biggest players in AI, which are, Amazon, Google, Facebook, etc they are leading because they have access to so much data. Not all companies have access to massive data.

Quality of Data: There are many aspects to data quality, including consistency, integrity, accuracy, and completeness. Modern systems need to become aware of the quality of data I/O. They must instantly identify potential issues and avoid exposing dirty, inaccurate, or incomplete data to connected production components/ clients. This implies that, even if there is a sudden problematic situation resulting in poor-data quality entries, the system will be able to handle the quality issue and proactively notify the right users. Depending on how critical the issues are, it might also deny serving data to its clients — or serve data while raising the alert/ flagging the potential issues.

A Shift in Human Experience: If AI takes over menial tasks and allows humans to significantly reduce the amount of time they need to spend at a job, the extra freedom might seem like a utopia at first glance. However, in order to feel their life has a purpose, humans will need to channel their newfound freedom into new activities that give them the same social and mental benefits that their job used to provide. This might be easier for some people and communities than others. There will likely be economic considerations as well when machines take over responsibilities that humans used to get paid to do. The economic benefits of increased efficiencies are pretty clear on the profit-loss statements of businesses, but the overall benefits to society and the human condition are a bit opaquer.

Global Regulations: While our world is a much smaller place than ever before because of technology, this also means that AI technology that requires new laws and regulations will need to be determined among various governments to allow safe and effective global interactions. Since we are no longer isolated from one another, the actions and decisions regarding artificial intelligence in one country could adversely affect others very easily. We are seeing this already playing out, where Europe has adopted a robust regulatory approach to ensure consent and transparency, while the US and particularly China allows its companies to apply AI much more liberally.

Accelerated Hacking: Artificial intelligence increases the speed of what can be accomplished and in many cases, it exceeds our ability as humans to follow along. With automation, nefarious acts such as phishing, delivery of viruses to software and taking advantage of AI systems because of the way they see the world, might be difficult for humans to uncover until there is a real quagmire to deal with.

AI Terrorism: Similarly, there may be new AI-enabled form of terrorism to deal with: From the expansion of autonomous drones and the introduction of robotic

swarms to remote attacks or the delivery of disease through Nano robots. Our law enforcement and defense organizations will need to adjust to the potential threat these present. It will take time and extensive human reasoning to determine the best way to prepare for a future with even more artificial intelligence applications to ensure that even though there is potential for adverse impacts with its further adoption, it is minimized as much as possible. As is the case with any disruptive event, these aren't easy situations to solve, but as long as we still have humans involved in determining solutions, we will be able to take advantage of the many benefits of artificial intelligence while reducing and mitigating the negative impacts.

Concluding Reflections

From certain perspectives, it can be argued that there is a high level of diversity of AI deployment on the African continent. As revealed in this article, one aspect of diversity is in the types of problems that are being addressed by AI. From financial inclusion to combatting cultural and linguistic marginalization, AI innovations are aimed at many different aspects of African society, economy, and government. Another form of diversity is in the people implementing AI solutions, and in this regard, the relatively high level of participation by women in African entrepreneurship is encouraging. Diversity of location is also noteworthy—while AI is clearly developing in countries that are well known as technology hubs (e.g., Kenya, Nigeria, and South Africa), there are also significant AI-focused activities in countries that are less frequently recognized for cutting-edge digital adoption (e.g., Uganda and Ethiopia). In contrast, government policy is an area where there is less diversity, as the vast majority of African countries lack a dedicated AI policy instrument. AI has the potential to be as impactful in Africa as it is in other regions of the world, but as explained herein, the unique context will influence the depth and breadth of that impact. The labour force in Africa is very different from the labour forces in, for example, Europe and the United States, and, accordingly, the impact of AI on labour will likely also be quite different. Artificial intelligence has contributed enormously to the development of our economy. From the discuss above, we affirmed that for there to be effective and efficient working of our different sectors of economy, there is need to develop, maximize and utilize our artificial intelligence in a prudent manner.

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