Role of Big data and artificial intelligence (AI) in building a prosperous Africa

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Abstract— Machine learning and associated computer-facilitated governance support have been described as the fourth industrial revolution, and the core driver of this revolution is data. Data sets collected from disparate sources are transformed through Artificial intelligence (AI) into actionable information, and having changed the business environment is now beginning to determine the jobs of the future. Although experts believe that AI will lead to job losses, among them there is an acknowledgment that many more jobs will be created as a result of needs created by AI. One thing is sure and that is: there will be disruptions in today's jobs due to AI.

While the future that AI may usher in may be of varying impact and consequences, the current state of societal well-being in Africa does not offer any consolation. Africa's population is growing at an alarming rate of 2.56% and it is estimated that by the year 2100, the continent will house one-third of the world population. According to the Poverty and Shared Prosperity, 2018 report, people living in poverty in South Asia and sub-Saharan Africa grew from 278 million in 1990 to 413 million in 2015, despite poverty decline in other regions [1]. Furthermore, it is estimated that by 2050, approximately 40 percent of the world's extremely poor are expected to live in two African countries — Nigeria and the Democratic Republic of Congo (DRC).

Arresting the growing trend of poverty calls for an urgent intervention by all stakeholders – governments, concerned organizations, and AI professionals to innovatively disrupt capacity building in an entrepreneurial scene and create jobs for the youth population. This intervention requires collaborations in data gathering and sharing; and with the adoption of AI will usher in a bright new vista in the future of the African continent.

Index Terms—Africa, African future, Africa Union, Artificial intelligence, Collaborations, Data Management, Open Data Standards, Open training, Opportunities, Population, Research

1 Introduction

The goal of this paper is to elaborate on how information technology and artificial intelligence can be used as an enabler to foster collaborations among African stakeholders to create a template for a prosperous continent. Africa, unfortunately, has been associated with poverty, conflicts, and uncommon diseases. To make a positive change it is important to recognize that today's events are as a result of yesteryears' actions and tomorrow's events will be greatly determined by the quality of our efforts today.

The foregoing does not mean that there have not been efforts and progress made, however, much of what we have achieved so far are silo achievements that are insufficient to catapult the continent to her expected greatness. A desperate situation requires equally matching actions; a continent with a population growth rate (PGR) of 2.52%, compared to 0.89% in Asia and 0.63% in North America [2] means that if not properly managed or addressed, it could be a ticking time-bomb.

A Comparison of world population and productivity in terms of Gross Domestic Product (GDP) clearly shows that Africa is the world's least productive continent. Africa makes up 16.69% of the world population as of 2019 but a meager 2.79% of the global GDP compared to North America with 4.75% of the world population but controls 26.11% of the world's GDP (as depicted in **Figure 1**). This calls for an urgent need to collaborate on utilizing the population to good and productive use.

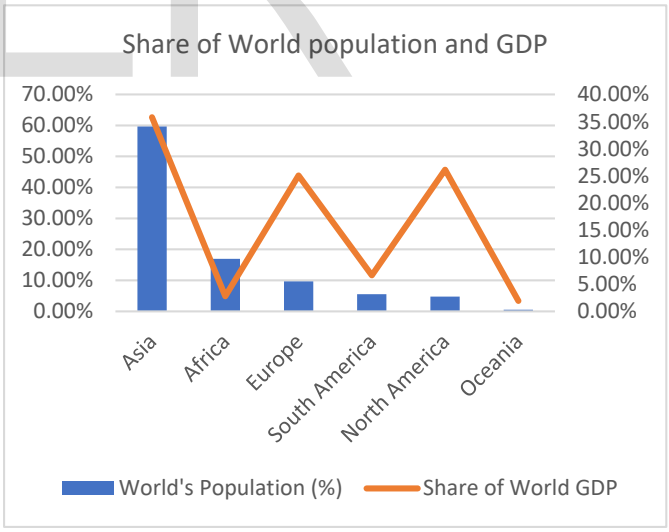

Figure 1: Share of World Population against Gross Domestic Product (by Continents)

Information and communication technology (ICT) has found its implementation and usefulness in every facet of life ranging from education, health, agriculture, finance, and other sectors. In addition, big data and artificial intelligence have raised the bar in terms of how technology affects humans.

Artificial intelligence has been defined by Merriam Webster dictionary as a branch of computer science dealing with the

simulation of intelligent behavior in computers and as the capability of a machine to imitate intelligent human behavior [3]. Artificial intelligence has been applied to health, customer support, e-commerce experience, travel, and navigations among others. The same can be adopted to learning methodologies and capacity building in Africa with higher returns on investment.
As posited by Gurdip Kaur Saminder Singh, "The digital transformation, heralded by IoT, AI, and big data analytics, is already bringing innovation to learning methodologies and tools, through "smart learning" practices. The amalgamation of smart devices and intelligent technologies offers a powerful means of enhancing and extending the learning experience." [4]
Big data is generally referred to as large, diverse sets of information that grow at ever-increasing rates. It encompasses the volume of information, the velocity or speed at which it is created and collected, and the variety or scope of the data points being covered. Big data often comes from multiple sources and arrives in multiple formats [5].

2 AFRICAN DEMOGRAPHY (SWOT ANALYSIS)

Background

In 2009, United Nations Population Fund stated that the population of Africa had hit the one billion mark and had therefore doubled in size over the last 27 years [6], and by 2050 there will be an estimated 2.5 billion people in the continent. African population estimate as of 2019 stands at 1,308,064,195 (i.e. over 1.3 billion people and 16.96% of the global population) [7]. The summary is shown in **Table 1** below:

Table 1: Continent Populations Summary 2019

Name	2019 Population	World's Population (%)	Growth Rate (%)	Pop Density (sq km)
Asia	4,601,371,198	59.65%	0.89%	103.22
Africa	1,308,064,195	16.96%	2.52%	43.17
Europe	747,182,751	9.69%	0.10%	33.76
South America	427,199,446	5.54%	0.85%	23.95
North America	366,600,964	4.75%	0.63%	14.84
Oceania	42,128,035	0.55%	1.34%	4.96

Having a relatively unproductive population is a burden but more burdensome is the threat it portends to today's young generation in another 50 years.
It is estimated that about 41% of the people in the continent are below 15 years old while another 19% are youth between 15 and 24 years old. By inference, it means that about 60% of the continent's population (over 780 million) are below 24 years. This is scary and is partly responsible for the poverty level in the land. Artificial intelligence is the tool needed to address the critical challenge we have at hand with other processes
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2.1 Dangers

Without raising unnecessary alarms, the facts, and trends before us do not look bright. The global population is expected to reach 9.5 billion by 2050 with Africa taking a large chunk of 42.11% as against 16.96% share as of today. The forecast surge in population growth does not in any way translate to economic growth rate as discussed in the introduction Section.
Martina Schwikowski in her "Preparing for Africa's population boom" [8], said that if economic growth does not keep up with the increasing population, rates of poverty are also expected to rise. The Bill & Melinda Gates Foundation saw this trend as an opportunity to publish a new Goalkeepers study as a catalyst for action. But the forecasts are rather bleak: by 2050, approximately 40 percent of the world's extremely poor are expected to live in two African countries — Nigeria and the Democratic Republic of Congo (DRC).
To avert the danger ahead, here are some of the issues that require immediate attention:

- Population growth
- Population distribution
- Total fertility rate
- Teenage pregnancy
- Population age structure

It has been established that by 2050 sub-Saharan African will have an estimated population of 2.2bn – three times as that of Europe as compared to 180m people in 1950, which was one-third of Europe's population. If UN forecasts are right, sub-Saharan Africa will have 4bn people in 2100.

2.3 Opportunities

The population could either be a blessing or a curse or rather paying adequate attention to an increasing population could translate to fortunes. The African population is an asset, there is a need to understand the inherent values and constant evaluation of its worth. The African youth population is even a greater asset.
The greatest resource of any continent is its people; it is neither oil nor gold. This point must be taught, emphasized until all leaders and stakeholders digest the message. It seems lack of this one knowledge is a cog in the developmental wheel of the continent. With more than 1.2 billion people, 43% of which are below the age of 15, Africa is well endowed with human resources. For the region to compete in the global, digitizing economy and to make a dent in poverty, it is imperative that Africa's young people and future workers are enabled to fully develop their human capital. Fortifying Africans to reach their full potential enables access to a world buoyant with opportunity and promise, and results in a high return on investment. [1]
Increased collaboration among member states is even more important now not just to treat symptoms but to address the fundamental issues.

3 Artificial Intelligence As A Panacea

3.1 Efforts so far

AI Research Labs

Research efforts into artificial intelligence on African soil are being led majorly by global big technology companies while the governments are either not informed or simply playing catchup. In 2013, IBM Research opened its first African office in Nairobi and in 2016, added another in Johannesburg, South Africa. Google also in 2018 opened a new AI lab in Accra, Ghana. Furthermore, Facebook and Google partnered with the African Institute for Mathematical Sciences (AIMS) in 2018 to launch a one-year intensive African Master's in Machine Intelligence (AMMI).

This points out the obvious, there is a gap as far as collaboration with other African stakeholders is concerned.

African Continental Free Trade Agreement (AfCFTA)

The recent African Continental Free Trade Agreement is a welcome development in terms of collaboration among African countries. This agreement is expected to favor small and medium-sized businesses, usually known by the acronym SMEs, which are responsible for more than 80% of Africa's employment and 50% of its GDP [9].

Among other benefits, it is expected to create new opportunities for existing African companies, increase efficiency & sales, and by implication, more job opportunities for the teeming youth population.

AI implementations across the continent

There have been a few implementations of AI on the continent especially in the Agriculture and Health and a few of them will be discussed in the sub-Section.

There is no gainsaying that the youth's innovation and creative nature are critical in creating "inclusive and sustainable economic growth, employment, and decent work for all".

Furthermore, where jobs exist, resources for investment in upskilling and reskilling are often limited. Closure of IT training firms in days the same is blossoming in India and other countries with youth advantage is alarming.

Universities

Universities are trying to meet the demand. In South Africa, the Center for Artificial Intelligence Research (CAIR), founded in 2011, operates a research network with nodes at five universities. In Nairobi, Strathmore University established the @iLabAfrica Research Center, which seeks to promote cutting-edge research in AI, among other emerging technologies. And the University of Lagos in Nigeria recently opened an AI Hub that will focus on deep learning and tools to collect data.

Other Siloed efforts

SingularityNET is an AI firm, one of the companies behind the controversial Sophia robot (the first robot to be nationalized worldwide by the Saudi Arabian government), has an office in Ethiopia, a growing hotspot for AI research, with more local partnerships in the works.

InstaDeep, is an AI company leveraging its expertise in GPU-accelerated computing, deep learning, and reinforcement learning, it has built AI systems to tackle the most complex challenges across a range of industries and sectors; which are not limited to manufacturing, logistics, mobility, and energy.

Kudi.ai is an AI-powered chatbot that uses an everyday conversational style to conduct financial transactions. Available transactions range from Bill Payments, funds transfer, airtime purchases, among others.

DataProphet is South African based and a global leader in AI for manufacturing. Their technology embeds unique adaptations and advancements of deep learning, enabling AI to have a significant, practical, impact on the factory floor. Their clients include BMW and Mercedes Benz.

Aajoh is another Nigerian based e-health tool that uses artificial intelligence (AI) to diagnose patients. The tool receives inputs via text, audio, and photographs and diagnoses their patients instantly.

Others are Clevva, Aerobotics, Stockshop.co.za, AI Saturdays to mention a few.

4 Challenges

Funding issues

Funding has often been a challenge to research initiatives in general and AI is not an exception. More often than none, the volume, duration, and conditions attached to funds make it difficult for researchers to complete projects in time and within budget.

The dearth of AI experts

The vast majority of AI experts are in North America, Europe, and Asia; lack of African representation has posed challenges to biases against the continent. For example, Google Photos in 2015 tagged images of black people as "gorillas" drawing criticism and leaving the company scrambling to fix the issue. According to Moustapha Cisse, "Such lack of diversity can entrench unintended algorithmic biases and build discrimination into AI products. And that is not the only gap: fewer African AI researchers and engineers means fewer opportunities to use AI to improve the lives of Africans. The research community is also missing out on talented individuals simply because they have not received the right education."

Traveling across Africa

Taking flights between African countries is always expensive, circuitous, and unsafe. For example, there is no direct flight between Kinshasa (Democratic Republic of Congo) and Lagos (Nigeria), the two largest cities in Africa and the situation applies across the region.

Visa issues for AI professionals

Tejumade Afonja of AI Saturdays could not physically make her presentation at the *Black in AI* workshop at 2018 NeurIPS, one of the most preeminent AI conferences in the world owning to visa denial and visa processing time for her and those of over 100 other African researchers. She ended up having to do her presentation via a video call.

Google's head of AI Accra Moustapha Cisse also lamented on his blog about visa challenges as an AI professional. In his words, "Despite the support, many of us still have trouble making it to conferences. I have had papers accepted at meetings but been unable to attend because Western countries such as Australia denied me a visa, even though I was already settled and working professionally in Europe,".

This is the same story for other AI professionals which limits our exposure and participation on the global stage.

AI from a Pessimistic view

There are mixed feelings at some quota about the fate of Artificial intelligence and the danger it portends for the human race in general. There have been calls by concerned individuals and major Information technology players about the risk of AI and the need for regulation and slowdown of events. Such calls have been heightened by Elon Musk and Stephen Hawkings. Elon Musk for example while speaking at MIT in 2014, called AI humanity's "biggest existential threat" and compared it to "summoning the demon." [10]

5 The new Approach

A new set of approaches is required to fast-track capacity building to increase the effectiveness of the African entrepreneurs and by effect achieve increased job creation. At the heart of this approach is collaboration. There is an urgent need for all major stakeholders to come together, starting with the basics.

Three broad groups of stakeholders have been identified, which include the government, independent organizations or individuals, and artificial intelligence professionals. The extent to which the joint effort goes will determine how successful the continent catches up with the population growth and by extension provides a template for several years ahead.

In no order, I have been able to identify the set of activities that must be embarked on with all seriousness by the stakeholders as discussed below:

Identification of critical and key indicators

To better understand the continent's informal sector and her current skill base while attempting to bridge the youth skill gap, identification of critical indicators, and understanding of the diversity and peculiarities of the continent are paramount. On the surface, the challenges are identical howbeit the solutions are complex.

Adoption of common definitions of these indicators

Language is one of the barriers to effective integration and collaboration of ideas. This is the major reason why the adoption of common definitions is important. For example, the definition of SMEs for example varies from countries (though not peculiar to Africa), adopting a single way of categorization will ensure we speak with the same concept in mind.

Adoption of Open Data standards

As discussed earlier, quality data is at the core of AI implementations; it is thus pertinent to develop open standards that will be used to define existing data (sitting across the continent) and a new set of data that will be required going forward. Also, it was discussed earlier the various AI efforts going on across the continent and the world at large; the time is now to begin reaping from the silo efforts by defining standards suitable to solve African challenges.

Capacity building

Out of the top eight challenges facing Small and Medium Enterprises (SMEs) as highlighted by Dr. Muriithi [11], four (as shown in **Table 2**) have to do with capacity building and access to reliable information. These challenges could be addressed with the help of big data and artificial intelligence implementations.

Table 2: Challenges facing SMEs in Africa

Ranking	Challenges
1	Electricity supply
2	Access to financing
3	Poor management
4	Competency and capability
5	Negative perception
6	Access to reliable information
7	Government support
8	Corruption

Delivering personalized training contents that factors the various indicators and in preferred languages will go a long way to address the lack of skills and capacity development of the youth, and those close the gap between employers' needs and youth skills and impeding youth's entrepreneurial capabilities. This can be achieved effectively by AI and at a cheaper cost.

Data management

There is also the need for a data management plan across the continent. Data governance is common among corporate entities and the same is required at this point to iron out data creation processes and data ownership.

The emphasis here should be placed on data gathering/collection and integration of existing data using the defined standards mentioned earlier.

Knowledge sharing

Once quality data is guaranteed (to an extent), implementation of AI strategies can kickstart. AI comes with a feedback loop that increases the model and thus making the system auto-tuned and auto-correct. One major output of this system is the ability to learn and share knowledge among the participating member countries. This will enable citizens to avoid previous mistakes and have an active interaction with other experiences.

6 RECOMMENDATIONS

In all, my submissions regarding the role of big data and AI in our attempt to building a prosperous Africa are highlighted in this Section. For each point, an attempt is made to discuss the responsibilities of the three major categories of stakeholders and how the interventions will be beneficial.

1. *Development of Open Training*

There is an urgent need to create AI online training platform to bridge the gaps with faculties around the world but with African contents. The AI advantage will enable the platform to analyze individual skill gaps and provide the necessary training to bridge them by providing tailor-made tutorials.

The training sessions are expected to be delivered in indigenous languages, training will adapt to user needs and not the other way round.

Another AI advantage is the provision of real-time feedback into the process to fine-tune the training models for better contents and user experience.

Physical training will be limited and provided only when online training will not deliver effectively, and it will be delivered cost-effectively.

2. Hands-on entrepreneurship sessions

Hands-on entrepreneurship training sessions are necessary for capacity building to create jobs. Tracking systems will be used to collate feedbacks and send it to the centralized collation center. These for form another set of data sources for the overall AI system.

A similar approach can be adopted for skills in the political terrain and good governance, leveraging the power of artificial intelligence.

Instead of operating in silos, we should be each other's cheerleaders. We should learn from each other but how do we quickly bring that to fruition without the power of technology?

3. Increased participation in AI global space

In 2016, several industry leaders including Amazon, Apple, DeepMind, Google, IBM, and Microsoft joined together to create Partnership on AI to Benefit People and Society to develop and share best practices, advance the public understanding, provide an open platform for discussion and to identify aspirational effort in AI for socially beneficial purposes [12]. There is a need for African stakeholders to actively engage such initiatives to hasten the bridging of the capacity gap and shoot our continent to the awaited glory.

It is noteworthy to mention that there is not a single partner from Africa (see **Figure 2)** in this initiative aimed at transforming the world for today and tomorrow's jobs. We are also recommending that AfDB and other ivory towers of knowledge in Africa to join the likes of UNICEF, UNDP, Amnesty International, Santa Clara University and other partners to rightly project the interest of the continent in the scheme of things.

Figure 2: Partnership on AI partners across the globe.

4. Enhanced and deliberate collaborations

A conference like "African Economic Conference" is a great example of deliberate collaboration among stakeholders, but more of these are required to address the deficiencies on the continent. This will entail many engagements and negotiations with leaders of various governments as well as government agencies set up to address some of these needs.

Also, improved collaborations between African Universities and AI professionals is essential at this juncture. Every stakeholder is required to chart a new course for our motherland.

7 CONCLUSION

I will conclude with Moustapha Cisse's quote [14], "The future of machine-learning research is in Africa, whether people know it or not". Machine learning and AI have proven to enhance productivity and create jobs of the future, we have no choice as Africans to utilize the technology with our number to better our future.

To unlock the creativity in today's youth, paradoxically there is a need to guarantee tomorrow's security. A man yet to meet the basic necessity of life (food, shelter, and clothing) will not be able to explore or innovate to his full potentials. A two-pronged

approach is required, one that looks at the immediate challenges and the other tackling the future.

Jeffrey G. et al [14] suggested the development of a regional data collection and management system (DCMS). They concluded that working together is more economical than separate data centers and has the potential to improve data quality by encouraging shared case definitions, data validation strategies, and analytic approaches including the molecular analysis of treatment successes and failures. I cannot agree less.

African Union's Agenda 2063 is ambitious and cannot remain on the pages of papers, collaboration is required by all stakeholders from government to organizations, agencies, and high net worth individuals. Looking at the antecedents, what I term "a productive partnership" is required across the continent. A similar handshake like that implemented by AfDB and other similar organizations will be required where every government is expected to collaborate or lose out. Beyond technical rhetoric, there is a need to understand and implement flexible policies that factor the peculiarity of each government into their formulation.

With the adoption of AI implementations using our data, the future is bright for Africa.

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