Artificial intelligence for sustainable human development

Alex Comninos, Emily Shobana Muller and Grace Mutung'u
Research ICT Africa, Imperial College London, and the Centre for Intellectual Property and Information Technology (Strathmore University)
@alexcomninos @bomu @mathwis_emily on Twitter

Introduction

Artificial intelligence (AI) research is addressing many of the 17 Sustainable Development Goals (SDGs) set by the United Nations General Assembly for the year 2030.[1] The potential of AI to accelerate human development has been acknowledged by international institutions, attracted the focus of civil society and the research community, and resulted in the forging of partnerships between governments, civil society, the technical community and the private sector aimed at implementing AI in pursuit of the SDGs. In the same breath yet at a different pace, AI ethics are being addressed by the private sector and civil society and national policies are being drawn up to mitigate potential injustices and unsustainable externalities. These negative externalities unfold as biased technologies, inequitably deployed technologies, technologies that violate human rights, the marketisation of innovation and the widening of inequality intersect. The potential of technology to both accelerate and hinder human development is not new and the world is rediscovering that the human layers of technological systems are as relevant to the transfer of the technology as the technology itself. This report shows that AI is not only changing the practice of development, but also the structures of power in international development.

This report investigates many of the advances, challenges and changes made by AI for development. It will firstly provide examples of applications of AI for development using the framework of the 17 SDGs, also highlighting the challenges and potential for human harm. It then proceeds to identify two key areas where the impact of AI is shaping development agendas in the global South: the changing power structures in international development in the era of big data, and the widespread introduction of biometric identification (ID).

AI applications for development

AI has a range of applications for achieving the SDGs, or in the new emerging discourse, there are a range of applications of AI for Development (#AI4D) and AI for Good (#AI4Good). Public health is one of the most exciting areas of AI4Good/AI4D. AI can be used to detect malaria outbreaks and track the spread of infectious diseases, monitor preeclampsia[2] in pregnant mothers, catalyse and reduce the costs of drug discovery, assist doctors with decision making and diagnoses, and augment communications with patients through the use of chatbots. AI also has a host of possible applications in agriculture and food security. It can be used to understand diseases affecting crops (for example, cassava, a staple of west African cuisine and a very important plant for food security), to analyse the nutrient composition of soil, and to estimate crop yield. AI could be used in the classroom to assist teachers with their work (grading papers and administration), to create personalised learning assistants that can interact with students and respond to their specialised needs, to translate curricula into different languages, and to augment information and communications technology (ICT) access and usage for those with disabilities. Examples of how AI can help achieve the SDGs are listed in Table 1.

As Table 1 also shows, there are also a wide range of potential societal harms that can be produced by AI.

Responsibility for ensuring that AI4D maximises benefits while minimising risks and harms falls not only on the decision makers, but also the technologists who provide the solutions. It is nevertheless essential that decision makers adopt AI systems in a safe and just manner, guided by legal and regulatory frameworks that protect people from the

1 For an explanation of the SDGs see https://sustainabledevelopment.un.org/sdgs

2 Preeclampsia is a pregnancy disorder characterised by high blood pressure which can be treated and managed but can also lead to serious or even fatal complications for mothers and their babies.

TABLE 1

AI and the SDGs: Examples of opportunities and challenges

1. No poverty	*Microfinance:* Machine learning can be used to predict the ability to repay a loan; useful for people with no credit histories.[1] *Digital ID:* Computer vision and biometrics can augment the roll-out of state ID to those without it. Data sources such as imagery and mobile phone records can be used to map poverty for potential interventions.[2]	Digital ID programmes augment opportunities for real-time surveillance by the state as well as by non-state actors. Digital ID is being rolled out in countries in the global South that have weak data protection regimes or no data protection legislation in force. Current research fails to address poverty mapping at small areas which are useful for policy intervention.
2. Zero hunger	*Food security:* Machine learning can be used to better understand plant diseases[3] and AI combined with sensors (e.g. soil sensors) can gather and analyse environmental information in real time.[4]	A lot of this work is being done within the market, providing many job opportunities, but exacerbating inequalities faced by smallholder farm owners who cannot afford technologies.
3. Good health and well-being	AI can be used in health to understand disease outbreaks,[5] monitor conditions like preeclampsia in pregnant mothers,[6] track the spread of infectious diseases,[7] provide decision-making tools for doctors and medical professionals,[8] accelerate drug discovery,[9] and augment communications with patients through the use of chatbots (for example, in the South African MomConnect Maternal Health Platform).[10]	New inequalities could be created through the divide between those with access to AI-driven health and those without. In the global South, AI could replace human staff in an already thinly stretched health care sector facing brain drain. AI is being applied in developing countries often without safeguards for personal and patient information. AI is possibly affecting our mental health in ways that we are only beginning to unpack.
4. Quality education	Personalised learning[11] can be used to augment teaching and curricula for specialised needs and in resource-constrained settings, natural language processing (NLP) can be used to translate curricula into different languages.[12]	AI can introduce new biases into the education system. AI can also be used to surveil students who may give away a lot of personal data to education systems.[13]
5. Gender equality	AI has the potential to make neutral decisions. AI can be used to address gender equality. For example, a design firm released an application which uses machine learning to track gender equality in meetings.[14]	AI has particular problems that can reinforce inequalities including gender bias in algorithms, arising from biased data and a workforce that faces diversity challenges (is disproportionately white and male according to some accounts).
6. Clean water and sanitation	Machine learning and deep learning can be used in water sciences to augment water management.[15]	Smart sanitation projects in countries like India have been shown to perpetuate systemic caste biases.[16]
7. Affordable and clean energy	Machine learning can be used in energy forecasting, helping to smooth the transition to clean and green energy as well as in the implementation of smart grids.	A recent study investigating carbon emissions in the training of some of the cutting-edge national language processing (NLP) models found that the training of one of these models could emit more carbon dioxide than the lifetime emissions of the average American car (including its manufacture).[17]
8. Decent work and economic growth	AI has the potential to catalyse growth in the economy. Through cheaper and more accurate predictions, AI can generate productivity gains.[18]	AI and automation will result in the loss of jobs requiring both skilled and unskilled labour. AI is used in platforms of the gig economy which has threatened the quality of work and sidestepped labour regulations in many countries.
9. Industry, innovation and infrastructure	AI can accelerate innovation and make infrastructure smarter. Online retailers can contribute to a sharing community (such as housing rentals).[19] Low-skilled data cleaning jobs.	AI can result in job losses. The gig economy is radically changing the nature and quality of work while sidestepping regulations. Can contribute to rising inflation of housing costs in areas within a city.[20] Plentiful supply of cheap labour risks turning into a liability.
10. Reduced inequalities	"Data can help bridge inequalities that plague every social, political, and economical sphere."[21] Deep learning was used by researchers at Imperial College London to detect inequalities in four UK cities using official statistics and Google Street View images.[22]	Bias in algorithmic design, and in training data, has been shown to perpetuate prejudice. Algorithms used in calculating social benefits in countries like Poland have been shown to discriminate against groups such as mothers, people with disabilities, and rural citizens, effectively increasing inequality.[23]

SDGs	Opportunities	Challenges and harms
11. Sustainable cities and communities	AI can be used in smart cities and in urban management.[24]	Data privacy regulations are imperative in cities to ensure safe surveillance. Concerns have been raised about the recent use of Zimbabwe state ID data for facial image recognition by Chinese company CloudWalk.[25]
12. Responsible consumption and production	AI can be used in environmental decision support systems to allocate resources more efficiently.[26]	AI is being used by big business to stimulate the unnecessary consumption of goods and services, rather than create a culture of responsible consumption.
13. Climate action	AI can be used in tackling climate change.[27]	The interpretation of big data is open to abuse by climate change denialists. There is also a danger that AI can be used to manage scarce natural resources for the benefit of the powerful few or privileged.
14. Life below water	AI can be used in marine resource management. The Global Fishing Watch Platform (which arose from collaboration between Google, a digital mapping NGO called Skytruth and Oceana) uses neural networks to track fishing activity and activities such as overfishing and human trafficking.[28]	AI can be used by extractive gas and oil industries for underwater drilling at the expense of sea-life ecosystems.
15. Life on land	AI can be hooked up to soil sensors to monitor nutrients in the soil in real time and provide information and decision support to farmers. AI can be used to estimate crop yields.[29]	Factory farms and AI in the agricultural sector and the encroachment of data-driven businesses such as Amazon in the food supply chain are displacing rural farmers and food hawkers, and privatising natural resources such as soil and water.[30]
16. Peace, justice and strong institutions	AI can be used in e-government programmes to create a more responsive government.[31] AI could possibly be used to forecast conflict.[32]	Without the necessary checks and balances, AI can make public institutions more opaque, and undermine rather than enhance participatory governance.[33] AI used in the judicial system has raised concerns regarding due process.[34]
17. Partnerships for the goals	AI is creating synergies between the technical, research and development communities.	AI is transforming power structures in international development, increasing the role of the private sector as a development actor and thus introducing a variety of challenges.

(1) Kostadinov, S. (2019, 30 July). The Future of Lending Money Is Deep Learning. *Towards Data Science*. https://towardsdatascience.com/the-future-of-lending-money-is-deep-learning-61a9e21cf179. (2) Blumenstock, J., Cadamuro, G., & On, R. (2015). Predicting poverty and wealth from mobile phone metadata. *Science, 350*(6264), 1073-1076. https://science.sciencemag.org/content/350/6264/1073. (3) Ramcharan, A., et al. (2019). A Mobile-Based Deep Learning Model for Cassava Disease Diagnosis. *Frontiers in Plant Science, 10*; see also https://plantheus.com.ng. (4) https://mel.cgiar.org/projects/71. (5) Pindolia, D. K., et al. (2012). Human movement data for malaria control and elimination strategic planning. *Malaria Journal, 11*. (6) Espinilla, M., Medina, J., García-Fernández, A., Campaña, S., & Londoño, J. (2017). Fuzzy Intelligent System for Patients with Preeclampsia in Wearable Devices." *Mobile Information Systems*. https://doi.org/10.1155/2017/7838464. (7) Tang, L., Bie, B., Park, S., & Zhi, D. (2019). Social media and outbreaks of emerging infectious diseases: A systematic review of literature. *American Journal of Infection Control, 46*(9). (8) Topol, E. J. (2019). High-performance medicine: the convergence of human and artificial intelligence. *Nature Medicine, 25*, 44-56. (9) Fleming, N. (2018, 30 May). How Artificial Intelligence Is Changing Drug Discovery. *Nature*. https://www.nature.com/articles/d41586-018-05267-x. (10) https://www.praekelt.org/momconnect. (11) Nye, B. D. (2014). Intelligent Tutoring Systems by and for the Developing World: A Review of Trends and Approaches for Educational Technology in a Global Context. *International Journal of Artificial Intelligence in Education, 25*(2). (12) Abbott, J. Z., & Martinus, L. (2018). Towards Neural Machine Translation for African Languages. *ArXiv*. https://arxiv.org/abs/1811.05467. (13) Shobana Muller, E., & Marivate, V. (2019). 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(19) Barron, K., Kung, E., & Proserpio, D. (2018, 29 March). The Effect of Home-Sharing on House Prices and Rents: Evidence from Airbnb. *SSRN*. https://ssrn.com/abstract=3006832. (20) Wachsmuth, D., & Weisner, A. (2018). Airbnb and the rent gap: Gentrification through the sharing economy. *Environment and Planning A: Economy and Space, 50*(6), 1147-1170. https://doi.org/10.1177/0308518X18778038. (21) Birhane, A. (2019, 18 July). The Algorithmic Colonization of Africa. *Real Life*. https://reallifemag.com/the-algorithmic-colonization-of-africa. (22) Suel, E., Polak, J. W., Bennett, J., & Ezzati, M. (2019). Measuring Social, Environmental and Health Inequalities Using Deep Learning and Street Imagery. *Scientific Reports, 9*. https://www.nature.com/articles/s41598-019-42036-w. (23) See the Poland country report in this edition of GISWatch. (24) Woetzel, J., et al. (2018). *Smart Cities: Digital solutions for a more liveable future*. 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harms of AI. Furthermore, humans who create these systems need to be guided by human rights principles and accord with data protection frameworks. Creating an environment where this is possible will require effective channels of communication between all stakeholders in government, the private sector, the research community, the technical community and civil society.

Data, computational intelligence and development

While development practice has benefited from the new avenues of big data generated by new ICTs as well as from waves of innovation in mathematics and computing, national statistics remain essential for measuring, monitoring and planning for development. Regular, complete, accurate and reliable statistics are essential for equitable development and for the formulation of good economic development policies.[3] The traditional source of information for national development planning has been statistics. These statistics are the result of surveys and censuses often conducted by national statistical offices and international organisations and assisted through international development aid.

Good and informative statistics are collected regularly over long time periods and require human and technical capacity. The production of statistics in the global South (for example, through conducting surveys) can be inhibited by budget, geographic barriers, as well as infrastructural barriers such as transport. The proliferation of mobile phones in the global South has led to a reliance, in both research and policy literature, on supply-side data generated by mobile operators[4] with little demand-side data (e.g. household surveys) to validate this data. More recently, mobile phones and user-generated content/social media platforms have resulted in even more online behaviour and other data being generated, collected and processed by corporations. A promise for many is that big data and AI will augment statistical measurement. However, the ability of supply-side data, which is mostly collected by and controlled by corporations, to represent fairly everyone in the society is questionable and any solution created from this data has the potential to be inequitably deployed.

Changes to power structures in international development

Taylor and Broeders argue that big data is potentially valuable in development research and policy but is also changing power structures within the field and practice of development. One example is a change of where and who donors are going to for data:

> Where previously development donors (governments or international NGOs) worked with LMICs' [low- and middle-income countries] own statistical apparatuses to generate population data, it is becoming increasingly possible and cost-efficient for donors to turn to corporations for consumer-generated data that can proxy for traditional household surveys and other statistics.

The growing "discourse on big data as a resource for development" is another effect of these power shifts and "indicates that a shift is underway from the predominance of state-collected data as a way of defining identities and sorting and categorising individuals, groups and societies to a big-data model where data is primarily collected and processed by corporations and only secondarily accessed by governmental authorities."[5]

Taylor and Broeders investigate two trends arising from this change in power structure. Firstly, they are empowering public-private partnerships in achieving development goals and resulting in "growing the agency of corporations as development actors": "As corporations expand into emerging markets through services which generate digital data, they now find themselves simultaneously expanding into the development field." Secondly, they are creating alternative representations of social phenomena – "data doubles"– that are created in parallel to national data and statistics (for example, when data from mobile phone and internet users are used to create different representations of the same phenomena that are represented in national statistics).[6]

Digital identification

Digital ID in the global South is an example of the application of AI4D. AI technologies like computer vision used in biometrics are being implemented in the roll-out of digital ID in many developing countries. The potential of digital ID has spurred the uptake of official state ID programmes which have been seen as important for development, as well as essential to enabling human rights. Without some form of ID,

3 Shangodoyin, D. K., & Lasisi, T. A. (2011). The Role of Statistics in National Development with Reference to Botswana and Nigeria Statistical Systems. *Journal of Sustainable Development, 4*(3).

4 The International Telecommunication Union's data (gathered from mobile and telco operators) is considered a proxy for statistics on mobile phone penetration even though this data often counts inactive SIM cards and does not account for the fact that many users in the developing world own multiple SIM cards as a cost-saving strategy.

5 Taylor, L., & Broeders, D. (2015). In the Name of Development: Power, Profit and the Datafication of the Global South. *Geoforum, 64*, 229-237.

6 Ibid.

citizens find it hard to receive government services, to enrol children in schools, and may face obstacles in finding employment or seeking access to loans. Almost 40% of the population over 15 in low-income countries do not have an ID, the poorest are least likely to have an ID, and there are also gender gaps in official ID programmes.[7] SDG target 16.9 calls for provision of "legal identity for all including birth registration" by 2030. The roll-out of digital ID provides an opportunity for reaching this goal.

State-issued identity is essential for social protection. Social protection is defined by the UN Food and Agriculture Organization as "initiatives that provide cash or in-kind transfers to the poor, protect the vulnerable against risks and enhance the social status and rights of the marginalized – all with the overall goal of reducing poverty and economic and social vulnerability,"[8] and includes social assistance ("publicly provided conditional or unconditional cash or in-kind transfers, or public works programmes"), social insurance (like welfare, unemployment benefits, household subsidies and child grants), and labour protection. A third of the population of the developing world (about 2.1 billion people) receive some form of social protection.[9]

However, digital ID programmes present several nuanced challenges.

India's digital ID project, the Unique Identification Authority of India (UIDAI, or Aadhaar), which has been underway since 2008, aims to provide every Indian resident with an ID number linked to their demographic and biometric data. Aadhaar is linked to welfare delivery and widely incorporated into India's social protection schemes. According to Masiero, Aadhaar's "nature as a requirement for social protection has led to concerns of social justice, due to the burden of authentication failure and importantly, to the confinement of social protection entitlements to those residents who 'chose' to enrol."[10] Controversially, an Aadhaar ID is only available to Indian residents who are registered in the National Register of Citizens (NRC) and not to refugees or stateless persons. There is a possibility that over 1.9 million people in the north Indian state of Assam could be excluded from the NRC, and thus from citizenship, Aadhaar ID, state services and social welfare.[11] The criteria for inclusion into the NRC are that an individual, or one of their ancestors, must have had their name on an electoral roll from before 1971.[12] Aaadhaar demonstrates that new ways of counting citizenry will intersect with structures of exclusion, possibly creating new layers of exclusion or amplifying existing ones.

Kenya's digital ID programme, Huduma Namba – which means "service number" in Swahili – is the popular name for the National Integrated Identity Management System (NIIMS). A bill proposed in August 2019 envisages the Huduma Namba system as having three components: a centralised database (or central electronic register), a unique identifier for each person, and a card to be carried for mandatory use in accessing services.[13] Unique identifiers include fingerprints, hand geometry, earlobe geometry, retina and iris patterns and voice waves.[14] DNA and GPS coordinates were originally meant to be collected too, although the collection of this data, together with the mandatory use of the card to access government services, have been temporarily halted by the High Court.[15]

Huduma Namba also has the potential to intersect with existing topologies of societal inclusion and exclusion, ethnic cleavages, and statelessness in Kenya. When governments link digital ID to determination of citizenship, it puts at risk populations who for historical reasons lack primary identification documents. For example, in Kenya, the Nubian, Shona and Makonde communities, which have historically lived in areas that became borders during colonialism, are subjected to long vetting processes before they can acquire identity documents.[16] Huduma Namba also captures ethnicity information which in light of Kenya's recent history concerns many Kenyans. While it does not feed into census data and national statistics, its roll-out was integrated into the recent Kenyan census, also in August 2019.

7 World Bank Group. (2018). *Identification for Development: 2018 Annual Report*. https://id4d.worldbank.org/sites/id4d.worldbank.org/files/2018_ID4D_Annual_Report.pdf

8 Food and Agriculture Organisation of the United Nations. (2015). *The State of Food and Agriculture. Social Protection and Agriculture: Breaking the Cycle of Rural Poverty*. www.fao.org/3/i4910e/I4910E.pdf

9 Ibid.

10 Masiero, S. (2019, 12 September). A new layer of exclusion? Assam, Aadhaar and the NRC. *South Asia @ LSE*. https://blogs.lse.ac.uk/southasia/2019/09/12/a-new-layer-of-exclusion-assam-aadhaar-and-the-nrc

11 Ibid.

12 Ibid.

13 https://www.hudumanamba.go.ke/wp-content/uploads/2019/07/12-07-2019-The-Huduma-Bill-2019-2-1.pdf

14 http://kenyalaw.org/kl/fileadmin/pdfdownloads/AmendmentActs/2018/StatuteLawMischellaneousN018of2018.pdf

15 Kakah, M. (2019, 2 April). High Court allows Huduma Namba listing but with conditions. *Daily Nation*. https://www.nation.co.ke/news/Huduma-Namba-Govt-barred-from-forced-listing/1056-5051788-t78f1xz/index.html

16 Kenya National Commission on Human Rights. (2007). *An Identity Crisis? A Study on the Issuance of National Identity Cards In Kenya*. https://www.knchr.org/Portals/0/EcosocReports/KNCHR%20Final%20IDs%20Report.pdf

Digital ID programmes in the global South also often involve international companies. India's Aadhaar is "the largest-scale public-private partnership currently underway in a developing country in terms of its coverage of the population."[17] Officially, Aadhaar is "a quasi-governmental organisation, attached to the national planning authority," but is effectively autonomous with little legal framework governing it, and with little parliamentary oversight. "Besides being non-governmental, UIDAI is also a collaboration between and amongst corporations," is managed and chaired by a co-founder of one of India's largest technology consulting companies, and "the day-to-day work of gathering, processing and storing data is done by private companies."[18]

As countries roll out biometric digital ID programmes, they produce massive amounts of data that may be useful to companies. However, the programmes are being rolled out in the developing world often without any regard for data protection,[19] in many countries with no data protection frameworks in place, and in other countries with weak new data protection regimes. For example, a bilateral agreement between Zimbabwe and China has resulted in the government of Zimbabwe sharing its national ID database with a Chinese company for use in training facial recognition software.[20]

Conclusion

Many of the same challenges that faced ICT for development will face AI4D. Connectivity, literacy, and the price of data remain constraints on the uptake of ICTs and on internet usage and will also be constraints on any benefits from AI.

Regulatory challenges are also important and on the horizon for AI4D. Biased data and the increasing amount of automated decisions that may work themselves into development processes and applications point towards important ethical issues, as well as the need for regulation. In the years and decades to come, a strong regulatory framework must be adopted by all nations to ensure readiness for the widespread use of AI for development.

Data protection regulation and capacity building for data protection enforcement will be very important, especially as so much of the AI in the developing world will be processing data that is possibly private and personally identifying information. The roll-out of digital ID could stimulate the uptake of state identification and ensure that everyone has an ID and access to state services and is equal before the law, and thus act as a stimulus for development. But it is important that digital ID and social protection is rolled out with consideration for privacy and data protection and where possible, after privacy and data protection frameworks are formalised. Data protection need not be a luxury that is considered second to development imperatives, and there need not be any tension perceived between privacy and data protection.

Strengthening the capacity for beneficial AI in the developing world will include strengthening communication between the institutions that house researchers who create AI solutions, and the political bodies able to leverage resources for deployment, with all parties working under a human rights framework. At the same time, as is always the case with development, care is needed to make sure that those most affected are included in the dialogue from the beginning and solutions are not simply being transferred from one nation to the other under the banner of "technological evangelicalism". Efforts are being made in this respect with the creation of the AI4D network[21] in Nairobi this year, and UNESCO's Forum on AI in Africa.[22]

Simultaneously, at the national level, capacity building is essential to get those most passionate about human development working in the space of AI for human development. Huge strides have been taken by the Deep Learning Indaba organisation.[23] This year the Indaba conference hosted 700 African technologists, researchers, innovators and learners in Nairobi with an additional 27 satellite events across the continent. By ensuring policy, people and capacity are in place, the opportunities available will no doubt transform human development and pave the way to a better future.

17 Taylor, L., & Broeders, D. (2015). Op. cit.

18 Ibid.

19 Sepúlveda, M. (2019, 16 April). Data Protection Is Social Protection. *Project Syndicate*. https://www.project-syndicate.org/commentary/social-protection-biometric-data-privacy-by-magdalena-sep-lveda-2019-04.

20 Chutel, L. (2018, 25 May). China is exporting facial recognition software to Africa, expanding its vast database. *Quartz Africa*. https://qz.com/africa/1287675/china-is-exporting-facial-recognition-to-africa-ensuring-ai-dominance-through-diversity

21 AI4D. (2019, 8 May). A roadmap for artificial intelligence for development in Africa. https://ai4d.ai/blog-africa-roadmap

22 https://en.unesco.org/sites/default/files/ai_outcome-statement_africa-forum_en.pdf

23 The Deep Learning Indaba is the annual gathering for the African AI community, with a mission to strengthen machine learning in Africa. www.deeplearningindaba.com