Carnegie Mellon University Africa
Certificate Program in AI and Machine Learning in Africa

Course AIML01: Artificial Intelligence – Past, Present, and Future

Module 4: Future Challenges
Lecture 3: Social and Ethical Aspects of AI

Welcome to Lecture 3 of Module 4 in which we will study some of the social and ethical aspects of AI. In Certificate II, we will study these matters more deeply in AIML07 Social, Ethical, Legal, and Economic Impact of AI & ML. For the moment, this lecture will give you an impression of the issues these aspects of AI focus on.

In this lecture, we will identify the many ways in which AI is having a positive impact in Africa. We will explain the phenomenon of premature deindustrialization and the problems this poses for African economies. We will identify the ethical imperatives necessary to avoid the potential negative impact of AI, including the need to eliminate bias of all types, including gender and racial bias, foster trust, safeguard privacy, guarantee confidentiality, and maximize explainability. We will introduce the concept of democratization of AI and the need for open access to AI technology. We will finish up by summarizing what we have covered and identifying the articles that you should read to consolidate what you have learned.

We have three learning objectives, so that, after studying the material covered in this lecture, you should be able to do the following.

1. Highlight and illustrate the relevance of the fourth industrial revolution and AI to developing countries, in general, and Africa, in particular.

2. Identify ways in which AI can have a negative impact on developing countries.

3. Identify ethical issues that arise in the deployment of AI.

Slide 1 Welcome to Lecture 3 of Module 4 in which we will study some of the social and ethical aspects of AI.

We will study these matters more deeply in AIML02 Social, Ethical, Legal, and Economic Impact of AI & ML.

For the moment, this lecture will give you an impression of the issues these aspects of AI focus on.

Slide 2 AI can benefit everyone.

However, the examples we have given so far focused on applications in the developed world.

Indeed, most of the national strategies on AI have been created by governments in developed countries.

Nevertheless, the fourth industrial revolution, in general, and AI, in particular, are just as relevant to developing countries.

Slide 3 Many African countries have tremendous opportunities to use AI

Slide 4 For example, AI is having an increasingly positive impact in Africa, in sectors such as energy, healthcare, agriculture, public services, and financial services.

Slide 5 It has the potential to drive economic growth, development, and democratization,

to reduce poverty

to improve education

to support health-care delivery

to increase food production

to improve the capacity of existing road infrastructure by increasing traffic flow

to improve public services, and

to improve the quality of life of people with disabilities.

Slide 6	Internet-of-things applications can improve yields on tea plantations
Slide 7	and drones are transforming Africa's agriculture
Slide 8	along with satellite images and AI
Slide 9	The Microsoft Farmbeats platform integrates AI, edge computing, and drones to enable greater productivity.
Slide 10	Zipline drones deliver blood packs
Slide 11	across Rwanda.
Slide 12	In only a few minutes, the required blood.
Slide 13	can be selected.
Slide 14	packed
Slide 15	and loaded onto the drone.
Slide 16	The drone is then prepared for take-off
Slide 17	and launched.
Slide 18	When it reaches its destination, the drone releases its payload
Slide 19	which drops accurately
Slide 20	to the target location
Slide 21	and is picked up by staff at the clinic.

Here is a video of a drop in rural Rwanda.

Slide 22 [play video]

Slide 23 Robots

Slide 24 inspect pipelines for damage.

Slide 25 This application analyses the sound of a baby's cry to trigger warnings of possible sickness or injury.

Slide 26 And it uses AI

Slide 27 to save the lives of babies.

Slide 28 Other AI applications provide advisory notices to farmers

Slide 29 to improve food production

Slide 30 even on small holder farms

Slide 31 potentially supporting millions of farmers

Slide 32 In education, robotics helps

Slide 33 children engage with STEM subjects and prepare them for a bright future, powered by AI.

Slide 34 Paradoxically, the deployment of AI in developed countries can have a severe negative impact on developing countries due to the phenomenon known as premature deindustrialization.

This sees low-wage developing countries having fewer opportunities for industrialization before achieving income levels comparable to those in developed countries.

Developing countries lose their competitive advantage in manufacturing

due to the lower cost automation in developed countries

and, therefore, miss out on the economic benefits that developed countries enjoyed

as their workforces moved from low-value work to manufacturing,
before progressing to a post-industrial service economy.

Slide 35 Consequently, developing countries are increasingly likely not to have the opportunity for rapid economic growth by shifting workers from farms to factory jobs

Because automation undermines the labor cost advantage and developments in robotics

and additive manufacturing allow companies in advanced economies to locate production closer to domestic markets in automated factories,

allowing this work to be moved closer to home in the developed countries.

Slide 36 AI can have a negative impact, either intentionally or unintentionally, in many other ways, if certain ethical imperatives are not embraced.

For example, by fomenting religious, ethnic, social, and political divisions through fake misinformation created by deep networks.

These ethical imperatives are to

Eliminate bias of all types, including gender and racial bias
Ensure fairness
Safeguard privacy
Guarantee confidentiality
Maximize transparency

Slide 37 Of particular concern is the issue of implicit and explicit bias in the data that are used to train the AI models, thereby resulting in discrimination against people on the basis of gender or race.

Examples of bias against dark-skinned people include

- face analysis
- pedestrian detection
- and predicting recidivism, that is, the tendency of a convicted criminal to reoffend

The next course, AIML02 Social, Ethical, Legal, and Economic Impact of AI & ML, covers these issues in more detail.

Slide 38 There is also the issue of democratization in AI, i.e., open access to AI technology by developers everywhere, in both developing and developed countries.

Training deep neural networks requires access to very powerful, expensive, computational resources which may be out of reach of some.

Training also requires very large data sets, and these may not be available.

Slide 39 For example, in efforts to use machine learning to make the web available in local African languages

progress is being inhibited for so-called “low- resourced” languages,

That is, languages for which few digital or computational data resources exist

because of the lack of sufficient training data.

This is a problem that is endemic to almost all applications of machine learning in developing countries: the lack of data.

To summarize:

1. AI has the potential to improve significantly the lives of people in Africa

2. AI can be applied in many different sectors, from agriculture, to education, to healthcare

3. The adoption of AI in developed countries can make it difficult (but not impossible) for developing countries to make the transition to an industrialized economy

4. We need to be aware of the dangers of inappropriate use of AI, for example to generate fake misinformation

5. We need to ensure that the training sets for machine learning do not have any bias, such as racial bias or gender bias

As we mentioned at the beginning, we will study these matters more deeply in Certificate II in AIML07 Social, Ethical, Legal, and Economic Impact of AI & ML.

Recommended Reading
Here is some recommended reading.

Bassereau, P., Cangelosi, A., Cejkova, J., Gershenson, C., Goldstein, R., Martins, Z., Matthews, S., Ritort, F., Seager, S., Van Tiggelen, B., Vernon, D., and Westall, F., (2024) Chapter 4 Physics for Understanding Life, **Section 4.3 Artificial Intelligence: Powering the Fourth Industrial Revolution**, EPS Grand Challenges: Physics for Society at the Horizon 2050, IOP Publishing.
http://vernon.eu/publications/2024_Bassereau_et_al.pdf

Delmus Alupo, C., Omeiza, D., and Vernon, D. (2022) "Realizing the Potential of AI in Africa – It All Turns on Trust", in *Towards Trustworthy Artificial Intelligence Systems*, M. I. Aldinhas Ferreira, O. Tokhi (Eds.), Intelligent Systems, Control and Automation: Science and Engineering. Springer.
http://vernon.eu/publications/2022_Delmus_Alupo_et_al.pdf

Vernon D (2019) "Robotics and Artificial Intelligence in Africa", IEEE Robotics & Automation Magazine, Vol. 26, No. 4, pp. 131-135, December.
http://vernon.eu/publications/2019_Vernon_RAM.pdf

References
Here are the references cited to support the main points in what we covered today.

Access Partnership (2018) Artificial intelligence for Africa: an opportunity for growth, development, and democratization. White paper, University of Pretoria.
https://doi.org/10.1162/99608f92.f06c6e61

Besaw C, Filitz J (2019) AI & global governance: AI in Africa is a double-edged sword. Tech. Rep., United Nations University. https://cpr.unu.edu/ai-in-africa-is-a- doubleedged-sword.html

Buolamwini, J., & Gebru, T. (2018). Gender shades: Intersectional accuracy disparities in commercial gender classification. In Conference on fairness, accountability and transparency (pp. 77-91). Proceedings of Machine Learning Research 81:1–15. https://proceedings.mlr.press/v81/buolamwini18a/buolamwini18a.pdf

Larson J, Mattu S, Kirchner L, Angwin J (2016) How we analyzed the COMPAS recidivism algorithm. ProPublica (5 2016) 9(1). https://www.propublica.org/article/how-we-analyzed-the-compas-recidivism-algorithm

Nekoto W, Marivate V, Matsila T, Fasubaa T, Fagbohungbe T, Akinola SO, Muhammad S, Kabongo Kabenamualu S, Osei S, Sackey F, Niyongabo RA, Macharm R, Ogayo P, Ahia O, Berhe MM, Adeyemi M, Mokgesi-Selinga M, Okegbemi L, Martinus L, Tajudeen K, Degila K, Ogueji K, Siminyu K, Kreutzer J, Webster J, Ali JT, Abbott J, Orife I, Ezeani I, Dangana IA, Kamper H, Elsahar H, Duru G, Kioko G, Espoir M, van Biljon E, Whitenack D, Onyefuluchi C, Emezue CC, Dossou BFP, Sibanda B, Bassey B, Olabiyi A, Ramkilowan A, Oktem A, Akinfaderin A, Bashir A (2020) Participatory research for low-resourced machine translation: A case study in African languages. In: Findings of the Association for Computational Linguistics: EMNLP 2020, Association for Computational Linguistics, pp 2144–2160. https://aclanthology.org/2020.findings-emnlp.195.pdf

Novitske L (2018) The AI invasion is coming to Africa (and it's a good thing). Stanford Social Innovation Review https://ssir.org/articles/entry/the_ai_invasion_is_coming_to_africa_and_its_a_good_thing#

OECDAI (2021) National AI Policies & Strategies. https://oecd.ai/dashboards

Rodrik D (2016) Premature deindustrialization. Journal of Economic Growth 21(1):1–33 http://drodrik.scholar.harvard.edu/files/dani-rodrik/files/premature_deindustrialization.pdf

UNCTAD (2016) Robots and industrialization in developing countries. Tech. Rep. United Nations Conference on Trade and Development (UNCTAD). https://unctad.org/en/PublicationsLibrary/presspb2016d6_en.pdf

Wilson B, Hoffman J, Morgenstern J (2019) Predictive inequity in object detection. arXiv preprint arXiv:190211097 https://arxiv.org/pdf/1902.11097.pdf