Certificate I: Understanding AI and Machine Learning in Africa

Course AIML02: AI and Machine Learning in Africa

Module 1: The Potential of AI and Machine Learning in Africa

Lecture 1: Realizing the Potential of AI in Africa

Carnegie Mellon University
Africa

Course Overview

Module 1: The Potential of AI and Machine Learning in Africa.

Lecture 1: Realizing the Potential of AI in Africa (Delmus Alupo et al., 2022)

Lecture 2: Computational Sustainability and Artificial Intelligence in the Developing World (Quinn et al., 2014)

Course Overview

Module 2: Application Case Studies.

Lecture 1: Healthcare (Onu et al., 2017; Onu et al., 2019)

Lecture 2: Logistics (Ackerman and Koziol, 2019)

Lecture 3: Agriculture (Quinn, 2013)

Lecture 4: E-Commerce (Uwizera et al., 2020)

Lecture 5: Socioeconomics (Yeh et al., 2020)

Lecture 6: Conservation (Xu et al., 2020)

Course Overview

Module 3: AI Business Strategy.

Lecture 1: Artificial Intelligence for the Real World (Davenport and Ronanki, 2019)

Lecture 2: How to Choose Your First AI Project (Ng, 2019)

Lecture 3: Collaborative Intelligence: Humas and AI Are Joining Forces (Wilson and Daugherty, 2019)

Lecture 4: The Future of AI Will Be About Less Data, Not More (Wilson, Daugherty, and Davenport, 2019)

Course Overview

Module 4: Deployment of AI and Machine Learning in Africa.

Lecture 1: Machine learning for the developing world (De-Arteaga et al., 2018)

Lecture 2: AI deployment in Africa: benefits, challenges, and policy dimensions (Gwagwa et al., 2020)

Learning Objectives

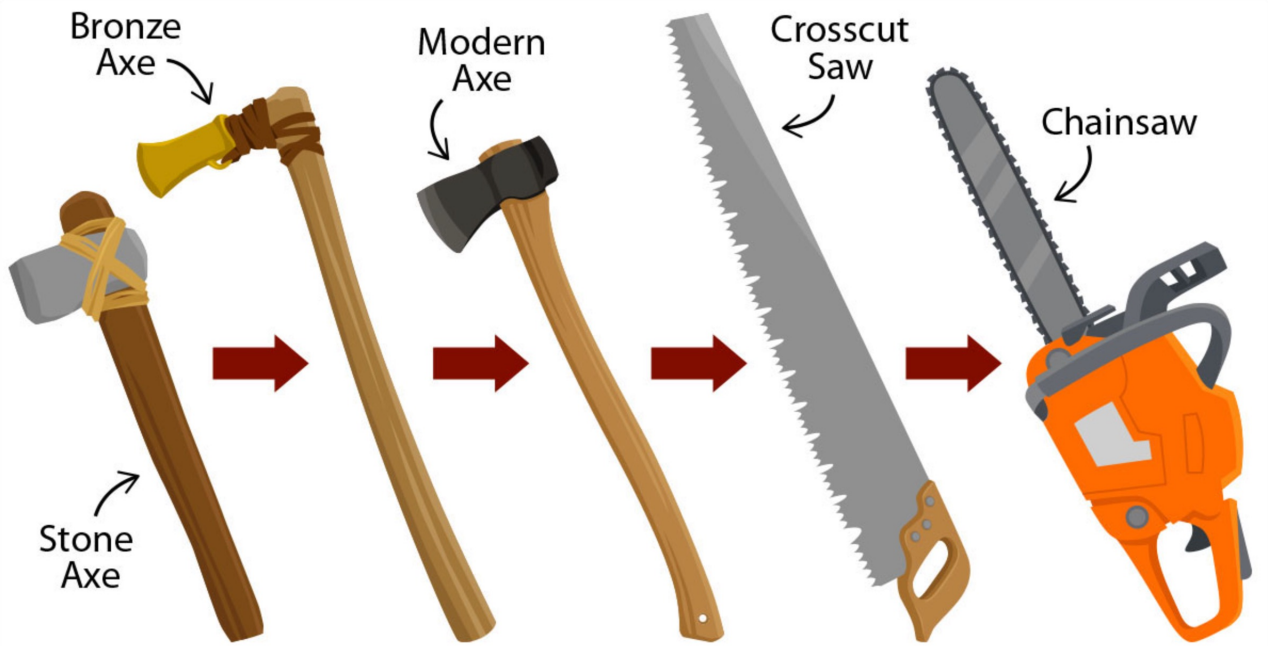
1. Explain how AI amplifies and extends human cognitive abilities
2. Explain why AI forms the foundation of the Fourth Industrial Revolution
3. Explain why the benefits of AI depend on innovation, and hence on adoption and trust
4. Identify several examples of the use of AI and machine learning in Africa

Lecture Contents

1. Licklider's prediction: the Cognitive Era
2. Fourth Industrial Revolution
3. Adoption and trust
4. Examples of AI in Africa
5. Lecture summary
6. Recommended reading & references

Licklider's Prediction and the Cognitive Era

Humans have always used tools to augment & amplify their physical capabilities



http://devichedesigns.com/work/tool-evolution

Licklider's Prediction and the Cognitive Era

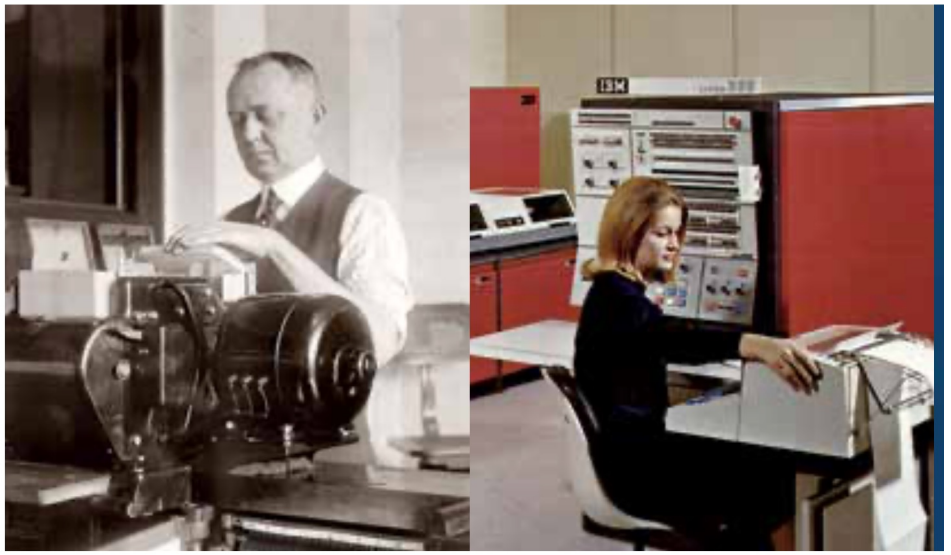
Humans have always used tools to augment & amplify their physical capabilities

https://oneacrefund.org/what-we-do/countries-we-serve/rwanda/

Photo by Sam Ngendahimana
https://www.newtimes.co.rw/news/roads-authority-under-fire-overpaying-maintenance-contractor

Licklider's Prediction and the Cognitive Era

The computer extended this to mental work …



Mainly as a tool for greatly increasing the speed of processing

The Tabulating Era
(1900s – 1940s)

The Programming Era
(1950s – present)

(Kelly, 2015)

Licklider's Prediction and the Cognitive Era

The computer extended this to mental work ...

The Tabulating Era
(1900s – 1940s)

The Programming Era
(1950s – present)

The Cognitive Era
(2011 –)

(Kelly, 2015)

Licklider's Prediction and the Cognitive Era

Cooperative "living together in intimate association, or even close union, of two dissimilar organisms"

"Man-computer symbiosis is an expected development in cooperative interaction between men and electronic computers."

(Licklider, 1960)

Unfortunately, there was little sensitivity to gender bias in 1960

wikipedia.org/wiki/J._C._R._Licklider

Licklider's Prediction and the Cognitive Era

"... the symbiotic partnership will perform intellectual operations much more effectively than man alone can perform them"

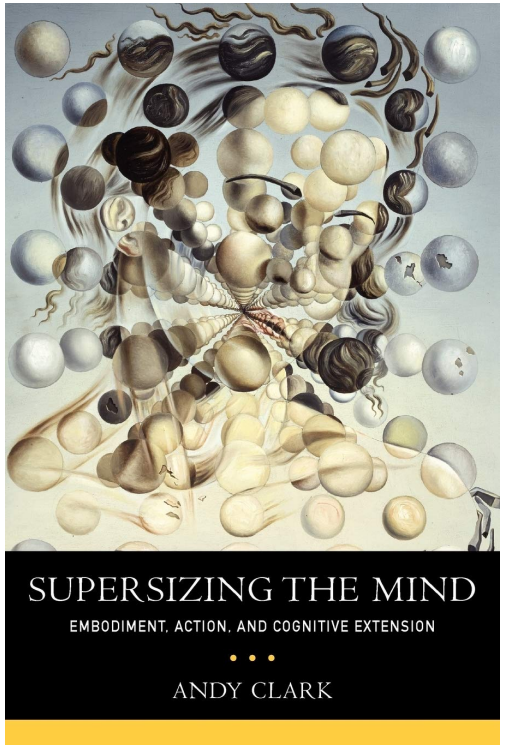
(Licklider 1960)

Licklider's Prediction and the Cognitive Era

- This symbiotic partnership is being realized today through artificial intelligence (AI)
- AI both amplifies and augments human cognitive abilities

With AI, we do what we used to do, but more quickly, more efficiently, and more effectively

With AI, we can also solve problems we weren't able to solve before



https://www.amazon.ca/Supersizing-Mind-Embodiment-Cognitive-Extension/dp/0199773688

The Fourth Industrial Revolution

AI forms the foundation of the Fourth Industrial Revolution

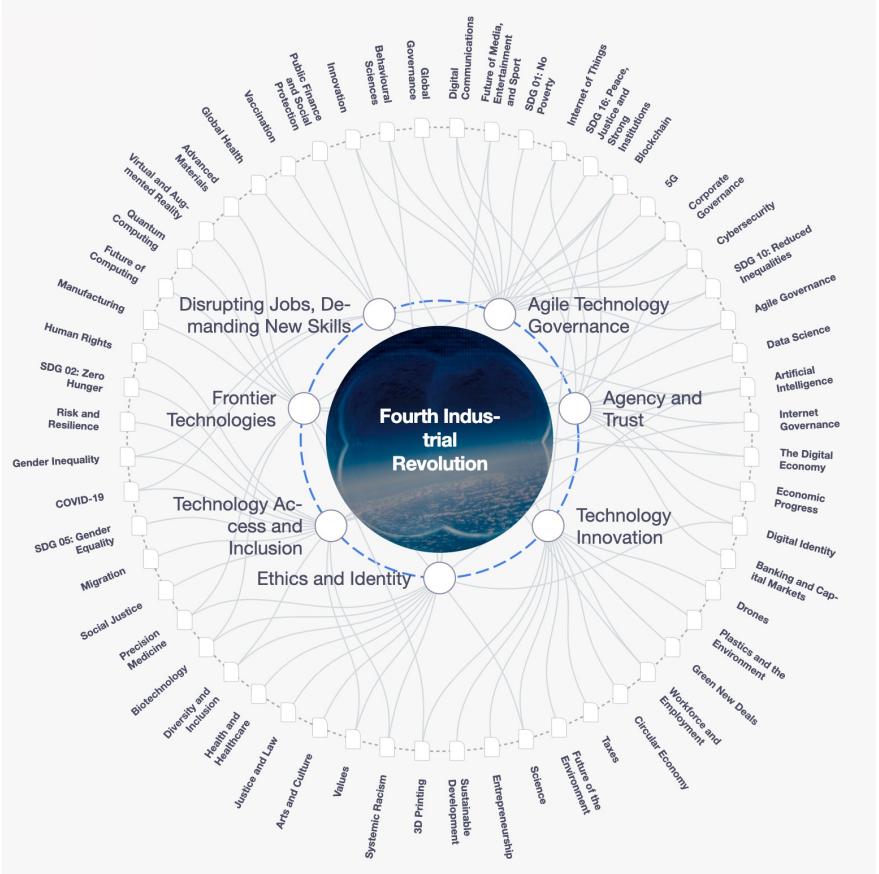
- The fusion of physical, digital, and biological technologies in cyber-physical systems
- Powered by AI and machine learning
- Enabled by ubiquitous communication and near-universal access to information
- Also known as 4IR and Industry 4.0

The Fourth Industrial Revolution

"The Fourth Industrial Revolution represents a fundamental change in the ways that we live and work

It is a new chapter in human development, ... merging the physical, digital, and biological worlds and fusing technologies in ways that create both promise and peril"

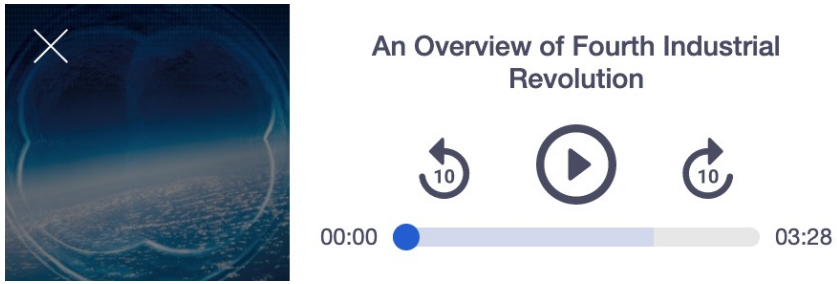
World Economic Forum, 2022



https://intelligence.weforum.org/topics/a1Gb0000001RIhBEAW?tab=publications

The Fourth Industrial Revolution

The fourth industrial revolution is irreversibly altering how humans live, work, and relate to one another



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Centre for the Fourth Industrial Revolution

C4IR Rwanda

The Centre for the Fourth Industrial Revolution Rwanda (C4IR Rwanda) brings together government, industry, civil society, and academia to co-design, test and refine policy frameworks and governance protocols that maximize the benefits and minimize the risks of 4IR technologies. The Centre is primarily focusing on artificial intelligence and data policy, and seeks to develop multi-stakeholder partnerships to drive innovation and adoption at scale for the benefit of society.

https://www.weforum.org/centre-for-the-fourth-industrial-revolution/c4ir-rwanda

C4IR South Africa

The Centre for the Fourth Industrial Revolution South Africa (C4IR South Africa) supports industry transformation across various sectors, supports government transformation to maintain robust and resilient technology governance protocols and develops and deploys frameworks to support awareness and development of frontier technologies.

https://www.weforum.org/centre-for-the-fourth-industrial-revolution/c4ir-south-africa

The Fourth Industrial Revolution

The challenge is to harness AI within an ethical framework

- that achieves economic benefits and
- social development

for everyone, everywhere

"in ways that create a more inclusive, human-centred global economy."

https://intelligence.weforum.org/topics/a1Gb0000001RIhBEAW?tab=publications

The Fourth Industrial Revolution

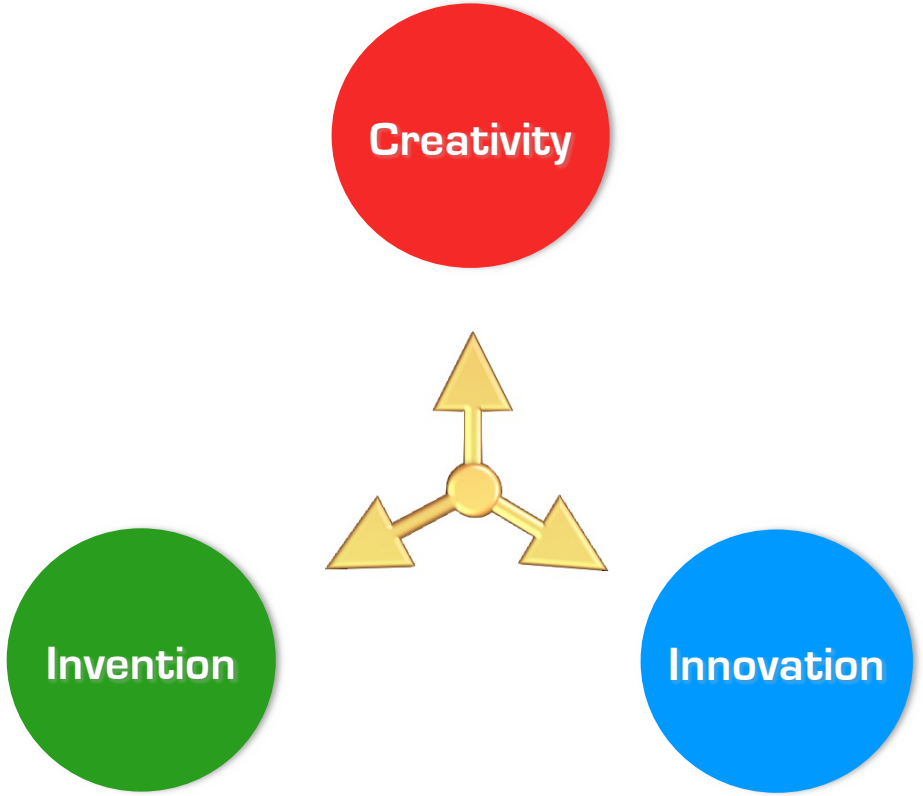
REPORT

The Fourth Industrial Revolution and digitization will transform Africa into a global powerhouse

Njuguna Ndung'u and **Landry Signé** · Wednesday, January 8, 2020

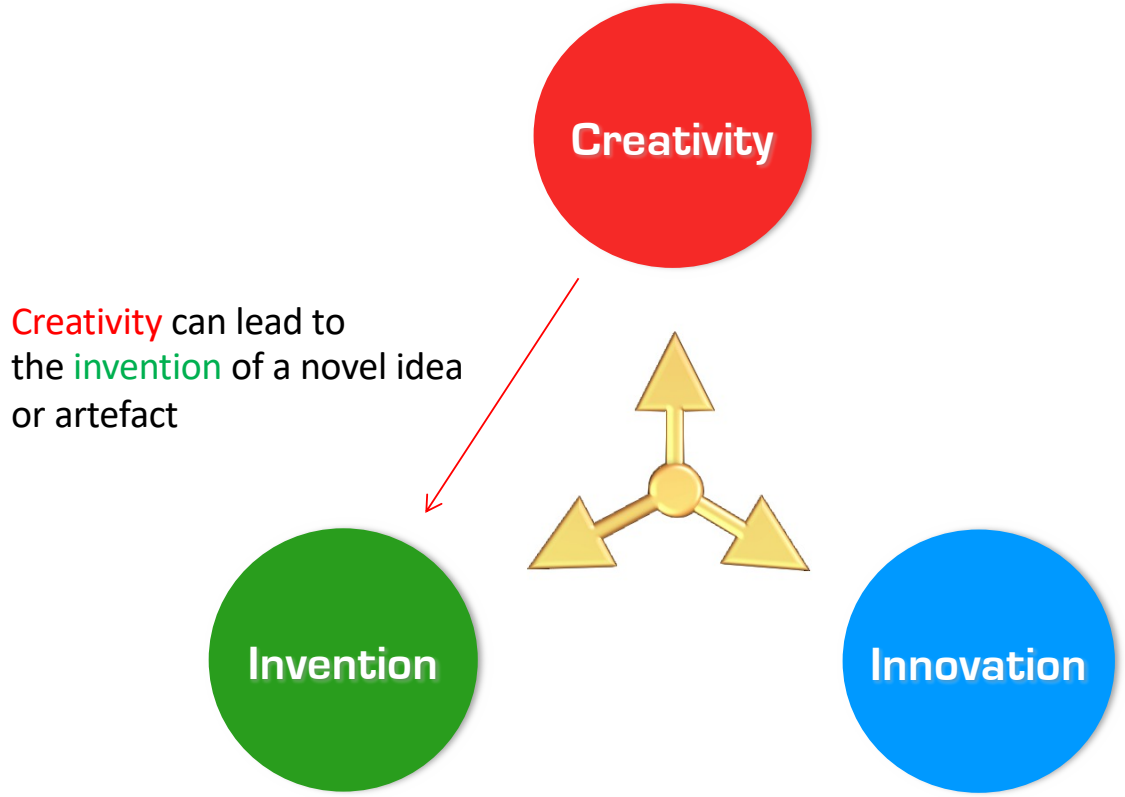
https://www.brookings.edu/research/the-fourth-industrial-revolution-and-digitization-will-transform-africa-into-a-global-powerhouse/

The Benefits of AI Depend on Adoption and Trust

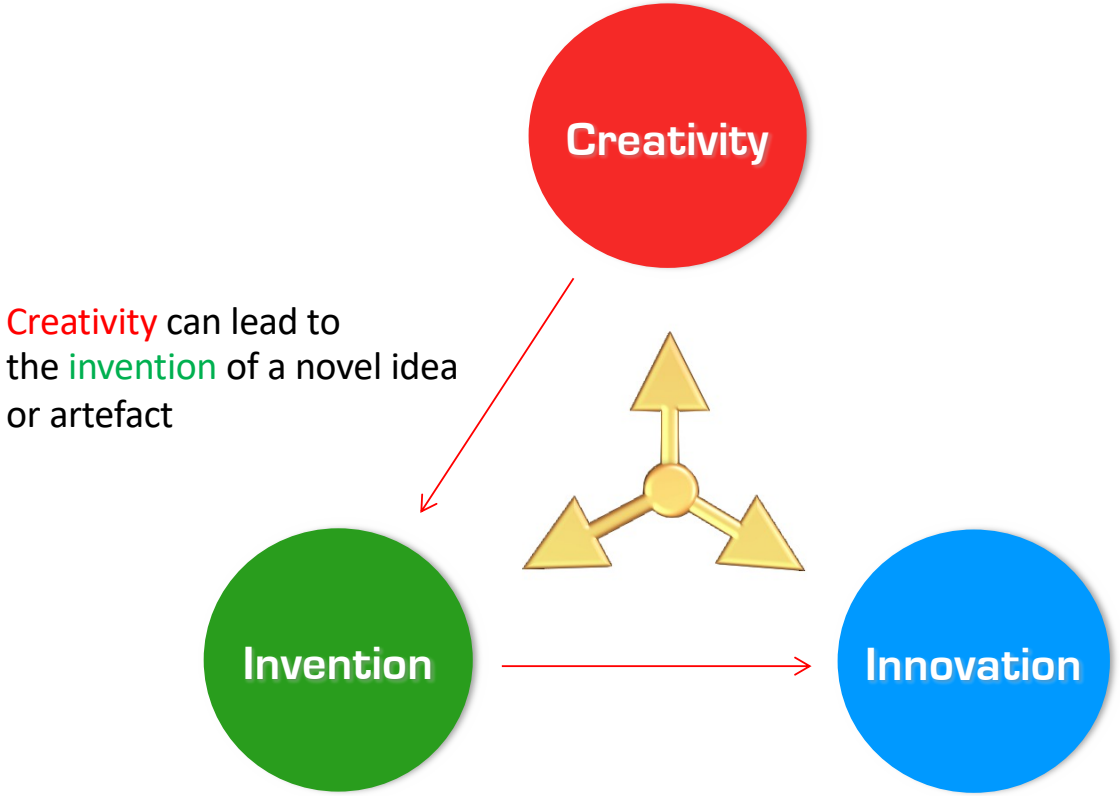


(Rose, 2010)

The Benefits of AI Depend on Adoption and Trust



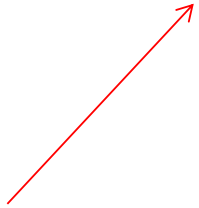
The Benefits of AI Depend on Adoption and Trust



Innovation brings creativity & inventions into wider use:
the diffusion of that invention and its widespread adoption, leading to substantial social change in the practices of a community of people

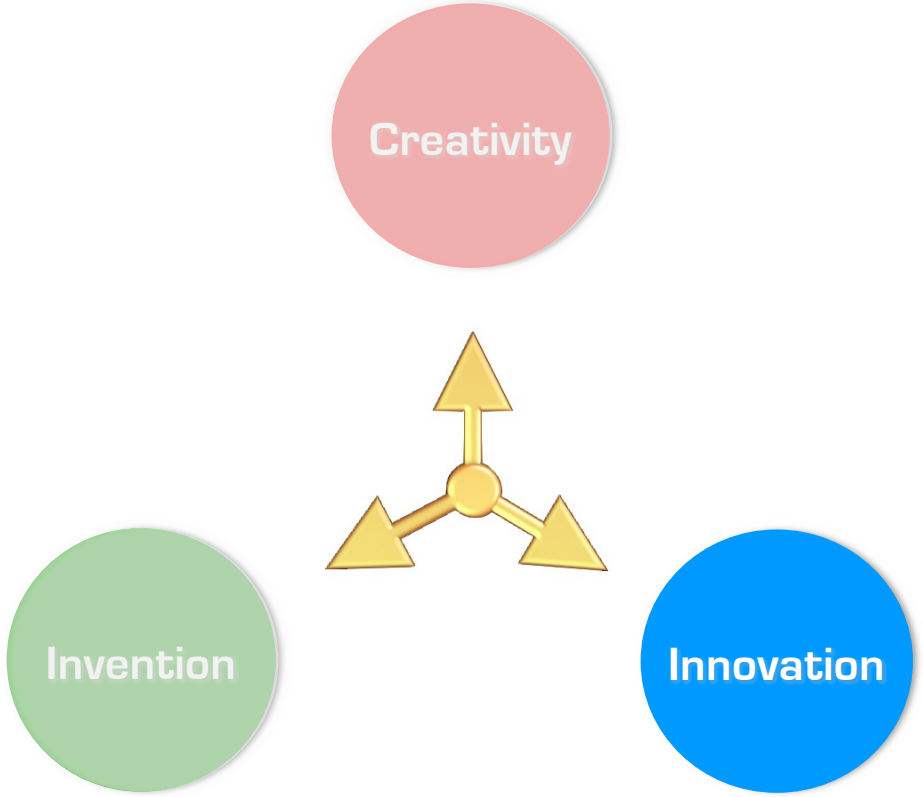
The Benefits of AI Depend on Adoption and Trust

Innovation = Invention + Exploitation + Diffusion



Commercially developed & exploited,
adopted in a wider community of users

The Benefits of AI Depend on Adoption and Trust



Innovation also depends on infrastructure (an unnoticed precondition for technology innovation)

1. Physical infrastructure

   Availability of electrical power, communications networks, or internet connectivity

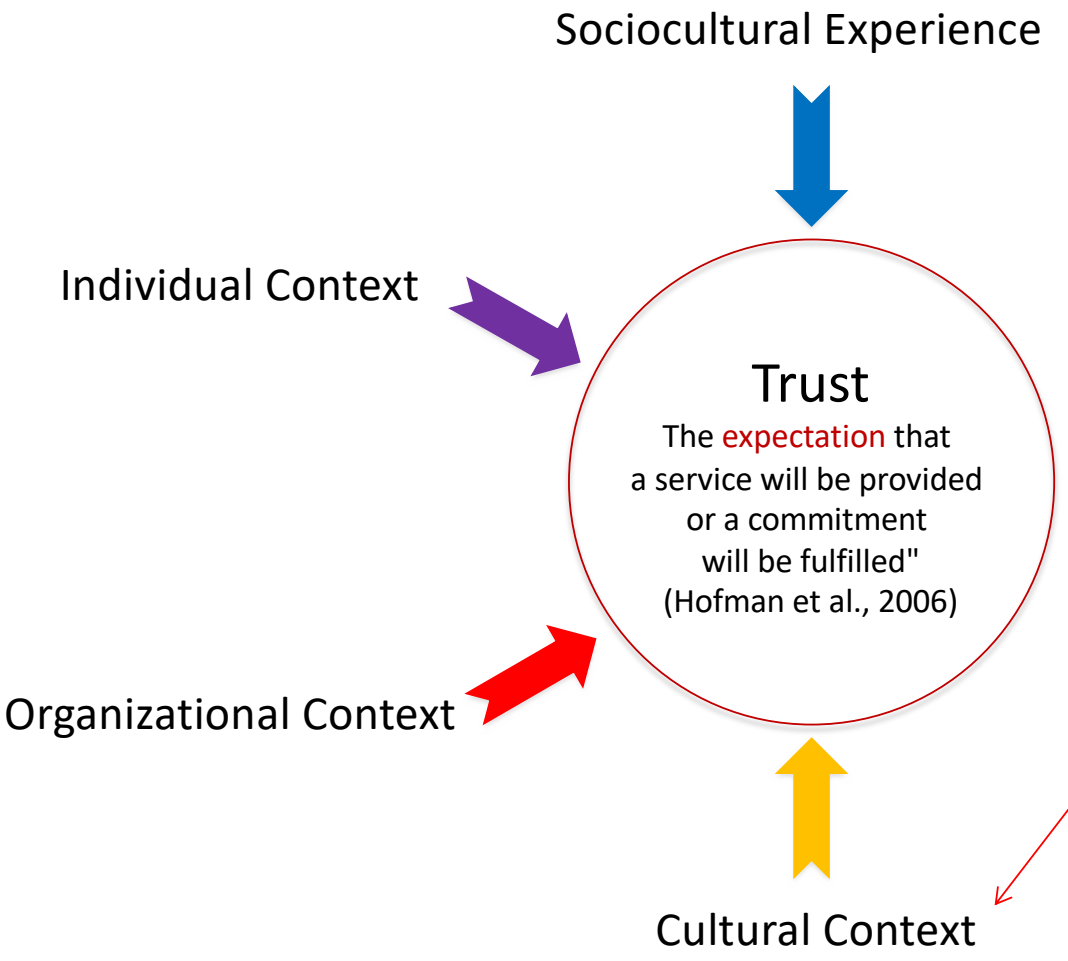
2. Social infrastructure

   Social conventions:
   - What's acceptable & not acceptable
   - What is **trustworthy**

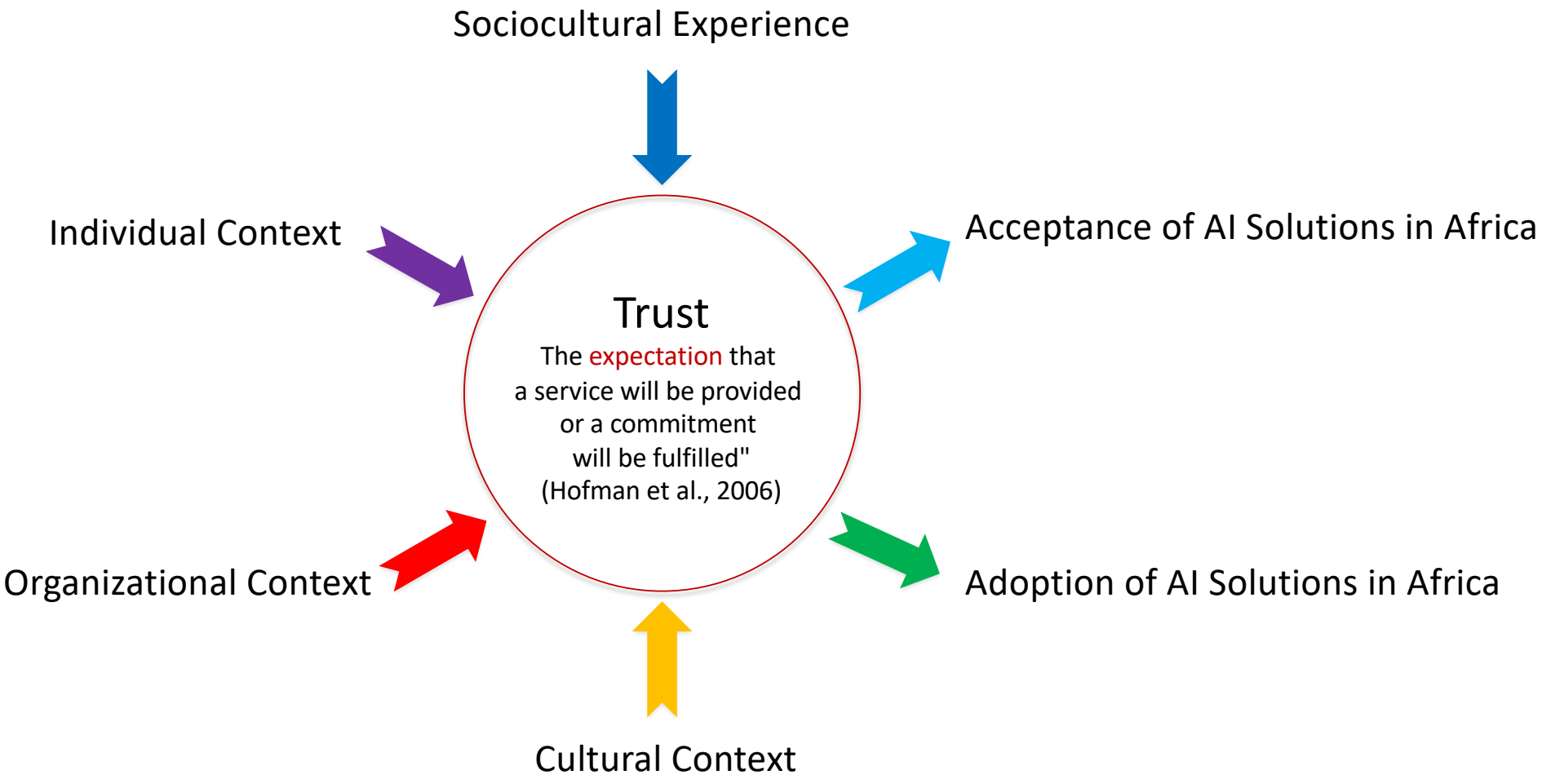
   These have a major impact on adoption

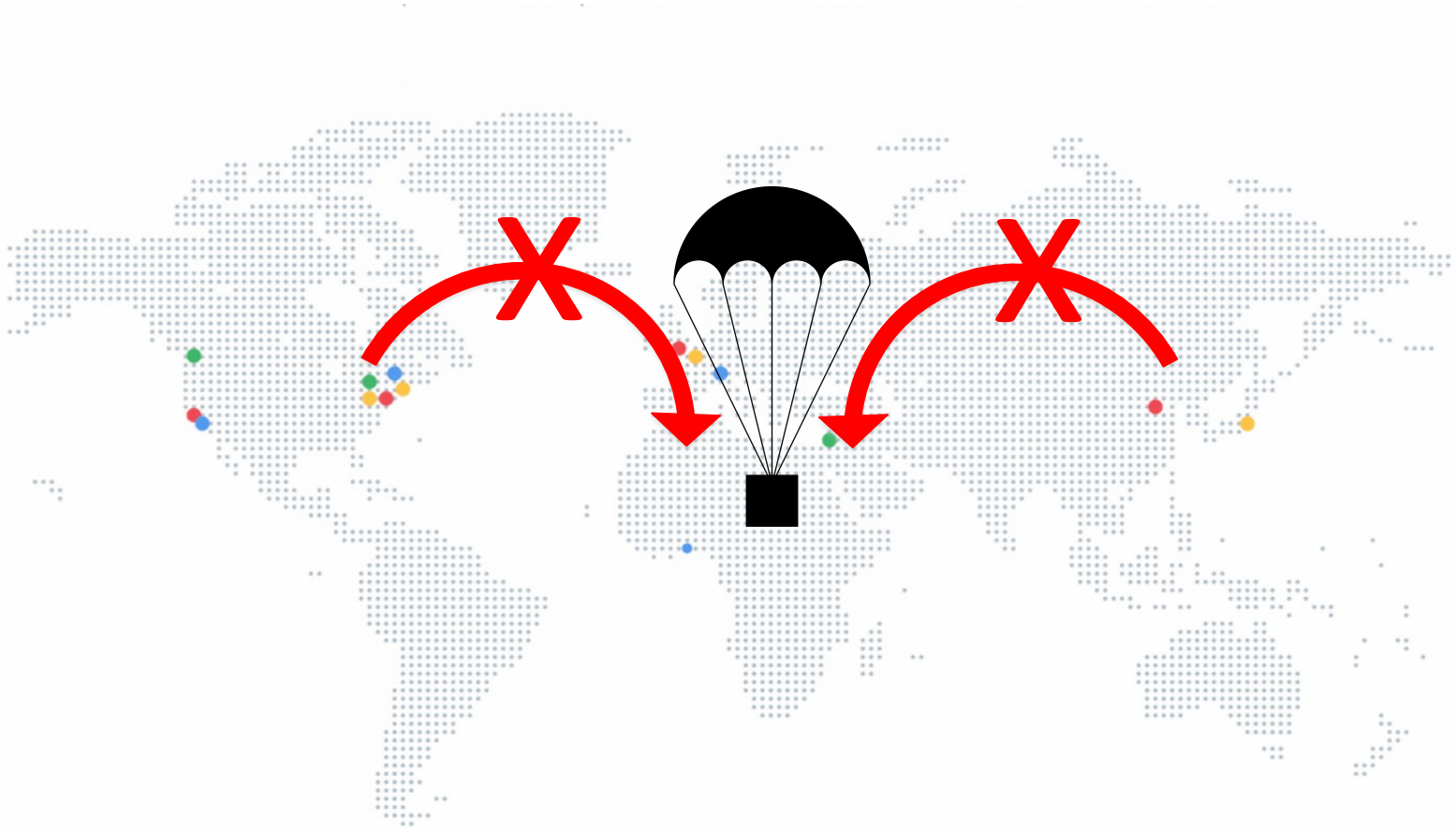

Trust
The expectation that
a service will be provided
or a commitment
will be fulfilled"
(Hofman et al., 2006)

Sociocultural Experience



Culture is “a set of social norms and expectations that reflect shared educational and life experiences associated with national differences or distinct cohorts of workers”
(Lee and See, 2004)


Sociocultural Experience
Individual Context
Acceptance of AI Solutions in Africa
Trust
The expectation that
a service will be provided
or a commitment
will be fulfilled"
(Hofman et al., 2006)
Organizational Context
Adoption of AI Solutions in Africa
Cultural Context



https://www.blog.google/around-the-globe/google-africa/google-ai-ghana/

https://www.kindpng.com/imgv/iiJhmwR_big-image-png-parachute-clipart-transparent-png/#gal_big-image-png-parachute-clipart-transparent-png_iiJhmwR_1805273.png

We need an "African innovation market where new ICT solutions that are adapted to Africa's environment and needs will be developed by Africans for Africa"

(Bézy, 2021)

WORLD VIEW · 23 OCTOBER 2018

Look to Africa to advance artificial intelligence

If AI is to improve lives and reduce inequalities, we must build expertise beyond the present-day centres of innovation, says Moustapha Cisse.

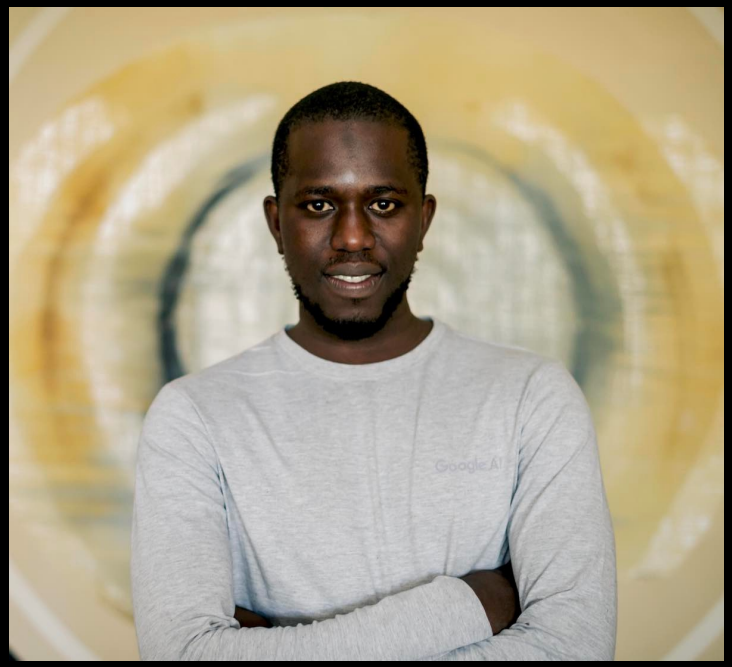
Moustapha Cisse ✉

Moustapha Cisse is head and co-founder of the Google AI Research Lab in Accra, Ghana, and professor of machine learning at the African Institute of Mathematical Sciences.

✉ Contact

Nature 562, 461 (2018)
https://www.nature.com/articles/d41586-018-07104-7

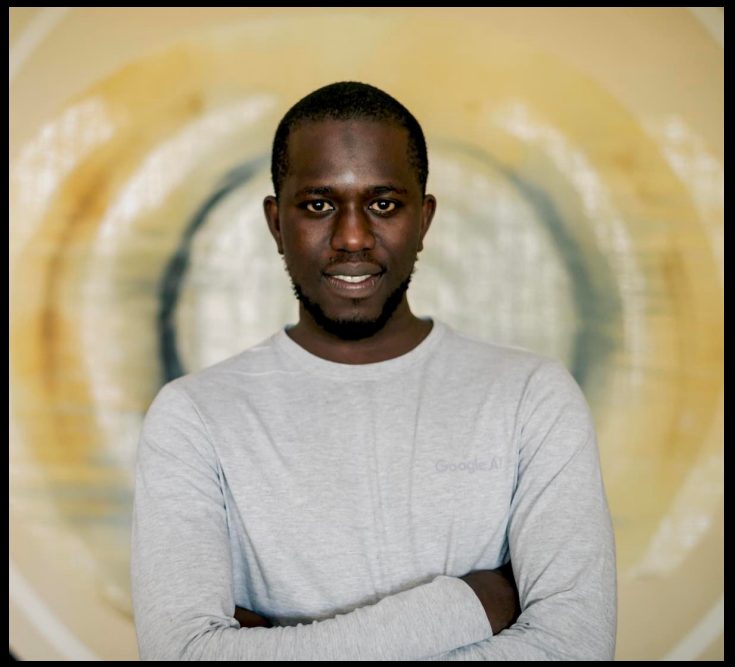
"AI ... offers a unique chance to improve lives
without opening up and exacerbating global inequalities."



Moustapha Cissé

Head of the Google AI Center in Accra, Ghana

"That will require widening of the locations where AI is done."

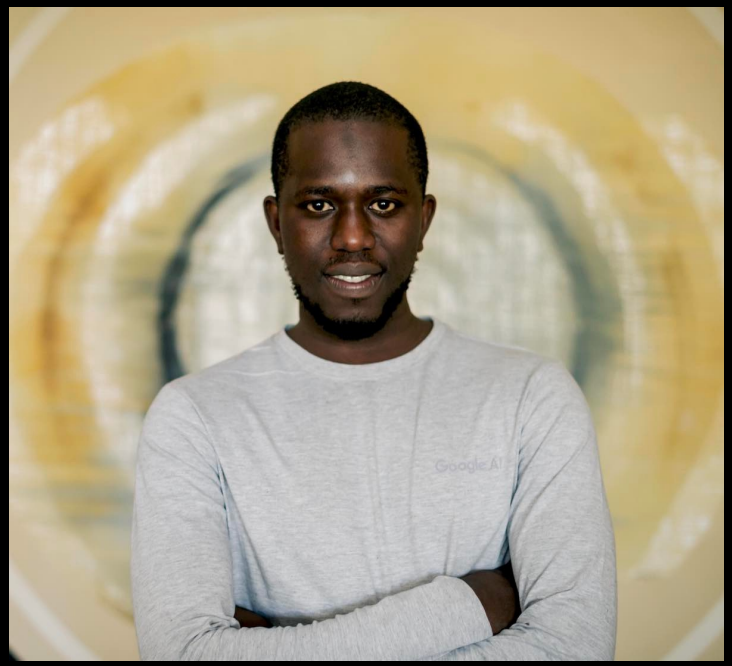


Moustapha Cissé

Head of the Google AI Center in Accra, Ghana

"The vast majority of experts are in North America, Europe and Asia.

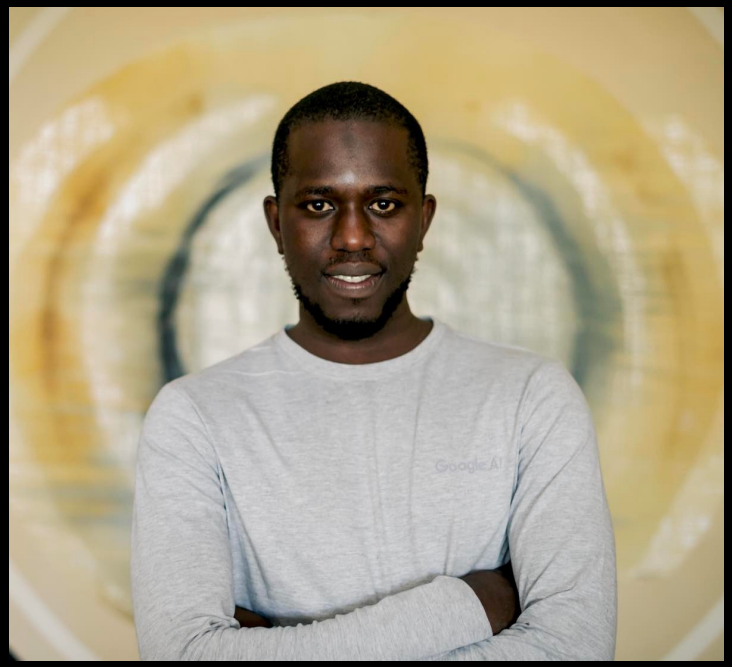
Africa, in particular, is barely represented."



Moustapha Cissé

Head of the Google AI Center in Accra, Ghana

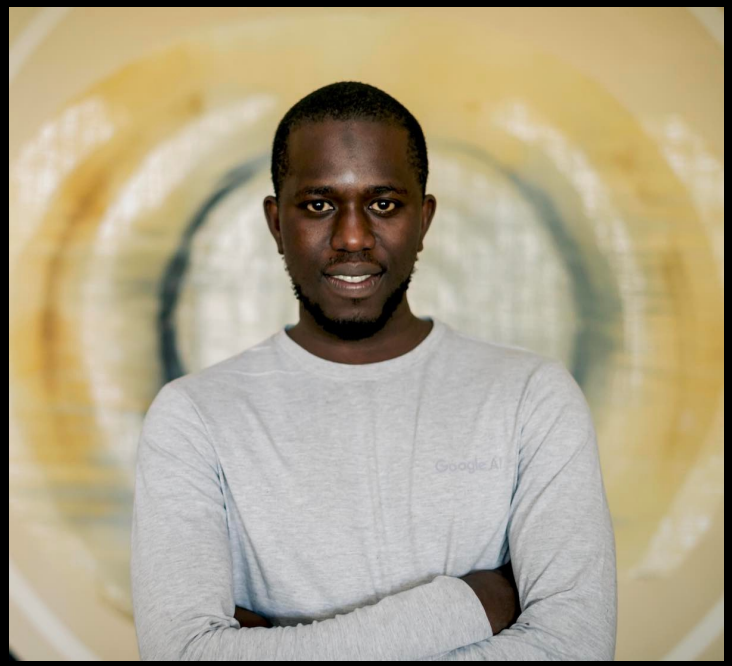
"Such lack of diversity can entrench unintended algorithmic biases and build discrimination into AI products."



Moustapha Cissé

Head of the Google AI Center in Accra, Ghana

"Fewer African AI researchers and engineers means fewer opportunities to use AI to improve the lives of Africans."



Moustapha Cissé

Head of the Google AI Center in Accra, Ghana

This is changing ... fast

Why?

Because of the accelerating rate of education

And because you are here, taking this course

Examples of AI and Machine Learning in Africa

Let's finish up with brief previews of the six case studies in Module 2.

These are good examples of AI and machine learning in Africa, each drawn from a different sector.

Healthcare (Onu et al., 2017, Onu et al., 2019)

Logistics (Ackerman and Koziol, 2019)

Agriculture (Quinn, 2013)

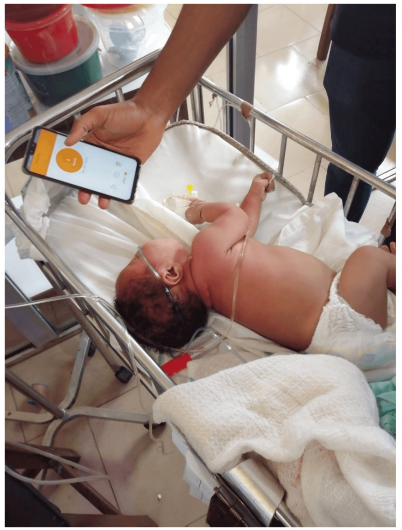
E-Commerce (Uwizera et al., 2020)

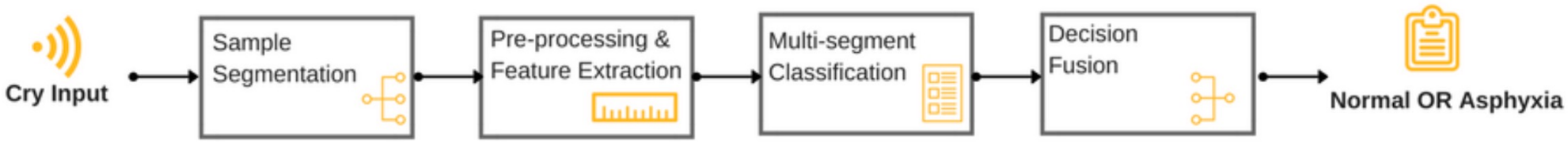
Socioeconomics (Yeh et al., 2020)

Conservation (Xu et al., 2020)

Healthcare Case Study

See Lecture AIML02-02-01

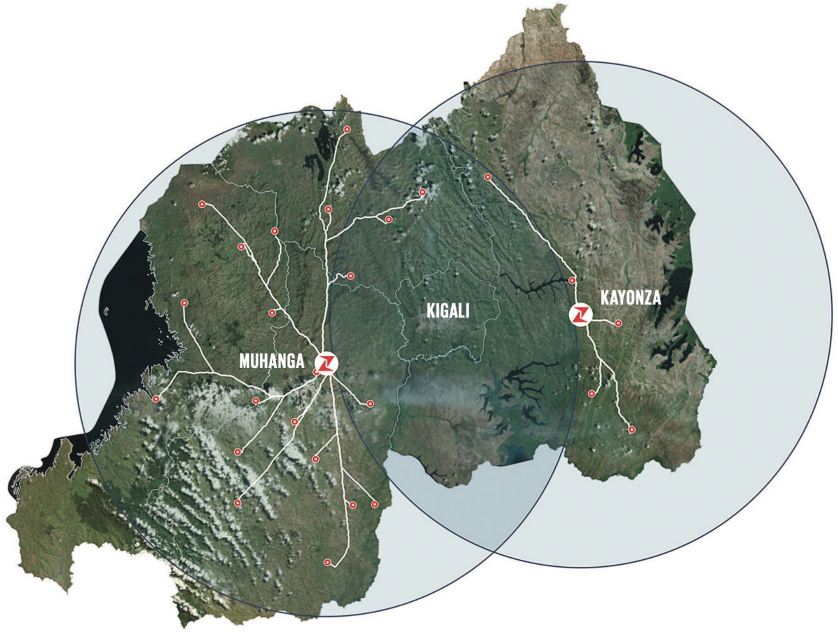




Ubenwa: Cry-based Diagnosis of Birth Asphyxia
(Ona et al., 2017; Ona et al., 2019)

Logistics Case Study

See Lecture AIML02-02-02



COVERING A COUNTRY: Zipline's drones can fly to hospitals up to 80 kilometers away along predetermined routes, allowing two distribution sites to cover nearly all of Rwanda.

The Blood is Here
(Ackerman and Koziol, 2019)

Agriculture Case Study

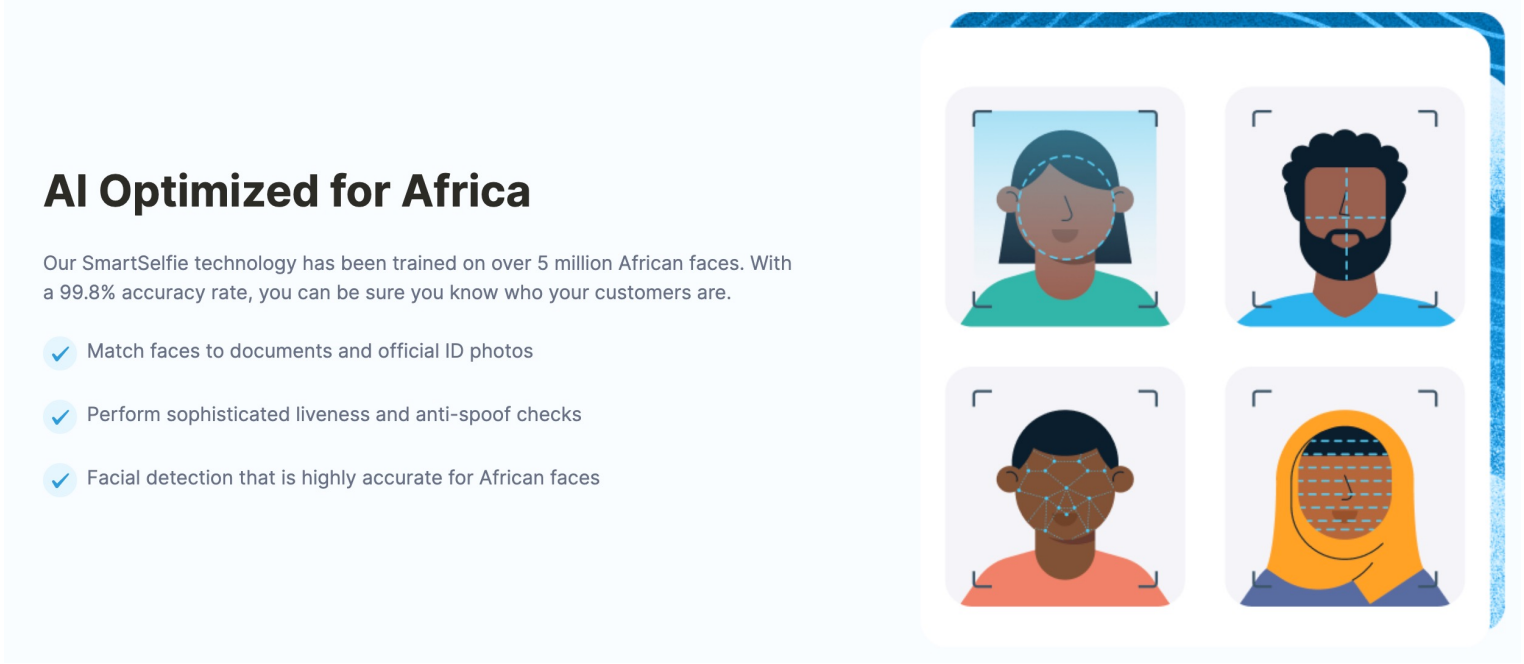
See Lecture AIML02-02-03

Fig. 3. Phone based survey with automated diagnosis. Left: mobile-phone based survey of cassava field; center: software on the phone detects cassava mosaic disease from leaf appearance; right: data collected with the phone is instantly uploaded to the web.

Computational Techniques for Crop Disease Monitoring in the Developing World (Quinn, 2013)

E-Commerce Case Study

See Lecture AIML02-02-04

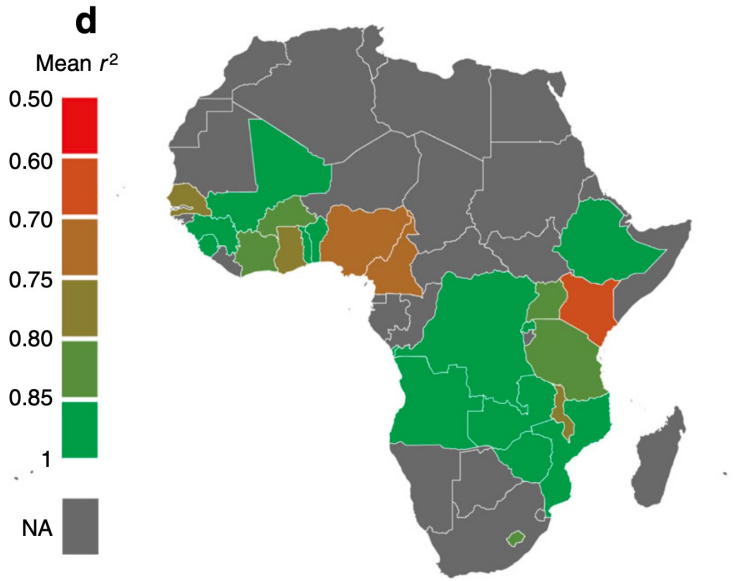


www.smileidentity.com

Data Centric Face Recognition for African Face Authentication (Uwizera et al., 2020)

Socioeconomics Case Study

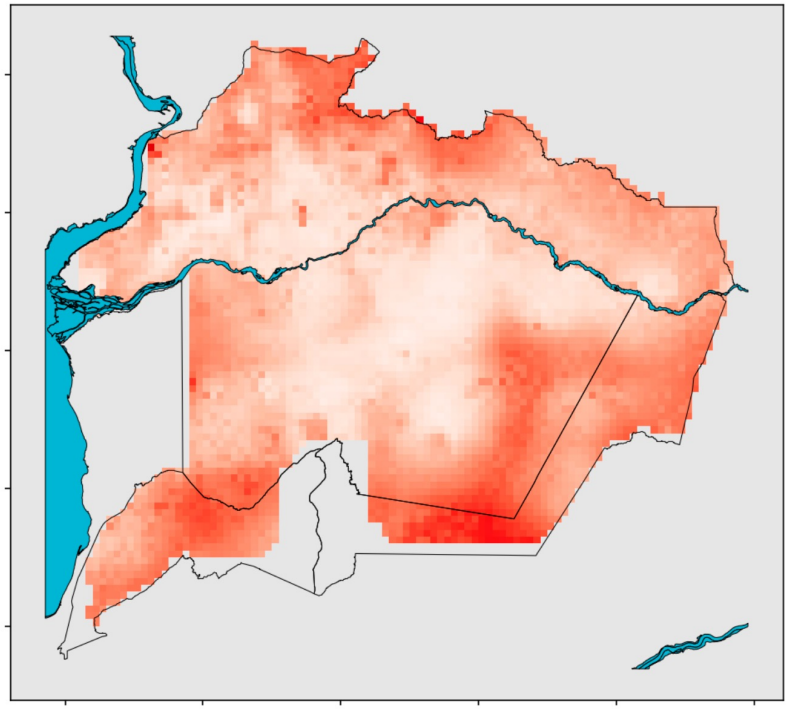
See Lecture AIML02-02-05



Using publicly available satellite imagery and deep learning to understand economic well-being in Africa (Yeh et al., 2020)

Conservation Case Study

See Lecture AIML02-02-06



Probability of detecting poaching activity
Murchison Falls National Park, Uganda

Stay Ahead of Poachers:
Illegal Wildlife Poaching Prediction and Patrol Planning Under Uncertainty with Field Test Evaluations
(Xu et al., 2020)

Lecture Summary

1. We are currently in the cognitive era, in which humans and computers are forming a symbiotic partnership, powered by AI and machine learning

2. This era is being accompanied by the Fourth Industrial Revolution, with centres in Rwanda and South Africa

3. Africa can benefit greatly from the Fourth Industrial Revolution through socioculturally-sensitive innovation

4. Innovation involves invention, exploitation, and diffusion, but it depends on adoption and trust

5. The means that we must develop solutions that are adapted to Africa's environment, and they need to be developed by Africans for Africa

Recommended Reading

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

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https://spectrum.ieee.org/robotics/drones/in-the-air-with-ziplines-medical-delivery-drones
https://www.youtube.com/watch?v=jEbRVNxL44c video: How Rwanda Built A Drone Delivery Service: video highlighting the engineering accomplishments of the delivery service
https://databricks.com/customers/zipline Data-driven drones deliver lifesaving medical aid around the world : Databricks customer story on Zipline

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https://ieeexplore.ieee.org/document/4503259

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https://hbr.org/2019/02/how-to-choose-your-first-ai-project

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Quinn, J., Frias-Martinez, V., and Subramanian, L. (2014). Computational sustainability and artificial intelligence in the developing world. AI Magazine, 35(3).
https://ojs.aaai.org/index.php/aimagazine/article/view/2529

Rose J (2010) Software Innovation: eight work-style heuristics for creative software developer, Software Innovation, Dept. of Computer Science, Aalborg University.
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Wilson, H. J., Daugherty, P., and Davenport, C. (2019). The Future of AI Will Be About Less Data, Not More, in Insights You Need from Harvard Business Review – Artificial Intelligence, Harvard Business School Publishing Corporation.
https://hbr.org/2019/01/the-future-of-ai-will-be-about-less-data-not-more

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https://www.researchgate.net/publication/341687515_Stay_Ahead_of_Poachers_Illegal_Wildlife_Poaching_Prediction_and_Patrol_Planning_Under_Uncertainty_with_ Field_Test_Evaluations_Short_Version

Yeh, C., Perez, A., Driscoll, A., Azzari, G., Tang, Z., Lobell, D., Ermon, S., and Burke, M. (2020). Using publicly available satellite imagery and deep learning to understand economic well-being in Africa. Nature Communications 11, 2583.
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