Artificial intelligence for sustainability science

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Background

The emergence of artificial intelligence (AI) and data science is transforming not only our societies, but also the way research is conducted, structured and understood in other scientific disciplines. Sustainability science, which aims to find sustainable solutions within planetary boundaries, is one such discipline because of its reliance on data and models. But what can AI do today? What impact might AI have on sustainability science and the SDGs? These are important questions for IRD researchers, many of whom are already using AI in their own research.

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Further reading

NISHANT R. *et al.*, 2020 – Artificial intelligence for sustainability Challenges, opportunities, and a research agenda. *Int. J. Inf. Manag.*, 53 : 102-104.

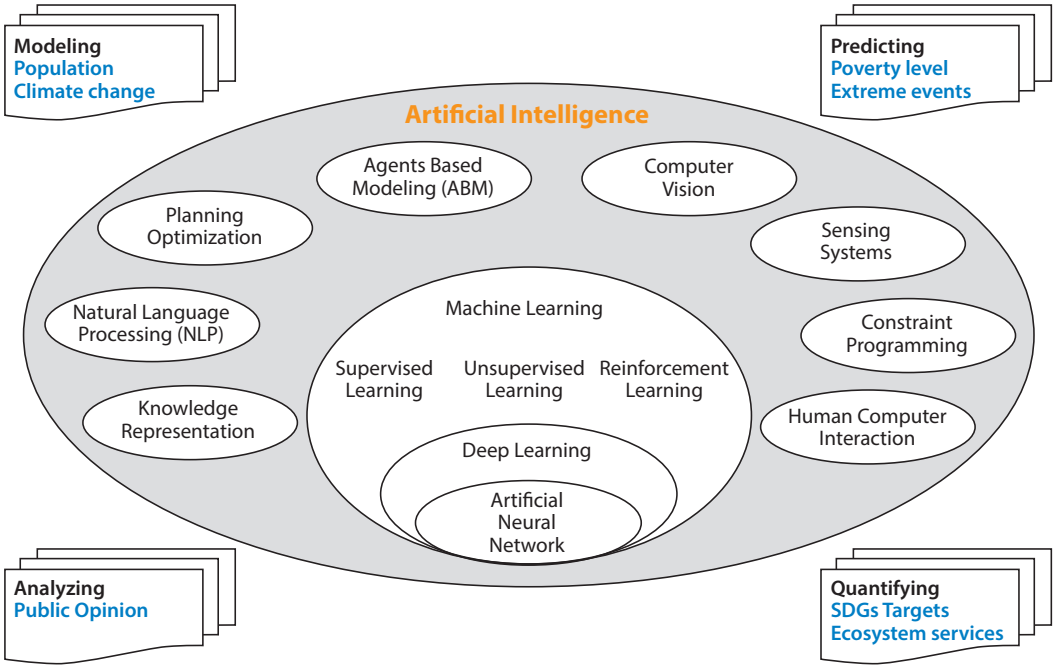
AI today and its success in many different areas

Artificial intelligence (AI) is defined as "the set of theories and techniques used to create machines capable of simulating human intelligence". Its use has become indispensable for all sciences needing to scale up (increase their processing capacities as the volume of data increases) to extract knowledge or build models from masses of data. AI has been interdisciplinary since its inception, just like cybernetics, which played a key role in its emergence. It has absorbed and advanced theories and techniques from many fields, including computer science, statistics, epidemiology, economics and biology. But one of the undeniable reasons for the meteoric rise of AI is linked to its success over the last ten years in reproducing and even surpassing human capabilities in an ever-increasing number of tasks. This is largely due to the success of Machine Learning and, more specifically, Deep Learning, which gives AI models the ability to be unbeatable at the game of Go, to excel at driving cars, to diagnose cancer from medical images and to detect galaxies. In the words of world-leading expert Andrew Ng: "If a human can perform a mental task in less than a second, it's likely a computer aided by AI can take over that task".
And this process often involves building classification or prediction models, which are automatically learned from data.

There are many ways in which AI can be applied to sustainability science (Nishant *et al.*, 2020): to quantify, analyse and monitor biodiversity, air and soil pollution or changes in climate; to plan how sustainable cities or traffic will be managed; to model solutions for energy transition or for the conservation of natural or water resources; to predict and reduce the risks of disasters, etc. But AI is not just limited to Machine Learning. It also offers ways and means of putting interdisciplinarity "into practice" through the wide range of formalisms it employs (mathematical, logical, rule-based, agent-based, etc.) and of generating and exploring "possible" scenarios (knowledge creation in ways that are neither inductive nor deductive, but generative) for different uses because of the various modelling scales (spatial and temporal) that it combines. Furthermore, the tools that AI develops as part of participatory approaches foster collaboration between various scientific communities, in fields as varied as economics, climatology, oceanography and ecology.

Using AI to achieve the SDGs

AI4Good, AI4SG, AI4Climate, AI for Climate Action are all names for the many initiatives and movements currently under way, whose aim is to build international communities of knowledge and expertise that use AI to address climate and social issues. These joint research and development efforts on theoretical, methodological and applied aspects place the SDGs squarely at the heart of the fields in which AI is used and are already demonstrating its very great potential in many sectors. AI applied to



The fields of AI in the centre and some examples of applications at IRD in the four corners.

the SDGs requires interdisciplinarity with the added benefit of adhering to the FAIR (Findable, Accessible, Interoperable, Reusable) and CARE (Collective Benefit, Authority to Control, Responsibility, Ethics) principles. These principles apply to data as well as to AI outputs and developments such as predictions, estimates, classification results, clustering results, simulations, models, knowledge representations and their computer code. Furthermore, one of the advantages of AI is that it lends itself to rapid operational deployment in many technical areas related to sustainable development. It has been positioned for several years as a key technology for transition, adaptation and crisis management, drawing on data from several disciplines. For example, it has been used to estimate the amount of carbon sequestered by forests from LiDAR data, providing a means of estimating tree heights; to assess and predict poverty from satellite images in places where social and economic surveys cannot be conducted; and to create near-real-time maps and disaster evacuation strategies using data from social media platforms and aerial photographs.

Lastly, the strength of using AI to help achieve the SDGs lies in its ability to take into account different scales of time and space by leveraging data of various types (text, images, audio, video, etc.). It also has the potential to provide methodologies that can be replicated and automated at low cost and used to answer a variety of thematic questions, while taking into account externalities, socio-technical aspects of solutions and human expertise. Myriad initiatives provide evidence of these benefits, as does the "actionability" of AI for the SDGs. These initiatives also raise more general questions about the role of AI in society (and societies) and about the role IRD wishes to play in this international drive to use AI, as a legitimate stakeholder and contributor in partnerships in the Global South.

KEY POINTS

AI has the potential to be a key enabler in the development of sustainability science. AI is, by construction, interdisciplinary and takes an approach that favours the modelling of complex systems by providing tools to strengthen dialogue between experts and to co-construct knowledge on sustainability science models. Furthermore, through learning, it enables the construction of innovative tools for the SDGs. We have a great deal of room for improvement and a role to play in making IRD a leading contributor to the international drive to use AI to help achieve the SDGs.

SUSTAINABILITY SCIENCE

UNDERSTAND, CO-CONSTRUCT, TRANSFORM

Collective thinking coordinated
by Olivier Dangles and Claire Fréour

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