



# Towards Sustainable Artificial Intelligence

A Framework to Create Value  
and Understand Risk



Ghislain Landry Tsafack Chetsa

Apress®

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# ***Towards Sustainable Artificial Intelligence: A Framework to Create Value and Understand Risk***

Ghislain Landry Tsafack Chetsa  
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Printed on acid-free paper

*To my family Valerie and Adlynnne, and  
my sister Bertine.*

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# About the Author

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**Ghislain Landry Tsafack Chetsa** is Head of Data Science at Elemental Concept 2016 Ltd (EC), where he steers the organization's AI strategy. As part of this, he leads the company's work in leveraging the latest advances in AI to help clients create value from their data and auditing AI systems developed by third parties on behalf of potential investors.

As part of Ghislain's work in the healthcare industry at EC, he is supporting the development of data-related healthcare products for his clients. This made him appreciate the challenges involved in and the complexity of developing AI systems that people trust to make the right decision for them. It further motivated him to write this book.

Before joining EC, Ghislain held positions as performance engineer and data scientist in the telecommunications and energy sectors. Prior to this, Ghislain worked as an academic at the French National Institute for Research and Automation (INRIA) and the University of Lyon I. His work primarily focused on analyzing the behaviors of high-performance systems to improve their energy efficiency, and this gave him the opportunity to coauthor several scientific publications presenting methodologies for improving the energy efficiency of large-scale computing infrastructures. He holds a PhD in computer science from École Normale Supérieure of Lyon, France.

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# Introduction

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Artificial intelligence (AI) by now infiltrates various aspects of daily life. While some are skeptical of its potential, others believe AI can provide fast and effective approaches for addressing a wide range of problems: from policing and crime prevention to personalized healthcare or streamlining the judiciary system. This is a belief which is likely motivated by the successful application of AI in industries such as the retail and the manufacturing industries. It is, therefore, not surprising that many organizations, including public institutions, are trying to adopt AI and related technologies in some shape or form.

It should, however, not be surprising that adopting a technology that has as much potential as AI generally requires many more inputs than the technology itself. In other words, recruiting data-related professionals or experts and having them develop AI systems for an organization is unlikely to be sufficient to meet all its objectives.

In fact, we observed a similar trend with the advent of the Internet.

With the use of the Internet increasing throughout the 21st century, users have increasingly been subject to abusive practices such as unwanted commercial emails (spam), identity theft, and more recently user tracking. Experts have responded to and mitigated some of these through technical solutions, while regulators and governments have stepped in to prohibit certain practices. In some cases, it is now required that organizations inform their users of their practices in advance. Importantly, we as users expect organizations that we interact with online to mitigate our exposure to abusive practices. This means that from an organization's perspective, simply creating an online presence is probably not the biggest challenge. The real complexity lies in understanding the following questions: What are the greatest potential challenges, and are they addressed adequately? How is the potential return on investment in building an online presence impacted by such challenges? What is the impact of the online presence on my organization's ability to create value in the short, medium, and long term? In essence, organizations need to invest to understand and manage the risk around their online presence.

Investing in AI is not so different: Successfully developing AI systems that meet the constantly changing needs of today's society requires a holistic, methodical, and adaptive approach designed to assess and manage the risks around introducing AI. Such an approach should ensure that AI systems developed by an organization are aligned with its way of conducting business and

meet certain social standards. The increasing importance of principles such as fairness, privacy, and social equality in discussions around AI corroborates the importance of this. Failing to meet those standards can result in lost opportunities for an organization. Worse yet, it may even lead to an organization's demise.<sup>1</sup>

Preventing or managing the social, political, and economic challenges that organizations wishing to develop and/or deploy sustainable AI systems may face today is of great importance. We understand sustainable AI systems to be those that manage to incorporate both business and human values and principles in their design. Potential challenges include, for example, an AI system's need to remain consistent with the company's as well as human principles to be truly effective and/or remain flexible to adjust to new regulations imposing alignment with such social standards. While it is often easy to identify a problem once it has happened, making sure that similar problems do not arise in the future is challenging because it requires a methodical approach involving all stakeholders.

This book discusses the concept of sustainability in AI. To help businesses achieve the objective of developing sustainable AI systems, this book introduces the sustainable artificial intelligence framework (SAIF). This is designed to help organizations create value and understand risks when adopting and/or developing AI systems.

## Audience

The challenges addressed in this book are of interest not only to mainstream adopters of AI but also to organizations seeking to improve their efficiency through AI.

The primary audience for this book is decision makers in organizations wishing to deploy AI systems. This includes government officials, members of the C-suite or other business managers, data scientists, as well as any technology experts aspiring to a data-related leadership role. While the book refers to the technical aspects of AI in places, sufficient context is provided whenever needed to facilitate understanding. As a result, the reader is not required to have a deep background knowledge of AI to understand the key concepts of the methodology discussed in this book; a basic training in statistical methods should be sufficient. This being said, readers with some knowledge of AI may find the book more accessible.

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<sup>1</sup>The example of Cambridge Analytica demonstrates this.

## What You Will Learn

By the end of the material presented here, the reader will learn

- How to develop and deploy AI systems that meet certain social standards and principles
- How to identify ethical risks in the development of AI systems
- How various aspects of data make it both an asset and a liability, and why today's data may be inadequate for future projects
- How to design and implement an effective AI strategy along with necessary governance, and how to assess the effectiveness of the AI governance strategy
- How to assess the impact of AI on an organization's ability to create value in the short, medium, and long term
- The principles and requirements of effective regulation for AI

## Organization

This book is structured as follows:

Chapter 1 provides an overview of the complex relationship between AI and today's society and introduces the four pillars of the sustainable AI framework. Chapter 2 reviews the human factor pillar of AI; it further discusses the relevance of ethics and sources of ethical hazards in AI. The SAIF framework for the development and deployment of AI systems is then introduced in Chapter 3. Chapter 4 highlights the need for an understanding of AI at the organization's level and introduces the concepts of AI governance. Chapter 5 summarizes existing performance metrics used to evaluate AI systems and introduces a new framework to account for the human factor of data science (DS). Chapter 6 presents a practical example of an implementation of the SAIF framework in the form of the design and implementation of an AI-powered credit scoring system. Chapter 7 discusses regulatory mechanisms for AI along with their limitations; it further introduces an effective regulatory arrangement for the development and deployment of AI systems. A discussion around the development and deployment of AI in the medical decision context can be found in Chapter 8. Finally, Chapter 9 presents concluding remarks and a discussion on the need for standards and definitions.

# AI in Our Society

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Up to the early 2000s, artificial intelligence (AI) was perceived as a utopia outside of the restricted AI research and development community. A reputation that AI owed to its relatively poor performance at the time. In the early 2000s, significant progress had been made in the design and development of microprocessors, leading to computers capable of efficiently executing AI tasks. Additionally, the ubiquity of the Internet had led to data proliferation, characterized by the continuous generation of large volumes of structured and unstructured data at an unprecedented rate. The combination of the increasing computing power and the availability of large data sets stimulated extensive research in the field of AI, which led to successful deployments of the AI technology in various industries. Through such success, AI earned a place in the spotlight as organizations continue to devote significant effort to integrate it as an integral part of their day-to-day operational strategy. However, the complex nature of AI often introduces challenges that organizations must efficiently address to fully realize the potential of the AI technology.

This chapter provides an overview of the increasingly complex relationship between AI and today's society and introduces the foundational concepts of the sustainable AI framework.

The remainder of the chapter is structured as follows:

- First, we discuss the relevance of AI in today’s society.
- We then present various challenges that AI faces today.
- Finally, we introduce the concept of sustainable AI and examine how these challenges can be addressed.

## The Need for Artificial Intelligence

Jhon MacCarthy, one of the founding fathers of the artificial intelligence discipline, defined AI in 1955 as

*[...] the science and engineering of making intelligent machines, especially intelligent computer programs [...]*<sup>1</sup>

where

*intelligence is the computational part of the ability to achieve goals in the world*<sup>1</sup>

MacCarthy further provided an alternative definition or interpretation of AI as

*[...] making a machine behave in ways that would be called intelligent if a human were so behaving [...]*<sup>1</sup>

Over the years, and especially within the business world, the definition or interpretation of the term AI has evolved or has been altered to incorporate development and progress made within the discipline. For example, Accenture in its “Boost Your AIQ” report defines AI as

*[...] a constellation of technologies that extend human capabilities by sensing, comprehending, acting, and learning – allowing people to do much more*<sup>2</sup>

<sup>1</sup>[www-formal.stanford.edu/jmc/whatisai/node1.html](http://www-formal.stanford.edu/jmc/whatisai/node1.html)

<sup>2</sup>[www.accenture.com/t20170614T050454\\_w\\_us-en/\\_acnmedia/Accenture/next-gen-5/event-g20-yea-summit/pdfs/Accenture-Boost-Your-AIQ.pdf](http://www.accenture.com/t20170614T050454_w_us-en/_acnmedia/Accenture/next-gen-5/event-g20-yea-summit/pdfs/Accenture-Boost-Your-AIQ.pdf)

Likewise, PWC's "Bot.Me: A Revolutionary Partnership" Consumer Intelligence Series report defines AI as

*[...] technologies emerging today that can understand, learn, and then act based on that information<sup>3</sup>*

Other definitions exist: for example, the Oxford dictionary defines AI as

*[...] the theory and development of computer systems able to perform tasks normally requiring human intelligence such as visual perception, speech recognition, decision making, and translation between languages. (Oxford Living dictionaries 2020)*

A common theme from these definitions is the emphasis on "human-like" characteristics and behaviors requiring a certain degree of autonomy such as learning, understanding, sensing, and acting. They, however, do not provide a framework to underpin such behaviors. This is problematic because humans, whose behavior AI systems or agents are supposed to mimic or in certain cases act on behalf of, behave according to a number of principles and standards such as social norms. Social norms can be argued to provide a framework to navigate among all the behaviors that are possible in any given situation. They introduce the notion of acceptable behavior, because they determine the behaviors that "others (as a group, as a community, as a society ...) think are the correct ones for one reason or another" (Saadi 2018). As a result, socially accepted behavior is central to how we act in a given context or environment. This suggests that the definitions of AI presented above are somewhat incomplete, because the AI agent or system has no way of determining which behavior is acceptable among those that are possible without such an equivalent framework.

While fictional, Asimov's three laws of robotics probably represent one of the first attempts to provide artificially intelligent systems or agents with such a framework. Attempts to create new guidelines for robots' behaviors generally follow similar principles.<sup>4</sup> However, numerous arguments suggest that Asimov's laws are inadequate. This can be attributed to the complexity involved in the translation of explicitly formulated robot guidelines into a format the robots understand. In addition, explicitly formulated principles, while allowing the development of safe and compliant AI agents, may be perceived as unacceptable depending on the environment in which they operate. Consequently, a comprehensive definition of AI must also provide a flexible framework that allows AI agents or systems to operate within the accepted boundaries of the

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<sup>3</sup>[www.pwc.in/assets/pdfs/consulting/digital-enablement-advisory1/pwc-botme-booklet.pdf](http://www.pwc.in/assets/pdfs/consulting/digital-enablement-advisory1/pwc-botme-booklet.pdf)

<sup>4</sup><https://epsrc.ukri.org/research/ourportfolio/themes/engineering/activities/principlesofrobotics/>

community, group, or society in which they operate. By doing this, activities of AI agents or systems designed under such a framework naturally allow other stakeholders to regulate their activities, too. As a consequence, we choose to adopt a new, extended definition in this book: by AI, we understand any system (such as software and/or hardware) that, given an objective and some context in the form of data, performs a range of operations to provide the best course of action(s) to achieve that objective while simultaneously maintaining certain human/business values and principles.

AI (or more generally data science (DS)<sup>5</sup>) holds the potential to provide new and often better approaches for solving complex problems in almost every aspect of everyday life. While there is no single definition of AI, in this book, it is defined as stated above.<sup>6</sup>

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■ **Note** For the sake of simplicity of this book, the terms DS and AI are used interchangeably. Similarly, AI algorithm and machine learning (ML) algorithm are used interchangeably.

AI is defined as any system (such as software and/or hardware) that, given an objective and some context in the form of data, performs a range of operations to provide the best course of action(s) to achieve that objective while simultaneously maintaining certain human/business values and principles.

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Organizations often rely upon AI to process and find patterns in large volumes of data, which can in turn lead to innovation, new insights, and improvements in organizational performance and can also help firms create a competitive advantage over market rivals. As of today, there are countless examples of where AI is already being used for such purposes from a variety of industries. For example, law firms specialized in litigation might use AI to process and review large number of contracts, which speeds up their contract review process and helps them deliver more cost-efficient services to their clients.<sup>7</sup>

Another example can be observed in the retail industry, where ecommerce organizations use AI to boost their sales through recommendations. To illustrate, the ecommerce leader Amazon uses AI to power its recommendation

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<sup>5</sup>While one may argue the differences between AI and DS, from a practical standpoint AI is an integral part of the DS process.

<sup>6</sup>Systems (such as software and/or hardware) that, given an objective and some context in the form of data, perform a range of operations to provide the best course of action(s) to take to achieve that objective while simultaneously maintaining certain human/business values and principles.

<sup>7</sup>For example, <https://digital.hbs.edu/platform-rctom/submission/jp-morgan-coin-a-banks-side-project-spells-disruption-for-the-legal-industry/>

engine, which is associated with 35% of all purchases on the Amazon website.<sup>8</sup> Banks and insurance companies rely on virtual assistants to increase their productivity and create new and cost-effective ways to serve and interact with their customers. Similarly, in the healthcare industry, hospitals and other health organizations may use AI to automate their workflow and reduce the number of unnecessary hospital visits.<sup>9</sup> Likewise, pharmaceutical companies may use pattern recognition to create new drugs and develop sophisticated image processing techniques to help improve doctors' diagnostic capabilities and reduce the amount of time required for accurate diagnosis of expensive-to-treat, life-threatening diseases (Ganesan et al. 2010; Alizadeh et al. 2016; Leonardo et al. 1997; Lyons et al. 2016).

Looking at these examples, it is not surprising that AI is gaining traction in nearly every industry, including, but not limited to, manufacturing, retail, healthcare, life sciences, and legal. The future holds many exciting possibilities in these fields, and research is putting once futuristic ideas into practice. Many would consider the fact that self-driving cars are now being trialled out on our roads to illustrate this point.

This acceleration of the use of AI is amplified by the widespread availability of AI technology vendors, with many offering cheap and easy-to-integrate state-of-the-art AI tools into existing products and solutions, and the research and development of new business processes and solutions.

However, the use of AI in some, if not all, of these industries presents multiple challenges, in terms of governance and in relation to the safety and the liability of devices and system equipped with it, that need to be addressed. To illustrate, AI solutions in the healthcare industry, along with supporting technologies such as Internet of Things (IoT) devices, represent the biggest market opportunity in the foreseeable future, according to Allied Market Research.<sup>10</sup> Yet, it is likely going to present one of the most challenging environments in relation to fundamental rights, patients' safety, and efficacy of devices used (Char, Shah, and Magnus 2018): AI-powered healthcare products inherently rely on sensitive patient records, giving rise to data privacy concerns. Additionally, such data is likely to be population specific, meaning that AI solutions may scale poorly.

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<sup>8</sup>[www.mckinsey.com/industries/retail/our-insights/how-retailers-can-keep-up-with-consumers](http://www.mckinsey.com/industries/retail/our-insights/how-retailers-can-keep-up-with-consumers)

<sup>9</sup>[builtin.com/artificial-intelligence/examples-ai-in-industry](http://builtin.com/artificial-intelligence/examples-ai-in-industry)

<sup>10</sup>According to Allied Research, the US healthcare IT market is projected to reach \$149.17 billion by 2025 at 11.7% CAGR.

[www.prnewswire.com/news-releases/u-s-healthcare-it-market-to-reach-149-17-billion-by-2025-at-11-7-cagr-says-allied-market-research-839141421.html](http://www.prnewswire.com/news-releases/u-s-healthcare-it-market-to-reach-149-17-billion-by-2025-at-11-7-cagr-says-allied-market-research-839141421.html) (Accessed on 2019-10-02)