Directed by FÉLIX PAGEAU
TENZIN WANGMO • EMILIAN MIHAILOV

ROBOTS AND GADGETS

AGING AT HOME

ÉTHIQUE IA ET SOCIÉTÉ
Collection

PUL

FONDATION BROCHER

This publication was produced following a workshop organized at the Brocher Foundation and thanks to the financial support that complemented it.

The Brocher Foundation mission is to encourage a research on the ethical, legal and social implications of new medical technologies. Its main activities are to host visiting researchers and to organize workshops and summer academies. More information on the Brocher foundation program is available at www.brocher.ch.

ROBOTS AND GADGETS

AGING AT HOME

ÉTHIQUE, IA ET SOCIÉTÉ

Series editor: Lyse Langlois

Technological innovations in artificial intelligence have been an important vector of economic development and may help improve living conditions significantly for current and future generations. Their impact nonetheless raises major issues in employment, health care, education, security, democracy, justice, and ethics. These issues cut across borders and will have to be thought out and acted upon. For this, the entire research community should play a key role, in close collaboration with stakeholders from industry, government, and civil society. This collection features scholarly works and popular books that deal specifically with the societal and ethical impacts of artificial intelligence and digital technology.

Previous titles in this collection

Schallum Pierre et Fehmi Jaafar (dir.), *Médias sociaux : perspectives sur les défis liés à la cybersécurité, la gouvernementalité algorithmique et l'intelligence artificielle*, 2020.

Gentelet, Karine (dir.). *Les intelligences artificielles au prisme de la justice sociale / Considering Artificial Intelligence Through the Lens of Social Justice*, 2023.

Directed by FÉLIX PAGEAU
TENZIN WANGMO • EMILIAN MIHAILOV

ROBOTS AND GADGETS

AGING AT HOME

PUL
Presses de
l'Université Laval

Financé par le gouvernement du Canada
Funded by the Government of Canada | Canada

Nous remercions le Conseil des arts du Canada de son soutien.
We acknowledge the support of the Canada Council for the Arts.

Conseil des arts du Canada | Canada Council for the Arts

Each year, Presses de l'Université Laval receives financial support from the Société de développement des entreprises culturelles du Québec for their publishing programs.

SODEC Québec

Bibliothèque et Archives nationales du Québec and Library and Archives Canada Cataloguing in Publication

Title: Robots and gadgets : aging at home / directed by Félix Pageau, Tenzin Wangmo, Emilian Mihailov.

Names: Pageau, Félix, editor. | Wangmo, Tenzin, 1982- editor. | Mihailov, Emilian, editor.

Description: Series statement: Éthique, IA et société | Includes bibliographical references.

Identifiers: Canadiana (print) 20230076769 | Canadiana (ebook) 20230076777 | ISBN 9782766302536 | ISBN 9782766302543 (PDF)

Subjects: LCSH: Older people—Home care—Moral and ethical aspects. | LCSH: Older people—Home care—Technological innovations. | LCSH: Home automation—Social aspects. | LCSH: Artificial intelligence—Medical applications—Moral and ethical aspects. | LCSH: Dementia—Patients—Care—Moral and ethical aspects. | LCSH: Self-help devices for older people. | LCSH: Human-robot interaction.

Classification: LCC RA564.8.R63 2023 | DDC 174.2/9897—dc23

Linguistic Review: Anne Curry
Layout: Diane Trottier
Cover Design: Laurie Patry
Cover illustration: Silviu Jureschi

Print in Canada
Legal deposit 1st quarter 2024

ISBN : 978-2-7663-0253-6
ISBN PDF : 9782766302543

Les Presses de l'Université Laval
www.pulaval.com

TABLE OF CONTENTS

INTRODUCTION

Félix Pageau

On 18 May 2021, amid the COVID-19 pandemic and months of isolation, ten strangers gathered online and in person for the first time since the beginning of the worldwide outbreak. Almost like a mirror image of smart-home technologies, we experienced the benefits and limitations of online and in-person interactions for three consecutive days. At the Brocher Foundation located on the shores of Lake Leman in Switzerland, academics, scientists, ethicists, and people from the technology industry debated how smart-home technologies will impact the care of the older person.

This group came together for the workshop as part of a larger project funded by the Swiss National Science Foundation (SNSF: NRP 77 "Digital Transformation"), on which they were collaborating. The project was titled SmaRt homES, Older adUlts, and caRegivers: Facilitating social aCceptance and negotiating rEsponsibilities (RESOURCE). The key goal of the project, as evident in the title above, was to critically evaluate how smart technologies could be applied to the care of older adults in Switzerland in an ethically responsible manner. Our goals for this meeting were to provide an academic space to discuss this important topic and to provide networking opportunities for participants, with the possibility of publishing the book that you are holding at this very moment.

With the awareness that the world's population is becoming increasingly older, which places greater caregiving responsibilities on families, health care, and social care systems, many questions were raised about potential benefits and pitfalls of these technologies for the older person. Since I am an ethicist and geriatrician, I took pleasure in addressing experts on my perspective on these topics while gazing at the World Health Organization building in the city of Geneva. I believe we need to start with these simple questions:

Why did we need to reflect on and write about smart-home technologies for the older person?

And what is a smart-home technology?

Based on existing literature (Sparrow and Sparrow 2006; Sorell and Draper 2014), our research group defined a smart home as being a

> welfare techno house and ubiquitous homes, where sensors, magnetic switches, and automated biomedical devices collect critical data about the residents as well as unusual events. New studies note how correct and careful placing of assisted video technology in nursing homes could not only secure the safety and privacy of its residents but also improve the well-being of the caregivers. Also developed and marketed are internet of things (IoT) platforms that aim to reduce caregiver burden of both professional and family caregivers. Such platforms use sensors to detect deviations and the data are communicated to care providers".

In geriatrics, the usage of smart homes will most likely be oriented toward the elder with dementia or with mobility problems. Major neurocognitive disorder (MND), the novel term created by the American Association of Psychiatry (2013) to capture dementia and other neurological decline, comprises four criteria, which are described below:

> (A) There must be a cognitive decline of one or more cognitive aspects: complex attention, executive function, learning and memory, language, perceptual-motor skills, or social cognition. (B) A growing incapacity to perform activities of daily living (ADLs) is essential for a diagnosis of MND.
>
> There must be no diagnosis of either (C) delirium or (D) another mental disorder like depression, schizophrenia, or anxiety since both delirium and mental disorders mimicking MND.

It is important to make this point since smart-home technologies can palliate loss of capacity and cognitive decline. These technologies also must adapt to the decline and the behavioural disturbances associated with MND. Moreover, to better understand the need for smart-home technologies, we must detail the possible impact of dementia on instrumental activities of daily living (IADLs) in addition to on ADLs.

In most cases, MND will first adversely influence IADLs and then ADLs. This is the case because IADLs are cognitively more demanding than ADLs. IADLs comprise complex tasks such as housework, managing money, running errands, driving a car, and using electronic devices. ADLs include feeding, dressing, performing personal hygiene, walking, and being continent. These are all losses due to MND for which smart-home technologies have been suggested.

Sensors, cameras, and robots could help in reducing falls by monitoring older inhabitants, stimulating exercising programs, issuing alerts in case of precarious behaviours, etc. Fall detection may also be performed by hidden devices. In the case of very severe mobility problems, mobility equipment and/or furniture could prevent falls. “Moving” could mean that artificial-intelligence (AI) appliances move to help when they see a person falling or that they strategically move things to better locations to prevent falls.

In the face of smart-home promises to help the elderly person, and before these technologies are more widely used, we need to examine the ethical issues (Bedaf et al. 2013; Begum et al. 2013; Bemelmans et al. 2012; Pageau 2019; Pearce et al. 2012). Indeed, ethicists have already studied these pros and cons (Pageau 2019; Sharkey and Sharkey 2012; Sorell and Draper 2014; Sparrow 2006). We provide only a list here as authors will discuss them in depth in each chapter of our book. The pros include a heightened sense of security, autonomy, and dignity (Pageau 2019; Sharkey and Sharkey 2012; Sorell and Draper 2014; Sparrow and Sparrow 2006). A few authors note that private life and social relationships could be safer and better with smart-home technologies (Pageau 2019; Sharkey and Sharkey 2012; Sorell and Draper 2014; Sparrow and Sparrow 2006). The cons pertain to reduced digital security and reduced physical freedom. Furthermore, recent empirical studies have highlighted that the replacement of human care by technologies is feared by different stakeholders (Ienca et al. 2021; Wangmo et al. 2019). Reliability, adaptability, and financial limitations are major cons related to smart-home technologies, especially for elders with dementia or MND (Mordoch et al. 2013; Pageau 2019; Sparrow and Sparrow 2006; Wu et al. 2010). In the era of climate changes, robots and new technologies that are not environmentally friendly are frowned upon. Many components of robots and computers require rare metals that come from the developing world. An industry that does not consider this issue is unethical as well.

Therefore, we solicited contributions from experts in AI, the ethics of smart-home technologies, elder care, and philosophy. The academics who participated in this book also attended our workshop at the Brocher Foundation.

Firstly, Friedemann Zenke and Koshika Yadava explain the different forms of AI: how they work, what defines them, and what relationship they have to new technologies. Various forms of AI coexist to power smart-home technologies. Zenke and Yadava also present promising uses and upcoming developments that will make AI more energy-efficient and more applicable to smart homes.

The following chapter, by Athena McLean, throws light on the social background of elder care in Switzerland and in similar countries such as the United States. She explains how the home is transformed into a site of care with smart-home technologies and compares long-term care in different countries. This transformation might not be ideal in the face of developing smart-home technologies leading to more care at home and less in long-term care homes. As well, caregivers must consider the notion of dignity of risk, which implies the possibility of an individual taking risks autonomously, even risks leading to death. Thus, she highlights the issue of autonomy versus safety in the care of the elderly.

Thereafter, in the third chapter, Bernice Elger reminds the reader of basic ethical principles. She explains how beneficence, which fosters safety by reducing freedom of movement, is often privileged in elderly care, even over autonomy. She uses the example of restraints in an intensive-care unit to prevent geriatric patients from self-extubating falling off their bed. Moreover, she shows how benevolent deception is often used in geriatric care. She also explains how dignity of risk is an important concept to consider when restricting liberty.

The last two chapters go deeper into specific ethical issues related to smart-home technologies. Yi Jiao (Angelina) Tian and Tenzin Wangmo define types of privacy and intrusion. By conceptualizing their varying dimensions, they demonstrate whether and how technologies could interfere with end-users' privacy, inviting a deeper reflection on caregiving decisions about technologies at home. These authors explained how to reduce harm to privacy, as important trade-offs for the elderly in needs of care.

Finally, Emilian Mihailov analyzes various meanings of the words "dignity" and "objectification." He argues that human relationships and dignity could be damaged by smart-home technologies because the act of care has embedded meaning and sentiments. It is not only mechanical. However, Mihailov suggested that economic incentives be modified to better help the older person. The goal would be for technologies to be mediators in caring relationships while making sure that they do not replace real human interaction.

References

APA [American Psychiatric Association]. 2013. *Diagnostic and Statistical Manual of Mental Disorders: DSM-5.* Washington, DC: APA.

Bedaf, S. et al. 2013. "Selecting Services for a Service Robot: Evaluating the Problematic Activities Threatening the Independence of Elderly Persons." *IEEE International Conference on Rehabilitation Robotics*, Seattle, WA, June 2013.

Begum, M. et al. 2013. "Performance of Daily Activities by Older Adults with Dementia: The Role of an Assistive Robot." *IEEE International Conference on Rehabilitation Robotics*, Seattle, WA, June 2013.

Bemelmans, R. et al. 2012. "Socially Assistive Robots in Elderly Care: A Systematic Review into Effects and Effectiveness." *Journal of the American Directors Association* 13: 114–20.

Ienca, M. et al. (2021). "Digital Health Interventions for Healthy Ageing: A Qualitative User Evaluation and Ethical Assessment." *BMC Geriatrics* 21 (412). https://doi.org/10.1186/s12877-021-02338-z.

Mordoch, E. et al. 2013. "Use of Social Commitment Robots in the Care of Elderly People with Dementia: A Literature Review." *Maturitas* 74: 14–20.

Pageau, F. 2019. "Robots soignants en gériatrie: réalité ou illusion?" In *La société robotisée*, edited by M.H. Parizeau, 237-258. Québec: Presses de Université Laval.

Pearce, A.J. et al. 2012. "Review Article – Robotics to Enable Older Adults to Remain Living at Home." *Journal of Aging* 2012 (538169). doi:10.1155/2012/538169.

Sharkey, A., and N. Sharkey. 2012. "Granny and the Robots: Ethical Issues in Robot Care for the Elderly." *Ethics and Information Technology* 14 (1): 27–40.

Sorell, T., and H. Draper, H. 2014. "Robot Carers, Ethics, and Older People." *Ethics Information and Technology* 16 (3): 183–95.

Sparrow, R., and L. Sparrow. 2006. "In the Hands of Machines? The Future of Aged Care." *Minds and Machines* 16 :141–61. https://doi.org/10.1007/s11023-006-9030-6.

Wangmo T. et al. 2019. "Ethical Concerns with the Use of Intelligent Assistive Technology: Findings from a Qualitative Study with Professional Stakeholders." *BMC Medical Ethics* 20 (98). https://doi.org/10.1186/s12910-019-0437-z.

Wu, Y.-H. et al. 2010. "Robotic Agents for Supporting Community-Dwelling Elderly People with Memory Complaints: Perceived Needs and Preferences." *Health Informatics Journal* 17 (1): 33–40.

1

Artificial Intelligence: A Brief Introduction for Non-Experts on the Technological Advances That Are Bringing Smart Devices into Our Lives

Friedemann Zenke and Koshika Yadava

We navigate the world guided by the invisible. As we search the web, Google learns from our behaviours and predicts what we are looking for even before we completely type it. We can even forgo typing and gently whisper our wishes to our smartphones. An amiable virtual assistant accompanies us on our commute and helps us plan our day. At home, smart systems fine-tune lights, music volume, and heating to match our moods across the day and seasons. Artificial intelligence (AI) empowers these smart systems to find patterns within the expanses of our behavioural data to predict and adapt to our ever-changing desires. Even our robot vacuum cleaner constitutes a form of embodied albeit different artificial intelligence, precisely navigating around furniture to grab dirt. At the same time, we converse with algorithms that know how to entertain us. AI is employed even in the bureaucratic humdrum: facial-recognition systems at airports compare our faces to the biometric image stored on our passports and wave us through or redirect us to a human customs officer if further inquiry is needed. Smart technologies rely on our interactions to become "smarter," and our increasing engagement with and dependence on these technologies signal two inevitabilities. On the one hand, the emergence of more mature and competent AI. And on the other hand, an ever-growing presence of these technologies in virtually all aspects of our daily lives. Yet most users of these smart technologies seldom pay much attention to what AI is, how it works, and its similarities to or differences from human intelligence.

Let us first define what intelligence is. Intelligence combines perceiving and retaining information with the ability to apply it in different contexts. For instance, most of us get our food at the local store. Still, when shopping for cheese in a new city, we expect to find it within the dairy section and not in the laundry-detergent section. This expectation arises because we have learned that cheese is milk-based and usually needs to be refrigerated and is thus typically in the corner of the shop with the coolers. Acquiring knowledge through experience allows us to find our bearings in new situations quickly.

This ability is what computer scientists call generalization. Humans and some animal species such as monkeys or crows are very good at it and are remarkably adept at applying prior knowledge to new situations. AI comprises artificial systems capable of solving tasks that previously required the biological intelligence exhibited by humans and animals. Though several different definitions for AI exist, most of them centre on the notions of problem-solving through reasoning and of planning by considering previous knowledge and adapting it from one scenario to a new, unfamiliar setting (Russell and Norvig 2020). In other words, one can think of intelligence as a meta-skill that allows one to solve novel problems, acquire new skills, and learn.

Researchers further distinguish between narrow and general AI. Most current AI systems fall into the former category. For instance, a self-driving car can keep within its lane while on a highway, and a robot vacuum cleaner will move around objects in your home while cleaning. Yet neither would apply their driving skill to the other domain nor learn to play chess. Humans, on the other hand, are capable of mastering diverse tasks. The machine equivalent of such intelligence would be what we call artificial general intelligence (AGI). Although AGI is the object of intense research efforts backed by major industries, we are presumably still far from developing true AGI. In the following, we focus on narrow-AI systems whose possibilities are limited to one or several specific tasks, such as speech recognition and computer vision. Their capabilities are still impressive, and researchers have made great strides in developing them further.

1. RECENT ADVANCES AND CURRENT POSSIBILITIES OF AI

The first Grand Challenge for autonomous vehicles, a 142-mile course through the Californian desert, was organized by the Defence Advanced Research Projects Agency (DARPA) in 2004. No vehicle completed the course (DARPA 2004). However, only a few years later, in 2009, a self-driving vehicle from Google had completed over ten drives that were longer than one hundred miles each. Self-driving cars use advanced vision sensors, radar, and lidar to constantly map their surroundings while in motion. Machine-learning algorithms process these data streams and infer the position of the vehicle with respect to the lane on the road, other vehicles, and any unforeseen obstacles. Based on this information, they control actuators to keep the car in lane and to avoid collisions. When the algorithms encounter a situation they cannot handle, they usually pass control back to the human driver or initiate an emergency stop of the vehicle.

Driving and many tasks we perform as humans rely on vision and, consequently, improving computer vision algorithms is an intense focus area in AI research. The annual ImageNet Large Scale Visual Recognition Challenges (Russakovsky et al. 2015) have showcased just how far this field has progressed. At the competition, computer vision algorithms have to categorize an object or animal depicted in a photograph. While the categories are known in advance, the competing algorithms have never before seen the images that they have to classify. For instance, the algorithms would have to "know" whether a picture they have never seen before shows a chair, a container ship, or a cow. In 2012, AlexNet, a convolutional neural network (Krizhevsky et al. 2012), with an architecture inspired by the primate visual system, won the ImageNet competition by a large margin. AlexNet's success largely relied on a novel, "deep" neural-network architecture, and their win heralded the age of deep neural networks, which have since transformed most modern AI approaches. We will learn more about what deep neural networks are in the next section but, for now, let us focus on what they can do.

DeepMind, a deep learning[1] start-up that has since become a subsidiary of Google, developed an AI software called AlphaGo that plays the game of Go. In 2016, AlphaGo, primarily built on progress in deep-neural-network technology, won in the game of Go against a human grandmaster (Silver et al. 2016). It was an extraordinary feat. In chess, a computer had beaten the champion, Garry Kasparov, twenty years earlier, in 1997, by simply using brute force to simulate a myriad of possible games to assess its next move. This strategy is not viable in Go because there are too many possible games, and using it would lead to a combinatorial explosion. There are too many games for even the most powerful supercomputers to simulate. Modern AI systems have parted with purely brute-force strategies and instead take inspiration from the brain, which uses neural networks trained through experience to detect and evaluate patterns. This knowledge enables neural networks to, for instance, judge one chess position resulting from

1. For this and others words, see the glossary at the end of this chapter.

a move as "looking" more advantageous than another, without necessarily having to play out all possible future games that could ensue. And, presumably, this strategy is more like the intuitions that grandmasters like Kasparov, through extensive training, have learned to use to excel at their trade.

The breakthroughs with deep neural networks keep coming. In 2020, OpenAI released GPT-3, an AI system with the ability to write and talk almost like a human about virtually any topic you could think of. But AI has not been limited to self-driving cars, playing games, and robotic banter. In 2020 as well, DeepMind released AlphaFold-2, an AI system (Jumper et al. 2021) that constitutes a chemistry Nobel Prize–worthy advance in protein-structure prediction and which has the potential to fundamentally change pharmaceutical research. Simultaneously, there has been tremendous progress for AI in health-care and nursing applications. For instance, AI is helping to identify, classify, and quantify pathologies in medical images (Shen et al. 2017). Similarly, in elderly care, AI is heralding a new age by providing smart systems that monitor human movements through unobtrusive computer vision systems and alert caregivers in the event of falls or when they detect behaviour that is out of the ordinary (Corbyn, 2021). AI is also advancing the capabilities of neuroprosthetics, thereby allowing paralyzed persons with anarthria to speak (Moses et al. 2021). To that end, an implanted electrode array picks up the person's brain signals from the speech sensorimotor cortex. These signals are subsequently processed by a neural processing system that infers the probabilities of the person thinking of specific words that they want to communicate. Finally, the predicted word probabilities are fed into a language model similar to GPT-3, and the outputs are decoded as sentences displayed on a screen or enunciated through an artificial speech-generation system. So how do modern AI systems achieve this level of accomplishment?

2. THE TECHNICAL AND CONCEPTUAL PROGRESS THAT HAS ENABLED MODERN AI TECHNOLOGIES

When George Boole 1854) published his *Investigation of the Laws of Thought* some 150 years ago, he believed that one day we would understand the mind and, ultimately, intelligence through logic and mathematical equations that can be written down succinctly. Boole's influential work heralded the information age, laid the theoretical foundations of modern computers, and has defined in large part how people are trying to build AI. It was only around the turn of the new millennium when AI researchers gradually realized that the rules of intelligence seem too complex to be written down by hand.

This realization formed the foundations of machine learning, which is concerned with "learning" the rules and identifying the relevant patterns from the data. Deep artificial neural networks (ANNs), which constitute one specific branch of machine learning, proved particularly suitable for this purpose (Krizhevsky et al. 2012; Rumelhart et al. 1986; LeCun et al. 2015; Schmidhuber 2015; Goodfellow et al. 2017). Their design was inspired by that of the brain in which large numbers of identical neurons connect to vast networks whose computational abilities are primarily determined by how they are connected. The central technological advance that made deep learning possible was that researchers have worked out effective algorithms that can learn from large amounts of training data and automatically adjust the myriad of synaptic connections, thereby creating ANNs that can complete a particular task such as recognizing what is in an image (Figure 1.1).

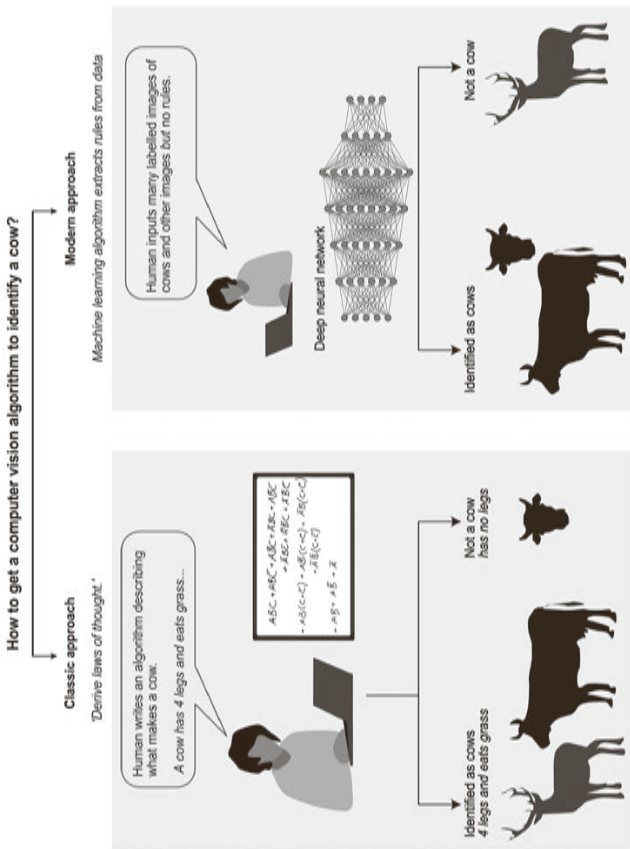

Figure 1.1 – Classic and Current Approaches to Identifying an Image

Architecturally, ANNs need to be deep, which means that information travels through many layers before an output is generated. Moreover, depending on the task at hand, neurons need to be pre-wired in specific ways. For instance, in convolutional neural networks, which are essential for computer vision, each neuron in the input layers receives input from only a small part of the image. Then, neurons in subsequent layers receive input from neighbouring neurons in the previous layer, thereby gradually pooling over local information in the input image as the data flow through the ever-deeper layers. To train these deep networks, computer scientists had to advance their theoretical understanding of network dynamics to allow for effective weight-initialization strategies and develop new training algorithms to update the many connection weights more efficiently. Another advance was the emergence of powerful computational capabilities, which arrived in the form of graphic processing units (GPUs), initially developed for the gaming industry. Unlike the highly specialized central processing units (CPUs) at the heart of every computer, GPUs perform simpler operations but allow for massive parallelism. This parallelism allows the application of the same algorithmic functions to different data in parallel, which proved ideal for speeding the vast neural-network simulations used in AI, which require that many identical neurons receive distinct inputs. Thus, GPUs have increased sheer computing power. There now exist diverse specialized hardware tailored for deeplearning applications. Finally, and perhaps most importantly, training deep neural networks requires large amounts of data from which synaptic connections are "learned." The underlying optimization algorithms are said to operate end to end in that they directly distill knowledge from vast amounts of data into the connections between the deep network layers. That is ultimately the reason why we speak of "deep" learning.

While its reliance on learning from data is deep learning's strength, it is also one of its potential weaknesses because nothing prevents implicit or explicit biases present in the data from being