Determining the Ethical Codes of Artificial Intelligence-Assisted Informed Consent

The Future of Autonomy

By

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This book first published 2025

Ethics International Press Ltd, UK

British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library

Print Book ISBN: 978-1-83711-280-7

eBook ISBN: 978-1-83711-281-4

Paperback ISBN: 978-1-83711-282-1

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Preface

Despite concerns and biases about artificial intelligence, I believe an unstoppable transformation is on the horizon. Furthermore, humanity needs AI to progress and utilize natural resources effectively. At this point, I want to stress the importance of moving beyond whether artificial intelligence poses risks and instead consider how it can be more beneficial. Both political and ethical discussions should focus on this direction.

This book explores how to act if artificial intelligence gains informed consent and revisits challenging philosophical topics, such as what it means to be human, the nature of free will, the ethical status of artificial intelligence, and the boundaries of autonomy in the age of artificial intelligence.

While reading this book, readers will encounter fundamental issues such as the principles of artificial intelligence and the key elements of informed consent. They will also participate in reflective exercises on possible future scenarios, guided by the philosophical views of prominent thinkers such as Kant, Hegel, and Marx, who have significantly influenced the framework of contemporary societal thought.

Fatih Aydin
Eskisehir, 2025

Acknowledgments

I want to thank my professor and advisor, Nilufer Demirsoy, who provided her invaluable help from start to finish the study and throughout the book-writing process.

I also thank my bioethicist and engineering advisors, M. Yusuf Kansiz, C. Hakan Basaran, and Fatih Artvinli, who supported me at every research stage.

Additionally, I want to acknowledge my beloved wife, Ayşe Hüseyinoğlu Aydin, who supported me during this time with her intellectual insight and open-mindedness.

I wish to express my heartfelt appreciation.

Introduction

The Ethical Frontier of Artificial Intelligence

Informed consent has been a part of American law for over 200 years and is based on the principles of human dignity and the right to one's own body (Ersoy, 1995). Throughout history, many painful experiences have shown us the importance of consent, and horrific events in human history, such as Nuremberg and Tuskegee, have proven its vital value. Although informed consent may seem like an agreement or a legal document at first glance, it is a philosophical doctrine as old as humanity. It raises questions about what it means to be human, the limits of individual freedom, whether one person can touch another -even for their good- whether a few people can be sacrificed for the benefit of the majority, and issues of race and gender inequality, age and intelligence differences, the relationship between economic and political status, and even the very question of whether a person is considered human. At its core lies the principle that a human is untouchable without consent.

Of course, at this point, we are confronted with two questions that have been pondered for centuries but remain unresolved: 1. What is a human being? 2. Is free will possible? In this book, we propose that everyone possessing dignity should be recognized as human beings and treated with the respect and dignity they deserve. We further contend that no living being with dignity should be subjected to physical intervention without their consent or that of a legally authorized representative, in accordance with established declarations and ethical guidelines.

The 'free will' concept presents a more complex challenge to informed consent. The crux of the issue lies in the notion of 'will', which can be defined as the driving force behind freedom. In philosophical discourse, 'will' is often understood in two dimensions: the individual will, unique to each person, and the universal will, which emerges from the collective influences of all spatial and temporal elements surrounding the individual.

In this context, when a human being makes a decision, they do so according to a resulting vector z, shaped by the interplay between their individual will (x) and the universal will (y). Through their individual will, people exert an influence on the universal will. In this dynamic interaction, they make a decision shaped by—and simultaneously shape—the will of all humanity and even the universe itself. This can be considered an adaptation of Edward Lorenz's Chaos Theory (Gleick, 2000) to whether humans can make autonomous decisions. Therefore, a subject can only decide with free will in a *metaverse* universe isolated from time and space, where all conditions are under their control, because only then are they both the universal and the particular will. Therefore, under current conditions, it seems impossible to discuss the absolute free will of human beings, who occupy a minimal space both spatially and temporally in our universe, which is part of a more extensive spatial and temporal system; in other words, it seems impossible to discuss perfect informed consent. However, humanity is at least approaching a threshold where informed consent can be more perfect than ever in terms of free will. Following digital consent, artificial intelligence-assisted consent systems, currently used for internet data security checks, will soon be applied in finance, law, and biomedical contexts (Jones, 2018). In this way, we foresee that many problems such as paternalistic consent, which is still a

problem in obtaining biomedical consent (Taylor, 1987) and the level of education of the patient, the insufficient time required for the consent giver and the consent receiver to understand the procedure (Grundner, 1980; Cassileth, 1980), language and dialect differences, which cause problems in the agreement of consent forms, can be overcome with artificial intelligence. AI systems will provide each patient with a clear explanation of the proposed medical intervention. This includes outlining alternative options, describing the potential consequences of not undergoing the procedure, and discussing its associated risks. The explanation will also include a definition of the concept of risk, tailored to the patient's level of education and understanding, as well as information about the probability of different outcomes. The AI system will be able to understand the questions asked by the people and will be able to explain to them about the issues they are curious about over and over again until the other party understands without any time anxiety, boredom, impatience, or anger; it will be able to present the patients with illustrations, videos, sections from case experiences in the literature, and video recordings of interviews in which other patients who have experienced this intervention and who are at the same educational and social level as the patients describe their experiences before and after the procedure. They will question the reasons for informed consent or refusal, test this with a simple quiz according to the level of education, record all the patient's opinions and decisions regarding consent or refusal, and this will be available for both the patient and the doctor and, in case of a legal dispute, the courts. The patient's illiteracy, disabilities such as deafness or blindness, linguistic problems such as speaking a different language or dialect, educational level, and cognitive deficiencies, including comprehension capacity, will no longer challenge

informed consent. Subjective decisions such as the current mood of the physician who will perform the procedure, unconscious labeling of the patient based on ethnicity, age, gender or education level, and individual interest (profit, a new case that physicians think can increase their skill, fear of malpractice), which are very difficult to change, will be eliminated.

The doctor's conversation with the patient will be subjective and paternalistic, even if it is partly self-interested or to protect the patient based on past painful experiences. For this reason, when a patient and physician engage in shared decision-making, the informed consent process -intended to serve primarily the interests of the more vulnerable party, the patient- can never fully reflect equality regarding informational freedom and decision-making power. As long as it remains impossible to verify how much objective information or implicit influence the stronger party (the physician) holds, the validity of informed consent remains open to question. Informed consent is, to some extent, inherently paternalistic and cannot be left solely to the goodwill, experience, knowledge, or motivation of the physician—who, in the modern context, often takes on the role of a 'father figure.' Humanity has now developed more scientific and objective methods to safeguard the autonomy and rights of individuals.

In summary, technology now enables overcoming problems that hinder informed consent, a symbol of autonomy, such as time, language, education, and social status differences. It is only a matter of time before informed consents obtained with AI are integrated into daily medical practice, and this is inevitable due to the inadequacy of human capacity in the face of constantly evolving and expanding medical knowledge. However, this new

and unfamiliar form of intelligence also brings significant ethical concerns. These machines, which have already demonstrated superior performance compared to their human counterparts, are now technically advanced and have rapidly entered the biomedical field under the premise of 'serving humanity' (Bächle, 2019; Froomkin, 2019; Meskó, 2018). It is indisputable that new ethical violations, which we are not yet aware of, are waiting at our doorstep. A biomedical ethicist—perhaps thinking with the foresight of an engineer or software developer—can play a crucial role in identifying potential ethical issues and proposing solutions before a modern-day 'Tuskegee' tragedy unfolds. Such proactive engagement is essential to preventing future human rights violations in the name of scientific progress.

This study aims to investigate the ethical challenges that may arise in the process of obtaining informed consent through the use of AI systems. It seeks to propose a set of ethical codes specifically for AI-assisted informed consent—to define what additional considerations should be incorporated beyond conventional informed consent when it is programmed and delivered by AI systems in patient communication. Our literature review revealed that this topic remains largely unexplored. Given the rapid integration of AI into healthcare, we believe it is both timely and necessary to examine this issue through the lens of biomedical ethics.

Part I

Foundations of Consent and Intelligence

Chapter 1
The Pillars of Informed Consent

The narrowest definition of informed consent refers to a patient's agreement to undergo a surgical procedure or a volunteer's participation in a medical experiment, provided they fully understand what the procedure or study entails (The Webster's Medical Desk Dictionary, 1986). The American College of Physicians Ethics Manual states, "Every patient has the right to self-determination and the right to know and consent to their treatment" (Ad Hoc Committee on Medical Ethics, 1984). According to a definition provided by Jonsen and colleagues, informed consent is defined as "the voluntary and uncoerced acceptance of a medical intervention by a patient after the physician has provided adequate explanation of the nature of the intervention, its risks and benefits, and alternatives" (Jonsen, 2010).

Informed consent encompasses more than concepts of experimentation and surgery. It applies to any patient-physician interaction that involves making decisions about diagnosis and treatment strategies. Effective personal communication within the physician-patient relationship is the most effective way to obtain informed consent, which cannot be achieved solely by signing a legal consent form (Ad Hoc Committee on Medical Ethics, 1984). The doctrine of informed consent can be rephrased as the "doctrine of informed decision-making," complemented by "informed assent" or "informed refusal" (Connelly, 1988).

The Nuremberg codes establish that "human voluntary consent is essential" (Ghooi, 2011). Informed consent, based on the principles of biomedical ethics (especially autonomy, non-maleficence, and beneficence), is central to the relationship between the patient and the physician. Informed consent is the cornerstone of patient-centered decision-making. Rooted in the principles of biomedical ethics—particularly autonomy, nonmaleficence, and beneficence—it plays a central role in the physician–patient relationship. It requires disclosure and understanding of information and voluntary and competent decision-making (Connelly, 1988).

Informed consent is based on the promotion of individual autonomy, the protection of patients, the avoidance of coercion, the encouragement of self-examination by medical professionals, the promotion of rational decision-making, the support of the subject's autonomy, and participation in controlling biomedical research (Capron, 1974).

Although the above-mentioned elements and principles for informed consent in biomedical ethics are considered, this is not always the case in practice. One study reveals that physicians perceived a loss of individual decision-making power due to patient autonomy during informed consent, felt an increase in professional responsibility, and expressed concern that informed consent would impact the ongoing relationship with the patient (Taylor, 1987). Furthermore, very few consent forms pass readability tests; many patients do not read the forms carefully, and many believe that consent forms protect the rights of physicians (Grundner, 1980; Cassileth et al., 1980). Informed consent does not yet appear to be primarily concerned with

ensuring patients' understanding of medical procedures or enhancing patients' decision-making abilities.

Two models for implementing informed consent are commonly described: the *event and process models*. The event model describes little more than obtaining informed consent: it takes place before treatment, emphasizes the disclosure of information, and expects the patient to make an unassisted acceptance or rejection of the intervention. While this model may fulfill legal requirements, it falls short of promoting the ideals of meaningful patient involvement. Nevertheless, it is the model most frequently used clinically. The process model integrates informed consent into the patient-physician relationship, relying on continuous attention and active patient participation. For this model to be successful, three conditions must be met: (1) The physician must be willing to use a collaborative or negotiation-based model. (2) An interactive rather than paternalistic style is preferred; the patient and physician should strive to understand each other's cultural differences and explore unusual beliefs. (3) Both should be able to articulate the goals of care and expectations of proposed treatments (4) (Connelly, 1988).

Some commentators have defined informed consent as analyzing the shared decision-making process between doctor and patient, thus making informed consent and mutual decision-making synonymous. However, informed consent should not be equated with shared decision-making.

Health professionals often practice informed consent through shared decision-making, an inadequate model for many research and medical treatments. We must distinguish between its actions

and the processes of information exchange and communication, where patients and subjects come to choose interventions, often based on medical advice. Consent and authorization belong to the patient, not a physician or research officer, even when an extensive shared dialogue occurs. Shared decision-making may seem like a worthy ideal in some areas of medicine, but the proposed model of shared decisions is vague and potentially misleading. The attempt to arrive at a "shared decision" due to the clinician deciding A and the patient deciding B minimizes the patient's fundamental ethical and legal right to informed consent and decision-making. Consent and authorization are not shared in an adequately informed model. In short, this model neither defines nor supplants informed consent nor fails to appropriately apply the principle of respect for autonomy (Beauchamp & Childress, 2019). Suppose shared decision-making is framed solely as a justification for allowing patients to participate in decisions about diagnostic and treatment procedures. In that case, it risks perpetuating the legacy of medical paternalism by overlooking patients' fundamental rights to consent to or refuse these interventions.

Two distinct meanings of informed consent emerge in the current literature, policy, and practice (Beauchamp & Childress, 2013). In its primary sense, informed consent is an expression of autonomous choice—an individual's voluntary and informed agreement to undergo a medical intervention or participate in research. In this context, a person must authorize the proposed action through a deliberate and informed decision. A well-known example involves a physician who obtained consent to operate on the right ear of Anna Mohr. During the surgery, the surgeon realized that it was the left ear that needed surgery rather than the

right ear, so he operated on the left ear without the patient's consent. However, the patient sued his doctor after the surgery because his consent had not been obtained. The court ruled that the doctor should have obtained the patient's consent for the left ear surgery: "If a doctor advises a patient to undergo a particular operation, and the patient weighs the dangers and risks associated with the operation and finally gives consent, the doctor may operate on the patient, and the doctor is authorized to operate to the extent of the consent given to him in the contract." As illustrated in the example, informed consent in this first sense refers to the voluntary consent of the patient or subject, given in accordance with the information provided by the person performing the procedure (Beauchamp & Childress, 2013).

In the second sense, informed consent refers to professionals' compliance with social consent rules that require them to obtain legally or institutionally valid consent from patients or subjects before proceeding with diagnostic, treatment, or research procedures. Informed consent is not necessarily an autonomous act under these rules and is sometimes not even referred to as authorization. Informed consent is an institutionally or legally effective authorization determined by applicable laws and regulations. For example, a minor may autonomously consent to an intervention, but their authorization may not constitute effective consent under existing legal or institutional rules. Thus, a patient may autonomously consent to an intervention without competently authorizing it and thus without giving informed consent in the strict sense (Beauchamp & Childress, 2013).

Chapter 2
The Anatomy of Autonomy

Informed consent is fundamentally an indicator of autonomy, and its anatomical elements have been repeatedly discussed in the literature. For example, according to the model proposed by Länsimies-Antikainen et al., three main dimensions are defined: preconditions, decision-making activities, and the consequences of decision-making (Länsimies-Antikainen et al., 2007). Preconditions include knowledge, competence, understanding, willingness, voluntariness, and the absence of coercion. The outcomes of decision-making activities are consent, acceptance, or rejection.

The information component refers to the disclosure and often understanding of information. The consent component refers to a voluntary decision and the authorization to proceed. Legal, regulatory, philosophical, medical, and psychological literatures generally support the following elements as components of informed consent: (1) competence (capacity or ability), (2) disclosure, (3) understanding (comprehension), (4) voluntariness, and (5) consent. Some authors present these elements as the foundational components of informed consent. According to this view, a person gives informed consent to an intervention if—and perhaps only if—they are competent to make decisions, receive a comprehensive explanation of the intervention, understand that explanation, act voluntarily, and explicitly agree to the proposed course of action. This five-element definition is far superior to the one-element definition of disclosure that courts and the medical

literature often rely on. However, a more comprehensive seven-element model of informed consent has also been presented:

I. Threshold items (prerequisites)

1. Competence (ability to understand and make decisions)
2. Volunteering (in decision-making)

II. Elements of knowledge

1. Disclosure (of important information)
2. Advice (of a plan)
3. Understanding (of 3 and 4)

III. Elements of consent

1. Decision (in favor of a plan)
2. Authorization (of the chosen plan) (Beauchamp & Childress, 2013)

O'Leary categorized and defined the elements of consent as follows (O'Leary, 2010): competence and capacity; discussion with the patient; disclosure of information, including treatments and alternatives as well as material risks (both standard and serious, rare risks); autonomy; and documentation.

Competence and capacity

"Competence" refers to a patient's legal authority to make decisions. Adult patients, generally defined as those 18 or older, are presumed legally competent to make healthcare decisions unless otherwise ordered by a court. A parent or legal guardian must provide authorization to treat a minor unless the laws of the

country in question recognize certain conditions that may constitute an exception. Underage parents may legally give consent for their health care.

Capacity refers to a medical professional's determination that a patient can make a particular decision at a specific time. To have capacity, patients must understand and reason about their medical condition; appreciate the indications, risks, benefits, and alternatives to proposed treatments; and make informed decisions. If the patient lacks capacity, consent must be obtained from an authorized decision-maker unless an emergency or other exception applies (O'Leary, 2010).

Disclosure of information

Obtaining informed consent is an ethical obligation of the practice of medicine and a legal requirement under statute and case law in many countries (American Medical Association, 2009). Informed consent requires a dialogue between the physician and patient in which the patient is provided with sufficient information to make an informed and respectful decision. The process must also allow patients' questions to be addressed openly and honestly. What constitutes "adequate information"? Two criteria are generally considered for adequate information. These include the "reasonable person" standard (i.e., what a reasonable individual would consider appropriate when making an informed decision) and the "professional practice" standard (i.e., using information that another doctor in the community would disclose under similar circumstances).

Specifically, the informed consent discussion should address the indications for the proposed treatment, provide a clear and

accessible explanation of the procedure in lay terms, and present the available alternatives. Disclosing any financial implications of the proposed and alternative treatments is also essential. A key component of this discussion is the communication of *material risks*—risks a reasonable person would want to know before deciding whether to proceed. Material risks include those that are frequent but carry minimal long-term consequences and those that are rare but may lead to significant morbidity or mortality.

Autonomous authorization

After a dialogue that considers the indications for treatment, explains the material risks, benefits, and alternative options, and answers the patient's questions, the patient is positioned to make an informed decision regarding the proposed care. The patient's authorization to proceed with an intended course of treatment expresses their right to self-determination and is the basis for informed consent.

Documentation

The informed consent process should be documented in the medical record. Several methods exist, including handwritten notes, pre-printed consent forms, and interactive computer programs (O'Leary, 2010).

Chapter 3
A History of Trust:
The Evolution of Consent

Informed consent has evolved over many years and is now implemented across many countries with broadly similar standards, reflecting a shared commitment to patient autonomy and ethical medical practice. The development of informed consent has evolved due to profound experiences and court rulings, each establishing a fundamental principle for informed consent. As surgical standards become increasingly globalized, many countries must adapt practices surrounding the process historically encompassed by the term "informed consent" (Wheeler, 2017).

In 1905, a patient named Ann Mohr consented to surgery on her right ear. During the operation, the surgeon decides that the left ear needs treatment instead of the right and operates on it. The patient sued because the surgery was performed without consent, and the court ruled that although there was no medical error in the surgery, it was "unauthorized touching" and therefore considered to be misconduct. Following this case, it became part of informed consent that the procedure could only intervene in organs authorized by the patient (Mazur, 1986).

In 1914, in a lawsuit brought by the patient Schloendorff against the New York Hospital, the judge ruled that "every person of adult age and average intelligence has the right to determine what is

done to their own body." This case emphasized competence and decision-making rights (Vaccarino, 1978).

In 1918, the Hunter Burroughs case emphasized the need for "disclosure of information" and "voluntariness" to obtain informed consent. The concept of informing the patient, ensuring their voluntariness, and engaging in decision-making was proposed (Purtilo, 1984).

In the 1930s, a woman with Dupuytren's contracture in Canada was told by her surgeon that emergency surgery would restore her lost function within three weeks. However, the patient developed permanent dysfunction after surgery. The patient claimed that she had not been told of such a risk and would have refused surgery if she had known about it. He, therefore, sued the surgeon who operated on him. The Court of Appeal ruled that the surgeon's duty to disclose information did not extend to warnings "... calculated to frighten or upset the patient". Twenty years later, a woman in England developed permanent vocal cord paralysis after undergoing goitre surgery. The patient claimed she had not been misled about the risk, and her surgeon admitted that he had told her there was no risk to her voice... Encouraged by the judge, the jury dismissed the case. These cases raised the question of whether the standard of disclosure should be set by the reasonable patient, not the reasonable doctor.

In 1970 in Canada, a 44-year-old Hungarian man with a headache was diagnosed with carotid atheroma. Elective endarterectomy was recommended to prevent a stroke. The court held that the surgeon knew (or should have known) that the operation posed a four percent risk of death and a ten percent risk of iatrogenic stroke

and that he should have told the patient before the operation and warned him of these risks. He said that a reasonable person in this patient's situation might have chosen to oppose the surgery in the meantime if it had been explained to them. It can be inferred from this that the standard of disclosure in Canada in the 1980s was measured against what a reasonable patient would have required (Wheeler, 2017).

As a child, an Australian patient developed vision loss in his right eye because of a penetrating injury. Forty years later, a surgeon suggested that his damaged eye's appearance (and possibly function) could be surgically improved. Before the surgery, the patient explicitly asked the surgeon what the possible consequences of the surgery might be but did not ask whether surgery on the right eye might cause damage to the other eye. After surgery, the patient's healthy eye was affected, and the patient lost all vision in that eye. Adopting the reasonable patient standard, the Australian court held that this risk of ophthalmia should have been disclosed (Wheeler, 2017).

In 1957, in a legal case between Stanford University and a patient named Salgo, the question of "how much information should be disclosed" was answered. As a result of the decision, the "obligation to warn about possible dangers" was established with the view that "it is a duty to disclose the benefits, harms, and possible dangers that may affect the patient's health and body" (Purtilo, 1984).

These cases highlighted the need to standardize informed consent. As a result, the American Hospital Association published the Patient's Bill of Rights in 1972. The declaration establishes that the

patient has the right to receive accurate and complete information about their diagnosis, treatment, and disease course, to understand the information, and to expect to be enabled to make reasonable decisions (Annas, 2004).

Doctors who carried out inhumane experiments on prisoners of war in Nazi concentration camps during World War II were tried at the Nuremberg Trials in 1947. These experiments conducted without consent forced humanity to determine the principles of informed consent. The following decisions were taken regarding informed consent:

1) The physician must inform the patient.

2) The scope of the duty to inform includes explaining the potential risks of the intervention.

3) The scope of the duty to inform is a question of law, and the physician should not be authorized to determine it.

4) The perspective that the information may harm the patient is only substantiated in certain instances.

The 1949 Nuremberg Code, as these principles were known, established a rule for obtaining the informed consent of volunteers in experiments on humans (Veatch, 1995).

A female patient, Pearce, 14 days after giving birth, pregnant with her sixth baby, approached her obstetrician and asked him to agree to have the child removed. The obstetrician refused, arguing that she should not be treated like a child, and asked her to wait for a standard delivery. He did not explain the risk of the baby being

stillborn. Mrs. Pearce was upset but accepted his advice. Days later, her baby died in the womb. The patient claimed she should have been warned about the risk of stillbirth. In this case, the appeals court had set a standard of disclosure in 2017 that was followed very closely: "...(if) there is a significant risk that would influence a reasonable patient's decision, then it is the doctor's responsibility to inform the patient of that significant risk if the information is needed so that the patient can decide for herself what course she should take in the normal course of events." This principle established the necessity in the UK to use the "reasonable patient" rather than the "reasonable doctor" as the objective standard for disclosing information. With immediate effect, courts no longer require doctors to provide expert evidence on what information should be disclosed to the patient (sometimes beyond identifying the full range of foreseeable risks associated with clinical situations) but instead consider the reasonable patient standard (Wheeler, 2017). Once foreseeable risks were identified, courts felt they could put themselves in the shoes of a reasonable patient and decide which risks would be considered "significant" without assistance. The Pearce maxim was incorporated nearly verbatim into the consent guidelines established by the General Medical Council approximately a decade later (Campbell, 2008).

Mrs. Montgomery was small in stature and had diabetes. Babies of diabetic mothers have a risk of shoulder dystocia, and this risk was not explained to her. The obstetrician's practice was that he "should not waste time" discussing the potential risks of shoulder dystocia. The physician informed the patient that she may elect to undergo a caesarean section, should she desire, as the likelihood of encountering a serious complication attributed to the significant size of the infant is relatively minimal. However, due to the

insufficient explanation of the associated risks, she opted for a vaginal delivery. Labor was induced; the baby was stuck in the birth canal, and a few minutes later, cerebral hypoxia occurred, leading to cerebral palsy and quadriplegia. The court ruled that an elective cesarean section would have prevented the injury. It determined that doctors must ensure patients are informed of any material risks related to proposed treatments and reasonable alternative options. The Court emphasized that when a reasonable person in the patient's position could recognize the significance of the risk, it must be clearly explained. The Supreme Court also took this opportunity to reiterate that a numerical threshold cannot be used to indicate a potential risk.

It provides a persuasive context to argue that, unless the patient in Montgomery's case were adequately informed about the potential risks, she would not have been able to express her views to the surgeon. Suppose you accept that a reasonable woman in Mrs. Montgomery's position would want to know both the risk of mechanical obstruction during labor and the potential to avoid shoulder dystocia by cesarean section. In that case, the objective standard of the threshold described must be that of the reasonable patient, as affirmed by the Supreme Court. Had Ms. Montgomery known the risks she faced (and the potential harm to her baby), she would undoubtedly have requested a caesarean section, and her baby would have avoided quadriplegia. When it occurred, the decision to disclose information was made solely by the obstetrician, and the patient was not fully involved in the decision-making process because she was not adequately informed. Mrs. Montgomery remained unaware of the potential obstetric risks. The Montgomery decision clarified the threshold for informed consent regarding disclosure (Turton, 2019).

Chapter 4
The Rise of Artificial Minds

General Concepts Related to Artificial Intelligence

Artificial intelligence is a term used to describe software that mimics human intelligence. To begin, it is essential to define the concept of intelligence. In its most restricted sense, intelligence can be described as the capacity to perform appropriate actions at opportune moments. Additionally, intelligence may be interpreted as: (1) a trait that an individual possesses when engaging with their environment, (2) a quality that provides the individual with the capability to achieve success or benefit under specific goals or objectives, and (3) the faculty that allows the individual to adjust to varying goals and environmental circumstances (Liao, 2020).

Artificial intelligence refers to systems that exhibit intelligent behavior by analyzing their environment and taking actions with a degree of autonomy to achieve specific goals (EPRS, 2020).

Machine learning is the term used for AI adapting to its environment, particularly in software or robotics, where systems can learn. There are a wide variety of approaches to machine learning, but they generally fall into two categories: Supervised and unsupervised learning. Supervised learning systems typically train AI by presenting Artificial Neural Networks (ANNs) with inputs (e.g., images of animals), each labeled by humans with a corresponding output (e.g., giraffe, lion, gorilla). These inputs and corresponding outputs are collectively called the training data set.