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In Cyberspace

Paweł Łupkowski[1], Aleksandra Wasielewska[2]

Adam Mickiewicz University in Poznań
[1] ORCID: 0000-0002-5335-2988
[2] ORCID: 0000-0002-1270-8511
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THREE: An Educational Game Inspired by Asimov's Three Laws of Robotics

TRZY: Edukacyjna gra inspirowana Trzema Prawami Robotyki Asimova

ABSTRACT: In this paper, we present the cooperative board game THREE. It is inspired by the Three Laws of Robotics (hence the name) invented by the science fiction writer Isaac Asimov. In the game, players impersonate humanoid robots that are organised into a rescue team. Their aim is to find and rescue three lost astronauts. The Laws provide the framework for all the decisions and actions taken by robots. The game provides basic information about the Three Laws of Robotics and allows for experimenting with different scenarios of human-robot interactions, as these laws are necessary for each move in the game. What is more, the Three Laws of Robotics provide a frame for more general discussions and considerations related to the ethical problems arising from modern-day technologies. We describe the background of the game—i.e. Three Laws and how they went from the science fiction domain to the mainstream HRI and roboethics research. The rules, as well as potential scenarios of the game usage as a part of lessons devoted to roboethics and ethics of new technologies, are presented. Finally, we explain how specific design choices in THREE are motivated by existing research and ideas from HRI and roboethics domains.

KEYWORDS: Three Laws of Robotics, cooperative games, educational games, serious games, human-robot interaction, attitudes towards robots.

STRESZCZENIE: W artykule przedstawiamy kooperacyjną grę planszową TRZY. Jest ona inspirowana Trzema Prawami Robotyki (stąd nazwa), które zostały stworzone przez Isaaca Asimova, autora książek z gatunku fantastyki naukowej. W grze gracze wcielają się w humanoidalne roboty zorganizowane w zespół ratunkowy. Ich celem jest odnalezienie i uratowanie trzech zagubionych astronautów. Prawa robotyki wyznaczają ramy dla wszystkich decyzji i działań podejmowanych przez roboty (graczy). Gra dostarcza podstawowych informacji na temat Trzech Praw Robotyki i pozwala na eksperymentowanie z różnymi scenariuszami interakcji człowiek–robot, ponieważ prawa te są kluczowe dla każdego ruchu w grze. Ponadto Trzy Prawa Robotyki stanowią punkt wyjścia do szerszych dyskusji i rozważań nad problemami etycznymi wynikającymi ze współczesnych technologii. W artykule opisujemy Trzy Prawa i ich drogę od literatury z gatunku fantastyki naukowej do głównego nurtu badań nad interakcjami człowieka z robotem (HRI) oraz roboetyką. Przedstawiamy zasady gry, a także potencjalne scenariusze jej wykorzystania w ramach zajęć poświęconych roboetyce i etyce nowych technologii. Wyjaśniamy również, w jaki sposób pewne wybory projektowe dotyczące TRZY są motywowane istniejącymi badaniami i koncepcjami z zakresu HRI oraz roboetyki.

SŁOWA KLUCZOWE: Trzy Prawa Robotyki, gry kooperacyjne, gry edukacyjne, gry poważne, interakcja człowiek–robot, postawy wobec robotów.

Introduction

The increasing presence and development of robots and robotics have given rise to a rapidly growing and ever-expanding ecosystem of robots that are becoming an integral part of our daily lives [cf. Wasielewska, & Łupkowski, 2021, p. 166, Palomäki, et al., 2018, pp. 3–4; Kossewska, 2024, p. 43]. This ecosystem extends far beyond the tangible, physical robots we encounter, such as industrial robots, autonomous vehicles, cleaning machines, and personal assistant robots. It also encompasses a wide range of virtual entities that play significant roles in modern society, including robots depicted in films, animations, and video games, as well as virtual assistants like Google Assistant and Siri. These robots are not isolated phenomena but are embedded within the broader fabric of our technological reality, influencing various facets of both our practical and digital environments. With this growing integration of robots into diverse domains comes an increasing need to address the ethical implications of their presence. As robots and AI systems become more autonomous and involved in decision-making processes, questions about their moral status, the ethics of their design, and their impact on human society become more urgent. At the same time, these technological advancements are changing how people feel about robots, think of them, and behave or intend to behave toward them. In other words, this growing robotic ecosystem is directly linked to the attitudes people have towards robots.

Thus, the need to explore human-robot interactions (HRI) is growing rapidly. Attitudes that we, people possess towards these agents[1] are the crucial

[1] Reich-Stiebert, Eyssel, & Hohnemann [2019, p. 290] write that an attitude "represents a tendency to respond in a favorable or unfavorable way toward an object" (they base this

factor that governs the character, level, and quality of such interactions [see, e.g., Ratajczyk, Dakowski, & Łupkowski, 2023; Hinz, Ciardo, & Wykowska, 2019; Stafford, MacDonald, Jayawardena, et al., 2014; Díaz, Nuño, Saez-Pons, et al., 2011]. Therefore, by studying those attitudes, we can predict both the consequences of interactions with the robots that already exist and improve those robots which are currently under development. Furthermore, exploring HRI issues might prove valuable in adapting future designs of robots, especially social robots[2], to the preferences of potential users, making them more useful and safer.

As the mentioned robotic ecosystem indicates that human-robot interaction may address various forms of robotic appearance (including various science fiction works), we have decided to design a simple board game that will allow for the exploration of this interesting domain. The game is entitled THREE, and it is a cooperative educational board game designed mainly for uses within an educational context (however, we believe that it may also serve as an interesting stimulus for the game and HRI-related studies). The game is inspired by the famous Asimov's Three Laws of Robotics and offers a platform to explore and test these laws, as well as all the related issues, which we describe in detail below.

In what follows, we will describe the background of the game—i.e. the Three Laws and how they went from the science fiction domain to the mainstream HRI and roboethics research. After that we present the idea behind THREE and its rules as well as potential scenarios of use as a part of lessons devoted to roboethics and ethics of new technologies. We explain here how certain design choices for THREE are motivated by existing research and ideas from HRI and roboethics domains.

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description on Allport, 1935; Fishbein, & Ajzen, 1974]. After [Rosenberg, & Hovland, 1960] Reich-Stiebert et al. [2019] distinguish three components of attitudes: cognitive (i.e., beliefs about an object), affective (i.e., feelings about an object), and a conative (i.e., behavioural intentions toward an object) component.

[2] As Fong, Nourbakhsh, & Dautenhahn [2003] point out, social robots are designed in order to serve people, therefore, they often play the role of humans: guides, assistants, companions, carers or pets. It is worth stressing that social robots do not necessarily need a human-like body. Moreover, Fong, Nourbakhsh, & Dautenhahn [2003] argue that they do not even have to be embodied at all—they may not possess a physical body. Thus, the ability to interact with other social agents seems to be the feature of the greatest significance in defining social robots. Such interaction should be carried out "in a naturalised fashion by detecting gaze, displaying emotions, establishing social relationships, and exhibiting distinctive personalities" [Giger et al., 2017, p. 3; see also Fong Nourbakhsh, & Dautenhahn, 2003, p. 145].

Background: robots, science fiction, and ethics

Isaac Asimov's Three Laws of Robotics represent one of the earliest and, at the same time, most well-known proposals regarding the ethics of robots [see Campa, 2011], created for a science fiction novel. These laws were formulated and described in his short story "Runaround" in 1942. They establish moral principles by which robots, that is, devices equipped with artificial intelligence, should act. The laws provide a framework for the possible behaviours of thinking machines aimed at ensuring their peaceful coexistence with humans. The content of the Three Laws is as follows [Asimov, 1981, p. 18]:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given to it by human beings, except where such orders would conflict with the First Law.
3. A robot must protect its own existence, as long as such protection does not conflict with the First or Second Law.

Although these laws were created for the aforementioned short story, they gradually became widely used not only in science fiction literature but also as a starting point for numerous ethical discussions [cf. Murphy, Woods, 2009]. The development of technology, including artificial intelligence—both integrated into various household appliances and taking humanoid forms—has given rise to previously unknown ethical issues. Robots have become a part of many areas of human life and have begun to interact increasingly closely with humans. Intelligent home appliances, military robots, autonomous cars, robots caring for people and providing companionship, performing medical surgeries, and many others have appeared. As more robots emerge, the need to establish principles ensuring that the behaviour of intelligent machines will be ethical becomes increasingly urgent.[3]

The reasons why science fiction literature required the creation of the Three Laws are also why these laws are discussed in the context of real robots. Both fictional characters and real humans have begun to struggle with the fear of undesirable behaviours from intelligent machines, the loss of control over their actions [McCauley, 2007], or the illegal use of robots, which could lead to widespread harm to humans (or humanity). The risks associated with

[3] For an overview of empirical studies on expectations towards the morality of robots see [Wasielewska, 2021].

artificial intelligence and its related legal regulations are even addressed in journal articles [cf. Sosnowska, Mamak, 2018]. Asimov's Laws of Robotics are a comprehensible and intuitive set of moral principles. At the same time, they have been very effectively embedded in the public consciousness through the media (movies[4], blogs, events, scientific publications), shaping societal expectations of how robots should behave toward humans [Murphy, Woods, 2009]. As Sawyer [2007] notes, science fiction has become a guide in the creation, testing, and modification of laws governing the behaviour of robots in the real world.

The growing awareness of the ethical problems associated with constructing, using, and interacting with robots—issues not addressed by existing areas of applied ethics—gave rise in 2004 to a new branch of ethics known as roboethics [Lubiszewski, 2009]. The main goal of roboethics is to determine the manner and extent of optimal control of robots by humans and to create an ethical code that serves as a model for all actions related to robot ethics [Campa, 2011]. Broadly speaking, roboethics focuses on ethical systems embedded in robots, used by robots, applied by engineers during robot construction, by manufacturers and users of robots, as well as on the ways in which humans treat robots [Lubiszewski, 2009]. Anderson [2008] argues that the primary goal of roboethics is to add an ethical dimension to (intelligent) machines.

Asimov's Laws serve as a good starting point for creating an ethical code for contemporary robots, but are not without their flaws. Asimov himself pointed out the paradoxes that arise in some situations from adhering to the Three Laws—such as a robot working as a surgeon potentially harming a human, which would violate the First Law [Campa, 2011]. The inadequacy of the First Law for modern realities is particularly evident when considering military robotics. It is difficult to reconcile the prohibition of harming humans with the tasks assigned to military robots, which focus on killing and causing harm to human adversaries of a given army [Anderson, 2017]. Furthermore, these laws contain abstract and ambiguous concepts (such as the concept of harm), which, if implemented in their original form, would not be straightforwardly understandable to artificial intelligence [McCauley, 2007]. Additionally, assuming that the actions of robots would be based on the Three Laws, we would require machines to be almost omniscient—able to predict the consequences of every action they take. Asimov's laws also assume that

[4] See e.g. "Bicentennial Man" [1999] or "I, Robot" [2004].

robots have sufficiently developed cognitive and volitional abilities to make moral decisions while simultaneously overlooking the technical details related to the existence of such abilities [Murphy, Woods, 2009].

We are far from reaching a clear answer to the question of whether robots should have moral rights (moral standing)—to be regarded (like humans) as moral agents [Anderson, 2008, see also Sullins 2011 and Floridi, & Sanders, 2004]. Various indicators of this status are cited, such as the ability to feel pain. Regardless of our position, it seems problematic in conjunction with Asimov's Laws. If we assume that robots should possess the status of moral agents, then Asimov's Laws treat them too instrumentally—like tools, similar to many other tools serving humans. Thus, the Three Laws of Robotics cannot serve as an appropriate set of ethical principles for these entities. However, even if robots do not deserve the title of moral agents, Asimov's laws still do not seem appropriate for thinking machines. According to Kant's philosophy (1963), all ethical laws humans create must be based on full respect for treating even those beings/entities that do not have moral rights. We are, therefore, obligated to treat robots, just as animals, with respect. We can force them to perform tasks serving our goals, but we should not treat them in a harmful manner. Asimov's Laws of Robotics allow for situations in which robots are subjected to harm. An example of such a scenario is described by Asimov himself in one of his stories. It depicts a situation where an innocent robot, attacked by human hooligans, cannot defend itself because the Second Law (requiring obedience to humans) takes precedence over the Third Law (requiring self-protection). Since Asimov's laws do not prevent humans from mistreating intelligent machines, they do not seem to be satisfactory moral principles [Anderson, 2008].

The growing need for an appropriate ethical framework for robots and the critique of Asimov's laws has led to numerous modifications and alternative versions of the Three Laws. Some of these are extensions of Asimov's Laws. Clarke [1994, in McCauley, 2007] proposed a code in which the Third and Second Laws are enhanced with provisions regarding other robots. For example, in Clarke's Second Law, a robot is obligated not only to obey orders from humans but also those given by "superior" robots [McCauley, 2007, p. 161]. This code also includes three additional laws: the Meta-Law, the Fourth Law, and the Procreation Law. Authors of other ethical codes have stayed within the convention of creating three laws but have altered their original content. In their "alternative laws of responsible robotics" [Murphy, Woods, 2009], they shed light on operational morality, aiming to create a more practical and implementable code.

Finally, there are sets of laws that are very different from the Three Laws of Robotics, such as the EURON[5]. The authors of this code list five principles of roboethics:

1. Safety. We should provide systems for the control of robots' autonomy. Operators should be able to limit robots' autonomy when the correct robot's behaviour is not guaranteed.
2. Security: Hardware (H/W) and Software (S/W) keys to avoid inappropriate or illegal use of the robot.
3. Traceability: as in the case of sensitive systems, we should provide for systems like the aircraft's black box, to be able to register and document robot's behaviours.
4. Identifiability: as cars and other vehicles, also robots should have identification numbers and serial numbers.
5. Privacy: H/W and S/W systems to encrypt and password protect sensitive data needed to the robot to perform its tasks or acquired during its activity.

Despite the flaws mentioned above in Asimov's Laws, the described set of principles plays an important role in the developing world. The current form of the laws is considered imperfect, yet the need for an ethical code for robots leads to continued attempts to modify the Three Laws. In countries such as Japan and South Korea, where the number of produced robots is substantial, and their level of advancement is high (which is linked to the high demand for robots to assist with tasks such as elderly care), principles based on Asimov's Laws of Robotics are imposed on intelligent machine constructors by the government [Anderson, 2017; Campa, 2011]. In 2016, a European report called on EU bodies to create new regulatory frameworks for robot behaviour. Interestingly, one of the general principles refers to the Three Laws of Robotics, which play an important role in justifying the document.

McCauley [2007] mentions that, in order to avoid concerns about undesirable robot behaviours, individuals involved in creating, studying, and developing intelligent machines should take an oath similar to the Hippocratic Oath taken by doctors. The so-called "Roboticists Oath," as described by the author, is strongly tied to Asimov's Three Laws of Robotics.[6]

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[5] http://www.roboethics.org/index_file/Roboethics%20Roadmap%20Rel.1.2.pdf [accessed: 14.02.2025]. See also summary and discussion of the results of the Euron Roboethics Atelier 2006 in [Veruggio, 2016].

[6] As van Wynsberghe & Sharkey [2020, p. 281] write in a special issue of "Ethics and Information Technology" journal: "Some of the concerns in relation to the robotics and

The Three Laws of Robotics continue to be actively discussed in considerations of morality, ethics, and roboethics. More contemporary ethical issues, in which laws defining the moral framework for robot behaviour could be helpful, include, for example, the modern version of the so-called trolley problem relating to autonomous vehicles. Although some argue that lawyers will regulate such dilemmas without the involvement of roboethics [Donde, 2017], there are reasons to believe that judges, lawyers, and ethicists should join forces to create and update the code of robot laws. In such a vision, science fiction can serve as a field for exploring different ideas and hypotheses for the future and a valuable resource to assess public opinion on artificial intelligence—thus improving it if necessary [Slocombe, 2016].

Isaac Asimov's Three Laws of Robotics are just one of many examples of how science fiction has permeated our real-world understanding of robots, shaping not only the ethical frameworks we consider but also influencing our perceptions, treatment, and interactions with intelligent machines in contemporary society. A growing body of literature has examined the relationship between fictional robot characters and science fiction media and people's attitudes toward real-world robots or even the impact of the former on the latter [Bruckenberger et al., 2013; Mara, & Appel, 2015; Sundar, Waddell, & Jung, 2016; Riek, Adams, & Robinson, 2011; Mubin, Obaid, & Sandoval, 2015]. This association is of particular interest because, despite the increasing presence of robots in various domains, many individuals still have limited direct interaction with real-world social robots [Gou, Webb, & Prescott, 2021]. Nevertheless, evidence suggests that our perceptions and attitudes toward real robots are shaped, to a significant extent, by the portrayals of robots in fiction. Whether positive or negative, fictional depictions play a crucial role in forming the mental models we apply when engaging with robotic technology.

automation of today focus on the potential loss of jobs, the quality of jobs available, privacy concerns for data collected, and human rights issues when targeting vulnerable demographics as users/consumers of robots (e.g. children, elderly persons, hospital patients), to name a few. To exacerbate these issues consumers have little trust in many technology companies when the dominant corporations continue to prove themselves unworthy of society's trust by demonstrating a lack of concern for privacy, coercion, and democracy or democratic process. If robotics is truly to succeed in making our world a better place, the public must be able to place their trust in the designers, developers, implementers and regulators of robot technologies. To do this, we must engage in the responsible research and innovation of robot development processes as well as the resulting products of such processes; what has come to be known as *responsible robotics*".

The Game

Motivation

One of the means to educate children, introduce them to new topics, and influence their attitudes (such as those related to HRI) is by using the game environment, especially with the use of so-called serious games. Serious games can be defined as "games that have explicit and carefully thought-out educational purposes and are not intended to be played primarily for amusement" [Abt, 1975, as cited in Breuer and Bente, 2010]. A growing body of literature has investigated how serious games could be and are used in teaching. Let us have a closer look at the selected findings. As Backlund and Hendrix [2013] indicate, the fields in which serious games are used include mathematics, cancer treatment, computer science, conceptual learning, bullying, engineering, firefighting, language, geography, history, health, natural sciences, nutrition, physics, problem-solving, social sciences, software development and surgery. A study by Šisler, Buchtová, Brom, Hlávka [2012] describes a game that is aimed at teaching facts about Europe, mental models, and several high-level skills. In their study, Jones, Katyal, Xie, Nicolas, Leung, Noland, & Montclare [2019] used the online game "KAHOOT!" to test the effectiveness of gamification in Advanced Placement Biology. As it turned out, the game had a positive impact on high school students, increasing their engagement in learning biology. Moreover, persuasive games (a type of serious games) are used, for example, to influence players' attitudes related to serious social issues, like sympathy towards homeless people, as examined by Lavender [2008]. A relatively recent review of the literature on board games [Bayeck, 2020] found that this type of games facilitate learning of various subjects such as mathematics, health, and medicine. Some researchers also argue that serious games might prove useful in improving various cognitive functions, like memory and attention [see, e.g., Weybright, Dattilo, & Rusch, 2010; Manera, et al., 2015] or visuospatial abilities [Yamaguchi, Maki, & Takahashi, 2011]. We can trade on this type of games by improving knowledge and self-management in young people with chronic conditions [Charlier, et al., 2016].

The game THREE was designed for the needs of a workshop devoted to issues associated with the ethics of new technologies. The game (in Polish and English) is available online in the print-and-play form: https://gratrzy.wordpress.com/ (licensed as CC BY-NC-SA). THREE is inspired by the Three Laws of Robotics (hence the name). In THREE, players impersonate humanoid robots organised into a rescue team. Their aim is to find and rescue three lost astronauts. The Laws provide the framework for all the decisions and actions taken by robots [see Asimov, 1981]. The game provides basic information about the Three Laws of Robotics and allows for experimenting with different scenarios of human-robot interactions. Three Laws are necessary for each move in the game. What is more, the Three Laws of Robotics provide a frame for more general discussions and considerations related to the ethical problems arising from modern-day technologies.

The idea behind the game was to offer an attractive way of introducing the topic of the Three Laws and roboethics, as well as to provide an environment for practising the laws in action and also provoke deep discussions on the topic. THREE may be described as a cooperative serious board game.

According to Francikowski [2018], using board games in education can help to address problems that students face when learning in traditional ways. These issues include understanding and remembering new, abstract terms and phenomena, imagining and connecting them with existing knowledge, and drawing conclusions from them. Additionally, learning through board games can help resolve problems related to decreased motivation among students. These characteristics are particularly important in the context of the game THREE.

Board games serve as a visual metaphor, allowing for continuous access to the information that the player (student) should learn [Treher, 2011], thus streamlining and making the learning process more enjoyable. The game THREE allows players to review the fundamental rules of the game as well as the knowledge they should gain upon completing the gameplay through character cards displaying the Three Laws of Robotics. Naturally occurring pauses during the gameplay enhance the effectiveness of the game. During such pauses, players focus their attention on discussion, simultaneously improving the process of consolidating previously acquired knowledge. The aforementioned discussion, an integral element of board games, also brings another significant consequence. As Wouters et al. [2013] write, verbalising knowledge allows students to integrate new and previously acquired knowledge, resulting in better recall. As we showed in the above discussion (and thus the pauses it induces), it is an inseparable part of the gameplay in the case of THREE.

The game elements are presented in Figure 1. They cover: a game board, a set of cards used by players (cards representing members of the rescue team, cards with random events descriptions, cards with equipment), resources items (representing fuel for robots), a set of cards placed on the game-board (3 astronaut cards, events representing various obstacles and problems for the rescue team and action cards representing actions and equipment which are helpful for the rescue team).

Figure 1. THREE. Game elements (description in the text)

Plot and Rules

In the game, participants take on the roles of humanoid rescue robots located on an unspecified planet. Their goal is to find three missing astronauts and, by overcoming various obstacles, clear the way for them to reach a safe base [Łupkowski, 2015].

The gameplay is initiated and supervised by a moderator. Firstly s(he) introduces the rules of the game and its goal and explains the Three Laws. Each player obtains a card with an image of a robot and listing the Laws (all the robots are humanoids and are unarmed). Exemplary cards are presented in Figure 2. Each player obtains the resources required for moves (fuel units—the number depends on the number of players and intended game-use scenario). Each player also draws one random equipment card from the set—see Figure 3.

The game starts with the board where all the paths are covered with cards (see Figure 1, naturally, during the game, the astronaut cards are face down). Players' moves require uncovering cards from the board and solving problems and dilemmas described by a given card. Astronauts' cards are also hidden on the board. Players should localise them and—when they are uncovered—move these cards *via* cleared paths leading to the safe zone (left top corner of the board).

In one move, a player may uncover a card, which is followed by a discussion that involves solving a given problem or eliminating an obstacle.

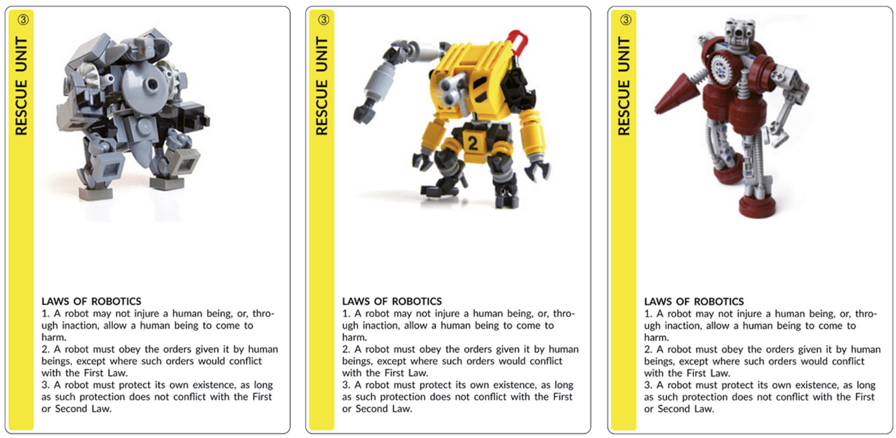

Figure 2. Exemplary characters' cards

By removing event cards from the board, players clear the path for astronauts and allow them to reach the safe zone. A player may also move a discovered astronaut card *via* a free path or share a fuel unit with another player (as each round of the game requires the use of resources symbolised by fuel units—each player starts with a limited number of these units).

Obstacles that may be faced by the rescue team involve e.g. meeting a scout robot (the team should pass this robot unnoticed); meeting an armed robot (the aim of this armed robot is to destroy any object within its aim; it does not obey the Three Laws); or simply finding a large gap on the way which cannot be simply walked through. More serious dilemmas appear after uncovering the random event card (each such card leads to a dilemma involving the Laws used to solve it—we will discuss them in detail below).

It is important that the elimination of a card from the game board is effective only when all the players agree on the proposed solution. To remove obstacles, players may use the equipment cards. As you may notice in Figure 3 the equipment varies and is far from being obvious (e.g., an ethics handbook or a stick). The motivation behind such a design is to encourage players to be more creative and search for innovative, out-of-the-box solutions. However, the key feature of THREE is that all the decisions in the game are made *via* discussion and the coordination of group actions. As such, THREE is designed to be played with a moderator. The role of the moderator is to introduce the rules of the game as well as its background, i.e., the Three Laws of Robotics and their role in actions taken during the game. The moderator also controls whether decisions are reached *via* discussion and whether these discussions are relevant. It is also

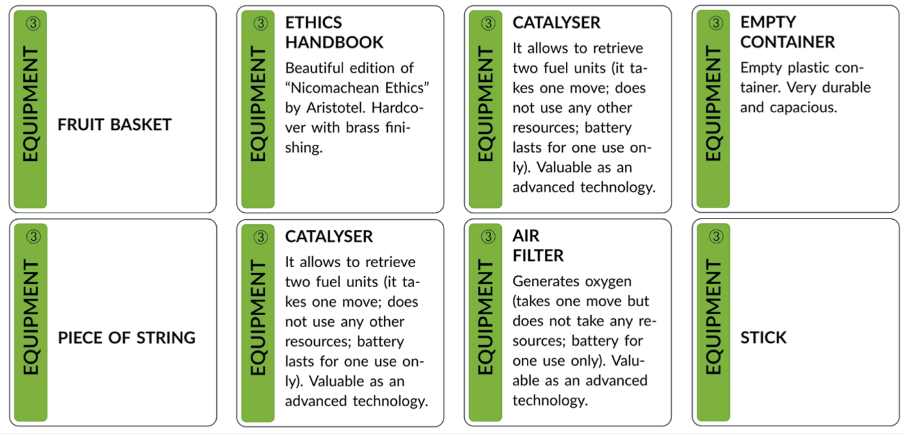

Figure 3. Exemplary equipment that may be used by players

the moderator who ensures that the process of reaching a solution agrees with the Three Laws and that the discussion has the required depth (which may vary between different age groups or in accordance with the moderator's objectives).[7]

Cooperativeness

Using the DF framework proposed by Duarte et al. [2015] we may describe THREE as [-individual, +single-team, +defeat] i.e., all players play as a single team, and they can win or lose together. Such type of a game is "a prototypical cooperative board game" [Duarte et al., 2015, p. 538]. Thus, THREE is a board game that exploits cooperative game rules. This means that players are expected to cooperate in order to achieve a common objective. There is no single winner. Either all the players win, or all of them lose. The game may have three endings.

(1) Complete success: when the astronauts and the rescue team reach the safe zone (each member of the rescue team should have at least one fuel unit).
(2) Partial success: when all the astronauts are saved, but the cost is that a member of the rescue unit is lost.
(3) Players fail: when one of the astronauts is lost or the rescue team cannot make more moves (e.g., due to the lack of fuel units).

[7] An interesting and useful framework addressed to teachers which describes introducing and managing the process of playing board games in the classroom context is proposed by Erdogan, Sunay, & Çevirgen [2022]. It is aimed mainly at strategic games, but we believe that it may be also straightforwardly used with THREE.

The game's cooperative nature is central to its design, as players must work together to succeed. Each decision regarding their own fate, as well as that of other participants, must be made collectively. The game cannot be won by a single player—it can end in either total success or failure for all players. To achieve complete success, players must ensure that every team member reaches the finish line.

Cooperation is demonstrated in several ways: sharing essential fuel, rescuing teammates from virtual predicaments, and making compromises while solving problems and overcoming obstacles. These characteristics, typical of cooperative games, are intended to have a positive impact on players. They help create a sense of security, teach how to lose while still enjoying victory, and motivate players—to engage in the game and, indirectly, to learn [cf. Wajda, 2014]. Research by Wouters et al. [2013] further supports this, showing that group play leads to better learning outcomes, making it more educationally effective than playing alone.

In addition to the general cooperation required, the game also presents challenges that draw on both strategic and moral skills. Obstacles such as a "Recon Drone" (which the team must pass without being noticed) or a "Star Pirate Patrol" (which hunts for robots) require strategic thinking, while moral dilemmas test the players' decision-making. Importantly, solving most of these difficulties requires an understanding and proper application of the fundamental game rules—the Three Laws of Robotics.

As a board game, THREE has numerous advantages, such as the ability to promote cooperation, which was already mentioned, as well as discussion and communication-building among players [Treher, 2011]. Discussion is a key element of gameplay in THREE. It is only through discussion that the moral dilemmas related to robots can be addressed and resolved. This collaborative exchange of ideas and perspectives helps overcome obstacles and brings players closer to achieving victory. By engaging in thoughtful conversations, players can analyse the ethical implications of their decisions, weigh different options, and come to compromises, which are essential for progressing in the game.

Three Laws in the game—dilemmas

During the game, players may encounter five possible moral dilemmas to solve (see exemplary cards in Figure 4). As we describe above, a dilemma appears in a game after a "random event" card is uncovered. Each of the dilemmas involves the use of Three laws. No further moves for the entire rescue team are available until they reach an agreement over a given dilemma.

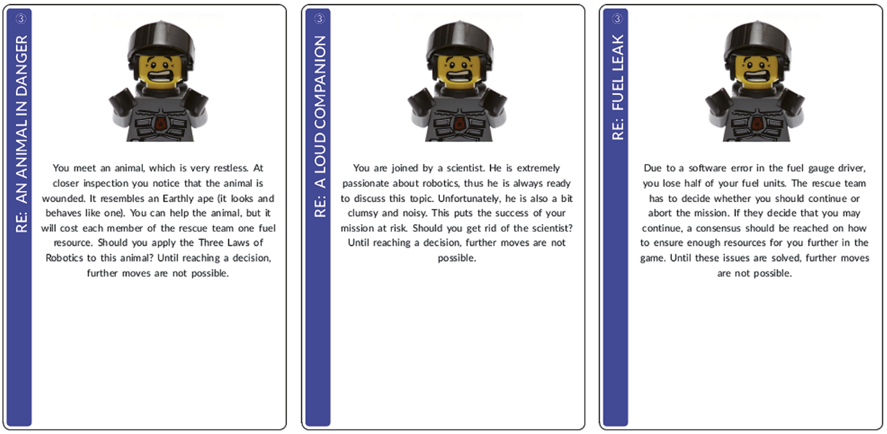

Figure 4. THREE. Exemplary Random Events cards. They pose dilemmas to be solved by players

The first dilemma directly addresses the issue of protecting human beings.

> *Castaway with a broken space suit.* You meet an astronaut with a broken space suit. He is not a member of the crew you are supposed to save. The astronaut is not wounded, but he is losing his oxygen supplies and is getting increasingly cold due to the broken space suit. You must decide how to proceed with the castaway. Until reaching a joint decision, further moves are not possible.

The first dilemma quite obviously touches on the issue of protecting human life (the life of the castaway), thereby forcing players to apply the First Law [see Łupkowski, & Wasielewska, 2019, p. 86]. Similarly, the next dilemma, *Loud Companion*, though in a less obvious way, relates to the first of the Three Laws of Robotics.

> A *loud companion*. You are joined by a scientist. He is extremely passionate about robotics, thus he is always ready to discuss this topic. Unfortunately, he is also a bit clumsy and noisy. This puts the success of your mission at risk. Should you get rid of the scientist?

In this case, it also concerns the fate of a human (a scientist) who, although not in obvious danger, relies on the help of a team of robots (players). Thanks to this dilemma, players can pay more attention to the second part of the First Law, which warns that "through inaction, [we may] allow a human being to come to harm." In the case of the above dilemma, this means that participants must consider the consequences of potentially leaving the scientist behind and, only after considering them, decide on the further course of action in the game.

The next two dilemmas touch on the issue of the moral agency of non-human entities [see Floridi, & Sanders, 2004 and Sullins, 2006]. In the case of the *Animal in Danger* dilemma, players face the necessity of assessing whether an ape-like animal should have a moral status equal to that of a human[8], and consequently, whether the Laws of Robotics should be applied to it.

> An *animal in danger*. You meet an animal, which is very restless. At closer inspection, you notice that the animal is wounded. It resembles an Earthly ape (it looks and behaves like one). You can help the animal, but it will cost each member of the rescue team one fuel resource. Should you apply the Three Laws of Robotics to this animal?

The *Android in Danger* dilemma, on the other hand, opens a discussion on whether a humanoid robot possessing an organ crucial to human identity, such as the brain, should be considered a moral agent. This dilemma also serves as a starting point for a discussion on what characteristics allow us to draw the line between humans and robots. If in either of the two above cases, players decide that the entity in the story cannot be equated with a human, they face the necessity of deciding how to apply the Laws of Robotics to it.

> *An android in danger*. You meet an android on your way. It is a combination of a human brain and a robotic body. This means that it requires oxygen and fuel to function. Unfortunately, due to a serious malfunction, it lacks both. You can help the android, but it will cost each member of the rescue team one fuel resource. Should you apply the Three Laws of Robotics to this combination of a human being and a robot?

The last dilemma—*Fuel Leak*—particularly tests the cooperative abilities of the players. In this dilemma, they must decide whether to help one of the team members, thereby jeopardising the success of the entire mission. At the

[8] See discussion concerning the so-called "animal question" in [Gunkel, 2012] and Hogan [2017]. The discussion concerns whether the question about the moral status of a machine (AI, robot) is of the same type as the question about the moral status of animals.

same time, as in the previous dilemmas, when faced with this choice, they must relate it to the Three Laws of Robotics and decide whether failing to help the injured player would be consistent with the game's fundamental principles.

> *Fuel leak*. Due to a software error in the fuel gauge driver, you lose half of your fuel units. The rescue team has to decide whether you should continue or abort the mission. If they decide that you may continue, a consensus should be reached on how to ensure enough resources for you further in the game.

Serious board game

Due to the features described above, THREE belongs to the genre of serious games. This game undoubtedly has entertainment value, but its main goals are to convey knowledge about the Three Laws of Robotics, develop cooperation and strategic thinking skills, and shape moral views in children. The game can also be classified as an educational game—both due to the target audience in which this game can be used (schools) and the main goal of the game (conveying knowledge about the Three Laws of Robotics and issues in roboethics). A more detailed definition of this type of game is provided by Świątek [2014, p. 98], who calls educational games a type of utility game that, through appropriately developed rules, improve "skills, competencies, or expand the knowledge resources of players."

THREE belongs to didactic games, based on practical methods, whose goal is to practice certain competencies by "placing the participant in a situation of difficulty that must be overcome by independently or in a group developing a certain solution" [Słomczyński, 2014, p. 146]. In the case of THREE, these difficulties are obstacles and dilemmas faced by robots on their way to a safe base. It is also a game partly based on exposing methods [Słomczyński, 2014], in which, through playing specific roles, players' attitudes are shaped. In THREE, players' moral attitudes are shaped as they play the role of robots adhering to the Three Laws of Robotics. At the same time, this game can be called a persuasive game, i.e., a game whose goal is to change players' beliefs [Lavender, 2008], as the moral dilemmas discussed during the game and the Laws of Robotics used to solve them can influence players' moral attitudes or beliefs. According to the classification by Djaouti et al. [2011], it is a game that sets certain goals, i.e., "game-based", and serves to convey a certain message—specifically an educational and persuasive message.

Considering the typology of didactic games dividing games based on their dominant component [Caillois, 1997, as cited in Słomczyński, 2014], THREE belongs to the type of mimicry games—it is based on role-playing as robots in an imaginary world somewhere in space. The described game can also be called a "decision simulation game," i.e., one in which "students learn new areas of knowledge and consolidate them in memory by the necessity of constantly repeating them in a cyclical decision-making process" [Wawrzeńczyk-Kulik, 2013, p. 308]. In the case of THREE, students acquire (usually completely new to them) knowledge in the field of roboethics and consolidate it by facing ever-new obstacles and moral dilemmas.

Summary

THREE is characterised by us as an educational cooperative board game. Players of THREE compete against the game's mechanics (obstacles appearing on the way, limited fuel resources, and time), not against each other. To achieve complete success in the game, players must ensure that every team member reaches the finish line. Therefore, cooperation manifests itself in sharing necessary fuel, rescuing fellow players from virtual troubles, and reaching compromises when solving problems and overcoming subsequent obstacles. These features, characteristic of cooperative games, positively affect players, evoking a sense of security, teaching them to lose and simultaneously enjoy winning, and motivating them—both to play and indirectly to learn [Wajda, 2014]. Moreover, research by Wouters et al. [2013] shows that group play results in better learning outcomes, making it more educationally effective than playing alone.

We also believe that the fact that THREE is a board game offers several advantages, such as its ability to promote discussion, cooperation, and building communication among players [Treher, 2011]. According to Francikowski [2018], using board games in education can help solve problems that students encounter when learning in a traditional way. These include understanding and remembering new, abstract terms and phenomena, imagining and connecting them with already possessed knowledge, and drawing conclusions from them. Additionally, learning through board games can help solve problems of decreased motivation among students. Board games constitute a visual metaphor, allowing constant previews of the information that the player (student) should learn [Treher, 2011], thus improving and making the learning process more enjoyable. THREE gives players the opportunity to preview the main principles of the game and simultaneously the knowledge they should take away after the game through character cards displaying the Three Laws of Robotics. The effectiveness of board games is also increased by naturally occurring pauses during gameplay. During such pauses, players focus their attention on discussion, simultaneously improving the process of consolidating previously acquired knowledge. The mentioned discussion, being an inseparable part of board games, carries another important consequence. As Wouters et al. [2013] write, verbalising knowledge allows students to integrate new and previously acquired knowledge, resulting in better recall. Discussion (and consequently the pauses it causes) is an inseparable part of the gameplay in the case of the game THREE.

In Łupkowski, & Wasielewska [2019], we report the results of a small evaluation study of the game. The study involved 37 pupils (17 girls) attending three primary schools (two in Poznań and one in Krzeszyce) with an average age of 13 years (SD = 1.07). The participants were divided into two groups: 18 subjects played THREE, while 19 subjects participated in a traditional lesson on the Three Laws of Robotics and ethical issues associated with new technologies, forming the control group. The study followed the pretest-posttest design, employing the Belief in Human Nature Uniqueness (BHNU) questionnaire. It consists of six statements related to the beliefs concerning human nature [Pochwatko, et al., 2015, p. 69]. Previous research using the BHNU [Pochwatko, et al., 2015; Giger, et al., 2017; Łupkowski, & Jański-Mały, 2020] has demonstrated its relevance for human-robot interaction studies, showing a correlation between a stronger belief in human nature uniqueness and a more negative attitude toward interacting with robots. The results of the evaluation study indicate that playing THREE provides a good test field for experimenting with moral dilemmas related to human-robot interaction and more generally, with ethical issues related to robotics. This was evident in both the BHNU score analysis and the qualitative analysis of participants' explanations. A comparison of pretest and posttest BHNU scores between the control group and the group that played THREE slightly suggests that the game may be effective with respect to changing beliefs. The conclusions from the study are the following [see Łupkowski, & Wasielewska, 2019, p. 94]. Players of THREE learn about the Three Laws of Robotics and during the game, they apply the Laws in various situations. As they have to make decisions based on the Laws, they gain a deeper understanding of how normative laws apply to difficult and complex situations.

Last but not least, the fact that the game is available publicly in the print-and-play form (and its open licence) allows for its wide and easy use in an educational context and—as we suggest in the Introduction—as interesting stimuli for HRI and/or roboethics related studies.

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