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Coverage of ethics within the artificial intelligence and machine learning academic literature: The case of disabled people

Abstract

Disabled people are often the anticipated users of scientific and technological products and processes advanced and enabled by artificial intelligence (AI) and machine learning (ML). Disabled people are also impacted by societal impacts of AI/ML. Many ethical issues are identified within AI/ML as fields and within individual applications of AI/ML. At the same time, problems have been identified in how ethics discourses engage with disabled people. The aim of our scoping review was to better understand to what extent and how the AI/ML focused academic literature engaged with the ethics of AI/ML in relation to disabled people. Of the n = 1659 abstracts engaging with AI/ML and ethics downloaded from Scopus (which includes all Medline articles) and the 70 databases of EBSCO ALL, we found 54 relevant abstracts using the term "patient" and 11 relevant abstracts mentioning terms linked to "impair*", "disab*" and "deaf". Our study suggests a gap in the literature that should be filled given the many AI/ML related ethical issues identified in the literature and their impact on disabled people.

Keywords: disabled people; people with disabilities; artificial intelligence; machine learning; ethics

Introduction

Artificial intelligence (AI) and machine learning (ML) are applied to many scientific and technological endeavors such as personalized medicine (Feng, Badgeley, Mocco, & Oermann, 2018), medical diagnostics (Ilyasova, Kupriyanov, Paringer, & Kirsh, 2018), big data (André et al., 2018), virtual reality (Falconer & Ortega, 2018), neuroimaging (Feng et al., 2018), brain computer interface (BCI) (Lee, 2016), artificial brain (Buttazzo, 2001), deep brain stimulation (Camara et al., 2015; Catherwood, Finlay, & McLaughlin, 2016), cochlear implants (Meeuws et al., 2017), transcranial magnetic stimulation (Erguzel et al., 2015), gaming (Shubik, 1960), autono- mous cars (Gonzalez et al., 2016), drones for military purposes (Sharkey, 2011), and various assistive technologies.

Disabled people are one group of anticipated user of many AI/ML products and processes including assistive devices and technologies (World Health Organization, 2016) but many problems exist such as costs, access and design issues (Nierling et al., 2018), the imagery of the disabled person (Wolbring & Diep, 2016a; Yumakulov, Yergens, & Wolbring, 2012) and the fear of being judged for using them (Diep & Wolbring, 2013, 2015) or not using them (Nierling et al., 2018).

Discussions around ethics of AI/ML have taken place for some time outside of academic literature (Asilomar and AI conference participants, 2017; European Group on Ethics in Science and New Technologies, 2018; Floridi et al., 2018; IEEE, 2018; Participants in the Forum on the Socially Responsible Development of AI, 2017; Partnership on AI, 2018; The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems, 2018) and in academic literature under the header of "machine ethics" (Köse, 2018) and "AI ethics" (Burton et al., 2017), and in relation to individual applications of AI/ML such as robotics (roboethics) and brain computer interface use (Nijboer, Clausen, Allison, & Haselager, 2013; Sullivan & Illes, 2018).

Disabled people are impacted by AI/ML advancements either directly as potential users of AI/ML products and processes or indirectly by changing societal parameters caused by AI/ML application such as robotics (Wolbring, 2016). As such, it is important to understand how ethics is applied to disabled peo- ple. However, various problems are flagged as problems in how ethics are discussed in relation to disabled people (Wolbring, 2001), such as the imagery of disabled people used (Harris, 2000; Koch, 2001; Reindal, 2000) and what actions are seen as ethical in relation to disabled people (Newell, 1999; Parens & Asch, 1999; Wolbring & Diep, 2016b).

The objective of our study was to gain a better understanding of the extent and how the academic AI/ML literature engaged with disabled people in relation to ethics. Academic literature is one source that informs public policies (Wolbring & Djebrouni, 2018) including non-academic AI-ethics discourses. Given that academic literature can inform non- academic ethics discourses it is important to understand to what extent and how the academic AI/ML ethics literature engages with disabled people to be able to judge whether such literature does justice and informs AI ethics policy discourses in relation to disabled people.

Methods

Study design

We used a modified scoping review drawing from (Arksey & O'Malley, 2005) as the most appropriate approach for the study given the aim of our study. Scoping studies "map rapidly the key concepts underpinning a research area" (Arksey & O'Malley, 2005, p. 21), to identify the extent of research conducted on a given topic (Davis, Drey, & Gould, 2009; Grant & Booth, 2009) and the current understanding of a given topic (S. Anderson, Allen, Peckham, & Goodwin, 2008).

Data sources and data collection

We searched two academic databases, namely EBSCO ALL, an umbrella database that includes over 70 other databases itself and Scopus, which incorporates the full Medline database collection. These two databases contained journals that cover a wide range of disciplines and topics of relevance to the aim of our study. We did not set any time restrictions. The first article with the term "ethic*" and any of the AI terms within the EBSCO databases was published in 1981, while the first article within Scopus was published in 1962.

Search strategy

We performed initially the searches on July 25, 2018 for submission of the article (data not shown in final article version). We redid the exact same searches on February 25, 2019 in the revision stage of the article so that the study dealt with up to date data (Tables 1 and 2).
We employed two search strategies;
Strategy 1, step 1: We searched EBSCO-HOST and Scopus first for the presence of the terms "artificial intelligence" OR "AI" OR "machine learning" in conjunction with "ethic*" in the abstract of the articles (Table 1).
Strategy 1, step 2, we searched the abstracts obtained from step 1 of strategy 1 for the presence of the terms "patient" OR "user*" OR "impair*" OR "disab*" OR "deaf" in the abstracts (Table 2). Results for the terms in Table 2 reflect non-duplicate results. Duplicate results were eliminated by manually eliminat- ing duplicates by reading the abstracts.
Strategy 2, step 1: we used Scopus to search journals that contained "artificial intelligence" OR "machine learning" OR the word "AI" in the journal title and the term "ethic*"in the abstract (Table 1).
Strategy 2, step 2: We searched the obtained abstracts of step 1 of strategy 2 for the presence of the terms "patient" OR "user*" OR "impair*" OR "disab*" OR "deaf" in the abstracts (Table 2). Results for the terms in Table 2 reflect non-duplicate results. Duplicate results were eliminated by manu- ally eliminating duplicates by reading the abstracts.

The restriction of using specific terms and using the abstracts as a source is similar to an exclusion criteria used in a scoping review conducted by others (Burwell, Sample, & Racine, 2017) and was chosen so we could ensure the articles we found focused on AI or ML and ethics. Additionally, in EBSCO, we only searched for scholarly peer reviewed journals, while we searched for reviews, peer reviewed articles, conference papers, and editorials in Scopus. To obtain documents for the qualitative content analysis we downloaded the abstracts obtained from step 1 of strategy 1 and 2 and eliminated duplicate abstracts which were part of our results because sometimes the same articles were obtained from searching EBSCO-HOST and Scopus and sometimes an abstract contained more than one of the AI/ML terms such as abstracts sometimes contained "AI" and "artificial intelligence". Non-duplicate abstracts from strategy 1, step 1 (n = 947) and strategy 2, step 1 (n = 711) were exported into two separate word documents and the word documents were imported into Atlast8.ti – a qualitative data analysis software application for content analysis.

Data analysis

To fulfill the aim of our study we employed a) a descriptive quantitative analysis approach of the databases to obtain the abstracts (Table 1) and to generate hit counts for the presence of the terms "patient" OR "user*" OR "impair*" OR "disab*" OR "deaf" in the abstract (Table 2) and b) a thematic quali- tative content approach (Edling & Mooney Simmie, 2017; Hsieh & Shannon, 2005) on the level of the abstract for the articles found with the term "patient" in the abstract and on the level of the abstract and full text for the relevant articles found with the terms "disab*","impair*" and "deaf" in the abstract (some results obtained with AI were not about arti- ficial intelligence for example). Both authors generated the hit counts for Table 1–2 to ensure that the hits are correct, and both authors read the abstracts and full articles and performed the qualitative content analysis. The authors constantly com- pared their results and peer debriefing

was used to discuss and resolve the few differences between the authors (Baxter & Jack, 2008; Lincoln & Guba, 1985; Shenton, 2004).

Limitation:

Our findings are not to be generalized to the whole academic literature. Our findings also do not cover all words one could use to depict disabled people and as such, our results can not be generalized to every disability term. Our findings, however, allow for conclusions to be made within the parameters of the searches.

Results

Descriptive quantitative data

We first generated article frequency counts to obtain an over- view of a) how many abstracts of articles covered "ethic*" within the AI/ML terms used (Table 1); b) and how often these "ethic*" containing abstracts contain the terms "user*", "patient", 'disab*", "impair*" and "deaf" (Table 2).

Table 1: AI/ML related articles containing ethic* in the abstract:

Search term 1	Search Term 2 in the abstract	Article count found from search terms 1 or 1 and 2 in abstracts (search strategy 1)	Article count found from search term 1in title of journal and search term 2 in abstract (Search strategy 2)
"artificial intelligence"	N/A	84947	490897
"artificial intelligence"	Ethic*	685	557
"AI"	N/A	113365	14276
"AI"	Ethic*	562	146
"Machine Learning"	N/A	147804	23065
"Machine learning"	Ethic*	233	8

Table 1 shows although there are abstracts that contain the term "ethics*" the numbers are not particularly high given the abstracts of articles that cover AI/ML.

Table 2: Presence of the terms user*", "patient", 'disab*", "impair*" OR "deaf" in the ethics containing AI/ML articles

Search term 1	Search Term 2 in the abstract	Search term 3 in abstract	Number of Abstracts from search strategy 1 n=947 containing the search terms (duplicates removed)	Number of abstracts from search strategy 2 n=711 containing the search terms
	Artificial Intelligence			
"artificial intelligence"	Ethic*	User*	63	126
"artificial intelligence"	Ethic*	Disab*	2	5
"artificial intelligence"	Ethic*	Impair*	2	3
"artificial intelligence"	Ethic*	Patient	41	45
"artificial intelligence"	Ethic*	Deaf	1	5
	AI			
"AI"	Ethic*	User*	42	17
"AI"	Ethic*	Disab*	5	2
"AI"	Ethic*	Impair*	5	0
"AI"	Ethic*	Patient	39	7
"AI"	Ethic*	Deaf	0	0
	Machine Learning			
"Machine learning"	Ethic*	User*	31	3
"Machine learning"	Ethic*	Disab*	1	0
"Machine learning"	Ethic*	Impair*	1	0
"Machine learning"	Ethic*	Patient	32	0
"Machine learning"	Ethic*	Deaf	1	0

Table 2 shows that the term user was the dominant one followed by the term "patient". Terms depicting disabled people (not counting the term patient) were used much less or were not present at all.

Qualitative Analysis:

Ethics issues identified in abstracts containing the term "patient"

Many of the patient related articles were false positive as they did not include discussion about ethics issues but used terms such as "ethics approval". Reading the relevant n = 54 abstracts revealed that the two main ethics foci where privacy and other issues linked to the use and generation of big data, n = 24 times, and the use of AI/ML to help with the medical and clinical decision making, n = 17 times. Ethics as a roadblock for advancement was mentioned n = 5 times. Educating profes- sionals was the topic in one article (Lin, Shyu, Lu, & Huang, 2012). Machine medical ethics was mentioned once covering privacy issues, responsibility for error of machine decisions and actions, social inequality linked to access issues, and trust between machines, patients, and professionals (Vallverdú & Casacuberta, 2015). One article generated "a draft for a patient declaration, by which people can determine whether and how they want to be treated and cared for by a robot" (Bendel, 2018, p. 12). One article engaged with the ethical challenge in counterfactual modeling of adversarial patients

(Papangelou, Sechidis, Weatherall, & Brown, 2018), another article cautions that virtual technology "may depersonalize medical interactions and erode therapeutic relationships" (Ho, 2019, p. 36). Four articles deal with various aspects of AI supported surgery including safety (O'sullivan et al.'s, 2019).

Ethics issues identified in the articles containing the term disab*, impair* or deaf in the abstracts

Only n = 11 were relevant (Abascal & Azevedo, 2007; Adams, Encarnação, Rios-Rincón, & Cook, 2018; Bruhn, Homann, & Renzelberg, 2006; Busnel & Giroux, 2010; Fosch-Villaronga & Albo-Canals, 2019; Hersh, 2016; Molina-Carmona, Satorre- Cuerda, Villagrá-Arnedo, & Compañ-Rosique, 2017; Panek et al., 2004; Ramanathan, Sangeetha, Talwai, & Natarajan, 2018; Salvini, Datteri, Laschi, & Dario, 2008; Satterfield & Fabri, 2017). Authors were from UK (n = 3 times); Canada, Portugal, Spain, USA (each n = 2 times) and Germany, Columbia and India (n = 1 times).

Terms used for the recipient were diverse. Disabled people linked to the term users was present n = 7 times including the term neuro-diverse users (Satterfield & Fabri, 2017), disabled people and people with disabilities were used n = 4 times; children with disabilities n = 2 times and 16 other terms were used n = 1 times. Many of the terms had a medical or deficiency connotation of the body such as "children with physical dis- abilities," "secondary disabilities," "motor impairment"; motor disability; cognitively impaired people; disabled recipient of care; disabled patient; people affected by sensorimotor disabil- ities; cognitive disability; visual impairment or explicitly gave a medical definition (Molina-Carmona et al., 2017). Some terms indicated a social angle: "Disabled people's movement," "social model of disability," "disabling technology" and the academic field of "disability studies" were mentioned once.

As to AI/ML supported technologies the following were engaged with: Assistive robot, Human-Computer Interaction (HCI); Communication Technologies; Assistive Technologies; cochlear implant; ubiquitous and pervasive computing, Smart Homes (SH); ambient intelligence, socially assistive robots for elderly people with mild dementia, video games, toilet, hybrid bionic system;

cortical HBS technologies; brain machine inter- face, probabilistic determination of Down's Syndrome and player IT project.
As to application, design was the focus of n = 6 articles; Children Play support; restore motor ability of amputees, and smart home application to interact with residents to foster their autonomy and to provide for health monitoring and home security requirements were other foci. One article focused on how to use narrative ethics to instill ethics in engineering students (Hersh, 2016).
As to the engagement with ethics some were generic without content mentioning the need to investigate ethical implications (Adams et al., 2018), or to follow ethical guidelines (Busnel & Giroux, 2010). One argued for the need to include professional ethics in engineering curricula (Molina-Carmona et al., 2017) and one flagged user autonomy, privacy and consent (Abascal & Azevedo, 2007). One thematized that they had to add an ethics angle to their neurorobotic project proposal due to reviewer comments (Salvini et al., 2008) and then made the point that researchers in biomedical engineering as experts are perfectly positioned to analyze techno-ethical issues to increase "the impact of robotics technologies on human dignity, autonomy, and freedom" (Salvini et al., 2008, p. 434). One made the point that there is the danger that ethical implications and "contra- dicting interests of potential users, who reject the use of certain technologies because of fear and/or expected consequences" are ignored (Bruhn et al., 2006, p. 533) and that ethics and technol- ogy assessment have a complementary relationship whereby both have the task "to make material information as well as normative orientation available" (Bruhn et al., 2006, p. 534). One article engaged extensively with how to instill an ongoing subconscious ethics angle in engineers and proposes a methodology of narrative ethics (Hersh, 2016) while also thematizing that ethics is not cut and dry and that rules and code of ethics is not enough as it does not cover the full context and does not give voice to marginalized individuals and com- munities. One mentioned the following ethical challenges for the use of social robots in therapy: gaps in governance frameworks; unclear medical device regulation; nursing standards; inade- quate safety rules; lack of regulation; safety of users; privacy of user; long-term consequences of use and ethics training as part of STEM education is proposed (Fosch-Villaronga & Albo- Canals, 2019).

Discussion

Ethics theories, concepts and principles are employed to give guidance on what one ought to do or not to do, and we found n = 1659 abstracts that mentioned ethics in conjunc- tion with AI/ML (Table 1). Our findings covering the n = 1659 academic abstracts and 11 full text articles suggest a lack of use of ethics as a framework to engage with AI/ML and disabled people. Many ethics issues pertinent to disabled people were discussed within the abstracts; for example the ethical decision making of robots but without engaging with disabled people. Given the contentious discussions around the imagery of the disabled person (Harris, 2000; Koch, 2001; Reindal, 2000; Wolbring, 2001) including in the social

robotics literature (Yumakulov et al., 2012), and what actions are ethical in relation to disabled people (Newell, 1999; Parens & Asch, 1999; Wolbring & Diep, 2016b), the question arises what will a programmed robot see as ethical actions in relation to disabled people. The concept of Malevolent Artificial Intelligence (MAI)(Aliman, 2017) could be used to discuss what

disabled people might see as malevolent. It is proposed that autonomous systems behavior should follow ethical principles based on a consensus of ethicists (M. Anderson & Anderson, 2014). However, what if the consen- sus of the ethicists is not in sync with views disabled people have of themselves? Pro-active threat research is proposed for AI (Aycock & Sullins, 2010), which fits with the move toward anticipatory governance of science and technology (Diep, 2017; Diep, Cabibihan, & Wolbring, 2014). However, many barriers have been identified for disabled people to shape technology governance discussions in an anticipatory way (Diep, 2017) including that the medical imagery of disabled people is seen to hinder their involvement in policy discussions (Wolbring, Mackay, Rybchinski, & Noga, 2013). The literature acknowledged that ethics depends on socio- cultural context (Dignum, 2017) raising the question as to why disabled people were not covered. One study looking at the 2016 report by the White House, the European Parliament, and the UK House of Commons on AI con- cluded that the various ethical, social, and economic topics were adequately addressed (Cath, Wachter, Mittelstadt, Taddeo, & Floridi, 2018). This article did not cover disabled people and that might explain the statement because if it would have covered disabled people it could not have come to that conclusion given that the US report mentioned dis- abled people only once in that autonomous cars are good for disabled people (Executive Office of the President National Science and Technology Council Committee on Technology, 2016) and the UK report mentioned disabled people only three times each with the angle of robotics helping disabled people (House of Commons Science and Technology, 2016). Furthermore, although the EU report mentioned disabled people more, the coverage mostly highlighted positive con- sequences for employment, everyday life activities and self- determined life and the report asked for equal access to "medical cyber-physical systems" (European Parliament Committee on Legal Affairs, 2016, p. 36). Only one section could be seen to address a problem "whether people living with intellectual disabilities will be able to take independent decisions by means of supported decision-making as out- lined in the Convention on the Rights of Persons with Disabilities with the help of robots and how to divide responsibility among them"(European Parliament Committee on Legal Affairs, 2016, p. 43). Interestingly, the report thematized that the very meaning of 'disability' as an impairment might change with the enablement of generating "people with extraordinary abilities" with the accompanying advantages (European Parliament Committee on Legal Affairs, 2016, p. 42/43). It is acknowledged that teaching ethics to AI practitioners is important (Goldsmith & Burton, 2017). However, beyond the article by Hersh (Hersh, 2016) it is unclear what that would entail in relation to disabled people. In one study, it is acknowledged that ethical, moral, social, cultural, and political issues have been traditionally de-emphasized in research guided by usability concerns (Fallman, 2010). This might explain our findings as the AI/ML focus in relation to disabled people is mostly on the usability of products.

Conclusion and Future research

Our findings suggest minor to no engagement with ethics and AI/ML in relation to disabled people. As such, the academic literature does not provide guidance in relation to AI-ethics and disabled people to non-academic discourses that look at how to govern AI-advancement such as (Asilomar and AI conference participants, 2017; European Group on Ethics in Science and New Technologies, 2018; Floridi et al., 2018; IEEE, 2018; Participants in the Forum on the Socially Responsible Development of AI, 2017; Partnership on AI, 2018; The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems, T. I. G. I, 2018).

Given the breadth of academic disciplines, including disability studies covered by the two databases, and given that we found only one article coming from a disability studies program based out of Bremen, Germany (Bruhn et al., 2006), it might be war- ranted to investigate how academics choose their topics of inves- tigation and why the topics we found lacking in the literature were not chosen. Another angle of investigation could be why students are not acting as knowledge producers on the topics we found lacking. As to disabled students, based on a study that investigated the experience of disabled postsecondary students in postsecond- ary education (Hutcheon & Wolbring, 2012) we suggest that the experience reported (feeling medicalized, hesitant to self-advocate, to try to fit in with the norm) might be factors that hinder disabled students to be knowledge producers especially on contentious issues such as ethics and disabled people.

Our findings suggest that research on how to change what we found by interviewing disabled students, disabled aca- demics, disabled members of the community in general, pro- fessionals engaged with disabled people and members of the AI and the ethics and science and technology governance community might also be useful.

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References

Abascal, J., & Azevedo, L. (2007). Fundamentals of inclusive HCI design. In C. Stephanidis (Ed.), *Universal acess in human computer interac- tion. Coping with diversity. UAHCI 2007, LNCS. Lecture notes in computer science (including subseries lecture notes in artificial intelli- gence and lecture notes in bioinformatics)* (Vol. 4554, pp. 3–9). Berlin, Germany: Springer.

Adams, K., Encarnação, P., Rios-Rincón, A. M., & Cook, A. M. (2018). Will artificial intelligence be a blessing or concern in assistive robots for play? *Journal of Human Growth and Development*, *28*(2), 213–218. doi:10.7322/jhgd.147242

Aliman, N. M. (2017). Malevolent cyborgization. In T. Everitt, B. Goertzel, & A. Potapov (Eds.), *Artificial general intelligence. AGI 2017, LNAI. Lecture notes in computer science (including subseries lecture notes in artificial intelligence and lecture notes in bioinfor- matics*) (Vol. 10414, pp. 188–197). Berlin, Germany: Springer.

Anderson, M., & Anderson, S. L. (2014). *GenEth: A general ethical dilemma analyzer*. Paper presented at the Proceedings of the National Conference on Artificial Intelligence. Retrieved February 27, 2019, from https://www.aaai.org/ocs/index.php/AAAI/AAAI14/paper/view/8308/8428

Anderson, S., Allen, P., Peckham, S., & Goodwin, N. (2008). Asking the right questions: Scoping studies in the commissioning of research on the organisation and delivery of health services. *Health Research Policy and Systems*, *6*(1), 7. doi:10.1186/1478-4505-6-7

André, Q., Carmon, Z., Wertenbroch, K., Crum, A., Frank, D., Goldstein, W., … Yang, H. (2018). Consumer choice and autonomy in the age of artificial intelligence and big data. *Customer Needs and Solutions*, *5*(1–2), 28–37. doi:10.1007/s40547-017-0085-8

Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology*, *8*(1), 19–32. doi:10.1080/1364557032000119616

Asilomar and AI conference participants. (2017). *Asilomar AI principles principles developed in conjunction with the 2017 asilomar conference*. Retrieved from https://futureoflife.org/ai-principles/?cn-reloaded=1

Aycock, J., & Sullins, J. (2010). Ethical proactive threat research. In R. Sion, et al. (Eds.), *Financial cryptography and data security. FC 2010. LNCS. Lecture notes in computer science (including subseries lecture notes in artificial intelligence and lecture notes in bioinformatics)* (Vol. 6054, pp. 231–239). Berlin, Germany: Springer.

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report*, *13*(4), 544–559.

Bendel, O. (2018). Service robots from the perspectives of information and machine ethics. In M. Coeckelbergh (Ed.), *Envisioning robots in society–power, politics, public space* (pp. 12–18). Amsterdam, The Netherlands: IOS Press.

Bruhn, L., Homann, J., & Renzelberg, G. (2006). Participation in devel- opment of computers helping people. In K. Miesenberger, J. Klaus, W.
L. Zagler, & A. I. Karshmer (Eds.), *Computers helping people with special needs. ICCHP 2006. Lecture notes in computer science* (Vol. 4061, pp. 532–535). Berlin, Germany: Springer.

Burton, E., Goldsmith, J., Koenig, S., Kuipers, B., Mattei, N., & Walsh, T. (2017). Ethical considerations in artificial intelligence courses. *AI Magazine*, *38*(2), 22–34. doi:10.1609/aimag.v38i2.2731

Burwell, S., Sample, M., & Racine, E. (2017). Ethical aspects of brain computer interfaces: A scoping review. *BMC Medical Ethics*, *18*. doi:10.1186/s12910-017-0220-y

Busnel, P., & Giroux, S. (2010). Security, privacy, and dependability in smart homes: A pattern catalog approach. In Y. Lee, et al. (Eds.), *Aging friendly technology for health and independence. ICOST 2010, LNCS. Lecture notes in computer science (including subseries lecture notes in artificial intelligence and lecture notes in bioinfor- matics)* (Vol. 6159, pp. 24–31). Berlin, Germany: Springer.

Buttazzo, G. (2001). Artificial consciousness: Utopia or real possibility? *Computer*, *34*(7), 24–30. doi:10.1109/2.933500

Camara, C., Isasi, P., Warwick, K., Ruiz, V., Aziz, T., Stein, J., & Bakštein, E. (2015). Resting tremor classification and detection in Parkinson's disease patients. *Biomedical Signal Processing and Control*, *16*, 88–97. doi:10.1016/j.bspc.2014.09.006

Cath, C., Wachter, S., Mittelstadt, B., Taddeo, M., & Floridi, L. (2018). Artificial intelligence and the 'good society': The US, EU, and UK approach. *Science and Engineering Ethics*, *24*(2), 505–528. doi:10.1007/ s11948-017-9901-7

Catherwood, P., Finlay, D., & McLaughlin, J. (2016). Intelligent subcu- taneous body area networks: Anticipating implantable devices. *IEEE Technology and Society Magazine*, *35*(3), 73–80. doi:10.1109/ MTS.2016.2593219

Davis, K., Drey, N., & Gould, D. (2009). What are scoping studies? A review of the nursing literature. *International Journal of Nursing Studies*, *46*(10), 1386–1400. doi:10.1016/j.ijnurstu.2009.02.010

Diep, L. (2017). *Anticipatory Governance, Anticipatory Advocacy, Knowledge Brokering, and the State of Disabled People's Rights*

Advocacy in Canada: Perspectives of Two Canadian Cross-Disability Rights Organizations (MSc). University of Calgary, University reposi- tory. Retrieved from https://prism.ucalgary.ca/bitstream/handle/11023/4051/ucalgary_2017_diep_lucy.pdf?sequence=3&isAllowed=y

Diep, L., Cabibihan, -J.-J., & Wolbring, G. (2014). Social robotics through an anticipatory governance lens. In M. Beetz, B. Johnston, & M. A. Williams (Eds.), *Social robotics. ICSR 2014. Lecture notes in computer science (including subseries lecture notes in artificial intelligence and lecture notes in bioinformatics)* (Vol. 8755, pp. 24–31, 115–124). Cham: Springer.

Diep, L., & Wolbring, G. (2013). Who needs to fit in? Who gets to stand out? Communication technologies including brain-machine interfaces revealed from the perspectives of special education school teachers through an ableism lens. *Education Sciences*, *3*(1), 30–49. doi:10.3390/ educsci3010030

Diep, L., & Wolbring, G. (2015). Perceptions of brain-machine interface technology among mothers of disabled children. *Disability Studies Quarterly*, *35*(4). doi:10.18061/dsq.v35i4

Dignum, V. (2017). *Responsible autonomy*. Paper presented at the IJCAI International Joint Conference on Artificial Intelligence. Retrieved February 27, 2019, from https://www.ijcai.org/proceedings/2017/ 0655.pdf

Edling, S., & Mooney Simmie, G. (2017). Democracy and emancipation in teacher education: A summative content analysis of teacher educators' democratic assignment expressed in policies for teacher education in Sweden and Ireland between 2000–2010. *Citizenship, Social and Economics Education*, *17*(1), 20–34. doi:10.1177/2047173417743760

Erguzel, T. T., Ozekes, S., Gultekin, S., Tarhan, N., Sayar, G. H., & Bayram, A. (2015). Neural network based response prediction of rTMS in major depressive disorder using QEEG cordance. *Psychiatry Investigation*, *12*(1), 61–65. doi:10.4306/pi.2015.12.1.61

European Group on Ethics in Science and New Technologies. (2018). *Statement on artificial intelligence, robotics and* '*autonomous*' *Systems*. Retrieved from https://ec.europa.eu/research/ege/pdf/ege_ai_state ment_2018.pdf

European Parliament Committee on Legal Affairs. (2016). *REPORT with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL))*. Retrieved from http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-%2f%2fEP%2f%2fNONSGML%2bREPORT%2bA8-2017-0005%2b0%2bDOC%2bPDF%2bV0%2f%2fEN

Executive Office of the President National Science and Technology Council Committee on Technology. (2016). *PREPARING FOR THE FUTURE OF ARTIFICIAL INTELLIGENCE*. Retrieved from https:// obamawhitehouse.archives.gov/sites/default/files/whitehouse_files/microsites/ostp/NSTC/preparing_for_the_future_of_ai.pdf

Falconer, L., & Ortega, M. (2018). *Virtual worlds: Concepts, applications and future directions*. Hauppauge, NY: Nova Science Publishers.

Fallman, D. (2010). A different way of seeing: Albert Borgmann's philo- sophy of technology and human-computer interaction. *AI and Society*, *25*(1), 53–60. doi:10.1007/s00146-009-0234-1

Feng, R., Badgeley, M., Mocco, J., & Oermann, E. (2018). Deep learning guided stroke management: A review of clinical applications. *Journal of Neurointerventional Surgery*, *10*(4), 358–361. doi:10.1136/neurint- surg-2017-013355

Floridi, L., Cowls, J., Beltrametti, M., Chatila, R., Chazerand, P., Dignum, V., … Vayena, E. (2018). An ethical framework for a good AI society: Opportunities, risks, principles, and recommendations. *Mind and Maschine,* in press doi:10.1007/s11023-018-9482-5

Fosch-Villaronga, E., & Albo-Canals, J. (2019). "I'll take care of you," said the robot. *Paladyn, Journal of Behavioral Robotics*, *10*(1), 77–93. doi:10.1515/pjbr-2019-0006

Goldsmith, J., & Burton, E. (2017). *Why teaching ethics to AI practi- tioners is important*. Paper presented at the 31st AAAI Conference on Artificial Intelligence, AAAI 2017. Retrieved February 27, 2019, from https://aaai.org/ocs/index.php/WS/AAAIW17/paper/download/ 15210/14652

Gonzalez, L. F., Montes, G. A., Puig, E., Johnson, S., Mengersen, K., & Gaston, K. J. (2016). Unmanned Aerial Vehicles (UAVs) and artificial intelligence revolutionizing wildlife monitoring and conservation. *Sensors*, *16*(1), 97. doi:10.3390/s16122100

Grant, M. J., & Booth, A. (2009). A typology of reviews: An analysis of 14 review types and associated methodologies. *Health Information & Libraries Journal*, *26*(2), 91–108. doi:10.1111/j.1471-1842.2009.00848.x

Harris, J. (2000). Is there a coherent social conception of disability? *Journal of Medical Ethics*, *26*(2), 95–100.

Hersh, M. A. (2016). Engineers and the other: The role of narrative ethics. *AI and Society*, *31*(3), 327–345. doi:10.1007/s00146-015-0594-7 Ho, A. (2019). Deep ethical learning: Taking the interplay of human and artificial intelligence seriously. *Hastings Center Report*, *49*(1), 36–39. doi:10.1002/hast.977

House of Commons Science and Technology. (2016). *Robotics and arti- ficial intelligence Fifth Report of Session 2016–17*. Retrieved from https://publications.parliament.uk/pa/cm201617/cmselect/cmsctech/ 145/145.pdf

Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, *15*. doi:10.1177/ 1049732305276687

Hutcheon, E. J., & Wolbring, G. (2012). Voices of disabled post second- ary students: Examining higher education disability policy using an ableism lens. *Journal of Diversity in Higher Education*, *5*(1), 39–49. doi:10.1037/a0027002

IEEE. (2018). *Ethics in Action The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems*. Ethically Aligned Design. Retrieved from https://ethicsinaction.ieee.org/

The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems, T. I. G. I. (2018). *Ethically aligned design: A vision for prioritizing human Well-being with autonomous and intelligent systems (A/IS)* Retrieved from http://standards.ieee.org/develop/indconn/ec/ead_v2.pdf

Ilyasova, N., Kupriyanov, A., Paringer, R., & Kirsh, D. (2018). Particular use of BIG DATA in medical diagnostic tasks. *Pattern Recognition and Image Analysis*, *28*(1), 114–121. doi:10.1134/S1054661818010066

Koch, T. (2001). Disability and difference: Balancing social and physical constructions. *Journal of Medical Ethics*, *27*(6), 370–376.

Köse, U. (2018). Are we safe enough in the future of artificial intelli- gence? A discussion on machine ethics and artificial intelligence safety. *BRAIN: Broad Research in Artificial Intelligence & Neuroscience*, *9*(2), 184–197.

Lee, J. (2016). Brain-computer interfaces and dualism: A problem of brain, mind, and body. *AI & Society*, *31*(1), 29–40. doi:10.1007/ s00146-014-0545-8

Lin, C. F., Shyu, M. L., Lu, M. S., & Huang, C. I. (2012). Examining the effectiveness of a distant learning education program: Use of patient safety and reporting law and ethics as

example. In J. J. Park, A. Zomaya, S. S. Yeo, & S. Sahni (Eds.), *Network and parallel computing. NPC 2012, LNCS. Lecture notes in computer science (including sub- series lecture notes in artificial intelligence and lecture notes in bioin- formatics)* (Vol. 7513, pp. 381–385). Berlin, Heidelberg: Springer. Retrieved February 27, 2019, from httphttps://link.springer.com/con tent/pdf/10.1007%2F978-3-642-35606-3_44.pdf

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Beverly Hills, CA: SAGE Publications.

Meeuws, M., Pascoal, D., Bermejo, I., Artaso, M., De Ceulaer, G., & Govaerts, P. J. (2017). Computer-assisted CI fitting: Is the learning capacity of the intelligent agent FOX beneficial for speech understanding? *Cochlear Implants International*, *18*(4), 198–206. doi:10.1080/14670100.2017.1325093

Molina-Carmona, R., Satorre-Cuerda, R., Villagrá-Arnedo, C., & Compañ-Rosique, P. (2017). Training socially responsible engineers by developing accessible video games. In P P. Zaphiris, & A. Ioannou (Eds.), *Learning and collaboration technologies. Technology in education. LCT 2017, LNCS. Lecture notes in computer science (including subseries lecture notes in artificial intelligence and lecture notes in bioinformatics)* (Vol. 10296, pp. 182–201). Berlin, Germany: Springer.

Newell, C. (1999). The social nature of disability, disease and genetics: A response to gillam, persson, holtug, draper and chadwick. *Journal ofMedical Ethics*, *25*(2), 172–175.

Nierling, L., João-Maia, M., Hennen, L., Bratan, T., Kuuk, P., Cas, J., … Wolbring, G. (2018). *Assistive technologies for people with disabilities part III: Perspectives on assistive technologies*. www.europarl.europa.eu/RegData/etudes/IDAN/2018/603218/EPRS_IDA(2018)603218(ANN3)_EN.pdf

Nijboer, F., Clausen, J., Allison, B. Z., & Haselager, P. (2013). The asilomar survey: Stakeholders' opinions on ethical issues related to brain-computer interfacing. *Neuroethics*, *6*(3), 541–578. doi:10.1007/s12152-011-9132-6

O'sullivan, S., Nevejans, N., Allen, C., Blyth, A., Leonard, S., Pagallo, U., … Ashrafian, H. (2019). Legal, regulatory, and ethical frameworks for development of standards in artificial intelligence (AI) and autonomous robotic surgery. *The International Journal of Medical Robotics Computer Assisted Surgery*, *15*(1), e1968. doi:10.1002/rcs.1968

Panek, P., Edelmayer, G., Magnusson, C., Mayer, P., Molenbroek, J. F. M., Neveryd, H., … Zagler, W. L. (2004). Investigations to develop a fully adjustable intelligent toilet for sup- porting old people and persons with disabilities - The friendly rest room (FRR) project. In K. Miesenberger, J. Klaus, W. L. Zagler, & D. Burger (Eds.), *Computers helping people with special needs. ICCHP 2004. Lecture notes in computer science (including subseries lecture notes in artificial intelligence and lecture notes in bioinformatics)* (Vol. 3118, pp. 392–399). Berlin, Germany: Springer.

Papangelou, K., Sechidis, K., Weatherall, J., & Brown, G. (2018). Toward an understanding of adversarial examples in clinical trials. In F. Bonchi, M. Berlingerio, T. Gärtner, N. Hurley, & G. Ifrim (Eds.), *Machine learning and knowledge discovery in databases. ECML PKDD 2018. Lecture notes in computer science* (Vol. 11051, pp. 35–51). Cham: Springer.

Parens, E., & Asch, A. (1999). The disability rights critique of prenatal genetic testing. reflections and recommendations. *Hastings Central Reports*, *29*(5), S1–22.

Participants in the Forum on the Socially Responsible Development of AI. (2017). *Montreal declaration for a responsible development of artificial intelligence*. Retrieved from https://www.montrealdeclara tion-responsibleai.com/the-declaration

Partnership on AI. (2018). *Tenets*. Retrieved from https://www.partner shiponai.org/tenets/
Ramanathan, S., Sangeetha, M., Talwai, S., & Natarajan, S. (2018). *Probabilistic determination of down's syndrome using machine learning techniques*. Paper presented at the 2018 International Conference on Advances in Computing, Communications and Informatics (ICACCI), Bangalore, India
Reindal, S. M. (2000). Disability, gene therapy and eugenics–A challenge to John Harris. *Journal of Medical Ethics*, *26*(2), 89–94.
Salvini, P., Datteri, E., Laschi, C., & Dario, P. (2008). Scientific models and ethical issues in hybrid bionic systems research. *AI and Society*, *22* (3), 431–448. doi:10.1007/s00146-007-0158-6
Satterfield, D., & Fabri, M. (2017). User participatory methods for inclu- sive design and research in autism: A case study in teaching UX design. In A. Marcus, & W. Wang (Eds.), *Design, user experience, and usability: Theory, methodology, and management. DUXU 2017*, *LNCS. Lecture notes in computer science (including subseries lecture notes in artificial intelligence and lecture notes in bioinformatics)* (Vol. 10288, pp. 186–197). Berlin, Germany: Springer.
Sharkey, N. (2011). Automating warfare: Lessons learned from the drones. *Journal of Law, Information and Science*, *21*(2), 140–154. doi:10.5778/JLIS.2011.21.Sharkey.1
Shenton, A. K. (2004). Strategies for ensuring trustworthiness in quali- tative research projects. *Education for Information*, *22*(2), 63–75. doi:10.3233/EFI-2004-22201
Shubik, M. (1960). Bibliography on simulation, gaming, artificial intelli- gence and allied topics. *Journal of the American Statistical Association*, *55*(292), 736–751. doi:10.1080/01621459.1960.10483374
Sullivan, L. S., & Illes, J. (2018). Ethics in published brain–Computer interface research. *Journal of Neural Engineering*, *15*(1), 013001. doi:10.1088/1741-2552/aa8e05
Vallverdú, J., & Casacuberta, D. (2015). Ethical and technical aspects of emotions to create empathy in medical machines. In S. van Rysewyk, & M. Pontier (Eds.), *Intelligent systems, control and automation: Science and engineering* (Vol. 74, pp. 341–362). Berlin, Germany: Springer.
Wolbring, G. (2001). Disabled people's approach to bioethics. *American Journal of Bioethics*, *1*(3), 1–2. doi:10.1162/152651601750418198
Wolbring, G. (2016). Employment, disabled people and robots: What is the narrative in the academic literature and Canadian newspapers? *Societies*, *6*(2), 15. doi:10.3390/soc6020015
Wolbring, G., & Diep, L. (2016a). Cognitive/Neuroenhancement through an ability studies lens. In F. Jotterand & V. Dubljevic (Eds.), *Cognitive enhancement* (pp. 57–75). Oxford, UK: Oxford University Press.
Wolbring, G., & Diep, L. (2016b). The discussions around precision genetic engineering: Role of and impact on disabled people. *Laws*, *5* (3), 37. doi:10.3390/laws5030037
Wolbring, G., & Djebrouni, M. (2018). Motivated reasoning and disabled people. *Interdisciplinary Perspectives on Equality and Diversity*, *4*(2). Retrieved February 27, 2019, from http://journals.hw.ac.uk/index.php/ IPED/article/view/61/47
Wolbring, G., Mackay, R., Rybchinski, T., & Noga, J. (2013). disabled people and the post-2015 development goal agenda through a disability studies lens. *Sustainability*, *5*(10), 4152–4182. doi:10.3390/su5104152
World Health Organization. (2016). *Launch of the first WHO priority assistive products list*. Retrieved from http://www.who.int/phi/imple mentation/assistive_technology/en/

Yumakulov, S., Yergens, D., & Wolbring, G. (2012). Imagery of disabled people within social robotics research. In S. Ge, O. Khatib, -J.-J. Cabibihan, R. Simmons, & M.-A. Williams (Eds.), *Social Robotics* (Vol. 7621, pp. 168–177). Berlin, Germany: Springer.