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Trustworthy artificial intelligence for personalized healthcare decision making: development of open and safe measures, models and methods

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Abstract: Our DIHEML research project develops open and safe measures, models and methods that can support personalized healthcare decision making with trustworthy artificial intelligence addressing carefully patient's rights and data privacy regulation. With our new methodology statistically significant rating differences of questionnaire answers can be linked to machine learning results thus enabling to develop better machine learning for well-personalized care.

Introduction

Developed and initiated by Lauri Lahti, DIHEML research project ("Development of method for interpretation of health expressions based on machine learning to support various care events and persons (DIHEML)") at Aalto University, Finland, since 2017 develops measuring of the health condition and quality of life to assist in developing artificial intelligence to support public sector healthcare and wellbeing by addressing the personalized needs of the patient (Lahti, Lauri, 2017; Lahti, Lauri, 2018; Lahti, Lauri, 2020a; Lahti, Lauri, submitted 2020b).

Everyone is welcome to participate freely in the research collaboration initiatives created by Lauri Lahti based on the DIHEML research project at the web address: https://ilmaisu.cs.aalto.fi/research/welcome/ref-lahti-lauri-20211023

Methods and materials

Our DIHEML research project gathers with an online questionnaire rating answers measuring how the person interprets various real-life and imagined healthcare and health-related situations, defined by *expression statements* (ES), presented in the form of texts, images and videos. Furthermore, the person is asked to answer to various *background questions* (BQ) concerning his/her demographic information, life situation, quality of life, and health condition (such as evaluation about own health, and satisfaction about health and ability). A special emphasis is to collect answers from persons of patient and disabled people's organizations, other health and wellness organizations, and educational institutions as well as organizations of healthcare professionals.

DIHEML research project aims to develop, test and validate a diverse set of alternative approaches of machine learning to develop new models that can fruitfully support modeling healthcare processes and the decision making about the patient's care, especially addressing the patient's personal needs and preferences.

We have extracted the expression statements with the method that we developed and reported in our previous research (Lahti, Lauri, et al., 2018) from a broad collection of national and international health-related resources (such as Terveyskirjasto, 2021; ICD-10, 2011; ICF, 2013; ICHI, 2021; guidelines of THL and WHO; guides and support materials offered by patient and disabled people's organizations; online discussions) and measures, methods, materials and data sets developed and applied in previous health-related research. Also the background questions are based on the same just-mentioned resources, being among others adapted from de Bruin et al. (1996), Nosikov & Gudex (2003), Koskinen et al. (2012), and Aalto et al. (2013).

Results

DIHEML research project has carried out a quantitative cross-sectional study with an online questionnaire gathering the "need for help" rating answers for twenty health-related expression statements concerning the coronavirus COVID-19 epidemic, and nine answers of background questions about the person's health and wellbeing, sex and age (Lahti, Lauri, 2020a; Lahti, Lauri, submitted 2020b). This our mentioned study involved online respondents between 30 May and 3 August 2020 recruited from Finnish patient and disabled people's organizations, other health-related organizations and professionals, and educational institutions (n=673). We identified statistically significant rating differences for several health-related expression statements in respect to groupings based on the answer values of background questions, such as the ratings of suspecting to have the coronavirus infection and having it depending on the estimated health condition, quality of life and sex (Lahti, Lauri, 2020a; Lahti, Lauri, submitted 2020b). With our new methodology statistically significant rating differences can be linked to machine learning results thus enabling to develop better machine learning to identify, interpret and address the patient's needs for well-personalized care (see more details in Lahti, Lauri, submitted 2020b).

Conclusions

Addressing the patient's rights, European Union (EU) data privacy regulation and European Commission's proposal for artificial intelligence regulation, ethical guidelines, key requirements and the self-assessment list to enable trustworthy artificial intelligence (Lahti, Raimo, 2012; Townend et al., 2016; European Commission, 2019, 2020, 2021a, 2021b), DIHEML research project is currently actively advancing multidisciplinary research collaboration efforts to develop new kinds of interpretable learning models for artificial intelligence support units (ILMAISU). The development of these new models is carried out with related supplementing development of suitable measures and methods, all of them being open and safe. Relying on the research collaboration and results DIHEML research project aims to develop trustworthy artificial intelligence solutions that can support especially personalized healthcare decision making.

References:

Aalto, A., Korpilahti, U., Sainio, P., Malmivaara, A., Koskinen, S., Saarni, S., Valkeinen, H., & Luoma, M. (2013). Aikuisten geneeriset elämänlaatumittarit terveys- ja hyvinvointitutkimuksessa sekä terveys- ja kuntoutuspalvelujen vaikutusten arvioinnissa. Terveyden ja hyvinvoinnin laitos (THL). TOIMIA-suositus, TOIMIA-verkosto. http://urn.fi/URN:NBN:fi-fe2016092224121; https://www.terveysportti.fi/dtk/tmi/tms00040

de Bruin, A., Picavet, H., & Nossikov, A. (eds.) (1996). Health interview surveys: towards international harmonization of methods and instruments. World Health Organization (WHO). WHO regional publications, European series, no. 58. ISBN 92-890-1322-2. https://www.euro.who.int/__data/assets/pdf_file/0017/111149/E72841.pdf

European Commission (2019). Ethics guidelines for trustworthy AI. High-Level Expert Group on Artificial Intelligence, European Commission, DOI: 10.2759/177365. https://op.europa.eu/s/snXz

European Commission (2020). The Assessment List for Trustworthy Artificial Intelligence (ALTAI) for self assessment. DOI: 10.2759/002360. https://op.europa.eu/s/ssOB

European Commission (2021a). Proposal for a Regulation of the European Parliament and of the Council Laying down harmonised rules on artificial intelligence (Artificial Intelligence Act) and amending certain Union legislative acts (COM(2021) 206 final), https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021PC0206

European Commission (2021b). The European Commission's Coordinated Plan on Artificial Intelligence (AI) 2021 Review https://ec.europa.eu/newsroom/dae/redirection/document/75787

ICD-10 (2011). International Classification of Diseases (ICD-10), in Finnish. WHO and THL. http://urn.fi/URN:NBN:fi-fe201205085423

ICF (2013). International Classification of Functioning, Disability and Health (ICF), in Finnish. WHO and THL. http://urn.fi/URN:NBN:fi-fe201303252595

ICHI (2021). International Classification of Health Interventions (ICHI). WHO. https://icd.who.int/dev11/l-ichi/en

Koskinen, S., Lundqvist, A., & Ristiluoma, N. (eds.) (2012). Health, functional capacity and welfare in Finland in 2011. National Institute for Health and Welfare in Finland (THL [as of 2019 the new official English name is: Finnish Institute for Health and Welfare]), Report 68/2012. 290 pages. Helsinki, Finland, 2012. ISBN 978-952-245-768-4 (printed), ISBN 978-952-245-769-1 (online publication, http://urn.fi/URN:ISBN:978-952-245-769-1). A health questionnaire appendix "Terveys 2011, tutkimus suomalaisten terveydestä ja toimintakyvystä, terveyskysely", form T4095, https://thl.fi/documents/10531/2797097/T4095_terveyskysely.pdf

Lahti, Lauri (2017). Interpretation of health-related expressions and dialogues: enabling personalized care with contextual measuring and machine learning. International Journal of New Technology and Research (IJNTR), Volume 3, Issue 11, November 2017, pages 171-179, ISSN 2454-4116. Open access: https://www.ijntr.org/download_data/IJNTR03110081.pdf and http://urn.fi/URN:NBN:fi:aalto-201712298340

Lahti, Lauri (2018). Supporting care by interpretation of expressions about patient experience with machine learning. International Journal of New Technology and Research (IJNTR). volume 4, issue 12, December 2018, pages 27-34. ISSN 2454-4116. DOI: 10.31871/IJNTR.4.12.16. https://www.ijntr.org/download_data/IJNTR04120016.pdf and http://urn.fi/URN:NBN:fi:aalto-201812015463

Lahti, Lauri, Tenhunen, Henni, & Nieminen, Marko (2018). How patients talk about care? Identifying patient experience expressions from online discussions. Proc. Medical Informatics Europe (MIE 2018). ISBN 978-1-61499-851-8. http://ebooks.iospress.nl/volumearticle/48765 and http://urn.fi/URN:NBN:fi:aalto-201812106386

Lahti, Lauri (2020a). Interpretation of the patient's need for help can be supported with machine learning. In Mansnérus, Juli, Lahti, Raimo, & Blick, Amanda (eds.), Personalized medicine: legal and ethical challenges. Pages 215-240. Faculty of Law, University of Helsinki, Finland, Forum Iuris Series, Helsinki, 2020. ISBN 978-951-51-6940-2. DOI: 10.31885/9789515150219. Open access: https://www.doi.org/10.31885/9789515169419

Lahti, Lauri (submitted 2020b). Detecting the patient's need for help with machine learning. A preprint of a research article that is currently in peer-review, self-archived on the open-access Arxiv repository on 24 December 2020, and an updated version on 23 March 2021. Open access: https://arxiv.org/abs/2012.13626

Lahti, Raimo (2012). Medical law and biolaw. In Nuotio, K., Melander, S., & Huomo-Kettunen, M. (eds.), Introduction to Finnish Law and Legal Culture. Faculty of Law, University of Helsinki, Finland. Forum Iuris Series, Helsinki. Pages 249-260. ISBN 978-952-10-7817-0.

Nosikov, A., & Gudex, C. (eds.) (2003). EUROHIS: Developing common instruments for health surveys. World Health Organization (WHO) and IOS Press, Amsterdam, the Netherlands. 2003. https://www.euro.who.int/__data/assets/pdf_file/0015/101193/WA9502003EU.pdf

Terveyskirjasto (2021). Healthcare guidelines given by Terveyskirjasto provided by The Finnish Medical Society Duodecim (in Finnish). https://www.terveyskirjasto.fi

Townend, D., Clemens, C., Shaw, D., Brand, H., Nys, H., & Palm, W. (2016). Patients' rights in the European Union: mapping exercise, final report - study. European Commission. DOI: 10.2875/751285. https://op.europa.eu/s/snVa

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Ethics approval, consent to participate and for publication, and availability of open access data:

Aalto University Research Ethics Committee has given a supporting ethical statement for DIHEML research project on 18 June 2019. While taking appropriate and sufficient anonymization actions in respect to addressing the General Data Protection Regulation of the European Union in handling the research data, DIHEML research project publishes an anonymized version of the research data (an open access data set) to be used by anyone for non-commercial purposes (while citing the appropriate research publication of DIHEML research project). An informed consent was obtained from all individual persons participating in the data acquisition and regarding publishing their anonymized data sets. The author did not receive any specific funding for this research work and he has no competing interests.