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How Do Medical Professionals Perceive Artificial Intelligence: An Analysis of Reddit Data

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Abstract. With the advent of big data and the ever-increasing computing power, technologies that use artificial intelligence (AI) are becoming continuously widespread. In several applications, AI has already reached or surpassed human-like capabilities, paving its way in many fields, including medicine. However, when AI takes over tasks from medical professionals (MPs) in making high-stake health-determining decisions, skepticism seems to prevail on the one hand and overconfidence in AI on the other. This research-in-progress aims to investigate these mechanisms to contribute designing a successful human-AI collaboration. To do so, we will examine what MPs understand by the broad concept of AI, how opinions about AI arose, and what MPs' emotions are. Therefore, we will analyze AI-related data of medical subreddits using natural language processing (NLP) techniques and qualitative analysis.

Keywords: Artificial Intelligence (AI), Human-AI-Collaboration, Medicine

1 Introduction

Digital technologies promise to address current issues (e.g., shortage of MPs and challenging work conditions [1–3]) in health care. With the rise of AI, the increasing amount of medical data available becomes also more valuable and usable [4]. As these data massively exceed human cognitive capacities, AI-based systems (i.e., systems employing capabilities developed in AI research [5]) are more than considered to help by sorting and analyzing data. For example, research has shown that AI, with its ability to process and learn from large data sets, can play an important role in various tasks such as diagnosis [6], treatment [7], or clinical decision making [8].

However, high expectations of the introduction of AI-based systems [9] are also changing the beliefs about the future role of physicians' work, thus altering perceptions of vital job characteristics such as their autonomy [10, 11]. In areas where AI already performs better than humans this leads to fears of replacement [12]. Thereby, perceptions of AI amongst MPs partially results from a lack of a unified definition of AI [13]. Due to the innovativeness and novelty of AI-enabled healthcare technologies and its limited application in clinical practice, many MPs currently have various notions and perceptions of AI arising from social influences, stereotypes, and their own definition of healthcare technologies and their role for practice [14].

Although research suggests that the importance of attitude towards technology for the prediction of an effective collaboration between human and AI increases [15], there is a lack of research investigating the understanding of AI and its consequences for collaboration. Therefore, we propose the following research question (RQ):

RQ: What are MPs' perceptions and attitudes towards AI-enabled technologies and how do they affect the collaboration between human actor and AI?

To reach this objective, we crawled posts and comments from MPs on the social media platform Reddit to analyze characteristic contents and patterns concerning (potential) human-AI collaboration.

2 Background

2.1 AI in the medical sector

To meet increasing levels of case complexity and workload, digital technologies are utilized to support work routines of MPs. E.g., clinical decision support systems (CDSS) are utilized to predict adverse drug effects [16] or assist MPs finding diagnoses [17]. By integrating AI in these CDSS, performance and reliability increases [18].

However, the majority of MPs lack a comprehensive understanding of AI and its versatile applications, possibly due to shortcomings in application and practical experience [19, 20]. Although MPs seem to expect that AI-enabled technologies might save time or improve the monitoring of patients, Lai et al. [14] conclude that MPs still have only few ideas about what and how AI will be changing their routines and practice. This emphasizes the notion that MPs might generalize specific ideas or perceptions of AI and, therefore, are affected by them during situations in which they (are going to) interact or collaborate with AI-enabled technologies. For example, there seem to be contrary attitudes of skepticism against AI-based advice or overconfidence in AI-based advice [21, 22]. Additionally, there are fears in areas where AI already performs better than humans. In the field of radiology, 38% of MPs are afraid of being replaced by AI [12]. Interestingly, this fear seems to be related to the level of knowledge. The higher the AI-specific knowledge, the lower the fear and the more positive the attitude towards AI [12]. Against this backdrop, research has yet only begun to reason about suitable ways to explore MPs' perception towards AI [23].

Therefore, questions about subjective factors predicting the adoption of AI-enabled systems occur. Considering that non-AI technologies for health care already struggle with adoption due to MPs' reservations [12, 20, 24], research on the impact of human-like augmentation of technologies on their adoption implies that psychological factors like trust or the perception of technology becomes more and more relevant for human-AI collaboration, while other factors traditionally explaining and predicting technology adoption, like ease-of-use, become less relevant [15]. Indeed, ongoing research shows that psychological factors like trust have significant effects on a sustainable and successful collaboration between human and AI-enabled technology [25], as well as a user's personality [26]. Therefore, MPs' attitude towards AI is of high interest for research on the adoption of AI-enabled systems. As Tschandl et al. [18] suggest, there

are likely different types or groups of users amongst MPs, whose attitudes towards AI differ due to their knowledge, medical and technological expertise, and perceptions. The differentiation of these groups and their specific characteristics appears to be vital for the comprehensive implementation and adoption of AI-enabled technology for health care in the near future [19]. Therefore, we seek to understand these attitudes, their origin, and to differentiate types or groups of attitudes, reflected by MPs' connotations with AI and their impact on technology adoption.

2.2 Reddit

Reddit is a social media platform serving as a social news aggregator and contains discussions on various topics. The platform allows registered users to post content in form of text posts, links or pictures etc. and organizes these posts by subject in so-called subreddits. The interaction of the users (called redditors) is designed in a way that users comment the posts and respond back in a conversation tree of comments. The platform is continuously growing and by the end of 2020, it had 52 million daily active users who contributed 303.4 million posts and 2 billion comments [27].

As our goal is to investigate attitudes of MPs towards AI, we focused on the medical subreddits *r/medicine*, *r/radiology*, *r/surgery* and *r/psychiatry*. The subreddit *r/medicine* is one of the biggest medical subreddits. To cover a broader spectrum and to investigate possible differences between medical disciplines, we additionally included related subreddits with a focus on physician-patient interaction (i.e., *r/psychiatry*) and with a focus on technology usage (i.e., *r/radiology* & *r/surgery*). In addition to these selected ones, there are also other medical subreddits (listed in the *r/medicine* wiki). However, these are either very small or do not (only) reflect the perspective of MPs. In general, the chosen subreddits describe themselves as communities of MPs discussing related topics. To ensure professional discussions within the subreddits, there are rules in the communities (e.g., no asking for medical advice or no marketing), which are ensured by the supervision of moderators. As such, reddit is a credible source for collecting relevant information about attitudes of MPs towards AI.

3 Methodology

3.1 Data collection

To gather relevant data for our analysis, we crawled every post in the medical subreddits from 01/01/2015 to 05/01/2021. As the official reddit API is limited to a few requests, we used the Pushshift API, which collects and archives reddit data since 2015 and allows to gather such a huge dataset [28]. The next step was to filter these posts so that only posts related to AI remained. To achieve this, we filtered posts that contained at least one relevant term (e.g., AI, artificial intelligence, AI, XAI, machine learning, ML, deep learning, unsupervised learning, supervised learning, reinforcement learning, natural language processing, NLP, image recognition, or neural network) using regular expressions. After this, we crawled all comments of the relevant posts. However, as the

Pushshift archive is not flawless, we additionally used the Python Reddit API Wrapper [29] directly extracting missing comment information. By combining these methods of data extraction, we were able to recreate historical and recent data reliably. We considered each post with at least one comment to be a relevant document for analysis.

3.2 Data preprocessing and analysis

Before analyzing the data quantitatively in the next step, each document was preprocessed separately. To do so, we lowercased the text, used regex to replace characters not in $\{A-Za-z0-9\}$ with a single space, to remove popular English abbreviations, to replace trailing whitespaces with a single space, and to replace line breaks in the document for a single space. After this, we tokenized the data by spaces and removed common stop-words using the NLTK and spaCy Python library [30, 31]. We did not yet perform word stemming because we were concerned that this might obscure the name of AI frameworks, products, or services that use atypical language and reduce the inference or comprehensibility of the topics. However, since we are still at the beginning of our analysis, further preprocessing is required.

For data analysis, we will take a twofold approach. (1) *Quantitative analysis*: We utilize different types of NLP techniques for data analysis in Python namely Sentiment Analysis and Topic Modeling, which are included in Gensim library [32]. In a first step, to understand connotations MPs use to describe their perceptions and attitude towards AI, we analyze the occurrence of specific terms within our data by underlying broader topics, as well as Latent Dirichlet Allocation [33], a Bayesian approach that models bodies of text as a mixture of underlying latent topics. To differentiate connotations that reflect the perceptions and attitude of MPs towards AI, we use the word2vec technique, a deep learning approach for Sentiment Analysis and efficient estimation of words in vector space [34]. Here, we are able to separate positive, negative, and neutral statements concerning our objective and connect these differentiations to users' attributes, arguments, or beliefs [35, 36]. (2) *Qualitative analysis*: To extract MPs' meaningful expressions reflecting their perceptions and attitudes towards AI and its application in health care, we analyze the selected documents with content analysis referring to the Grounded Theory Method (GTM). GTM appears to be suitable, as research has not yet provided an in-depth understanding of the relationship between attitude towards AI and its possible causes amongst MPs [14]. Following a common approach of GTM [37], we use open, axial and selective coding to build content-related categories and derive possible relationships between them.

4 Preliminary results

After following our described data collection, we crawled 255 posts and 3845 comments in total. We built 146 documents from the subreddit r/medicine, 91 from the subreddit r/radiology, 14 documents from the subreddit r/psychiatry, and 4 documents from the subreddit r/surgery. Members of the community r/medicine (20 comments per post on average) show a stronger participation to discuss posts than other, more specific

communities (between 8 and 9 comments per post on average). Considering the development over time, a positive trend in the discussion about AI in medicine can be noticed over the period from 2015 to 2021. While discussions are steadily increasing in the r/radiology community, there is a decline in the r/medicine subreddit after a strong increase in the years 2016-2018. The other two communities, on the other hand, seem to be just starting discussions about AI. Figure 1 highlights the developments of the AI-related posts in the medical subreddits.

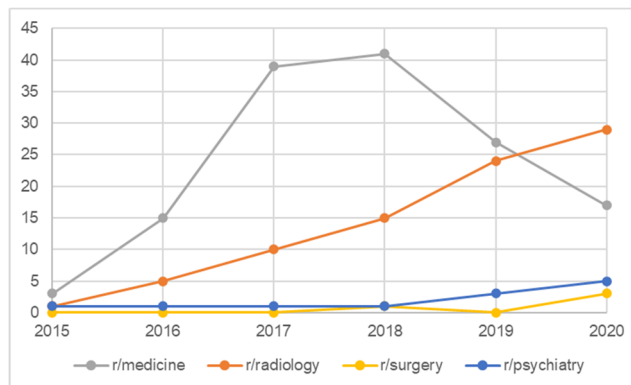


Figure 1. Posts per year in medical subreddits

5 Discussion & Outlook

Our preliminary results show that, in line with technological developments, AI is an important topic amongst MPs. MPs are increasingly concerned with the expected impact of AI [9] and the ubiquity of this topic, as expressed by the increasing discussions in subreddits. Furthermore, the results show that particularly in areas where the progress of AI-based systems has greatly increased and even reached human-like or surpassing capabilities, the discussions increase the most rapidly. For example, in the community r/radiology, which has only 1/7 of the members of r/medicine, more AI-related posts were posted in 2020 than in r/medicine. However, since many radiologists claim to be afraid of being replaced by AI [12], their increasing and stronger exposure to the topic might be a logical consequence. It is interesting that in surgery, which is also a technology-oriented discipline, there is still little discussion. However, as Hashimoto et al. [38] show, AI is just beginning to be integrated into surgical activities that require noticeable human-AI interactions. Not surprisingly, in interaction-based disciplines such as psychiatry, the topic of AI is only just emerging. Through our upcoming data analysis, we will be able to derive more insights concerning MPs' understanding of and attitude towards AI. Arguing that social and psychological factors are increasingly important to predict the adoption of AI-enabled technology and successful collaboration between human and AI [15], our results reflect a first approach to recreate affects and topics that are associated with AI adoption. Therefore, we can reason about the semantic structure of an ongoing discourse between MPs and factors that are relevant for the future direction of technological innovation.

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