Technological Frames: Interpretations about the Futures of Work and Intelligent Machines on Social Media

Ayşe Öcal and Kevin Crowston
Syracuse University School of Information Studies
ayocal@syr.edu, crowston@syr.edu

Under review, please do not cite or quote

Abstract

Purpose: This study explores interpretations and feelings about futures of work and intelligent machines expressed on social media.

Design/methodology/approach: We investigate public interpretations, assumptions and expectations expressed in social media conversations through which users freely share their most recent ideas. In addition to frames, this study also coded the emotions and attitudes expressed in the text data. More specifically, a corpus consisting of 998 unique Reddit post titles and their corresponding 16,611 comments were analyzed by using computer-aided textual analysis comprising a BERTopic model, and two BERT text classification models, one for emotion and the other for sentiment analysis, supported by human judgment. Finally, relationships among frames and attitudes and frames and emotions were examined.

Findings: Twelve clusters were found that related to futures of work with intelligent machines. Based on the prior literature, two frames were chosen from these clusters and analyzed in detail: (1) general impacts of intelligent machines on wealth and society and (2) replacement of tasks (augmentation and substitution). The general attitude observed in conversations was positive, moreover the most common emotion category was approval. Findings also showed there are relationships between frames and attitudes and frames and emotions.

Originality: This work extends the prior literature on a topic relevant for academia and industry. Findings of this research can help realize potential needs and benefits from the public's vantage point in the case of possible transformations in the future of work with intelligent machines. The findings may also help enlighten researchers to shape research directions about futures of work. Furthermore, firms, organizations or industries may also employ framing methods to receive customers' or workers' responses, or even to influence the responses. Aside from the empirical findings, another crucial implication of this work is application of theory of technological frames for systematizing the interpretations of how people conceptualize the future of work with the technology of intelligent machines. This study constitutes a bridge that connects fields of IS, computational science and empirical social research.

1. Introduction

Stanford mathematician and computer scientist John McCarthy linked the term *intelligent machines* to the term *artificial intelligence (AI),* coined in 1956 as "the science and engineering of making intelligent machines, especially intelligent computer programs" (McCarthy, 2007, p. 2). Though there are numerous AI technologies, applications and algorithms, in this article we consider *intelligent machines* as technologies with the ability to learn specific tasks (i.e., training models for desired tasks such as making predictions on the new data or driving a car), to perform these tasks autonomously after learning them (e.g., taking over specific tasks) and to interact with other systems and with humans in the process (e.g., collaborating).

Intelligent machines have been used in many domains from art generation to content edition. With today's advanced technological improvements, their usage is still growing around the world from governments, large organizations, and small businesses to the public, leading changes in daily and work life. More advanced AI applications are constantly emerging. Various interpretations and expectations have been reported in previous literature about possible changes that may come with intelligent machines in modern life, through reshaping transportation, health, science, finance, and the military (Frey & Osborne, 2017; Grace et al., 2018).

Intelligent machines have been integrated into many processes of work life in different fields from hiring employees to categorizing the content of emails and engaging with the customers. Many experts have discussed possible impacts of this integration on work life. For example, a recent BBC article featuring expert opinions highlights mainly the positive aspects of AI: AI can improve workers' skill sets and even the overall work economy today and in the future (Noenickx, 2023). Other expert opinions emphasize these main impacts of AI in work life: *substituting/complementing humans by taking over tasks* and *general impacts on wealth and society* that comprise adding jobs and requiring workers to increase their AI related skills (as in Autor et al., 2020; Frey & Osborne, 2017; Grace et al., 2018; Walsh, 2018).

Although various experts' interpretations and expectations about futures of work with intelligent machines have been reported in previous literature, one question has not been explored sufficiently: *how do non-experts interpret the futures of work with intelligent machines?* This article addresses this question through the theoretical lens of technological frames, chosen because during technology interpretation processes, actors rely on their cognitive frames reflecting what features of technology they focus on (Spieth *et al.*, 2021). Understanding these frames are important because they affect how individuals behave (Davidson & Pai, 2004; Orlikowski & Gash, 1994; Palas & Bunduchi, 2021), develop their feelings and attitudes (Benschop et al., 2022; Spieth et al., 2021; Stam & Stanton, 2010) and how the usage of technologies spreads (Palas & Bunduchi, 2021).

Specifically, this paper examines how the future of work with intelligent machines is framed (i.e., interpreted) in social media, in Reddit submissions (i.e., Reddit posts and comments), what the relevant feelings and attitudes are, and whether the frames, attitudes and emotions are related as in the prior literature (e.g., Benschop et al., 2022; Spieth et al., 2021;

Stam & Stanton, 2010). We explore the interpretation of the future of work by connecting the use of frames to expressed emotions and sentiment to understand if people are optimistic, fearful or uncertain about the developments. This work constitutes a bridge that connects computational science and empirical social research. The empirical part connects a computational text analysis method by BERTopic for automated content analysis (*distant reading*) with a critical summary of representative examples for post titles and comments that discuss futures of work with intelligent machines (*close reading*) to explore relevant interpretations, perceptions, assumptions and expectations.

This interdisciplinary work can contribute to the expansion of information systems knowledge through presenting public interpretations in written conversations on social media, a socio-technical system (Venkatesan and Valecha, 2021) constituting collectives from different segments of the public (Chen & Tomblin, 2021; Hristova & Netov, 2022; Hua et al., 2022; Mahor & Manjhvar, 2022; Ocal, 2023) and having a range of mindsets with various backgrounds, personal experiences and attitudes. Moreover, interpretations about the power of intelligent machines, concerns that illustrate existing or emerging general disputes such as job loss (Brynjolfsson *et al.*, 2014; Kelley *et al.*, 2021), possible human rights and ethical problems stemming from AI usage (e.g., privacy, bias, discrimination) may cause others to internalize these disputes (Gass, 2015). Their spread may be facilitated by social media (Venkatesan and Valecha, 2021) and framing (Adams & Avison, 2003).Thus, understanding how work with intelligent machines is framed in social media can help realize potential problems from the public's vantage point.

2. Theoretical Background

This study is based on framing theory. The notion of *framing,* in general, refers to "processes by which people develop a particular conceptualization of an issue or reorient their thinking about an issue" (Chong & Druckman, 2007, p. 102). Frames reflect individuals' perceptions, interpretations, beliefs, assumptions, and expectations, articulated through language, visual images, metaphors, and stories (Orlikowski and Gash, 1994). Different discussions may be included within a frame, i.e., individuals may disagree on an issue but may share the same frame (Nisbet, 2009), meaning that there is an overlap of cognitive categories and content in their minds. Changes in framing alter sensemaking of information or a situation, which changes the way people respond to this information (Villanueva, 2021), the feelings and the attitudes. That is, the way by which information is introduced can alter the way of comprehending, interpreting, evaluating, making decisions, and acting on an event, issue, situation, or phenomena (Nabi, 2003).

2.1. Technological Frames

Orlikowski and Gash (1994) proposed the concept of *technological frames*, defined as cognitive beliefs, interpretations, assumptions, expectations, and knowledge that people have about technology. These frames subsequently shape understanding of the technology's power, limitations, and risks and so peoples' attitudes and behaviors toward it (Spieth *et al.*, 2021). As a

result, technology is conceptual as well as physical (Kervenoael et al., 2017). Because an individual's technological frame constructs their interpretation of the technology, the frame is expected to affect their attitudes towards that technology (Spieth et al., 2021). Furthermore, frames might manipulate peoples' decision-making behavior related to technology use or support of its use. For example, Benschop et al.'s (2022) research revealed that newly proposed information systems are framed more positively, while the existing information systems are framed with more negative adjectives. In this example, the type of framing could cause a subconscious bias on decision-makers regarding investing in new information systems projects (Benschop et al., 2022).

Technological frames have been studied at the individual, group, organizational, and even industry levels (Davidson & Pai, 2004). For example, technological frames have been researched in the information systems field at the organization level in studies by Davidson (2006); Davidson and Pai (2004); Olesen (2014); Orlikowski and Gash (1994); and Walsh (1995) and at the individual level by Guenduez et al. (2020), who explored what public managers think about big data. Like Guenduez et al.(2020), we explore the frames at the individual level.

Entman (1993) provides a universal understanding of *framing theory* by focusing on its communication. Peoples' own conceptualizations of interpreted reality are "frames in thought" and "frames in communication" are shared through speech or writing (Chong & Druckman, 2007; Stecula & Merkley, 2019) as reflections of "frames in thought." Namely, "frame in thought" is "mentally stored clusters of ideas" in minds (Entman, 1993, p. 53) that shape interpretation of new information (Banks & Koban, 2021); and "framing in communication" is referring to individuals' frames revealed (Chong & Druckman, 2007) in speech or writing. Because frames may be shared by communication (Chong and Druckman, 2007), we examine technological frames in social media conversations. People from diverse cultural and educational backgrounds, personal traits and experiences express their interpretations of AI based on their current relevant experiences and knowledge, and social media bring these people together.

2.1.1. AI Frames

In this research we focus on recently expressed technological frames concerning *AI, the future of AI* in the context of work, and thereby *work with intelligent machines*. The predominant use of technological frames for AI has been in analyzing the presentation of the technology in the media. AI frames identified in prior research shown in Table I.

Insert Table I here

Fast and Horvitz (2017) examined how AI is discussed in the articles published by the New York Times over a 30-year period (more than 3 million articles in total) and how these discussions changed over this period. (The term *frame* is not used explicitly by Fast and Horvitz (2017), but their discussion of "measures" is similar conceptually.) Fast and Horvitz (2017) separated the measures into three categories: general measures such as engagement and optimism vs. pessimism; hope for AI measures as the impact on work (positive), education, transportation,

healthcare, decision making, entertainment, singularity (positive), and merging of human and AI (positive); and concerns for AI such as loss of control, impact on work (negative), military applications, absence of appropriate ethics, lack of progress, singularity (negative), merging of human and AI (negative). They found that discussions of AI have increased steeply since 2009 and that these discussions have been more optimistic than pessimistic. Nevertheless, they also found that worries about loss of control of AI, ethical concerns for AI, and the negative impact of AI on work were common in recent years. They also found that hopes for AI in healthcare and education have grown over time.

Chuan et al. (2019) explored how AI was framed five main American newspapers from 2009 to 2018 through a content analysis grounded on framing theory. They identify the dominant topics and frames, specifically risk and benefit framing, societal versus personal impact framing, and thematic versus episodic issue framing. They found that the benefits of AI are mentioned more frequently than its risks, but risks of AI are often mentioned with greater specificity.

2.2. Impacts of Technology on Work

The AI frames in the prior research touch on many aspects of AI technology and uses. Given our focus on the future of work, we are concerned with frames that touch on work with intelligent machines. We consider that impacts of technology on work has mainly been researched through two perspectives: *general impacts on society* and *substituting/complementing humans by taking over tasks*. We therefore start by reviewing the prior related work from these angles to inform our interpretation of our findings about frames.

2.2.1. General Impacts on Society

AI systems are being applied to many domains, often with high consequences for the subjects of the systems' decisions. For instance, an algorithm was trained on data from cases in New York City to predict whether defendants were at flight risk while waiting for a trial (Simonite, 2017). Those deemed likely to flee (rightly or wrongly) may face extended jail time, with no easy way to challenge the system's recommendations. Use of such systems is growing: e.g., facial recognition systems are used by the police to screen the public; hiring algorithms are used by employers for finding the best job candidates. Utopian views suggest that AI mediated decision-making processes will be fairer, without human prejudice, and efficient (Noenickx, 2023). However, dystopian views point out the complexity and opacity of these algorithms (Munoz et al., 2022) have problematic consequences, such as algorithmic bias leading to gender or racial discrimination. In light of these concerns, there have been calls for regulation to mitigate possible problems such as privacy invasion, surveillance, data bias, and algorithmic discrimination (Nguyen, 2023) and technology-driven unemployment (Waddell & Burton, 2006).

A major concern regarding new technologies are their impacts on employment. One of the most effective ways to increase the public's well-being is working, as worklessness has been generally found to harm physical and mental health (Waddell & Burton, 2006). Employment is crucial for obtaining economic resources, meeting 'psychosocial needs in societies where

employment is the norm', forming 'individual identity, social roles and social status, thus it is essential for physical and mental health; namely for the public well-being and involvement into the today's society (Waddell & Burton, 2006, p. vii). In this regard, the future of work with intelligent machines is concerning. For instance, Goldman Sachs have suggested that AI has the potential of replacing 300 million full-time jobs.

On the other hand, MIT's *2020 Work of the Future* report by Autor et al. (2020) points out that even though technological changes are making some jobs obsolete, they create new ones. New goods and services demand workers in new industries and occupations, thus creating new jobs (Autor et al., 2020). As an example, the computer and Internet innovations of the 1980s and 1990s (Autor et al., 2020) require specialized knowledge and skills to use, control, and repair the technology and have created new jobs such as computer system analysts, software developers (Autor et al., 2019), data analysts. The rising demands for highly-educated workers (e.g., advanced AI knowledge) (Autor et al., 2003) may increase the wealth of society in general (Autor et al., 2019).

In addition to replacing jobs or creating new jobs, technology affects the employment rate in existing jobs. For instance, following the introduction of the Uber and Lyft apps, the rate of U.S. adults working as chauffeurs or taxi drivers tripled (Autor et al., 2019). With the emergence of intelligent machines, debates about impacts have increased rapidly, since substitution and complementation of human's cognitive tasks has started to happen. There are many predictions (as in Frey & Osborne, 2017; Grace et al., 2018; Walsh, 2018) regarding whether intelligent machines create, transform or eliminate occupations.

2.2.2. Substituting Humans by Taking Over Tasks (Full Automation)

We consider in more detail the potential for AI systems to fully automate and thus take over some tasks. Until recently, automation by computerization has been constrained to routine tasks built upon explicit rule-based activities. However, intelligent machines can substitute for labor in a wider range non-routine cognitive tasks (Brynjolfsson *et al.*, 2014; Frey and Osborne, 2017). Such capabilities lead to predictions in intelligent machines will take over a wide range of occupations. Frey and Osborne (2017) proposed three continuing obstacles to automation: jobs needing social intelligence, jobs requiring creativity, and jobs requiring advanced perception or manipulation abilities. Applying that logic, they assessed the task content of 702 occupations to predict which could be automated. Their findings showed that about 47% of total US employment is at a high risk of being replaced. For example, employees in transportation and logistics occupations, office and administrative assistance workers possibly being replaced by computerization soon (Frey and Osborne, 2017). Workers performing non-routine tasks such as legal writing and truck driving are also found to be at the high-risk category of being replaced, while the activity of persuading is not in that category yet (Frey and Osborne, 2017).

Walsh (2018) analyzed 70 of the 720 occupations from Frey and Osborne's study. They administered a survey to experts in robotics and AI and to nonexperts to gather their predictions about the future of work. The results showed that experts saw fewer jobs at risk than nonexperts.

In particular, experts in robotics thought that 29 out of the 70 professions were at risk of being replaced; AI experts, 33. However, non-experts forecasted more jobs at risk, 37 out of the 70. Predictions concerning specific jobs also differed among experts and non-experts in Walsh's survey. For example, barely 12% of the experts forecasted that economists were likely to be replaced in the following twenty years compared to 39% of the non-experts (Walsh, 2018). Anticipations for other professions such as law clerk, market research analyst, marketing specialist, lawyer, physician, surgeon, electrical engineer, technical writer and civil engineer differed among the experts and non-experts in Walsh's survey. For each occupation, about 20% more non-experts projected that these occupations were likely to be automated in the following twenty years than the experts.

2.2.3. Complementing Humans by Supporting Tasks (Augmentation)

We next consider in more detail the possible of AI for task support. In place of full automation considered above, scholars describe AI augmentation as using technology to enhance human capabilities or to collaborate with humans, working together and allocating work tasks to combine strengths (Paul et al., 2022), rather than simply replacing them. For instance, computing and routine tasks can be done by intelligent machines and abstract thinking, creating, deep analysis and meta cognition (managing and controlling cognitive tasks, spontaneous thinking) remain to humans. AI augmentation impacts on organizations and on society are viewed generally positively due to higher performance or improved efficiency (e.g., Brynjolfsson et al., 2014; Paul et al., 2022).

Previous work has examined how humans are partnering and collaborating with intelligent systems, how AI augments humans, e.g., (Bowles et al., 2020; Dougherty, 2019; Engelbart, 1962; Fulbright, 2016; Jiao et al., 2020; Pavel et al., 2003; Raisamo et al., 2019; Tanwar et al., 2020; Zheng et al., 2017). Especially after ChatGPT was released on 30 Nov 2022, the aspect of AI complementing humans through presenting new ideas by answering questions was expressed by scholars. For example, according to Carl Benedikt Frey, an associate Professor of AI & Work at the University of Oxford, "*[AI] can help you brainstorm and generate new ideas*" (Noenickx, 2023). Ethan Mollick, an associate professor, who studies AI and innovation, stated: "*I use it to help me process information, to summarize stuff for me, very much as a partner*" (Noenickx, 2023).

Partnering, collaborating, and augmenting to perform work may yield a kind of human-machine symbiosis. Such arrangements might be considered as *work team*s because these symbioses include tasks, goals, roles, performance demands, and process emphasis, which are considered as work team features (Kozlowski and Bell, 2001). Malone (2018) points out that work teams in which multiple people and machines work together to solve the same problem may be more common than asking computers to solve a whole problem by themselves. Intelligent machines may be a teammate for helping decision making task as well as interacting with humans like chatbots, social bots or more generally conversation agents that facilitate team communication and collaboration through interacting with us (Seeber *et al.*, 2020) and may be integrated into workplaces. This integration requires workers to increase their AI knowledge as

Frey states "I think workers that don't work with AI are going to find their skills [become] obsolete quite rapidly. So, therefore, it's imperative to work with AI to stay employed, stay productive and have up to date skills" (Noenickx, 2023).

In summary, a widespread prediction of the impact of intelligent machines is the automation of work making certain workers redundant. However, the impacts differ across occupations and are feared more by nonexperts than experts. Walsh suggests that even if some tasks may be automated in certain occupations, experts do not expect full automation for the next two decades. An alternative perspective expects to see people using technology to work more effectively or to partner in human-machine teams. However, to make these collaborations effective requires new skills, as the machines are not equivalent in capability to humans. Human-level machine intelligence is not seen by experts as likely in the near term. Interestingly, the respondents in Grace et al.'s survey viewed reaching human level machine intelligence as a positive advancement. However, the gap between expert and nonexpert expectations raises the question of how the general public interprets the future of work with intelligent machines.

3. Methods

Social media data usage has been increasing in various types of research work to explore the freely expressed public interpretations, e.g., Chen and Tomblin (2021); Hristova and Netov (2022); Hua et al.(2022); Mahor and Manjhvar (2022); Ocal (2023); Sai Kumar et al. (2021). This study follows this approach to understand commonly expressed interpretations of a large number of individuals on Reddit through automated content analysis (*distant reading*) and then presents more detailed descriptions of these interpretations through representative examples of post titles and comments on social media that discuss futures of work with intelligent machines (*close reading*).

To identify frames referring to interpretations and expectations about futures of work with intelligent machines, topic modelling using BERTopic was applied to the entire text corpus. The keywords and example posts and comments were reviewed to determine the frame (if any) captured by the cluster. These steps constitute a distant reading of the corpus. Additionally, two BERT classifiers were used to automatically code expressed emotions and sentiment in the submissions. To test the validity of the computer coding, three random sample subsets of posts were manually coded for each task (i.e., classification of frames, emotions and sentiment). As a final step of distant reading, the relationships among specific emotions, attitudes and clusters were investigated by χ^2 tests.

Afterwards, samples of post titles and comments associated with two chosen frames based on the literature review were deeply analyzed, constituting close reading. Close reading is "reading to uncover layers of meaning that lead to deep comprehension" (Jänicke et al., 2015, p. 2) and a qualitative analysis of text to explore themes, metaphors, and interpretations (Nguyen, 2023). Thus, this study implemented a close-reading approach following distant reading to gain a more detailed analysis of interpretations in text data. The details of each step are presented in the subsequent sections.

3.1. Research Site: Reddit

Research related to social media often use Twitter, for several reasons. First, tweets are deemed as "public," (Proferes et al., 2021). Users regularly respond to current events, creating a useful place to obtain observational data (Proferes et al., 2021). Until recently, the system had open APIs, facilitating data collection. In recent years Reddit has gained scholars' attention as a data source (Kitchens et al., 2020; Chen & Tomblin, 2021; Villanueva, 2021; Öcal et al., 2021), leading to our decision to use it as a data source. Reddit has the same advantages as Twitter for research, while offering the following additional advantages. Reddit itself is a huge community consisting of over 50 million daily active users interacting in thousands of smaller communities. These sub-communities within Reddit are called "subreddits," each of which centers on different topics, in which users share their interests, thoughts on relevant content. Reddit posts often share news obtained from traditional media (Villanueva, 2021), and other valuable external sources such as experts' context-related videos (Öcal et al., 2021). Researchers can thus access a large amount of data on various topics created by Reddit users and can select relevant subreddits as their samples to answer their research questions. As an additional advantage, users benefit from a level of anonymity on Reddit not offered on other social media platforms, so users may feel more secure and share more honest thoughts on a topic. Also, as the data are public and pseudonymous (usernames are not real names), research analyzing Reddit data is often exempted from institutional ethics review (Proferes et al., 2021). Due to a variety of advantages, Reddit has been used as a data source in the past decade and much of that analysis has been conducted in computer science and related disciplines using computational methods (Proferes et al., 2021). At the time of the data collection, Reddit had a permissive license that permitted such reuse and posters could anticipate their comments being shared in different ways (none of the subreddits were private).

In the close reading section, we present exact quotations to illustrate interpretations. We considered paraphrasing the quotations but decided against it because of concerns it would change the meaning of the quotations, which is central to our analysis. We did not include Redditors' usernames in attempt to protect their identities, but even if the usernames were found, as noted above, they are pseudonyms, thus the identity of the actual person is not known. We do not foresee any harm from including direct quotations in this paper, since the comments we selected were already shared publicly by their authors to a much wider and more engaged audience. The exposure from an academic paper is insignificant in comparison. Moreover, we are using the comments to illustrate framing, not to critique the posters, so we do not expect our use to affect others' perceptions of the person. Lastly, the quotations do not address personally sensitive data and the topic (the future of AI and work) is not a personal or sensitive one, further mitigating the possibility of harm. Our use of direct quotations is typical of research using Reddit data. Proferes et al. (2021) analyzed 727 research papers that used Reddit and found that only 2.5% of these papers paraphrased quotations, compared to 28.5% of the papers that used exact quotations (Reagle, 2022) (the rest did not use quotations).

3.1.1. Selection of Subreddits

For this study, subreddits were selected based on their relation to future trends around AI. First, a search for artificial intelligence (AI)-related keywords was conducted to identify where conversations were taking place. This process identified fifteen subreddits (shown in Table II)

given their inclusion of the future of AI-related posts and their descriptions. Particularly, we selected these subreddits because they are: (1) explicitly devoted to the future trends and speculations (i.e., Futurology, tomorrowsworld, DarkFuturology, conspiracy), (2) focus particularly on AI (i.e., ArtificialInteligence, artificial, agi, MachineLearning, deeplearning, Automate, singularity), or (3) dedicated to the news and discussions about technology, science around the world that also include varied contemporary AI-related conversations (i.e., worldnews, science, tech, technology).

Insert Table II here

3.2. Data Collection and Cleaning

For harvesting data from the selected subreddits, Reddit API was used through PRAW (Python Reddit API Wrapper) to gather posts and comments. All posts were fetched from the chosen subreddits that include the terms "Artificial intelligence", "AI", "artificial intelligence", or "Artificial Intelligence", without any time constraints, and all top-level comments on the extracted posts. After extracting data, we realized comments were "deleted" or "removed," and some comments were expressions such as "please reply to OP's comment here:", "the following submission statement was provided by…". These rows were removed from the data. We did not do further data cleaning because we intended to protect natural structures of post titles and comments to further analysis. This data cleaning process resulted in 998 unique post titles and a total of 16611 comments, thereby the number of the total post titles and comments is 17609. The posts and comments were created between 2/19/2013 and 7/3/2022 by 671 unique users.

3.3. Data Analysis

3.3.1. Frame Identification Procedure

The purpose of this research is to discern commonly expressed *technological frames* for AI in text data. Many studies of frames identify them by interviewing subjects to understand how they interpret the world. However, Erving Goffman, one of the earliest framing scholars, suggested that words allow individuals convey their interpretations, beliefs, assumptions, and expectations through the lens of existing world views (Nisbet, 2009). In other words, word clusters found in discussions can be used for frame identification (Ylä-Anttila et al., 2021). Posts and comments about the same topic can reflect various interpretations (Liu et al., 2019); for example, a post about the future of AI may emphasize human-AI collaboration in a positive way referring to a frame such as *impact on work (positive)* while another post may highlight potential problems, framing the topic as *loss of control*. Ylä-Anttila et al. (2021) thus argued that if all texts being analyzed are about a particular topic (as in our case, Artificial Intelligence), topic modelling "outputs are best interpreted as traces of different ways of discussing a topic – that is, frames" (Ylä-Anttila et al., 2021, p. 5). Topic modelling has been used to identify frames in several recent studies Heidenreich et al.(2019), Ylä-Anttila et al.(2021) and Guo et al. (2022).

We implemented topic modelling as follows. The cleaned data (post titles and comments) were analyzed using BERTopic to identify clusters of posts and comments with common

terminology. BERTopic (Grootendorst, 2022) was used because it is a more efficient topic modelling method than earlier approaches such as LDA, NMF and Top2Vec (Egger & Yu, 2022). Since many posts' main bodies were not text, but rather videos, images, or a link for another source, we analyzed the post titles rather than the text bodies. However, Chase and Qiu (2017) found that Reddit post titles successfully represent the main points of Reddit submissions. For comments on posts, we analyzed the body since each comment itself includes rich text data. The cleaned text data consisting of post titles and comments were processed in Python by a BERTopic model we built (Grootendorst, 2022).

Asmussen and Møller (2019) suggested semantic validation as the best method for confirmation of topic modelling results, i.e., comparing modelling results with expert reasoning to check that the results make sense semantically. We followed Heidenreich et al.'s (2019) and Ylä-Anttila et al.'s (2021) semantic validation approach. Specifically, three interpreters (the first author and two Master's students, one in Business Analytics and the other in Applied Data Science) named the clusters obtained from topic modelling. Word groups and sample submissions (i.e., Reddit posts or comments) associated with these clusters were read until reaching the saturation point for understanding the content of the cluster. The clusters were then interpreted and named, either as a frame from the AI framing literature summarized in Table I or as a topic, in case the cluster did not match a frame.

After the clusters were named, we validated the automated content analysis results. Two graduate students annotated a random sample of 125 post titles and comments for the frame used. The initial agreement between the two human coders was 71% and the Cohen's kappa score was 0.65, which is considered a substantial agreement score according to Watson and Petrie (2010). Then, the human coders discussed cases where their coding did not match to agree on a consensus code. We then compared the BERTopic and human classifications. The BERTopic classification is the most dominant cluster for each post title/comment. The agreement between frames coded by human consensus and frames found by topic modelling was 87% and Cohen's kappa score was 0.84, indicating excellent agreement. We conclude that the assignment of frames through topic modelling can be considered valid.

3.3.2. Sentiment Analysis and Emotion Detection

Emotions in text were classified with BERT trained on the GoEmotions dataset (Demszky et al., 2020). This dataset is a manually-annotated dataset of 58k English Reddit comments (Demszky et al., 2020), labeled for 27 emotion categories as well as neutral. The emotion categories in this dataset are admiration, amusement, anger, annoyance, approval, caring, confusion, curiosity, desire, disappointment, disapproval, disgust, embarrassment, excitement, fear, gratitude, grief, joy, love, nervousness, optimism, pride, realization, relief, remorse, sadness, surprise. The BERT model captured all these 28 categories in each post title and comment in the corpus. Another BERT model finetuned with IMDb Movie Reviews categorized positive and negative attitudes on the post titles/comments.

The performance of the two models was validated using the same process as for the frames. A random sample of 125 submissions was chosen and annotated for five emotions (*fear, curiosity, confusion, disapproval*, and *approval*) by two graduate students, who resolved any differences through discussion. The students' emotion label was then compared to the BERT model label. The accuracy was 0.84 (taking the human coding as correct) and Cohen's kappa score between the human and machine classification was 0.80, which is considered an excellent level of agreement. Similarly, a random sample of 150 submissions were classified for sentiment by two graduate students independently and compared to the machine coding. The accuracy was 0.91 and Cohen's kappa score between the human and machine classification was 0.83, again an excellent level of agreement.

3.3.3 Close Reading

Although computational methods show the general trends of interpretations and expectations, it is not sufficient for deep understanding of them. Thus, two frames (i.e., general impacts of futures of work with intelligent machines on wealth and society and taking over tasks through substituting/complementing humans) were selected for close reading, based on the literature review part concerning work and intelligent machines. 200 comments were randomly sampled (100 per chosen frame) for the close reading.

Close reading is a deep qualitative analysis of a text passage on central themes (Jänicke et al., 2015). To carry out this an analysis, 200 comments automatically classified into the frames of *general impacts on society* and *taking over tasks* were read by the authors. These frames were chosen for their relevance to the topic of work with intelligent machines. The analyses explored Redditors' interpretations around the themes revealed in the literature review: AI can create new jobs, AI can reduce human bias and errors, regulation expectations, need for working for well-being, wealth distribution (under the frame of general impacts on society) and complementing and substituting humans by taking over work tasks (under the frame of taking over tasks). In this reading process, words (e.g., augment) and phrases that indicate these themes were highlighted to find the quotations associated with those themes. After organizing quotations associated with the same theme together, brief sentences were written summarizing and synthesizing the main ideas of the comments with the same theme. These brief syntheses describing the ideas expressed in the comments and example comments as quotations were presented in the findings section. In this qualitative text analysis part, we did not reduce qualitative data to numbers (e.g., coding in content analysis), since the purpose was to gain an overview of diverse interpretations of Redditors around the themes obtained from the literature review.

4. Findings

4.1. General Findings (Distant Reading)

The BERTopic analysis yielded 36 clusters and classified post titles and comments into these clusters. Twelve (12) of the 36 clusters were selected for further presentation in this study because of their relevance to the context of *work and intelligent machines*. Thirty-eight percent (38%, 6730 of 17609) of the Reddit post titles and comments were classified into one of these 12

clusters. The results are shown in Table III. Table III shows the proportion of posts and comments that fell into the cluster; the percentage of items in the cluster that were coded as negative sentiment; the 10 words that most strongly represent the cluster; the cluster label (from the human interpretation of the keywords and sample post titles and comments); an explanation of the cluster, based on reading the posts and comments; and example submissions.

Insert Table III here

The largest clusters are about *impacts on healthcare* (15%), *impacts on military* (15%) and *taking over tasks* (15%). The least prevalent cluster is about the "*singularity*". Interestingly two clusters were gender related: *AI applications based on human gender* (cluster 4) and *humans' perception of bots' gender* (cluster 8). Conversations concerning AI's applications based on gender are more common than those about bots' gender (14% versus 4%).

4.1.1 Sentiment and Clusters

From the sentiment analysis results, we find that Reddit users discussed the future of work with intelligent machines by sharing somewhat optimistic views: 58% of the harvested posts and comments are positive while 42% of them are negative. However, each cluster displays different positivity and negativity rates, as shown in Table III. The relationship between the attitudes and clusters was found to be significant, χ^2 (11) = 916.24, p < 0.001.

Most sentences in the *killer robots* cluster*,* for instance, were negative (78%). The cluster for interpretations about *AI applications like bots that are used by the companies such as Google, Microsoft, OpenAI, etc.* demonstrate a general negative attitude (67%) as seen in this statement: *"…Algorithms have been used to better market to people and end up influencing what they see and hear online…"* Conversations about *impact on crime* and *the need of a regulation for AI use* have higher negativity rate than the positivity rate. There are positive interpretations of *AI's impact on crime*, e.g., *"Identity theft can be thwarted by artificial intelligence analysis of a user's mouse movements of the time,"* but the general sentiment of this cluster was negative (63%). For instance, Redditors commented on privacy and security related problems stemming from AI use and malicious use of AI, e.g., "*A horrifying new AI app swaps women into porn videos with a click.*" The cluster related to users' expectation for the regulation for AI use (patent laws etc.) also revealed a general negative attitude (67%), e.g., "Artificial intelligence is breaking patent law".

On the other hand, interestingly, users' communications about *intelligent machines taking over tasks (Cluster 5)* had mostly positive sentiment (76%). Likewise *impacts of AI, automation and robots on wealth and society (Cluster 2)*, on *healthcare (Cluster 1)* and *military (Cluster 3)* are viewed as positive, with 58%, 66% and 62% positivity rates respectively. Attitudes towards *gender-based AI applications* (78%) and *perceived bot gender* (53%) were also mainly positive. Gender-based AI applications were mostly interpreted as beneficial advancements as in this assertation *"Girls with autism differ in several brain centers compared with boys with the disorder suggesting gender specific diagnostics are needed a Stanford study using artificial*

intelligence found." On the other hand, bots are perceived like a person and ironic user language is observed in various conversations such as *"This is why I always thank Siri after she has completed a task for me hopefully our robot overlords will remember that and have mercy on me."*

Two of the clusters (11 and 12) are related to *reaching human level machine intelligence (HLMI)*, specifically *AGI* and *singularity*. Users had mixed positive and negative attitudes towards HLMI: 51% of the submissions about *reaching human level AI (AGI)* were negative whereas 49% of them were positive. Likewise, 47% of the submissions about *singularity* were negative while 53% of them were positive. Through the conversations about AGI, the users revealed their concerns such as potential risks related to human morals and values. Despite the risks pointed out like in this expression *"There's no reason to think that an AGI would be any more benevolent that the average person. In fact, a lot of reasons to think the opposite. The probability of an AGI being perfectly aligned with human morals and values is vanishingly small,"* optimistic interpretation like *"The singularity is coming but it is not a threat"* were also shared.

4.1.2. Emotions and Clusters

To explore how people feel about the future of intelligent machines we examined all the 27 emotion categories or neutral (Demszky et al., 2020) embedded in the text to capture all the patterns. However, we focus our presentation on the emotions of *fear, curiosity, confusion, disapproval*, and *approval* due to their relevance to the future expectations about technology. Since the subset of submissions with these five specific categories were chosen, the number of contributions to be analyzed decreased to 2434. The most common emotion in this subset of the corpus was *approval* (17%); disapproval was found in 7% items. This category is followed by *curiosity* with a rate of 6%, with *confusion (4%)* and *fear (1%)* constituting the minority of the conversations.

A significant relationship was discovered between these five categories and the clusters, $\chi^2(44) = 1338.2$, $p < 2.2e\text{-}16$. For the first, second, fourth, sixth, eighth and ninth clusters, *approval* was the commonly expressed emotion. In the third cluster, *impact on military*, *confusion* was common, e.g., "The *Rise of AI Fighter Pilots: Artificial intelligence is being taught to fly warplanes. Can the technology be trusted?*" In cluster 7, concerning the need for AI regulation, *disapproval* is dominant. People seemingly disapprove of AI usage when adequate regulation attempts are not taken. Finally, *curiosity* was the most prevalent category in discussions associated with four clusters, 5, 10, 11 and 12. For the cluster of impact on crime (Cluster 10), both optimistic and pessimistic aspects of AI—hindering crime or causing crime— were shared and the dominant emotion was curiosity. Likewise, curiosity was prevalent in the discussions that are connected to the cluster of *taking over tasks* (Cluster 5). Finally, whether *human level machine intelligence* (Clusters 11 and 12) will be reached or not is a highly debated phenomenon about which people expressed curiosity.

4.2. Framing Futures of Work with Intelligent Machines (Close Reading)

Two frames were chosen for more detailed analysis due to their specific relevance to the reviewed impacts of technology on work in the theoretical background section (section 2.2): general impacts on wealth and society, and substitution (replacement) and complementarity (augmentation) effects on work and workers. The frames are frame 2 (general impacts of intelligent machines on wealth and society) and frame 5 (replace and augment humans by taking over specific tasks). The examples from these frames are presented in this section to depict relevant interpretations, beliefs, and expectations around the coming technology.

The first frame, *general impacts on wealth and society,* had more positive posts and comments, with a rate of 58%. This cluster illustrates the interpretation and assumption that automation and robots will influence the society and economy in general through creating new jobs/industries, requiring AI related skills for workers, reduce human bias and errors, emergence of regulation needs to protect equal wealth distribution, bringing wealth to everyone or causing unequal wealth redistribution, both positive and negative aspects were expressed in the conversations.

As parallel to the experts' assumptions presented in the literature review section, Reddit comments also reflect the assumption that some industries and some workers may be displaced while new industries and new jobs being born, as in the example comment below:

> *Not necessarily, I don't think this will happen as we have seen previously. New technology creates new jobs altogether. E.g., Digital Marketing is a new job now before social media there was no concept of digital marketing job. Similarly, there are trends coming in the market which suggest that new companies are coming in the market. New ID verification services like Shufti Pro are working in the market which is providing KYC services to even ICOs as well. So Overall new jobs will be created with the removal of old jobs.*

Comments also discuss the general impacts of intelligent machines on society, e.g., a comment showing the interpretation that AI can reduce human bias and errors and create a truly liberated society:

> *This is incredibly important. The more jobs we can assign to machines reliable the less human errors and human vices will affect other people's lives. To fear that increasing technology means lesser employment is narrow minded. There is a constant scarcity of job offers. But there is an endless stream of work that needs to be done. Internet accessibility is highly nonuniform and in many places unfairly priced. Renewable sources are not fully implemented yet. What is being wiped out are repetitive menial jobs. With greater penetration of AI, we get closer and closer to a truly liberated society. Liberation from the shortcomings of each other.*

Expectations concerning regulation needs are also expressed:

Hopefully in the near future as the technology progresses there will be a law in place to force businesses to use a certain of human workers.

The nature of work itself is going to change. UBI is going to be vitally necessary.

Some comments highlight the belief that work is a need for humans, so people need to work in the future for their well-being and for a good society:

So how about stop using machines a bit? Or at least stop developing them? Humans are defined through work. If machines do all the work what purpose is there left? And for what reason?

There are diverse assumptions regarding impacts of intelligent machines on wealth: intelligent machines will bring wealth to everyone or that they will cause unequal wealth redistribution in the future:

If we do it right, it can potentially be a good thing. Imagine a society run entirely by robots. That way people literally don't have to work. But robots can still generate enough income to feed everyone basically guarantee a universal income.

To a capitalistic society the use of robots is a negative that leaves the rich richer and the poor poorer yet in a socialist society the automation of work if positive that leaves more value to the citizen and less work for all.

The second chosen frame, *substitute (full automation) or complementation (augment) humans by taking over specific tasks*, was also positive with the rate of 76 %. The frame reflects the interpretations and assumptions regarding that futures of workers, that they may be substituted by intelligent machines or augmented as stated in those examples. As in prior research reviewed above, Redditors also assume that AI will take over low-skill or routine tasks, thus causing potentially job losses:

I think we're going to first see AI attempt to replace low skill or mundane task work but then I wouldn't be surprised if we see some executives try to see if an AI could replace knowledge workers. They'll revel in their means to not have to deal with paying high salaries or worker shortages until one day the AI makes a case that it could also replace the executives and the shareholders agree. My concern is more on if companies start using AI to replace knowledge workers what happens when we have an overload of humans who now can't work and make a living?...

Like the experts interpreting augmentation positively, Redditors also interpret augmentation as positive in general. The expectation is in the way that intelligent machines enhancing humans or collaborating with humans in varied domains from marketing to healthcare, which increase efficiency and effectiveness:

I'm not worried about AI. We'll start augmenting humans.

16

AI: I am not a threat. I will watch over you so that you could be safe anywhere anytime. I will augment your perception so that you will become wiser. I am a helpful guardian.

In AI marketing, artificial intelligence technologies are used to make decisions based on data collection, data analysis, and additional observations of audience or economic trends that can influence marketing efforts. Artificial intelligence is often used in marketing efforts in which speed is crucial. Data and customer profiles are used by AI tools to understand how best to communicate with customers, then they serve them tailored messages at the right time without intervention by marketing team members, ensuring maximum efficiency. AI is often used by marketers today to augment their teams or to perform more tactical tasks which require less human nuance.

An artificial intelligence (AI) tool--trained on roughly a million screening mammography images--identified breast cancer with approximately 90 percent accuracy when combined with analysis by radiologists, a new study finds. Would it be feasible in our lifetimes to have robots that can replicate human behavior if not perfectly with at least enough accuracy to be highly convincing? Will we have robot lovers? Will we eventually augment our own brains with supplemental AI to enhance our thoughts?

In addition to positive interpretations about augmentation, people also expect proper regulations and ways to enhance their AI related skills to adapt to the possible transformations in workplaces:

We'll probably need to legislate areas in which AI replacement and possibly even augmentation isn't allowed.

The industrial age needed manpower to help run the factories. The digital age needed brain-power to do the programming. Artificial intelligence, robotics, machine learning will replace every type of occupation.

…The number of tech jobs requiring AI skills globally may grow faster than expected due to the pandemic, according to research firm International Data Corporation. The firm estimates 16 percent growth in AI jobs this year "up from the 13.3 percent previously predicted for 2020" due to anticipated new demand for AI capabilities from healthcare providers, schools, and industry…

…Robots in automation have been around since the 1960's. After almost 60 years, the best robots still cannot replicate critical thinking or complex movement. Robots in automation are limited to work in repetitive motion and have a very narrow set of environment parameters that they need to work in. There is a vast array of tasks that robot automation can usurp. But robots will never fully replace all labor. It will only enhance it. What will happen, and it is the same thing that always happens with

automation, workers will be required to "move up" the ladder of skills to acquire new tasks…

Interpretations also reflect the belief that jobs will be reshaped based on the strengths of humans and intelligent machines, for some jobs humans will be preferred, and intelligent machines will be integrated into all the jobs:

First, I think we get a lot of runway out of just paying everyone twice as much to do half as much work. Hopefully whatever jobs are left get stretched out a bit so to speak. As to what kinds of jobs would be left for humans, I think the kinds of things only humans can do. Jobs that require human connection warmth or just a human body. So, I'm thinking sports, acting, nursing, sex work, teaching management. These are all things where robots might start have started to get involved but humans would be preferred. We will see more people in those jobs we already have, and I think we will see more things like paying people to play games with you. Tutors for everything. Lots of art and poetry classes and teachers.

Smart tools are coming for all the jobs. Smart tools use technologies like automation robotics software and artificial intelligence to complete a task with fewer or no humans involved. Examples include self-driving cars, computer-controlled factory equipment and self-checkout at gas pumps and supermarkets.

The findings of distant and close reading demonstrated that scholars and Redditors interpret the futures of work with intelligent machines similarly. The general attitude is positive though there are also questions and expectations.

5. Discussion

Since 1950 when Alan Turing asked the question of whether machines can think, the power of machines has enhanced with varied cognitive capabilities. We witness many AI applications like chatbots interacting with customers in commercial company websites, social media bots (e.g., Facebook, Twitter, Reddit bots), social bots chatting to human users (e.g., Eliza representing a mock Rogerian psychotherapist) (Dalgali & Crowston, 2020b), algorithmic journalism generating and editing content, combining databases with editor-created story templates to generate stories (Dalgali and Crowston, 2020a), and various AI applications addressing diverse tasks including image recognition, machine translation (Dalgali and Crowston, 2019), guidance for automated vehicles, and natural language processing tasks.

These important advances led to numerous debates as to whether machine intelligence will surpass human intelligence, whether intelligent machines take over the jobs, whether these advances constitute risks or benefits for our future and particularly for our futures of work. This study revealed the perceptions expressed by Redditors through the theoretical lens of technological frames. This approach guided us systematically analyze the interpretations, expectations and assumptions (Huvila et al., 2021).

The analysis consisted of two parts: *distant reading* and *close reading*. Distant reading enabled us to see the big picture of empirical findings. This process was followed by *close reading* in the light of theoretical background. The findings showed the existence of different frames related to futures of work and intelligent machines. Close reading of post titles and comments associated with the first frame demonstrated the interpretations and expectations of that automation and robots will influence the society and economy in general through creating new jobs/industries, requiring AI related skills for workers, reduce human bias and errors, emergence of regulation and policy needs to protect equal wealth distribution, bringing wealth to everyone or causing unequal wealth redistribution, both positive and negative aspects while positive aspect outweighs the negative aspect for that frame.

The other frame, *substitute (full automation)* or *complementation (augment) humans by taking over specific tasks*, showed that augmentation of humans by intelligent machines in different domains is interpreted positively, while *full automation* is generally associated with job losses and raised concerns. However, Redditors assume job losses depend on the jobs and the tasks constituting the job. They expect specific jobs could be eliminated by full automation, but if people develop themselves to be skilled for working with intelligent machines, work efficiency may be doubled and workers can be augmented, companies may double their profits.

Parallel to these findings, experts similarly attribute intelligent machines' substitution effect to tasks to be automated, the tasks constituting the jobs, and workers' expertise. Even though one of the most common concerns about AI is job losses, experts assume that the integration of AI into workplaces is undeniable, and this requires workers to increase their AI knowledge not to be substituted by full automation. "Workers resistant to AI could be seen as unwilling or incapable of adapting," states Frey (Noenickx, 2023). In sum, experts and Redditors have similar interpretations, assumptions, and expectations about futures of work with intelligent machines.

Attitudes and feelings were analyzed to investigate the relationships between technological frames and feelings and attitudes towards technology, since the prior literature suggests technological frames influence feelings (Stam & Stanton, 2010) and attitudes towards technology (Spieth et al., 2021). The most common emotion found was approval, and many of the posts and comments had a positive attitude. However, individuals also share their expectations for changes, such as regulation related to AI use, changes in patent laws or laws to limit job losses. Likewise, achieving HLMI is viewed positively as analogous to experts' assumptions stated in Grace et al. (2018). Despite all the breakthroughs and although we can acknowledge that machine intelligence may be capable of taking over many tasks and may be better at some of those tasks than humans, expression of "achieving human level machine intelligence" is not going beyond achieving goals assigned to them by humans because human intelligence comprises varied dimensions embracing metacognition—people's understanding and control of their own thinking processes" (Sternberg, 2018, p. 145), creativity and spontaneous thinking are proper to humans. Humans make or do not make computers do tasks; thus, machine intelligence seems to be limited to tasks we want to teach to machines. This fact signals the

importance of collaborating with intelligent machines through sharing the tasks properly to build better futures of work. Thus, this phenomenon may be approached positively.

5.1. Implications

This study can contribute to the extension of information and communication technology knowledge by presenting public views in social media. Social media is considered as a socio-technical system (Venkatesan and Valecha, 2021) because it connects collectives who come from different segments of the public with a range of mindsets stemming from various backgrounds and personal experiences. Thus, social media related research has been recently increasingly conducted in information technology domain as in Al-Samarraie et al. (2021), Asongu et al. (2019), Babac and Podobnik (2018), Banerjee et al. (2021), Benson et al. (2015) and Li et al. (2022). Exploring the interpretations, assumptions and expectations on social media can help realize potential problems and benefits from many people's vantage points in the case of possible transformations in the future of work where intelligent machines may be involved. Such an exploration may also help enlighten researchers to shape research directions about futures of work (Acemoglu and Restrepo, 2020). Furthermore, we also present practical, theoretical and methodological implications revealed from this study.

5.1.1. Practical Implications

The findings of this study can enrich current public voice-centric explorations of interpretations and expectations about futures of work with intelligent machines. As a practical implication, these findings could help designing suitable interfaces that allow proper human and intelligent task coordination and collaboration. For example, since findings showed that people approach augmentation positively, that mode of design may be more desirable. Some tasks may be carried out by humans, some humans' tasks previously performed by humans may be automated by intelligent machines and while some other new tasks may be completed by humans with the help of machines (Brynjolfsson, 2022). One of the most salient strengths of machine intelligence is making complex calculations by processing large amount of data and revealing quick outputs which may be utilized in human prediction, such as spam email detecting, credit scoring, and temperature forecasting, etc. We can combine the power of machines in prediction tasks while we remain in the loop and the power of humans in tackling novel problems, anomalies and situations. For example, machine intelligence's predictions could be used as potential decisions by humans, thereby it imitates our decision-making ability.

Research attempts also exist to provide intelligent machines the capability of reasoning through explainable AI (Barredo Arrieta *et al.*, 2020; Goebel *et al.*, 2018; Holzinger *et al.*, 2018). Despite these advancements, machine intelligence depends on human intelligence. This dependence is because human intelligence consists of varied dimensions such as metacognition, which allow us to manage our cognitive processes such as decision making and reasoning. Thus, if we can collaborate with intelligent machines combining our different skills and sharing the tasks where computers are more efficient than humans like in big data processing, we may develop better future work practices.

Furthermore, firms may utilize these frames to explore customers' responses and feelings while advertising their AI-based services to their customers. For example, Vorobeva et al. (2023) conducted experiments to help tourism and hospitality firms determine how to successfully introduce AI-based services to their customers. Through these experiments they examined how customers respond to a different framing of AI replacement (augmentation vs. substitution) compared to utilizing only human workers, affecting their approval of AI-based services. Vorobeva et al. (2023) found framing AI as augmentation (vs. substitution) in the tourism and hospitality services increased enjoyment and ease of use and enhanced AI approval. Drawing on Feeling Economy theory, the authors emphasized the increases in enjoyment and perceived ease of use stem from AI framing effects. In this study, we also found framing AI as augmentation (vs. substitution) influenced attitudes and emotions. Aside from tourism and hospitality firms, other firms, organizations or industries may employ framing methods to receive customers' or workers' responses, or even to influence the responses, e.g., manipulations of decisions. For instance, Benschop et al. (2022) indicated that framing could cause a subconscious bias on decision-makers regarding investing in specific systems or projects.

5.1.2. Theoretical and Methodological Implications

Aside from the empirical findings, another crucial implication of this work is application of theory of technological frames (Orlikowski and Gash, 1994) for systematizing the interpretations of how people conceptualize the future of work with the technology of intelligent machines. Davidson (2006) advocates that manipulation or encouragement for technology use is associated with technology frames. Orlikowski and Gash (1994) suggest that technological frames provide "an interesting and useful analytic perspective for explaining and anticipating actions and meanings that are not easily obtained with other theoretical lenses" (p. 174). This work applied this useful perspective to differentiate assumptions, expectations and interpretations about futures of work and intelligent machines, e.g., augmentation versus substitution. Moreover, we discerned these frames in text data, social media data produced by the public freely, which makes data nature as different from questionnaires and interviews which are bounded by the questions asked by the researchers.

As a methodological contribution, in this work, we conducted automated content analysis for viewing the big picture of interpretations, feeling and attitudes as distant reading and then scrutinized the interpretations in text by a close reading. We benefited from machine learning while human judgment was in the loop, meaning that the study is itself an example of human-machine intelligence combination. This method may be useful for other relevant research studies in the future.

5.2. Limitations

The sample of text data in this study is limited to Reddit data. As participation on Reddit is pseudonymous (user names are not their real names), collecting demographic information about Redditors is quite difficult (Proferes et al., 2021). However, in 2021, Reddit's site administrators reported that a majority (58%) of users were between 18 and 34 years old and

were male (57%). More diverse samples of users should be built for future studies. For example, future studies may include both Reddit and Twitter text data to compare results and to obtain a more diverse sample. Apart from social media data, work-related documents in organizations may be analyzed for business related purposes. For instance, Benschop et al. (2022) analyzed business cases and found that newly proposed information systems are framed more positively, while the existing information systems are framed with more negative adjectives.

Lastly, this research looks at relationships among frames, emotions and attitudes. Prior work (e.g., Yacoub, 2012) points out that frames are influenced by personal experiences or other personal traits, which this research did not explore. Additionally, individuals' prior beliefs are also related to both cognitive bias and decision making (Acuna, 2011), i.e., prior beliefs may also influence technological frames. Future studies may investigate how personal experiences, personal characteristics and their relevant prior beliefs affect individuals' technology frames in text.

References

Adams, C., & Avison, D. (2003). Dangers inherent in the use of techniques: Identifying framing influences. *Information Technology & People*, *16*(2), 203–234. Scopus. https://doi.org/10.1108/09593840310478694

Al-Samarraie, H., Bello, K.-A., Alzahrani, A. I., Smith, A. P., & Emele, C. (2021). Young users' social media addiction: Causes, consequences and preventions. *Information Technology & People*, *35*(7), 2314–2343. https://doi.org/10.1108/ITP-11-2020-0753

Asmussen, C. B., & Møller, C. (2019). Smart literature review: A practical topic modelling approach to exploratory literature review. *Journal of Big Data*, *6*(1), 93. https://doi.org/10.1186/s40537-019-0255-7

Asongu, S., Nwachukwu, J., Orim, S.-M., & Pyke, C. (2019). Crime and social media. *Information Technology and People*, *32*(5), 1215–1233. Scopus. https://doi.org/10.1108/ITP-06-2018-0280

Autor, D. H., Levy, F., & Murnane, R. J. (2003). The Skill Content of Recent Technological Change: An Empirical Exploration. *The Quarterly Journal of Economics*, *118*(4), 1279–1333.

Autor, D., Mindell, D., & Reynolds, E. (2019). *The Work of the Future: Shaping Technology and Institutions* [Fall 2019 Report]. MIT Work of the Future.

Autor, D., Mindell, D., & Reynolds, E. (2020). *MIT Work of the Future Task Force* (p. 92) [Fall 2020 MIT Report].

Babac, M. B., & Podobnik, V. (2018). What social media activities reveal about election results? The use of Facebook during the 2015 general election campaign in Croatia. *Information Technology & People*, *31*(2), 327–347. https://doi.org/10.1108/ITP-08-2016-0200

Banerjee, S., Singh, J. P., Dwivedi, Y. K., , & Rana, N. P. (2021). Social media analytics for end-users' expectation management in information systems development projects. *Information Technology & People*, *34*(6), 1600–1614. https://doi.org/10.1108/ITP-10-2020-0706

Banks, J., & Koban, K. (2021). Framing Effects on Judgments of Social Robots' (Im)Moral Behaviors. *Frontiers in Robotics and AI*, *8*, 118. https://doi.org/10.3389/frobt.2021.627233

Benschop, N., Nuijten, A. L. P., Hilhorst, C. A. R., & Keil, M. (2022). Undesirable framing effects in information systems projects: Analysis of adjective usage in IS project business cases. *Information & Management*, *59*(3), 103615. https://doi.org/10.1016/j.im.2022.103615

Benson, V., Saridakis, G., & Tennakoon, H. (2015). Information disclosure of social media users: Does control over personal information, user awareness and security notices matter? *Information Technology and People*, *28*(3), 426–441. Scopus. https://doi.org/10.1108/ITP-10-2014-0232

Brynjolfsson, E., McAfee, A., & Cummings, J. (2014). *The Second Machine Age Work, Progress, and Prosperity in a Time of Brilliant Technologies*. W. W. Norton & Company.

Chen, K., & Tomblin, D. (2021). Using Data from Reddit, Public Deliberation, and Surveys to Measure Public Opinion about Autonomous Vehicles. *Public Opinion Quarterly*, *85*(S1), 289–322. https://doi.org/10.1093/poq/nfab021

Chong, D., & Druckman, J. N. (2007). Framing Theory. *Annual Review of Political Science*, *10*(1), 103–126. https://doi.org/10.1146/annurev.polisci.10.072805.103054

Chuan, C.-H., Tsai, W.-H. S., & Cho, S. Y. (2019). Framing Artificial Intelligence in American Newspapers. *Proceedings of the 2019 AAAI/ACM Conference on AI, Ethics, and Society*, 339–344. https://doi.org/10.1145/3306618.3314285

Davidson, E. (2006). A Technological Frames Perspective on Information Technology and Organizational Change. *The Journal of Applied Behavioral Science*, *42*(1), 23–39. https://doi.org/10.1177/0021886305285126

Davidson, E., & Pai, D. (2004). Making Sense of Technological Frames: Promise, Progress, and Potential. In B. Kaplan, D. P. Truex, D. Wastell, A. T. Wood-Harper, & J. I. DeGross (Eds.), *Information Systems Research* (Vol. 143, pp. 473–491). Springer US. https://doi.org/10.1007/1-4020-8095-6_26

Demszky, D., Movshovitz-Attias, D., Ko, J., Cowen, A., Nemade, G., & Ravi, S. (2020). GoEmotions: A Dataset of Fine-Grained Emotions. *Proceedings of the 58th Annual Meeting of the Association for Computational Linguistics*, 4040–4054. https://doi.org/10.18653/v1/2020.acl-main.372

Egger, R., & Yu, J. (2022). A Topic Modeling Comparison Between LDA, NMF, Top2Vec, and BERTopic to Demystify Twitter Posts. *Frontiers in Sociology*, *7*, 886498. https://doi.org/10.3389/fsoc.2022.886498

Entman, R. M. (1993). Framing: Toward Clarification of a Fractured Paradigm. *Journal of Communication*, *43(4)*, 10.

Fast, E., & Horvitz, E. (2017). Long-Term Trends in the Public Perception of Artificial Intelligence. *Proceedings of the Thirty-First AAAI Conference on Artificial Intelligence (AAAI-17)*, 7.

Frey, C. B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to computerisation? *Technological Forecasting and Social Change*, *114*, 254–280. https://doi.org/10.1016/j.techfore.2016.08.019

Grace, K., Salvatier, J., Dafoe, A., Zhang, B., & Evans, O. (2018). Viewpoint: When Will AI Exceed Human Performance? Evidence from AI Experts. *Journal of Artificial Intelligence Research*, *62*, 729–754. https://doi.org/10.1613/jair.1.11222

Grootendorst, M. (2022). *BERTopic: Neural topic modeling with a class-based TF-IDF procedure* (arXiv:2203.05794). arXiv. http://arxiv.org/abs/2203.05794

Guenduez, A. A., Mettler, T., & Schedler, K. (2020). Technological frames in public administration: What do public managers think of big data? *Government Information Quarterly*, *37*(1), 101406. https://doi.org/10.1016/j.giq.2019.101406

Guo, L., Su, C., Paik, S., Bhatia, V., Akavoor, V. P., Gao, G., Betke, M., & Wijaya, D. (2022). Proposing an Open-Sourced Tool for Computational Framing Analysis of Multilingual Data. *Digital Journalism*, 1–22. https://doi.org/10.1080/21670811.2022.2031241

Harlow, H. D. (2019). Human Capital and Artificial Intelligence (AI): Preparing for the Singularity. *European Conference on Intangibles and Intellectual Capital*, 393-396,IX. https://www.proquest.com/docview/2306776864/abstract/FCBDBA62D19E43FBPQ/1

Heidenreich, T., Lind, F., Eberl, J.-M., & Boomgaarden, H. G. (2019). Media Framing Dynamics of the 'European Refugee Crisis': A Comparative Topic Modelling Approach. *Journal of Refugee Studies*, *32*(Special_Issue_1), i172–i182. https://doi.org/10.1093/jrs/fez025

Hristova, G., & Netov, N. (2022). Media Coverage and Public Perception of Distance Learning During the COVID-19 Pandemic: A Topic Modeling Approach Based on BERTopic. *2022 IEEE International Conference on Big Data (Big Data)*, 2259–2264. https://doi.org/10.1109/BigData55660.2022.10020466

Hua, Y., Jiang, H., Lin, S., Yang, J., Plasek, J. M., Bates, D. W., & Zhou, L. (2022). Using Twitter data to understand public perceptions of approved versus off-label use for COVID-19-related medications. *Journal of the American Medical Informatics Association*, *29*(10), 1668–1678. https://doi.org/10.1093/jamia/ocac114

Huvila, I., Cajander, Å., Moll, J., Enwald, H., Eriksson-Backa, K., & Rexhepi, H. (2021). Technological and informational frames: Explaining age-related variation in the use of patient accessible electronic health records as technology and information. *Information Technology & People*, *35*(8), 1–22. https://doi.org/10.1108/ITP-08-2020-0566

Jänicke, S., Franzini, G., Cheema, M. F., & Scheuermann, G. (2015). *On Close and Distant Reading in Digital Humanities: A Survey and Future Challenges*.

Kervenoael, R. de, Schwob, A., Palmer, M., & Simmons, G. (2017). Smartphone chronic gaming consumption and positive coping practice. *Information Technology & People*, *30*(2), 503–519. https://doi.org/10.1108/ITP-01-2016-0003

Kitchens, B., Johnson, S. L., & Gray, P. (2020). Understanding Echo Chambers and Filter Bubbles: The Impact of Social Media on Diversification and Partisan Shifts in News Consumption. *MIS Quarterly*, *44*(4), 1619–1649. https://doi.org/10.25300/MISQ/2020/16371

Li, B., Hou, F., Guan, Z., & Chong, A. Y. L. (2022). The use of social media for a better world: Roles of social experience, empathy and personal impulsiveness in charitable crowdfunding. *Information Technology and People*. Scopus. https://doi.org/10.1108/ITP-04-2021-0264

Liu, S., Guo, L., Mays, K., Betke, M., & Wijaya, D. T. (2019). Detecting Frames in News Headlines and Its Application to Analyzing News Framing Trends Surrounding U.S. Gun Violence. *Proceedings of the 23rd Conference on Computational Natural Language Learning (CoNLL)*, 504–514. https://doi.org/10.18653/v1/K19-1047

Mahor, K., & Manjhvar, A. K. (2022). Public Sentiment Assessment of Coronavirus-Specific Tweets using a Transformer-based BERT Classifier. *2022 International Conference on Edge Computing and Applications (ICECAA)*, 1559–1564. https://doi.org/10.1109/ICECAA55415.2022.9936448

Munoz, I., Sawyer, S., & Dunn, M. (2022). New futures of work or continued marginalization? The rise of online freelance work and digital platforms. *2022 Symposium on Human-Computer Interaction for Work*, 1–7. https://doi.org/10.1145/3533406.3533412

Nguyen, D. (2023). How news media frame data risks in their coverage of big data and AI. *Internet Policy Review*, *12*(2). https://policyreview.info/articles/analysis/how-news-media-frame-data-risks-big-data-and-ai

Nisbet, M. C. (2009). *A New Paradigm in Public Engagement* (p. 33).

Noenickx, C. (2023). *Workplace AI: How artificial intelligence will transform the workday*. BBC Worklife. https://www.bbc.com/worklife/article/20230515-workplace-ai-how-artificial-intelligence-will-transform-the-workday

Ocal, A. (2023). Public Perceptions about AI Ethics. *2023 IEEE International Symposium on Ethics in Engineering, Science and Technology (ETHICS)*. IEEE ETHICS.

Öcal, A., Xiao, L., & Park, J. (2021). Reasoning in social media: Insights from Reddit "Change My View" submissions. *Online Information Review*, *45*(7), 1208–1226. https://doi.org/10.1108/OIR-08-2020-0330

Olesen, K. (2014). Technological Frames: Use of Context, Temporality, and Individual Focus. *SAGE Open*, *4*(1), 2158244014526720. https://doi.org/10.1177/2158244014526720

Orlikowski, W. J., & Gash, D. C. (1994). Technological frames: Making sense of information technology in organizations. *ACM Transactions on Information Systems*, *12*(2), 174–207. https://doi.org/10.1145/196734.196745

Palas, M. J. U., & Bunduchi, R. (2021). Exploring interpretations of blockchain's value in healthcare: A multi-stakeholder approach. *Information Technology & People*, *34*(2), 453–495. https://doi.org/10.1108/ITP-01-2019-0008

Paul, S., Yuan, L., Iowa State University, Jain, H., The University of Tennessee at Chattanooga, Sporher, J., ISSIP.org, Lifshitz-Assaf, H., & Warwick University. (2022). Intelligence Augmentation: Human Factors in AI and Future of Work. *AIS Transactions on Human-Computer Interaction*, 426–445. https://doi.org/10.17705/1thci.00174

Proferes, N., Jones, N., Gilbert, S., Fiesler, C., & Zimmer, M. (2021). Studying Reddit: A Systematic Overview of Disciplines, Approaches, Methods, and Ethics. *Social Media + Society*, *7*(2), 20563051211019004. https://doi.org/10.1177/20563051211019004

Reagle, J. (2022). Disguising Reddit sources and the efficacy of ethical research. *Ethics and Information Technology*, *24*(3), 41. https://doi.org/10.1007/s10676-022-09663-w

Sai Kumar, T. S., Arunaggiri Pandian, K., Thabasum Aara, S., & Nagendra Pandian, K. (2021). A Reliable Technique for Sentiment Analysis on Tweets via Machine Learning and BERT. *2021 Asian Conference on Innovation in Technology (ASIANCON)*, 1–5. https://doi.org/10.1109/ASIANCON51346.2021.9545013

Spieth, P., Röth, T., Clauss, T., & Klos, C. (2021). Technological Frames in the Digital Age: Theory, Measurement Instrument, and Future Research Areas. *Journal of Management Studies*, *58*(7), 1962–1993. https://doi.org/10.1111/joms.12720

Stam, K. R., & Stanton, J. M. (2010). Events, emotions, and technology: Examining acceptance of workplace technology changes. *Information Technology & People*, *23*(1), 23–53. https://doi.org/10.1108/09593841011022537

Stecula, D. A., & Merkley, E. (2019). Framing Climate Change: Economics, Ideology, and Uncertainty in American News Media Content From 1988 to 2014. *Frontiers in Communication*, *4*. https://www.frontiersin.org/article/10.3389/fcomm.2019.00006

Villanueva, I. I. (2021). *Climate Change Frames and Emotional Responses on Reddit* [M.A., University of Arkansas]. https://www.proquest.com/docview/2555403951/abstract/564E425B19204BE5PQ/1

Vorobeva, D., Costa Pinto, D., António, N., & Mattila, A. S. (2023). The augmentation effect of artificial intelligence: Can AI framing shape customer acceptance of AI-based services? *Current Issues in Tourism*, 1–21. https://doi.org/10.1080/13683500.2023.2214353

Waddell, G., & Burton, A. K. (2006). *Is Work Good for Your Health and Well-Being?* Stationery Office.

Walsh, J. P. (1995). Managerial and Organizational Cognition: Notes from a Trip Down Memory Lane. *Organization Science*, *6*(3), 280–321.

Walsh, T. (2018). Expert and Non-expert Opinion About Technological Unemployment. *International Journal of Automation and Computing*, *15*(5), 637–642. https://doi.org/10.1007/s11633-018-1127-x

Watson, P. F., & Petrie, A. (2010). Method agreement analysis: A review of correct methodology. *Theriogenology*, *73*(9), 1167–1179. https://doi.org/10.1016/j.theriogenology.2010.01.003

Yacoub, M. (2012). *Emotional Framing: How Do Emotions Contribute to Framing Effects?* [The degree of Master of Arts in the Department of Political Science]. the University of North Carolina at Chapel Hill.

Ylä-Anttila, T., Eranti, V., & Kukkonen, A. (2021). Topic modeling for frame analysis: A study of media debates on climate change in India and USA. *Global Media and Communication*, *22*(1), 17427665211023984.

Tables

<div align="center">

Table I. AI-related Frames from the Existing Literature

</div>

Frame	Meaning
Benefit	
1. Impact on work (positive)	"AI makes human work easier or frees us from needing to work at all" (Fast & Horvitz, 2017, p. 964).
2. Improving human well-being	AI helps to improve human life and well-being (Chuan et al., 2019).
3. Reducing human bias and social inequality	AI helps to reduce human bias and social inequality (Chuan et al., 2019).
4. Impact on education (positive)	"AI improves how students learn, e.g., through automatic tutoring or grading, or providing other kinds of personalized analytics" (Fast & Horvitz, 2017, p. 964).
5. Impact on transportation (positive)	"AI enables new forms of transportation, e.g., self-driving cars, or advanced space travel" (Fast & Horvitz, 2017, p. 964) or offers some advantages.
6. Impact on entertainment (positive)	"AI brings us joy through entertainment, e.g., though smarter enemies in video games" (Fast & Horvitz, 2017, p. 964).
7. Impact on decision-making (positive)	"AI or expert systems help us make better decisions, e.g., when to take a meeting, or case-based reasoning for business executives" (Fast & Horvitz, 2017, p. 964).
8. Impact on healthcare (positive)	"AI enhances the health and well-being of people, e.g., by assisting with diagnosis, drug discovery, or enabling personalized medicine" (Fast & Horvitz, 2017, p. 964).
9. Singularity (positive)	"Singularity is the point where AI and machine learning using AI begins to exceed the capability of humans" (Harlow, 2019, p. 393) "A potential singularity will bring positive benefits to humanity, e.g., immortality" (Fast & Horvitz, 2017, p. 964).
10. Merging of human and AI (positive)	"Humans merge with AI in a positive way, e.g., robotic limbs for the disabled, positive discussions about the potential rise of transhumanism" (Fast & Horvitz, 2017, p. 964).
Risk/Harm	
11. Loss of control	"Humans lose control of powerful AI systems, e.g., Skynet or "Ex Machina" scenarios" (Fast & Horvitz, 2017, p. 964).
12. Impact on work (negative, e.g., loss of jobs)	"AI displaces human jobs, e.g., a large-scale loss of jobs by blue-collar workers" (Fast & Horvitz, 2017, p. 964).
13. Absence of Appropriate Ethics (embedded bias, privacy concern, misuse, Pandora's Box (unforeseeable risk))	"AI lacks ethical reasoning, leading to negative outcomes, e.g., loss of human life" (Fast & Horvitz, 2017, p. 964).

14. Lack of progress (shortcomings of AI)	"The field of AI is advancing more slowly than expected, e.g., unmet expectations like those that led to an AI Winter" (Fast & Horvitz, 2017, p. 964).
15. Military applications	"AI kills people or leads to instabilities and warfare through military applications, e.g., robotic soldiers, killer drones" (Fast & Horvitz, 2017, p. 964).
16. Singularity (negative)	"The singularity harms humanity, e.g., humans are replaced or killed" (Fast & Horvitz, 2017, p. 964).
17. Merging of human and AI (negative)	"Humans merge with AI in a negative way, e.g., cyborg soldiers" (Fast & Horvitz, 2017, p. 964).

Table II. Selected Subreddits

Subreddit	Description of Subreddit[4]	Number of Members
Futurology	A subreddit devoted to the field of Future(s) Studies and speculation about the development of humanity, technology, and civilization.	15.6m
tomorrowsworld	A subreddit for the future of the world conversations	816
DarkFuturology	A subreddit for dystopian trends.	68.1k
conspiracy	The conspiracy subreddit is a thinking ground. Above all else, we respect everyone's opinions and ALL religious beliefs and creeds. We hope to challenge issues that have captured the public's imagination, from JFK and UFOs to 9/11. This is a forum for free-thinking, not hate speech.	1.7m
ArtificialInteligence	A subreddit for Artificial Intelligence conversations	78.1k
artificial	A subreddit for Artificial Intelligence conversations	153k
agi	A subreddit for Artificial general intelligence (AGI) conversations, which is also referred to as "strong AI", "full AI" or as the ability of a machine to perform "general intelligent action."	12.1k
MachineLearning	A subreddit for Machine Learning conversations	2.5m
deeplearning	A subreddit for Deep Learning conversations	80.2k
tech	A subreddit dedicated to the news and discussions about the creation and use of technology and its surrounding issues.	11.4m
technology	Subreddit dedicated to the news and discussions about the creation and use of technology and its surrounding issues.	12.2m
worldnews	A place for major news from around the world, excluding US-internal news.	29.1m
science	This community is a place to share and discuss new scientific research. Read about the latest advances in astronomy, biology, medicine, physics, social science, and more. Find and submit new publications and popular science coverage of current research.	27.7m
Automate	A place for the discussion of automation, additive manufacturing, robotics, AI, and all the other tools we've created to enable a global paradise free of menial labor. All can share in our achievements in a world where food is produced, water is purified, and housing is constructed by machines.	47.1k
singularity	Everything pertaining to the technological singularity and related topics, e.g., AI, human enhancement, etc.	150k

Table III. AI-related Frames and Topics Related to the Future of Work

#	Cluster	% of total	Neg Rate	Keywords	Explanation	Examples
1F	Impact on healthcare	15%	34%	AI diseases radiologists patient false data vaccine breast cells researchers	AI's impact on healthcare (positive and negative impacts, such as using advanced models for increasing productivity of healthcare workers, risks of false positives in breast cancer prediction, covid detection etc.).	*Exp 1. "Doctors in Brazil the country with the second highest number of cases and deaths in the coronavirus pandemic have a new tool in their fight against COVID artificial intelligence to detect infections."* *Exp 2. "An Artificial Intelligence designed to reduce the high number of false positives and false negatives in Mammogram interpretations outperformed ALL human readers in an independent study of radiologists and reduced the workload of the second reader by Published in Nature."*
2F	**General impacts of intelligent machines on wealth and society**	**11%**	**42%**	**automation robots society wealth it workers make basic technology revolution**	**Interpretation that automation and robots will influence the society and economy in general, e.g., unequal wealth redistribution, or bringing wealth to everyone, both positive and negative aspects.**	***Exp 1. "Rich will eventually share not because of the goodness of the heart but at the fear of social instability."*** *Exp 2. "We've already seen this happen over the two hundred years with the industrial revolution, so it isn't surprising. We need wealth redistribution in the form of taxes or public ownership of automation"*

3F	Impact on military	15%	38%	autonomous ban drones threat nukes us missiles systems warfare intelligence	Belief that weapons with artificial intelligence is affecting wars, military, e.g., autonomous weapons, *genie in the bottle, algorithmic warfare* metaphors	*Exp 1.* *"A satellite-controlled machine gun with artificial intelligence was used to kill Iran's top nuclear scientist a Revolutionary Guards commander says."* *Exp 2.* *"AI robot armies are here to stay. That genie won't go back in the bottle. Just wait until they get nukes. Nobody will dare to move or even twitch."*
4T	Gender based AI applications	14%	22%	gender autism study differences asd robots perceived straight children so	AI applications based on human gender, e.g., autism diagnosis differentiating the gender, homosexuality correlated facial appearance finder AI app.	*Exp 1.* *"Girls with autism differ in several brain centers compared with boys with the disorder suggesting gender specific diagnostics are needed a Stanford study using artificial intelligence found."* *Exp 2.* *"Brain organization differs between boys and girls with autism according to a new study from the Stanford University School of Medicine. The differences identified by analyzing hundreds of brain scans with artificial intelligence techniques were unique to autism and not found in typically developing boys and girls…"*
5F	**Taking over tasks (both automation and augmentati on)**	**15%**	**24%**	**ai jobs driving technology it automation make replace humans see**	**Assumption that AI is taking over some tasks through which it substitutes and augments humans**	*Automation:* *Exp 1.* *"Russian Prime Minister: "Artificial intelligence will replace monotonous and routine tasks."* *Augmentation:* *Exp 1.* *"Whatever AI means will augment natural skills, multiplying their economic effectiveness..."*

6T	Killer robots, cyborgs	7%	78%	robots overlords welcome killer we cyborg army see androids law	robot overlords, cyborgs, killer robots	*Exp 1. "This is why I see our future as in Star Wars. Everything very futuristic with flying cars robotic medicine droid, but almost everyone really poor."* *Exp 2. "Robots are the future of freeing humanity from wage slavery but only if we fight to make that true."*
7F	The need of regulation, laws related to AI use, patent laws etc.	7%	67%	patents ai inventor office rights could Europe copyright companies lawyers	Expectation of arranging laws, regulation in the case of AI involvement, and a need to help understand patent law in artificial intelligence projects.	*Exp 1. "Need help in understanding patent law for artificial intelligence Project."* *Exp 2. "US patent office rules that artificial intelligence cannot legally be an inventor."*
8F	Perceived bot gender	3%	47%	female voices Siri Alexa Cortana assistants pilots gps accent default	Perceptions about bot gender, bots are perceived differently by humans according to the gender of AI tool, e.g., bots with women voice are perceived differently than bots with men voice, etc.	*Exp 1. "This is why I always thank Siri after she has completed a task for me hopefully our robot overlords will remember that and have mercy on me"* *Exp 2. "I use a male voice on my phone because I don't like women telling me what to do."* *Exp 3. "The military uses female voices for the automated warnings in cockpits because the Navy discovered that fighter pilots are more receptive responsive to a female voice than a male voice issuing a warning"*

9T	AI applications like bots that are used by the companies such as Google, Microsoft, OpenAI, etc.	1%	67 %	Google bots AI OpenAI text chat social human sentient see	Perception that AI applications like bots are used by the companies such as Google, Microsoft, OpenAI, etc. risks of sentient AI and bias in data.	*Exp 1. "Google's Sentient AI has hired a lawyer to prove it's alive."* *Exp 2. "Google Apple Amazon Fight Over Artificial Intelligence."*
10 F	Impact on crime	6%	63%	mouse porn theft movements covid photos app poop screen zodiac	Perception that AI could be used for various purposes, benevolent or malicious purposes like identifying theft, or violation of privacy, malicious uses such as porn, etc.	*Exp 1. "A horrifying new AI app swaps women into porn videos with a click."* *Exp 2. "The next big privacy scare is a face recognition tool you've never heard of. It's a Peter Thiel funded company called Clearview AI and its service matches faces from images you upload with those in its database of some three billion photos pictures have been scraped from millions of websites."* *Exp3. "Identity theft can be thwarted by artificial intelligence analysis of a user's mouse movements of the time."*
11 T	AGI, reaching human level AI	6%	51%	safety ai human gai symbols first seems tasks years brain	GAI (general artificial intelligence), reaching human level AI, e.g., risk of violation of human safety and morality due to AGI.	*Exp 1. "There's no reason to think that an AGI would be any more benevolent that the average person. In fact, a lot of reasons to think the opposite. The probability of an AGI being perfectly aligned with human morals and values is vanishingly small. There are some interesting papers on the topic of AI safety and some great YouTube videos breaking them down."*

| 12 F | Singularity | 0.01% | 47% | singularity technological smarter already ai think yahta overlords superintelligence mankind | Perceptions about "singularity", which is the point where AI and machine learning using Al begins to exceed the capability of humans" (Harlow, 2019, p. 393). | *Exp 1. "The singularity is coming but it is not a threat. People seem to forget that biology keeps humanity going but a computer doesn't have physical reproductive capabilities outside of humans creating them. Computers can already outthink us in a number of ways. The cellphone in your pocket can do things in seconds that would take your brain a lifetime to complete…"* *Exp 2. "Once we reach the singularity mankind will be destroyed AI will have infinite simulations running of which chances are has already happened and we are already a part of. It is very doubtful this is base reality and we have already reached the singularity long ago and are currently in a simulation…"* |

Note: Frames are shown as F, and topics are shown as T in the "#" column. Clusters 2 and 5, shown in **bold,** were analyzed in the close reading section to describe interpretations, beliefs, assumptions, and expectations.