Exploring AI Principles in Global Top 500 Enterprises: A Delphi Technique of LDA Topic Modeling Results

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Abstract

Artificial Intelligence (AI) technology has already penetrated deeply into our daily lives, and we live with the convenience of it anytime, anywhere, and sometimes even without us noticing it. However, because AI is imitative intelligence based on human Intelligence, it inevitably has both good and evil sides of humans, which is why ethical principles are essential. The starting point of this study is the AI principles for companies or organizations to develop products. Since the late 2010s, studies on ethics and principles of AI have been actively published. This study focused on AI principles declared by global companies currently developing various products through AI technology. So, we surveyed the AI principles of the Global 500 companies by market capitalization at a given specific time and collected the AI principles explicitly declared by 46 of them. AI analysis technology primarily analyzed this text data, especially LDA (Latent Dirichlet Allocation) topic modeling, which belongs to Machine Learning (ML) analysis technology. Then, we conducted a Delphi technique to reach a meaningful consensus by presenting the primary analysis results. We expect to provide meaningful guidelines in AI-related government policy establishment, corporate ethics declarations, and academic research, where debates on AI ethics and principles often occur recently based on the results of our study.

Keywords : AI principle, AI ethics, LDA, Delphi, Enterprise AI

Major Classification Code : Artificial Intelligence

1. Introduction

Artificial intelligence technology is embedded in our daily lives. This phenomenon is not just for younger generations but can also reduce isolation and promote social connection among older adults (Park & Kim, 2020). AI technology has great potential to improve daily life and as well as create profound societal and ethical challenges (Grosz & Stone, 2018).

In this study, we plan to focus on the social responsibility and ethical challenges of AI technology, and various studies are already being conducted in academia on these challenges. For example, there is an argument that what is needed for a trustworthy AI system is the initiation of a deliberation that includes the broadest possible expertise, which should give confidence that AI technology is safe, reliable, and effective (Grosz & Stone, 2018). In addition to the argument that ethical issues in AI should be addressed through forced filtering, some studies emphasize

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a broader conscious perspective approach, which are emphasized: first, the principles approach; second, the ethical-by-design/processes approach; and third, the ethical consciousness approach (Kazim & Koshiyama, 2021). In particular, it was mentioned that the principles could be more specific and, thereby, easier to interpret as a weakness in dealing with the ethical aspects of AI technology from the principal point of view in Kazim & Koshiyama's study. In this study, we decided to study AI principles of the world's top 500 companies by market capitalization as of October 1, 2021, to overcome the weakness of principal ambiguity and derive viable AI principles.

As a result of data collection, we confirmed that 49 companies officially announced AI principles, we collected all text form principles, and we used LDA topic modeling for the primary analysis. The reason for using LDA topic modeling was to derive topics by performing primary data analysis objectively that did not involve human intentions as much as possible. In addition, we shared the results of the first analysis with 9 AI experts, conducted a Delphi technique in the form of an open-ended question, and reached meaningful results within two iterations. As a result, we could derive principles for four categories: the principle of products using AI technology, the principle of system design applying AI technology, the principle of service adopting AI technology, and the responsibility of AI solutions.

2. Literature Review

In January 2017, after the Asilomar AI principles were announced at 'Beneficial AI 2017' held in California, USA, by a non-profit foundation, companies also began to announce their own AI principles to respond to challenges to AI ethics and principles.

In our daily lives, we utilize AI services through various products such as computers, mobile devices, electronic products, automobiles, and others. In particular, Generative AI services, collectively called AI services similar to Open AI's ChatGPT, Google's Bard, and others, are profoundly infiltrating daily life with great attention and issue for misuse (Megahed, Chen, Ferris, Knoth & Jones-Farmer, 2023) from people worldwide. However, research on AI principles actively researched only in the late 2010s, has not been enough to expand to the corporate level. For this reason, research on AI principles should proliferate among companies.

Prior studies on corporate AI principles can be classified into two types, as shown in Table 1. First is research analysis through interviews with related experts; second, human researchers or algorithms analyze the charter of AI principles and summarize AI principles.

Table 1: Previous literature on AI principles

Analysis method and data	Authors	Year	Title
Interview	Ibáñez, Olmeda	2022	Operationalising AI ethics: how are companies bridging the gap between practice and principles? An exploratory study.
Interview	Birkstedt, Mäntymäki	2021	From Ethical AI Principles to Governed AI
Interview	Baker-Brunnbauer	2021	Management perspective of ethics in artificial intelligence
Interview	Kelley	2022	Employee Perceptions of the Effective Adoption of AI Principles
Interview	Rothenberger, Fabian, Arunov	2019	Relevance Of Ethical Guidelines For Artificial Intelligence- A Survey And Evaluation
Interview	Divakaran, Sridhar, Srinivasan	2022	Broadening AI Ethics Narratives: An Indic Art View
AI principle charter analysis (public sector)	Floridi, Cowls	2019	A Unified Framework of Five Principles for AI in Society
AI principle charter analysis (public and corporate sector) by content analysis (Nvivo)	Jobin, Ienca, Vayena	2019	Artificial Intelligence: the global landscape of ethics guidelines
AI principle charter analysis (public and corporate sector) by researcher	Hagendorff	2020	The Ethics of AI Ethics: An Evaluation of Guidelines
AI principle charter analysis (public sector) by researcher	Greene, Hoffmann, Stark	2019	Better, Nicer, Clearer, Fairer: A Critical Assessment of the Movement for Ethical Artificial Intelligence and Machine Learning
AI principle charter analysis (public and corporate sector) by researcher	Eitel-Porter	2021	Beyond the promise: implementing ethical AI

The first method, the interview with related experts, has the disadvantage that it can produce narrow results due to the diversity and number of interviewees. There may be large deviations depending on the question type and method of interviewers. The method of analyzing the second AI principle needs strict rules on data collection, such as corporate charters or non-profit foundation charters only, and presents 'Keywords' summarized by human researchers or algorithms as research results, making it difficult to persuade the process of keywords summarization. In addition, there is a disadvantage in that it is difficult to convey a precise meaning as fragmentary 'Keywords' are derived.

In this study, we supplemented the shortcomings of previous studies by applying both methods. First, clear criteria for data collection for AI principle analysis were established, and only company data was collected. In the primary analysis of the collected data, LDA topic modeling, commonly used for content analysis, was used in consideration of the researcher's bias for the primary analysis. Finally, Enterprise AI principles were derived by presenting the group of keywords derived in this way to an anonymous expert group and using the Delphi technique to reach a consensus on AI principles.

3. Data and Analysis Methods

In this study, to focus on analyzing the AI principles of companies, only the AI principles of companies that produce various products and services using AI technology were collected without collecting AI principle data from academia or non-profit organizations. In addition, clear standards were established for corporate data collection to enhance the objectivity of data collection. In addition, to overcome the limitations of qualitative analysis, an objective analysis method using LDA topic modeling and then the Delphi technique to derive expert consensus were used.

3.1. Data and Analysis Method

We followed strict rules to collect the research subject data.
- Research target companies: Top 500 global companies by market capitalization as of October 1, 2021.
- Collect AI principles: Publicly and explicitly declared by the company.

We collected AI principles by searching Google search engines, company websites, business performance reports, and sustainability reports.

Table 2: A company that can collect AI principles among the top 500 global market capitalization companies

Rank	Name	Rank	Name	Rank	Name
2	Microsoft	97	Sony	331	Ping An Bank
4	Alphabet	108	Ping An Insurance	335	Honda
6	Meta	110	Siemens	349	Nordea Bank
10	Tencent	111	IBM	358	NXP Semiconductors
15	Samsung	122	Sanofi	367	Humana
30	Adobe	141	HSBC	383	Naver
32	Salesforce	143	Airbus	428	Banco Bilbao Vizcaya Argentaria
35	Prosus	158	Daimler	429	Barclays
54	Accenture	159	Deutsche Telekom	444	Vodafone
59	AT&T	161	Infosys	447	Kakao
65	AstraZeneca	166	Allianz	478	Philips
66	Novartis	220	KDDI	486	Cognizant Technology Solutions
76	SAP	268	Workday	487	Motorola Solutions
87	Citigroup	270	BMW	490	Munich RE
89	Royal Bank Of Canada	292	Hitachi		
93	Unilever	327	Thomson Reuters		

We compiled the AI Ethical Principles of the 46 Global Top 500 companies in Table 2. Appendix 1 summarizes information on these 46 companies and links to websites with search dates.

As shown in Figure 1, we analyzed the data collected in three stages. We performed data preprocessing and LDA topic modeling before the Delphi technique because we judged that it would take many iterations and challenging to converge the opinion, and it could be subjective when we present the collected text data to experts first. Therefore, we reduced the subjectivity and bias of the analysis by performing a second Delphi technique on the set data of keywords objectively derived through LDA topic modeling.
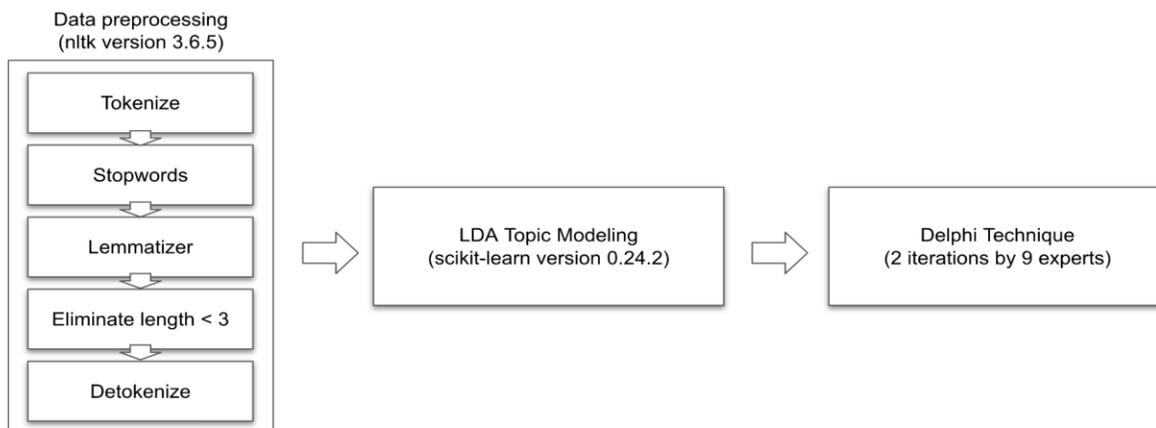

Figure 1: AI principle analysis process of 46 companies

3.2. LDA Topic Modeling

As a potentially promising tool, the topic model can automatically mine the underlying structures hidden in unstructured texts (Chen, Zhang Liu, Ye & Lin, 2019). When it comes to the topic models, the most popular methods are the probabilistic graphical models, in which topics are usually viewed as distributions over words and documents are treated to share the underlying topics with different proportions from the perspective of probability (Blei, Ng & Edu, 2003) (Griffiths, Jordan, Tenenbaum & Blei, 2003). Latent Dirichlet Allocation (LDA) (Blei, Ng & Jordan, 2001) is a typical example.

Latent Dirichlet Allocation (LDA) (Blei, Ng & Jordan, 2001) (Blei, Ng & Edu, 2003) is a generative probabilistic model for a given text collection. Basically, there is an assumption that latent topics are hidden in the given documents corpus. Each topic is represented as a multinomial distribution over the words in the vocabulary extracted from the above text collection. Each document is generated by sampling a mixture of these topics and then sampling words from that mixture (Chen, Zhang, Liu, Ye & Lin, 2019).

We used LDA in our research because there are many cases where the analysis of unstructured text related to companies or businesses is being used in academic research, as shown in Table 3.

As such, LDA is widely used to analyze short texts such as social media and online reviews and lengthy and complex company-related texts such as CSR reports, sustainability reports, internal audit research, and system problem reports. Considering that LDA has been widely used in various studies until recently, we utilized LDA for the analysis of textual AI principles declared by companies.

In the LDA topic modeling process, as shown in Figure 2, we pre-processed the data using Python 3.9.7 and The Natural Language Toolkit (nltk version 3.6.5), and LDA (scikit-learn version 0.24.2) was used for topic modeling.

Table 3: Previous literature using LDA analysis for company-related analysis

Year	Author	Title	LDA analysis target
2021	Ning, Yim & Khuntia	Online Sustainability Reporting and Firm Performance: Lessons Learned from Text Mining	Sustainability report
2021	Mashayekhi, Vanaki & Sivandian	A Review of Internal Audit Research Using Topic Modeling	Internal Audit Research
2020	Amin, Mohamed & Elragal	Corporate disclosure via social media: a data science approach	Social media

2019	Korfiatis, Stamolampros, Kourouthanassis & Sagiadinos	Measuring service quality from unstructured data: A topic modeling application on airline passengers' online reviews.	Online reviews
2018	Benites-Lazaro, Giatti & Giarolla	Sustainability and governance of sugarcane ethanol companies in Brazil: Topic modeling analysis of CSR reporting	CSR report
2016	Layman, Nikora, Meek & Menzies	Topic modeling of NASA space system problem reports research in practice	System problem reports

3.3. Delphi Technique

The Delphi Technique can be viewed as obtaining the most reliable consensus through repetition of the expert groups' opinions, feedback, survey, etc. (Hsu, 2007). It is an intuitive methodology for organizing and sharing "expert" forecasts about the future. Its original use was to establish a chronology of scientific and technological events and to judge when the events might occur through the speculations of several experts (Weaver, 1971).

We shared the keywords group, which is the result of the LDA analysis with 9 AI experts, and conducted a Delphi technique in the form of an open-ended question. The composition of nine experts was selected considering their expertise in the AI field and the distribution of various countries, as shown in Table 4.

The observation that people tend to shift their estimates toward a group norm under conditions of iteration is a consistent and sound observation based on several controlled experiments with Delphi. For this study (Weaver, 1971), we can converge experts' opinions through two iterations.

Table 4: Nine experts to apply Delphi Technique

No.	Affiliated company	Affiliated industry	Entire career (years)	AI career (years)	Affiliation Countries Region
1	LG	Research	20	3~5	APAC
2	Google	IT	10~20	10~20	America
3	Amazon	IT	10~20	10~20	America
4	IBM	IT	20	3~5	America
5	Africa	Research	20	5~10	APAC
6	Microsoft	IT	20	3~5	America
7	Naver	IT	3~5	1	APAC
8	DB Fire & Marine	Finance	20	5~10	APAC
9	Delivery Hero	IT	10~20	3~5	EMEA

4. Result

As a result of LDA topic modeling, ten keywords each for four topics, a total of 12, were derived. Afterward, we presented the LDA analysis results to nine AI experts as the Delphi technique and reached a final consensus through two iterations. In conclusion, we derived a total of twenty-five AI principles of four categories, and the detailed results are as follows.

4.1. LDA Topic Modeling Result

As a result of analyzing while changing 'n', the number of topics, using the visualization tool (pyLDAvis-3.3.1), as shown in Figure 2 and Figure 3, when n=5, topics 4 and 5 circles are overlapped in Figure 2, and n=4 when the topics did not overlap in Figure 3, and the distance distribution between topics was appropriate. We recognized that the distance between topics 3 and 4 was closer than other topics when n = 4, but it could be a meaningful result because they did not overlap.
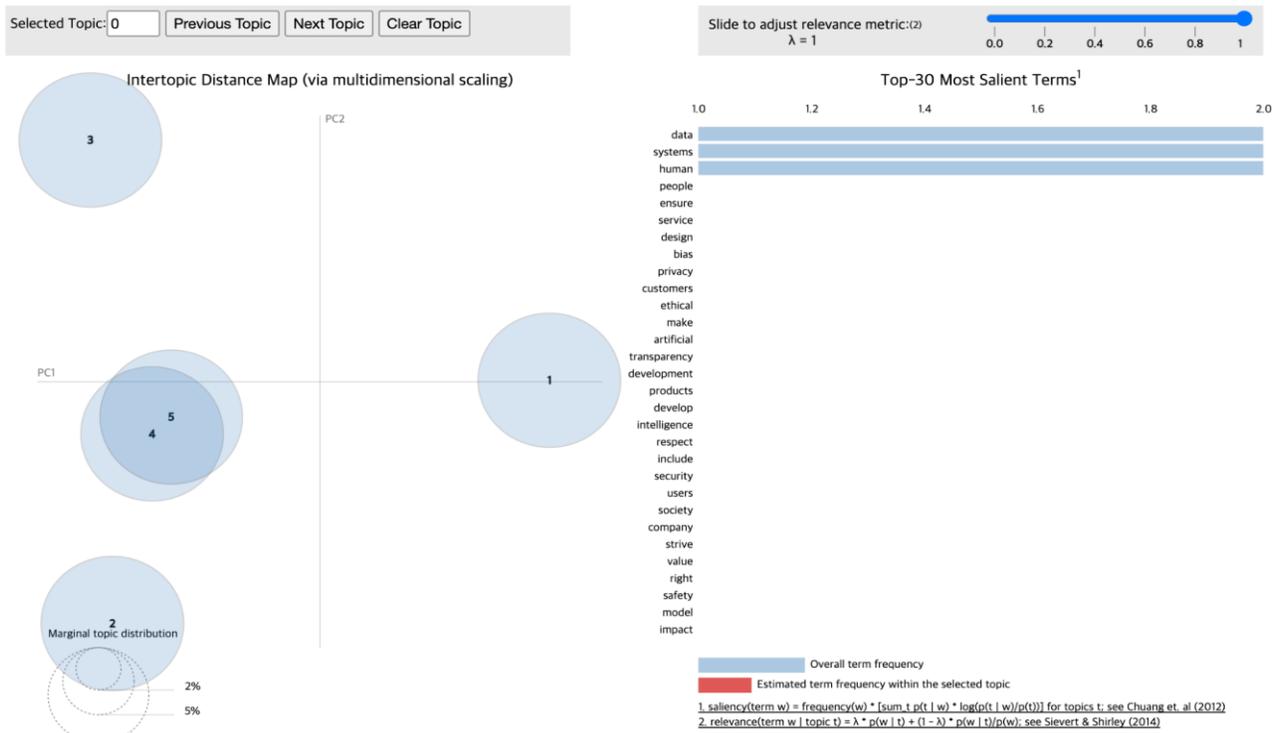
Figure 2: Intertopic distance map(left graph) when the number of topics is defined as 5 (n=5)
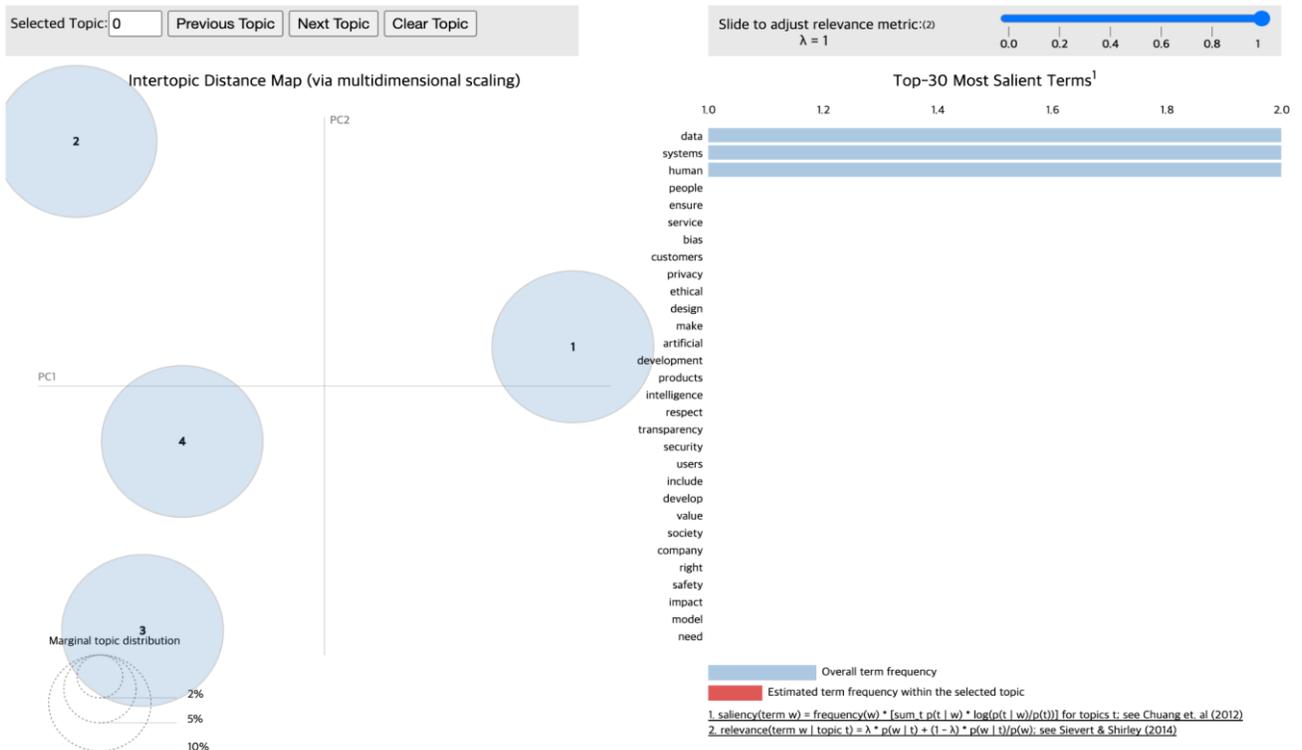

Figure 3: Inter-topic distance map(left graph) when the number of topics is defined as 4 (n=4)

The LDA topic modeling result, with four topics, is shown in Table 5.

Table 5: Topic Modeling result when n=4

Topic number	Topic 1	Topic 2	Topic 3	Topic 4
Keywords	people	data	ensure	privacy
	bias	systems	service	development
	ethical	human	customers	transparency
	artificial	design	value	society
	products	make	impact	model
	respect	intelligence	need	strive
	include	security	appropriate	principles
	safety	users	humans	provide
	protect	develop	work	responsible
	risk	company	applications	solutions

4.2. Delphi Technique Result

The first question presented to the experts was open-ended, as shown in Appendix 2, and the answers. After incorporating similarities, answers were summarized below Table 6. For one thing, LDA topic modeling cannot generate the name of a topic. After looking at the keywords, the researcher should decide on the topic's name. After collecting the experts' first answers, we tentatively defined them in the first column of Table 6.

For the second question (Appendix 3), while providing the tentatively defined topic names and summarized sentences for each topic in [Table 6], we were asked to select only three that we thought were most necessary from the point of view of AI principles. We summarized the confirmed topic names and the three most frequently selected principles for each topic in [Table 7]. In particular, 'Model reliability' is the principle chosen by all experts. In the second iteration, only 8 experts responded.

Table 6: The result of the first iteration of the Delphi

Topic number	1st iteration result
Topic 1 'AI Products'	● Protect people's safety ● Protect people from the risk ● Protect people from the risk of bias ● Unbiased for the people ● Ethical for the people ● Respect human diversity ● Minimize the risk for the people
Topic 2 'AI System'	● Design and develop for the user's security ● Design for enhancing human productivity ● Design for data security ● Do not harm people and customers ● User data security should be the top priority
Topic 3 'AI Value'	● Ensure customer value ● Ensure appropriate response ● Ensure positive impact to the humans ● Consider the negative impact to the humans
Topic 4 'AI Responsibility'	● Responsibility to protect the privacy ● Responsible for transparent design ● Respond to social issues ● Provide reliable models

Table 7: The final result of the second iteration of the Delphi

Principles of AI products:
● AI products must be ethical
● AI products must be unbiased
● AI products must respect human diversity

Principles of AI system design:
● AI system should be designed and developed for the user's security
● AI system should be designed for enhancing human productivity
● AI system should not be designed to harm people and customers

Principles of AI value:
● Ensure customer's value
● Ensure a positive impact to humans
● Ensure good value for human

Principles of AI responsibility:
● Model reliability*
● Protect the privacy
● Transparent design

5. Discussion and Conclusion

We analyzed the AI principles of 46 companies and derived four categories and a total of 12 principles. All or parts of these results may be referenced for companies to declare AI principles newly.

As shown in Table 8, we compared the results of analyzing only the AI principles declared by the public sector in the previous literature and Table 7, the analysis results of our analysis of only the AI principles declared by companies. In the case of Table 7, which analyzes only the AI principles declared by companies, it can be seen that the relatively detailed requirements that AI products and AI systems must have for providing customer service and the value to customers are emphasized compared to Table 8. However, in the case of Table 8, which analyzed only the AI principles declared in the public sector, it was found that the universal good for humanity and the principles of AI supervision and measurement are more emphasized.

Table 8: Results of previous literature that only studied AI principles published in the public domain

Authors	Years	AI principles
Floridi, Cowls	2019	- Beneficence - Non-maleficence - Autonomy - Justice - Explicability
Greene, Hoffmann, Stark	2019	- Universal concerns objectively measured - Expert oversight - Values-driven determinism - Design as the locus of ethical scrutiny - Better building - Stakeholder-driven legitimacy and machine translation

This study contributed two things. First, the company's AI principles were analyzed by combining LDA topic modeling and Delphi techniques. As a result, a viable principle was derived by combining the objective advantages of topic modeling and the advantages of collecting expert opinions from the Delphi technique. At the same time, this is the result of complementing the subjective disadvantage of the Delphi technique and the disadvantage that the result of topic modeling is ambiguous. Second, we did not analyze a mixture of business and academic AI principles but only business AI principles. Just as business and academia have different reasons for existence, each organization's AI principles exist for different purposes. We

have achieved more pragmatic results by focusing only on the principles of corporate AI that affect our real lives by using AI to produce products and services.

However, our study also has limitations. Many companies still need to establish AI principles, so we have only collected data from 46 companies. In the future, it is expected that more meaningful results will be obtained if more companies declare AI principles representing various industries.

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Appendixes

Appendix 1: Summary of AI Principle information on 46 companies

No.	Rank	Name	market cap(USD)	country	searching date	site link
1	2	Microsoft	2172554838016	United States	2021.10.08	link
2	4	Alphabet (Google)	1822655905792	United States	2021.10.08	link
3	6	Facebook	967096205312	United States	2021.10.08	link
4	10	Tencent	564399702016	China	2021.10.08	link
5	15	Samsung	415970599215	South Korea	2021.10.08	link
6	30	Adobe	274760204288	United States	2021.10.08	link
7	32	Salesforce	269479542784	United States	2021.10.08	link
8	35	Prosus	249060453248	Netherlands	2021.10.09	link
9	54	Accenture	205497335808	Ireland	2021.10.09	link
10	59	AT&T	193922383872	United States	2021.10.09	link
11	65	Astrazeneca	185148850176	United Kingdom	2021.10.09	link
12	66	Novartis	184420810752	Switzerland	2021.10.09	link
13	76	SAP	160991985664	Germany	2021.10.04	link

14	87	Citigroup	144266919936	United States	2021.10.04	link
15	89	Royal Bank Of Canada	142215544832	Canada	2021.10.04	link
16	93	Unilever	140110086144	Netherlands	2021.10.04	link
17	97	Sony	137121857536	Japan	2021.10.04	link
18	108	Ping An Insurance	131409674240	China	2021.10.04	link
19	110	Siemens	129045831680	Germany	2021.10.04	link
20	111	IBM	128460587008	United States	2021.10.04	link
21	122	Sanofi	120249597952	France	2021.10.10	link
22	141	HSBC	107917672448	United Kingdom	2021.10.10	link
23	143	Airbus	106652745728	Netherlands	2021.10.10	link
24	158	Daimler	95825169929	Germany	2021.10.10	link
25	159	Deutsche Telekom	95345314376	Germany	2021.10.10	link
26	161	Infosys	94688354304	India	2021.10.10	link
27	166	Allianz	92726829056	Germany	2021.10.10	link
28	220	KDDI	74975510528	Japan	2021.10.13	link
29	268	Workday	63128399872	United States	2021.10.18	link
30	270	BMW	62889799962	Germany	2021.10.18	link
31	292	Hitachi	59844202496	Japan	2021.10.20	link
32	327	Thomson Reuters	54622949376	Canada	2021.10.22	link
33	331	Ping An Bank	53972171377	China	2021.10.23	link
34	335	Honda	53378293760	Japan	2021.10.26	link
35	349	Nordea Bank	52002719073	Finland	2021.10.26	link
36	358	NXP Semiconductors	51141890048	Netherlands	2021.10.26	link
37	367	Humana	50316132352	United States	2021.10.26	link
38	383	Naver	48059240663	South Korea	2021.10.12	link
39	428	Banco Bilbao Vizcaya Argentaria	43947356160	Spain	2021.10.31	link
40	429	Barclays	43938254848	United Kingdom	2021.10.31	link
41	444	Vodafone	42707251200	United Kingdom	2021.10.31	link
42	447	Kakao	42429718592	South Korea	2021.10.31	link
43	478	Philips	40315797504	Netherlands	2021.11.01	link
44	486	Cognizant Technology Solutions	39742558208	United States	2021.11.01	link
45	487	Motorola Solutions	39674540032	United States	2021.11.01	link
46	490	Munich RE	39449269688	Germany	2021.10.31	link

Appendix 2: The first iteration questions of the Delphi technique

Research on Enterprise AI Principles (1)

Although many companies use AI technology to produce products and services, most companies still need ethical principles. In this study, AI ethical principles of 46 of the top 500 global companies by market capitalization were analyzed through topic modeling, and four topics consisting of 10 words each were derived.
The panelists, composed of 9 AI experts, read the 10 words derived from each topic and freely write the AI ethical principles that come to mind. You can write more than one ethical principle for each topic. Once again, you can read the ten words of each topic and write creatively, associating with the AI ethical principles that you think are essential for your company.
(This study is a Delphi technique, starting with the 1st iteration question, and 2nd or 3rd multiple choice questions will be added.)

1. Combine the following 10 words and freely write at least one AI ethical principle (sentence form) for companies
people, bias, ethical, AI, products, respect, include, safety, protect, risk

2. Please freely write at least one AI ethical principle (in sentence form) for companies by combining the following 10 words.
data, systems, human, design, make, AI, security, users, develop, company

3. Please freely write at least one AI ethical principle (in sentence form) for companies by combining the following 10 words.
ensure, service, customers, value, impact, need, appropriate, humans, work, applications

4. Please freely write at least one AI ethical principle (in sentence form) for companies by combining the following 10 words.
privacy, development, transparency, society, model, strive, principles, provide, responsible, solutions

Appendix 3: The second iteration questions of the Delphi technique

Research on Enterprise AI Principles (2)

We have collected AI ethical principles that companies should have on 4 topics from 9 AI experts currently active, including you.
Feel free to read the opinions of other experts and choose only three essential principles for each item. (Expected to take 5 minutes)

1. From the following 7 principles, please select 3 principles that you think are the most important for an AI product produced by a company.
- Protect people's safety
- Protect people from the risk
- Protect people from the risk of bias
- Unbiased for the people
- Ethical for the people
- Respect human diversity
- Minimize the risk for the people

2. Among the following 5 principles, please select 3 principles that you think are the most important for AI system design.
- Design and develop for the user's security
- Design for enhancing human productivity
- Design for data security
- Do not harm people and customers
- User data security should be the top priority

3. From the following 7 principles, please select 3 principles that you think are the most important for a company's AI service.
- Ensure customer value
- Ensure appropriate response
- Ensure positive impact to the humans
- Consider the negative impact to the humans

4. Out of the following six corporate AI solution responsibilities, please select three principles that you consider most important.
- Responsibility to protect the privacy
- Provide transparent design principles
- Respond to social issues
- Provide reliable models