Hertie School

Identifying AI's Environmental Risks:

Using NLP to Analyzing Public Consultation Feedback on the AI Act

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1. Executive Summary

In this research note, I used Natural Language Processing (NLP) to analyze public consultation feedback on the AI Act, focusing on environmental and climate-related concerns identified by stakeholders. The feedback was numerically represented using word embeddings, averaged to create sentence embeddings, and then reduced to two dimensions with UMAP to preserve semantic relationships. This approach allowed the clustering of feedback into four thematic groups through KMeans, highlighting recurring environmental concerns associated with AI systems. Finally, feedback from each cluster was summarized using the BART model, helping in the interpretation of the cluster's content. This methodology bridges quantitative analysis with qualitative exploration, providing insights to assess if the environmental concerns raised by stakeholders were adequately incorporated in the final version of the AI Act.[1]

2. Introduction

The EU AI Act, entered into force in August 2024, establishes a regulatory framework for the development and deployment of artificial intelligence (AI) systems within the European Union.[2] Its primary objective is to ensure that AI technologies are trustworthy, safe, and aligned with the protection of fundamental rights.[3] According to the Act, an AI system is defined as a machine-based system designed to operate with varying levels of autonomy and capable of generating outputs that can influence physical or virtual environments.[4] Under this framework, AI systems are classified into different risk levels (unacceptable, high, limited, and low risk) based on their potential impact on safety and rights. According to those classifications, the AI Act mandates prohibitions, application of specific requirements or

[1] This project, including the analysis code and processed data, is available on GitHub: https://github.com/Monlo/nlp-research-note-ai-act.

[2] European Union AI Act, "Regulation of the European Parliament and of the Council Laying Down Harmonised Rules on Artificial Intelligence (Artificial Intelligence Act)," Article 1, accessed December 15, 2024, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1689

[3] Ibid., Article 3.

[4] Ibid., Article 6.

transparency obligations.[5] Non-compliance can result in administrative fines from 1.5% to 7% of a company's annual global revenue, depending on the severity of the violation.[6]

The creation of the AI Act involved multiple rounds of public consultations with stakeholders, including citizens, NGOs, academic institutions, and industry representatives. In particular, the consultation on 'Artificial Intelligence- ethical and legal requirements' consisted of three periods from February 2020 to August 2021.[7] In the first period, stakeholders were invited to provide broad feedback and opinions on the first draft of the Act, known as the 'AI White Paper', serving as the basis for the creation of an Inception Impact Assessment.[8] This document was then published for stakeholder comments in a second round, and in the third one, stakeholders were asked to respond to specific regulatory measures and compliance mechanisms. At the end of this process, feedback from all periods was integrated in the final text.

In this research note, Natural Language Processing (NLP) methods were applied to analyze stakeholder feedback, focusing specifically on the second and third consultation rounds. These stages contain specialized insights and recommendations building on the broad feedback from the initial consultation phase. NLP serves as an essential tool for this analysis, as it enables the processing of large volumes of diverse, extensive, and complex textual data that would be challenging to analyze manually. The research focuses particularly on environmental risks of AI systems, which are increasing concerns in recent years. The methodology allows to identify recurring themes and stakeholder priorities, offering a clearer understanding of how environmental risks are perceived and addressed in the consultation process.

3. Methodology

Data collection and preprocessing

To get data from the last two rounds of the consultation, I scraped 437 feedbacks from different stakeholders, published by the European Commission.[9] Some of those feedbacks

[5] Ibid., Recital 26.
[6] Ibid., Article 99.
[7] European Commission, "Artificial Intelligence: Ethical and Legal Requirements," accessed December 15, 2024, https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12527-Artificial-intelligence-ethical-and-legal-requirements_e
[8] European Commission, "Commission Staff Working Document: Impact Assessment Accompanying the Proposal for a Regulation of the European Parliament and of the Council Laying Down Harmonised Rules on Artificial Intelligence (Artificial Intelligence Act)," (2021), accessed December 15, 2024, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52021SC0084 .
[9] European Commission, "Feedback on Artificial Intelligence: Ethical and Legal Requirements," accessed December 15, 2024, https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12527-Artificial-intelligence-ethical-and-l

were accompanied by extended pdfs. That information was extracted and merged to the database by the feedback reference number. In the cases where no pdf was provided, I used the direct description of the feedback.

As the document files have different formats from each organization, I applied a cleaning function with regex patterns to clean as much as possible the text data. This function standardized the text by removing non-ASCII characters, excessive whitespace, URLs, phone numbers, and formatting elements like enumerations, roman numerals, and graph-related terms. Additionally, I applied a normalization step, removing any extra spaces, tabs, or other whitespace characters that appear at the beginning (leading) or end (trailing) of a string.

The final dataset contained 428 observations after removing 9 entries without feedback and duplicated text, with 7 variables: organization, feedback reference number, date of submission, user type, organization size, country of origin, and the text of the feedback. As the consultation was opened to different countries, the dataset contained feedback in different languages, with English being the predominant with 88.5% of the observations. For this project, I filtered only the English feedback, keeping the other languages entries for future analysis.

4. Analysis and Results

As expected, the most common word in the full clean dataset was AI (with 22,0647 mentions), followed by systems (7,459), data (6,683), risk (6,248), use (4,087), regulation (3,945), high (3,926), european (3,512), and rights (3,148). All those words are related to the purpose of the consultation on identifying risks in AI systems to develop an AI regulation aligned with the EU human rights.

Environmental Risk Mentions

To identify feedback mentions on environmental risks, each text entry was first split into individual sentences using the NLTK sent_tokenize function. Each sentence was then scanned and filtered if it contained any of the following keywords: 'climate', 'environmental', 'carbon', 'emission', 'energy', 'sustainability', and 'footprint'. This filtering process resulted in a dataset with 122 entries specifically discussing environmental risks.

A Word Cloud was generated to highlight the most frequently mentioned words within the filtered dataset. As the most common words from the broader dataset were repeated in occurrence, such as 'AI', 'systems', 'use', 'data', 'regulation', and 'rights', they were excluded to

egal-requirements/feedback_en?p_id=8242911; and https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12527-Artificial-intelligence-ethical-and-legal-requirements/feedback_en?p_id=24212003.

reduce noise. The graph filtered by those common words highlights recurring concerns around the environmental impact of AI systems, particularly focusing on sustainability, energy consumption, climate change, and social risks.

Figure 1. Word Cloud of the Environmental Risk Mentions Feedbacks

Using embeddings to understand relationships between words

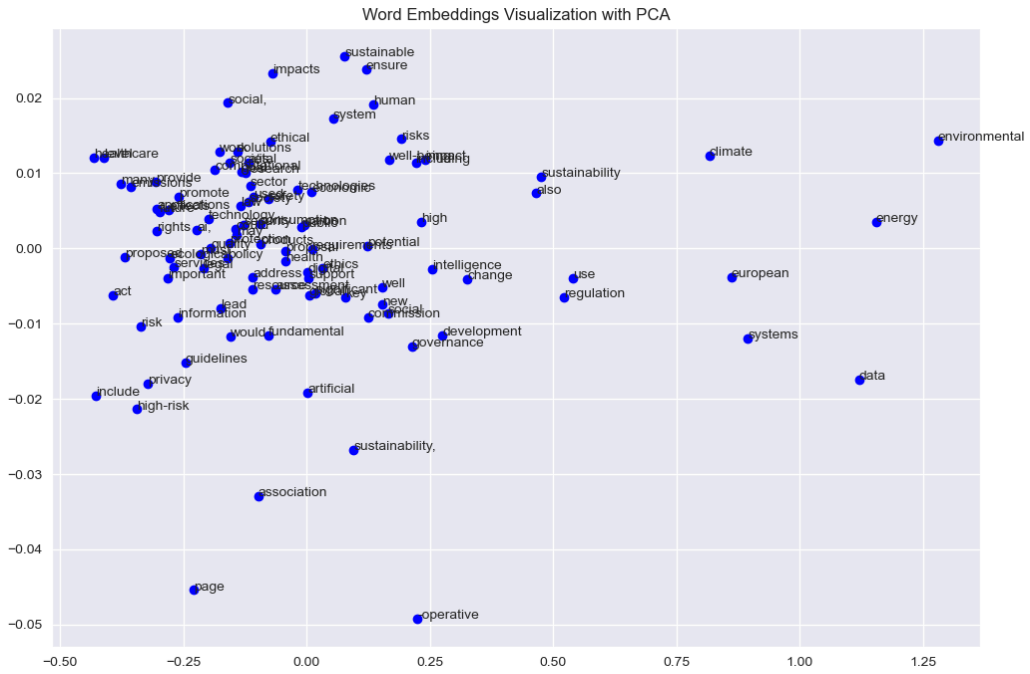
In the previous section, the most frequent words in the dataset were identified, providing an initial overview of recurring terms related to environmental and climate feedback in the AI Act consultation. However, word frequency analysis lacks semantic context and does not capture relationships between words. Terms like "climate" and "energy" may frequently appear together or in similar contexts, but frequency-based analysis cannot represent these connections. To address this limitation, word embeddings were used.

First, sentences were tokenized into individual words. Common stopwords like "the," "is," "and" and words with fewer than three characters were removed to reduce noise and improve the quality of the embeddings. Following this, the Word2Vec model was trained on the tokenized sentences to learn vector representations of words. The model analyzed each word within a context window of five surrounding words, refining these representations over ten iterations to enhance their accuracy.

Figure 2 illustrates the relationships between words in the dataset using a two-dimensional representation of the embeddings. From the Word2Vec vocabulary, the 100 most frequent words were selected and reduced to two dimensions using Principal Component Analysis (PCA). This visualization reveals semantic clusters, grouping together words that frequently

share similar contexts. Terms like "climate" and "sustainability" appear closely related in this semantic space, reflecting their contextual similarity in the feedback text.

Figure 2. Word Embeddings Visualization with PCA



Clustering embeddings

For further analysis of public consultation feedback on the environmental risks of AI systems, sentence embeddings were generated and clustered. First, sentence embeddings were created by averaging word embeddings for each tokenized sentence, allowing each sentence to be represented as a single vector. Given the high dimensionality of these embeddings, UMAP (Uniform Manifold Approximation and Projection) was applied for dimensionality reduction. UMAP captures non-linear relationships in high-dimensional data, preserving both local and global data structures.[10]

To group feedback sentences into clusters, KMeans clustering was applied to the reduced embeddings.[11] Each cluster consists of sentences extracted from different stakeholder feedback entries that were grouped based on their semantic similarity. This approach led to four distinct thematic clusters, revealing recurring themes in stakeholder feedback.

[10] Leland McInnes, John Healy, and James Melville, "UMAP: Uniform Manifold Approximation and Projection," GeeksforGeeks, July 3, 2024, https://www.geeksforgeeks.org/umap-uniform-manifold-approximation-and-projection/.
[11] "K-Means Clustering – Introduction," GeeksforGeeks, August 29, 2024, https://www.geeksforgeeks.org/k-means-clustering-introduction/?ref=header_outind.

Cluster Summary Analysis

Once the clusters were identified, a pre-trained BART model[12] was used to generate concise summaries for each cluster. The feedback text was chunked into smaller segments, allowing the summarizer to process text chunks more efficiently. This summarization step provided a clear synthesis of each cluster's insights, helping to identify stakeholder concerns regarding AI's climate and environmental risks., presented in Table 1.

Table 1. Cluster Summaries

Cluster	Cluster Content	Example Sentences in the Summaries
Cluster 0: Industry Perspectives on AI	This cluster highlights industry stakeholders' perspectives on leveraging AI to address climate change and environmental risks. There is an emphasis on regulatory coherence, alignment with sector-specific frameworks, and avoiding conflicting regulations.	- *"E.ON calls for a priority focus on any AI use case with a benefit for climate and the environment. The Act should focus as well on leveraging the use of AI to mitigate the risks of climate change."* - *"The EACB trusts that its comments will be taken into account. We believe that overlapping or conflicting regulation needs to be avoided and sector-specific legislation such as the CRR should prevail."*
Cluster 1: Governance and Oversight	This cluster emphasizes the need for harmonized regulations and clear legal frameworks to enable effective AI deployment and trust. Stakeholders call for a stable governance structure to prevent regulatory fragmentation across Member States and enhance public trust in AI systems.	- *"More widespread deployment of AI in particular in healthcare will benefit European citizens, patients, and healthcare professionals."* - *"Lack of a harmonised interpretation of the rules can lead to a situation of competition among the type-approval authorities of different Member States."* - *"The proposal can enhance trust in AI applications, by establishing a clear and stable legal framework."*
Cluster 2: Ethical and Structural Concerns of AI	Stakeholders emphasize ethical and structural concerns related to AI, including its environmental footprint, energy consumption, and potential for	- *"AI has the potential to help achieve the green transition but also comes with a big environmental footprint."*

[12] "BART (Large-Sized Model), Fine-Tuned on CNN Daily Mail," Hugging Face, accessed December 20, 2024, https://huggingface.co/facebook/bart-large-cnn.

	exacerbating social inequalities. There are calls for sustainable AI infrastructures, alignment with well-being metrics and Sustainable Development Goals (SDGs), and policies that balance technological growth with environmental responsibility.	*- "We recommend incentivising the use of greener infrastructures."* *- "Technology has a long history of contributing to ecological degradation."* *- "The negative environmental impacts of technology are commonly concentrated on the middle class and working poor."* *-" There is a risk that it will increase fossil fuel use and have a negative impact on the environment and the climate.* *- "Digital technologies contribute to 4% of overall greenhouse gas emissions."* *- "Strong emphasis must be placed not only on respecting fundamental human rights but also on sustainability."*
Cluster 3: Accountability, Transparency, and Risk Management	This cluster focuses on transparency and accountability mechanisms for AI systems, particularly those categorized as high-risk. Stakeholders call for legal stress tests, third-party audits, and binding regulatory measures to ensure compliance with ethical and environmental standards.	*- "We call for a broad legal AI stress test."* *- "Civil society organisations must have the right to request audits of high-risk AI systems."* *- "The European Commission should support the development of clear and binding measures to address the risks that AI tools pose."* *- "We argue here that climate change mitigation and adaptation should be named more explicitly."*

As shown in the table, the analysis of stakeholder feedback on the AI Act reveals four key thematic clusters. The first cluster captures industry perspectives, emphasizing the need for using AI to address climate change and environmental risks while ensuring coherent regulations that avoid conflicts. The second cluster focuses on the need for harmonized regulations and legal frameworks to build trust in AI deployment. The third one addresses ethical and structural concerns, highlighting the need for sustainable AI infrastructure and alignment with global sustainability goals. The final cluster centers on the importance of accountability, transparency, and oversight mechanisms, including stress tests and third-party audits, to ensure responsible deployment of high-risk AI systems.

5. Discussion

The analysis of public consultation feedback on the AI Act using NLP methods revealed four thematic clusters, reflecting different stakeholder concerns about environmental and climate-related risks associated with AI systems. These clusters highlight recurring issues such as regulatory coherence, governance and oversight, ethical and structural challenges, and accountability mechanisms.

The final version of the AI Act addressed some of those concerns. In Article 1 environmental protection is considered one of the fundamental rights to protect against the harmful effects of AI systems. For high-risk AI systems, the technical documentation referred to in Article 11(1) requires recording the computational resources used to develop, train, test and validate the AI system. Article 40 outlines standardization requests, focusing on reducing energy consumption in high-risk AI systems and promoting energy-efficient development of general-purpose AI models. Finally, voluntary codes of conduct are considered to assess and minimise the impact of AI systems on environmental sustainability, including energy-efficient programming and techniques for the efficient design and training and use of AI.[13]

Despite these measures, the Act has faced criticism for being insufficient. Stakeholders have pointed out that key provisions, such as life cycle assessments of environmental impacts and mandatory energy efficiency standards, were removed during legislative negotiations.[14] The requirements on energy consumption of providers of general-purpose AI models are also considered to be low, without a strong framework to ensure compliance.[15] Also, the legislation relies on voluntary codes of conduct in the disclosure of the environmental impact of AI systems, without considering mandatory requirements and clear enforcement mechanisms, which raises concerns about its effectiveness.[16]

In conclusion, while the EU AI Act represents an important step in integrating environmental concerns into AI governance, it ultimately falls short in addressing the significant challenges identified by stakeholders. The NLP analysis in this research note helped to identify those gaps, and can serve as a valuable tool for informing future revisions of the legislation.

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[13] European Union AI Act, "Regulation of the European Parliament and of the Council Laying Down Harmonised Rules on Artificial Intelligence (Artificial Intelligence Act)," Article 95, accessed December 20, 2024, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1689

[14] Heinrich-Böll-Stiftung European Union. "The EU AI Act: A Missed Opportunity." April 8, 2024. https://eu.boell.org/en/2024/04/08/eu-ai-act-missed-opportunity.

[15] Tech Policy Press. "Hope: The AI Act's Approach to Address the Environmental Impact of AI." May 21, 2024. https://www.techpolicy.press/hope-the-ai-acts-approach-to-address-the-environmental-impact-of-ai/

[16] Green Software Foundation. "The EU AI Act: Insights from the Green AI Committee." October 17, 2024. https://greensoftware.foundation/articles/the-eu-ai-act-insights-from-the-green-ai-committee.

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