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A Comparative Analysis of European Media Coverage of the Israel–Gaza War Using Hesitant Fuzzy Linguistic Term Sets

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Abstract: Representing and interpreting human opinions within an unstructured framework is inherently complex. Hesitant fuzzy linguistic term sets offer a comprehensive context that facilitates a nuanced understanding of diverse perspectives. This study introduces a methodology that integrates sentiment analysis with hesitant fuzzy linguistic term sets to effectively aggregate and compare news from diverse sources. By employing linguistic scales, our approach enhances the interpretation of various perceptions and attitudes, facilitating comprehensive knowledge extraction and representation. The main objective of this research is to conduct a comparative analysis of news coverage across European countries in relation to the Israel–Gaza war. This analysis aims to capture the multifaceted sensitivities surrounding the ongoing situation, highlighting how different nations perceive the conflict.

Keywords: linguistic modeling; knowledge extraction; knowledge representation; unbalanced hesitant fuzzy linguistic term sets; news aggregation; sentiment analysis

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1. Introduction

The news provides essential information that shapes and influences the opinions and interests of citizens [1–3]. In this direction, the news that appears in newspapers on various conflicts and crises around the world models the perspectives and beliefs of citizens [4,5]. Different newspapers explain the same news by emphasizing different aspects, contextualizing them differently, and using more or less extreme language. The linguistic terms used depend on the journalist's background, the editorial line, the ideology of the media outlet, and the strategic interests of the country to which the media outlet belongs. In order to analyze the sentiment about an event based on news from various media outlets, it is necessary to take these differences into account [6]. A new method of analysis that considers information that is not explicitly stated in linguistic terms but in the tradition in which each media outlet uses these terms is needed.

The technical contribution of this study lies in its novel approach to analyzing the use of linguistic terms in the media by employing *hesitant fuzzy linguistic term sets* (HFLTSs) and sentiment analysis. This methodology improves the representation of uncertainty and the aggregation of information. Compared to existing approaches, it provides a

unique capability to address diverse interpretations of linguistic expressions and facilitates comparisons of media coverage across different countries.

Hesitant fuzzy linguistic term sets, which are an extension of the hesitant fuzzy sets introduced by V. Torra [7], have advanced within the area of linguistic computation. In particular, they have been applied in contexts where understanding people's emotions or sentiments has been of interest [8–10]. HFLTSs provide an effective conceptual framework for dealing with the problem of knowledge representation in environments characterized by imprecision and hesitancy. HFLTSs are particularly suitable for incorporating diverse perspectives, including the representation of individual opinions and the qualitative fusion of multiple points of view to capture a group consensus [11,12].

The methodology is based on the concept of a linguistic perceptual map, which was recently introduced in the context of HFLTSs and aims to formalize the idea that individuals using the same linguistic expressions may not always intend to convey exactly the same concepts. Instead, the meaning of these linguistic expressions depends on the experiences and background of the users. Linguistic perceptual maps have already been applied in various fields, such as entrepreneurship and marketing [13,14]. However, we believe that news narration provides an excellent context to illustrate the utility of the linguistic perceptual map concept. The step-by-step methodology described in this work serves as a guideline for applying this concept in similar scenarios.

We perform a comparative analysis of news coverage from various European countries in relation to the Israel–Gaza war. To achieve this, sentiment analysis is employed to capture the emotional tone, specifically the negative emotional tone and the underlying feelings about the news about the Israel–Gaza war. For this study, we used a large-scale data set of the news media coverage from the GDELT project (*Global Database of Events, Location, and Tone*), which tracks news coverage in more than 100 languages around the world [15]. This open-source data set is intended to facilitate the analysis of trends and provide insight into the behaviors driving various events. Information is gathered from a wide range of sources, including major international, national, regional, and local news outlets. In addition, both local services and global news agencies contribute to the platform [16].

We study and compare the perception of the news among four European countries, specifically Germany, France, Spain, and the UK, toward the Israel–Gaza war during the first ten months of the war, from 7 October 2023 to 7 August 2024. To achieve this, we have considered some of the most read and most relevant media in each country that cover a broad spectrum of ideologies and sensitivities. To determine the specific meanings of the different linguistic scales, a baseline is constructed by analyzing the use of the different linguistic terms by the media of each country during the first week of each month from January to September 2023. In this way, this approach goes beyond surface-level interpretations, taking into account the distinct narrative traditions and unique linguistic expressions inherent in each language [14,17].

The following sections of the paper are organized as follows. Section 2 represents the fundamental concepts of the linguistic perceptual maps, perceptual-based distance, and centroid. In Section 3, we present the real case study. We begin by introducing the conflict under analysis, then describe the origin and structure of the data used, and justify the suitability of HLTSs for this analysis. In addition, in this section, we analyze the news coverage and perceptions of the Israel–Gaza war, introduce our methodology, and discuss the results obtained. Finally, the conclusions, challenges, and future research directions are listed in Section 4.

2. Preliminaries

This section includes definitions of key preliminary concepts on HFLTSs and linguistic perceptual maps based on [14] that are necessary for the methodology presented.

Let S be a totally ordered set of *basic linguistic terms* (BLTs), $S = \{s_1, \ldots, s_n\}$, with $s_1 < \cdots < s_n$. We consider the concept of hesitant fuzzy linguistic terms, which represent intervals of consecutive BLTs.

Definition 1 ([11]). *A hesitant fuzzy linguistic term set (HFLTS) over S is a subset of consecutive BLTs of S, i.e.,* $\{x \in S \; s_i \leq x \leq s_j\}$*, for some* $i, j \in \{1, \ldots, n\}$ *with* $i \leq j$.

The non-empty HFLTSs $\{x \in S \; s_i \leq x \leq s_j\}$ are denoted by $[s_i, s_j]$, or $\{s_i\}$ if $i = j$. The set of all non-empty HFLTSs over S is denoted by $\mathcal{H}_S$.

Example 1. *Let S be a totally ordered set of basic linguistic terms with granularity* $n = 4$, $S = \{s_1, s_2, s_3, s_4\}$. *In the linguistic context in which these structures are usually employed, a term can be associated with each basic label, such as* $s_1 =$ *low,* $s_2 =$ *medium,* $s_3 =$ *high and* $s_4 =$ *very high. Non-basic HFLTSs can be associated with other (non-unique) linguistic terms. For instance,* $[s_3, s_4] =$ *considerably high, while* $[s_2, s_3] =$ *not low but not very high.*

In $\mathcal{H}_S$, the *set inclusion* relation ($\subseteq$) provides a partial order. The *connected union* of two HFLTSs is defined as the smallest element of $\mathcal{H}_S \cup \{\emptyset\}$, based on the subset inclusion relation, that contains both HFLTSs. The *connected union* together with the *intersection* provide the set of HFLTSs, $\mathcal{H}_S \cup \{\emptyset\}$, a *lattice structure,* as proven in [14].

Unlike quantitative values (numbers), the meaning of linguistic labels is not always the same and is highly dependent on the context and, above all, on the user's background [18,19]. For this reason, the concept of *a linguistic perceptual map* was introduced in [13] as a normalized measure in the set of HFLTSs. Different users may apply the same linguistic labels according to different perceptual maps. The following definition presents the concept of a linguistic perceptual map into $\mathcal{H}_S$ together with the concept of HFLTSs width.

Definition 2 ([14]). *Let us consider a normalized measure* μ *over S, i.e.,* $\mu : S \to [0, 1]$ *such that* $\sum_{i=1}^{n} \mu(s_i) = 1$. *For any* $s_i \in S$, *we call* $\mu(s_i) \equiv \mu_i$ *the width of the basic label* s_i. *Given* $H = [s_i, s_j] \in \mathcal{H}_S$, *the width of H is* $\mu([s_i, s_j]) \equiv \sum_{k=i}^{j} \mu_k$. *The pair* $(\mathcal{H}_S, \mu)$, *which we also denote as* $\mathcal{H}_{(S,\mu)}$, *is called the linguistic perceptual map.*

Any linguistic perceptual map is uniquely associated with a partition of the interval $[0, 1]$ into n subintervals of lengths $\mu_1, \ldots, \mu_n$ and also with a set of landmarks $\lambda_0 = 0$, $\lambda_1, \ldots, \lambda_{n-1}, \lambda_n = 1$.

Example 2. *In the structure defined in Example 1, let us assume, for instance, that the widths of the basics are* $\mu_1 = \mu_2 = \mu_3 = 0.2$ *and* $\mu_4 = 0.4$, *then* $\mu(\text{'considerably high'}) \equiv \mu([s_3, s_4]) = 0.6$ *and* $\mu(\text{'not low but not very high'}) \equiv \mu([s_2, s_3]) = 0.4$.

Based on the linguistic perceptual map's lattice structure, a *perceptual-based distance* between HFLTSs is defined. This distance will allow us to introduce the concept of a *centroid*.

Definition 3 ([13]). *Let* $\mathcal{H}_{(S,\mu)}$ *be a linguistic perceptual map. Given* $H_1, H_2 \in \mathcal{H}_{(S,\mu)}$, *the perceptual-based distance between* H_1 *and* H_2 *is defined as follows:*

$$D_\mu(H_1, H_2) = 2 \cdot \mu(H_1 \sqcup H_2) - \mu(H_1) - \mu(H_2) \tag{1}$$

In [13], it is proven that this definition is indeed a true distance in $\mathcal{H}_{(S,\mu)}$.

Definition 4 ([13]). *Let $\mathcal{H}_{(S,\mu)}$ be a linguistic perceptual map. Let $\{H_m = [s_{L_m}, s_{R_m}] \in \mathcal{H}_{(S,\mu)} : m \in \{1,\ldots,k\}\}$ be a set of HFLTSs, while the centroid of this set, denoted as H^C, is defined as follows:*

$$H^C = arg \min_{H \in \mathcal{H}_{(S,\mu)}} \sum_{m=1}^{k} D_\mu(H, H_m). \tag{2}$$

In [13], it is proven that a practical method for finding the centroid is to calculate the medians of the left and right indices of all the BLTSs defining the HFLTS.

Example 3. *Let us consider three newspapers that use the three linguistic terms X = 'considerably high', Y = 'low' and Z = 'not low but not very high' to describe a certain event. As we saw in Example 1, these linguistic labels had been assigned the HFLTSs $[s_3, s_4]$,$\{s_1\}$ and $[s_2, s_3]$. The centroid of these HFLTSs is $H^C = [s_2, s_3]$ because 2 is the median of the indices $\{3, 1, 2\}$ and 3 is the median of the indices $\{4, 1, 3\}$. The sum of distances between H^C and X, Y and Z is $D_\mu(H^C, X) + D_\mu(H^C, Y) + D_\mu(H^C, Z) = (\mu_2 + \mu_4) + (\mu_1 + \mu_2 + \mu_3) + 0 = \mu_1 + 2\mu_2 + \mu_3 + \mu_4 = 1.2$. This sum is the minimum among the distances between these three HFLTSs, X, Y and Z and any other HFLTSs. It can be shown that, in fact, the centroid is independent of the values of the widths as long as the elements are all expressed in the same perceptual map.*

To compare linguistic terms represented in different linguistic perceptual maps, this paper adopts the procedure outlined in [14], and utilizes the *common perceptual map* that provides a unified context. Although the common perceptual map usually has a higher granularity, it is an adequate framework to represent, fuse, and compare different expressions of the same linguistic terms.

Definition 5 ([14]). *Let $\mathcal{H}_{(S^m,\mu^m)}, m \in \{1,\cdots,k\}$ be a set of k linguistic perceptual maps. Let $\{\lambda_0^m = 0, \lambda_1^m, \cdots, \lambda_{n_m}^m = 1\}$, for $m \in \{1,\cdots,k\}$, be the sets of landmarks associated with the k partitions. The common perceptual map, $H_{(S^U,\mu^U)}$, is the perceptual map associated with the partition, P_U, with landmarks $\bigcup_{m=1}^{k} \bigcup_{i=0}^{n_m} \{\lambda_i^m\}$. The cardinality of this partition satisfies $N \equiv \#P_U \leq \sum_{m=1}^{k} n_m - 1$.*

Given a set of k linguistic perceptual maps $\mathcal{H}_{(S^m,\mu^m)}, m \in \{1,\cdots,k\}$ and its corresponding common perceptual map $H_{(S^U,\mu^U)}$, the *projection* of basic linguistic terms is defined as follows.

Definition 6 ([14]). *Let $S = \{s_1,\ldots,s_n\}$ be a set of BLTs and $\mathcal{H}_{(S,\mu)}$ be one of the linguistic perceptual maps of the set $\{\mathcal{H}_{(S^m,\mu^m)} \mid m \in \{1,\ldots,k\}\}$. For the sake of simplicity, we will ignore the index m. Let $\mathcal{H}_{(S^U,\mu^U)}$ be the common perceptual map with $N = \#S^U$. The projection function of BLTs is $\pi : S \to \mathcal{H}_{(S^U,\mu^U)}$ defined by $\pi(s_i) = [s_{L_i}^U, s_{R_i}^U] \in \mathcal{H}_{(S^U,\mu^U)}$, holding $\sum_{l=1}^{i-1} \mu_l = \sum_{\alpha=1}^{L_i-1} \mu_\alpha^U$ and $\sum_{l=i+1}^{n} \mu_l = \sum_{\alpha=R_i+1}^{N} \mu_\alpha^U$, for each $i \in \{1,\ldots,n\}$.*

Note that every basic linguistic term s_i divides the unit interval into three parts: $(s_1 \cup \ldots \cup s_{i-1})$ on its left side, s_i itself, and $(s_{i+1} \cup \ldots \cup s_n)$ on its right side. From Definition 6, we see that the projection $\pi(s_i)$ preserves the measures of these three parts (see Figure 1).

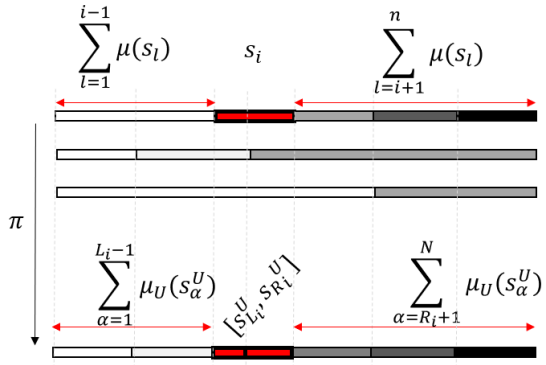

Figure 1. Projection of basic linguistic term s_i from original perceptual map (at the top) onto the common perceptual map (at the bottom).

The following definition extends the projection function from Definition 6 to non-basic HFLTSs through the connected union.

Definition 7 ([14]). *The projection function* $\Pi : \mathcal{H}_{(S,\mu)} \cup \{\emptyset\} \to \mathcal{H}_{(S^U,\mu^U)} \cup \{\emptyset\}$ *associates a HFLTS* $H = [s_i, s_j] \in \mathcal{H}_{(S,\mu)}$ *with the element* $\Pi(H) = \pi(s_i) \sqcup \pi(s_j) = \left[s_{L_i}^U, s_{R_j}^U\right] \in \mathcal{H}_{(S^U,\mu^U)}$. *The empty set* $\Pi(\emptyset) = \emptyset$.

In [14], it was proven that the projection Π constitutes a monomorphism between lattices (which is injective and preserves the lattice operations) and that it also preserves the set inclusion and the preference order relation.

Example 4. *Following the previous examples, let us also consider three newspapers from a different country. To describe the same event considered in Example 3, these three newspapers use the terms* X' = *'between medium and high'*, Y' = *'very high'*, *and* Z' = *'medium'. The respective HFLTSs for these linguistic terms are* $H'_X = [s_2, s_3]$, $H'_Y = \{s_4\}$ *and* $H'_Z = \{s_2\}$. *Let us assume that in this country, a different perceptual map is used:* $\mu_1 = 0.1, \mu_2 = 0.5, \mu_3 = 0.2$ *and* $\mu_4 = 0.2$, *then* $\mu'(H_{X'}) = \mu'([s_2, s_3]) = 0.7, \mu'(H_{Y'}) = \mu'(\{s_4\}) = 0.2$ *and* $\mu'(H_{Z'}) = \mu'(\{s_2\}) = 0.5$. *The centroid of these three news descriptions is* $H'^C = [s_2, s_3]$. *Although the centroid appears to be the same value as the one obtained in Example 3, it is not; this is due to the different perceptual maps used for each country. The common perceptual map is defined by the basics labels* $\{s_1^U, \ldots, s_6^U\}$, *with widths* $\mu_1^U = \mu_2^U = 0.1$, $\mu_3^U = \mu_4^U = \mu_5^U = \mu_6^U = 0.2$. *The projected centroids for the newspapers from the two countries in the common perceptual map are* $\Pi(H^C) = [s_3^U, s_4^U]$ *and* $\Pi(H'^C) = [s_2^U, s_5^U]$.

3. A Comparative Analysis of Media Coverage: A Real Case Study

This section begins with an introduction to the Israel–Gaza conflict and its representation in media coverage. Following this, the methodology, based on the conceptual framework outlined in Section 2, is presented. This methodological approach is used to examine the prevalence of negative sentiment in media coverage of the Israel–Gaza conflict across four European countries: Germany, France, Spain, and the United Kingdom. Finally, the results obtained from these analyses are discussed and compared across the four nations.

3.1. An Overview of Media Coverage of the Israel–Gaza Conflict

The Israel–Gaza conflict is a long-standing and complex geopolitical struggle, primarily taking place between Israel and Palestinian groups—most notably Hamas, which controls the Gaza Strip. The roots of the conflict trace back to the early 20th century, stemming from disputes over Palestinian territory, identity, and sovereignty, particularly

surrounding the creation of Israel in 1948 and the subsequent displacement of Palestinians. The most recent escalation began on 7 October 2023, when Hamas-led militant groups launched a surprise attack on Israel. During this attack, 1195 Israelis and foreign nationals were killed and 251 Israelis and foreigners were taken captive in Gaza. Since the start of the war, more than 40,000 Palestinians in Gaza have lost their lives, and almost all of the Gaza Strip's Palestinian population (around 2.3 million people) have been displaced. The war continues to have significant regional and international repercussions.

The Israel–Gaza war has been extensively covered by media outlets around the world. This coverage comprises a wide variety of perspectives and narratives. The media play an influential role in shaping public views of the Israel–Palestine conflict [4]. The conflict has been extensively shaped, represented, and disseminated through social networks, which play a crucial role in shaping public perception and influencing international responses [20,21]. Zahoor and Sadiq [22] explore the evolution of traditional media coverage of this long-standing conflict in the context of emerging communication technologies, drawing insights through a comprehensive review of the existing literature.

The position of each country in this conflict is strongly influenced by its political interests and the media in those countries generally cover the conflict according to their country's position. In this direction, some analysts argue that media coverage demonstrates a notable imbalance between representations of Israelis and pro-Israel perspectives versus Palestinians and pro-Palestinian viewpoints. This disparity reflects a bias that favors Israeli narratives in certain countries while, conversely, prioritizing Palestinian narratives in others [23,24]. In a recent article published in *The Intercept* [25], a study is presented in which more than 1000 articles from three major newspapers from the United States (*The New York Times*, *Washington Post*, and *Los Angeles Times*) showed a consistent bias against Palestinians.

3.2. Experimental Approach: Methodology

In the present study, our aim is to analyze and compare the negative sentiment in the media of four European countries regarding the Israel–Gaza war. To this end, we used a large-scale news media coverage data set from the GDELT project [15]. The GDELT Project monitors the world's broadcast, print, and web news from nearly every country in more than 100 languages, almost in real-time. The GDELT Project translates articles from these languages into English. It collects data from news sources and other open media from almost every country and uses machine learning and natural language processing to process vast amounts of information that quantify sentiment and emotional content.

GDELT uses predefined dictionaries, such as the *Harvard General Inquirer* or its custom lexicons, to associate words and phrases with emotional or tonal weights. These weights help determine whether the text conveys positivity, negativity, or neutrality. From these dictionaries, it evaluates the sentiment in the context of the article. It produces several metrics: *Positive tone*: The prevalence of words and phrases associated with positive sentiment. *Negative Tone*: The prevalence of terms that reflect negativity. *Overall Tone*: A net score summarizing the general sentiment balance of the article. Focusing on the negative tone instead of the overall tone can be more useful because it highlights potential issues, risks, or areas of concern. Negative tones often signal problems, crises, or dissatisfaction. In texts with both positive and negative tones, the overall score might suggest neutrality or balance, masking the underlying problems. Isolating the negative tone ensures that these concerns are not overlooked. The negative tone, which ranges from 0 to +100, is the percentage of all words in the article that were found to have a negative emotional connotation.

Each news item is associated with a unique negative score, which can be discretized into a finite set of categories or basic labels. This process transforms abstract numerical data into more intuitive and descriptive terms, making the data easier to interpret and understand. By simplifying continuous values into categories like '*low*'. '*medium*', '*high*', and '*very high*', it becomes possible to uncover patterns, trends, or relationships that might be harder to identify in raw numerical form.

The experimental approach considered in this paper is based on a methodology structured around the following seven steps:

Step 1 *Define a baseline of linguistic terms for negative sentiment:* To achieve this, we analyze a prior period of time to establish a baseline across all countries. The negative sentiment of the news from the preceding time period is categorized into a finite and small number of levels.

Step 2 *Deduce countries' linguistic perceptual maps:* For each country, a linguistic perceptual map $\{(\mathcal{H}_{S^m}, \mu^m) \mid m \in 1, \ldots, k\}$ is generated based on the relative frequency with which newspapers in that country align with the defined levels of negative sentiment during the preceding time period. The rationale for assigning distinct linguistic perceptual maps to different countries lies in the variations in how negative language is expressed and perceived across nations.

Step 3 *Obtain a common perceptual map:* Based on the perceptual maps established for each country, $\mathcal{H}_{(S^m,\mu^m)}$, the common perceptual map, $\mathcal{H}_{(S^U,\mu^U)}$, is computed in accordance with Definition 5.

Step 4 *Select articles associated with the topic of interest during the targeted period:* In this step, we identify and filter news articles that reference the topic of interest.

Step 5 Represent the negative sentiment of each news item on its respective country's linguistic perceptual map, and then project it onto the common perceptual map: For each country, the negative sentiment of news items during the defined period is categorized according to its specific linguistic perceptual map. Afterwards, the negative sentiment of the articles is projected onto a common perceptual map, enabling a comparison across countries.

Step 6 *Compute the centroid for each country per day:* Based on Definition 4, for each day within the selected period, we calculate four distinct centroids on the common perceptual map, reflecting the central opinion of each country per day.

Step 7 *Compare negativity in the news among countries:* Since the set of HFLTSs is not totally ordered, we use the distance from the centroid to the most negative label to compare the negativity. For each day, we calculate the distance from each country's centroid to the term in the common perceptual map that has the maximum level of negativity.

3.3. Analysis of Media Coverage of the Israel–Gaza War

We analyze and compare negative news sentiment in Germany, France, Spain, and the UK towards the Israel–Gaza war during the first ten months of the war, from 7 October 2023 to 7 August 2024. To this end, we have considered the following newspapers among the most prominent online newspapers in these countries: *Bild* (bild.de), *Süddeutsche Zeitung* (sueddeutsche.de), *Die Welt* (welt.de), *Frankfurter Allgemeine Zeitung* (faz.net) and *Die Tageszeitung* (taz.de) from Germany; *La Croix* (la-croix.com), *Le Monde* (lemonde.fr), *Les Echos* (lesechos.fr), *Libération* (liberation.fr), *l'Humanité* (humanite.fr), and *Le Figaro* (lefigaro.fr) from France; *ABC* (abc.es), *El Periódico* (elperiodico.com), *La Razón* (larazon.es), *El País* (elpais.com), and *La Vanguardia* (lavanguardia.com) from Spain; *Daily Mail* (dailymail.co.uk), *Independent* (independent.co.uk), *The Guardian* (theguardian.com), *The Telegraph* (telegraph.co.uk), and *BBC* (bbc.co.uk) from the UK. We selected these newspapers due to their robust digital presence on the GDELT platform, ensuring global accessibility and

significant national and international readerships, which enhance their influence as sources of information. These publications represented a wide range of political ideologies, offering diverse perspectives on various issues, including the Israel–Gaza war. They were recognized for their established reputations with regard to their journalistic quality, accuracy, and credibility. Furthermore, these outlets provided comprehensive coverage of topics such as politics, economics, culture, and international affairs, making them representative of broader national and global discourses.

Initially, as stated in Step 1, we defined a baseline of terms for the set of four countries. Using a previous period of time (one week per month from January to September 2023), four labels for the negative tone were considered: '*low*', '*medium*', '*high*' and '*very high*'. The negative tone ranged from 0 to 100. However, the data were highly concentrated in the lower-value range, with 75% of values below 5.63. Using the equal-frequency discretization method, the four labels were defined by the quartiles q_1 = 2.22, q_2 = 3.73, and q_3 = 5.63. For example, a value of 3.2 would correspond to the label '*medium*', while a value of 6.2 would correspond to the label '*very high*'. By construction, each label was assigned 25% of the data. However, due to the heterogeneity among the countries, this proportion did not hold for each country individually. The relative frequencies of the defined labels for each country are presented in Table 1.

Table 1. Relative frequencies of the defined basic linguistic terms for each of the four countries.

Negative Tone	Germany	France	Spain	UK
low	24.1%	18.9%	31.3%	22.9%
medium	22.5%	26.6%	27.9%	23.9%
high	23.8%	29.1%	23.7%	25.5%
very high	29.6%	25.4%	17.1%	27.7%

In accordance with Step 2, these relative frequencies were used to determine the widths of the basic labels on each country's perceptual map. Next, as outlined in Step 3, the common perceptual map was obtained in accordance with Definition 5. The partition associated with the common perceptual map was as follows:

$$\mathcal{H}_{(S^U,\mu^U)} : \{0.0, 0.189, 0.229, 0.241, 0.313, 0.455, 0.466, 0.468, 0.592, 0.703, 0, 723, 0.746, 0.828, 1.0\}.$$

The perceptual maps of the four countries, along with the common perceptual map, are graphically represented in Figure 2. From this figure, it can be noted that, for example, the language used in German newspapers tends to exhibit more extreme negative values than in the rest of the countries. The opposite is true for newspapers in Spain, where the language used exhibits fewer negative values. The measures of the most negative basic linguistic term s_4 are, respectively, $\mu^{Ge}(s_4) = 0.2957$, $\mu^{Fr}(s_4) = 0.254$, $\mu^{Sp}(s_4) = 0.171$ and $\mu^{UK}(s_4) = 0.277$. Note that the cardinals of each country's perceptual map are labelled with the number 4, while the cardinal of the common perceptual map is N = 13 in this case.

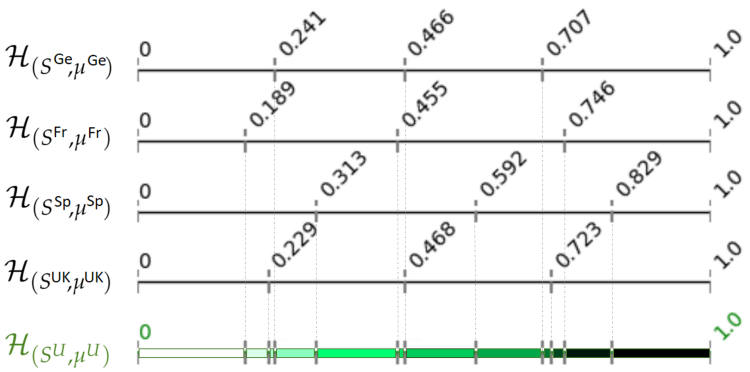

Figure 2. The perceptual maps from each country (defined through its landmarks) and the common perceptual map.

Once the perceptual maps of each country and the common perceptual map were determined, in accordance with Step 4, all articles related to the conflict were collected from all of the considered media sources over a 10-month period, from 7 October 2023, the day the war began, until 7 August 2024, before other countries in the region became involved in the war. In this step, we identified news articles that referenced the topic of interest (with hashtags such as *Palestinian*, *Palestine liberation*, *group Islamic jihad movement in Palestine*, ...), or the names of the actors involved. According to GDELT terminology, an actor can refer to a person (*Netanyahu*, *Yahya Sinwar*, ...), country (*Israel*, *Palestine*), geographic area (*Gaza*, *West Bank*, *Rafah*, *Deir al-Balah*, ...), or organization *(Hamas*, ...) closely associated with the topic. The news articles were then filtered on the basis of either the topic itself or one of these types of actors.

As outlined in Step 5, we mapped the negative sentiment scores of articles pertaining to each country onto their respective linguistic perceptual maps (Figure 3). The labels were then projected onto the common perceptual map. Afterwards, in accordance with Step 6, we calculated the daily centroid for each country within the common perceptual space. Finally, as detailed in the last step of the methodology, we computed the perceptual-based distance of each day and country centroid to the maximum value (s_{13}^{U}) within the common perceptual map (Figure 4). In this way, we were able to numerically compare the negative sentiment of news among countries. When the distance was close to zero, the negative sentiment of the corresponding country was very high.

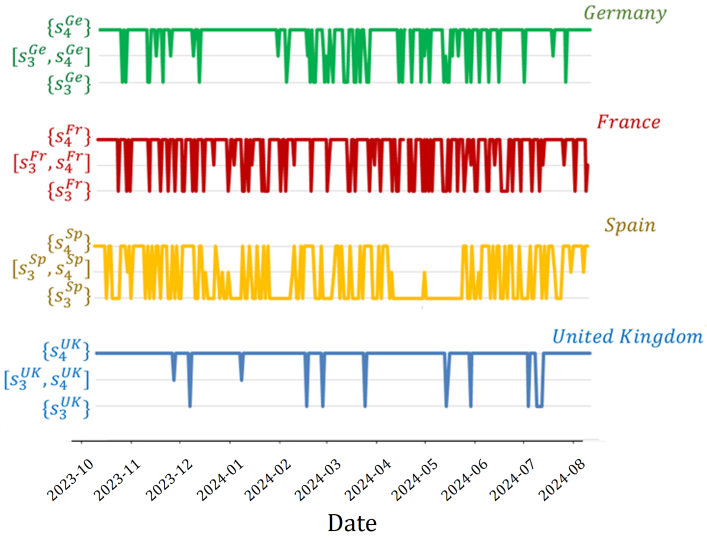

Figure 3. The negative sentiment in the respective linguistic perceptual maps for each day.

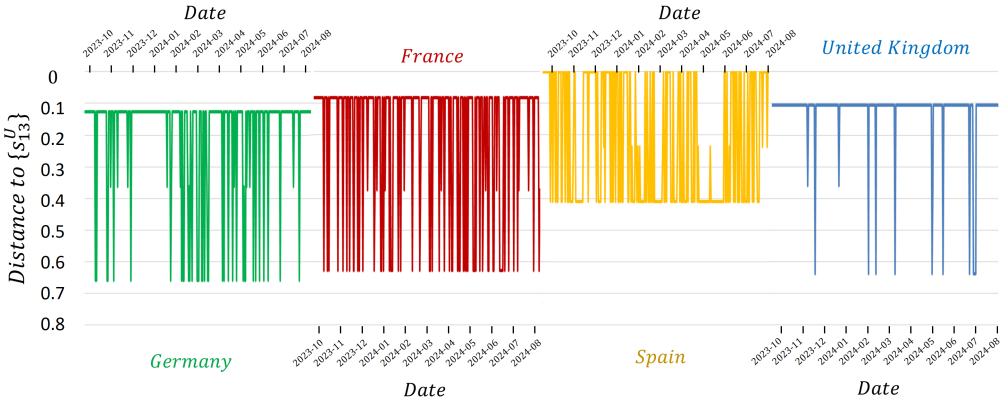

Figure 4. Perceptual-based distance of each daily centroid to the maximum value s_{13}^U within the common perceptual space.

3.4. Discussion

The first observation from Figure 3 is that, for all the media outlets analyzed, perceptions of the conflict are highly negative, as expected. This conclusion is based on the fact that all perceptions correspond to the labels $\{s_3\}$, $[s_3, s_4]$ and $\{s_4\}$, that is, '*high*', '*between high and very high*', and '*very high*'. However, these labels do not have exactly the same meaning in all four countries.

Figure 4 shows the distances of each daily centroid from the maximum value s_{13}^U within the common perceptual space. In addition, it illustrates how the meaning of labels changes between countries. For example, the label s_4^{Sp} in Spain is more negative than the corresponding s_4 labels in other countries.

Although Figure 3 might suggest that the UK media outlets are more negative than those of other countries, the common perceptual map reveals that the UK only has the most negative sentiment toward the conflict on 14.71% of the days. In contrast, Spain leads with the highest percentage of days (44.12%) showing the most negative perception, followed by France with 40.52%. Germany, meanwhile, stands out on only two days (24 November 2023, and 8 July 2024) as the country with the highest negative sentiment among those analyzed, but it is also the country that shows the lowest negative sentiment on the greatest number of days. These results are summarized in Figure 5, where the distribution of negative sentiment rankings among the four countries during the Israel–Gaza war is represented.

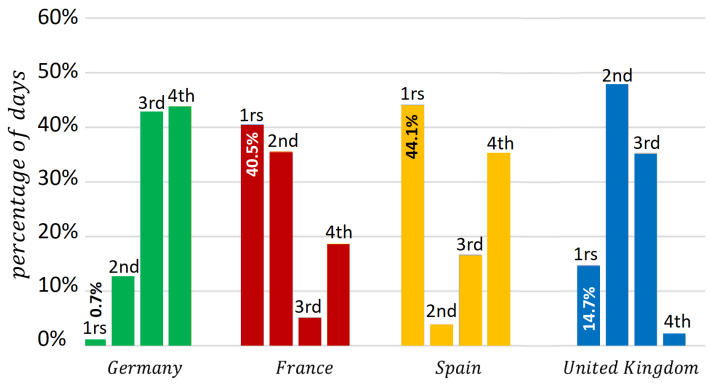

Figure 5. Order distribution of negative sentiment of the countries from 7 October 2023 to 7 August 2024.

For each day during this period, the countries were ranked based on their levels of negative sentiment. The columns labeled "1st" represent the percentage of days on which each country recorded the highest negativity, with higher percentages indicating more frequent spikes in negative sentiment. As previously noted, Spain was most frequently

ranked first, indicating that it experienced the highest negativity on the majority of the days. However, Spain also had a significant number of days on which it was in the last position in the ranking. France showed a balanced distribution between the first and second positions, reflecting fluctuating but notable levels of negativity. The UK exhibited moderate rankings, frequently placing in the second and third positions, suggesting a consistent pattern. Finally, Germany was predominantly ranked in the third and fourth positions, indicating relatively lower levels of negative sentiment.

Finally, a sample of the results presented in Figures 3 and 4 is illustrated in Figure 6. For each country, Figure 6 shows the distances of the centroid from the value of the maximum negative sentiment in the common perceptual map during a ten-day period in January 2024.

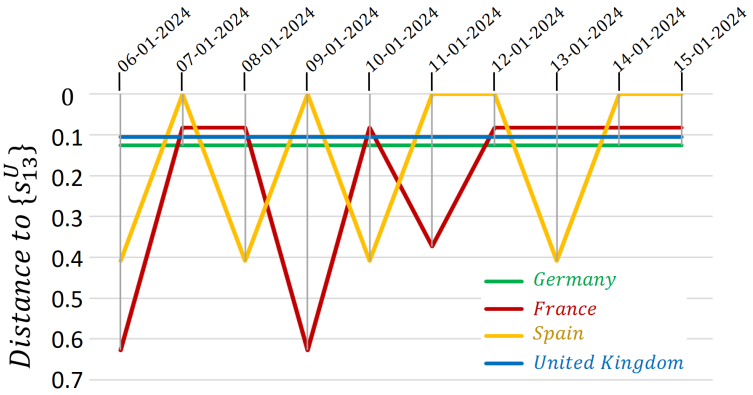

Figure 6. An example of the distances from the maximum negative value in the common perceptual map, recorded from 6 January to 15 January 2024.

Figure 6 offers insights into the varying levels of negativity among the countries, highlighting differences reflected in the news coverage of the war. The figure clearly shows that Spain and France have the greatest variability in their negativity, as opposed to Germany and the United Kingdom. Finally, note that on the majority of days during this ten-day period, Spain exhibited the most negative sentiment (on six out of ten days), followed by France (three days) and the UK (one day).

4. Conclusions and Future Research

A methodology for aggregating opinions from international newspapers is presented, along with its application to a real case study. The real case study involves an analysis of negative opinions in news coverage from four European countries, specifically Germany, France, Spain and the UK, regarding the Israel–Gaza war.

This article's primary technical contribution to HFLTSs lies in the proposed methodology, which builds upon and enhances the approach in [14] by establishing a baseline from which the linguistic perceptual map of negative sentiment in each country can be induced. To the best of the authors' knowledge, this is the first study to employ unbalanced linguistic scales to define distinct linguistic perceptual maps that differentiate news sentiment across countries. Compared to existing studies [4,5,25], this approach accounts for the unique narrative tendencies and linguistic expressions inherent in each country, facilitating a comparative analysis of negative news coverage of the Israel–Gaza war across four European countries. The results show that there are relevant differences in negative sentiment among countries towards this ongoing conflict, with Spain conveying the most negative sentiment.

Future research will focus on four key directions. First, we aim to automate the extraction of linguistic perceptual maps for each country using deep learning and other machine learning techniques. Second, we recognize that the results of the real case presented relied on the accuracy of the negative tone values provided by the GDELT Project. In the future,

we plan to obtain these tone values through other sentiment analysis methods and compare the results. Third, we intend to analyze and compare the degree of consensus within each country to evaluate the level of polarization in news coverage across nations. Finally, we will expand our analysis to include data that span the entire length of the Israel–Gaza conflict in order to gain deeper insights into the evolving sentiment toward the conflict.

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