Using qualitative reasoning to compare media coverage of Israel-Gaza war

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Abstract. In this study, we present a methodology based on absolute orders-of-magnitude qualitative reasoning to aggregate and compare news from diverse sources. Our approach integrates linguistic scales to enhance the comprehension of different perceptions and attitudes. We conduct a comparative analysis of news coverage across European countries with respect to the Israel-Gaza war, aiming to capture the sensitivity towards this ongoing conflict.

1 Introduction

News is core information to manage and influence citizens' opinions and interests. In this direction, the news that appears in newspapers on various conflicts and crisis around the world, model citizens' knowledge and perspectives. However, concerning the same event, different opinions are expressed in different contexts. In this article, the information in terms of sentiment is analysed and compared from the perspective of different European countries.

We consider a large-scale news media coverage data set collected by the GDELT (Global Data on Events, Location, and Tone) Project. GDELT covers news media in over 100 languages from the whole world [5]. The data is open-source and is designed to provide a means of analyzing trends and better understand the behaviours behind different types of events. The events are collected from major international, national, regional, and local news sources. Local services and global news agencies also contribute to this platform.

In this paper we represent sentiment tone in a linguistic ordinal scale with unbalanced terms to capture the interest and emotions on the on-line news with respect to the Israel-Gaza war. Traditional qualitative reasoning models address diverse perspectives, such as individual opinion representation and the qualitative fusion of opinions to capture group consensus [4, 11]. These models have advanced within linguistic computation and are particularly applied in contexts where understanding people's emotions or sentiments is of interest [2, 3, 12].

We study and compare news perception among four European countries, specifically, the UK, Germany, France and Spain, towards the Israel-Gaza war during the first 143 days of the war, from 7th October, 2023 to 26th February, 2024. In particular, in this preliminary study, we have considered the following newspapers: 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 UK.

We consider that the linguistic scales used have a different meaning for each country, and even so, we will be able to aggregate all this information to obtain a global sentiment value and a real comparison between the different sensitivities of countries regarding the war between Israel and Gaza, beyond appearances, due to the different traditions in narrative and the linguistic expressions unique to each language ([7], [8]).

An automated methodology which aggregates and compares news sentiment across countries' is defined based on sentiment analysis and perceptual maps.

The reminder of the paper is organized as follows. Section 2 contains the basic concepts of linguistic perceptual maps, centroid and degree of consensus. Then, in Section 3, we delve into the real case study, analyzing news perceptions of the Israel-Gaza war. We introduce our methodology and discuss the results we obtained. Finally, conclusions, challenges and future research directions are drawn in Section 4.

2 Preliminaries

This section contains the definitions of some preliminary concepts on linguistic perceptual maps based on [1] 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 $s_1 < \ldots < s_n$ and we consider the concept of hesitant linguistic terms, which encompasses the intervals of consecutive BLTs.

Definition 1 *A hesitant linguistic term (HLT)* 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 $i \leq j$. For completeness, the empty set $\{\} = \emptyset$ is also considered as a HLT and it is called the *empty HLT*.

The non-empty HLTs $\{x \in S \,|\, s_i \leq x \leq s_j\}$ are denoted by $[s_i, s_j]$. If $i = j$, $[s_i, s_i]$ is the singleton $\{s_i\}$. The set of all non-empty HLTs over S is denoted by $\mathcal{H}_S$, that is, $\mathcal{H}_S = \{[s_i, s_j] : i, j \in \{1, \ldots, n\}, i \leq j\}$. In this way, the set of all HLTs over S is $\mathcal{H}_S \cup \{\emptyset\}$.

Example 1 Let S be a totally ordered set of basic linguistic terms with granularity $n = 4$, $S = \{s_1, s_2, s_3, s_4\}$ being s_1 =*low*, s_2 =*medium*, s_3 =*high* and s_4 =*very high*. Given the negative sentiments corresponding to the news of three different newspapers from the same country in a specific day, A = *considerably high*, B = *low*, and C = *not low but not very high*, their respective HLT can be represented as $H_A = [s_3, s_4]$, $H_B = \{s_1\}$ and $H_C = [s_2, s_3]$.

In $\mathcal{H}_S$, the *set inclusion* relation ($\subseteq$) provides a partial order. The connected union of two HLTs is defined as the least element of $\mathcal{H}_S \cup \{\emptyset\}$, based on the subset inclusion relation $\subseteq$, that contains both HLTs. The connected union together with the intersection provide to the set of HLTs, $\mathcal{H}_S \cup \{\emptyset\}$, a *lattice structure*, as proven in [8].

Unlike quantitative values (numbers), the meaning of linguistic labels is not always the same and depends greatly on the context and, above all, on the user's background [6]. For this reason, the concept of *linguistic perceptual map* was introduced in [10] as a normalized measure in the set of HLTs. Different users may handle the same linguistic labels but different perceptual maps.

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. The following definition extends to $\mathcal{H}_S$ the concept of width.

Definition 2 Given $H = [s_i, s_j] \in \mathcal{H}_S$, then the *width* of H is $\mu([s_i, s_j]) \equiv \sum_{k=i}^{j} \mu_k$. The pair $(\mathcal{H}_S, \mu)$, that we also denote as $\mathcal{H}_{(S,\mu)}$, is called *linguistic perceptual map.*

Any linguistic perceptual map is uniquely associated with a partition of the interval $[0, 1]$ into n sub-intervals of lengths $\mu_1, \ldots, \mu_n$ and also with a set of landmarks $\lambda_0 = 0, \lambda_1, \ldots, \lambda_{n-1}, \lambda_n = 1$. The relationship between the landmarks and the width of the basic linguistic labels is $\lambda_m = \sum_{i=1}^{m} \mu_i$ and $\mu_m = \lambda_m - \lambda_{m-1}$, for any $m = 2, ...n$ and $\mu_1 = \lambda_1$.

To compare linguistic terms expressed in different linguistic perceptual maps, in this paper, following the procedure introduced in [1], we consider the common perceptual map that provides a unified context. Although the common perceptual map usually has a higher granularity, it is the adequate framework to represent, fuse and compare different expressions of the same linguistic terms.

Definition 3 Let $\mathcal{H}_{(S^m,\mu^m)}, m \in \{1, \cdots, k\}$ a set of k linguistic perceptual maps. Let $\{\lambda_0^m = 0, \lambda_1^m, \cdots, \lambda_{n_m}^m = 1\}$, for $m \in \{1, \cdots, k\}$, the sets of landmarks of the k partitions associated. The *common perceptual map,* $H_{\left(S^U,\mu^U\right)}$, is the linguistic perceptual map associated to the partition, P_U, of landmarks $\bigcup_{m=1}^{k} \bigcup_{i=0}^{n_m} \{\lambda_i^m\}$. The cardinality of this partition satisfies $N \equiv \#P_U \leq \sum_{m=1}^{k} n_m - 1$.

In addition, based on the linguistic perceptual maps lattice structure, a perceptual-based distance between HLTs is defined. This distance will allow us to introduce the concept of centroid.

Definition 4 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:

$$D_\mu(H_1, H_2) = 2 \cdot \mu(H_1 \sqcup H_2) - \mu(H_1) - \mu(H_2) \qquad (1)$$

Example 2 Considering the same three newspapers from Example 1, let's assume that in their country $\mu(s_1) = 0.22, \mu(s_2) = 0.24, \mu(s_3) = 0.26, \mu(s_4) = 0.28$. According to Equation (1), the distances between A, B and C are $D_\mu(H_A, H_B) = 2 \cdot \mu(H_A \sqcup H_B) - \mu(H_A) - \mu(H_B) = 2 \cdot 1 - 0.54 - 0.22 = 1.24$, $D_\mu(H_A, H_C) = 2 \cdot \mu(H_A \sqcup H_C) - \mu(H_A) - \mu(H_C) = 2 \cdot 0.78 - 0.54 - 0.5 = 0.52$ and $D_\mu(H_B, H_C) = 2 \cdot \mu(H_B \sqcup H_C) - \mu(H_B) - \mu(H_C) = 2 \cdot 0.72 - 0.22 - 0.5 = 0.72$.

In [10] it is proved that this definition is indeed a distance in $\mathcal{H}_S$. The centroid of a set of HLTs is introduced in order to obtain a collective opinion.

Definition 5 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 HLTs, the *centroid of this set,* denoted as H^C, is defined as:

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

In [10], it was proved that the centroid can be any term from the set:

$$\{[s_L, s_R] \in \mathcal{H}_{(S,\mu)} \mid L \in \mathbb{M}(L_1, \cdots, L_k), \qquad (3)$$

$$R \in \mathbb{M}(R_1, \cdots, R_k), L \leq R\}$$

where $\mathbb{M}()$ is the set that contains just the median if k is an odd number or the set of two central values and any integer number between them if k is even.

Example 3 Following Examples 1 and 2, the centroid of the three newspapers' negative sentiments is: $H^C = [s_2, s_3]$. Note that, since $H_A = [s_3, s_4]$, $H_B = \{s_1\}$ and $H_C = [s_2, s_3]$, 2 is the median of the set of three left-hand indexes $\{1, 2, 3\}$ and 3 is the median of the set of three right-hand indexes $\{1, 3, 4\}$.

On the other hand, given a set of k linguistic perceptual maps $\{\mathcal{H}_{(S^m,\mu^m)} \mid m \in \{1, ..., k\}\}$ and its corresponding common perceptual map $\mathcal{H}_{(S^U,\mu^U)}$, the projection of basic linguistic terms is defined in the following way.

Definition 6 Let $S = \{s_1, ..., s_n\}$ be a set of BLTs and $\mathcal{H}_{(S,\mu)}$ be one of the linguistic perceptual maps from the set $\{\mathcal{H}_{(S^m,\mu^m)} \mid m \in \{1, ..., k\}\}$ in which, for the sake of simplicity, we avoid 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 $i \in \{1, \ldots, n\}$.

Definition 7 Let $S = \{s_1, \ldots, s_n\}$ be a set of BLTs and $\mathcal{H}_{(S,\mu)}$ be one of the linguistic perceptual maps from the set $\{(\mathcal{H}_{(S^m,\mu^m)} \mid m \in \{1, ..., k\}\}$. Let $S^U = \{s_m^U \mid m \in \{1, \ldots, N\}\}$ and let $\mathcal{H}_{(S^U,\mu^U)}$ denote the common perceptual map. The *projection function* $\Pi : \mathcal{H}_{(S,\mu)} \cup \{\emptyset\} \to \mathcal{H}_{(S^U,\mu^U)} \cup \{\emptyset\}$ associates to a HLT $H = [s_i, s_j] \in \mathcal{H}_{(S,\mu)}$, the element $\Pi(H) = \pi(s_i) \sqcup \pi(s_j) = \left[s_{L_i}^U, s_{R_j}^U\right] \in \mathcal{H}_{(S^U,\mu^U)}$. For the empty set $\Pi(\emptyset) = \emptyset$.

This projection function extends the previous definition to non-basic HLTs.

3 A comparative study of news perception

In this section we study and compare news perception among four European countries, specifically, the UK, Germany, France and Spain, towards the Israel-Gaza war using the concepts presented in Section 2. The data set for this case is gathered from the GDELT data set [5].

In GDELT data set, the tone for an article is described in terms of six emotional dimensions: the average tone of the article, the positive score, negative score, percentage of words found in the tonal dictionary, percentage of active words, and percentage of self/group reference [9].

Although describing emotions would be more accurate by considering multidimensionality, this preliminary study specifically focuses on the negative score. The negative score represents the percentage of words conveying a negative emotional connotation. We have selected this dimension because negativity was the prevailing emotion in the tone of news during the specified period, from October 7th, 2023, to February 26th, 2024. This is largely attributed to the negative impact of the war on the news sentiment presented in European newspapers.

3.1 Methodology

The methodology of the use case follows seven steps:

1. *Define a baseline of linguistic terms for negative sentiment:* To do so we consider a previous period of time to define a baseline considering all the countries. We discretize the negative sentiment during this period and assign four levels of linguistic terms for the negative sentiment: "Low", "Medium", "High", and "Very high". Note that in this preliminary work, we have used a one-week period to establish the baseline. However, extending this period could be beneficial for capturing a broader range of sentiment nuances.
2. *Deduce countries' linguistic perceptual maps:* For each country, the linguistic perceptual map $\{(\mathcal{H}_{S^m}, \mu^m) \mid m \in 1, \ldots, k\}$ is calculated based on the relative frequency with which newspapers within the country were associated with the four defined levels of negative sentiment. The motivation for assigning distinct linguistic perceptual maps to different countries lies in the varying usage of negative words across those countries.
3. *Obtain Common Perceptual Map:* From the perceptual maps determined for each country, $\mathcal{H}_{(S^m,\mu^m)}$, the common perceptual map, $\mathcal{H}_{(S^U,\mu^U)}$ is calculated following Definition 3. The landmarks in the common perceptual map are renamed $\{\lambda_0, \lambda_1, ..., \lambda_N\}$ for ease of reference and computation.
4. *Select articles associated with the concerned topic during the target period of time:* In this step, news referencing the concerned topic or actors involved are identified. Following GDELT terminology, an actor can be a person, country, geographical area, or organization closely related to the topic. News are filtered for either the topic or one of these types of actors.
5. *Represent their negative sentiment in its own linguistic perceptual map, and project it to the common perceptual map:* For each country, articles' negative sentiment during the defined period is represented in the specific linguistic perceptual map as "Low", "Medium", "High", or "Very high". Then we project articles' negative sentiment to the common perceptual map.
6. *Compute the centroid for each country per day:* For each day during the selected period, we compute, in the common scale, four different centroids corresponding to the central opinion of each country following Definition 5.
7. *Compare the news negativeness among countries:* For each day we compute the distances from each country centroid to the term in the common scale that has the maximum level of negativeness. Then we compare the results to analyze which country has the strongest level of negativeness per day during the period.

3.2 Results

Articles were collected for a time period of 143 days, since October 7th, 2023, the day in which Israel attack started, to February 26th, 2024. GDELT Project translates into English those articles that were written in other languages.

Previously, as explained in the methodology, we define a baseline of linguistic terms considering all countries. The period considered was before the start of the war, specifically from 1st to 7th September, 2023. We discretized the negative sentiment during this period considering the most important newspapers of each country to determine the quartiles (see Table 1). In Table 2, the distribution of the four levels of linguistic terms for the negative sentiment: "Low", "Medium", "High", and "Very high" are presented.

Table 1. Set of thresholds obtained from 1st to 7th September, 2023

min	0
q_1	2.25
q_2	3.73
q_3	5.58
max	23.8

The perceptual map landmarks are calculated from the relative frequency of newspapers within the country associated with the four defined levels of negative sentiment. These relative frequencies determine the widths of the basic labels in the country's perceptual map.

Table 2. Distribution of the linguistic terms in the four countries.

Negative Tone	Germany	France	Spain	UK
Low	25%	20%	30%	22%
Medium	21%	30%	28%	24%
High	24%	26%	25%	26%
Very high	30%	24%	17%	28%

For each country, we use the relative frequency of the levels of negative sentiment (see Table 2) to define the landmarks in the partition associated with the linguistic perceptual map. The corresponding partitions of the unit interval, and their resulting perceptual maps, are the following for Germany (1), France (2), Spain (3), and the United Kingdom (4), respectively:

$$\mathcal{H}_{(S^1,\mu^1)} : \{0.0, 0.250, 0.462, 0.698, 1.0\};$$
$$\mathcal{H}_{(S^2,\mu^2)} : \{0.0, 0.204, 0.496, 0.757, 1.0\};$$
$$\mathcal{H}_{(S^3,\mu^3)} : \{0.0, 0.303, 0.585, 0.829, 1.0\};$$
$$\mathcal{H}_{(S^4,\mu^4)} : \{0.0, 0.220, 0.457, 0.719, 1.0\}.$$

Note that, for example, the language used in German newspapers tends to exhibit more extreme negative values than in the rest of the countries.

Next, the common perceptual map is obtained following Definition 4. The partition associated with the common perceptual map is:

$$\mathcal{H}_{(S^U,\mu^U)} :$$
$$\{0.0, 0.204, 0.220, 0.205, 0.303, 0.457, 0.462, 0.496, 0.585,$$
$$0.698, 0, 719, 0.757, 0.829, 1.0\}.$$

Note that the cardinals of S^1, S^2, S^3 and S^4 are equal to 4 in all countries, while the cardinal of S^U is $N = 13$ in this case.

Then, we calculate a centroid per each day and country within the common perceptual map. Finally, we compute their distances to the maximum value of the common perceptual map, i.e. s_{13}^U to numerically compare the negative sentiment of news among countries.

When comparing per each day distances to s_{13}^U among countries, the results show that there are significant differences among them. In the 56.5% of days during the period, Spain is the country with the most negative sentiment towards the war. In the 37% of days during the period, France is the country with the most negative sentiment towards the war. In the 5,8% of days during the period, United Kingdom is the country with the most negative sentiment towards the war. Only in one day during the period, Germany is the country with the most negative sentiment towards the war. It is noteworthy that this day, November 24th, 2023, marked the first day of the ceasefire in the war. As part of the agreement between Israel and Hamas, Hamas released 39 hostages, while Israel released 24 hostages on that day.

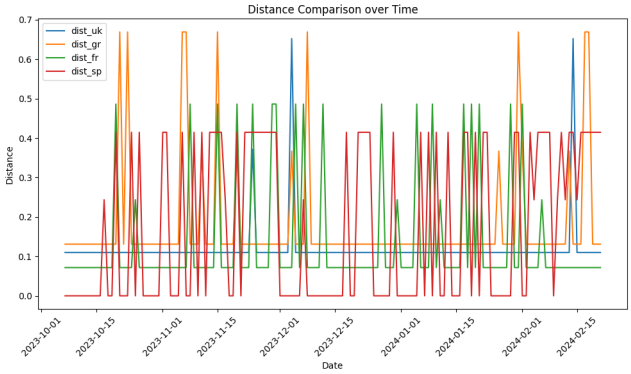

Figure 1. The distance to the maximum value of the common perceptual map per day cross all four countries during the first 143 days of the war.

Finally, for each country, we have computed the centroid corresponding to the complete period of time. Table 3 shows the centroids for each country computed in their respective linguistic perceptual maps, together with their expressions in the common perceptual map.

Table 3. Distribution of the sentiment centroids in their original perceptual maps and in the common perceptual map.

Centroids	Spain	France	UK	Germany
original maps	$\{s_4\}$	$\{s_4\}$	$\{s_4\}$	$\{s_4\}$
common map	$\{s_{13}^U\}$	$[s_{12}^U, s_{13}^U]$	$[s_{11}^U, s_{13}^U]$	$[s_{10}^U, s_{13}^U]$

Note that, considering the complete period of time, the top negative score s_4 is obtained for all the countries in their original linguistic perceptual map. However, in the common perceptual map, Spain is the only country among these four, that expresses the most significantly negative sentiment (the top negative score s_{13}^U).

4 Conclusions and future research

In this paper we present a methodology to aggregate sentiment coming from international newspapers. Unbalanced linguistic scales are considered to define different linguistic perceptual maps to characterize sentiment from news. We present a use case study focused on analyzing the negative sentiment of news coming from four European countries about the Israel-Gaza war. We conduct a comparative analysis of news coverage across European countries with respect to the Israel-Gaza war, aiming to capture the negative sentiment towards this ongoing conflict.

Results show that there are differences in the negative sentiment among countries, where Spain is the country with the most negative sentiment not only considering the sentiment day by day but also all the period at once.

As a future work, we plan to study and compare the degree of consensus within each country as a measure of the existing polarization within news in each country. From the application point of view, we plan to consider data from the entire period of the Israel-Gaza war to study the dynamic evolution of sentiment towards the war. On the other hand, we plan to perform a multidimensional study taking into account the six emotional dimensions provided by GDELT.

Acknowledgements. This research has been partially supported by the PERCEPTIONS Research Project (PID2020-114247GB-I00), funded by the Spanish Ministry of Science and Information Technology.

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